SQLAlchemy Documentation

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Contents

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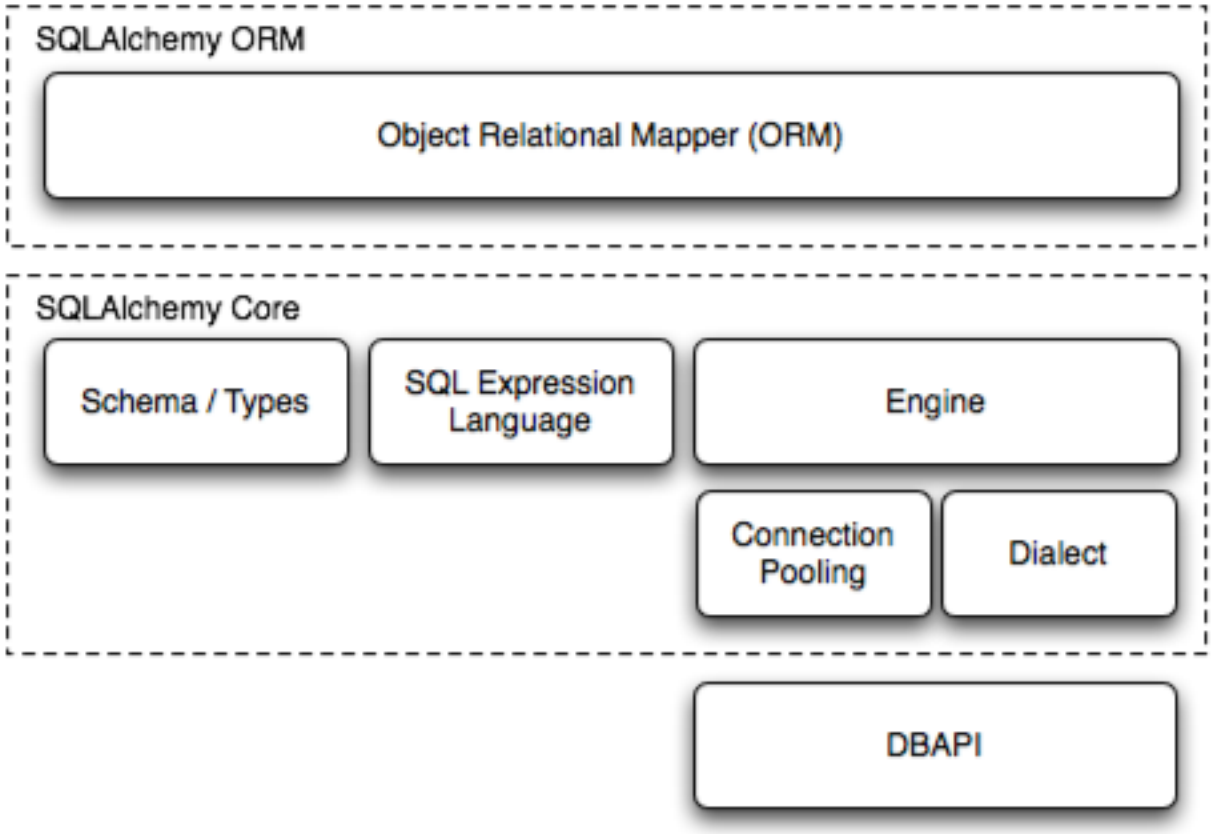
CHAPTER 1

Overview

The SQLAlchemy SQL Toolkit and Object Relational Mapper is a comprehensive set of tools for working with databases and Python. It has several distinct areas of functionality which can be used individually or combined together. Its major components are illustrated in below, with component dependencies organized into layers:



Above, the two most significant front-facing portions of SQLAlchemy are the **Object Relational Mapper** and the **SQL Expression Language**. SQL Expressions can be used independently of the ORM. When using the ORM, the SQL Expression language remains part of the public facing API as it is used within object-relational configurations and queries.

1.1 Documentation Overview

The documentation is separated into three sections: *SQLAlchemy ORM*, *SQLAlchemy Core*, and *Dialects*.

In *SQLAlchemy ORM*, the Object Relational Mapper is introduced and fully described. New users should begin with the *Object Relational Tutorial*. If you want to work with higher-level SQL which is constructed automatically for you, as well as management of Python objects, proceed to this tutorial.

In *SQLAlchemy Core*, the breadth of SQLAlchemy's SQL and database integration and description services are documented, the core of which is the SQL Expression language. The SQL Expression Language is a toolkit all its own, independent of the ORM package, which can be used to construct manipulable SQL expressions which can be programmatically constructed, modified, and executed, returning cursor-like result sets. In contrast to the ORM's domain-centric mode of usage, the expression language provides a schema-centric usage paradigm. New users should begin here with *SQL Expression Language Tutorial*. SQLAlchemy engine, connection, and pooling services are also described in *SQLAlchemy Core*.

In *Dialects*, reference documentation for all provided database and DBAPI backends is provided.

1.2 Code Examples

Working code examples, mostly regarding the ORM, are included in the SQLAlchemy distribution. A description of all the included example applications is at *Examples*.

There is also a wide variety of examples involving both core SQLAlchemy constructs as well as the ORM on the wiki. See Theatrum Chemicum.

1.3 Installation Guide

1.3.1 Supported Platforms

SQLAlchemy has been tested against the following platforms:

- cPython since version 2.4, through the 2.xx series
- cPython version 3, throughout all 3.xx series
- Jython 2.5 or greater
- Pypy 1.5 or greater

1.3.2 Supported Installation Methods

SQLAlchemy supports installation using standard Python "distutils" or "setuptools" methodologies. An overview of potential setups is as follows:

- **Plain Python Distutils** - SQLAlchemy can be installed with a clean Python install using the services provided via Python Distutils, using the `setup.py` script. The C extensions as well as Python 3 builds are supported.
- **Standard Setuptools** - When using setuptools, SQLAlchemy can be installed via `setup.py` or `easy_install`, and the C extensions are supported. setuptools is not supported on Python 3 at the time of of this writing.
- **Distribute** - With distribute, SQLAlchemy can be installed via `setup.py` or `easy_install`, and the C extensions as well as Python 3 builds are supported.

- **pip** - pip is an installer that rides on top of `setuptools` or `distribute`, replacing the usage of `easy_install`. It is often preferred for its simpler mode of usage.

Note: It is strongly recommended that either `setuptools` or `distribute` be installed. Python's built-in `distutils` lacks many widely used installation features.

1.3.3 Install via easy_install or pip

When `easy_install` or `pip` is available, the distribution can be downloaded from Pypi and installed in one step:

```
easy_install SQLAlchemy
```

Or with pip:

```
pip install SQLAlchemy
```

This command will download the latest version of SQLAlchemy from the Python Cheese Shop and install it to your system.

1.3.4 Installing using setup.py

Otherwise, you can install from the distribution using the `setup.py` script:

```
python setup.py install
```

1.3.5 Installing the C Extensions

SQLAlchemy includes C extensions which provide an extra speed boost for dealing with result sets. Currently, the extensions are only supported on the 2.xx series of cPython, not Python 3 or Pypy.

setup.py will automatically build the extensions if an appropriate platform is detected. If the build of the C extensions fails, due to missing compiler or other issue, the setup process will output a warning message, and re-run the build without the C extensions, upon completion reporting final status.

To run the build/install without even attempting to compile the C extensions, pass the flag `--without-cextensions` to the `setup.py` script:

```
python setup.py --without-cextensions install
```

Or with pip:

```
pip install --global-option='--without-cextensions' SQLAlchemy
```

Note: The `--without-cextensions` flag is available **only** if `setuptools` or `distribute` is installed. It is not available on a plain Python `distutils` installation. The library will still install without the C extensions if they cannot be built, however.

1.3.6 Installing on Python 3

SQLAlchemy ships as Python 2 code. For Python 3 usage, the `setup.py` script will invoke the Python `2to3` tool on the build, plugging in an extra "preprocessor" as well. The 2to3 step works with Python distutils (part of the standard Python install) and Distribute - it will **not** work with a non-Distribute setuptools installation.

1.3.7 Installing a Database API

SQLAlchemy is designed to operate with a DB-API implementation built for a particular database, and includes support for the most popular databases. The current list is at *Supported Databases*.

1.3.8 Checking the Installed SQLAlchemy Version

This documentation covers SQLAlchemy version 0.7. If you're working on a system that already has SQLAlchemy installed, check the version from your Python prompt like this:

```
>>> import sqlalchemy
>>> sqlalchemy.__version__
0.7.0
```

1.4 0.6 to 0.7 Migration

Notes on what's changed from 0.6 to 0.7 is available at `changelog/migration_07`.

CHAPTER 2

SQLAlchemy ORM

Here, the Object Relational Mapper is introduced and fully described. If you want to work with higher-level SQL which is constructed automatically for you, as well as automated persistence of Python objects, proceed first to the tutorial.

2.1 Object Relational Tutorial

The SQLAlchemy Object Relational Mapper presents a method of associating user-defined Python classes with database tables, and instances of those classes (objects) with rows in their corresponding tables. It includes a system that transparently synchronizes all changes in state between objects and their related rows, called a unit of work, as well as a system for expressing database queries in terms of the user defined classes and their defined relationships between each other.

The ORM is in contrast to the SQLAlchemy Expression Language, upon which the ORM is constructed. Whereas the SQL Expression Language, introduced in *SQL Expression Language Tutorial*, presents a system of representing the primitive constructs of the relational database directly without opinion, the ORM presents a high level and abstracted pattern of usage, which itself is an example of applied usage of the Expression Language.

While there is overlap among the usage patterns of the ORM and the Expression Language, the similarities are more superficial than they may at first appear. One approaches the structure and content of data from the perspective of a user-defined domain model which is transparently persisted and refreshed from its underlying storage model. The other approaches it from the perspective of literal schema and SQL expression representations which are explicitly composed into messages consumed individually by the database.

A successful application may be constructed using the Object Relational Mapper exclusively. In advanced situations, an application constructed with the ORM may make occasional usage of the Expression Language directly in certain areas where specific database interactions are required.

The following tutorial is in doctest format, meaning each >>> line represents something you can type at a Python command prompt, and the following text represents the expected return value.

2.1.1 Version Check

A quick check to verify that we are on at least **version 0.7** of SQLAlchemy:

```
>>> import sqlalchemy
>>> sqlalchemy.__version__
0.7.0
```

2.1.2 Connecting

For this tutorial we will use an in-memory-only SQLite database. To connect we use `create_engine()`:

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite:///:memory:', echo=True)
```

The `echo` flag is a shortcut to setting up SQLAlchemy logging, which is accomplished via Python's standard `logging` module. With it enabled, we'll see all the generated SQL produced. If you are working through this tutorial and want less output generated, set it to `False`. This tutorial will format the SQL behind a popup window so it doesn't get in our way; just click the "SQL" links to see what's being generated.

The return value of `create_engine()` is an instance of `Engine`, and it represents the core interface to the database, adapted through a **dialect** that handles the details of the database and DBAPI in use. In this case the SQLite dialect will interpret instructions to the Python built-in `sqlite3` module.

The `Engine` has not actually tried to connect to the database yet; that happens only the first time it is asked to perform a task against the database. We can illustrate this by asking it to perform a simple SELECT statement:

```
>>> engine.execute("select 1").scalar()
select 1
()
1
```

As the `Engine.execute()` method is called, the `Engine` establishes a connection to the SQLite database, which is then used to emit the SQL. The connection is then returned to an internal connection pool where it will be reused on subsequent statement executions. While we illustrate direct usage of the `Engine` here, this isn't typically necessary when using the ORM, where the `Engine`, once created, is used behind the scenes by the ORM as we'll see shortly.

2.1.3 Declare a Mapping

When using the ORM, the configurational process starts by describing the database tables we'll be dealing with, and then by defining our own classes which will be mapped to those tables. In modern SQLAlchemy, these two tasks are usually performed together, using a system known as *Declarative*, which allows us to create classes that include directives to describe the actual database table they will be mapped to.

Classes mapped using the Declarative system are defined in terms of a base class which maintains a catalog of classes and tables relative to that base - this is known as the **declarative base class**. Our application will usually have just one instance of this base in a commonly imported module. We create the base class using the `declarative_base()` function, as follows:

```
>>> from sqlalchemy.ext.declarative import declarative_base

>>> Base = declarative_base()
```

Now that we have a "base", we can define any number of mapped classes in terms of it. We will start with just a single table called `users`, which will store records for the end-users using our application. A new class called `User` will be the class to which we map this table. The imports we'll need to accomplish this include objects that represent the components of our table, including the `Column` class which represents a database column, as well as the `Integer` and `String` classes that represent basic datatypes used in columns:

```
>>> from sqlalchemy import Column, Integer, String
>>> class User(Base):
...     __tablename__ = 'users'
...
...     id = Column(Integer, primary_key=True)
...     name = Column(String)
...     fullname = Column(String)
```

```
...     password = Column(String)
...
...     def __init__(self, name, fullname, password):
...         self.name = name
...         self.fullname = fullname
...         self.password = password
...
...     def __repr__(self):
...        return "<User('%s','%s', '%s')>" % (self.name, self.fullname, self.password)
```

The above `User` class establishes details about the table being mapped, including the name of the table denoted by the `__tablename__` attribute, a set of columns `id`, `name`, `fullname` and `password`, where the `id` column will also be the primary key of the table. While its certainly possible that some database tables don't have primary key columns (as is also the case with views, which can also be mapped), the ORM in order to actually map to a particular table needs there to be at least one column denoted as a primary key column; multiple-column, i.e. composite, primary keys are of course entirely feasible as well.

We define a constructor via `__init__()` and also a `__repr__()` method - both are optional. The class of course can have any number of other methods and attributes as required by the application, as it's basically just a plain Python class. Inheriting from `Base` is also only a requirement of the declarative configurational system, which itself is optional and relatively open ended; at its core, the SQLAlchemy ORM only requires that a class be a so-called "new style class", that is, it inherits from `object` in Python 2, in order to be mapped. All classes in Python 3 are "new style" classes.

The Non Opinionated Philosophy

In our `User` mapping example, it was required that we identify the name of the table in use, as well as the names and characteristics of all columns which we care about, including which column or columns represent the primary key, as well as some basic information about the types in use. SQLAlchemy never makes assumptions about these decisions - the developer must always be explicit about specific conventions in use. However, that doesn't mean the task can't be automated. While this tutorial will keep things explicit, developers are encouraged to make use of helper functions as well as "Declarative Mixins" to automate their tasks in large scale applications. The section *Mixin and Custom Base Classes* introduces many of these techniques.

With our `User` class constructed via the Declarative system, we have defined information about our table, known as **table metadata**, as well as a user-defined class which is linked to this table, known as a **mapped class**. Declarative has provided for us a shorthand system for what in SQLAlchemy is called a "Classical Mapping", which specifies these two units separately and is discussed in *Classical Mappings*. The table is actually represented by a datastructure known as `Table`, and the mapping represented by a `Mapper` object generated by a function called `mapper()`. Declarative performs both of these steps for us, making available the `Table` it has created via the `__table__` attribute:

```
>>> User.__table__
Table('users', MetaData(None),
            Column('id', Integer(), table=<users>, primary_key=True, nullable=False),
            Column('name', String(), table=<users>),
            Column('fullname', String(), table=<users>),
            Column('password', String(), table=<users>), schema=None)
```

and while rarely needed, making available the `Mapper` object via the `__mapper__` attribute:

```
>>> User.__mapper__
<Mapper at 0x...; User>
```

The Declarative base class also contains a catalog of all the `Table` objects that have been defined called `MetaData`, available via the `.metadata` attribute. In this example, we are defining new tables that have yet to be created in our SQLite database, so one helpful feature the `MetaData` object offers is the ability to issue CREATE TABLE statements

to the database for all tables that don't yet exist. We illustrate this by calling the `MetaData.create_all()` method, passing in our `Engine` as a source of database connectivity. We will see that special commands are first emitted to check for the presence of the `users` table, and following that the actual `CREATE TABLE` statement:

```
>>> Base.metadata.create_all(engine)
PRAGMA table_info("users")
()
CREATE TABLE users (
    id INTEGER NOT NULL,
    name VARCHAR,
    fullname VARCHAR,
    password VARCHAR,
    PRIMARY KEY (id)
)
()
COMMIT
```

Minimal Table Descriptions vs. Full Descriptions

Users familiar with the syntax of CREATE TABLE may notice that the VARCHAR columns were generated without a length; on SQLite and Postgresql, this is a valid datatype, but on others, it's not allowed. So if running this tutorial on one of those databases, and you wish to use SQLAlchemy to issue CREATE TABLE, a "length" may be provided to the `String` type as below:

```
Column(String(50))
```

The length field on `String`, as well as similar precision/scale fields available on `Integer`, `Numeric`, etc. are not referenced by SQLAlchemy other than when creating tables.
Additionally, Firebird and Oracle require sequences to generate new primary key identifiers, and SQLAlchemy doesn't generate or assume these without being instructed. For that, you use the `Sequence` construct:

```
from sqlalchemy import Sequence
Column(Integer, Sequence('user_id_seq'), primary_key=True)
```

A full, foolproof `Table` generated via our declarative mapping is therefore:

```
class User(Base):
    __tablename__ = 'users'
    id = Column(Integer, Sequence('user_id_seq'), primary_key=True)
    name = Column(String(50))
    fullname = Column(String(50))
    password = Column(String(12))

    def __init__(self, name, fullname, password):
        self.name = name
        self.fullname = fullname
        self.password = password

    def __repr__(self):
        return "<User('%s','%s', '%s')>" % (self.name, self.fullname, self.password)
```

We include this more verbose table definition separately to highlight the difference between a minimal construct geared primarily towards in-Python usage only, versus one that will be used to emit CREATE TABLE statements on a particular set of backends with more stringent requirements.

2.1.4 Create an Instance of the Mapped Class

With mappings complete, let's now create and inspect a `User` object:

```
>>> ed_user = User('ed', 'Ed Jones', 'edspassword')
>>> ed_user.name
'ed'
>>> ed_user.password
'edspassword'
>>> str(ed_user.id)
'None'
```

The `id` attribute, which while not defined by our `__init__()` method, exists with a value of `None` on our `User` instance due to the `id` column we declared in our mapping. By default, the ORM creates class attributes for all columns present in the table being mapped. These class attributes exist as Python descriptors, and define **instrumentation** for the mapped class. The functionality of this instrumentation includes the ability to fire on change events, track modifications, and to automatically load new data from the database when needed.

Since we have not yet told SQLAlchemy to persist `Ed Jones` within the database, its id is `None`. When we persist the object later, this attribute will be populated with a newly generated value.

The default `__init__()` method

Note that in our `User` example we supplied an `__init__()` method, which receives `name`, `fullname` and `password` as positional arguments. The Declarative system supplies for us a default constructor if one is not already present, which accepts keyword arguments of the same name as that of the mapped attributes. Below we define `User` without specifying a constructor:

```
class User(Base):
    __tablename__ = 'users'
    id = Column(Integer, primary_key=True)
    name = Column(String)
    fullname = Column(String)
    password = Column(String)
```

Our `User` class above will make usage of the default constructor, and provide `id`, `name`, `fullname`, and `password` as keyword arguments:

```
u1 = User(name='ed', fullname='Ed Jones', password='foobar')
```

2.1.5 Creating a Session

We're now ready to start talking to the database. The ORM's "handle" to the database is the `Session`. When we first set up the application, at the same level as our `create_engine()` statement, we define a `Session` class which will serve as a factory for new `Session` objects:

```
>>> from sqlalchemy.orm import sessionmaker
>>> Session = sessionmaker(bind=engine)
```

In the case where your application does not yet have an `Engine` when you define your module-level objects, just set it up like this:

```
>>> Session = sessionmaker()
```

Later, when you create your engine with `create_engine()`, connect it to the `Session` using `configure()`:

```
>>> Session.configure(bind=engine)  # once engine is available
```

This custom-made `Session` class will create new `Session` objects which are bound to our database. Other transactional characteristics may be defined when calling `sessionmaker()` as well; these are described in a later chapter. Then, whenever you need to have a conversation with the database, you instantiate a `Session`:

```
>>> session = Session()
```

The above Session is associated with our SQLite-enabled Engine, but it hasn't opened any connections yet. When it's first used, it retrieves a connection from a pool of connections maintained by the Engine, and holds onto it until we commit all changes and/or close the session object.

Session Creational Patterns

The business of acquiring a Session has a good deal of variety based on the variety of types of applications and frameworks out there. Keep in mind the Session is just a workspace for your objects, local to a particular database connection - if you think of an application thread as a guest at a dinner party, the Session is the guest's plate and the objects it holds are the food (and the database...the kitchen?)! Hints on how Session is integrated into an application are at *Session Frequently Asked Questions*.

2.1.6 Adding New Objects

To persist our User object, we add() it to our Session:

```
>>> ed_user = User('ed', 'Ed Jones', 'edspassword')
>>> session.add(ed_user)
```

At this point, we say that the instance is **pending**; no SQL has yet been issued and the object is not yet represented by a row in the database. The Session will issue the SQL to persist Ed Jones as soon as is needed, using a process known as a **flush**. If we query the database for Ed Jones, all pending information will first be flushed, and the query is issued immediately thereafter.

For example, below we create a new Query object which loads instances of User. We "filter by" the name attribute of ed, and indicate that we'd like only the first result in the full list of rows. A User instance is returned which is equivalent to that which we've added:

```
>>> our_user = session.query(User).filter_by(name='ed').first()
BEGIN (implicit)
INSERT INTO users (name, fullname, password) VALUES (?, ?, ?)
('ed', 'Ed Jones', 'edspassword')
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name = ?
 LIMIT ? OFFSET ?
('ed', 1, 0)
>>> our_user
<User('ed','Ed Jones', 'edspassword')>
```

In fact, the Session has identified that the row returned is the **same** row as one already represented within its internal map of objects, so we actually got back the identical instance as that which we just added:

```
>>> ed_user is our_user
True
```

The ORM concept at work here is known as an identity map and ensures that all operations upon a particular row within a Session operate upon the same set of data. Once an object with a particular primary key is present in the Session, all SQL queries on that Session will always return the same Python object for that particular primary key; it also will raise an error if an attempt is made to place a second, already-persisted object with the same primary key within the session.

We can add more `User` objects at once using `add_all()`:

```
>>> session.add_all([
...     User('wendy', 'Wendy Williams', 'foobar'),
...     User('mary', 'Mary Contrary', 'xxg527'),
...     User('fred', 'Fred Flinstone', 'blah')])
```

Also, we've decided the password for Ed isn't too secure, so lets change it:

```
>>> ed_user.password = 'f8s7ccs'
```

The `Session` is paying attention. It knows, for example, that `Ed Jones` has been modified:

```
>>> session.dirty
IdentitySet([<User('ed','Ed Jones', 'f8s7ccs')>])
```

and that three new `User` objects are pending:

```
>>> session.new
IdentitySet([<User('wendy','Wendy Williams', 'foobar')>,
<User('mary','Mary Contrary', 'xxg527')>,
<User('fred','Fred Flinstone', 'blah')>])
```

We tell the `Session` that we'd like to issue all remaining changes to the database and commit the transaction, which has been in progress throughout. We do this via `commit()`:

```
>>> session.commit()
UPDATE users SET password=? WHERE users.id = ?
('f8s7ccs', 1)
INSERT INTO users (name, fullname, password) VALUES (?, ?, ?)
('wendy', 'Wendy Williams', 'foobar')
INSERT INTO users (name, fullname, password) VALUES (?, ?, ?)
('mary', 'Mary Contrary', 'xxg527')
INSERT INTO users (name, fullname, password) VALUES (?, ?, ?)
('fred', 'Fred Flinstone', 'blah')
COMMIT
```

`commit()` flushes whatever remaining changes remain to the database, and commits the transaction. The connection resources referenced by the session are now returned to the connection pool. Subsequent operations with this session will occur in a **new** transaction, which will again re-acquire connection resources when first needed.

If we look at Ed's `id` attribute, which earlier was `None`, it now has a value:

```
>>> ed_user.id
BEGIN (implicit)
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.id = ?
(1,)
1
```

After the `Session` inserts new rows in the database, all newly generated identifiers and database-generated defaults become available on the instance, either immediately or via load-on-first-access. In this case, the entire row was re-loaded on access because a new transaction was begun after we issued `commit()`. SQLAlchemy by default refreshes data from a previous transaction the first time it's accessed within a new transaction, so that the most recent state is available. The level of reloading is configurable as is described in *Using the Session*.

Session Object States

As our `User` object moved from being outside the `Session`, to inside the `Session` without a primary key, to actually being inserted, it moved between three out of four available "object states" - **transient**, **pending**, and **persistent**. Being aware of these states and what they mean is always a good idea - be sure to read *Quickie Intro to Object States* for a quick overview.

2.1.7 Rolling Back

Since the `Session` works within a transaction, we can roll back changes made too. Let's make two changes that we'll revert; `ed_user`'s user name gets set to `Edwardo`:

```
>>> ed_user.name = 'Edwardo'
```

and we'll add another erroneous user, `fake_user`:

```
>>> fake_user = User('fakeuser', 'Invalid', '12345')
>>> session.add(fake_user)
```

Querying the session, we can see that they're flushed into the current transaction:

```
>>> session.query(User).filter(User.name.in_(['Edwardo', 'fakeuser'])).all()
UPDATE users SET name=? WHERE users.id = ?
('Edwardo', 1)
INSERT INTO users (name, fullname, password) VALUES (?, ?, ?)
('fakeuser', 'Invalid', '12345')
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name IN (?, ?)
('Edwardo', 'fakeuser')
[<User('Edwardo','Ed Jones', 'f8s7ccs')>, <User('fakeuser','Invalid', '12345')>]
```

Rolling back, we can see that `ed_user`'s name is back to `ed`, and `fake_user` has been kicked out of the session:

```
>>> session.rollback()
ROLLBACK


>>> ed_user.name
BEGIN (implicit)
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.id = ?
(1,)
u'ed'
>>> fake_user in session
False
```

issuing a SELECT illustrates the changes made to the database:

```
>>> session.query(User).filter(User.name.in_(['ed', 'fakeuser'])).all()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name IN (?, ?)
('ed', 'fakeuser')
[<User('ed','Ed Jones', 'f8s7ccs')>]
```

2.1.8 Querying

A `Query` object is created using the `query()` method on `Session`. This function takes a variable number of arguments, which can be any combination of classes and class-instrumented descriptors. Below, we indicate a `Query` which loads `User` instances. When evaluated in an iterative context, the list of `User` objects present is returned:

```
>>> for instance in session.query(User).order_by(User.id):
...     print instance.name, instance.fullname
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users ORDER BY users.id
()
ed Ed Jones
wendy Wendy Williams
mary Mary Contrary
fred Fred Flinstone
```

The `Query` also accepts ORM-instrumented descriptors as arguments. Any time multiple class entities or column-based entities are expressed as arguments to the `query()` function, the return result is expressed as tuples:

```
>>> for name, fullname in session.query(User.name, User.fullname):
...     print name, fullname
SELECT users.name AS users_name,
        users.fullname AS users_fullname
FROM users
()
ed Ed Jones
wendy Wendy Williams
mary Mary Contrary
fred Fred Flinstone
```

The tuples returned by `Query` are *named* tuples, and can be treated much like an ordinary Python object. The names are the same as the attribute's name for an attribute, and the class name for a class:

```
>>> for row in session.query(User, User.name).all():
...    print row.User, row.name
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
()
<User('ed','Ed Jones', 'f8s7ccs')> ed
<User('wendy','Wendy Williams', 'foobar')> wendy
```

```
<User('mary','Mary Contrary', 'xxg527')> mary
<User('fred','Fred Flinstone', 'blah')> fred
```

You can control the names of individual column expressions using the `label()` construct, which is available from any `ColumnElement`-derived object, as well as any class attribute which is mapped to one (such as `User.name`):

```
>>> for row in session.query(User.name.label('name_label')).all():
...     print(row.name_label)
SELECT users.name AS name_label
FROM users
()
ed
wendy
mary
fred
```

The name given to a full entity such as `User`, assuming that multiple entities are present in the call to `query()`, can be controlled using `aliased` :

```
>>> from sqlalchemy.orm import aliased
>>> user_alias = aliased(User, name='user_alias')

>>> for row in session.query(user_alias, user_alias.name).all():
...     print row.user_alias
SELECT user_alias.id AS user_alias_id,
        user_alias.name AS user_alias_name,
        user_alias.fullname AS user_alias_fullname,
        user_alias.password AS user_alias_password
FROM users AS user_alias
()
<User('ed','Ed Jones', 'f8s7ccs')>
<User('wendy','Wendy Williams', 'foobar')>
<User('mary','Mary Contrary', 'xxg527')>
<User('fred','Fred Flinstone', 'blah')>
```

Basic operations with `Query` include issuing LIMIT and OFFSET, most conveniently using Python array slices and typically in conjunction with ORDER BY:

```
>>> for u in session.query(User).order_by(User.id)[1:3]:
...     print u
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users ORDER BY users.id
LIMIT ? OFFSET ?
(2, 1)
<User('wendy','Wendy Williams', 'foobar')>
<User('mary','Mary Contrary', 'xxg527')>
```

and filtering results, which is accomplished either with `filter_by()`, which uses keyword arguments:

```
>>> for name, in session.query(User.name).\
...             filter_by(fullname='Ed Jones'):
...     print name
SELECT users.name AS users_name FROM users
WHERE users.fullname = ?
('Ed Jones',)
ed
```

...or `filter()`, which uses more flexible SQL expression language constructs. These allow you to use regular Python operators with the class-level attributes on your mapped class:

```
>>> for name, in session.query(User.name).\
...             filter(User.fullname=='Ed Jones'):
...     print name
SELECT users.name AS users_name FROM users
WHERE users.fullname = ?
('Ed Jones',)
ed
```

The `Query` object is fully **generative**, meaning that most method calls return a new `Query` object upon which further criteria may be added. For example, to query for users named "ed" with a full name of "Ed Jones", you can call `filter()` twice, which joins criteria using `AND`:

```
>>> for user in session.query(User).\
...           filter(User.name=='ed').\
...           filter(User.fullname=='Ed Jones'):
...     print user
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name = ? AND users.fullname = ?
('ed', 'Ed Jones')
<User('ed','Ed Jones', 'f8s7ccs')>
```

Common Filter Operators

Here's a rundown of some of the most common operators used in `filter()`:

- equals:

  ```
  query.filter(User.name == 'ed')
  ```

- not equals:

  ```
  query.filter(User.name != 'ed')
  ```

- LIKE:

  ```
  query.filter(User.name.like('%ed%'))
  ```

- IN:

  ```
  query.filter(User.name.in_(['ed', 'wendy', 'jack']))

  # works with query objects too:

  query.filter(User.name.in_(session.query(User.name).filter(User.name.like('%ed%'))))
  ```

- NOT IN:

  ```
  query.filter(~User.name.in_(['ed', 'wendy', 'jack']))
  ```

- IS NULL:

```
filter(User.name == None)
```

- IS NOT NULL:

```
filter(User.name != None)
```

- AND:

```
from sqlalchemy import and_
filter(and_(User.name == 'ed', User.fullname == 'Ed Jones'))

# or call filter()/filter_by() multiple times
filter(User.name == 'ed').filter(User.fullname == 'Ed Jones')
```

- OR:

```
from sqlalchemy import or_
filter(or_(User.name == 'ed', User.name == 'wendy'))
```

- match:

```
query.filter(User.name.match('wendy'))
```

The contents of the match parameter are database backend specific.

Returning Lists and Scalars

The `all()`, `one()`, and `first()` methods of `Query` immediately issue SQL and return a non-iterator value. `all()` returns a list:

```
>>> query = session.query(User).filter(User.name.like('%ed')).order_by(User.id)
>>> query.all()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name LIKE ? ORDER BY users.id
('%ed',)
[<User('ed','Ed Jones', 'f8s7ccs')>, <User('fred','Fred Flinstone', 'blah')>]
```

`first()` applies a limit of one and returns the first result as a scalar:

```
>>> query.first()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name LIKE ? ORDER BY users.id
 LIMIT ? OFFSET ?
('%ed', 1, 0)
<User('ed','Ed Jones', 'f8s7ccs')>
```

`one()`, fully fetches all rows, and if not exactly one object identity or composite row is present in the result, raises an error:

```
>>> from sqlalchemy.orm.exc import MultipleResultsFound
>>> try:
```

```
...     user = query.one()
... except MultipleResultsFound, e:
...     print e
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name LIKE ? ORDER BY users.id
('%ed',)
Multiple rows were found for one()

>>> from sqlalchemy.orm.exc import NoResultFound
>>> try:
...     user = query.filter(User.id == 99).one()
... except NoResultFound, e:
...     print e
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name LIKE ? AND users.id = ? ORDER BY users.id
('%ed', 99)
No row was found for one()
```

Using Literal SQL

Literal strings can be used flexibly with `Query`. Most methods accept strings in addition to SQLAlchemy clause constructs. For example, `filter()` and `order_by()`:

```
>>> for user in session.query(User).\
...             filter("id<224").\
...             order_by("id").all():
...     print user.name
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE id<224 ORDER BY id
()
ed
wendy
mary
fred
```

Bind parameters can be specified with string-based SQL, using a colon. To specify the values, use the `params()` method:

```
>>> session.query(User).filter("id<:value and name=:name").\
...     params(value=224, name='fred').order_by(User.id).one()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
```

```
WHERE id<? and name=? ORDER BY users.id
(224, 'fred')
<User('fred','Fred Flinstone', 'blah')>
```

To use an entirely string-based statement, using `from_statement()`; just ensure that the columns clause of the statement contains the column names normally used by the mapper (below illustrated using an asterisk):

```
>>> session.query(User).from_statement(
...                     "SELECT * FROM users where name=:name").\
...                     params(name='ed').all()
SELECT * FROM users where name=?
('ed',)
[<User('ed','Ed Jones', 'f8s7ccs')>]
```

You can use `from_statement()` to go completely "raw", using string names to identify desired columns:

```
>>> session.query("id", "name", "thenumber12").\
...         from_statement("SELECT id, name, 12 as "
...                 "thenumber12 FROM users where name=:name").\
...                 params(name='ed').all()
SELECT id, name, 12 as thenumber12 FROM users where name=?
('ed',)
[(1, u'ed', 12)]
```

Pros and Cons of Literal SQL

`Query` is constructed like the rest of SQLAlchemy, in that it tries to always allow "falling back" to a less automated, lower level approach to things. Accepting strings for all SQL fragments is a big part of that, so that you can bypass the need to organize SQL constructs if you know specifically what string output you'd like. But when using literal strings, the `Query` no longer knows anything about that part of the SQL construct being emitted, and has no ability to **transform** it to adapt to new contexts.
For example, suppose we selected `User` objects and ordered by the `name` column, using a string to indicate `name`:

```
>>> q = session.query(User.id, User.name)
>>> q.order_by("name").all()
SELECT users.id AS users_id, users.name AS users_name
FROM users ORDER BY name
()
[(1, u'ed'), (4, u'fred'), (3, u'mary'), (2, u'wendy')]
```

Perfectly fine. But suppose, before we got a hold of the `Query`, some sophisticated transformations were applied to it, such as below where we use `from_self()`, a particularly advanced method, to retrieve pairs of user names with different numbers of characters:

```
>>> from sqlalchemy import func
>>> ua = aliased(User)
>>> q = q.from_self(User.id, User.name, ua.name).\
...     filter(User.name < ua.name).\
...     filter(func.length(ua.name) != func.length(User.name))
```

The `Query` now represents a select from a subquery, where `User` is represented twice both inside and outside of the subquery. Telling the `Query` to order by "name" doesn't really give us much guarantee which "name" it's going to order on. In this case it assumes "name" is against the outer "aliased" `User` construct:

```
>>> q.order_by("name").all()
SELECT anon_1.users_id AS anon_1_users_id,
         anon_1.users_name AS anon_1_users_name,
         users_1.name AS users_1_name
FROM (SELECT users.id AS users_id, users.name AS users_name
     FROM users) AS anon_1, users AS users_1
WHERE anon_1.users_name < users_1.name
     AND length(users_1.name) != length(anon_1.users_name)
ORDER BY name
()
[(1, u'ed', u'fred'), (1, u'ed', u'mary'), (1, u'ed', u'wendy'), (3, u'mary', u'wendy'), (4, u'fred'
```

Only if we use the SQL element directly, in this case `User.name` or `ua.name`, do we give `Query` enough information to know for sure which "name" we'd like to order on, where we can see we get different results for each:

```
>>> q.order_by(ua.name).all()
SELECT anon_1.users_id AS anon_1_users_id,
         anon_1.users_name AS anon_1_users_name,
         users_1.name AS users_1_name
FROM (SELECT users.id AS users_id, users.name AS users_name
     FROM users) AS anon_1, users AS users_1
WHERE anon_1.users_name < users_1.name
     AND length(users_1.name) != length(anon_1.users_name)
ORDER BY users_1.name
()
[(1, u'ed', u'fred'), (1, u'ed', u'mary'), (1, u'ed', u'wendy'), (3, u'mary', u'wendy'), (4, u'fred'

>>> q.order_by(User.name).all()
SELECT anon_1.users_id AS anon_1_users_id,
         anon_1.users_name AS anon_1_users_name,
         users_1.name AS users_1_name
FROM (SELECT users.id AS users_id, users.name AS users_name
     FROM users) AS anon_1, users AS users_1
WHERE anon_1.users_name < users_1.name
     AND length(users_1.name) != length(anon_1.users_name)
```

Counting

`Query` includes a convenience method for counting called `count()`:

```
>>> session.query(User).filter(User.name.like('%ed')).count()
SELECT count(*) AS count_1
FROM (SELECT users.id AS users_id,
                users.name AS users_name,
                users.fullname AS users_fullname,
                users.password AS users_password
FROM users
WHERE users.name LIKE ?) AS anon_1
('%ed',)
2
```

The `count()` method is used to determine how many rows the SQL statement would return. Looking at the generated SQL above, SQLAlchemy always places whatever it is we are querying into a subquery, then counts the rows from that. In some cases this can be reduced to a simpler `SELECT count(*) FROM table`, however modern versions of SQLAlchemy don't try to guess when this is appropriate, as the exact SQL can be emitted using more explicit means.

For situations where the "thing to be counted" needs to be indicated specifically, we can specify the "count" function directly using the expression `func.count()`, available from the `func` construct. Below we use it to return the count of each distinct user name:

```
>>> from sqlalchemy import func
>>> session.query(func.count(User.name), User.name).group_by(User.name).all()
SELECT count(users.name) AS count_1, users.name AS users_name
FROM users GROUP BY users.name
()
[(1, u'ed'), (1, u'fred'), (1, u'mary'), (1, u'wendy')]
```

To achieve our simple `SELECT count(*) FROM table`, we can apply it as:

```
>>> session.query(func.count('*')).select_from(User).scalar()
SELECT count(?) AS count_1
FROM users
('*',)
4
```

The usage of `select_from()` can be removed if we express the count in terms of the `User` primary key directly:

```
>>> session.query(func.count(User.id)).scalar()
SELECT count(users.id) AS count_1
FROM users
()
4
```

2.1.9 Building a Relationship

Let's consider how a second table, related to `User`, can be mapped and queried. Users in our system can store any number of email addresses associated with their username. This implies a basic one to many association from the `users` to a new table which stores email addresses, which we will call `addresses`. Using declarative, we define this table along with its mapped class, `Address`:

```
>>> from sqlalchemy import ForeignKey
>>> from sqlalchemy.orm import relationship, backref
```

```
>>> class Address(Base):
...     __tablename__ = 'addresses'
...     id = Column(Integer, primary_key=True)
...     email_address = Column(String, nullable=False)
...     user_id = Column(Integer, ForeignKey('users.id'))
...
...     user = relationship("User", backref=backref('addresses', order_by=id))
...
...     def __init__(self, email_address):
...         self.email_address = email_address
...
...     def __repr__(self):
...         return "<Address('%s')>" % self.email_address
```

The above class introduces the `ForeignKey` construct, which is a directive applied to `Column` that indicates that values in this column should be **constrained** to be values present in the named remote column. This is a core feature of relational databases, and is the "glue" that transforms an otherwise unconnected collection of tables to have rich overlapping relationships. The `ForeignKey` above expresses that values in the `addresses.user_id` column should be constrained to those values in the `users.id` column, i.e. its primary key.

A second directive, known as `relationship()`, tells the ORM that the `Address` class itself should be linked to the `User` class, using the attribute `Address.user`. `relationship()` uses the foreign key relationships between the two tables to determine the nature of this linkage, determining that `Address.user` will be **many-to-one**. A subdirective of `relationship()` called `backref()` is placed inside of `relationship()`, providing details about the relationship as expressed in reverse, that of a collection of `Address` objects on `User` referenced by `User.addresses`. The reverse side of a many-to-one relationship is always **one-to-many**. A full catalog of available `relationship()` configurations is at *Basic Relational Patterns*.

The two complementing relationships `Address.user` and `User.addresses` are referred to as a **bidirectional relationship**, and is a key feature of the SQLAlchemy ORM. The section *Linking Relationships with Backref* discusses the "backref" feature in detail.

Arguments to `relationship()` which concern the remote class can be specified using strings, assuming the Declarative system is in use. Once all mappings are complete, these strings are evaluated as Python expressions in order to produce the actual argument, in the above case the `User` class. The names which are allowed during this evaluation include, among other things, the names of all classes which have been created in terms of the declared base. Below we illustrate creation of the same "addresses/user" bidirectional relationship in terms of `User` instead of `Address`:

```
class User(Base):
    # ....
    addresses = relationship("Address", order_by="Address.id", backref="user")
```

See the docstring for `relationship()` for more detail on argument style.

Did you know ?

- a FOREIGN KEY constraint in most (though not all) relational databases can only link to a primary key column, or a column that has a UNIQUE constraint.
- a FOREIGN KEY constraint that refers to a multiple column primary key, and itself has multiple columns, is known as a "composite foreign key". It can also reference a subset of those columns.
- FOREIGN KEY columns can automatically update themselves, in response to a change in the referenced column or row. This is known as the CASCADE *referential action*, and is a built in function of the relational database.
- FOREIGN KEY can refer to its own table. This is referred to as a "self-referential" foreign key.
- Read more about foreign keys at Foreign Key - Wikipedia.

We'll need to create the `addresses` table in the database, so we will issue another CREATE from our metadata, which will skip over tables which have already been created:

```
>>> Base.metadata.create_all(engine)
PRAGMA table_info("users")
()
PRAGMA table_info("addresses")
()
CREATE TABLE addresses (
    id INTEGER NOT NULL,
    email_address VARCHAR NOT NULL,
    user_id INTEGER,
    PRIMARY KEY (id),
     FOREIGN KEY(user_id) REFERENCES users (id)
)
()
COMMIT
```

2.1.10 Working with Related Objects

Now when we create a `User`, a blank `addresses` collection will be present. Various collection types, such as sets and dictionaries, are possible here (see *Customizing Collection Access* for details), but by default, the collection is a Python list.

```
>>> jack = User('jack', 'Jack Bean', 'gjffdd')
>>> jack.addresses
[]
```

We are free to add `Address` objects on our `User` object. In this case we just assign a full list directly:

```
>>> jack.addresses = [
...                 Address(email_address='jack@google.com'),
...                 Address(email_address='j25@yahoo.com')]
```

When using a bidirectional relationship, elements added in one direction automatically become visible in the other direction. This behavior occurs based on attribute on-change events and is evaluated in Python, without using any SQL:

```
>>> jack.addresses[1]
<Address('j25@yahoo.com')>

>>> jack.addresses[1].user
<User('jack','Jack Bean', 'gjffdd')>
```

Let's add and commit `Jack Bean` to the database. `jack` as well as the two `Address` members in the corresponding `addresses` collection are both added to the session at once, using a process known as **cascading**:

```
>>> session.add(jack)
>>> session.commit()
INSERT INTO users (name, fullname, password) VALUES (?, ?, ?)
('jack', 'Jack Bean', 'gjffdd')
INSERT INTO addresses (email_address, user_id) VALUES (?, ?)
('jack@google.com', 5)
INSERT INTO addresses (email_address, user_id) VALUES (?, ?)
('j25@yahoo.com', 5)
COMMIT
```

Querying for Jack, we get just Jack back. No SQL is yet issued for Jack's addresses:

```
>>> jack = session.query(User).\
... filter_by(name='jack').one()
BEGIN (implicit)
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name = ?
('jack',)

>>> jack
<User('jack','Jack Bean', 'gjffdd')>
```

Let's look at the `addresses` collection. Watch the SQL:

```
>>> jack.addresses
SELECT addresses.id AS addresses_id,
        addresses.email_address AS
        addresses_email_address,
        addresses.user_id AS addresses_user_id
FROM addresses
WHERE ? = addresses.user_id ORDER BY addresses.id
(5,)
[<Address('jack@google.com')>, <Address('j25@yahoo.com')>]
```

When we accessed the `addresses` collection, SQL was suddenly issued. This is an example of a **lazy loading relationship**. The `addresses` collection is now loaded and behaves just like an ordinary list. We'll cover ways to optimize the loading of this collection in a bit.

2.1.11 Querying with Joins

Now that we have two tables, we can show some more features of `Query`, specifically how to create queries that deal with both tables at the same time. The Wikipedia page on SQL JOIN offers a good introduction to join techniques, several of which we'll illustrate here.

To construct a simple implicit join between `User` and `Address`, we can use `Query.filter()` to equate their related columns together. Below we load the `User` and `Address` entities at once using this method:

```
>>> for u, a in session.query(User, Address).\
...                     filter(User.id==Address.user_id).\
...                     filter(Address.email_address=='jack@google.com').\
...                     all():
...     print u, a
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password,
        addresses.id AS addresses_id,
        addresses.email_address AS addresses_email_address,
        addresses.user_id AS addresses_user_id
FROM users, addresses
WHERE users.id = addresses.user_id
        AND addresses.email_address = ?
('jack@google.com',)
<User('jack','Jack Bean', 'gjffdd')> <Address('jack@google.com')>
```

The actual SQL JOIN syntax, on the other hand, is most easily achieved using the `Query.join()` method:

```
>>> session.query(User).join(Address).\
...         filter(Address.email_address=='jack@google.com').\
...         all()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users JOIN addresses ON users.id = addresses.user_id
WHERE addresses.email_address = ?
('jack@google.com',)
[<User('jack','Jack Bean', 'gjffdd')>]
```

`Query.join()` knows how to join between `User` and `Address` because there's only one foreign key between them. If there were no foreign keys, or several, `Query.join()` works better when one of the following forms are used:

```
query.join(Address, User.id==Address.user_id)     # explicit condition
query.join(User.addresses)                        # specify relationship from left to right
query.join(Address, User.addresses)               # same, with explicit target
query.join('addresses')                           # same, using a string
```

As you would expect, the same idea is used for "outer" joins, using the `outerjoin()` function:

```
query.outerjoin(User.addresses)    # LEFT OUTER JOIN
```

The reference documentation for `join()` contains detailed information and examples of the calling styles accepted by this method; `join()` is an important method at the center of usage for any SQL-fluent application.

Using Aliases

When querying across multiple tables, if the same table needs to be referenced more than once, SQL typically requires that the table be *aliased* with another name, so that it can be distinguished against other occurrences of that table. The `Query` supports this most explicitly using the `aliased` construct. Below we join to the `Address` entity twice, to locate a user who has two distinct email addresses at the same time:

```
>>> from sqlalchemy.orm import aliased
>>> adalias1 = aliased(Address)
>>> adalias2 = aliased(Address)
>>> for username, email1, email2 in \
...     session.query(User.name, adalias1.email_address, adalias2.email_address).\
...     join(adalias1, User.addresses).\
...     join(adalias2, User.addresses).\
...     filter(adalias1.email_address=='jack@google.com').\
...     filter(adalias2.email_address=='j25@yahoo.com'):
...     print username, email1, email2
SELECT users.name AS users_name,
        addresses_1.email_address AS addresses_1_email_address,
        addresses_2.email_address AS addresses_2_email_address
FROM users JOIN addresses AS addresses_1
        ON users.id = addresses_1.user_id
JOIN addresses AS addresses_2
        ON users.id = addresses_2.user_id
WHERE addresses_1.email_address = ?
        AND addresses_2.email_address = ?
('jack@google.com', 'j25@yahoo.com')
jack jack@google.com j25@yahoo.com
```

Using Subqueries

The `Query` is suitable for generating statements which can be used as subqueries. Suppose we wanted to load `User` objects along with a count of how many `Address` records each user has. The best way to generate SQL like this is to get the count of addresses grouped by user ids, and JOIN to the parent. In this case we use a LEFT OUTER JOIN so that we get rows back for those users who don't have any addresses, e.g.:

```
SELECT users.*, adr_count.address_count FROM users LEFT OUTER JOIN
    (SELECT user_id, count(*) AS address_count
        FROM addresses GROUP BY user_id) AS adr_count
    ON users.id=adr_count.user_id
```

Using the `Query`, we build a statement like this from the inside out. The `statement` accessor returns a SQL expression representing the statement generated by a particular `Query` - this is an instance of a `select()` construct, which are described in *SQL Expression Language Tutorial*:

```
>>> from sqlalchemy.sql import func
>>> stmt = session.query(Address.user_id, func.count('*').\
...          label('address_count')).\
...          group_by(Address.user_id).subquery()
```

The `func` keyword generates SQL functions, and the `subquery()` method on `Query` produces a SQL expression construct representing a SELECT statement embedded within an alias (it's actually shorthand for `query.statement.alias()`).

Once we have our statement, it behaves like a `Table` construct, such as the one we created for `users` at the start of this tutorial. The columns on the statement are accessible through an attribute called `c`:

```
>>> for u, count in session.query(User, stmt.c.address_count).\
...     outerjoin(stmt, User.id==stmt.c.user_id).order_by(User.id):
...     print u, count
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password,
        anon_1.address_count AS anon_1_address_count
FROM users LEFT OUTER JOIN
    (SELECT addresses.user_id AS user_id, count(?) AS address_count
    FROM addresses GROUP BY addresses.user_id) AS anon_1
    ON users.id = anon_1.user_id
ORDER BY users.id
('*',)
<User('ed','Ed Jones', 'f8s7ccs')> None
<User('wendy','Wendy Williams', 'foobar')> None
<User('mary','Mary Contrary', 'xxg527')> None
<User('fred','Fred Flinstone', 'blah')> None
<User('jack','Jack Bean', 'gjffdd')> 2
```

Selecting Entities from Subqueries

Above, we just selected a result that included a column from a subquery. What if we wanted our subquery to map to an entity ? For this we use `aliased()` to associate an "alias" of a mapped class to a subquery:

```
>>> stmt = session.query(Address).\
...                 filter(Address.email_address != 'j25@yahoo.com').\
...                 subquery()
>>> adalias = aliased(Address, stmt)
>>> for user, address in session.query(User, adalias).\
```

```
...          join(adalias, User.addresses):
...      print user, address
SELECT users.id AS users_id,
            users.name AS users_name,
            users.fullname AS users_fullname,
            users.password AS users_password,
            anon_1.id AS anon_1_id,
            anon_1.email_address AS anon_1_email_address,
            anon_1.user_id AS anon_1_user_id
FROM users JOIN
    (SELECT addresses.id AS id,
            addresses.email_address AS email_address,
            addresses.user_id AS user_id
    FROM addresses
    WHERE addresses.email_address != ?) AS anon_1
    ON users.id = anon_1.user_id
('j25@yahoo.com',)
<User('jack','Jack Bean', 'gjffdd')> <Address('jack@google.com')>
```

Using EXISTS

The EXISTS keyword in SQL is a boolean operator which returns True if the given expression contains any rows. It may be used in many scenarios in place of joins, and is also useful for locating rows which do not have a corresponding row in a related table.

There is an explicit EXISTS construct, which looks like this:

```
>>> from sqlalchemy.sql import exists
>>> stmt = exists().where(Address.user_id==User.id)
>>> for name, in session.query(User.name).filter(stmt):
...     print name
SELECT users.name AS users_name
FROM users
WHERE EXISTS (SELECT *
FROM addresses
WHERE addresses.user_id = users.id)
()
jack
```

The `Query` features several operators which make usage of EXISTS automatically. Above, the statement can be expressed along the `User.addresses` relationship using `any()`:

```
>>> for name, in session.query(User.name).\
...          filter(User.addresses.any()):
...     print name
SELECT users.name AS users_name
FROM users
WHERE EXISTS (SELECT 1
FROM addresses
WHERE users.id = addresses.user_id)
()
jack
```

`any()` takes criterion as well, to limit the rows matched:

```
>>> for name, in session.query(User.name).\
...     filter(User.addresses.any(Address.email_address.like('%google%'))):
...     print name
```

```
SELECT users.name AS users_name
FROM users
WHERE EXISTS (SELECT 1
FROM addresses
WHERE users.id = addresses.user_id AND addresses.email_address LIKE ?)
('%google%',)
jack
```

has() is the same operator as any() for many-to-one relationships (note the ~ operator here too, which means "NOT"):

```
>>> session.query(Address).\
...         filter(~Address.user.has(User.name=='jack')).all()
SELECT addresses.id AS addresses_id,
        addresses.email_address AS addresses_email_address,
        addresses.user_id AS addresses_user_id
FROM addresses
WHERE NOT (EXISTS (SELECT 1
FROM users
WHERE users.id = addresses.user_id AND users.name = ?))
('jack',)
[]
```

Common Relationship Operators

Here's all the operators which build on relationships - each one is linked to its API documentation which includes full details on usage and behavior:

- __eq__() (many-to-one "equals" comparison):

  ```
  query.filter(Address.user == someuser)
  ```

- __ne__() (many-to-one "not equals" comparison):

  ```
  query.filter(Address.user != someuser)
  ```

- IS NULL (many-to-one comparison, also uses __eq__()):

  ```
  query.filter(Address.user == None)
  ```

- contains() (used for one-to-many collections):

  ```
  query.filter(User.addresses.contains(someaddress))
  ```

- any() (used for collections):

  ```
  query.filter(User.addresses.any(Address.email_address == 'bar'))

  # also takes keyword arguments:
  query.filter(User.addresses.any(email_address='bar'))
  ```

- has() (used for scalar references):

  ```
  query.filter(Address.user.has(name='ed'))
  ```

- Query.with_parent() (used for any relationship):

  ```
  session.query(Address).with_parent(someuser, 'addresses')
  ```

2.1.12 Eager Loading

Recall earlier that we illustrated a **lazy loading** operation, when we accessed the `User.addresses` collection of a `User` and SQL was emitted. If you want to reduce the number of queries (dramatically, in many cases), we can apply an **eager load** to the query operation. SQLAlchemy offers three types of eager loading, two of which are automatic, and a third which involves custom criterion. All three are usually invoked via functions known as **query options** which give additional instructions to the `Query` on how we would like various attributes to be loaded, via the `Query.options()` method.

Subquery Load

In this case we'd like to indicate that `User.addresses` should load eagerly. A good choice for loading a set of objects as well as their related collections is the `orm.subqueryload()` option, which emits a second SELECT statement that fully loads the collections associated with the results just loaded. The name "subquery" originates from the fact that the SELECT statement constructed directly via the `Query` is re-used, embedded as a subquery into a SELECT against the related table. This is a little elaborate but very easy to use:

```
>>> from sqlalchemy.orm import subqueryload
>>> jack = session.query(User).\
...                 options(subqueryload(User.addresses)).\
...                 filter_by(name='jack').one()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name = ?
('jack',)
SELECT addresses.id AS addresses_id,
        addresses.email_address AS addresses_email_address,
        addresses.user_id AS addresses_user_id,
        anon_1.users_id AS anon_1_users_id
FROM (SELECT users.id AS users_id
    FROM users WHERE users.name = ?) AS anon_1
JOIN addresses ON anon_1.users_id = addresses.user_id
ORDER BY anon_1.users_id, addresses.id
('jack',)
>>> jack
<User('jack','Jack Bean', 'gjffdd')>

>>> jack.addresses
[<Address('jack@google.com')>, <Address('j25@yahoo.com')>]
```

Joined Load

The other automatic eager loading function is more well known and is called `orm.joinedload()`. This style of loading emits a JOIN, by default a LEFT OUTER JOIN, so that the lead object as well as the related object or collection is loaded in one step. We illustrate loading the same `addresses` collection in this way - note that even though the `User.addresses` collection on `jack` is actually populated right now, the query will emit the extra join regardless:

```
>>> from sqlalchemy.orm import joinedload

>>> jack = session.query(User).\
...                         options(joinedload(User.addresses)).\
```

```
...                         filter_by(name='jack').one()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password,
        addresses_1.id AS addresses_1_id,
        addresses_1.email_address AS addresses_1_email_address,
        addresses_1.user_id AS addresses_1_user_id
FROM users
    LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = ? ORDER BY addresses_1.id
('jack',)

>>> jack
<User('jack','Jack Bean', 'gjffdd')>

>>> jack.addresses
[<Address('jack@google.com')>, <Address('j25@yahoo.com')>]
```

Note that even though the OUTER JOIN resulted in two rows, we still only got one instance of `User` back. This is because `Query` applies a "uniquing" strategy, based on object identity, to the returned entities. This is specifically so that joined eager loading can be applied without affecting the query results.

While `joinedload()` has been around for a long time, `subqueryload()` is a newer form of eager loading. `subqueryload()` tends to be more appropriate for loading related collections while `joinedload()` tends to be better suited for many-to-one relationships, due to the fact that only one row is loaded for both the lead and the related object.

`joinedload()` is not a replacement for `join()`

The join created by `joinedload()` is anonymously aliased such that it **does not affect the query results**. An `Query.order_by()` or `Query.filter()` call **cannot** reference these aliased tables - so-called "user space" joins are constructed using `Query.join()`. The rationale for this is that `joinedload()` is only applied in order to affect how related objects or collections are loaded as an optimizing detail - it can be added or removed with no impact on actual results. See the section *The Zen of Eager Loading* for a detailed description of how this is used.

Explicit Join + Eagerload

A third style of eager loading is when we are constructing a JOIN explicitly in order to locate the primary rows, and would like to additionally apply the extra table to a related object or collection on the primary object. This feature is supplied via the `orm.contains_eager()` function, and is most typically useful for pre-loading the many-to-one object on a query that needs to filter on that same object. Below we illustrate loading an `Address` row as well as the related `User` object, filtering on the `User` named "jack" and using `orm.contains_eager()` to apply the "user" columns to the `Address.user` attribute:

```
>>> from sqlalchemy.orm import contains_eager
>>> jacks_addresses = session.query(Address).\
...                             join(Address.user).\
...                             filter(User.name=='jack').\
...                             options(contains_eager(Address.user)).\
...                             all()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
```

```
        users.password AS users_password,
        addresses.id AS addresses_id,
        addresses.email_address AS addresses_email_address,
        addresses.user_id AS addresses_user_id
FROM addresses JOIN users ON users.id = addresses.user_id
WHERE users.name = ?
('jack',)

>>> jacks_addresses
[<Address('jack@google.com')>, <Address('j25@yahoo.com')>]

>>> jacks_addresses[0].user
<User('jack','Jack Bean', 'gjffdd')>
```

For more information on eager loading, including how to configure various forms of loading by default, see the section *Relationship Loading Techniques*.

2.1.13 Deleting

Let's try to delete `jack` and see how that goes. We'll mark as deleted in the session, then we'll issue a `count` query to see that no rows remain:

```
>>> session.delete(jack)
>>> session.query(User).filter_by(name='jack').count()
UPDATE addresses SET user_id=? WHERE addresses.id = ?
(None, 1)
UPDATE addresses SET user_id=? WHERE addresses.id = ?
(None, 2)
DELETE FROM users WHERE users.id = ?
(5,)
SELECT count(*) AS count_1
FROM (SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name = ?) AS anon_1
('jack',)
0
```

So far, so good. How about Jack's `Address` objects ?

```
>>> session.query(Address).filter(
...     Address.email_address.in_(['jack@google.com', 'j25@yahoo.com'])
...  ).count()
SELECT count(*) AS count_1
FROM (SELECT addresses.id AS addresses_id,
                addresses.email_address AS addresses_email_address,
                addresses.user_id AS addresses_user_id
FROM addresses
WHERE addresses.email_address IN (?, ?)) AS anon_1
('jack@google.com', 'j25@yahoo.com')
2
```

Uh oh, they're still there ! Analyzing the flush SQL, we can see that the `user_id` column of each address was set to NULL, but the rows weren't deleted. SQLAlchemy doesn't assume that deletes cascade, you have to tell it to do so.

Configuring delete/delete-orphan Cascade

We will configure **cascade** options on the `User.addresses` relationship to change the behavior. While SQLAlchemy allows you to add new attributes and relationships to mappings at any point in time, in this case the existing relationship needs to be removed, so we need to tear down the mappings completely and start again - we'll close the `Session`:

```
>>> session.close()
```

and use a new `declarative_base()`:

```
>>> Base = declarative_base()
```

Next we'll declare the `User` class, adding in the `addresses` relationship including the cascade configuration (we'll leave the constructor out too):

```
>>> class User(Base):
...     __tablename__ = 'users'
...
...     id = Column(Integer, primary_key=True)
...     name = Column(String)
...     fullname = Column(String)
...     password = Column(String)
...
...     addresses = relationship("Address", backref='user', cascade="all, delete, delete-orphan")
...
...     def __repr__(self):
...        return "<User('%s','%s', '%s')>" % (self.name, self.fullname, self.password)
```

Then we recreate `Address`, noting that in this case we've created the `Address.user` relationship via the `User` class already:

```
>>> class Address(Base):
...     __tablename__ = 'addresses'
...     id = Column(Integer, primary_key=True)
...     email_address = Column(String, nullable=False)
...     user_id = Column(Integer, ForeignKey('users.id'))
...
...     def __repr__(self):
...         return "<Address('%s')>" % self.email_address
```

Now when we load the user `jack` (below using `get()`, which loads by primary key), removing an address from the corresponding `addresses` collection will result in that `Address` being deleted:

```
# load Jack by primary key
>>> jack = session.query(User).get(5)
BEGIN (implicit)
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.id = ?
(5,)


# remove one Address (lazy load fires off)
>>> del jack.addresses[1]
SELECT addresses.id AS addresses_id,
```

```
        addresses.email_address AS addresses_email_address,
        addresses.user_id AS addresses_user_id
FROM addresses
WHERE ? = addresses.user_id
(5,)


# only one address remains
>>> session.query(Address).filter(
...     Address.email_address.in_(['jack@google.com', 'j25@yahoo.com'])
... ).count()
DELETE FROM addresses WHERE addresses.id = ?
(2,)
SELECT count(*) AS count_1
FROM (SELECT addresses.id AS addresses_id,
                addresses.email_address AS addresses_email_address,
                addresses.user_id AS addresses_user_id
FROM addresses
WHERE addresses.email_address IN (?, ?)) AS anon_1
('jack@google.com', 'j25@yahoo.com')
1
```

Deleting Jack will delete both Jack and the remaining `Address` associated with the user:

```
>>> session.delete(jack)

>>> session.query(User).filter_by(name='jack').count()
DELETE FROM addresses WHERE addresses.id = ?
(1,)
DELETE FROM users WHERE users.id = ?
(5,)
SELECT count(*) AS count_1
FROM (SELECT users.id AS users_id,
                users.name AS users_name,
                users.fullname AS users_fullname,
                users.password AS users_password
FROM users
WHERE users.name = ?) AS anon_1
('jack',)
0

>>> session.query(Address).filter(
...    Address.email_address.in_(['jack@google.com', 'j25@yahoo.com'])
... ).count()
SELECT count(*) AS count_1
FROM (SELECT addresses.id AS addresses_id,
                addresses.email_address AS addresses_email_address,
                addresses.user_id AS addresses_user_id
FROM addresses
WHERE addresses.email_address IN (?, ?)) AS anon_1
('jack@google.com', 'j25@yahoo.com')
0
```

More on Cascades

Further detail on configuration of cascades is at *Cascades*. The cascade functionality can also integrate smoothly with the `ON DELETE CASCADE` functionality of the relational database. See *Using Passive Deletes* for details.

2.1.14 Building a Many To Many Relationship

We're moving into the bonus round here, but lets show off a many-to-many relationship. We'll sneak in some other features too, just to take a tour. We'll make our application a blog application, where users can write `BlogPost` items, which have `Keyword` items associated with them.

For a plain many-to-many, we need to create an un-mapped `Table` construct to serve as the association table. This looks like the following:

```
>>> from sqlalchemy import Table, Text
>>> # association table
>>> post_keywords = Table('post_keywords', Base.metadata,
...     Column('post_id', Integer, ForeignKey('posts.id')),
...     Column('keyword_id', Integer, ForeignKey('keywords.id'))
... )
```

Above, we can see declaring a `Table` directly is a little different than declaring a mapped class. `Table` is a constructor function, so each individual `Column` argument is separated by a comma. The `Column` object is also given its name explicitly, rather than it being taken from an assigned attribute name.

Next we define `BlogPost` and `Keyword`, with a `relationship()` linked via the `post_keywords` table:

```
>>> class BlogPost(Base):
...     __tablename__ = 'posts'
...
...     id = Column(Integer, primary_key=True)
...     user_id = Column(Integer, ForeignKey('users.id'))
...     headline = Column(String(255), nullable=False)
...     body = Column(Text)
...
...     # many to many BlogPost<->Keyword
...     keywords = relationship('Keyword', secondary=post_keywords, backref='posts')
...
...     def __init__(self, headline, body, author):
...         self.author = author
...         self.headline = headline
...         self.body = body
...
...     def __repr__(self):
...         return "BlogPost(%r, %r, %r)" % (self.headline, self.body, self.author)


>>> class Keyword(Base):
...     __tablename__ = 'keywords'
...
...     id = Column(Integer, primary_key=True)
...     keyword = Column(String(50), nullable=False, unique=True)
...
...     def __init__(self, keyword):
...         self.keyword = keyword
```

Above, the many-to-many relationship is `BlogPost.keywords`. The defining feature of a many-to-many relationship is the `secondary` keyword argument which references a `Table` object representing the association table. This table only contains columns which reference the two sides of the relationship; if it has *any* other columns, such as its own primary key, or foreign keys to other tables, SQLAlchemy requires a different usage pattern called the "association object", described at *Association Object*.

We would also like our `BlogPost` class to have an `author` field. We will add this as another bidirectional relationship, except one issue we'll have is that a single user might have lots of blog posts. When we access `User.posts`,

we'd like to be able to filter results further so as not to load the entire collection. For this we use a setting accepted by `relationship()` called `lazy='dynamic'`, which configures an alternate **loader strategy** on the attribute. To use it on the "reverse" side of a `relationship()`, we use the `backref()` function:

```
>>> from sqlalchemy.orm import backref
>>> # "dynamic" loading relationship to User
>>> BlogPost.author = relationship(User, backref=backref('posts', lazy='dynamic'))
```

Create new tables:

```
>>> Base.metadata.create_all(engine)
PRAGMA table_info("users")
()
PRAGMA table_info("addresses")
()
PRAGMA table_info("posts")
()
PRAGMA table_info("keywords")
()
PRAGMA table_info("post_keywords")
()
CREATE TABLE posts (
    id INTEGER NOT NULL,
    user_id INTEGER,
    headline VARCHAR(255) NOT NULL,
    body TEXT,
    PRIMARY KEY (id),
     FOREIGN KEY(user_id) REFERENCES users (id)
)
()
COMMIT
CREATE TABLE keywords (
    id INTEGER NOT NULL,
    keyword VARCHAR(50) NOT NULL,
    PRIMARY KEY (id),
     UNIQUE (keyword)
)
()
COMMIT
CREATE TABLE post_keywords (
    post_id INTEGER,
    keyword_id INTEGER,
     FOREIGN KEY(post_id) REFERENCES posts (id),
     FOREIGN KEY(keyword_id) REFERENCES keywords (id)
)
()
COMMIT
```

Usage is not too different from what we've been doing. Let's give Wendy some blog posts:

```
>>> wendy = session.query(User).\
...                 filter_by(name='wendy').\
...                 one()
SELECT users.id AS users_id,
        users.name AS users_name,
        users.fullname AS users_fullname,
        users.password AS users_password
FROM users
WHERE users.name = ?
```

```
('wendy',)

>>> post = BlogPost("Wendy's Blog Post", "This is a test", wendy)
>>> session.add(post)
```

We're storing keywords uniquely in the database, but we know that we don't have any yet, so we can just create them:

```
>>> post.keywords.append(Keyword('wendy'))
>>> post.keywords.append(Keyword('firstpost'))
```

We can now look up all blog posts with the keyword 'firstpost'. We'll use the `any` operator to locate "blog posts where any of its keywords has the keyword string 'firstpost'":

```
>>> session.query(BlogPost).\
...             filter(BlogPost.keywords.any(keyword='firstpost')).\
...             all()
INSERT INTO keywords (keyword) VALUES (?)
('wendy',)
INSERT INTO keywords (keyword) VALUES (?)
('firstpost',)
INSERT INTO posts (user_id, headline, body) VALUES (?, ?, ?)
(2, "Wendy's Blog Post", 'This is a test')
INSERT INTO post_keywords (post_id, keyword_id) VALUES (?, ?)
((1, 1), (1, 2))
SELECT posts.id AS posts_id,
        posts.user_id AS posts_user_id,
        posts.headline AS posts_headline,
        posts.body AS posts_body
FROM posts
WHERE EXISTS (SELECT 1
    FROM post_keywords, keywords
    WHERE posts.id = post_keywords.post_id
        AND keywords.id = post_keywords.keyword_id
        AND keywords.keyword = ?)
('firstpost',)
[BlogPost("Wendy's Blog Post", 'This is a test', <User('wendy','Wendy Williams', 'foobar')>)]
```

If we want to look up posts owned by the user `wendy`, we can tell the query to narrow down to that `User` object as a parent:

```
>>> session.query(BlogPost).\
...             filter(BlogPost.author==wendy).\
...             filter(BlogPost.keywords.any(keyword='firstpost')).\
...             all()
SELECT posts.id AS posts_id,
        posts.user_id AS posts_user_id,
        posts.headline AS posts_headline,
        posts.body AS posts_body
FROM posts
WHERE ? = posts.user_id AND (EXISTS (SELECT 1
    FROM post_keywords, keywords
    WHERE posts.id = post_keywords.post_id
        AND keywords.id = post_keywords.keyword_id
        AND keywords.keyword = ?))
(2, 'firstpost')
[BlogPost("Wendy's Blog Post", 'This is a test', <User('wendy','Wendy Williams', 'foobar')>)]
```

Or we can use Wendy's own `posts` relationship, which is a "dynamic" relationship, to query straight from there:

```
>>> wendy.posts.\
...          filter(BlogPost.keywords.any(keyword='firstpost')).\
...          all()
SELECT posts.id AS posts_id,
        posts.user_id AS posts_user_id,
        posts.headline AS posts_headline,
        posts.body AS posts_body
FROM posts
WHERE ? = posts.user_id AND (EXISTS (SELECT 1
    FROM post_keywords, keywords
    WHERE posts.id = post_keywords.post_id
        AND keywords.id = post_keywords.keyword_id
        AND keywords.keyword = ?))
(2, 'firstpost')
[BlogPost("Wendy's Blog Post", 'This is a test', <User('wendy','Wendy Williams', 'foobar')>)]
```

2.1.15 Further Reference

Query Reference: *Querying*

Mapper Reference: *Mapper Configuration*

Relationship Reference: *Relationship Configuration*

Session Reference: *Using the Session*

2.2 Mapper Configuration

This section describes a variety of configurational patterns that are usable with mappers. It assumes you've worked through *Object Relational Tutorial* and know how to construct and use rudimentary mappers and relationships.

2.2.1 Classical Mappings

A *Classical Mapping* refers to the configuration of a mapped class using the `mapper()` function, without using the Declarative system. As an example, start with the declarative mapping introduced in *Object Relational Tutorial*:

```
class User(Base):
    __tablename__ = 'users'

    id = Column(Integer, primary_key=True)
    name = Column(String)
    fullname = Column(String)
    password = Column(String)
```

In "classical" form, the table metadata is created separately with the `Table` construct, then associated with the `User` class via the `mapper()` function:

```
from sqlalchemy import Table, MetaData, Column, ForeignKey, Integer, String
from sqlalchemy.orm import mapper

metadata = MetaData()

user = Table('user', metadata,
            Column('id', Integer, primary_key=True),
```

```
            Column('name', String(50)),
            Column('fullname', String(50)),
            Column('password', String(12))
        )

class User(object):
    def __init__(self, name, fullname, password):
        self.name = name
        self.fullname = fullname
        self.password = password

mapper(User, user)
```

Information about mapped attributes, such as relationships to other classes, are provided via the `properties` dictionary. The example below illustrates a second `Table` object, mapped to a class called `Address`, then linked to `User` via `relationship()`:

```
address = Table('address', metadata,
            Column('id', Integer, primary_key=True),
            Column('user_id', Integer, ForeignKey('user.id')),
            Column('email_address', String(50))
            )

mapper(User, user, properties={
    'addresses' : relationship(Address, backref='user', order_by=address.c.id)
})

mapper(Address, address)
```

When using classical mappings, classes must be provided directly without the benefit of the "string lookup" system provided by Declarative. SQL expressions are typically specified in terms of the `Table` objects, i.e. `address.c.id` above for the `Address` relationship, and not `Address.id`, as `Address` may not yet be linked to table metadata, nor can we specify a string here.

Some examples in the documentation still use the classical approach, but note that the classical as well as Declarative approaches are **fully interchangeable**. Both systems ultimately create the same configuration, consisting of a `Table`, user-defined class, linked together with a `mapper()`. When we talk about "the behavior of `mapper()`", this includes when using the Declarative system as well - it's still used, just behind the scenes.

2.2.2 Customizing Column Properties

The default behavior of `mapper()` is to assemble all the columns in the mapped `Table` into mapped object attributes, each of which are named according to the name of the column itself (specifically, the `key` attribute of `Column`). This behavior can be modified in several ways.

Naming Columns Distinctly from Attribute Names

A mapping by default shares the same name for a `Column` as that of the mapped attribute. The name assigned to the `Column` can be different, as we illustrate here in a Declarative mapping:

```
class User(Base):
    __tablename__ = 'user'
    id = Column('user_id', Integer, primary_key=True)
    name = Column('user_name', String(50))
```

Where above `User.id` resolves to a column named `user_id` and `User.name` resolves to a column named `user_name`.

When mapping to an existing table, the `Column` object can be referenced directly:

```
class User(Base):
    __table__ = user_table
    id = user_table.c.user_id
    name = user_table.c.user_name
```

Or in a classical mapping, placed in the `properties` dictionary with the desired key:

```
mapper(User, user_table, properties={
   'id': user_table.c.user_id,
   'name': user_table.c.user_name,
})
```

Naming All Columns with a Prefix

A way to automate the assignment of a prefix to the mapped attribute names relative to the column name is to use `column_prefix`:

```
class User(Base):
    __table__ = user_table
    __mapper_args__ = {'column_prefix':'_'}
```

The above will place attribute names such as `_user_id`, `_user_name`, `_password` etc. on the mapped `User` class.

The classical version of the above:

```
mapper(User, user_table, column_prefix='_')
```

Using column_property for column level options

Options can be specified when mapping a `Column` using the `column_property()` function. This function explicitly creates the `ColumnProperty` used by the `mapper()` to keep track of the `Column`; normally, the `mapper()` creates this automatically. Using `column_property()`, we can pass additional arguments about how we'd like the `Column` to be mapped. Below, we pass an option `active_history`, which specifies that a change to this column's value should result in the former value being loaded first:

```
from sqlalchemy.orm import column_property

class User(Base):
    __tablename__ = 'user'

    id = Column(Integer, primary_key=True)
    name = column_property(Column(String(50)), active_history=True)
```

`column_property()` is also used to map a single attribute to multiple columns. This use case arises when mapping to a `join()` which has attributes which are equated to each other:

```
class User(Base):
    __table__ = user.join(address)

    # assign "user.id", "address.user_id" to the
    # "id" attribute
    id = column_property(user_table.c.id, address_table.c.user_id)
```

For more examples featuring this usage, see *Mapping a Class against Multiple Tables*.

Another place where `column_property()` is needed is to specify SQL expressions as mapped attributes, such as below where we create an attribute `fullname` that is the string concatenation of the `firstname` and `lastname` columns:

```
class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    firstname = Column(String(50))
    lastname = Column(String(50))
    fullname = column_property(firstname + " " + lastname)
```

See examples of this usage at *SQL Expressions as Mapped Attributes*.

sqlalchemy.orm.**column_property**(**cols*, ***kw*)

Provide a column-level property for use with a Mapper.

Column-based properties can normally be applied to the mapper's `properties` dictionary using the `Column` element directly. Use this function when the given column is not directly present within the mapper's selectable; examples include SQL expressions, functions, and scalar SELECT queries.

Columns that aren't present in the mapper's selectable won't be persisted by the mapper and are effectively "read-only" attributes.

Parameters

- ***cols** – list of Column objects to be mapped.
- **active_history=False** – When `True`, indicates that the "previous" value for a scalar attribute should be loaded when replaced, if not already loaded. Normally, history tracking logic for simple non-primary-key scalar values only needs to be aware of the "new" value in order to perform a flush. This flag is available for applications that make use of `attributes.get_history()` or `Session.is_modified()` which also need to know the "previous" value of the attribute.

  New in version 0.6.6.
- **comparator_factory** – a class which extends `ColumnProperty.Comparator` which provides custom SQL clause generation for comparison operations.
- **group** – a group name for this property when marked as deferred.
- **deferred** – when True, the column property is "deferred", meaning that it does not load immediately, and is instead loaded when the attribute is first accessed on an instance. See also `deferred()`.
- **doc** – optional string that will be applied as the doc on the class-bound descriptor.
- **expire_on_flush=True** – Disable expiry on flush. A column_property() which refers to a SQL expression (and not a single table-bound column) is considered to be a "read only" property; populating it has no effect on the state of data, and it can only return database state. For this reason a column_property()'s value is expired whenever the parent object is involved in a flush, that is, has any kind of "dirty" state within a flush. Setting this parameter to `False` will have the effect of leaving any existing value present after the flush proceeds. Note however that the `Session` with default expiration settings still expires all attributes after a `Session.commit()` call, however.

  New in version 0.7.3.
- **extension** – an `AttributeExtension` instance, or list of extensions, which will be prepended to the list of attribute listeners for the resulting descriptor placed on the class.

Deprecated. Please see AttributeEvents.

Mapping a Subset of Table Columns

Sometimes, a Table object was made available using the reflection process described at *Reflecting Database Objects* to load the table's structure from the database. For such a table that has lots of columns that don't need to be referenced in the application, the include_properties or exclude_properties arguments can specify that only a subset of columns should be mapped. For example:

```
class User(Base):
    __table__ = user_table
    __mapper_args__ = {
        'include_properties' :['user_id', 'user_name']
    }
```

...will map the User class to the user_table table, only including the user_id and user_name columns - the rest are not referenced. Similarly:

```
class Address(Base):
    __table__ = address_table
    __mapper_args__ = {
        'exclude_properties' : ['street', 'city', 'state', 'zip']
    }
```

...will map the Address class to the address_table table, including all columns present except street, city, state, and zip.

When this mapping is used, the columns that are not included will not be referenced in any SELECT statements emitted by Query, nor will there be any mapped attribute on the mapped class which represents the column; assigning an attribute of that name will have no effect beyond that of a normal Python attribute assignment.

In some cases, multiple columns may have the same name, such as when mapping to a join of two or more tables that share some column name. include_properties and exclude_properties can also accommodate Column objects to more accurately describe which columns should be included or excluded:

```
class UserAddress(Base):
    __table__ = user_table.join(addresses_table)
    __mapper_args__ = {
        'exclude_properties' :[address_table.c.id],
        'primary_key' : [user_table.c.id]
    }
```

Note: insert and update defaults configured on individual Column objects, i.e. those described at *Column Insert/Update Defaults* including those configured by the default, update, server_default and server_onupdate arguments, will continue to function normally even if those Column objects are not mapped. This is because in the case of default and update, the Column object is still present on the underlying Table, thus allowing the default functions to take place when the ORM emits an INSERT or UPDATE, and in the case of server_default and server_onupdate, the relational database itself maintains these functions.

2.2.3 Deferred Column Loading

This feature allows particular columns of a table be loaded only upon direct access, instead of when the entity is queried using Query. This feature is useful when one wants to avoid loading a large text or binary field into memory when it's not needed. Individual columns can be lazy loaded by themselves or placed into groups that lazy-load together, using the orm.deferred() function to mark them as "deferred". In the example below, we define a mapping that

will load each of `.excerpt` and `.photo` in separate, individual-row SELECT statements when each attribute is first referenced on the individual object instance:

```
from sqlalchemy.orm import deferred
from sqlalchemy import Integer, String, Text, Binary, Column

class Book(Base):
    __tablename__ = 'book'

    book_id = Column(Integer, primary_key=True)
    title = Column(String(200), nullable=False)
    summary = Column(String(2000))
    excerpt = deferred(Column(Text))
    photo = deferred(Column(Binary))
```

Classical mappings as always place the usage of `orm.deferred()` in the `properties` dictionary against the table-bound `Column`:

```
mapper(Book, book_table, properties={
    'photo':deferred(book_table.c.photo)
})
```

Deferred columns can be associated with a "group" name, so that they load together when any of them are first accessed. The example below defines a mapping with a `photos` deferred group. When one `.photo` is accessed, all three photos will be loaded in one SELECT statement. The `.excerpt` will be loaded separately when it is accessed:

```
class Book(Base):
    __tablename__ = 'book'

    book_id = Column(Integer, primary_key=True)
    title = Column(String(200), nullable=False)
    summary = Column(String(2000))
    excerpt = deferred(Column(Text))
    photo1 = deferred(Column(Binary), group='photos')
    photo2 = deferred(Column(Binary), group='photos')
    photo3 = deferred(Column(Binary), group='photos')
```

You can defer or undefer columns at the `Query` level using the `orm.defer()` and `orm.undefer()` query options:

```
from sqlalchemy.orm import defer, undefer

query = session.query(Book)
query.options(defer('summary')).all()
query.options(undefer('excerpt')).all()
```

And an entire "deferred group", i.e. which uses the `group` keyword argument to `orm.deferred()`, can be undeferred using `orm.undefer_group()`, sending in the group name:

```
from sqlalchemy.orm import undefer_group

query = session.query(Book)
query.options(undefer_group('photos')).all()
```

Column Deferral API

`sqlalchemy.orm.`**`deferred`**`(`*columns*, ***kwargs*`)`

Return a `DeferredColumnProperty`, which indicates this object attributes should only be loaded from its corresponding table column when first accessed.

Used with the "properties" dictionary sent to `mapper()`.

See also:

Deferred Column Loading

sqlalchemy.orm.**defer**(**key*)

Return a `MapperOption` that will convert the column property of the given name into a deferred load.

Used with `Query.options()`.

e.g.:

```
from sqlalchemy.orm import defer

query(MyClass).options(defer("attribute_one"),
                       defer("attribute_two"))
```

A class bound descriptor is also accepted:

```
query(MyClass).options(
                       defer(MyClass.attribute_one),
                       defer(MyClass.attribute_two))
```

A "path" can be specified onto a related or collection object using a dotted name. The `orm.defer()` option will be applied to that object when loaded:

```
query(MyClass).options(
                       defer("related.attribute_one"),
                       defer("related.attribute_two"))
```

To specify a path via class, send multiple arguments:

```
query(MyClass).options(
                       defer(MyClass.related, MyOtherClass.attribute_one),
                       defer(MyClass.related, MyOtherClass.attribute_two))
```

See also:

Deferred Column Loading

Parameters ***key** – A key representing an individual path. Multiple entries are accepted to allow a multiple-token path for a single target, not multiple targets.

sqlalchemy.orm.**undefer**(**key*)

Return a `MapperOption` that will convert the column property of the given name into a non-deferred (regular column) load.

Used with `Query.options()`.

e.g.:

```
from sqlalchemy.orm import undefer

query(MyClass).options(undefer("attribute_one"),
                       undefer("attribute_two"))
```

A class bound descriptor is also accepted:

```
query(MyClass).options(
                       undefer(MyClass.attribute_one),
                       undefer(MyClass.attribute_two))
```

A "path" can be specified onto a related or collection object using a dotted name. The `orm.undefer()` option will be applied to that object when loaded:

```
query(MyClass).options(
                    undefer("related.attribute_one"),
                    undefer("related.attribute_two"))
```

To specify a path via class, send multiple arguments:

```
query(MyClass).options(
                    undefer(MyClass.related, MyOtherClass.attribute_one),
                    undefer(MyClass.related, MyOtherClass.attribute_two))
```

See also:

`orm.undefer_group()` as a means to "undefer" a group of attributes at once.

Deferred Column Loading

Parameters ***key** – A key representing an individual path. Multiple entries are accepted to allow a multiple-token path for a single target, not multiple targets.

`sqlalchemy.orm.`**`undefer_group`**(*name*)

Return a `MapperOption` that will convert the given group of deferred column properties into a non-deferred (regular column) load.

Used with `Query.options()`.

e.g.:

```
query(MyClass).options(undefer("group_one"))
```

See also:

Deferred Column Loading

Parameters **name** – String name of the deferred group. This name is established using the "group" name to the `orm.deferred()` configurational function.

2.2.4 SQL Expressions as Mapped Attributes

Attributes on a mapped class can be linked to SQL expressions, which can be used in queries.

Using a Hybrid

The easiest and most flexible way to link relatively simple SQL expressions to a class is to use a so-called "hybrid attribute", described in the section *Hybrid Attributes*. The hybrid provides for an expression that works at both the Python level as well as at the SQL expression level. For example, below we map a class `User`, containing attributes `firstname` and `lastname`, and include a hybrid that will provide for us the `fullname`, which is the string concatenation of the two:

```
from sqlalchemy.ext.hybrid import hybrid_property

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    firstname = Column(String(50))
    lastname = Column(String(50))
```

```
    @hybrid_property
    def fullname(self):
        return self.firstname + " " + self.lastname
```

Above, the `fullname` attribute is interpreted at both the instance and class level, so that it is available from an instance:

```
some_user = session.query(User).first()
print some_user.fullname
```

as well as usable wtihin queries:

```
some_user = session.query(User).filter(User.fullname == "John Smith").first()
```

The string concatenation example is a simple one, where the Python expression can be dual purposed at the instance and class level. Often, the SQL expression must be distinguished from the Python expression, which can be achieved using `hybrid_property.expression()`. Below we illustrate the case where a conditional needs to be present inside the hybrid, using the `if` statement in Python and the `sql.expression.case()` construct for SQL expressions:

```
from sqlalchemy.ext.hybrid import hybrid_property
from sqlalchemy.sql import case

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    firstname = Column(String(50))
    lastname = Column(String(50))

    @hybrid_property
    def fullname(self):
        if self.firstname is not None:
            return self.firstname + " " + self.lastname
        else:
            return self.lastname

    @fullname.expression
    def fullname(cls):
        return case([
            (cls.firstname != None, cls.firstname + " " + cls.lastname),
        ], else_ = cls.lastname)
```

Using column_property

The `orm.column_property()` function can be used to map a SQL expression in a manner similar to a regularly mapped `Column`. With this technique, the attribute is loaded along with all other column-mapped attributes at load time. This is in some cases an advantage over the usage of hybrids, as the value can be loaded up front at the same time as the parent row of the object, particularly if the expression is one which links to other tables (typically as a correlated subquery) to access data that wouldn't normally be available on an already loaded object.

Disadvantages to using `orm.column_property()` for SQL expressions include that the expression must be compatible with the SELECT statement emitted for the class as a whole, and there are also some configurational quirks which can occur when using `orm.column_property()` from declarative mixins.

Our "fullname" example can be expressed using `orm.column_property()` as follows:

```
from sqlalchemy.orm import column_property
```

```
class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    firstname = Column(String(50))
    lastname = Column(String(50))
    fullname = column_property(firstname + " " + lastname)
```

Correlated subqueries may be used as well. Below we use the `select()` construct to create a SELECT that links together the count of `Address` objects available for a particular `User`:

```
from sqlalchemy.orm import column_property
from sqlalchemy import select, func
from sqlalchemy import Column, Integer, String, ForeignKey

from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    user_id = Column(Integer, ForeignKey('user.id'))

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    address_count = column_property(
        select([func.count(Address.id)]).\
            where(Address.user_id==id)
    )
```

If import issues prevent the `column_property()` from being defined inline with the class, it can be assigned to the class after both are configured. In Declarative this has the effect of calling `Mapper.add_property()` to add an additional property after the fact:

```
User.address_count = column_property(
        select([func.count(Address.id)]).\
            where(Address.user_id==User.id)
    )
```

For many-to-many relationships, use `and_()` to join the fields of the association table to both tables in a relation, illustrated here with a classical mapping:

```
from sqlalchemy import and_

mapper(Author, authors, properties={
    'book_count': column_property(
                        select([func.count(books.c.id)],
                            and_(
                                book_authors.c.author_id==authors.c.id,
                                book_authors.c.book_id==books.c.id
                            )))
    })
```

Using a plain descriptor

In cases where a SQL query more elaborate than what `orm.column_property()` or `hybrid_property` can provide must be emitted, a regular Python function accessed as an attribute can be used, assuming the expression only

needs to be available on an already-loaded instance. The function is decorated with Python's own `@property` decorator to mark it as a read-only attribute. Within the function, `object_session()` is used to locate the `Session` corresponding to the current object, which is then used to emit a query:

```
from sqlalchemy.orm import object_session
from sqlalchemy import select, func

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    firstname = Column(String(50))
    lastname = Column(String(50))

    @property
    def address_count(self):
        return object_session(self).\
            scalar(
                select([func.count(Address.id)]).\
                    where(Address.user_id==self.id)
            )
```

The plain descriptor approach is useful as a last resort, but is less performant in the usual case than both the hybrid and column property approaches, in that it needs to emit a SQL query upon each access.

2.2.5 Changing Attribute Behavior

Simple Validators

A quick way to add a "validation" routine to an attribute is to use the `validates()` decorator. An attribute validator can raise an exception, halting the process of mutating the attribute's value, or can change the given value into something different. Validators, like all attribute extensions, are only called by normal userland code; they are not issued when the ORM is populating the object:

```
from sqlalchemy.orm import validates

class EmailAddress(Base):
    __tablename__ = 'address'

    id = Column(Integer, primary_key=True)
    email = Column(String)

    @validates('email')
    def validate_email(self, key, address):
        assert '@' in address
        return address
```

Validators also receive collection events, when items are added to a collection:

```
from sqlalchemy.orm import validates

class User(Base):
    # ...

    addresses = relationship("Address")

    @validates('addresses')
    def validate_address(self, key, address):
```

```
        assert '@' in address.email
        return address
```

Note that the `validates()` decorator is a convenience function built on top of attribute events. An application that requires more control over configuration of attribute change behavior can make use of this system, described at `AttributeEvents`.

`sqlalchemy.orm.`**`validates`**`(*names, **kw)`

Decorate a method as a 'validator' for one or more named properties.

Designates a method as a validator, a method which receives the name of the attribute as well as a value to be assigned, or in the case of a collection, the value to be added to the collection. The function can then raise validation exceptions to halt the process from continuing (where Python's built-in `ValueError` and `AssertionError` exceptions are reasonable choices), or can modify or replace the value before proceeding. The function should otherwise return the given value.

Note that a validator for a collection **cannot** issue a load of that collection within the validation routine - this usage raises an assertion to avoid recursion overflows. This is a reentrant condition which is not supported.

Parameters

- ***names** – list of attribute names to be validated.
- **include_removes** – if True, "remove" events will be sent as well - the validation function must accept an additional argument "is_remove" which will be a boolean.

  New in version 0.7.7.

Using Descriptors and Hybrids

A more comprehensive way to produce modified behavior for an attribute is to use descriptors. These are commonly used in Python using the `property()` function. The standard SQLAlchemy technique for descriptors is to create a plain descriptor, and to have it read/write from a mapped attribute with a different name. Below we illustrate this using Python 2.6-style properties:

```
class EmailAddress(Base):
    __tablename__ = 'email_address'

    id = Column(Integer, primary_key=True)

    # name the attribute with an underscore,
    # different from the column name
    _email = Column("email", String)

    # then create an ".email" attribute
    # to get/set "._email"
    @property
    def email(self):
        return self._email

    @email.setter
    def email(self, email):
        self._email = email
```

The approach above will work, but there's more we can add. While our `EmailAddress` object will shuttle the value through the `email` descriptor and into the `_email` mapped attribute, the class level `EmailAddress.email` attribute does not have the usual expression semantics usable with `Query`. To provide these, we instead use the `hybrid` extension as follows:

```
from sqlalchemy.ext.hybrid import hybrid_property

class EmailAddress(Base):
    __tablename__ = 'email_address'

    id = Column(Integer, primary_key=True)

    _email = Column("email", String)

    @hybrid_property
    def email(self):
        return self._email

    @email.setter
    def email(self, email):
        self._email = email
```

The `.email` attribute, in addition to providing getter/setter behavior when we have an instance of `EmailAddress`, also provides a SQL expression when used at the class level, that is, from the `EmailAddress` class directly:

```
from sqlalchemy.orm import Session
session = Session()

address = session.query(EmailAddress).\
                filter(EmailAddress.email == 'address@example.com').\
                one()
SELECT address.email AS address_email, address.id AS address_id
FROM address
WHERE address.email = ?
('address@example.com',)


address.email = 'otheraddress@example.com'
session.commit()
UPDATE address SET email=? WHERE address.id = ?
('otheraddress@example.com', 1)
COMMIT
```

The `hybrid_property` also allows us to change the behavior of the attribute, including defining separate behaviors when the attribute is accessed at the instance level versus at the class/expression level, using the `hybrid_property.expression()` modifier. Such as, if we wanted to add a host name automatically, we might define two sets of string manipulation logic:

```
class EmailAddress(Base):
    __tablename__ = 'email_address'

    id = Column(Integer, primary_key=True)

    _email = Column("email", String)

    @hybrid_property
    def email(self):
        """Return the value of _email up until the last twelve
        characters."""

        return self._email[:-12]

    @email.setter
    def email(self, email):
```

```
        """Set the value of _email, tacking on the twelve character
        value @example.com."""

        self._email = email + "@example.com"

    @email.expression
    def email(cls):
        """Produce a SQL expression that represents the value
        of the _email column, minus the last twelve characters."""

        return func.substr(cls._email, 0, func.length(cls._email) - 12)
```

Above, accessing the `email` property of an instance of `EmailAddress` will return the value of the `_email` attribute, removing or adding the hostname `@example.com` from the value. When we query against the `email` attribute, a SQL function is rendered which produces the same effect:

```
address = session.query(EmailAddress).filter(EmailAddress.email == 'address').one()
SELECT address.email AS address_email, address.id AS address_id
FROM address
WHERE substr(address.email, ?, length(address.email) - ?) = ?
(0, 12, 'address')
```

Read more about Hybrids at *Hybrid Attributes*.

Synonyms

Synonyms are a mapper-level construct that applies expression behavior to a descriptor based attribute.

Changed in version 0.7: The functionality of synonym is superceded as of 0.7 by hybrid attributes.

`sqlalchemy.orm.`**`synonym`**(*name*, *map_column=False*, *descriptor=None*, *comparator_factory=None*, *doc=None*)

Denote an attribute name as a synonym to a mapped property.

Changed in version 0.7: `synonym()` is superseded by the `hybrid` extension. See the documentation for hybrids at *Hybrid Attributes*.

Used with the `properties` dictionary sent to `mapper()`:

```
class MyClass(object):
    def _get_status(self):
        return self._status
    def _set_status(self, value):
        self._status = value
    status = property(_get_status, _set_status)

mapper(MyClass, sometable, properties={
    "status":synonym("_status", map_column=True)
})
```

Above, the `status` attribute of MyClass will produce expression behavior against the table column named `status`, using the Python attribute `_status` on the mapped class to represent the underlying value.

Parameters

- **name** – the name of the existing mapped property, which can be any other `MapperProperty` including column-based properties and relationships.

- **map_column** – if `True`, an additional `ColumnProperty` is created on the mapper automatically, using the synonym's name as the keyname of the property, and the keyname of this `synonym()` as the name of the column to map.

Custom Comparators

The expressions returned by comparison operations, such as `User.name=='ed'`, can be customized, by implementing an object that explicitly defines each comparison method needed.

This is a relatively rare use case which generally applies only to highly customized types. Usually, custom SQL behaviors can be associated with a mapped class by composing together the classes' existing mapped attributes with other expression components, using the techniques described in *SQL Expressions as Mapped Attributes*. Those approaches should be considered first before resorting to custom comparison objects.

Each of `orm.column_property()`, `composite()`, `relationship()`, and `comparable_property()` accept an argument called `comparator_factory`. A subclass of `PropComparator` can be provided for this argument, which can then reimplement basic Python comparison methods such as `__eq__()`, `__ne__()`, `__lt__()`, and so on.

It's best to subclass the `PropComparator` subclass provided by each type of property. For example, to allow a column-mapped attribute to do case-insensitive comparison:

```
from sqlalchemy.orm.properties import ColumnProperty
from sqlalchemy.sql import func, Column, Integer, String

class MyComparator(ColumnProperty.Comparator):
    def __eq__(self, other):
        return func.lower(self.__clause_element__()) == func.lower(other)

class EmailAddress(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    email = column_property(
                    Column('email', String),
                    comparator_factory=MyComparator
                )
```

Above, comparisons on the `email` column are wrapped in the SQL lower() function to produce case-insensitive matching:

```
>>> str(EmailAddress.email == 'SomeAddress@foo.com')
lower(address.email) = lower(:lower_1)
```

When building a `PropComparator`, the `__clause_element__()` method should be used in order to acquire the underlying mapped column. This will return a column that is appropriately wrapped in any kind of subquery or aliasing that has been applied in the context of the generated SQL statement.

`sqlalchemy.orm.`**`comparable_property`**(*comparator_factory*, *descriptor=None*)

Provides a method of applying a `PropComparator` to any Python descriptor attribute.

Changed in version 0.7: `comparable_property()` is superseded by the `hybrid` extension. See the example at *Building Custom Comparators*.

Allows any Python descriptor to behave like a SQL-enabled attribute when used at the class level in queries, allowing redefinition of expression operator behavior.

In the example below we redefine `PropComparator.operate()` to wrap both sides of an expression in `func.lower()` to produce case-insensitive comparison:

```
from sqlalchemy.orm import comparable_property
from sqlalchemy.orm.interfaces import PropComparator
from sqlalchemy.sql import func
from sqlalchemy import Integer, String, Column
from sqlalchemy.ext.declarative import declarative_base

class CaseInsensitiveComparator(PropComparator):
    def __clause_element__(self):
        return self.prop

    def operate(self, op, other):
        return op(
            func.lower(self.__clause_element__()),
            func.lower(other)
        )

Base = declarative_base()

class SearchWord(Base):
    __tablename__ = 'search_word'
    id = Column(Integer, primary_key=True)
    word = Column(String)
    word_insensitive = comparable_property(lambda prop, mapper:
                            CaseInsensitiveComparator(mapper.c.word, mapper)
                        )
```

A mapping like the above allows the `word_insensitive` attribute to render an expression like:

```
>>> print SearchWord.word_insensitive == "Trucks"
lower(search_word.word) = lower(:lower_1)
```

Parameters

- **comparator_factory** – A PropComparator subclass or factory that defines operator behavior for this property.
- **descriptor** – Optional when used in a `properties={}` declaration. The Python descriptor or property to layer comparison behavior on top of.

  The like-named descriptor will be automatically retrieved from the mapped class if left blank in a `properties` declaration.

2.2.6 Composite Column Types

Sets of columns can be associated with a single user-defined datatype. The ORM provides a single attribute which represents the group of columns using the class you provide.

Changed in version 0.7: Composites have been simplified such that they no longer "conceal" the underlying column based attributes. Additionally, in-place mutation is no longer automatic; see the section below on enabling mutability to support tracking of in-place changes.

A simple example represents pairs of columns as a `Point` object. `Point` represents such a pair as `.x` and `.y`:

```
class Point(object):
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

```
    def __composite_values__(self):
        return self.x, self.y

    def __repr__(self):
        return "Point(x=%r, y=%r)" % (self.x, self.y)

    def __eq__(self, other):
        return isinstance(other, Point) and \
            other.x == self.x and \
            other.y == self.y

    def __ne__(self, other):
        return not self.__eq__(other)
```

The requirements for the custom datatype class are that it have a constructor which accepts positional arguments corresponding to its column format, and also provides a method `__composite_values__()` which returns the state of the object as a list or tuple, in order of its column-based attributes. It also should supply adequate `__eq__()` and `__ne__()` methods which test the equality of two instances.

We will create a mapping to a table `vertice`, which represents two points as `x1/y1` and `x2/y2`. These are created normally as `Column` objects. Then, the `composite()` function is used to assign new attributes that will represent sets of columns via the `Point` class:

```
from sqlalchemy import Column, Integer
from sqlalchemy.orm import composite
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class Vertex(Base):
    __tablename__ = 'vertice'

    id = Column(Integer, primary_key=True)
    x1 = Column(Integer)
    y1 = Column(Integer)
    x2 = Column(Integer)
    y2 = Column(Integer)

    start = composite(Point, x1, y1)
    end = composite(Point, x2, y2)
```

A classical mapping above would define each `composite()` against the existing table:

```
mapper(Vertex, vertice_table, properties={
    'start':composite(Point, vertice_table.c.x1, vertice_table.c.y1),
    'end':composite(Point, vertice_table.c.x2, vertice_table.c.y2),
})
```

We can now persist and use `Vertex` instances, as well as query for them, using the `.start` and `.end` attributes against ad-hoc `Point` instances:

```
>>> v = Vertex(start=Point(3, 4), end=Point(5, 6))
>>> session.add(v)
>>> q = session.query(Vertex).filter(Vertex.start == Point(3, 4))
>>> print q.first().start
BEGIN (implicit)
INSERT INTO vertice (x1, y1, x2, y2) VALUES (?, ?, ?, ?)
(3, 4, 5, 6)
SELECT vertice.id AS vertice_id,
```

```
        vertice.x1 AS vertice_x1,
        vertice.y1 AS vertice_y1,
        vertice.x2 AS vertice_x2,
        vertice.y2 AS vertice_y2
FROM vertice
WHERE vertice.x1 = ? AND vertice.y1 = ?
 LIMIT ? OFFSET ?
(3, 4, 1, 0)
Point(x=3, y=4)
```

sqlalchemy.orm.**composite**(*class_*, **cols*, ***kwargs*)

Return a composite column-based property for use with a Mapper.

See the mapping documentation section *Composite Column Types* for a full usage example.

Parameters

- **class_** – The "composite type" class.
- ***cols** – List of Column objects to be mapped.
- **active_history=False** – When `True`, indicates that the "previous" value for a scalar attribute should be loaded when replaced, if not already loaded. See the same flag on `column_property()`.

  Changed in version 0.7: This flag specifically becomes meaningful - previously it was a placeholder.
- **group** – A group name for this property when marked as deferred.
- **deferred** – When True, the column property is "deferred", meaning that it does not load immediately, and is instead loaded when the attribute is first accessed on an instance. See also `deferred()`.
- **comparator_factory** – a class which extends `CompositeProperty.Comparator` which provides custom SQL clause generation for comparison operations.
- **doc** – optional string that will be applied as the doc on the class-bound descriptor.
- **extension** – an `AttributeExtension` instance, or list of extensions, which will be prepended to the list of attribute listeners for the resulting descriptor placed on the class. **Deprecated.** Please see `AttributeEvents`.

Tracking In-Place Mutations on Composites

In-place changes to an existing composite value are not tracked automatically. Instead, the composite class needs to provide events to its parent object explicitly. This task is largely automated via the usage of the `MutableComposite` mixin, which uses events to associate each user-defined composite object with all parent associations. Please see the example in *Establishing Mutability on Composites*.

Changed in version 0.7: No automatic tracking of in-place changes to an existing composite value.

Redefining Comparison Operations for Composites

The "equals" comparison operation by default produces an AND of all corresponding columns equated to one another. This can be changed using the `comparator_factory`, described in *Custom Comparators*. Below we illustrate the "greater than" operator, implementing the same expression that the base "greater than" does:

```
from sqlalchemy.orm.properties import CompositeProperty
from sqlalchemy import sql

class PointComparator(CompositeProperty.Comparator):
    def __gt__(self, other):
        """redefine the 'greater than' operation"""

        return sql.and_(*[a>b for a, b in
                          zip(self.__clause_element__().clauses,
                              other.__composite_values__())])

class Vertex(Base):
    ___tablename__ = 'vertice'

    id = Column(Integer, primary_key=True)
    x1 = Column(Integer)
    y1 = Column(Integer)
    x2 = Column(Integer)
    y2 = Column(Integer)

    start = composite(Point, x1, y1,
                      comparator_factory=PointComparator)
    end = composite(Point, x2, y2,
                      comparator_factory=PointComparator)
```

2.2.7 Mapping a Class against Multiple Tables

Mappers can be constructed against arbitrary relational units (called *selectables*) in addition to plain tables. For example, the `join()` function creates a selectable unit comprised of multiple tables, complete with its own composite primary key, which can be mapped in the same way as a `Table`:

```
from sqlalchemy import Table, Column, Integer, \
        String, MetaData, join, ForeignKey
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import column_property

metadata = MetaData()

# define two Table objects
user_table = Table('user', metadata,
            Column('id', Integer, primary_key=True),
            Column('name', String),
        )

address_table = Table('address', metadata,
            Column('id', Integer, primary_key=True),
            Column('user_id', Integer, ForeignKey('user.id')),
            Column('email_address', String)
            )

# define a join between them.  This
# takes place across the user.id and address.user_id
# columns.
user_address_join = join(user_table, address_table)

Base = declarative_base()
```

```
# map to it
class AddressUser(Base):
    __table__ = user_address_join

    id = column_property(user_table.c.id, address_table.c.user_id)
    address_id = address_table.c.id
```

In the example above, the join expresses columns for both the `user` and the `address` table. The `user.id` and `address.user_id` columns are equated by foreign key, so in the mapping they are defined as one attribute, `AddressUser.id`, using `column_property()` to indicate a specialized column mapping. Based on this part of the configuration, the mapping will copy new primary key values from `user.id` into the `address.user_id` column when a flush occurs.

Additionally, the `address.id` column is mapped explicitly to an attribute named `address_id`. This is to **disambiguate** the mapping of the `address.id` column from the same-named `AddressUser.id` attribute, which here has been assigned to refer to the `user` table combined with the `address.user_id` foreign key.

The natural primary key of the above mapping is the composite of `(user.id, address.id)`, as these are the primary key columns of the `user` and `address` table combined together. The identity of an `AddressUser` object will be in terms of these two values, and is represented from an `AddressUser` object as `(AddressUser.id, AddressUser.address_id)`.

2.2.8 Mapping a Class against Arbitrary Selects

Similar to mapping against a join, a plain `select()` object can be used with a mapper as well. The example fragment below illustrates mapping a class called `Customer` to a `select()` which includes a join to a subquery:

```
from sqlalchemy import select, func

subq = select([
            func.count(orders.c.id).label('order_count'),
            func.max(orders.c.price).label('highest_order'),
            orders.c.customer_id
            ]).group_by(orders.c.customer_id).alias()

customer_select = select([customers, subq]).\
            select_from(
                join(customers, subq,
                        customers.c.id == subq.c.customer_id)
            ).alias()

class Customer(Base):
    __table__ = customer_select
```

Above, the full row represented by `customer_select` will be all the columns of the `customers` table, in addition to those columns exposed by the `subq` subquery, which are `order_count`, `highest_order`, and `customer_id`. Mapping the `Customer` class to this selectable then creates a class which will contain those attributes.

When the ORM persists new instances of `Customer`, only the `customers` table will actually receive an INSERT. This is because the primary key of the `orders` table is not represented in the mapping; the ORM will only emit an INSERT into a table for which it has mapped the primary key.

Note: The practice of mapping to arbitrary SELECT statements, especially complex ones as above, is almost never needed; it necessarily tends to produce complex queries which are often less efficient than that which would be produced by direct query construction. The practice is to some degree based on the very early history of SQLAlchemy where the `mapper()` construct was meant to represent the primary querying interface; in modern usage, the `Query`

object can be used to construct virtually any SELECT statement, including complex composites, and should be favored over the "map-to-selectable" approach.

2.2.9 Multiple Mappers for One Class

In modern SQLAlchemy, a particular class is only mapped by one `mapper()` at a time. The rationale here is that the `mapper()` modifies the class itself, not only persisting it towards a particular `Table`, but also *instrumenting* attributes upon the class which are structured specifically according to the table metadata.

One potential use case for another mapper to exist at the same time is if we wanted to load instances of our class not just from the immediate `Table` to which it is mapped, but from another selectable that is a derivation of that `Table`. While there technically is a way to create such a `mapper()`, using the `non_primary=True` option, this approach is virtually never needed. Instead, we use the functionality of the `Query` object to achieve this, using a method such as `Query.select_from()` or `Query.from_statement()` to specify a derived selectable.

Another potential use is if we genuinely want instances of our class to be persisted into different tables at different times; certain kinds of data sharding configurations may persist a particular class into tables that are identical in structure except for their name. For this kind of pattern, Python offers a better approach than the complexity of mapping the same class multiple times, which is to instead create new mapped classes for each target table. SQLAlchemy refers to this as the "entity name" pattern, which is described as a recipe at Entity Name.

2.2.10 Constructors and Object Initialization

Mapping imposes no restrictions or requirements on the constructor (`__init__`) method for the class. You are free to require any arguments for the function that you wish, assign attributes to the instance that are unknown to the ORM, and generally do anything else you would normally do when writing a constructor for a Python class.

The SQLAlchemy ORM does not call `__init__` when recreating objects from database rows. The ORM's process is somewhat akin to the Python standard library's `pickle` module, invoking the low level `__new__` method and then quietly restoring attributes directly on the instance rather than calling `__init__`.

If you need to do some setup on database-loaded instances before they're ready to use, you can use the `@reconstructor` decorator to tag a method as the ORM counterpart to `__init__`. SQLAlchemy will call this method with no arguments every time it loads or reconstructs one of your instances. This is useful for recreating transient properties that are normally assigned in your `__init__`:

```
from sqlalchemy import orm

class MyMappedClass(object):
    def __init__(self, data):
        self.data = data
        # we need stuff on all instances, but not in the database.
        self.stuff = []

    @orm.reconstructor
    def init_on_load(self):
        self.stuff = []
```

When `obj = MyMappedClass()` is executed, Python calls the `__init__` method as normal and the `data` argument is required. When instances are loaded during a `Query` operation as in `query(MyMappedClass).one()`, `init_on_load` is called.

Any method may be tagged as the `reconstructor()`, even the `__init__` method. SQLAlchemy will call the reconstructor method with no arguments. Scalar (non-collection) database-mapped attributes of the instance will be available for use within the function. Eagerly-loaded collections are generally not yet available and will usually only

contain the first element. ORM state changes made to objects at this stage will not be recorded for the next flush() operation, so the activity within a reconstructor should be conservative.

`reconstructor()` is a shortcut into a larger system of "instance level" events, which can be subscribed to using the event API - see `InstanceEvents` for the full API description of these events.

sqlalchemy.orm.**reconstructor**(*fn*)
Decorate a method as the 'reconstructor' hook.

Designates a method as the "reconstructor", an `__init__`-like method that will be called by the ORM after the instance has been loaded from the database or otherwise reconstituted.

The reconstructor will be invoked with no arguments. Scalar (non-collection) database-mapped attributes of the instance will be available for use within the function. Eagerly-loaded collections are generally not yet available and will usually only contain the first element. ORM state changes made to objects at this stage will not be recorded for the next flush() operation, so the activity within a reconstructor should be conservative.

2.2.11 Class Mapping API

sqlalchemy.orm.**mapper**(*class_*, *local_table=None*, **args*, ***params*)
Return a new `Mapper` object.

This function is typically used behind the scenes via the Declarative extension. When using Declarative, many of the usual `mapper()` arguments are handled by the Declarative extension itself, including `class_`, `local_table`, `properties`, and `inherits`. Other options are passed to `mapper()` using the `__mapper_args__` class variable:

```
class MyClass(Base):
    __tablename__ = 'my_table'
    id = Column(Integer, primary_key=True)
    type = Column(String(50))
    alt = Column("some_alt", Integer)

    __mapper_args__ = {
        'polymorphic_on' : type
    }
```

Explicit use of `mapper()` is often referred to as *classical mapping*. The above declarative example is equivalent in classical form to:

```
my_table = Table("my_table", metadata,
    Column('id', Integer, primary_key=True),
    Column('type', String(50)),
    Column("some_alt", Integer)
)

class MyClass(object):
    pass

mapper(MyClass, my_table,
    polymorphic_on=my_table.c.type,
    properties={
        'alt':my_table.c.some_alt
    })
```

See also:

Classical Mappings - discussion of direct usage of `mapper()`

Parameters

- **class_** – The class to be mapped. When using Declarative, this argument is automatically passed as the declared class itself.
- **local_table** – The `Table` or other selectable to which the class is mapped. May be `None` if this mapper inherits from another mapper using single-table inheritance. When using Declarative, this argument is automatically passed by the extension, based on what is configured via the `__table__` argument or via the `Table` produced as a result of the `__tablename__` and `Column` arguments present.
- **always_refresh** – If True, all query operations for this mapped class will overwrite all data within object instances that already exist within the session, erasing any in-memory changes with whatever information was loaded from the database. Usage of this flag is highly discouraged; as an alternative, see the method `Query.populate_existing()`.
- **allow_null_pks** – This flag is deprecated - this is stated as allow_partial_pks which defaults to True.
- **allow_partial_pks** – Defaults to True. Indicates that a composite primary key with some NULL values should be considered as possibly existing within the database. This affects whether a mapper will assign an incoming row to an existing identity, as well as if `Session.merge()` will check the database first for a particular primary key value. A "partial primary key" can occur if one has mapped to an OUTER JOIN, for example.
- **batch** – Defaults to `True`, indicating that save operations of multiple entities can be batched together for efficiency. Setting to False indicates that an instance will be fully saved before saving the next instance. This is used in the extremely rare case that a `MapperEvents` listener requires being called in between individual row persistence operations.
- **column_prefix** – A string which will be prepended to the mapped attribute name when `Column` objects are automatically assigned as attributes to the mapped class. Does not affect explicitly specified column-based properties.

  See the section *Naming All Columns with a Prefix* for an example.
- **concrete** – If True, indicates this mapper should use concrete table inheritance with its parent mapper.

  See the section *Concrete Table Inheritance* for an example.
- **exclude_properties** – A list or set of string column names to be excluded from mapping.

  See *Mapping a Subset of Table Columns* for an example.
- **extension** – A `MapperExtension` instance or list of `MapperExtension` instances which will be applied to all operations by this `Mapper`. **Deprecated.** Please see `MapperEvents`.
- **include_properties** – An inclusive list or set of string column names to map.

  See *Mapping a Subset of Table Columns* for an example.
- **inherits** – A mapped class or the corresponding `Mapper` of one indicating a superclass to which this `Mapper` should *inherit* from. The mapped class here must be a subclass of the other mapper's class. When using Declarative, this argument is passed automatically as a result of the natural class hierarchy of the declared classes.

  See also:

  Mapping Class Inheritance Hierarchies
- **inherit_condition** – For joined table inheritance, a SQL expression which will define how the two tables are joined; defaults to a natural join between the two tables.

- **inherit_foreign_keys** – When `inherit_condition` is used and the columns present are missing a `ForeignKey` configuration, this parameter can be used to specify which columns are "foreign". In most cases can be left as `None`.
- **non_primary** – Specify that this `Mapper` is in addition to the "primary" mapper, that is, the one used for persistence. The `Mapper` created here may be used for ad-hoc mapping of the class to an alternate selectable, for loading only.

  The `non_primary` feature is rarely needed with modern usage.
- **order_by** – A single `Column` or list of `Column` objects for which selection operations should use as the default ordering for entities. By default mappers have no pre-defined ordering.
- **passive_updates** – Indicates UPDATE behavior of foreign key columns when a primary key column changes on a joined-table inheritance mapping. Defaults to `True`.

  When True, it is assumed that ON UPDATE CASCADE is configured on the foreign key in the database, and that the database will handle propagation of an UPDATE from a source column to dependent columns on joined-table rows.

  When False, it is assumed that the database does not enforce referential integrity and will not be issuing its own CASCADE operation for an update. The `Mapper` here will emit an UPDATE statement for the dependent columns during a primary key change.

  See also:

  Mutable Primary Keys / Update Cascades - description of a similar feature as used with `relationship()`
- **polymorphic_on** – Specifies the column, attribute, or SQL expression used to determine the target class for an incoming row, when inheriting classes are present.

  This value is commonly a `Column` object that's present in the mapped `Table`:

```
class Employee(Base):
    __tablename__ = 'employee'

    id = Column(Integer, primary_key=True)
    discriminator = Column(String(50))

    __mapper_args__ = {
        "polymorphic_on":discriminator,
        "polymorphic_identity":"employee"
    }
```

  It may also be specified as a SQL expression, as in this example where we use the `case()` construct to provide a conditional approach:

```
class Employee(Base):
    __tablename__ = 'employee'

    id = Column(Integer, primary_key=True)
    discriminator = Column(String(50))

    __mapper_args__ = {
        "polymorphic_on":case([
            (discriminator == "EN", "engineer"),
            (discriminator == "MA", "manager"),
        ], else_="employee"),
```

```
        "polymorphic_identity":"employee"
    }
```

It may also refer to any attribute configured with `column_property()`, or to the string name of one:

```
class Employee(Base):
    __tablename__ = 'employee'

    id = Column(Integer, primary_key=True)
    discriminator = Column(String(50))
    employee_type = column_property(
        case([
            (discriminator == "EN", "engineer"),
            (discriminator == "MA", "manager"),
        ], else_="employee")
    )

    __mapper_args__ = {
        "polymorphic_on":employee_type,
        "polymorphic_identity":"employee"
    }
```

Changed in version 0.7.4: `polymorphic_on` may be specified as a SQL expression, or refer to any attribute configured with `column_property()`, or to the string name of one.

When setting `polymorphic_on` to reference an attribute or expression that's not present in the locally mapped `Table`, yet the value of the discriminator should be persisted to the database, the value of the discriminator is not automatically set on new instances; this must be handled by the user, either through manual means or via event listeners. A typical approach to establishing such a listener looks like:

```
from sqlalchemy import event
from sqlalchemy.orm import object_mapper

@event.listens_for(Employee, "init", propagate=True)
def set_identity(instance, *arg, **kw):
    mapper = object_mapper(instance)
    instance.discriminator = mapper.polymorphic_identity
```

Where above, we assign the value of `polymorphic_identity` for the mapped class to the `discriminator` attribute, thus persisting the value to the `discriminator` column in the database.

See also:

Mapping Class Inheritance Hierarchies

- **polymorphic_identity** – Specifies the value which identifies this particular class as returned by the column expression referred to by the `polymorphic_on` setting. As rows are received, the value corresponding to the `polymorphic_on` column expression is compared to this value, indicating which subclass should be used for the newly reconstructed object.
- **properties** – A dictionary mapping the string names of object attributes to `MapperProperty` instances, which define the persistence behavior of that attribute. Note that `Column` objects present in the mapped `Table` are automatically placed into `ColumnProperty` instances upon mapping, unless overridden. When using Declarative,

this argument is passed automatically, based on all those MapperProperty instances declared in the declared class body.

- **primary_key** – A list of Column objects which define the primary key to be used against this mapper's selectable unit. This is normally simply the primary key of the local_table, but can be overridden here.
- **version_id_col** – A Column that will be used to keep a running version id of mapped entities in the database. This is used during save operations to ensure that no other thread or process has updated the instance during the lifetime of the entity, else a StaleDataError exception is thrown. By default the column must be of Integer type, unless version_id_generator specifies a new generation algorithm.
- **version_id_generator** – A callable which defines the algorithm used to generate new version ids. Defaults to an integer generator. Can be replaced with one that generates timestamps, uuids, etc. e.g.:

```
import uuid

class MyClass(Base):
    __tablename__ = 'mytable'
    id = Column(Integer, primary_key=True)
    version_uuid = Column(String(32))

    __mapper_args__ = {
        'version_id_col':version_uuid,
        'version_id_generator':lambda version:uuid.uuid4().hex
    }
```

  The callable receives the current version identifier as its single argument.
- **with_polymorphic** – A tuple in the form (<classes>, <selectable>) indicating the default style of "polymorphic" loading, that is, which tables are queried at once. <classes> is any single or list of mappers and/or classes indicating the inherited classes that should be loaded at once. The special value '*' may be used to indicate all descending classes should be loaded immediately. The second tuple argument <selectable> indicates a selectable that will be used to query for multiple classes.

  See also:

  Concrete Table Inheritance - typically uses with_polymorphic to specify a UNION statement to select from.

  Basic Control of Which Tables are Queried - usage example of the related Query.with_polymorphic() method

sqlalchemy.orm.**object_mapper**(*instance*)
Given an object, return the primary Mapper associated with the object instance.

Raises UnmappedInstanceError if no mapping is configured.

sqlalchemy.orm.**class_mapper**(*class_*, *compile=True*)
Given a class, return the primary Mapper associated with the key.

Raises UnmappedClassError if no mapping is configured on the given class, or ArgumentError if a non-class object is passed.

sqlalchemy.orm.**compile_mappers**()
Initialize the inter-mapper relationships of all mappers that have been defined.

Deprecated since version 0.7: compile_mappers() is renamed to configure_mappers()

sqlalchemy.orm.**configure_mappers**()
Initialize the inter-mapper relationships of all mappers that have been constructed thus far.

This function can be called any number of times, but in most cases is handled internally.

sqlalchemy.orm.**clear_mappers**()
Remove all mappers from all classes.

This function removes all instrumentation from classes and disposes of their associated mappers. Once called, the classes are unmapped and can be later re-mapped with new mappers.

clear_mappers() is *not* for normal use, as there is literally no valid usage for it outside of very specific testing scenarios. Normally, mappers are permanent structural components of user-defined classes, and are never discarded independently of their class. If a mapped class itself is garbage collected, its mapper is automatically disposed of as well. As such, clear_mappers() is only for usage in test suites that re-use the same classes with different mappings, which is itself an extremely rare use case - the only such use case is in fact SQLAlchemy's own test suite, and possibly the test suites of other ORM extension libraries which intend to test various combinations of mapper construction upon a fixed set of classes.

sqlalchemy.orm.util.**identity_key**(**args*, ***kwargs*)
Get an identity key.

Valid call signatures:

- identity_key(class, ident)

  class mapped class (must be a positional argument)

  ident primary key, if the key is composite this is a tuple

- identity_key(instance=instance)

  instance object instance (must be given as a keyword arg)

- identity_key(class, row=row)

  class mapped class (must be a positional argument)

  row result proxy row (must be given as a keyword arg)

sqlalchemy.orm.util.**polymorphic_union**(*table_map*, *typecolname*, *aliasname='p_union'*, *cast_nulls=True*)
Create a UNION statement used by a polymorphic mapper.

See *Concrete Table Inheritance* for an example of how this is used.

Parameters

- **table_map** – mapping of polymorphic identities to Table objects.
- **typecolname** – string name of a "discriminator" column, which will be derived from the query, producing the polymorphic identity for each row. If None, no polymorphic discriminator is generated.
- **aliasname** – name of the alias() construct generated.
- **cast_nulls** – if True, non-existent columns, which are represented as labeled NULLs, will be passed into CAST. This is a legacy behavior that is problematic on some backends such as Oracle - in which case it can be set to False.

class sqlalchemy.orm.mapper.**Mapper**(*class_*, *local_table*, *properties=None*, *primary_key=None*, *non_primary=False*, *inherits=None*, *inherit_condition=None*, *inherit_foreign_keys=None*, *extension=None*, *order_by=False*, *always_refresh=False*, *version_id_col=None*, *version_id_generator=None*, *polymorphic_on=None*, *_polymorphic_map=None*, *polymorphic_identity=None*, *concrete=False*, *with_polymorphic=None*, *allow_null_pks=None*, *allow_partial_pks=True*, *batch=True*, *column_prefix=None*, *include_properties=None*, *exclude_properties=None*, *passive_updates=True*, *eager_defaults=False*, *_compiled_cache_size=100*)

Define the correlation of class attributes to database table columns.

Instances of this class should be constructed via the `mapper()` function.

__init__(*class_*, *local_table*, *properties=None*, *primary_key=None*, *non_primary=False*, *inherits=None*, *inherit_condition=None*, *inherit_foreign_keys=None*, *extension=None*, *order_by=False*, *always_refresh=False*, *version_id_col=None*, *version_id_generator=None*, *polymorphic_on=None*, *_polymorphic_map=None*, *polymorphic_identity=None*, *concrete=False*, *with_polymorphic=None*, *allow_null_pks=None*, *allow_partial_pks=True*, *batch=True*, *column_prefix=None*, *include_properties=None*, *exclude_properties=None*, *passive_updates=True*, *eager_defaults=False*, *_compiled_cache_size=100*)

Construct a new mapper.

Mappers are normally constructed via the `mapper()` function. See for details.

add_properties(*dict_of_properties*)

Add the given dictionary of properties to this mapper, using *add_property*.

add_property(*key*, *prop*)

Add an individual MapperProperty to this mapper.

If the mapper has not been configured yet, just adds the property to the initial properties dictionary sent to the constructor. If this Mapper has already been configured, then the given MapperProperty is configured immediately.

base_mapper = None

The base-most `Mapper` in an inheritance chain.

In a non-inheriting scenario, this attribute will always be this `Mapper`. In an inheritance scenario, it references the `Mapper` which is parent to all other `Mapper` objects in the inheritance chain.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

c = None

A synonym for `columns`.

cascade_iterator(*type_*, *state*, *halt_on=None*)

Iterate each element and its mapper in an object graph, for all relationships that meet the given cascade rule.

Parameters

- **type** – The name of the cascade rule (i.e. save-update, delete, etc.)
- **state** – The lead InstanceState. child items will be processed per the relationships defined for this object's mapper.

the return value are object instances; this provides a strong reference so that they don't fall out of scope immediately.

class_ = None
The Python class which this Mapper maps.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

class_manager = None
The ClassManager which maintains event listeners and class-bound descriptors for this Mapper.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

columns = None
A collection of Column or other scalar expression objects maintained by this Mapper.

The collection behaves the same as that of the c attribute on any Table object, except that only those columns included in this mapping are present, and are keyed based on the attribute name defined in the mapping, not necessarily the key attribute of the Column itself. Additionally, scalar expressions mapped by column_property() are also present here.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

common_parent(*other*)
Return true if the given mapper shares a common inherited parent as this mapper.

compile()
Initialize the inter-mapper relationships of all mappers that

Deprecated since version 0.7: Mapper.compile() is replaced by configure_mappers()

have been constructed thus far.

compiled
Deprecated since version 0.7: Mapper.compiled is replaced by Mapper.configured

concrete = None
Represent True if this Mapper is a concrete inheritance mapper.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

configured = None
Represent True if this Mapper has been configured.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

See also configure_mappers().

get_property(*key*, *_compile_mappers=True*)
return a MapperProperty associated with the given key.

get_property_by_column(*column*)
Given a Column object, return the MapperProperty which maps this column.

identity_key_from_instance(*instance*)
Return the identity key for the given instance, based on its primary key attributes.

This value is typically also found on the instance state under the attribute name *key*.

identity_key_from_primary_key(*primary_key*)
Return an identity-map key for use in storing/retrieving an item from an identity map.

primary_key A list of values indicating the identifier.

identity_key_from_row(*row*, *adapter=None*)
Return an identity-map key for use in storing/retrieving an item from the identity map.

row A `sqlalchemy.engine.base.RowProxy` instance or a dictionary corresponding result-set `ColumnElement` instances to their values within a row.

inherits = None
References the `Mapper` which this `Mapper` inherits from, if any.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

isa(*other*)
Return True if the this mapper inherits from the given mapper.

iterate_properties
return an iterator of all MapperProperty objects.

local_table = None
The `Selectable` which this `Mapper` manages.

Typically is an instance of `Table` or `Alias`. May also be `None`.

The "local" table is the selectable that the `Mapper` is directly responsible for managing from an attribute access and flush perspective. For non-inheriting mappers, the local table is the same as the "mapped" table. For joined-table inheritance mappers, local_table will be the particular sub-table of the overall "join" which this `Mapper` represents. If this mapper is a single-table inheriting mapper, local_table will be `None`.

See also `mapped_table`.

mapped_table = None
The `Selectable` to which this `Mapper` is mapped.

Typically an instance of `Table`, `Join`, or `Alias`.

The "mapped" table is the selectable that the mapper selects from during queries. For non-inheriting mappers, the mapped table is the same as the "local" table. For joined-table inheritance mappers, mapped_table references the full `Join` representing full rows for this particular subclass. For single-table inheritance mappers, mapped_table references the base table.

See also `local_table`.

non_primary = None
Represent `True` if this `Mapper` is a "non-primary" mapper, e.g. a mapper that is used only to selet rows but not for persistence management.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

polymorphic_identity = None
Represent an identifier which is matched against the `polymorphic_on` column during result row loading.

Used only with inheritance, this object can be of any type which is comparable to the type of column represented by `polymorphic_on`.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

polymorphic_iterator()
Iterate through the collection including this mapper and all descendant mappers.

This includes not just the immediately inheriting mappers but all their inheriting mappers as well.

To iterate through an entire hierarchy, use `mapper.base_mapper.polymorphic_iterator()`.

polymorphic_map = None
A mapping of "polymorphic identity" identifiers mapped to `Mapper` instances, within an inheritance scenario.

The identifiers can be of any type which is comparable to the type of column represented by `polymorphic_on`.

An inheritance chain of mappers will all reference the same polymorphic map object. The object is used to correlate incoming result rows to target mappers.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

polymorphic_on = None
The `Column` specified as the `polymorphic_on` column for this `Mapper`, within an inheritance scenario.

This attribute may also be of other types besides `Column` in a future SQLAlchemy release.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

primary_key = None
An iterable containing the collection of `Column` objects which comprise the 'primary key' of the mapped table, from the perspective of this `Mapper`.

This list is against the selectable in `mapped_table`. In the case of inheriting mappers, some columns may be managed by a superclass mapper. For example, in the case of a `Join`, the primary key is determined by all of the primary key columns across all tables referenced by the `Join`.

The list is also not necessarily the same as the primary key column collection associated with the underlying tables; the `Mapper` features a `primary_key` argument that can override what the `Mapper` considers as primary key columns.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

primary_key_from_instance(*instance*)
Return the list of primary key values for the given instance.

primary_mapper()
Return the primary mapper corresponding to this mapper's class key (class).

self_and_descendants
The collection including this mapper and all descendant mappers.

This includes not just the immediately inheriting mappers but all their inheriting mappers as well.

single = None
Represent `True` if this `Mapper` is a single table inheritance mapper.

`local_table` will be `None` if this flag is set.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

tables = None
An iterable containing the collection of `Table` objects which this `Mapper` is aware of.

If the mapper is mapped to a `Join`, or an `Alias` representing a `Select`, the individual `Table` objects that comprise the full construct will be represented here.

This is a *read only* attribute determined during mapper construction. Behavior is undefined if directly modified.

validators = None
An immutable dictionary of attributes which have been decorated using the `validates()` decorator.

The dictionary contains string attribute names as keys mapped to the actual validation method.

2.3 Relationship Configuration

This section describes the `relationship()` function and in depth discussion of its usage. The reference material here continues into the next section, *Collection Configuration and Techniques*, which has additional detail on configuration of collections via `relationship()`.

2.3.1 Basic Relational Patterns

A quick walkthrough of the basic relational patterns.

The imports used for each of the following sections is as follows:

```
from sqlalchemy import Table, Column, Integer, ForeignKey
from sqlalchemy.orm import relationship, backref
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()
```

One To Many

A one to many relationship places a foreign key on the child table referencing the parent. `relationship()` is then specified on the parent, as referencing a collection of items represented by the child:

```
class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    children = relationship("Child")

class Child(Base):
    __tablename__ = 'child'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('parent.id'))
```

To establish a bidirectional relationship in one-to-many, where the "reverse" side is a many to one, specify the `backref` option:

```
class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    children = relationship("Child", backref="parent")

class Child(Base):
    __tablename__ = 'child'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('parent.id'))
```

`Child` will get a `parent` attribute with many-to-one semantics.

Many To One

Many to one places a foreign key in the parent table referencing the child. `relationship()` is declared on the parent, where a new scalar-holding attribute will be created:

```
class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    child_id = Column(Integer, ForeignKey('child.id'))
    child = relationship("Child")

class Child(Base):
    __tablename__ = 'child'
    id = Column(Integer, primary_key=True)
```

Bidirectional behavior is achieved by specifying `backref="parents"`, which will place a one-to-many collection on the `Child` class:

```
class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    child_id = Column(Integer, ForeignKey('child.id'))
    child = relationship("Child", backref="parents")
```

One To One

One To One is essentially a bidirectional relationship with a scalar attribute on both sides. To achieve this, the `uselist=False` flag indicates the placement of a scalar attribute instead of a collection on the "many" side of the relationship. To convert one-to-many into one-to-one:

```
class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    child = relationship("Child", uselist=False, backref="parent")

class Child(Base):
    __tablename__ = 'child'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('parent.id'))
```

Or to turn a one-to-many backref into one-to-one, use the `backref()` function to provide arguments for the reverse side:

```
class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    child_id = Column(Integer, ForeignKey('child.id'))
    child = relationship("Child", backref=backref("parent", uselist=False))

class Child(Base):
    __tablename__ = 'child'
    id = Column(Integer, primary_key=True)
```

Many To Many

Many to Many adds an association table between two classes. The association table is indicated by the `secondary` argument to `relationship()`. Usually, the `Table` uses the `MetaData` object associated with the declarative

base class, so that the `ForeignKey` directives can locate the remote tables with which to link:

```
association_table = Table('association', Base.metadata,
    Column('left_id', Integer, ForeignKey('left.id')),
    Column('right_id', Integer, ForeignKey('right.id'))
)

class Parent(Base):
    __tablename__ = 'left'
    id = Column(Integer, primary_key=True)
    children = relationship("Child",
                    secondary=association_table)

class Child(Base):
    __tablename__ = 'right'
    id = Column(Integer, primary_key=True)
```

For a bidirectional relationship, both sides of the relationship contain a collection. The `backref` keyword will automatically use the same `secondary` argument for the reverse relationship:

```
association_table = Table('association', Base.metadata,
    Column('left_id', Integer, ForeignKey('left.id')),
    Column('right_id', Integer, ForeignKey('right.id'))
)

class Parent(Base):
    __tablename__ = 'left'
    id = Column(Integer, primary_key=True)
    children = relationship("Child",
                    secondary=association_table,
                    backref="parents")

class Child(Base):
    __tablename__ = 'right'
    id = Column(Integer, primary_key=True)
```

The `secondary` argument of `relationship()` also accepts a callable that returns the ultimate argument, which is evaluated only when mappers are first used. Using this, we can define the `association_table` at a later point, as long as it's available to the callable after all module initialization is complete:

```
class Parent(Base):
    __tablename__ = 'left'
    id = Column(Integer, primary_key=True)
    children = relationship("Child",
                    secondary=lambda: association_table,
                    backref="parents")
```

With the declarative extension in use, the traditional "string name of the table" is accepted as well, matching the name of the table as stored in `Base.metadata.tables`:

```
class Parent(Base):
    __tablename__ = 'left'
    id = Column(Integer, primary_key=True)
    children = relationship("Child",
                    secondary="association",
                    backref="parents")
```

Deleting Rows from the Many to Many Table

A behavior which is unique to the `secondary` argument to `relationship()` is that the `Table` which is specified here is automatically subject to INSERT and DELETE statements, as objects are added or removed from the collection. There is **no need to delete from this table manually**. The act of removing a record from the collection will have the effect of the row being deleted on flush:

```
# row will be deleted from the "secondary" table
# automatically
myparent.children.remove(somechild)
```

A question which often arises is how the row in the "secondary" table can be deleted when the child object is handed directly to `Session.delete()`:

```
session.delete(somechild)
```

There are several possibilities here:

- If there is a `relationship()` from `Parent` to `Child`, but there is **not** a reverse-relationship that links a particular `Child` to each `Parent`, SQLAlchemy will not have any awareness that when deleting this particular `Child` object, it needs to maintain the "secondary" table that links it to the `Parent`. No delete of the "secondary" table will occur.
- If there is a relationship that links a particular `Child` to each `Parent`, suppose it's called `Child.parents`, SQLAlchemy by default will load in the `Child.parents` collection to locate all `Parent` objects, and remove each row from the "secondary" table which establishes this link. Note that this relationship does not need to be bidirectional; SQLAlchemy is strictly looking at every `relationship()` associated with the `Child` object being deleted.
- A higher performing option here is to use ON DELETE CASCADE directives with the foreign keys used by the database. Assuming the database supports this feature, the database itself can be made to automatically delete rows in the "secondary" table as referencing rows in "child" are deleted. SQLAlchemy can be instructed to forego actively loading in the `Child.parents` collection in this case using the `passive_deletes=True` directive on `relationship()`; see *Using Passive Deletes* for more details on this.

Note again, these behaviors are *only* relevant to the `secondary` option used with `relationship()`. If dealing with association tables that are mapped explicitly and are *not* present in the `secondary` option of a relevant `relationship()`, cascade rules can be used instead to automatically delete entities in reaction to a related entity being deleted - see *Cascades* for information on this feature.

Association Object

The association object pattern is a variant on many-to-many: it's used when your association table contains additional columns beyond those which are foreign keys to the left and right tables. Instead of using the `secondary` argument, you map a new class directly to the association table. The left side of the relationship references the association object via one-to-many, and the association class references the right side via many-to-one. Below we illustrate an association table mapped to the `Association` class which includes a column called `extra_data`, which is a string value that is stored along with each association between `Parent` and `Child`:

```
class Association(Base):
    __tablename__ = 'association'
    left_id = Column(Integer, ForeignKey('left.id'), primary_key=True)
    right_id = Column(Integer, ForeignKey('right.id'), primary_key=True)
    extra_data = Column(String(50))
    child = relationship("Child")

class Parent(Base):
```

```
    __tablename__ = 'left'
    id = Column(Integer, primary_key=True)
    children = relationship("Association")

class Child(Base):
    __tablename__ = 'right'
    id = Column(Integer, primary_key=True)
```

The bidirectional version adds backrefs to both relationships:

```
class Association(Base):
    __tablename__ = 'association'
    left_id = Column(Integer, ForeignKey('left.id'), primary_key=True)
    right_id = Column(Integer, ForeignKey('right.id'), primary_key=True)
    extra_data = Column(String(50))
    child = relationship("Child", backref="parent_assocs")

class Parent(Base):
    __tablename__ = 'left'
    id = Column(Integer, primary_key=True)
    children = relationship("Association", backref="parent")

class Child(Base):
    __tablename__ = 'right'
    id = Column(Integer, primary_key=True)
```

Working with the association pattern in its direct form requires that child objects are associated with an association instance before being appended to the parent; similarly, access from parent to child goes through the association object:

```
# create parent, append a child via association
p = Parent()
a = Association(extra_data="some data")
a.child = Child()
p.children.append(a)

# iterate through child objects via association, including association
# attributes
for assoc in p.children:
    print assoc.extra_data
    print assoc.child
```

To enhance the association object pattern such that direct access to the `Association` object is optional, SQLAlchemy provides the *Association Proxy* extension. This extension allows the configuration of attributes which will access two "hops" with a single access, one "hop" to the associated object, and a second to a target attribute.

Note: When using the association object pattern, it is advisable that the association-mapped table not be used as the `secondary` argument on a `relationship()` elsewhere, unless that `relationship()` contains the option `viewonly=True`. SQLAlchemy otherwise may attempt to emit redundant INSERT and DELETE statements on the same table, if similar state is detected on the related attribute as well as the associated object.

2.3.2 Adjacency List Relationships

The **adjacency list** pattern is a common relational pattern whereby a table contains a foreign key reference to itself. This is the most common way to represent hierarchical data in flat tables. Other methods include **nested sets**, sometimes called "modified preorder", as well as **materialized path**. Despite the appeal that modified preorder has when evaluated for its fluency within SQL queries, the adjacency list model is probably the most appropriate pattern for

the large majority of hierarchical storage needs, for reasons of concurrency, reduced complexity, and that modified preorder has little advantage over an application which can fully load subtrees into the application space.

In this example, we'll work with a single mapped class called `Node`, representing a tree structure:

```
class Node(Base):
    __tablename__ = 'node'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('node.id'))
    data = Column(String(50))
    children = relationship("Node")
```

With this structure, a graph such as the following:

```
root --+---> child1
       +---> child2 --+--> subchild1
       |              +--> subchild2
       +---> child3
```

Would be represented with data such as:

```
id        parent_id     data
---       -------       ----
1         NULL          root
2         1             child1
3         1             child2
4         3             subchild1
5         3             subchild2
6         1             child3
```

The `relationship()` configuration here works in the same way as a "normal" one-to-many relationship, with the exception that the "direction", i.e. whether the relationship is one-to-many or many-to-one, is assumed by default to be one-to-many. To establish the relationship as many-to-one, an extra directive is added known as `remote_side`, which is a `Column` or collection of `Column` objects that indicate those which should be considered to be "remote":

```
class Node(Base):
    __tablename__ = 'node'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('node.id'))
    data = Column(String(50))
    parent = relationship("Node", remote_side=[id])
```

Where above, the `id` column is applied as the `remote_side` of the `parent` `relationship()`, thus establishing `parent_id` as the "local" side, and the relationship then behaves as a many-to-one.

As always, both directions can be combined into a bidirectional relationship using the `backref()` function:

```
class Node(Base):
    __tablename__ = 'node'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('node.id'))
    data = Column(String(50))
    children = relationship("Node",
                backref=backref('parent', remote_side=[id])
            )
```

There are several examples included with SQLAlchemy illustrating self-referential strategies; these include *Adjacency List* and *XML Persistence*.

Self-Referential Query Strategies

Querying of self-referential structures works like any other query:

```
# get all nodes named 'child2'
session.query(Node).filter(Node.data=='child2')
```

However extra care is needed when attempting to join along the foreign key from one level of the tree to the next. In SQL, a join from a table to itself requires that at least one side of the expression be "aliased" so that it can be unambiguously referred to.

Recall from *Using Aliases* in the ORM tutorial that the `orm.aliased` construct is normally used to provide an "alias" of an ORM entity. Joining from `Node` to itself using this technique looks like:

```
from sqlalchemy.orm import aliased

nodealias = aliased(Node)
session.query(Node).filter(Node.data=='subchild1').\
                join(nodealias, Node.parent).\
                filter(nodealias.data=="child2").\
                all()
SELECT node.id AS node_id,
        node.parent_id AS node_parent_id,
        node.data AS node_data
FROM node JOIN node AS node_1
    ON node.parent_id = node_1.id
WHERE node.data = ?
    AND node_1.data = ?
['subchild1', 'child2']
```

`Query.join()` also includes a feature known as `aliased=True` that can shorten the verbosity self-referential joins, at the expense of query flexibility. This feature performs a similar "aliasing" step to that above, without the need for an explicit entity. Calls to `Query.filter()` and similar subsequent to the aliased join will **adapt** the `Node` entity to be that of the alias:

```
session.query(Node).filter(Node.data=='subchild1').\
        join(Node.parent, aliased=True).\
        filter(Node.data=='child2').\
        all()
SELECT node.id AS node_id,
        node.parent_id AS node_parent_id,
        node.data AS node_data
FROM node
    JOIN node AS node_1 ON node_1.id = node.parent_id
WHERE node.data = ? AND node_1.data = ?
['subchild1', 'child2']
```

To add criterion to multiple points along a longer join, add `from_joinpoint=True` to the additional `join()` calls:

```
# get all nodes named 'subchild1' with a
# parent named 'child2' and a grandparent 'root'
session.query(Node).\
        filter(Node.data=='subchild1').\
        join(Node.parent, aliased=True).\
        filter(Node.data=='child2').\
        join(Node.parent, aliased=True, from_joinpoint=True).\
        filter(Node.data=='root').\
        all()
```

```
SELECT node.id AS node_id,
        node.parent_id AS node_parent_id,
        node.data AS node_data
FROM node
    JOIN node AS node_1 ON node_1.id = node.parent_id
    JOIN node AS node_2 ON node_2.id = node_1.parent_id
WHERE node.data = ?
    AND node_1.data = ?
    AND node_2.data = ?
['subchild1', 'child2', 'root']
```

`Query.reset_joinpoint()` will also remove the "aliasing" from filtering calls:

```
session.query(Node).\
        join(Node.children, aliased=True).\
        filter(Node.data == 'foo').\
        reset_joinpoint().\
        filter(Node.data == 'bar')
```

For an example of using `aliased=True` to arbitrarily join along a chain of self-referential nodes, see *XML Persistence*.

Configuring Self-Referential Eager Loading

Eager loading of relationships occurs using joins or outerjoins from parent to child table during a normal query operation, such that the parent and its immediate child collection or reference can be populated from a single SQL statement, or a second statement for all immediate child collections. SQLAlchemy's joined and subquery eager loading use aliased tables in all cases when joining to related items, so are compatible with self-referential joining. However, to use eager loading with a self-referential relationship, SQLAlchemy needs to be told how many levels deep it should join and/or query; otherwise the eager load will not take place at all. This depth setting is configured via `join_depth`:

```
class Node(Base):
    __tablename__ = 'node'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('node.id'))
    data = Column(String(50))
    children = relationship("Node",
                    lazy="joined",
                    join_depth=2)

session.query(Node).all()
SELECT node_1.id AS node_1_id,
        node_1.parent_id AS node_1_parent_id,
        node_1.data AS node_1_data,
        node_2.id AS node_2_id,
        node_2.parent_id AS node_2_parent_id,
        node_2.data AS node_2_data,
        node.id AS node_id,
        node.parent_id AS node_parent_id,
        node.data AS node_data
FROM node
    LEFT OUTER JOIN node AS node_2
        ON node.id = node_2.parent_id
    LEFT OUTER JOIN node AS node_1
        ON node_2.id = node_1.parent_id
[]
```

2.3.3 Linking Relationships with Backref

The `backref` keyword argument was first introduced in *Object Relational Tutorial*, and has been mentioned throughout many of the examples here. What does it actually do ? Let's start with the canonical `User` and `Address` scenario:

```
from sqlalchemy import Integer, ForeignKey, String, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String)

    addresses = relationship("Address", backref="user")

class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    email = Column(String)
    user_id = Column(Integer, ForeignKey('user.id'))
```

The above configuration establishes a collection of `Address` objects on `User` called `User.addresses`. It also establishes a `.user` attribute on `Address` which will refer to the parent `User` object.

In fact, the `backref` keyword is only a common shortcut for placing a second `relationship` onto the `Address` mapping, including the establishment of an event listener on both sides which will mirror attribute operations in both directions. The above configuration is equivalent to:

```
from sqlalchemy import Integer, ForeignKey, String, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String)

    addresses = relationship("Address", back_populates="user")

class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    email = Column(String)
    user_id = Column(Integer, ForeignKey('user.id'))

    user = relationship("User", back_populates="addresses")
```

Above, we add a `.user` relationship to `Address` explicitly. On both relationships, the `back_populates` directive tells each relationship about the other one, indicating that they should establish "bidirectional" behavior between each other. The primary effect of this configuration is that the relationship adds event handlers to both attributes which have the behavior of "when an append or set event occurs here, set ourselves onto the incoming attribute using this particular attribute name". The behavior is illustrated as follows. Start with a `User` and an `Address` instance. The `.addresses` collection is empty, and the `.user` attribute is `None`:

```
>>> u1 = User()
>>> a1 = Address()
>>> u1.addresses
[]
>>> print a1.user
None
```

However, once the `Address` is appended to the `u1.addresses` collection, both the collection and the scalar attribute have been populated:

```
>>> u1.addresses.append(a1)
>>> u1.addresses
[<__main__.Address object at 0x12a6ed0>]
>>> a1.user
<__main__.User object at 0x12a6590>
```

This behavior of course works in reverse for removal operations as well, as well as for equivalent operations on both sides. Such as when `.user` is set again to `None`, the `Address` object is removed from the reverse collection:

```
>>> a1.user = None
>>> u1.addresses
[]
```

The manipulation of the `.addresses` collection and the `.user` attribute occurs entirely in Python without any interaction with the SQL database. Without this behavior, the proper state would be apparent on both sides once the data has been flushed to the database, and later reloaded after a commit or expiration operation occurs. The `backref`/`back_populates` behavior has the advantage that common bidirectional operations can reflect the correct state without requiring a database round trip.

Remember, when the `backref` keyword is used on a single relationship, it's exactly the same as if the above two relationships were created individually using `back_populates` on each.

Backref Arguments

We've established that the `backref` keyword is merely a shortcut for building two individual `relationship()` constructs that refer to each other. Part of the behavior of this shortcut is that certain configurational arguments applied to the `relationship()` will also be applied to the other direction - namely those arguments that describe the relationship at a schema level, and are unlikely to be different in the reverse direction. The usual case here is a many-to-many `relationship()` that has a `secondary` argument, or a one-to-many or many-to-one which has a `primaryjoin` argument (the `primaryjoin` argument is discussed in *Setting the primaryjoin and secondaryjoin*). Such as if we limited the list of `Address` objects to those which start with "tony":

```
from sqlalchemy import Integer, ForeignKey, String, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String)

    addresses = relationship("Address",
                    primaryjoin="and_(User.id==Address.user_id, "
                        "Address.email.startswith('tony'))",
                    backref="user")
```

```
class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    email = Column(String)
    user_id = Column(Integer, ForeignKey('user.id'))
```

We can observe, by inspecting the resulting property, that both sides of the relationship have this join condition applied:

```
>>> print User.addresses.property.primaryjoin
"user".id = address.user_id AND address.email LIKE :email_1 || '%%'
>>>
>>> print Address.user.property.primaryjoin
"user".id = address.user_id AND address.email LIKE :email_1 || '%%'
>>>
```

This reuse of arguments should pretty much do the "right thing" - it uses only arguments that are applicable, and in the case of a many-to-many relationship, will reverse the usage of `primaryjoin` and `secondaryjoin` to correspond to the other direction (see the example in *Self-Referential Many-to-Many Relationship* for this).

It's very often the case however that we'd like to specify arguments that are specific to just the side where we happened to place the "backref". This includes `relationship()` arguments like `lazy`, `remote_side`, `cascade` and `cascade_backrefs`. For this case we use the `backref()` function in place of a string:

```
# <other imports>
from sqlalchemy.orm import backref

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String)

    addresses = relationship("Address",
                    backref=backref("user", lazy="joined"))
```

Where above, we placed a `lazy="joined"` directive only on the `Address.user` side, indicating that when a query against `Address` is made, a join to the `User` entity should be made automatically which will populate the `.user` attribute of each returned `Address`. The `backref()` function formatted the arguments we gave it into a form that is interpreted by the receiving `relationship()` as additional arguments to be applied to the new relationship it creates.

One Way Backrefs

An unusual case is that of the "one way backref". This is where the "back-populating" behavior of the backref is only desirable in one direction. An example of this is a collection which contains a filtering `primaryjoin` condition. We'd like to append items to this collection as needed, and have them populate the "parent" object on the incoming object. However, we'd also like to have items that are not part of the collection, but still have the same "parent" association - these items should never be in the collection.

Taking our previous example, where we established a `primaryjoin` that limited the collection only to `Address` objects whose email address started with the word `tony`, the usual backref behavior is that all items populate in both directions. We wouldn't want this behavior for a case like the following:

```
>>> u1 = User()
>>> a1 = Address(email='mary')
>>> a1.user = u1
>>> u1.addresses
[<__main__.Address object at 0x1411910>]
```

Above, the Address object that doesn't match the criterion of "starts with 'tony'" is present in the addresses collection of u1. After these objects are flushed, the transaction committed and their attributes expired for a re-load, the addresses collection will hit the database on next access and no longer have this Address object present, due to the filtering condition. But we can do away with this unwanted side of the "backref" behavior on the Python side by using two separate relationship() constructs, placing back_populates only on one side:

```
from sqlalchemy import Integer, ForeignKey, String, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String)
    addresses = relationship("Address",
                    primaryjoin="and_(User.id==Address.user_id, "
                        "Address.email.startswith('tony'))",
                    back_populates="user")

class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    email = Column(String)
    user_id = Column(Integer, ForeignKey('user.id'))
    user = relationship("User")
```

With the above scenario, appending an Address object to the .addresses collection of a User will always establish the .user attribute on that Address:

```
>>> u1 = User()
>>> a1 = Address(email='tony')
>>> u1.addresses.append(a1)
>>> a1.user
<__main__.User object at 0x1411850>
```

However, applying a User to the .user attribute of an Address, will not append the Address object to the collection:

```
>>> a2 = Address(email='mary')
>>> a2.user = u1
>>> a2 in u1.addresses
False
```

Of course, we've disabled some of the usefulness of backref here, in that when we do append an Address that corresponds to the criteria of email.startswith('tony'), it won't show up in the User.addresses collection until the session is flushed, and the attributes reloaded after a commit or expire operation. While we could consider an attribute event that checks this criterion in Python, this starts to cross the line of duplicating too much SQL behavior in Python. The backref behavior itself is only a slight transgression of this philosophy - SQLAlchemy tries to keep these to a minimum overall.

2.3.4 Setting the primaryjoin and secondaryjoin

A common scenario arises when we attempt to relate two classes together, where there exist multiple ways to join the two tables.

Consider a Customer class that contains two foreign keys to an Address class:

```
from sqlalchemy import Integer, ForeignKey, String, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class Customer(Base):
    __tablename__ = 'customer'
    id = Column(Integer, primary_key=True)
    name = Column(String)

    billing_address_id = Column(Integer, ForeignKey("address.id"))
    shipping_address_id = Column(Integer, ForeignKey("address.id"))

    billing_address = relationship("Address")
    shipping_address = relationship("Address")

class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    street = Column(String)
    city = Column(String)
    state = Column(String)
    zip = Column(String)
```

The above mapping, when we attempt to use it, will produce the error:

```
sqlalchemy.exc.ArgumentError: Could not determine join condition between
parent/child tables on relationship Customer.billing_address. Specify a
'primaryjoin' expression. If 'secondary' is present, 'secondaryjoin' is
needed as well.
```

What this error means is that if you have a `Customer` object, and wish to load in an associated `Address`, there is the choice of retrieving the `Address` referred to by the `billing_address_id` column or the one referred to by the `shipping_address_id` column. The `relationship()`, as it is, cannot determine its full configuration. The examples at *Basic Relational Patterns* didn't have this issue, because in each of those examples there was only **one** way to refer to the related table.

To resolve this issue, `relationship()` accepts an argument named `primaryjoin` which accepts a Python-based SQL expression, using the system described at *SQL Expression Language Tutorial*, that describes how the two tables should be joined together. When using the declarative system, we often will specify this Python expression within a string, which is late-evaluated by the mapping configuration system so that it has access to the full namespace of available classes:

```
class Customer(Base):
    __tablename__ = 'customer'
    id = Column(Integer, primary_key=True)
    name = Column(String)

    billing_address_id = Column(Integer, ForeignKey("address.id"))
    shipping_address_id = Column(Integer, ForeignKey("address.id"))

    billing_address = relationship("Address",
                    primaryjoin="Address.id==Customer.billing_address_id")
    shipping_address = relationship("Address",
                    primaryjoin="Address.id==Customer.shipping_address_id")
```

Above, loading the `Customer.billing_address` relationship from a `Customer` object will use the value present in `billing_address_id` in order to identify the row in `Address` to be loaded; similarly,

shipping_address_id is used for the shipping_address relationship. The linkage of the two columns also plays a role during persistence; the newly generated primary key of a just-inserted Address object will be copied into the appropriate foreign key column of an associated Customer object during a flush.

Specifying Alternate Join Conditions

The open-ended nature of primaryjoin also allows us to customize how related items are loaded. In the example below, using the User class as well as an Address class which stores a street address, we create a relationship boston_addresses which will only load those Address objects which specify a city of "Boston":

```
from sqlalchemy import Integer, ForeignKey, String, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String)
    addresses = relationship("Address",
                    primaryjoin="and_(User.id==Address.user_id, "
                        "Address.city=='Boston')")

class Address(Base):
    __tablename__ = 'address'
    id = Column(Integer, primary_key=True)
    user_id = Column(Integer, ForeignKey('user.id'))

    street = Column(String)
    city = Column(String)
    state = Column(String)
    zip = Column(String)
```

Within this string SQL expression, we made use of the and_() conjunction construct to establish two distinct predicates for the join condition - joining both the User.id and Address.user_id columns to each other, as well as limiting rows in Address to just city='Boston'. When using Declarative, rudimentary SQL functions like and_() are automatically available in the evaluated namespace of a string relationship() argument.

When using classical mappings, we have the advantage of the Table objects already being present when the mapping is defined, so that the SQL expression can be created immediately:

```
from sqlalchemy.orm import relationship, mapper

class User(object):
    pass
class Address(object):
    pass

mapper(Address, addresses_table)
mapper(User, users_table, properties={
    'boston_addresses': relationship(Address, primaryjoin=
                and_(users_table.c.id==addresses_table.c.user_id,
                addresses_table.c.city=='Boston'))
})
```

Note that the custom criteria we use in a primaryjoin is generally only significant when SQLAlchemy is rendering SQL in order to load or represent this relationship. That is, it's used in the SQL statement that's emitted in order to

perform a per-attribute lazy load, or when a join is constructed at query time, such as via `Query.join()`, or via the eager "joined" or "subquery" styles of loading. When in-memory objects are being manipulated, we can place any `Address` object we'd like into the `boston_addresses` collection, regardless of what the value of the `.city` attribute is. The objects will remain present in the collection until the attribute is expired and re-loaded from the database where the criterion is applied. When a flush occurs, the objects inside of `boston_addresses` will be flushed unconditionally, assigning value of the primary key `user.id` column onto the foreign-key-holding `address.user_id` column for each row. The `city` criteria has no effect here, as the flush process only cares about synchronizing primary key values into referencing foreign key values.

Self-Referential Many-to-Many Relationship

Many to many relationships can be customized by one or both of `primaryjoin` and `secondaryjoin` - the latter is significant for a relationship that specifies a many-to-many reference using the `secondary` argument. A common situation which involves the usage of `primaryjoin` and `secondaryjoin` is when establishing a many-to-many relationship from a class to itself, as shown below:

```
from sqlalchemy import Integer, ForeignKey, String, Column, Table
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

node_to_node = Table("node_to_node", Base.metadata,
    Column("left_node_id", Integer, ForeignKey("node.id"), primary_key=True),
    Column("right_node_id", Integer, ForeignKey("node.id"), primary_key=True)
)

class Node(Base):
    __tablename__ = 'node'
    id = Column(Integer, primary_key=True)
    label = Column(String)
    right_nodes = relationship("Node",
                        secondary=node_to_node,
                        primaryjoin=id==node_to_node.c.left_node_id,
                        secondaryjoin=id==node_to_node.c.right_node_id,
                        backref="left_nodes"
    )
```

Where above, SQLAlchemy can't know automatically which columns should connect to which for the `right_nodes` and `left_nodes` relationships. The `primaryjoin` and `secondaryjoin` arguments establish how we'd like to join to the association table. In the Declarative form above, as we are declaring these conditions within the Python block that corresponds to the `Node` class, the `id` variable is available directly as the `Column` object we wish to join with.

A classical mapping situation here is similar, where `node_to_node` can be joined to `node.c.id`:

```
from sqlalchemy import Integer, ForeignKey, String, Column, Table, MetaData
from sqlalchemy.orm import relationship, mapper

metadata = MetaData()

node_to_node = Table("node_to_node", metadata,
    Column("left_node_id", Integer, ForeignKey("node.id"), primary_key=True),
    Column("right_node_id", Integer, ForeignKey("node.id"), primary_key=True)
)

node = Table("node", metadata,
```

```
    Column('id', Integer, primary_key=True),
    Column('label', String)
)
class Node(object):
    pass

mapper(Node, node, properties={
    'right_nodes':relationship(Node,
                        secondary=node_to_node,
                        primaryjoin=node.c.id==node_to_node.c.left_node_id,
                        secondaryjoin=node.c.id==node_to_node.c.right_node_id,
                        backref="left_nodes"
                    )})
```

Note that in both examples, the `backref` keyword specifies a `left_nodes` backref - when `relationship()` creates the second relationship in the reverse direction, it's smart enough to reverse the `primaryjoin` and `secondaryjoin` arguments.

Specifying Foreign Keys

When using `primaryjoin` and `secondaryjoin`, SQLAlchemy also needs to be aware of which columns in the relationship reference the other. In most cases, a `Table` construct will have `ForeignKey` constructs which take care of this; however, in the case of reflected tables on a database that does not report FKs (like MySQL ISAM) or when using join conditions on columns that don't have foreign keys, the `relationship()` needs to be told specifically which columns are "foreign" using the `foreign_keys` collection:

```
class Address(Base):
    __table__ = addresses_table

class User(Base):
    __table__ = users_table
    addresses = relationship(Address,
                    primaryjoin=
                    users_table.c.user_id==addresses_table.c.user_id,
                    foreign_keys=[addresses_table.c.user_id])
```

Building Query-Enabled Properties

Very ambitious custom join conditions may fail to be directly persistable, and in some cases may not even load correctly. To remove the persistence part of the equation, use the flag `viewonly=True` on the `relationship()`, which establishes it as a read-only attribute (data written to the collection will be ignored on flush()). However, in extreme cases, consider using a regular Python property in conjunction with `Query` as follows:

```
class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)

    def _get_addresses(self):
        return object_session(self).query(Address).with_parent(self).filter(...).all()
    addresses = property(_get_addresses)
```

2.3.5 Rows that point to themselves / Mutually Dependent Rows

This is a very specific case where relationship() must perform an INSERT and a second UPDATE in order to properly populate a row (and vice versa an UPDATE and DELETE in order to delete without violating foreign key constraints). The two use cases are:

- A table contains a foreign key to itself, and a single row will have a foreign key value pointing to its own primary key.
- Two tables each contain a foreign key referencing the other table, with a row in each table referencing the other.

For example:

```
          user
------------------------------
user_id    name   related_user_id
   1       'ed'          1
```

Or:

```
             widget                                          entry
-------------------------------------------     -----------------------------------
widget_id     name         favorite_entry_id     entry_id      name       widget_id
   1       'somewidget'          5                 5       'someentry'      1
```

In the first case, a row points to itself. Technically, a database that uses sequences such as PostgreSQL or Oracle can INSERT the row at once using a previously generated value, but databases which rely upon autoincrement-style primary key identifiers cannot. The `relationship()` always assumes a "parent/child" model of row population during flush, so unless you are populating the primary key/foreign key columns directly, `relationship()` needs to use two statements.

In the second case, the "widget" row must be inserted before any referring "entry" rows, but then the "favorite_entry_id" column of that "widget" row cannot be set until the "entry" rows have been generated. In this case, it's typically impossible to insert the "widget" and "entry" rows using just two INSERT statements; an UPDATE must be performed in order to keep foreign key constraints fulfilled. The exception is if the foreign keys are configured as "deferred until commit" (a feature some databases support) and if the identifiers were populated manually (again essentially bypassing `relationship()`).

To enable the usage of a supplementary UPDATE statement, we use the `post_update` option of `relationship()`. This specifies that the linkage between the two rows should be created using an UPDATE statement after both rows have been INSERTED; it also causes the rows to be de-associated with each other via UPDATE before a DELETE is emitted. The flag should be placed on just *one* of the relationships, preferably the many-to-one side. Below we illustrate a complete example, including two `ForeignKey` constructs, one which specifies `use_alter=True` to help with emitting CREATE TABLE statements:

```
from sqlalchemy import Integer, ForeignKey, Column
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class Entry(Base):
    __tablename__ = 'entry'
    entry_id = Column(Integer, primary_key=True)
    widget_id = Column(Integer, ForeignKey('widget.widget_id'))
    name = Column(String(50))

class Widget(Base):
    __tablename__ = 'widget'
```

```
    widget_id = Column(Integer, primary_key=True)
    favorite_entry_id = Column(Integer,
                               ForeignKey('entry.entry_id',
                               use_alter=True,
                               name="fk_favorite_entry"))
    name = Column(String(50))

    entries = relationship(Entry, primaryjoin=
                                    widget_id==Entry.widget_id)
    favorite_entry = relationship(Entry,
                                  primaryjoin=
                                      favorite_entry_id==Entry.entry_id,
                                  post_update=True)
```

When a structure against the above configuration is flushed, the "widget" row will be INSERTed minus the "favorite_entry_id" value, then all the "entry" rows will be INSERTed referencing the parent "widget" row, and then an UPDATE statement will populate the "favorite_entry_id" column of the "widget" table (it's one row at a time for the time being):

```
>>> w1 = Widget(name='somewidget')
>>> e1 = Entry(name='someentry')
>>> w1.favorite_entry = e1
>>> w1.entries = [e1]
>>> session.add_all([w1, e1])
>>> session.commit()
BEGIN (implicit)
INSERT INTO widget (favorite_entry_id, name) VALUES (?, ?)
(None, 'somewidget')
INSERT INTO entry (widget_id, name) VALUES (?, ?)
(1, 'someentry')
UPDATE widget SET favorite_entry_id=? WHERE widget.widget_id = ?
(1, 1)
COMMIT
```

An additional configuration we can specify is to supply a more comprehensive foreign key constraint on `Widget`, such that it's guaranteed that `favorite_entry_id` refers to an `Entry` that also refers to this `Widget`. We can use a composite foreign key, as illustrated below:

```
from sqlalchemy import Integer, ForeignKey, String, \
        Column, UniqueConstraint, ForeignKeyConstraint
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import relationship

Base = declarative_base()

class Entry(Base):
    __tablename__ = 'entry'
    entry_id = Column(Integer, primary_key=True)
    widget_id = Column(Integer, ForeignKey('widget.widget_id'))
    name = Column(String(50))
    __table_args__ = (
        UniqueConstraint("entry_id", "widget_id"),
    )

class Widget(Base):
    __tablename__ = 'widget'

    widget_id = Column(Integer, autoincrement='ignore_fk', primary_key=True)
```

```
    favorite_entry_id = Column(Integer)

    name = Column(String(50))

    __table_args__ = (
        ForeignKeyConstraint(
            ["widget_id", "favorite_entry_id"],
            ["entry.widget_id", "entry.entry_id"],
            name="fk_favorite_entry", use_alter=True
        ),
    )

    entries = relationship(Entry, primaryjoin=
                                    widget_id==Entry.widget_id,
                                    foreign_keys=Entry.widget_id)
    favorite_entry = relationship(Entry,
                                primaryjoin=
                                    favorite_entry_id==Entry.entry_id,
                                foreign_keys=favorite_entry_id,
                                post_update=True)
```

The above mapping features a composite `ForeignKeyConstraint` bridging the `widget_id` and `favorite_entry_id` columns. To ensure that `Widget.widget_id` remains an "autoincrementing" column we specify `autoincrement='ignore_fk'` on `Column`, and additionally on each `relationship()` we must limit those columns considered as part of the foreign key for the purposes of joining and cross-population.

New in version 0.7.4: `autoincrement='ignore_fk'` on `Column`.

2.3.6 Mutable Primary Keys / Update Cascades

When the primary key of an entity changes, related items which reference the primary key must also be updated as well. For databases which enforce referential integrity, it's required to use the database's ON UPDATE CASCADE functionality in order to propagate primary key changes to referenced foreign keys - the values cannot be out of sync for any moment.

For databases that don't support this, such as SQLite and MySQL without their referential integrity options turned on, the `passive_updates` flag can be set to `False`, most preferably on a one-to-many or many-to-many `relationship()`, which instructs SQLAlchemy to issue UPDATE statements individually for objects referenced in the collection, loading them into memory if not already locally present. The `passive_updates` flag can also be `False` in conjunction with ON UPDATE CASCADE functionality, although in that case the unit of work will be issuing extra SELECT and UPDATE statements unnecessarily.

A typical mutable primary key setup might look like:

```
class User(Base):
    __tablename__ = 'user'

    username = Column(String(50), primary_key=True)
    fullname = Column(String(100))

    # passive_updates=False *only* needed if the database
    # does not implement ON UPDATE CASCADE
    addresses = relationship("Address", passive_updates=False)

class Address(Base):
    __tablename__ = 'address'
```

```
    email = Column(String(50), primary_key=True)
    username = Column(String(50),
                ForeignKey('user.username', onupdate="cascade")
            )
```

`passive_updates` is set to `True` by default, indicating that ON UPDATE CASCADE is expected to be in place in the usual case for foreign keys that expect to have a mutating parent key.

`passive_updates=False` may be configured on any direction of relationship, i.e. one-to-many, many-to-one, and many-to-many, although it is much more effective when placed just on the one-to-many or many-to-many side. Configuring the `passive_updates=False` only on the many-to-one side will have only a partial effect, as the unit of work searches only through the current identity map for objects that may be referencing the one with a mutating primary key, not throughout the database.

2.3.7 Relationships API

`sqlalchemy.orm.`**`relationship`**(*argument*, *secondary=None*, ***kwargs*)

Provide a relationship of a primary Mapper to a secondary Mapper.

Changed in version 0.6: `relationship()` is historically known as `relation()`.

This corresponds to a parent-child or associative table relationship. The constructed class is an instance of `RelationshipProperty`.

A typical `relationship()`, used in a classical mapping:

```
mapper(Parent, properties={
  'children': relationship(Child)
})
```

Some arguments accepted by `relationship()` optionally accept a callable function, which when called produces the desired value. The callable is invoked by the parent `Mapper` at "mapper initialization" time, which happens only when mappers are first used, and is assumed to be after all mappings have been constructed. This can be used to resolve order-of-declaration and other dependency issues, such as if `Child` is declared below `Parent` in the same file:

```
mapper(Parent, properties={
    "children":relationship(lambda: Child,
                        order_by=lambda: Child.id)
})
```

When using the *Declarative* extension, the Declarative initializer allows string arguments to be passed to `relationship()`. These string arguments are converted into callables that evaluate the string as Python code, using the Declarative class-registry as a namespace. This allows the lookup of related classes to be automatic via their string name, and removes the need to import related classes at all into the local module space:

```
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class Parent(Base):
    __tablename__ = 'parent'
    id = Column(Integer, primary_key=True)
    children = relationship("Child", order_by="Child.id")
```

A full array of examples and reference documentation regarding `relationship()` is at *Relationship Configuration*.

Parameters

- **argument** – a mapped class, or actual `Mapper` instance, representing the target of the relationship.

  `argument` may also be passed as a callable function which is evaluated at mapper initialization time, and may be passed as a Python-evaluable string when using Declarative.

- **secondary** – for a many-to-many relationship, specifies the intermediary table, and is an instance of `Table`. The `secondary` keyword argument should generally only be used for a table that is not otherwise expressed in any class mapping, unless this relationship is declared as view only, otherwise conflicting persistence operations can occur.

  `secondary` may also be passed as a callable function which is evaluated at mapper initialization time.

- **active_history=False** – When `True`, indicates that the "previous" value for a many-to-one reference should be loaded when replaced, if not already loaded. Normally, history tracking logic for simple many-to-ones only needs to be aware of the "new" value in order to perform a flush. This flag is available for applications that make use of `attributes.get_history()` which also need to know the "previous" value of the attribute.

- **backref** – indicates the string name of a property to be placed on the related mapper's class that will handle this relationship in the other direction. The other property will be created automatically when the mappers are configured. Can also be passed as a `backref()` object to control the configuration of the new relationship.

- **back_populates** – Takes a string name and has the same meaning as `backref`, except the complementing property is **not** created automatically, and instead must be configured explicitly on the other mapper. The complementing property should also indicate `back_populates` to this relationship to ensure proper functioning.

- **cascade** –

  a comma-separated list of cascade rules which determines how Session operations should be "cascaded" from parent to child. This defaults to `False`, which means the default cascade should be used. The default value is `"save-update, merge"`.

  Available cascades are:

  – `save-update` - cascade the `Session.add()` operation. This cascade applies both to future and past calls to `add()`, meaning new items added to a collection or scalar relationship get placed into the same session as that of the parent, and also applies to items which have been removed from this relationship but are still part of unflushed history.

  – `merge` - cascade the `merge()` operation

  – `expunge` - cascade the `Session.expunge()` operation

  – `delete` - cascade the `Session.delete()` operation

  – `delete-orphan` - if an item of the child's type is detached from its parent, mark it for deletion.

    Changed in version 0.7: This option does not prevent a new instance of the child object from being persisted without a parent to start with; to constrain against that case, ensure the child's foreign key column(s) is configured as NOT NULL

  – `refresh-expire` - cascade the `Session.expire()` and `refresh()` operations

  – `all` - shorthand for "save-update,merge, refresh-expire, expunge, delete"

See the section *Cascades* for more background on configuring cascades.

- **cascade_backrefs=True** – a boolean value indicating if the `save-update` cascade should operate along an assignment event intercepted by a backref. When set to `False`, the attribute managed by this relationship will not cascade an incoming transient object into the session of a persistent parent, if the event is received via backref.

  That is:

  ```
  mapper(A, a_table, properties={
      'bs':relationship(B, backref="a", cascade_backrefs=False)
  })
  ```

  If an `A()` is present in the session, assigning it to the "a" attribute on a transient `B()` will not place the `B()` into the session. To set the flag in the other direction, i.e. so that `A().bs.append(B())` won't add a transient `A()` into the session for a persistent `B()`:

  ```
  mapper(A, a_table, properties={
      'bs':relationship(B,
                backref=backref("a", cascade_backrefs=False)
            )
  })
  ```

  See the section *Cascades* for more background on configuring cascades.

- **collection_class** – a class or callable that returns a new list-holding object. will be used in place of a plain list for storing elements. Behavior of this attribute is described in detail at *Customizing Collection Access*.

- **comparator_factory** – a class which extends `RelationshipProperty.Comparator` which provides custom SQL clause generation for comparison operations.

- **doc** – docstring which will be applied to the resulting descriptor.

- **extension** – an `AttributeExtension` instance, or list of extensions, which will be prepended to the list of attribute listeners for the resulting descriptor placed on the class. **Deprecated.** Please see `AttributeEvents`.

- **foreign_keys** – a list of columns which are to be used as "foreign key" columns. Normally, `relationship()` uses the `ForeignKey` and `ForeignKeyConstraint` objects present within the mapped or secondary `Table` to determine the "foreign" side of the join condition. This is used to construct SQL clauses in order to load objects, as well as to "synchronize" values from primary key columns to referencing foreign key columns. The `foreign_keys` parameter overrides the notion of what's "foreign" in the table metadata, allowing the specification of a list of `Column` objects that should be considered part of the foreign key.

  There are only two use cases for `foreign_keys` - one, when it is not convenient for `Table` metadata to contain its own foreign key metadata (which should be almost never, unless reflecting a large amount of tables from a MySQL MyISAM schema, or a schema that doesn't actually have foreign keys on it). The other is for extremely rare and exotic composite foreign key setups where some columns should artificially not be considered as foreign.

  `foreign_keys` may also be passed as a callable function which is evaluated at mapper initialization time, and may be passed as a Python-evaluable string when using Declarative.

- **innerjoin=False** – when `True`, joined eager loads will use an inner join to join against related tables instead of an outer join. The purpose of this option is generally one of perfor-

mance, as inner joins generally perform better than outer joins. Another reason can be the use of `with_lockmode`, which does not support outer joins.

This flag can be set to `True` when the relationship references an object via many-to-one using local foreign keys that are not nullable, or when the reference is one-to-one or a collection that is guaranteed to have one or at least one entry.

- **join_depth** – when non-`None`, an integer value indicating how many levels deep "eager" loaders should join on a self-referring or cyclical relationship. The number counts how many times the same Mapper shall be present in the loading condition along a particular join branch. When left at its default of `None`, eager loaders will stop chaining when they encounter a the same target mapper which is already higher up in the chain. This option applies both to joined- and subquery- eager loaders.
- **lazy='select'** – specifies how the related items should be loaded. Default value is `select`. Values include:
  - `select` - items should be loaded lazily when the property is first accessed, using a separate SELECT statement, or identity map fetch for simple many-to-one references.
  - `immediate` - items should be loaded as the parents are loaded, using a separate SELECT statement, or identity map fetch for simple many-to-one references.

    New in version 0.6.5.
  - `joined` - items should be loaded "eagerly" in the same query as that of the parent, using a JOIN or LEFT OUTER JOIN. Whether the join is "outer" or not is determined by the `innerjoin` parameter.
  - `subquery` - items should be loaded "eagerly" within the same query as that of the parent, using a second SQL statement which issues a JOIN to a subquery of the original statement.
  - `noload` - no loading should occur at any time. This is to support "write-only" attributes, or attributes which are populated in some manner specific to the application.
  - `dynamic` - the attribute will return a pre-configured `Query` object for all read operations, onto which further filtering operations can be applied before iterating the results. See the section *Dynamic Relationship Loaders* for more details.
  - True - a synonym for 'select'
  - False - a synonym for 'joined'
  - None - a synonym for 'noload'

  Detailed discussion of loader strategies is at *Relationship Loading Techniques*.
- **load_on_pending=False** – Indicates loading behavior for transient or pending parent objects.

  When set to `True`, causes the lazy-loader to issue a query for a parent object that is not persistent, meaning it has never been flushed. This may take effect for a pending object when autoflush is disabled, or for a transient object that has been "attached" to a `Session` but is not part of its pending collection. Attachment of transient objects to the session without moving to the "pending" state is not a supported behavior at this time.

  Note that the load of related objects on a pending or transient object also does not trigger any attribute change events - no user-defined events will be emitted for these attributes, and if and when the object is ultimately flushed, only the user-specific foreign key attributes will be part of the modified state.

The load_on_pending flag does not improve behavior when the ORM is used normally - object references should be constructed at the object level, not at the foreign key level, so that they are present in an ordinary way before flush() proceeds. This flag is not not intended for general use.

New in 0.6.5.

- **order_by** – indicates the ordering that should be applied when loading these items. `order_by` is expected to refer to one of the `Column` objects to which the target class is mapped, or the attribute itself bound to the target class which refers to the column.

  `order_by` may also be passed as a callable function which is evaluated at mapper initialization time, and may be passed as a Python-evaluable string when using Declarative.

- **passive_deletes=False** – Indicates loading behavior during delete operations.

  A value of True indicates that unloaded child items should not be loaded during a delete operation on the parent. Normally, when a parent item is deleted, all child items are loaded so that they can either be marked as deleted, or have their foreign key to the parent set to NULL. Marking this flag as True usually implies an ON DELETE <CASCADE|SET NULL> rule is in place which will handle updating/deleting child rows on the database side.

  Additionally, setting the flag to the string value 'all' will disable the "nulling out" of the child foreign keys, when there is no delete or delete-orphan cascade enabled. This is typically used when a triggering or error raise scenario is in place on the database side. Note that the foreign key attributes on in-session child objects will not be changed after a flush occurs so this is a very special use-case setting.

- **passive_updates=True** – Indicates loading and INSERT/UPDATE/DELETE behavior when the source of a foreign key value changes (i.e. an "on update" cascade), which are typically the primary key columns of the source row.

  When True, it is assumed that ON UPDATE CASCADE is configured on the foreign key in the database, and that the database will handle propagation of an UPDATE from a source column to dependent rows. Note that with databases which enforce referential integrity (i.e. PostgreSQL, MySQL with InnoDB tables), ON UPDATE CASCADE is required for this operation. The relationship() will update the value of the attribute on related items which are locally present in the session during a flush.

  When False, it is assumed that the database does not enforce referential integrity and will not be issuing its own CASCADE operation for an update. The relationship() will issue the appropriate UPDATE statements to the database in response to the change of a referenced key, and items locally present in the session during a flush will also be refreshed.

  This flag should probably be set to False if primary key changes are expected and the database in use doesn't support CASCADE (i.e. SQLite, MySQL MyISAM tables).

  Also see the passive_updates flag on `mapper()`.

  A future SQLAlchemy release will provide a "detect" feature for this flag.

- **post_update** – this indicates that the relationship should be handled by a second UPDATE statement after an INSERT or before a DELETE. Currently, it also will issue an UPDATE after the instance was UPDATEd as well, although this technically should be improved. This flag is used to handle saving bi-directional dependencies between two individual rows (i.e. each row references the other), where it would otherwise be impossible to INSERT or DELETE both rows fully since one row exists before the other. Use this flag when a particular mapping arrangement will incur two rows that are dependent on each other, such as a table that has a one-to-many relationship to a set of child rows, and also has a column

that references a single child row within that list (i.e. both tables contain a foreign key to each other). If a `flush()` operation returns an error that a "cyclical dependency" was detected, this is a cue that you might want to use `post_update` to "break" the cycle.

- **primaryjoin** – a SQL expression that will be used as the primary join of this child object against the parent object, or in a many-to-many relationship the join of the primary object to the association table. By default, this value is computed based on the foreign key relationships of the parent and child tables (or association table).

  `primaryjoin` may also be passed as a callable function which is evaluated at mapper initialization time, and may be passed as a Python-evaluable string when using Declarative.

- **remote_side** – used for self-referential relationships, indicates the column or list of columns that form the "remote side" of the relationship.

  `remote_side` may also be passed as a callable function which is evaluated at mapper initialization time, and may be passed as a Python-evaluable string when using Declarative.

- **query_class** – a `Query` subclass that will be used as the base of the "appender query" returned by a "dynamic" relationship, that is, a relationship that specifies `lazy="dynamic"` or was otherwise constructed using the `orm.dynamic_loader()` function.

- **secondaryjoin** – a SQL expression that will be used as the join of an association table to the child object. By default, this value is computed based on the foreign key relationships of the association and child tables.

  `secondaryjoin` may also be passed as a callable function which is evaluated at mapper initialization time, and may be passed as a Python-evaluable string when using Declarative.

- **single_parent=(True|False)** – when True, installs a validator which will prevent objects from being associated with more than one parent at a time. This is used for many-to-one or many-to-many relationships that should be treated either as one-to-one or one-to-many. Its usage is optional unless delete-orphan cascade is also set on this relationship(), in which case its required.

- **uselist=(True|False)** – a boolean that indicates if this property should be loaded as a list or a scalar. In most cases, this value is determined automatically by `relationship()`, based on the type and direction of the relationship - one to many forms a list, many to one forms a scalar, many to many is a list. If a scalar is desired where normally a list would be present, such as a bi-directional one-to-one relationship, set uselist to False.

- **viewonly=False** – when set to True, the relationship is used only for loading objects within the relationship, and has no effect on the unit-of-work flush process. Relationships with viewonly can specify any kind of join conditions to provide additional views of related objects onto a parent object. Note that the functionality of a viewonly relationship has its limits - complicated join conditions may not compile into eager or lazy loaders properly. If this is the case, use an alternative method.

sqlalchemy.orm.**backref**(*name*, ***kwargs*)
Create a back reference with explicit keyword arguments, which are the same arguments one can send to `relationship()`.

Used with the `backref` keyword argument to `relationship()` in place of a string argument, e.g.:

```
'items':relationship(SomeItem, backref=backref('parent', lazy='subquery'))
```

sqlalchemy.orm.**relation**(**arg*, ***kw*)
A synonym for `relationship()`.

sqlalchemy.orm.**dynamic_loader**(*argument*, ***kw*)
Construct a dynamically-loading mapper property.

This is essentially the same as using the `lazy='dynamic'` argument with `relationship()`:

```
dynamic_loader(SomeClass)

# is the same as

relationship(SomeClass, lazy="dynamic")
```

See the section *Dynamic Relationship Loaders* for more details on dynamic loading.

2.4 Collection Configuration and Techniques

The `relationship()` function defines a linkage between two classes. When the linkage defines a one-to-many or many-to-many relationship, it's represented as a Python collection when objects are loaded and manipulated. This section presents additional information about collection configuration and techniques.

2.4.1 Working with Large Collections

The default behavior of `relationship()` is to fully load the collection of items in, as according to the loading strategy of the relationship. Additionally, the `Session` by default only knows how to delete objects which are actually present within the session. When a parent instance is marked for deletion and flushed, the `Session` loads its full list of child items in so that they may either be deleted as well, or have their foreign key value set to null; this is to avoid constraint violations. For large collections of child items, there are several strategies to bypass full loading of child items both at load time as well as deletion time.

Dynamic Relationship Loaders

A key feature to enable management of a large collection is the so-called "dynamic" relationship. This is an optional form of `relationship()` which returns a `Query` object in place of a collection when accessed. `filter()` criterion may be applied as well as limits and offsets, either explicitly or via array slices:

```
class User(Base):
    __tablename__ = 'user'

    posts = relationship(Post, lazy="dynamic")

jack = session.query(User).get(id)

# filter Jack's blog posts
posts = jack.posts.filter(Post.headline=='this is a post')

# apply array slices
posts = jack.posts[5:20]
```

The dynamic relationship supports limited write operations, via the `append()` and `remove()` methods:

```
oldpost = jack.posts.filter(Post.headline=='old post').one()
jack.posts.remove(oldpost)

jack.posts.append(Post('new post'))
```

Since the read side of the dynamic relationship always queries the database, changes to the underlying collection will not be visible until the data has been flushed. However, as long as "autoflush" is enabled on the `Session` in use, this will occur automatically each time the collection is about to emit a query.

To place a dynamic relationship on a backref, use the `backref()` function in conjunction with `lazy='dynamic'`:

```
class Post(Base):
    __table__ = posts_table

    user = relationship(User,
                backref=backref('posts', lazy='dynamic')
            )
```

Note that eager/lazy loading options cannot be used in conjunction dynamic relationships at this time.

Note: The `dynamic_loader()` function is essentially the same as `relationship()` with the `lazy='dynamic'` argument specified.

Warning: The "dynamic" loader applies to **collections only**. It is not valid to use "dynamic" loaders with many-to-one, one-to-one, or uselist=False relationships. Newer versions of SQLAlchemy emit warnings or exceptions in these cases.

Setting Noload

A "noload" relationship never loads from the database, even when accessed. It is configured using `lazy='noload'`:

```
class MyClass(Base):
    __tablename__ = 'some_table'

    children = relationship(MyOtherClass, lazy='noload')
```

Above, the `children` collection is fully writeable, and changes to it will be persisted to the database as well as locally available for reading at the time they are added. However when instances of `MyClass` are freshly loaded from the database, the `children` collection stays empty.

Using Passive Deletes

Use `passive_deletes=True` to disable child object loading on a DELETE operation, in conjunction with "ON DELETE (CASCADE|SET NULL)" on your database to automatically cascade deletes to child objects:

```
class MyClass(Base):
    __tablename__ = 'mytable'
    id = Column(Integer, primary_key=True)
    children = relationship("MyOtherClass",
                    cascade="all, delete-orphan",
                    passive_deletes=True)

class MyOtherClass(Base):
    __tablename__ = 'myothertable'
    id = Column(Integer, primary_key=True)
    parent_id = Column(Integer,
                ForeignKey('mytable.id', ondelete='CASCADE')
                    )
```

Note: To use "ON DELETE CASCADE", the underlying database engine must support foreign keys.

- When using MySQL, an appropriate storage engine must be selected. See *Storage Engines* for details.
- When using SQLite, foreign key support must be enabled explicitly. See *Foreign Key Support* for details.

When `passive_deletes` is applied, the `children` relationship will not be loaded into memory when an instance of `MyClass` is marked for deletion. The `cascade="all, delete-orphan"` *will* take effect for instances of `MyOtherClass` which are currently present in the session; however for instances of `MyOtherClass` which are not loaded, SQLAlchemy assumes that "ON DELETE CASCADE" rules will ensure that those rows are deleted by the database.

2.4.2 Customizing Collection Access

Mapping a one-to-many or many-to-many relationship results in a collection of values accessible through an attribute on the parent instance. By default, this collection is a `list`:

```
class Parent(Base):
    __tablename__ = 'parent'
    parent_id = Column(Integer, primary_key=True)

    children = relationship(Child)

parent = Parent()
parent.children.append(Child())
print parent.children[0]
```

Collections are not limited to lists. Sets, mutable sequences and almost any other Python object that can act as a container can be used in place of the default list, by specifying the `collection_class` option on `relationship()`:

```
class Parent(Base):
    __tablename__ = 'parent'
    parent_id = Column(Integer, primary_key=True)

    # use a set
    children = relationship(Child, collection_class=set)

parent = Parent()
child = Child()
parent.children.add(child)
assert child in parent.children
```

Dictionary Collections

A little extra detail is needed when using a dictionary as a collection. This because objects are always loaded from the database as lists, and a key-generation strategy must be available to populate the dictionary correctly. The `attribute_mapped_collection()` function is by far the most common way to achieve a simple dictionary collection. It produces a dictionary class that will apply a particular attribute of the mapped class as a key. Below we map an `Item` class containing a dictionary of `Note` items keyed to the `Note.keyword` attribute:

```
from sqlalchemy import Column, Integer, String, ForeignKey
from sqlalchemy.orm import relationship
from sqlalchemy.orm.collections import attribute_mapped_collection
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class Item(Base):
    __tablename__ = 'item'
    id = Column(Integer, primary_key=True)
```

```
    notes = relationship("Note",
                collection_class=attribute_mapped_collection('keyword'),
                cascade="all, delete-orphan")

class Note(Base):
    __tablename__ = 'note'
    id = Column(Integer, primary_key=True)
    item_id = Column(Integer, ForeignKey('item.id'), nullable=False)
    keyword = Column(String)
    text = Column(String)

    def __init__(self, keyword, text):
        self.keyword = keyword
        self.text = text
```

`Item.notes` is then a dictionary:

```
>>> item = Item()
>>> item.notes['a'] = Note('a', 'atext')
>>> item.notes.items()
{'a': <__main__.Note object at 0x2eaaf0>}
```

`attribute_mapped_collection()` will ensure that the `.keyword` attribute of each `Note` complies with the key in the dictionary. Such as, when assigning to `Item.notes`, the dictionary key we supply must match that of the actual `Note` object:

```
item = Item()
item.notes = {
            'a': Note('a', 'atext'),
            'b': Note('b', 'btext')
        }
```

The attribute which `attribute_mapped_collection()` uses as a key does not need to be mapped at all! Using a regular Python `@property` allows virtually any detail or combination of details about the object to be used as the key, as below when we establish it as a tuple of `Note.keyword` and the first ten letters of the `Note.text` field:

```
class Item(Base):
    __tablename__ = 'item'
    id = Column(Integer, primary_key=True)
    notes = relationship("Note",
                collection_class=attribute_mapped_collection('note_key'),
                backref="item",
                cascade="all, delete-orphan")

class Note(Base):
    __tablename__ = 'note'
    id = Column(Integer, primary_key=True)
    item_id = Column(Integer, ForeignKey('item.id'), nullable=False)
    keyword = Column(String)
    text = Column(String)

    @property
    def note_key(self):
        return (self.keyword, self.text[0:10])

    def __init__(self, keyword, text):
        self.keyword = keyword
        self.text = text
```

Above we added a `Note.item` backref. Assigning to this reverse relationship, the `Note` is added to the `Item.notes` dictionary and the key is generated for us automatically:

```
>>> item = Item()
>>> n1 = Note("a", "atext")
>>> n1.item = item
>>> item.notes
{('a', 'atext'): <__main__.Note object at 0x2eaaf0>}
```

Other built-in dictionary types include `column_mapped_collection()`, which is almost like `attribute_mapped_collection()` except given the `Column` object directly:

```
from sqlalchemy.orm.collections import column_mapped_collection

class Item(Base):
    __tablename__ = 'item'
    id = Column(Integer, primary_key=True)
    notes = relationship("Note",
                collection_class=column_mapped_collection(Note.__table__.c.keyword),
                cascade="all, delete-orphan")
```

as well as `mapped_collection()` which is passed any callable function. Note that it's usually easier to use `attribute_mapped_collection()` along with a `@property` as mentioned earlier:

```
from sqlalchemy.orm.collections import mapped_collection

class Item(Base):
    __tablename__ = 'item'
    id = Column(Integer, primary_key=True)
    notes = relationship("Note",
                collection_class=mapped_collection(lambda note: note.text[0:10]),
                cascade="all, delete-orphan")
```

Dictionary mappings are often combined with the "Association Proxy" extension to produce streamlined dictionary views. See *Proxying to Dictionary Based Collections* and *Composite Association Proxies* for examples.

sqlalchemy.orm.collections.**attribute_mapped_collection**(*attr_name*)
A dictionary-based collection type with attribute-based keying.

Returns a `MappedCollection` factory with a keying based on the 'attr_name' attribute of entities in the collection, where `attr_name` is the string name of the attribute.

The key value must be immutable for the lifetime of the object. You can not, for example, map on foreign key values if those key values will change during the session, i.e. from None to a database-assigned integer after a session flush.

sqlalchemy.orm.collections.**column_mapped_collection**(*mapping_spec*)
A dictionary-based collection type with column-based keying.

Returns a `MappedCollection` factory with a keying function generated from mapping_spec, which may be a Column or a sequence of Columns.

The key value must be immutable for the lifetime of the object. You can not, for example, map on foreign key values if those key values will change during the session, i.e. from None to a database-assigned integer after a session flush.

sqlalchemy.orm.collections.**mapped_collection**(*keyfunc*)
A dictionary-based collection type with arbitrary keying.

Returns a `MappedCollection` factory with a keying function generated from keyfunc, a callable that takes an entity and returns a key value.

The key value must be immutable for the lifetime of the object. You can not, for example, map on foreign key values if those key values will change during the session, i.e. from None to a database-assigned integer after a session flush.

2.4.3 Custom Collection Implementations

You can use your own types for collections as well. In simple cases, inherting from `list` or `set`, adding custom behavior, is all that's needed. In other cases, special decorators are needed to tell SQLAlchemy more detail about how the collection operates.

Do I need a custom collection implementation?

In most cases not at all! The most common use cases for a "custom" collection is one that validates or marshals incoming values into a new form, such as a string that becomes a class instance, or one which goes a step beyond and represents the data internally in some fashion, presenting a "view" of that data on the outside of a different form.
For the first use case, the `orm.validates()` decorator is by far the simplest way to intercept incoming values in all cases for the purposes of validation and simple marshaling. See *Simple Validators* for an example of this.
For the second use case, the *Association Proxy* extension is a well-tested, widely used system that provides a read/write "view" of a collection in terms of some attribute present on the target object. As the target attribute can be a `@property` that returns virtually anything, a wide array of "alternative" views of a collection can be constructed with just a few functions. This approach leaves the underlying mapped collection unaffected and avoids the need to carefully tailor collection behavior on a method-by-method basis.
Customized collections are useful when the collection needs to have special behaviors upon access or mutation operations that can't otherwise be modeled externally to the collection. They can of course be combined with the above two approaches.

Collections in SQLAlchemy are transparently *instrumented*. Instrumentation means that normal operations on the collection are tracked and result in changes being written to the database at flush time. Additionally, collection operations can fire *events* which indicate some secondary operation must take place. Examples of a secondary operation include saving the child item in the parent's `Session` (i.e. the `save-update` cascade), as well as synchronizing the state of a bi-directional relationship (i.e. a `backref()`).

The collections package understands the basic interface of lists, sets and dicts and will automatically apply instrumentation to those built-in types and their subclasses. Object-derived types that implement a basic collection interface are detected and instrumented via duck-typing:

```
class ListLike(object):
    def __init__(self):
        self.data = []
    def append(self, item):
        self.data.append(item)
    def remove(self, item):
        self.data.remove(item)
    def extend(self, items):
        self.data.extend(items)
    def __iter__(self):
        return iter(self.data)
    def foo(self):
        return 'foo'
```

`append`, `remove`, and `extend` are known list-like methods, and will be instrumented automatically. `__iter__` is not a mutator method and won't be instrumented, and `foo` won't be either.

Duck-typing (i.e. guesswork) isn't rock-solid, of course, so you can be explicit about the interface you are implementing by providing an `__emulates__` class attribute:

```
class SetLike(object):
    __emulates__ = set

    def __init__(self):
        self.data = set()
    def append(self, item):
        self.data.add(item)
    def remove(self, item):
        self.data.remove(item)
    def __iter__(self):
        return iter(self.data)
```

This class looks list-like because of `append`, but `__emulates__` forces it to set-like. `remove` is known to be part of the set interface and will be instrumented.

But this class won't work quite yet: a little glue is needed to adapt it for use by SQLAlchemy. The ORM needs to know which methods to use to append, remove and iterate over members of the collection. When using a type like `list` or `set`, the appropriate methods are well-known and used automatically when present. This set-like class does not provide the expected `add` method, so we must supply an explicit mapping for the ORM via a decorator.

Annotating Custom Collections via Decorators

Decorators can be used to tag the individual methods the ORM needs to manage collections. Use them when your class doesn't quite meet the regular interface for its container type, or when you otherwise would like to use a different method to get the job done.

```
from sqlalchemy.orm.collections import collection

class SetLike(object):
    __emulates__ = set

    def __init__(self):
        self.data = set()

    @collection.appender
    def append(self, item):
        self.data.add(item)

    def remove(self, item):
        self.data.remove(item)

    def __iter__(self):
        return iter(self.data)
```

And that's all that's needed to complete the example. SQLAlchemy will add instances via the `append` method. `remove` and `__iter__` are the default methods for sets and will be used for removing and iteration. Default methods can be changed as well:

```
from sqlalchemy.orm.collections import collection

class MyList(list):
    @collection.remover
    def zark(self, item):
        # do something special...
```

```
@collection.iterator
def hey_use_this_instead_for_iteration(self):
    # ...
```

There is no requirement to be list-, or set-like at all. Collection classes can be any shape, so long as they have the append, remove and iterate interface marked for SQLAlchemy's use. Append and remove methods will be called with a mapped entity as the single argument, and iterator methods are called with no arguments and must return an iterator.

class sqlalchemy.orm.collections.**collection**

Decorators for entity collection classes.

The decorators fall into two groups: annotations and interception recipes.

The annotating decorators (appender, remover, iterator, internally_instrumented, link) indicate the method's purpose and take no arguments. They are not written with parens:

```
@collection.appender
def append(self, append): ...
```

The recipe decorators all require parens, even those that take no arguments:

```
@collection.adds('entity')
def insert(self, position, entity): ...

@collection.removes_return()
def popitem(self): ...
```

static adds(*arg*)

Mark the method as adding an entity to the collection.

Adds "add to collection" handling to the method. The decorator argument indicates which method argument holds the SQLAlchemy-relevant value. Arguments can be specified positionally (i.e. integer) or by name:

```
@collection.adds(1)
def push(self, item): ...

@collection.adds('entity')
def do_stuff(self, thing, entity=None): ...
```

static appender(*fn*)

Tag the method as the collection appender.

The appender method is called with one positional argument: the value to append. The method will be automatically decorated with 'adds(1)' if not already decorated:

```
@collection.appender
def add(self, append): ...

# or, equivalently
@collection.appender
@collection.adds(1)
def add(self, append): ...

# for mapping type, an 'append' may kick out a previous value
# that occupies that slot.  consider d['a'] = 'foo'- any previous
# value in d['a'] is discarded.
@collection.appender
@collection.replaces(1)
```

```
def add(self, entity):
    key = some_key_func(entity)
    previous = None
    if key in self:
        previous = self[key]
    self[key] = entity
    return previous
```

If the value to append is not allowed in the collection, you may raise an exception. Something to remember is that the appender will be called for each object mapped by a database query. If the database contains rows that violate your collection semantics, you will need to get creative to fix the problem, as access via the collection will not work.

If the appender method is internally instrumented, you must also receive the keyword argument '_sa_initiator' and ensure its promulgation to collection events.

static converter(*fn*)

Tag the method as the collection converter.

This optional method will be called when a collection is being replaced entirely, as in:

```
myobj.acollection = [newvalue1, newvalue2]
```

The converter method will receive the object being assigned and should return an iterable of values suitable for use by the `appender` method. A converter must not assign values or mutate the collection, it's sole job is to adapt the value the user provides into an iterable of values for the ORM's use.

The default converter implementation will use duck-typing to do the conversion. A dict-like collection will be convert into an iterable of dictionary values, and other types will simply be iterated:

```
@collection.converter
def convert(self, other): ...
```

If the duck-typing of the object does not match the type of this collection, a TypeError is raised.

Supply an implementation of this method if you want to expand the range of possible types that can be assigned in bulk or perform validation on the values about to be assigned.

static internally_instrumented(*fn*)

Tag the method as instrumented.

This tag will prevent any decoration from being applied to the method. Use this if you are orchestrating your own calls to `collection_adapter()` in one of the basic SQLAlchemy interface methods, or to prevent an automatic ABC method decoration from wrapping your implementation:

```
# normally an 'extend' method on a list-like class would be
# automatically intercepted and re-implemented in terms of
# SQLAlchemy events and append().  your implementation will
# never be called, unless:
@collection.internally_instrumented
def extend(self, items): ...
```

static iterator(*fn*)

Tag the method as the collection remover.

The iterator method is called with no arguments. It is expected to return an iterator over all collection members:

```
@collection.iterator
def __iter__(self): ...
```

static link(*fn*)
Tag the method as a the "linked to attribute" event handler.

This optional event handler will be called when the collection class is linked to or unlinked from the InstrumentedAttribute. It is invoked immediately after the '_sa_adapter' property is set on the instance. A single argument is passed: the collection adapter that has been linked, or None if unlinking.

static remover(*fn*)
Tag the method as the collection remover.

The remover method is called with one positional argument: the value to remove. The method will be automatically decorated with `removes_return()` if not already decorated:

```
@collection.remover
def zap(self, entity): ...

# or, equivalently
@collection.remover
@collection.removes_return()
def zap(self, ): ...
```

If the value to remove is not present in the collection, you may raise an exception or return None to ignore the error.

If the remove method is internally instrumented, you must also receive the keyword argument '_sa_initiator' and ensure its promulgation to collection events.

static removes(*arg*)
Mark the method as removing an entity in the collection.

Adds "remove from collection" handling to the method. The decorator argument indicates which method argument holds the SQLAlchemy-relevant value to be removed. Arguments can be specified positionally (i.e. integer) or by name:

```
@collection.removes(1)
def zap(self, item): ...
```

For methods where the value to remove is not known at call-time, use collection.removes_return.

static removes_return()
Mark the method as removing an entity in the collection.

Adds "remove from collection" handling to the method. The return value of the method, if any, is considered the value to remove. The method arguments are not inspected:

```
@collection.removes_return()
def pop(self): ...
```

For methods where the value to remove is known at call-time, use collection.remove.

static replaces(*arg*)
Mark the method as replacing an entity in the collection.

Adds "add to collection" and "remove from collection" handling to the method. The decorator argument indicates which method argument holds the SQLAlchemy-relevant value to be added, and return value, if any will be considered the value to remove.

Arguments can be specified positionally (i.e. integer) or by name:

```
@collection.replaces(2)
def __setitem__(self, index, item): ...
```

Custom Dictionary-Based Collections

The `MappedCollection` class can be used as a base class for your custom types or as a mix-in to quickly add `dict` collection support to other classes. It uses a keying function to delegate to `__setitem__` and `__delitem__`:

```
from sqlalchemy.util import OrderedDict
from sqlalchemy.orm.collections import MappedCollection

class NodeMap(OrderedDict, MappedCollection):
    """Holds 'Node' objects, keyed by the 'name' attribute with insert order maintained."""

    def __init__(self, *args, **kw):
        MappedCollection.__init__(self, keyfunc=lambda node: node.name)
        OrderedDict.__init__(self, *args, **kw)
```

When subclassing `MappedCollection`, user-defined versions of `__setitem__()` or `__delitem__()` should be decorated with `collection.internally_instrumented()`, **if** they call down to those same methods on `MappedCollection`. This because the methods on `MappedCollection` are already instrumented - calling them from within an already instrumented call can cause events to be fired off repeatedly, or inappropriately, leading to internal state corruption in rare cases:

```
from sqlalchemy.orm.collections import MappedCollection,\
                                       collection

class MyMappedCollection(MappedCollection):
    """Use @internally_instrumented when your methods
    call down to already-instrumented methods.

    """

    @collection.internally_instrumented
    def __setitem__(self, key, value, _sa_initiator=None):
        # do something with key, value
        super(MyMappedCollection, self).__setitem__(key, value, _sa_initiator)

    @collection.internally_instrumented
    def __delitem__(self, key, _sa_initiator=None):
        # do something with key
        super(MyMappedCollection, self).__delitem__(key, _sa_initiator)
```

The ORM understands the `dict` interface just like lists and sets, and will automatically instrument all dict-like methods if you choose to subclass `dict` or provide dict-like collection behavior in a duck-typed class. You must decorate appender and remover methods, however- there are no compatible methods in the basic dictionary interface for SQLAlchemy to use by default. Iteration will go through `itervalues()` unless otherwise decorated.

Note: Due to a bug in MappedCollection prior to version 0.7.6, this workaround usually needs to be called before a custom subclass of `MappedCollection` which uses `collection.internally_instrumented()` can be used:

```
from sqlalchemy.orm.collections import _instrument_class, MappedCollection
_instrument_class(MappedCollection)
```

This will ensure that the `MappedCollection` has been properly initialized with custom `__setitem__()` and `__delitem__()` methods before used in a custom subclass.

---

class `sqlalchemy.orm.collections.`**`MappedCollection`**(*keyfunc*)

A basic dictionary-based collection class.

Extends dict with the minimal bag semantics that collection classes require. `set` and `remove` are implemented in terms of a keying function: any callable that takes an object and returns an object for use as a dictionary key.

__init__(*keyfunc*)
Create a new collection with keying provided by keyfunc.

keyfunc may be any callable any callable that takes an object and returns an object for use as a dictionary key.

The keyfunc will be called every time the ORM needs to add a member by value-only (such as when loading instances from the database) or remove a member. The usual cautions about dictionary keying apply- `keyfunc(object)` should return the same output for the life of the collection. Keying based on mutable properties can result in unreachable instances "lost" in the collection.

clear() → None. Remove all items from D.

pop(*k*[, *d*]) → v, remove specified key and return the corresponding value.
If key is not found, d is returned if given, otherwise KeyError is raised

popitem() → (k, v), remove and return some (key, value) pair as a
2-tuple; but raise KeyError if D is empty.

remove(*value*, *_sa_initiator=None*)
Remove an item by value, consulting the keyfunc for the key.

set(*value*, *_sa_initiator=None*)
Add an item by value, consulting the keyfunc for the key.

setdefault(*k*[, *d*]) → D.get(k,d), also set D[k]=d if k not in D

update([*E*], ***F*) → None. Update D from dict/iterable E and F.
If E present and has a .keys() method, does: for k in E: D[k] = E[k] If E present and lacks .keys() method, does: for (k, v) in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]

Instrumentation and Custom Types

Many custom types and existing library classes can be used as a entity collection type as-is without further ado. However, it is important to note that the instrumentation process will modify the type, adding decorators around methods automatically.

The decorations are lightweight and no-op outside of relationships, but they do add unneeded overhead when triggered elsewhere. When using a library class as a collection, it can be good practice to use the "trivial subclass" trick to restrict the decorations to just your usage in relationships. For example:

```
class MyAwesomeList(some.great.library.AwesomeList):
    pass

# ... relationship(..., collection_class=MyAwesomeList)
```

The ORM uses this approach for built-ins, quietly substituting a trivial subclass when a `list`, `set` or `dict` is used directly.

2.4.4 Collection Internals

Various internal methods.

`sqlalchemy.orm.collections`.**bulk_replace**(*values*, *existing_adapter*, *new_adapter*)
Load a new collection, firing events based on prior like membership.

Appends instances in `values` onto the `new_adapter`. Events will be fired for any instance not present in the `existing_adapter`. Any instances in `existing_adapter` not present in `values` will have remove events fired upon them.

Parameters

- **values** – An iterable of collection member instances
- **existing_adapter** – A `CollectionAdapter` of instances to be replaced
- **new_adapter** – An empty `CollectionAdapter` to load with `values`

class sqlalchemy.orm.collections.**collection**
Decorators for entity collection classes.

The decorators fall into two groups: annotations and interception recipes.

The annotating decorators (appender, remover, iterator, internally_instrumented, link) indicate the method's purpose and take no arguments. They are not written with parens:

```
@collection.appender
def append(self, append): ...
```

The recipe decorators all require parens, even those that take no arguments:

```
@collection.adds('entity')
def insert(self, position, entity): ...

@collection.removes_return()
def popitem(self): ...
```

sqlalchemy.orm.collections.**collection_adapter**(*collection*)
Fetch the `CollectionAdapter` for a collection.

class sqlalchemy.orm.collections.**CollectionAdapter**(*attr*, *owner_state*, *data*)
Bridges between the ORM and arbitrary Python collections.

Proxies base-level collection operations (append, remove, iterate) to the underlying Python collection, and emits add/remove events for entities entering or leaving the collection.

The ORM uses `CollectionAdapter` exclusively for interaction with entity collections.

The usage of getattr()/setattr() is currently to allow injection of custom methods, such as to unwrap Zope security proxies.

class sqlalchemy.orm.collections.**InstrumentedDict**
An instrumented version of the built-in dict.

class sqlalchemy.orm.collections.**InstrumentedList**
An instrumented version of the built-in list.

class sqlalchemy.orm.collections.**InstrumentedSet**
An instrumented version of the built-in set.

sqlalchemy.orm.collections.**prepare_instrumentation**(*factory*)
Prepare a callable for future use as a collection class factory.

Given a collection class factory (either a type or no-arg callable), return another factory that will produce compatible instances when called.

This function is responsible for converting collection_class=list into the run-time behavior of collection_class=InstrumentedList.

2.5 Mapping Class Inheritance Hierarchies

SQLAlchemy supports three forms of inheritance: *single table inheritance*, where several types of classes are stored in one table, *concrete table inheritance*, where each type of class is stored in its own table, and *joined table inheritance*, where the parent/child classes are stored in their own tables that are joined together in a select. Whereas support for single and joined table inheritance is strong, concrete table inheritance is a less common scenario with some particular problems so is not quite as flexible.

When mappers are configured in an inheritance relationship, SQLAlchemy has the ability to load elements "polymorphically", meaning that a single query can return objects of multiple types.

Note: This section currently uses classical mappings to illustrate inheritance configurations, and will soon be updated to standardize on Declarative. Until then, please refer to *Inheritance Configuration* for information on how common inheritance mappings are constructed declaratively.

For the following sections, assume this class relationship:

```
class Employee(object):
    def __init__(self, name):
        self.name = name
    def __repr__(self):
        return self.__class__.__name__ + " " + self.name

class Manager(Employee):
    def __init__(self, name, manager_data):
        self.name = name
        self.manager_data = manager_data
    def __repr__(self):
        return (
            self.__class__.__name__ + " " +
            self.name + " " +  self.manager_data
        )

class Engineer(Employee):
    def __init__(self, name, engineer_info):
        self.name = name
        self.engineer_info = engineer_info
    def __repr__(self):
        return (
            self.__class__.__name__ + " " +
            self.name + " " +  self.engineer_info
        )
```

2.5.1 Joined Table Inheritance

In joined table inheritance, each class along a particular classes' list of parents is represented by a unique table. The total set of attributes for a particular instance is represented as a join along all tables in its inheritance path. Here, we first define a table to represent the `Employee` class. This table will contain a primary key column (or columns), and a column for each attribute that's represented by `Employee`. In this case it's just `name`:

```
employees = Table('employees', metadata,
   Column('employee_id', Integer, primary_key=True),
   Column('name', String(50)),
   Column('type', String(30), nullable=False)
)
```

The table also has a column called `type`. It is strongly advised in both single- and joined- table inheritance scenarios that the root table contains a column whose sole purpose is that of the **discriminator**; it stores a value which indicates the type of object represented within the row. The column may be of any desired datatype. While there are some "tricks" to work around the requirement that there be a discriminator column, they are more complicated to configure when one wishes to load polymorphically.

Next we define individual tables for each of `Engineer` and `Manager`, which contain columns that represent the attributes unique to the subclass they represent. Each table also must contain a primary key column (or columns), and in most cases a foreign key reference to the parent table. It is standard practice that the same column is used for both of these roles, and that the column is also named the same as that of the parent table. However this is optional in SQLAlchemy; separate columns may be used for primary key and parent-relationship, the column may be named differently than that of the parent, and even a custom join condition can be specified between parent and child tables instead of using a foreign key:

```
engineers = Table('engineers', metadata,
   Column('employee_id', Integer,
                  ForeignKey('employees.employee_id'),
                  primary_key=True),
   Column('engineer_info', String(50)),
)

managers = Table('managers', metadata,
   Column('employee_id', Integer,
                  ForeignKey('employees.employee_id'),
                  primary_key=True),
   Column('manager_data', String(50)),
)
```

One natural effect of the joined table inheritance configuration is that the identity of any mapped object can be determined entirely from the base table. This has obvious advantages, so SQLAlchemy always considers the primary key columns of a joined inheritance class to be those of the base table only, unless otherwise manually configured. In other words, the `employee_id` column of both the `engineers` and `managers` table is not used to locate the `Engineer` or `Manager` object itself - only the value in `employees.employee_id` is considered, and the primary key in this case is non-composite. `engineers.employee_id` and `managers.employee_id` are still of course critical to the proper operation of the pattern overall as they are used to locate the joined row, once the parent row has been determined, either through a distinct SELECT statement or all at once within a JOIN.

We then configure mappers as usual, except we use some additional arguments to indicate the inheritance relationship, the polymorphic discriminator column, and the **polymorphic identity** of each class; this is the value that will be stored in the polymorphic discriminator column.

```
mapper(Employee, employees, polymorphic_on=employees.c.type,
                            polymorphic_identity='employee')
mapper(Engineer, engineers, inherits=Employee,
                            polymorphic_identity='engineer')
mapper(Manager, managers, inherits=Employee,
                            polymorphic_identity='manager')
```

And that's it. Querying against `Employee` will return a combination of `Employee`, `Engineer` and `Manager` objects. Newly saved `Engineer`, `Manager`, and `Employee` objects will automatically populate the `employees.type` column with `engineer`, `manager`, or `employee`, as appropriate.

Basic Control of Which Tables are Queried

The `with_polymorphic()` method of `Query` affects the specific subclass tables which the Query selects from. Normally, a query such as this:

```
session.query(Employee).all()
```

...selects only from the `employees` table. When loading fresh from the database, our joined-table setup will query from the parent table only, using SQL such as this:

```
SELECT employees.employee_id AS employees_employee_id,
    employees.name AS employees_name, employees.type AS employees_type
FROM employees
[]
```

As attributes are requested from those `Employee` objects which are represented in either the `engineers` or `managers` child tables, a second load is issued for the columns in that related row, if the data was not already loaded. So above, after accessing the objects you'd see further SQL issued along the lines of:

```
SELECT managers.employee_id AS managers_employee_id,
    managers.manager_data AS managers_manager_data
FROM managers
WHERE ? = managers.employee_id
[5]
SELECT engineers.employee_id AS engineers_employee_id,
    engineers.engineer_info AS engineers_engineer_info
FROM engineers
WHERE ? = engineers.employee_id
[2]
```

This behavior works well when issuing searches for small numbers of items, such as when using `Query.get()`, since the full range of joined tables are not pulled in to the SQL statement unnecessarily. But when querying a larger span of rows which are known to be of many types, you may want to actively join to some or all of the joined tables. The `with_polymorphic` feature of `Query` and `mapper` provides this.

Telling our query to polymorphically load `Engineer` and `Manager` objects:

```
query = session.query(Employee).with_polymorphic([Engineer, Manager])
```

produces a query which joins the `employees` table to both the `engineers` and `managers` tables like the following:

```
query.all()
```

```
SELECT employees.employee_id AS employees_employee_id,
    engineers.employee_id AS engineers_employee_id,
    managers.employee_id AS managers_employee_id,
    employees.name AS employees_name,
    employees.type AS employees_type,
    engineers.engineer_info AS engineers_engineer_info,
    managers.manager_data AS managers_manager_data
FROM employees
    LEFT OUTER JOIN engineers
    ON employees.employee_id = engineers.employee_id
    LEFT OUTER JOIN managers
    ON employees.employee_id = managers.employee_id
[]
```

`with_polymorphic()` accepts a single class or mapper, a list of classes/mappers, or the string `'*'` to indicate all subclasses:

```
# join to the engineers table
query.with_polymorphic(Engineer)
```

```
# join to the engineers and managers tables
query.with_polymorphic([Engineer, Manager])

# join to all subclass tables
query.with_polymorphic('*')
```

It also accepts a second argument `selectable` which replaces the automatic join creation and instead selects directly from the selectable given. This feature is normally used with "concrete" inheritance, described later, but can be used with any kind of inheritance setup in the case that specialized SQL should be used to load polymorphically:

```
# custom selectable
query.with_polymorphic(
            [Engineer, Manager],
            employees.outerjoin(managers).outerjoin(engineers)
        )
```

`with_polymorphic()` is also needed when you wish to add filter criteria that are specific to one or more subclasses; it makes the subclasses' columns available to the WHERE clause:

```
session.query(Employee).with_polymorphic([Engineer, Manager]).\
    filter(or_(Engineer.engineer_info=='w', Manager.manager_data=='q'))
```

Note that if you only need to load a single subtype, such as just the `Engineer` objects, `with_polymorphic()` is not needed since you would query against the `Engineer` class directly.

The mapper also accepts `with_polymorphic` as a configurational argument so that the joined-style load will be issued automatically. This argument may be the string `'*'`, a list of classes, or a tuple consisting of either, followed by a selectable.

```
mapper(Employee, employees, polymorphic_on=employees.c.type,
                            polymorphic_identity='employee',
                            with_polymorphic='*')
mapper(Engineer, engineers, inherits=Employee,
                            polymorphic_identity='engineer')
mapper(Manager, managers, inherits=Employee,
                            polymorphic_identity='manager')
```

The above mapping will produce a query similar to that of `with_polymorphic('*')` for every query of `Employee` objects.

Using `with_polymorphic()` with `Query` will override the mapper-level `with_polymorphic` setting.

Advanced Control of Which Tables are Queried

The `Query.with_polymorphic()` method and configuration works fine for simplistic scenarios. However, it currently does not work with any `Query` that selects against individual columns or against multiple classes - it also has to be called at the outset of a query.

For total control of how `Query` joins along inheritance relationships, use the `Table` objects directly and construct joins manually. For example, to query the name of employees with particular criterion:

```
session.query(Employee.name).\
    outerjoin((engineer, engineer.c.employee_id==Employee.employee_id)).\
    outerjoin((manager, manager.c.employee_id==Employee.employee_id)).\
    filter(or_(Engineer.engineer_info=='w', Manager.manager_data=='q'))
```

The base table, in this case the "employees" table, isn't always necessary. A SQL query is always more efficient with fewer joins. Here, if we wanted to just load information specific to managers or engineers, we can instruct

Query to use only those tables. The FROM clause is determined by what's specified in the Session.query(), Query.filter(), or Query.select_from() methods:

```
session.query(Manager.manager_data).select_from(manager)

session.query(engineer.c.id).\
        filter(engineer.c.engineer_info==manager.c.manager_data)
```

Creating Joins to Specific Subtypes

The of_type() method is a helper which allows the construction of joins along relationship() paths while narrowing the criterion to specific subclasses. Suppose the employees table represents a collection of employees which are associated with a Company object. We'll add a company_id column to the employees table and a new table companies:

```
companies = Table('companies', metadata,
   Column('company_id', Integer, primary_key=True),
   Column('name', String(50))
   )

employees = Table('employees', metadata,
  Column('employee_id', Integer, primary_key=True),
  Column('name', String(50)),
  Column('type', String(30), nullable=False),
  Column('company_id', Integer, ForeignKey('companies.company_id'))
)

class Company(object):
    pass

mapper(Company, companies, properties={
    'employees': relationship(Employee)
})
```

When querying from Company onto the Employee relationship, the join() method as well as the any() and has() operators will create a join from companies to employees, without including engineers or managers in the mix. If we wish to have criterion which is specifically against the Engineer class, we can tell those methods to join or subquery against the joined table representing the subclass using the of_type() operator:

```
session.query(Company).\
    join(Company.employees.of_type(Engineer)).\
    filter(Engineer.engineer_info=='someinfo')
```

A longhand version of this would involve spelling out the full target selectable within a 2-tuple:

```
session.query(Company).\
    join((employees.join(engineers), Company.employees)).\
    filter(Engineer.engineer_info=='someinfo')
```

Currently, of_type() accepts a single class argument. It may be expanded later on to accept multiple classes. For now, to join to any group of subclasses, the longhand notation allows this flexibility:

```
session.query(Company).\
    join(
        (employees.outerjoin(engineers).outerjoin(managers),
        Company.employees)
    ).\
    filter(
```

```
        or_(Engineer.engineer_info=='someinfo',
            Manager.manager_data=='somedata')
    )
```

The `any()` and `has()` operators also can be used with `of_type()` when the embedded criterion is in terms of a subclass:

```
session.query(Company).\
        filter(
            Company.employees.of_type(Engineer).
                any(Engineer.engineer_info=='someinfo')
            ).all()
```

Note that the `any()` and `has()` are both shorthand for a correlated EXISTS query. To build one by hand looks like:

```
session.query(Company).filter(
    exists([1],
        and_(Engineer.engineer_info=='someinfo',
            employees.c.company_id==companies.c.company_id),
        from_obj=employees.join(engineers)
    )
).all()
```

The EXISTS subquery above selects from the join of `employees` to `engineers`, and also specifies criterion which correlates the EXISTS subselect back to the parent `companies` table.

2.5.2 Single Table Inheritance

Single table inheritance is where the attributes of the base class as well as all subclasses are represented within a single table. A column is present in the table for every attribute mapped to the base class and all subclasses; the columns which correspond to a single subclass are nullable. This configuration looks much like joined-table inheritance except there's only one table. In this case, a `type` column is required, as there would be no other way to discriminate between classes. The table is specified in the base mapper only; for the inheriting classes, leave their `table` parameter blank:

```
employees_table = Table('employees', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('manager_data', String(50)),
    Column('engineer_info', String(50)),
    Column('type', String(20), nullable=False)
)

employee_mapper = mapper(Employee, employees_table, \
    polymorphic_on=employees_table.c.type, polymorphic_identity='employee')
manager_mapper = mapper(Manager, inherits=employee_mapper,
                                    polymorphic_identity='manager')
engineer_mapper = mapper(Engineer, inherits=employee_mapper,
                                    polymorphic_identity='engineer')
```

Note that the mappers for the derived classes Manager and Engineer omit the specification of their associated table, as it is inherited from the employee_mapper. Omitting the table specification for derived mappers in single-table inheritance is required.

2.5.3 Concrete Table Inheritance

This form of inheritance maps each class to a distinct table, as below:

```
employees_table = Table('employees', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
)

managers_table = Table('managers', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('manager_data', String(50)),
)

engineers_table = Table('engineers', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('engineer_info', String(50)),
)
```

Notice in this case there is no `type` column. If polymorphic loading is not required, there's no advantage to using `inherits` here; you just define a separate mapper for each class.

```
mapper(Employee, employees_table)
mapper(Manager, managers_table)
mapper(Engineer, engineers_table)
```

To load polymorphically, the `with_polymorphic` argument is required, along with a selectable indicating how rows should be loaded. In this case we must construct a UNION of all three tables. SQLAlchemy includes a helper function to create these called `polymorphic_union()`, which will map all the different columns into a structure of selects with the same numbers and names of columns, and also generate a virtual `type` column for each subselect:

```
pjoin = polymorphic_union({
    'employee': employees_table,
    'manager': managers_table,
    'engineer': engineers_table
}, 'type', 'pjoin')

employee_mapper = mapper(Employee, employees_table,
                                   with_polymorphic=('*', pjoin),
                                   polymorphic_on=pjoin.c.type,
                                   polymorphic_identity='employee')
manager_mapper = mapper(Manager, managers_table,
                                   inherits=employee_mapper,
                                   concrete=True,
                                   polymorphic_identity='manager')
engineer_mapper = mapper(Engineer, engineers_table,
                                   inherits=employee_mapper,
                                   concrete=True,
                                   polymorphic_identity='engineer')
```

Upon select, the polymorphic union produces a query like this:

```
session.query(Employee).all()

SELECT pjoin.type AS pjoin_type,
        pjoin.manager_data AS pjoin_manager_data,
        pjoin.employee_id AS pjoin_employee_id,
pjoin.name AS pjoin_name, pjoin.engineer_info AS pjoin_engineer_info
FROM (
    SELECT employees.employee_id AS employee_id,
        CAST(NULL AS VARCHAR(50)) AS manager_data, employees.name AS name,
```

```
        CAST(NULL AS VARCHAR(50)) AS engineer_info, 'employee' AS type
    FROM employees
UNION ALL
    SELECT managers.employee_id AS employee_id,
        managers.manager_data AS manager_data, managers.name AS name,
        CAST(NULL AS VARCHAR(50)) AS engineer_info, 'manager' AS type
    FROM managers
UNION ALL
    SELECT engineers.employee_id AS employee_id,
        CAST(NULL AS VARCHAR(50)) AS manager_data, engineers.name AS name,
    engineers.engineer_info AS engineer_info, 'engineer' AS type
    FROM engineers
) AS pjoin
[]
```

Concrete Inheritance with Declarative

New in version 0.7.3: The *Declarative* module includes helpers for concrete inheritance. See *Using the Concrete Helpers* for more information.

2.5.4 Using Relationships with Inheritance

Both joined-table and single table inheritance scenarios produce mappings which are usable in `relationship()` functions; that is, it's possible to map a parent object to a child object which is polymorphic. Similarly, inheriting mappers can have `relationship()` objects of their own at any level, which are inherited to each child class. The only requirement for relationships is that there is a table relationship between parent and child. An example is the following modification to the joined table inheritance example, which sets a bi-directional relationship between `Employee` and `Company`:

```
employees_table = Table('employees', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('company_id', Integer, ForeignKey('companies.company_id'))
)

companies = Table('companies', metadata,
   Column('company_id', Integer, primary_key=True),
   Column('name', String(50)))

class Company(object):
    pass

mapper(Company, companies, properties={
   'employees': relationship(Employee, backref='company')
})
```

Relationships with Concrete Inheritance

In a concrete inheritance scenario, mapping relationships is more challenging since the distinct classes do not share a table. In this case, you *can* establish a relationship from parent to child if a join condition can be constructed from parent to child, if each child table contains a foreign key to the parent:

```
companies = Table('companies', metadata,
   Column('id', Integer, primary_key=True),
   Column('name', String(50)))

employees_table = Table('employees', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('company_id', Integer, ForeignKey('companies.id'))
)

managers_table = Table('managers', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('manager_data', String(50)),
    Column('company_id', Integer, ForeignKey('companies.id'))
)

engineers_table = Table('engineers', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('name', String(50)),
    Column('engineer_info', String(50)),
    Column('company_id', Integer, ForeignKey('companies.id'))
)

mapper(Employee, employees_table,
                with_polymorphic=('*', pjoin),
                polymorphic_on=pjoin.c.type,
                polymorphic_identity='employee')

mapper(Manager, managers_table,
                inherits=employee_mapper,
                concrete=True,
                polymorphic_identity='manager')

mapper(Engineer, engineers_table,
                inherits=employee_mapper,
                concrete=True,
                polymorphic_identity='engineer')

mapper(Company, companies, properties={
    'employees': relationship(Employee)
})
```

The big limitation with concrete table inheritance is that `relationship()` objects placed on each concrete mapper do **not** propagate to child mappers. If you want to have the same `relationship()` objects set up on all concrete mappers, they must be configured manually on each. To configure back references in such a configuration the `back_populates` keyword may be used instead of `backref`, such as below where both `A(object)` and `B(A)` bidirectionally reference `C`:

```
ajoin = polymorphic_union({
        'a':a_table,
        'b':b_table
    }, 'type', 'ajoin')

mapper(A, a_table, with_polymorphic=('*', ajoin),
    polymorphic_on=ajoin.c.type, polymorphic_identity='a',
    properties={
        'some_c':relationship(C, back_populates='many_a')
```

```
})
mapper(B, b_table,inherits=A, concrete=True,
    polymorphic_identity='b',
    properties={
        'some_c':relationship(C, back_populates='many_a')
})
mapper(C, c_table, properties={
    'many_a':relationship(A, collection_class=set,
                                back_populates='some_c'),
})
```

2.5.5 Using Inheritance with Declarative

Declarative makes inheritance configuration more intuitive. See the docs at *Inheritance Configuration*.

2.6 Using the Session

The `orm.mapper()` function and `declarative` extensions are the primary configurational interface for the ORM. Once mappings are configured, the primary usage interface for persistence operations is the `Session`.

2.6.1 What does the Session do ?

In the most general sense, the `Session` establishes all conversations with the database and represents a "holding zone" for all the objects which you've loaded or associated with it during its lifespan. It provides the entrypoint to acquire a `Query` object, which sends queries to the database using the `Session` object's current database connection, populating result rows into objects that are then stored in the `Session`, inside a structure called the Identity Map - a data structure that maintains unique copies of each object, where "unique" means "only one object with a particular primary key".

The `Session` begins in an essentially stateless form. Once queries are issued or other objects are persisted with it, it requests a connection resource from an `Engine` that is associated either with the `Session` itself or with the mapped `Table` objects being operated upon. This connection represents an ongoing transaction, which remains in effect until the `Session` is instructed to commit or roll back its pending state.

All changes to objects maintained by a `Session` are tracked - before the database is queried again or before the current transaction is committed, it **flushes** all pending changes to the database. This is known as the Unit of Work pattern.

When using a `Session`, it's important to note that the objects which are associated with it are **proxy objects** to the transaction being held by the `Session` - there are a variety of events that will cause objects to re-access the database in order to keep synchronized. It is possible to "detach" objects from a `Session`, and to continue using them, though this practice has its caveats. It's intended that usually, you'd re-associate detached objects another `Session` when you want to work with them again, so that they can resume their normal task of representing database state.

2.6.2 Getting a Session

`Session` is a regular Python class which can be directly instantiated. However, to standardize how sessions are configured and acquired, the `sessionmaker()` function is normally used to create a top level `Session` configuration which can then be used throughout an application without the need to repeat the configurational arguments.

The usage of `sessionmaker()` is illustrated below:

```
from sqlalchemy import create_engine
from sqlalchemy.orm import sessionmaker

# an Engine, which the Session will use for connection
# resources
some_engine = create_engine('postgresql://scott:tiger@localhost/')

# create a configured "Session" class
Session = sessionmaker(bind=some_engine)

# create a Session
session = Session()

# work with sess
myobject = MyObject('foo', 'bar')
session.add(myobject)
session.commit()
```

Above, the `sessionmaker()` call creates a factory for us, which we assign to the name `Session`. This factory, when called, will create a new `Session` object using the configurational arguments we've given the factory. In this case, as is typical, we've configured the factory to specify a particular `Engine` for connection resources.

A typical setup will associate the `sessionmaker()` with an `Engine`, so that each `Session` generated will use this `Engine` to acquire connection resources. This association can be set up as in the example above, using the `bind` argument.

When you write your application, place the `sessionmaker()` factory at the global level. This factory can then be used by the rest of the applcation as the source of new `Session` instances, keeping the configuration for how `Session` objects are constructed in one place.

The `sessionmaker()` factory can also be used in conjunction with other helpers, which are passed a user-defined `sessionmaker()` that is then maintained by the helper. Some of these helpers are discussed in the section *Session Frequently Asked Questions*.

Adding Additional Configuration to an Existing sessionmaker()

A common scenario is where the `sessionmaker()` is invoked at module import time, however the generation of one or more `Engine` instances to be associated with the `sessionmaker()` has not yet proceeded. For this use case, the `sessionmaker()` construct offers the `sessionmaker.configure()` method, which will place additional configuration directives into an existing `sessionmaker()` that will take place when the construct is invoked:

```
from sqlalchemy.orm import sessionmaker
from sqlalchemy import create_engine

# configure Session class with desired options
Session = sessionmaker()

# later, we create the engine
engine = create_engine('postgresql://...')

# associate it with our custom Session class
Session.configure(bind=engine)

# work with the session
session = Session()
```

Creating Ad-Hoc Session Objects with Alternate Arguments

For the use case where an application needs to create a new `Session` with special arguments that deviate from what is normally used throughout the application, such as a `Session` that binds to an alternate source of connectivity, or a `Session` that should have other arguments such as `expire_on_commit` established differently from what most of the application wants, specific arguments can be passed to the `sessionmaker()` factory's `sessionmaker.__call__()` method. These arguments will override whatever configurations have already been placed, such as below, where a new `Session` is constructed against a specific `Connection`:

```
# at the module level, the global sessionmaker,
# bound to a specific Engine
Session = sessionmaker(bind=engine)

# later, some unit of code wants to create a
# Session that is bound to a specific Connection
conn = engine.connect()
session = Session(bind=conn)
```

The typical rationale for the association of a `Session` with a specific `Connection` is that of a test fixture that maintains an external transaction - see *Joining a Session into an External Transaction* for an example of this.

2.6.3 Using the Session

Quickie Intro to Object States

It's helpful to know the states which an instance can have within a session:

- **Transient** - an instance that's not in a session, and is not saved to the database; i.e. it has no database identity. The only relationship such an object has to the ORM is that its class has a `mapper()` associated with it.
- **Pending** - when you `add()` a transient instance, it becomes pending. It still wasn't actually flushed to the database yet, but it will be when the next flush occurs.
- **Persistent** - An instance which is present in the session and has a record in the database. You get persistent instances by either flushing so that the pending instances become persistent, or by querying the database for existing instances (or moving persistent instances from other sessions into your local session).
- **Detached** - an instance which has a record in the database, but is not in any session. There's nothing wrong with this, and you can use objects normally when they're detached, **except** they will not be able to issue any SQL in order to load collections or attributes which are not yet loaded, or were marked as "expired".

Knowing these states is important, since the `Session` tries to be strict about ambiguous operations (such as trying to save the same object to two different sessions at the same time).

Session Frequently Asked Questions

- When do I make a `sessionmaker()` ?

  Just one time, somewhere in your application's global scope. It should be looked upon as part of your application's configuration. If your application has three .py files in a package, you could, for example, place the `sessionmaker()` line in your `__init__.py` file; from that point on your other modules say "from mypackage import Session". That way, everyone else just uses `Session()`, and the configuration of that session is controlled by that central point.

  If your application starts up, does imports, but does not know what database it's going to be connecting to, you can bind the `Session` at the "class" level to the engine later on, using `sessionmaker.configure()`.

In the examples in this section, we will frequently show the `sessionmaker()` being created right above the line where we actually invoke `Session`. But that's just for example's sake! In reality, the `sessionmaker()` would be somewhere at the module level. The calls to instantiate `Session` would then be placed at the point in the application where database conversations begin.

- When do I construct a `Session`, when do I commit it, and when do I close it ?

  A `Session` is typically constructed at the beginning of a logical operation where database access is potentially anticipated.

  The `Session`, whenever it is used to talk to the database, begins a database transaction as soon as it starts communicating. Assuming the `autocommit` flag is left at its recommended default of `False`, this transaction remains in progress until the `Session` is rolled back, committed, or closed. The `Session` will begin a new transaction if it is used again, subsequent to the previous transaction ending; from this it follows that the `Session` is capable of having a lifespan across many transactions, though only one at a time. We refer to these two concepts as **transaction scope** and **session scope**.

  The implication here is that the SQLAlchemy ORM is encouraging the developer to establish these two scopes in their application, including not only when the scopes begin and end, but also the expanse of those scopes, for example should a single `Session` instance be local to the execution flow within a function or method, should it be a global object used by the entire application, or somewhere in between these two.

  The burden placed on the developer to determine this scope is one area where the SQLAlchemy ORM necessarily has a strong opinion about how the database should be used. The unit-of-work pattern is specifically one of accumulating changes over time and flushing them periodically, keeping in-memory state in sync with what's known to be present in a local transaction. This pattern is only effective when meaningful transaction scopes are in place.

  It's usually not very hard to determine the best points at which to begin and end the scope of a `Session`, though the wide variety of application architectures possible can introduce challenging situations.

  A common choice is to tear down the `Session` at the same time the transaction ends, meaning the transaction and session scopes are the same. This is a great choice to start out with as it removes the need to consider session scope as separate from transaction scope.

  While there's no one-size-fits-all recommendation for how transaction scope should be determined, there are common patterns. Especially if one is writing a web application, the choice is pretty much established.

  A web application is the easiest case because such an appication is already constructed around a single, consistent scope - this is the **request**, which represents an incoming request from a browser, the processing of that request to formulate a response, and finally the delivery of that response back to the client. Integrating web applications with the `Session` is then the straightforward task of linking the scope of the `Session` to that of the request. The `Session` can be established as the request begins, or using a **lazy initialization** pattern which establishes one as soon as it is needed. The request then proceeds, with some system in place where application logic can access the current `Session` in a manner associated with how the actual request object is accessed. As the request ends, the `Session` is torn down as well, usually through the usage of event hooks provided by the web framework. The transaction used by the `Session` may also be committed at this point, or alternatively the application may opt for an explicit commit pattern, only committing for those requests where one is warranted, but still always tearing down the `Session` unconditionally at the end.

  Most web frameworks include infrastructure to establish a single `Session`, associated with the request, which is correctly constructed and torn down corresponding torn down at the end of a request. Such infrastructure pieces include products such as Flask-SQLAlchemy, for usage in conjunction

with the Flask web framework, and Zope-SQLAlchemy, for usage in conjunction with the Pyramid and Zope frameworks. SQLAlchemy strongly recommends that these products be used as available.

In those situations where integration libraries are not available, SQLAlchemy includes its own "helper" class known as `ScopedSession`. A tutorial on the usage of this object is at *Contextual/Thread-local Sessions*. It provides both a quick way to associate a `Session` with the current thread, as well as patterns to associate `Session` objects with other kinds of scopes.

As mentioned before, for non-web applications there is no one clear pattern, as applications themselves don't have just one pattern of architecture. The best strategy is to attempt to demarcate "operations", points at which a particular thread begins to perform a series of operations for some period of time, which can be committed at the end. Some examples:

- A background daemon which spawns off child forks would want to create a `Session` local to each child process work with that `Session` through the life of the "job" that the fork is handling, then tear it down when the job is completed.
- For a command-line script, the application would create a single, global `Session` that is established when the program begins to do its work, and commits it right as the program is completing its task.
- For a GUI interface-driven application, the scope of the `Session` may best be within the scope of a user-generated event, such as a button push. Or, the scope may correspond to explicit user interaction, such as the user "opening" a series of records, then "saving" them.

- Is the Session a cache ?

  Yeee...no. It's somewhat used as a cache, in that it implements the identity map pattern, and stores objects keyed to their primary key. However, it doesn't do any kind of query caching. This means, if you say `session.query(Foo).filter_by(name='bar')`, even if `Foo(name='bar')` is right there, in the identity map, the session has no idea about that. It has to issue SQL to the database, get the rows back, and then when it sees the primary key in the row, *then* it can look in the local identity map and see that the object is already there. It's only when you say `query.get({some primary key})` that the `Session` doesn't have to issue a query.

  Additionally, the Session stores object instances using a weak reference by default. This also defeats the purpose of using the Session as a cache.

  The `Session` is not designed to be a global object from which everyone consults as a "registry" of objects. That's more the job of a **second level cache**. SQLAlchemy provides a pattern for implementing second level caching using Beaker, via the *Beaker Caching* example.

- How can I get the `Session` for a certain object ?

  Use the `object_session()` classmethod available on `Session`:

  ```
  session = Session.object_session(someobject)
  ```

- Is the session thread-safe?

  The `Session` is very much intended to be used in a **non-concurrent** fashion, which usually means in only one thread at a time.

  The `Session` should be used in such a way that one instance exists for a single series of operations within a single transaction. One expedient way to get this effect is by associating a `Session` with the current thread (see *Contextual/Thread-local Sessions* for background). Another is to use a pattern where the `Session` is passed between functions and is otherwise not shared with other threads.

  The bigger point is that you should not *want* to use the session with multiple concurrent threads. That would be like having everyone at a restaurant all eat from the same plate. The session is a local "workspace" that you use for a specific set of tasks; you don't want to, or need to, share that session with other threads who are doing some other task.

If there are in fact multiple threads participating in the same task, then you may consider sharing the session between those threads, though this would be an extremely unusual scenario. In this case it would be necessary to implement a proper locking scheme so that the `Session` is still not exposed to concurrent access.

Querying

The `query()` function takes one or more *entities* and returns a new `Query` object which will issue mapper queries within the context of this Session. An entity is defined as a mapped class, a `Mapper` object, an orm-enabled *descriptor*, or an `AliasedClass` object:

```
# query from a class
session.query(User).filter_by(name='ed').all()

# query with multiple classes, returns tuples
session.query(User, Address).join('addresses').filter_by(name='ed').all()

# query using orm-enabled descriptors
session.query(User.name, User.fullname).all()

# query from a mapper
user_mapper = class_mapper(User)
session.query(user_mapper)
```

When `Query` returns results, each object instantiated is stored within the identity map. When a row matches an object which is already present, the same object is returned. In the latter case, whether or not the row is populated onto an existing object depends upon whether the attributes of the instance have been *expired* or not. A default-configured `Session` automatically expires all instances along transaction boundaries, so that with a normally isolated transaction, there shouldn't be any issue of instances representing data which is stale with regards to the current transaction.

The `Query` object is introduced in great detail in *Object Relational Tutorial*, and further documented in *Querying*.

Adding New or Existing Items

`add()` is used to place instances in the session. For *transient* (i.e. brand new) instances, this will have the effect of an INSERT taking place for those instances upon the next flush. For instances which are *persistent* (i.e. were loaded by this session), they are already present and do not need to be added. Instances which are *detached* (i.e. have been removed from a session) may be re-associated with a session using this method:

```
user1 = User(name='user1')
user2 = User(name='user2')
session.add(user1)
session.add(user2)

session.commit()     # write changes to the database
```

To add a list of items to the session at once, use `add_all()`:

```
session.add_all([item1, item2, item3])
```

The `add()` operation **cascades** along the `save-update` cascade. For more details see the section *Cascades*.

Merging

`merge()` transfers state from an outside object into a new or already existing instance within a session. It also

reconciles the incoming data against the state of the database, producing a history stream which will be applied towards the next flush, or alternatively can be made to produce a simple "transfer" of state without producing change history or accessing the database. Usage is as follows:

```
merged_object = session.merge(existing_object)
```

When given an instance, it follows these steps:

- It examines the primary key of the instance. If it's present, it attempts to locate that instance in the local identity map. If the `load=True` flag is left at its default, it also checks the database for this primary key if not located locally.
- If the given instance has no primary key, or if no instance can be found with the primary key given, a new instance is created.
- The state of the given instance is then copied onto the located/newly created instance. For attributes which are present on the source instance, the value is transferred to the target instance. For mapped attributes which aren't present on the source, the attribute is expired on the target instance, discarding its existing value.

  If the `load=True` flag is left at its default, this copy process emits events and will load the target object's unloaded collections for each attribute present on the source object, so that the incoming state can be reconciled against what's present in the database. If `load` is passed as `False`, the incoming data is "stamped" directly without producing any history.
- The operation is cascaded to related objects and collections, as indicated by the `merge` cascade (see *Cascades*).
- The new instance is returned.

With `merge()`, the given "source" instance is not modifed nor is it associated with the target `Session`, and remains available to be merged with any number of other `Session` objects. `merge()` is useful for taking the state of any kind of object structure without regard for its origins or current session associations and copying its state into a new session. Here's some examples:

- An application which reads an object structure from a file and wishes to save it to the database might parse the file, build up the structure, and then use `merge()` to save it to the database, ensuring that the data within the file is used to formulate the primary key of each element of the structure. Later, when the file has changed, the same process can be re-run, producing a slightly different object structure, which can then be `merged` in again, and the `Session` will automatically update the database to reflect those changes, loading each object from the database by primary key and then updating its state with the new state given.
- An application is storing objects in an in-memory cache, shared by many `Session` objects simultaneously. `merge()` is used each time an object is retrieved from the cache to create a local copy of it in each `Session` which requests it. The cached object remains detached; only its state is moved into copies of itself that are local to individual `Session` objects.

  In the caching use case, it's common that the `load=False` flag is used to remove the overhead of reconciling the object's state with the database. There's also a "bulk" version of `merge()` called `merge_result()` that was designed to work with cache-extended `Query` objects - see the section *Beaker Caching*.
- An application wants to transfer the state of a series of objects into a `Session` maintained by a worker thread or other concurrent system. `merge()` makes a copy of each object to be placed into this new `Session`. At the end of the operation, the parent thread/process maintains the objects it started with, and the thread/worker can proceed with local copies of those objects.

  In the "transfer between threads/processes" use case, the application may want to use the `load=False` flag as well to avoid overhead and redundant SQL queries as the data is transferred.

Merge Tips

`merge()` is an extremely useful method for many purposes. However, it deals with the intricate border between

objects that are transient/detached and those that are persistent, as well as the automated transferrence of state. The wide variety of scenarios that can present themselves here often require a more careful approach to the state of objects. Common problems with merge usually involve some unexpected state regarding the object being passed to `merge()`.

Lets use the canonical example of the User and Address objects:

```
class User(Base):
    __tablename__ = 'user'

    id = Column(Integer, primary_key=True)
    name = Column(String(50), nullable=False)
    addresses = relationship("Address", backref="user")

class Address(Base):
    __tablename__ = 'address'

    id = Column(Integer, primary_key=True)
    email_address = Column(String(50), nullable=False)
    user_id = Column(Integer, ForeignKey('user.id'), nullable=False)
```

Assume a `User` object with one `Address`, already persistent:

```
>>> u1 = User(name='ed', addresses=[Address(email_address='ed@ed.com')])
>>> session.add(u1)
>>> session.commit()
```

We now create `a1`, an object outside the session, which we'd like to merge on top of the existing `Address`:

```
>>> existing_a1 = u1.addresses[0]
>>> a1 = Address(id=existing_a1.id)
```

A surprise would occur if we said this:

```
>>> a1.user = u1
>>> a1 = session.merge(a1)
>>> session.commit()
sqlalchemy.orm.exc.FlushError: New instance <Address at 0x1298f50>
with identity key (<class '__main__.Address'>, (1,)) conflicts with
persistent instance <Address at 0x12a25d0>
```

Why is that ? We weren't careful with our cascades. The assignment of `a1.user` to a persistent object cascaded to the backref of `User.addresses` and made our `a1` object pending, as though we had added it. Now we have *two* `Address` objects in the session:

```
>>> a1 = Address()
>>> a1.user = u1
>>> a1 in session
True
>>> existing_a1 in session
True
>>> a1 is existing_a1
False
```

Above, our `a1` is already pending in the session. The subsequent `merge()` operation essentially does nothing. Cascade can be configured via the `cascade` option on `relationship()`, although in this case it would mean removing the `save-update` cascade from the `User.addresses` relationship - and usually, that behavior is extremely convenient. The solution here would usually be to not assign `a1.user` to an object already persistent in the target session.

The `cascade_backrefs=False` option of `relationship()` will also prevent the `Address` from being added to the session via the `a1.user = u1` assignment.

Further detail on cascade operation is at *Cascades*.

Another example of unexpected state:

```
>>> a1 = Address(id=existing_a1.id, user_id=u1.id)
>>> assert a1.user is None
>>> True
>>> a1 = session.merge(a1)
>>> session.commit()
sqlalchemy.exc.IntegrityError: (IntegrityError) address.user_id
may not be NULL
```

Here, we accessed a1.user, which returned its default value of `None`, which as a result of this access, has been placed in the `__dict__` of our object `a1`. Normally, this operation creates no change event, so the `user_id` attribute takes precedence during a flush. But when we merge the `Address` object into the session, the operation is equivalent to:

```
>>> existing_a1.id = existing_a1.id
>>> existing_a1.user_id = u1.id
>>> existing_a1.user = None
```

Where above, both `user_id` and `user` are assigned to, and change events are emitted for both. The `user` association takes precedence, and None is applied to `user_id`, causing a failure.

Most `merge()` issues can be examined by first checking - is the object prematurely in the session ?

```
>>> a1 = Address(id=existing_a1, user_id=user.id)
>>> assert a1 not in session
>>> a1 = session.merge(a1)
```

Or is there state on the object that we don't want ? Examining `__dict__` is a quick way to check:

```
>>> a1 = Address(id=existing_a1, user_id=user.id)
>>> a1.user
>>> a1.__dict__
{'_sa_instance_state': <sqlalchemy.orm.state.InstanceState object at 0x1298d10>,
    'user_id': 1,
    'id': 1,
    'user': None}
>>> # we don't want user=None merged, remove it
>>> del a1.user
>>> a1 = session.merge(a1)
>>> # success
>>> session.commit()
```

Deleting

The `delete()` method places an instance into the Session's list of objects to be marked as deleted:

```
# mark two objects to be deleted
session.delete(obj1)
session.delete(obj2)

# commit (or flush)
session.commit()
```

Deleting from Collections

A common confusion that arises regarding `delete()` is when objects which are members of a collection are being deleted. While the collection member is marked for deletion from the database, this does not impact the collection itself in memory until the collection is expired. Below, we illustrate that even after an `Address` object is marked for deletion, it's still present in the collection associated with the parent `User`, even after a flush:

```
>>> address = user.addresses[1]
>>> session.delete(address)
>>> session.flush()
>>> address in user.addresses
True
```

When the above session is committed, all attributes are expired. The next access of `user.addresses` will re-load the collection, revealing the desired state:

```
>>> session.commit()
>>> address in user.addresses
False
```

The usual practice of deleting items within collections is to forego the usage of `delete()` directly, and instead use cascade behavior to automatically invoke the deletion as a result of removing the object from the parent collection. The `delete-orphan` cascade accomplishes this, as illustrated in the example below:

```
mapper(User, users_table, properties={
    'addresses':relationship(Address, cascade="all, delete, delete-orphan")
})
del user.addresses[1]
session.flush()
```

Where above, upon removing the `Address` object from the `User.addresses` collection, the `delete-orphan` cascade has the effect of marking the `Address` object for deletion in the same way as passing it to `delete()`.

See also *Cascades* for detail on cascades.

Deleting based on Filter Criterion

The caveat with `Session.delete()` is that you need to have an object handy already in order to delete. The Query includes a `delete()` method which deletes based on filtering criteria:

```
session.query(User).filter(User.id==7).delete()
```

The `Query.delete()` method includes functionality to "expire" objects already in the session which match the criteria. However it does have some caveats, including that "delete" and "delete-orphan" cascades won't be fully expressed for collections which are already loaded. See the API docs for `delete()` for more details.

Flushing

When the `Session` is used with its default configuration, the flush step is nearly always done transparently. Specifically, the flush occurs before any individual `Query` is issued, as well as within the `commit()` call before the transaction is committed. It also occurs before a SAVEPOINT is issued when `begin_nested()` is used.

Regardless of the autoflush setting, a flush can always be forced by issuing `flush()`:

```
session.flush()
```

The "flush-on-Query" aspect of the behavior can be disabled by constructing `sessionmaker()` with the flag `autoflush=False`:

```
Session = sessionmaker(autoflush=False)
```

Additionally, autoflush can be temporarily disabled by setting the `autoflush` flag at any time:

```
mysession = Session()
mysession.autoflush = False
```

Some autoflush-disable recipes are available at DisableAutoFlush.

The flush process *always* occurs within a transaction, even if the `Session` has been configured with `autocommit=True`, a setting that disables the session's persistent transactional state. If no transaction is present, `flush()` creates its own transaction and commits it. Any failures during flush will always result in a rollback of whatever transaction is present. If the Session is not in `autocommit=True` mode, an explicit call to `rollback()` is required after a flush fails, even though the underlying transaction will have been rolled back already - this is so that the overall nesting pattern of so-called "subtransactions" is consistently maintained.

Committing

`commit()` is used to commit the current transaction. It always issues `flush()` beforehand to flush any remaining state to the database; this is independent of the "autoflush" setting. If no transaction is present, it raises an error. Note that the default behavior of the `Session` is that a "transaction" is always present; this behavior can be disabled by setting `autocommit=True`. In autocommit mode, a transaction can be initiated by calling the `begin()` method.

Note: The term "transaction" here refers to a transactional construct within the `Session` itself which may be maintaining zero or more actual database (DBAPI) transactions. An individual DBAPI connection begins participation in the "transaction" as it is first used to execute a SQL statement, then remains present until the session-level "transaction" is completed. See *Managing Transactions* for further detail.

Another behavior of `commit()` is that by default it expires the state of all instances present after the commit is complete. This is so that when the instances are next accessed, either through attribute access or by them being present in a `Query` result set, they receive the most recent state. To disable this behavior, configure `sessionmaker()` with `expire_on_commit=False`.

Normally, instances loaded into the `Session` are never changed by subsequent queries; the assumption is that the current transaction is isolated so the state most recently loaded is correct as long as the transaction continues. Setting `autocommit=True` works against this model to some degree since the `Session` behaves in exactly the same way with regard to attribute state, except no transaction is present.

Rolling Back

`rollback()` rolls back the current transaction. With a default configured session, the post-rollback state of the session is as follows:

- All transactions are rolled back and all connections returned to the connection pool, unless the Session was bound directly to a Connection, in which case the connection is still maintained (but still rolled back).
- Objects which were initially in the *pending* state when they were added to the `Session` within the lifespan of the transaction are expunged, corresponding to their INSERT statement being rolled back. The state of their attributes remains unchanged.
- Objects which were marked as *deleted* within the lifespan of the transaction are promoted back to the *persistent* state, corresponding to their DELETE statement being rolled back. Note that if those objects were first *pending* within the transaction, that operation takes precedence instead.

- All objects not expunged are fully expired.

With that state understood, the `Session` may safely continue usage after a rollback occurs.

When a `flush()` fails, typically for reasons like primary key, foreign key, or "not nullable" constraint violations, a `rollback()` is issued automatically (it's currently not possible for a flush to continue after a partial failure). However, the flush process always uses its own transactional demarcator called a *subtransaction*, which is described more fully in the docstrings for `Session`. What it means here is that even though the database transaction has been rolled back, the end user must still issue `rollback()` to fully reset the state of the `Session`.

Expunging

Expunge removes an object from the Session, sending persistent instances to the detached state, and pending instances to the transient state:

```
session.expunge(obj1)
```

To remove all items, call `expunge_all()` (this method was formerly known as `clear()`).

Closing

The `close()` method issues a `expunge_all()`, and *releases* any transactional/connection resources. When connections are returned to the connection pool, transactional state is rolled back as well.

Refreshing / Expiring

The Session normally works in the context of an ongoing transaction (with the default setting of autoflush=False). Most databases offer "isolated" transactions - this refers to a series of behaviors that allow the work within a transaction to remain consistent as time passes, regardless of the activities outside of that transaction. A key feature of a high degree of transaction isolation is that emitting the same SELECT statement twice will return the same results as when it was called the first time, even if the data has been modified in another transaction.

For this reason, the `Session` gains very efficient behavior by loading the attributes of each instance only once. Subsequent reads of the same row in the same transaction are assumed to have the same value. The user application also gains directly from this assumption, that the transaction is regarded as a temporary shield against concurrent changes - a good application will ensure that isolation levels are set appropriately such that this assumption can be made, given the kind of data being worked with.

To clear out the currently loaded state on an instance, the instance or its individual attributes can be marked as "expired", which results in a reload to occur upon next access of any of the instance's attrbutes. The instance can also be immediately reloaded from the database. The `expire()` and `refresh()` methods achieve this:

```
# immediately re-load attributes on obj1, obj2
session.refresh(obj1)
session.refresh(obj2)

# expire objects obj1, obj2, attributes will be reloaded
# on the next access:
session.expire(obj1)
session.expire(obj2)
```

When an expired object reloads, all non-deferred column-based attributes are loaded in one query. Current behavior for expired relationship-based attributes is that they load individually upon access - this behavior may be enhanced in a future release. When a refresh is invoked on an object, the ultimate operation is equivalent to a `Query.get()`, so any relationships configured with eager loading should also load within the scope of the refresh operation.

refresh() and expire() also support being passed a list of individual attribute names in which to be refreshed. These names can refer to any attribute, column-based or relationship based:

```
# immediately re-load the attributes 'hello', 'world' on obj1, obj2
session.refresh(obj1, ['hello', 'world'])
session.refresh(obj2, ['hello', 'world'])

# expire the attributes 'hello', 'world' objects obj1, obj2, attributes will be reloaded
# on the next access:
session.expire(obj1, ['hello', 'world'])
session.expire(obj2, ['hello', 'world'])
```

The full contents of the session may be expired at once using expire_all():

```
session.expire_all()
```

Note that expire_all() is called **automatically** whenever commit() or rollback() are called. If using the session in its default mode of autocommit=False and with a well-isolated transactional environment (which is provided by most backends with the notable exception of MySQL MyISAM), there is virtually *no reason* to ever call expire_all() directly - plenty of state will remain on the current transaction until it is rolled back or committed or otherwise removed.

refresh() and expire() similarly are usually only necessary when an UPDATE or DELETE has been issued manually within the transaction using Session.execute().

Session Attributes

The Session itself acts somewhat like a set-like collection. All items present may be accessed using the iterator interface:

```
for obj in session:
    print obj
```

And presence may be tested for using regular "contains" semantics:

```
if obj in session:
    print "Object is present"
```

The session is also keeping track of all newly created (i.e. pending) objects, all objects which have had changes since they were last loaded or saved (i.e. "dirty"), and everything that's been marked as deleted:

```
# pending objects recently added to the Session
session.new

# persistent objects which currently have changes detected
# (this collection is now created on the fly each time the property is called)
session.dirty

# persistent objects that have been marked as deleted via session.delete(obj)
session.deleted

# dictionary of all persistent objects, keyed on their
# identity key
session.identity_map
```

(Documentation: Session.new, Session.dirty, Session.deleted, Session.identity_map).

Note that objects within the session are by default *weakly referenced*. This means that when they are dereferenced in the outside application, they fall out of scope from within the Session as well and are subject to garbage collection by

the Python interpreter. The exceptions to this include objects which are pending, objects which are marked as deleted, or persistent objects which have pending changes on them. After a full flush, these collections are all empty, and all objects are again weakly referenced. To disable the weak referencing behavior and force all objects within the session to remain until explicitly expunged, configure `sessionmaker()` with the `weak_identity_map=False` setting.

2.6.4 Cascades

Mappers support the concept of configurable **cascade** behavior on `relationship()` constructs. This refers to how operations performed on a parent object relative to a particular `Session` should be propagated to items referred to by that relationship. The default cascade behavior is usually suitable for most situations, and the option is normally invoked explicitly in order to enable `delete` and `delete-orphan` cascades, which refer to how the relationship should be treated when the parent is marked for deletion as well as when a child is de-associated from its parent.

Cascade behavior is configured by setting the `cascade` keyword argument on `relationship()`:

```
class Order(Base):
    __tablename__ = 'order'

    items = relationship("Item", cascade="all, delete-orphan")
    customer = relationship("User", secondary=user_orders_table,
                                cascade="save-update")
```

To set cascades on a backref, the same flag can be used with the `backref()` function, which ultimately feeds its arguments back into `relationship()`:

```
class Item(Base):
    __tablename__ = 'item'

    order = relationship("Order",
                    backref=backref("items", cascade="all, delete-orphan")
                )
```

The default value of `cascade` is `save-update, merge`. The `all` symbol in the cascade options indicates that all cascade flags should be enabled, with the exception of `delete-orphan`. Typically, cascade is usually left at its default, or configured as `all, delete-orphan`, indicating the child objects should be treated as "owned" by the parent.

The list of available values which can be specified in `cascade` are as follows:

- `save-update` - Indicates that when an object is placed into a `Session` via `Session.add()`, all the objects associated with it via this `relationship()` should also be added to that same `Session`. Additionally, if this object is already present in a `Session`, child objects will be added to that session as they are associated with this parent, i.e. as they are appended to lists, added to sets, or otherwise associated with the parent.

  `save-update` cascade also cascades the *pending history* of the target attribute, meaning that objects which were removed from a scalar or collection attribute whose changes have not yet been flushed are also placed into the target session. This is because they may have foreign key attributes present which will need to be updated to no longer refer to the parent.

  The `save-update` cascade is on by default, and it's common to not even be aware of it. It's customary that only a single call to `Session.add()` against the lead object of a structure has the effect of placing the full structure of objects into the `Session` at once.

  However, it can be turned off, which would imply that objects associated with a parent would need to be placed individually using `Session.add()` calls for each one.

  Another default behavior of `save-update` cascade is that it will take effect in the reverse direction, that is, associating a child with a parent when a backref is present means both relationships are affected; the

parent will be added to the child's session. To disable this somewhat indirect session addition, use the `cascade_backrefs=False` option described below in *Controlling Cascade on Backrefs*.

- `delete` - This cascade indicates that when the parent object is marked for deletion, the related objects should also be marked for deletion. Without this cascade present, SQLAlchemy will set the foreign key on a one-to-many relationship to NULL when the parent object is deleted. When enabled, the row is instead deleted.

  `delete` cascade is often used in conjunction with `delete-orphan` cascade, as is appropriate for an object whose foreign key is not intended to be nullable. On some backends, it's also a good idea to set `ON DELETE` on the foreign key itself; see the section *Using Passive Deletes* for more details.

  Note that for many-to-many relationships which make usage of the `secondary` argument to `relationship()`, SQLAlchemy always emits a DELETE for the association row in between "parent" and "child", when the parent is deleted or whenever the linkage between a particular parent and child is broken.

- `delete-orphan` - This cascade adds behavior to the `delete` cascade, such that a child object will be marked for deletion when it is de-associated from the parent, not just when the parent is marked for deletion. This is a common feature when dealing with a related object that is "owned" by its parent, with a NOT NULL foreign key, so that removal of the item from the parent collection results in its deletion.

  `delete-orphan` cascade implies that each child object can only have one parent at a time, so is configured in the vast majority of cases on a one-to-many relationship. Setting it on a many-to-one or many-to-many relationship is more awkward; for this use case, SQLAlchemy requires that the `relationship()` be configured with the `single_parent=True` function, which establishes Python-side validation that ensures the object is associated with only one parent at a time.

- `merge` - This cascade indicates that the `Session.merge()` operation should be propagated from a parent that's the subject of the `Session.merge()` call down to referred objects. This cascade is also on by default.

- `refresh-expire` - A less common option, indicates that the `Session.expire()` operation should be propagated from a parent down to referred objects. When using `Session.refresh()`, the referred objects are expired only, but not actually refreshed.

- `expunge` - Indicate that when the parent object is removed from the `Session` using `Session.expunge()`, the operation should be propagated down to referred objects.

Controlling Cascade on Backrefs

The `save-update` cascade takes place on backrefs by default. This means that, given a mapping such as this:

```
mapper(Order, order_table, properties={
    'items' : relationship(Item, backref='order')
})
```

If an `Order` is already in the session, and is assigned to the `order` attribute of an `Item`, the backref appends the `Order` to the `items` collection of that `Order`, resulting in the `save-update` cascade taking place:

```
>>> o1 = Order()
>>> session.add(o1)
>>> o1 in session
True

>>> i1 = Item()
>>> i1.order = o1
>>> i1 in o1.items
True
>>> i1 in session
True
```

This behavior can be disabled using the `cascade_backrefs` flag:

```
mapper(Order, order_table, properties={
    'items' : relationship(Item, backref='order',
                                 cascade_backrefs=False)
})
```

So above, the assignment of `i1.order = o1` will append `i1` to the `items` collection of `o1`, but will not add `i1` to the session. You can, of course, `add()` `i1` to the session at a later point. This option may be helpful for situations where an object needs to be kept out of a session until it's construction is completed, but still needs to be given associations to objects which are already persistent in the target session.

2.6.5 Managing Transactions

A newly constructed `Session` may be said to be in the "begin" state. In this state, the `Session` has not established any connection or transactional state with any of the `Engine` objects that may be associated with it.

The `Session` then receives requests to operate upon a database connection. Typically, this means it is called upon to execute SQL statements using a particular `Engine`, which may be via `Session.query()`, `Session.execute()`, or within a flush operation of pending data, which occurs when such state exists and `Session.commit()` or `Session.flush()` is called.

As these requests are received, each new `Engine` encountered is associated with an ongoing transactional state maintained by the `Session`. When the first `Engine` is operated upon, the `Session` can be said to have left the "begin" state and entered "transactional" state. For each `Engine` encountered, a `Connection` is associated with it, which is acquired via the `Engine.contextual_connect()` method. If a `Connection` was directly associated with the `Session` (see *Joining a Session into an External Transaction* for an example of this), it is added to the transactional state directly.

For each `Connection`, the `Session` also maintains a `Transaction` object, which is acquired by calling `Connection.begin()` on each `Connection`, or if the `Session` object has been established using the flag `twophase=True`, a `TwoPhaseTransaction` object acquired via `Connection.begin_twophase()`. These transactions are all committed or rolled back corresponding to the invocation of the `Session.commit()` and `Session.rollback()` methods. A commit operation will also call the `TwoPhaseTransaction.prepare()` method on all transactions if applicable.

When the transactional state is completed after a rollback or commit, the `Session` *releases* all `Transaction` and `Connection` resources, and goes back to the "begin" state, which will again invoke new `Connection` and `Transaction` objects as new requests to emit SQL statements are received.

The example below illustrates this lifecycle:

```
engine = create_engine("...")
Session = sessionmaker(bind=engine)

# new session.   no connections are in use.
session = Session()
try:
    # first query.  a Connection is acquired
    # from the Engine, and a Transaction
    # started.
    item1 = session.query(Item).get(1)

    # second query.  the same Connection/Transaction
    # are used.
    item2 = session.query(Item).get(2)

    # pending changes are created.
```

```
    item1.foo = 'bar'
    item2.bar = 'foo'

    # commit.  The pending changes above
    # are flushed via flush(), the Transaction
    # is committed, the Connection object closed
    # and discarded, the underlying DBAPI connection
    # returned to the connection pool.
    session.commit()
except:
    # on rollback, the same closure of state
    # as that of commit proceeds.
    session.rollback()
    raise
```

Using SAVEPOINT

SAVEPOINT transactions, if supported by the underlying engine, may be delineated using the `begin_nested()` method:

```
Session = sessionmaker()
session = Session()
session.add(u1)
session.add(u2)

session.begin_nested() # establish a savepoint
session.add(u3)
session.rollback()  # rolls back u3, keeps u1 and u2

session.commit() # commits u1 and u2
```

`begin_nested()` may be called any number of times, which will issue a new SAVEPOINT with a unique identifier for each call. For each `begin_nested()` call, a corresponding `rollback()` or `commit()` must be issued.

When `begin_nested()` is called, a `flush()` is unconditionally issued (regardless of the `autoflush` setting). This is so that when a `rollback()` occurs, the full state of the session is expired, thus causing all subsequent attribute/instance access to reference the full state of the `Session` right before `begin_nested()` was called.

`begin_nested()`, in the same manner as the less often used `begin()` method, returns a transactional object which also works as a context manager. It can be succinctly used around individual record inserts in order to catch things like unique constraint exceptions:

```
for record in records:
    try:
        with session.begin_nested():
            session.merge(record)
    except:
        print "Skipped record %s" % record
session.commit()
```

Autocommit Mode

The example of `Session` transaction lifecycle illustrated at the start of *Managing Transactions* applies to a `Session` configured in the default mode of `autocommit=False`. Constructing a `Session` with `autocommit=True` produces a `Session` placed into "autocommit" mode, where each SQL statement invoked by a `Session.query()` or `Session.execute()` occurs using a new connection from the connection pool, discarding it after results have

been iterated. The `Session.flush()` operation still occurs within the scope of a single transaction, though this transaction is closed out after the `Session.flush()` operation completes.

"autocommit" mode should **not be considered for general use**. While very old versions of SQLAlchemy standardized on this mode, the modern `Session` benefits highly from being given a clear point of transaction demarcation via `Session.rollback()` and `Session.commit()`. The autoflush action can safely emit SQL to the database as needed without implicitly producing permanent effects, the contents of attributes are expired only when a logical series of steps has completed. If the `Session` were to be used in pure "autocommit" mode without an ongoing transaction, these features should be disabled, that is, `autoflush=False, expire_on_commit=False`.

Modern usage of "autocommit" is for framework integrations that need to control specifically when the "begin" state occurs. A session which is configured with `autocommit=True` may be placed into the "begin" state using the `Session.begin()` method. After the cycle completes upon `Session.commit()` or `Session.rollback()`, connection and transaction resources are *released* and the `Session` goes back into "autocommit" mode, until `Session.begin()` is called again:

```
Session = sessionmaker(bind=engine, autocommit=True)
session = Session()
session.begin()
try:
    item1 = session.query(Item).get(1)
    item2 = session.query(Item).get(2)
    item1.foo = 'bar'
    item2.bar = 'foo'
    session.commit()
except:
    session.rollback()
    raise
```

The `begin()` method also returns a transactional token which is compatible with the Python 2.6 `with` statement:

```
Session = sessionmaker(bind=engine, autocommit=True)
session = Session()
with session.begin():
    item1 = session.query(Item).get(1)
    item2 = session.query(Item).get(2)
    item1.foo = 'bar'
    item2.bar = 'foo'
```

Using Subtransactions with Autocommit

A subtransaction indicates usage of the `Session.begin()` method in conjunction with the `subtransactions=True` flag. This produces a a non-transactional, delimiting construct that allows nesting of calls to `begin()` and `commit()`. It's purpose is to allow the construction of code that can function within a transaction both independently of any external code that starts a transaction, as well as within a block that has already demarcated a transaction.

`subtransactions=True` is generally only useful in conjunction with autocommit, and is equivalent to the pattern described at *Nesting of Transaction Blocks*, where any number of functions can call `Connection.begin()` and `Transaction.commit()` as though they are the initiator of the transaction, but in fact may be participating in an already ongoing transaction:

```
# method_a starts a transaction and calls method_b
def method_a(session):
    session.begin(subtransactions=True)
    try:
        method_b(session)
        session.commit()  # transaction is committed here
```

```
    except:
        session.rollback() # rolls back the transaction
        raise

# method_b also starts a transaction, but when
# called from method_a participates in the ongoing
# transaction.
def method_b(session):
    session.begin(subtransactions=True)
    try:
        session.add(SomeObject('bat', 'lala'))
        session.commit()  # transaction is not committed yet
    except:
        session.rollback() # rolls back the transaction, in this case
                           # the one that was initiated in method_a().
        raise

# create a Session and call method_a
session = Session(autocommit=True)
method_a(session)
session.close()
```

Subtransactions are used by the `Session.flush()` process to ensure that the flush operation takes place within a transaction, regardless of autocommit. When autocommit is disabled, it is still useful in that it forces the `Session` into a "pending rollback" state, as a failed flush cannot be resumed in mid-operation, where the end user still maintains the "scope" of the transaction overall.

Enabling Two-Phase Commit

For backends which support two-phase operaration (currently MySQL and PostgreSQL), the session can be instructed to use two-phase commit semantics. This will coordinate the committing of transactions across databases so that the transaction is either committed or rolled back in all databases. You can also `prepare()` the session for interacting with transactions not managed by SQLAlchemy. To use two phase transactions set the flag `twophase=True` on the session:

```
engine1 = create_engine('postgresql://db1')
engine2 = create_engine('postgresql://db2')

Session = sessionmaker(twophase=True)

# bind User operations to engine 1, Account operations to engine 2
Session.configure(binds={User:engine1, Account:engine2})

session = Session()

# .... work with accounts and users

# commit.  session will issue a flush to all DBs, and a prepare step to all DBs,
# before committing both transactions
session.commit()
```

2.6.6 Embedding SQL Insert/Update Expressions into a Flush

This feature allows the value of a database column to be set to a SQL expression instead of a literal value. It's especially useful for atomic updates, calling stored procedures, etc. All you do is assign an expression to an attribute:

```
class SomeClass(object):
    pass
mapper(SomeClass, some_table)

someobject = session.query(SomeClass).get(5)

# set 'value' attribute to a SQL expression adding one
someobject.value = some_table.c.value + 1

# issues "UPDATE some_table SET value=value+1"
session.commit()
```

This technique works both for INSERT and UPDATE statements. After the flush/commit operation, the `value` attribute on `someobject` above is expired, so that when next accessed the newly generated value will be loaded from the database.

2.6.7 Using SQL Expressions with Sessions

SQL expressions and strings can be executed via the `Session` within its transactional context. This is most easily accomplished using the `execute()` method, which returns a `ResultProxy` in the same manner as an `Engine` or `Connection`:

```
Session = sessionmaker(bind=engine)
session = Session()

# execute a string statement
result = session.execute("select * from table where id=:id", {'id':7})

# execute a SQL expression construct
result = session.execute(select([mytable]).where(mytable.c.id==7))
```

The current `Connection` held by the `Session` is accessible using the `connection()` method:

```
connection = session.connection()
```

The examples above deal with a `Session` that's bound to a single `Engine` or `Connection`. To execute statements using a `Session` which is bound either to multiple engines, or none at all (i.e. relies upon bound metadata), both `execute()` and `connection()` accept a `mapper` keyword argument, which is passed a mapped class or `Mapper` instance, which is used to locate the proper context for the desired engine:

```
Session = sessionmaker()
session = Session()

# need to specify mapper or class when executing
result = session.execute("select * from table where id=:id", {'id':7}, mapper=MyMappedClass)

result = session.execute(select([mytable], mytable.c.id==7), mapper=MyMappedClass)

connection = session.connection(MyMappedClass)
```

2.6.8 Joining a Session into an External Transaction

If a `Connection` is being used which is already in a transactional state (i.e. has a `Transaction` established), a `Session` can be made to participate within that transaction by just binding the `Session` to that `Connection`. The usual rationale for this is a test suite that allows ORM code to work freely with a `Session`, including the ability to call `Session.commit()`, where afterwards the entire database interaction is rolled back:

```
from sqlalchemy.orm import sessionmaker
from sqlalchemy import create_engine
from unittest import TestCase

# global application scope.  create Session class, engine
Session = sessionmaker()

engine = create_engine('postgresql://...')

class SomeTest(TestCase):
    def setUp(self):
        # connect to the database
        self.connection = engine.connect()

        # begin a non-ORM transaction
        self.trans = connection.begin()

        # bind an individual Session to the connection
        self.session = Session(bind=self.connection)

    def test_something(self):
        # use the session in tests.

        self.session.add(Foo())
        self.session.commit()

    def tearDown(self):
        # rollback - everything that happened with the
        # Session above (including calls to commit())
        # is rolled back.
        self.trans.rollback()
        self.session.close()

        # return connection to the Engine
        self.connection.close()
```

Above, we issue `Session.commit()` as well as `Transaction.rollback()`. This is an example of where we take advantage of the `Connection` object's ability to maintain *subtransactions*, or nested begin/commit-or-rollback pairs where only the outermost begin/commit pair actually commits the transaction, or if the outermost block rolls back, everything is rolled back.

2.6.9 Contextual/Thread-local Sessions

Recall from the section *Session Frequently Asked Questions*, the concept of "session scopes" was introduced, with an emphasis on web applications and the practice of linking the scope of a `Session` with that of a web request. Most modern web frameworks include integration tools so that the scope of the `Session` can be managed automatically, and these tools should be used as they are available.

SQLAlchemy includes its own helper object, which helps with the establishment of user-defined `Session` scopes. It is also used by third-party integration systems to help construct their integration schemes.

The object is the `ScopedSession` object, and it represents a **registry** of `Session` objects. If you're not familiar with the registry pattern, a good introduction can be found in Patterns of Enterprise Architecture.

Note: The `ScopedSession` object is a very popular and useful object used by many SQLAlchemy applications. However, it is important to note that it presents **only one approach** to the issue of `Session` management. If you're

new to SQLAlchemy, and especially if the term "thread-local variable" seems strange to you, we recommend that if possible you familiarize first with an off-the-shelf integration system such as Flask-SQLAlchemy or zope.sqlalchemy.

A `ScopedSession` is constructed by calling the `scoped_session()` function, passing it a **factory** which can create new `Session` objects. A factory is just something that produces a new object when called, and in the case of `Session`, the most common factory is the `sessionmaker()`, introduced earlier in this section. Below we illustrate this usage:

```
>>> from sqlalchemy.orm import scoped_session
>>> from sqlalchemy.orm import sessionmaker

>>> session_factory = sessionmaker(bind=some_engine)
>>> Session = scoped_session(session_factory)
```

The `ScopedSession` object we've created will now call upon the `sessionmaker()` when we "call" the registry:

```
>>> some_session = Session()
```

Above, `some_session` is an instance of `Session`, which we can now use to talk to the database. This same `Session` is also present within the `ScopedSession` registry we've created. If we call upon the registry a second time, we get back the **same** `Session`:

```
>>> some_other_session = Session()
>>> some_session is some_other_session
True
```

This pattern allows disparate sections of the application to call upon a global `ScopedSession`, so that all those areas may share the same session without the need to pass it explicitly. The `Session` we've established in our registry will remain, until we explicitly tell our regsitry to dispose of it, by calling `ScopedSession.remove()`:

```
>>> Session.remove()
```

The `ScopedSession.remove()` method first calls `Session.close()` on the current `Session`, which has the effect of releasing any connection/transactional resources owned by the `Session` first, then discarding the `Session` itself. "Releasing" here means that any pending transaction will be rolled back using `connection.rollback()`.

At this point, the `ScopedSession` object is "empty", and will create a **new** `Session` when called again. As illustrated below, this is not the same `Session` we had before:

```
>>> new_session = Session()
>>> new_session is some_session
False
```

The above series of steps illustrates the idea of the "registry" pattern in a nutshell. With that basic idea in hand, we can discuss some of the details of how this pattern proceeds.

Implicit Method Access

The job of the `ScopedSession` is simple; hold onto a `Session` for all who ask for it. As a means of producing more transparent access to this `Session`, the `ScopedSession` also includes **proxy behavior**, meaning that the registry itself can be treated just like a `Session` directly; when methods are called on this object, they are **proxied** to the underlying `Session` being maintained by the registry:

```
Session = scoped_session(some_factory)

# equivalent to:
#
# session = Session()
```

```
# print session.query(MyClass).all()
#
print Session.query(MyClass).all()
```

The above code accomplishes the same task as that of acquiring the current `Session` by calling upon the registry, then using that `Session`.

Thread-Local Scope

Users who are familiar with multithreaded programming will note that representing anything as a global variable is usually a bad idea, as it implies that the global object will be accessed by many threads concurrently. The `Session` object is entirely designed to be used in a **non-concurrent** fashion, which in terms of multithreading means "only in one thread at a time". So our above example of `ScopedSession` usage, where the same `Session` object is maintained across multiple calls, suggests that some process needs to be in place such that mutltiple calls across many threads don't actually get a handle to the same session. We call this notion **thread local storage**, which means, a special object is used that will maintain a distinct object per each application thread. Python provides this via the threading.local() construct. The `ScopedSession` object by default uses this object as storage, so that a single `Session` is maintained for all who call upon the `ScopedSession` registry, but only within the scope of a single thread. Callers who call upon the registry in a different thread get a `Session` instance that is local to that other thread.

Using this technique, the `ScopedSession` provides a quick and relatively simple (if one is familiar with thread-local storage) way of providing a single, global object in an application that is safe to be called upon from multiple threads.

The `ScopedSession.remove()` method, as always, removes the current `Session` associated with the thread, if any. However, one advantage of the `threading.local()` object is that if the application thread itself ends, the "storage" for that thread is also garbage collected. So it is in fact "safe" to use thread local scope with an application that spawns and tears down threads, without the need to call `ScopedSession.remove()`. However, the scope of transactions themselves, i.e. ending them via `Session.commit()` or `Session.rollback()`, will usually still be something that must be explicitly arranged for at the appropriate time, unless the application actually ties the lifespan of a thread to the lifespan of a transaction.

Using Thread-Local Scope with Web Applications

As discussed in the section *Session Frequently Asked Questions*, a web application is architected around the concept of a **web request**, and integrating such an application with the `Session` usually implies that the `Session` will be associated with that request. As it turns out, most Python web frameworks, with notable exceptions such as the asynchronous frameworks Twisted and Tornado, use threads in a simple way, such that a particular web request is received, processed, and completed within the scope of a single *worker thread*. When the request ends, the worker thread is released to a pool of workers where it is available to handle another request.

This simple correspondence of web request and thread means that to associate a `Session` with a thread implies it is also associated with the web request running within that thread, and vice versa, provided that the `Session` is created only after the web request begins and torn down just before the web request ends. So it is a common practice to use `ScopedSession` as a quick way to integrate the `Session` with a web application. The sequence diagram below illustrates this flow:

```
Web Server          Web Framework        SQLAlchemy ORM Code
--------------      --------------       ------------------------------
startup        ->   Web framework        # Session registry is established
                    initializes          Session = scoped_session(sessionmaker())

incoming
web request    ->   web request     ->   # The registry is *optionally*
                    starts               # called upon explicitly to create
                                         # a Session local to the thread and/or request
```

```
                                    Session()

                                    # the Session registry can otherwise
                                    # be used at any time, creating the
                                    # request-local Session() if not present,
                                    # or returning the existing one
                                    Session.query(MyClass) # ...

                                    Session.add(some_object) # ...

                                    # if data was modified, commit the
                                    # transaction
                                    Session.commit()

                  web request ends  -> # the registry is instructed to
                                       # remove the Session
                                       Session.remove()

                  sends output      <-
outgoing web    <-
response
```

Using the above flow, the process of integrating the `Session` with the web application has exactly two requirements:

1. Create a single `ScopedSession` registry when the web application first starts, ensuring that this object is accessible by the rest of the application.
2. Ensure that `ScopedSession.remove()` is called when the web request ends, usually by integrating with the web framework's event system to establish an "on request end" event.

As noted earlier, the above pattern is **just one potential way** to integrate a `Session` with a web framework, one which in particular makes the significant assumption that the **web framework associates web requests with application threads**. It is however **strongly recommended that the integration tools provided with the web framework itself be used, if available**, instead of `ScopedSession`.

In particular, while using a thread local can be convenient, it is preferable that the `Session` be associated **directly with the request**, rather than with the current thread. The next section on custom scopes details a more advanced configuration which can combine the usage of `ScopedSession` with direct request based scope, or any kind of scope.

Using Custom Created Scopes

The `ScopedSession` object's default behavior of "thread local" scope is only one of many options on how to "scope" a `Session`. A custom scope can be defined based on any existing system of getting at "the current thing we are working with".

Suppose a web framework defines a library function `get_current_request()`. An application built using this framework can call this function at any time, and the result will be some kind of `Request` object that represents the current request being processed. If the `Request` object is hashable, then this function can be easily integrated with `ScopedSession` to associate the `Session` with the request. Below we illustrate this in conjunction with a hypothetical event marker provided by the web framework `on_request_end`, which allows code to be invoked whenever a request ends:

```
from my_web_framework import get_current_request, on_request_end
from sqlalchemy.orm import scoped_session, sessionmaker

Session = scoped_session(sessionmaker(bind=some_engine), scopefunc=get_current_request)
```

```
@on_request_end
def remove_session(req):
    Session.remove()
```

Above, we instantiate `ScopedSession` in the usual way, except that we pass our request-returning function as the "scopefunc". This instructs `ScopedSession` to use this function to generate a dictionary key whenever the registry is called upon to return the current `Session`. In this case it is particularly important that we ensure a reliable "remove" system is implemented, as this dictionary is not otherwise self-managed.

Contextual Session API

`sqlalchemy.orm.`**`scoped_session`**(*session_factory*, *scopefunc=None*)

Provides thread-local or scoped management of `Session` objects.

This is a front-end function to `ScopedSession`:

```
Session = scoped_session(sessionmaker(autoflush=True))
```

To instantiate a Session object which is part of the scoped context, instantiate normally:

```
session = Session()
```

Most session methods are available as classmethods from the scoped session:

```
Session.commit()
Session.close()
```

See also: *Contextual/Thread-local Sessions*.

Parameters

- **session_factory** – a callable function that produces `Session` instances, such as `sessionmaker()`.
- **scopefunc** – Optional "scope" function which would be passed to the `ScopedRegistry`. If None, the `ThreadLocalRegistry` is used by default.

Returns a `ScopedSession` instance

class `sqlalchemy.orm.scoping.`**`ScopedSession`**(*session_factory*, *scopefunc=None*)

Provides thread-local management of Sessions.

Typical invocation is via the `scoped_session()` function:

```
Session = scoped_session(sessionmaker())
```

The internal registry is accessible, and by default is an instance of `ThreadLocalRegistry`.

See also: *Contextual/Thread-local Sessions*.

`configure`(***kwargs*)

reconfigure the sessionmaker used by this ScopedSession.

`query_property`(*query_cls=None*)

return a class property which produces a *Query* object against the class when called.

e.g.:

```
Session = scoped_session(sessionmaker())

class MyClass(object):
    query = Session.query_property()
```

```
# after mappers are defined
result = MyClass.query.filter(MyClass.name=='foo').all()
```

Produces instances of the session's configured query class by default. To override and use a custom implementation, provide a `query_cls` callable. The callable will be invoked with the class's mapper as a positional argument and a session keyword argument.

There is no limit to the number of query properties placed on a class.

remove()
Dispose of the current contextual session.

class sqlalchemy.util.**ScopedRegistry**(*createfunc*, *scopefunc*)
A Registry that can store one or multiple instances of a single class on the basis of a "scope" function.

The object implements `__call__` as the "getter", so by calling `myregistry()` the contained object is returned for the current scope.

Parameters

- **createfunc** – a callable that returns a new object to be placed in the registry
- **scopefunc** – a callable that will return a key to store/retrieve an object.

__init__(*createfunc*, *scopefunc*)
Construct a new `ScopedRegistry`.

Parameters

- **createfunc** – A creation function that will generate a new value for the current scope, if none is present.
- **scopefunc** – A function that returns a hashable token representing the current scope (such as, current thread identifier).

clear()
Clear the current scope, if any.

has()
Return True if an object is present in the current scope.

set(*obj*)
Set the value forthe current scope.

class sqlalchemy.util.**ThreadLocalRegistry**(*createfunc*)
A `ScopedRegistry` that uses a `threading.local()` variable for storage.

2.6.10 Partitioning Strategies

Simple Vertical Partitioning

Vertical partitioning places different kinds of objects, or different tables, across multiple databases:

```
engine1 = create_engine('postgresql://db1')
engine2 = create_engine('postgresql://db2')

Session = sessionmaker(twophase=True)

# bind User operations to engine 1, Account operations to engine 2
Session.configure(binds={User:engine1, Account:engine2})
```

```
session = Session()
```

Above, operations against either class will make usage of the `Engine` linked to that class. Upon a flush operation, similar rules take place to ensure each class is written to the right database.

The transactions among the multiple databases can optionally be coordinated via two phase commit, if the underlying backend supports it. See *Enabling Two-Phase Commit* for an example.

Custom Vertical Partitioning

More comprehensive rule-based class-level partitioning can be built by overriding the `Session.get_bind()` method. Below we illustrate a custom `Session` which delivers the following rules:

1. Flush operations are delivered to the engine named `master`.
2. Operations on objects that subclass `MyOtherClass` all occur on the `other` engine.
3. Read operations for all other classes occur on a random choice of the `slave1` or `slave2` database.

```
engines = {
    'master':create_engine("sqlite:///master.db"),
    'other':create_engine("sqlite:///other.db"),
    'slave1':create_engine("sqlite:///slave1.db"),
    'slave2':create_engine("sqlite:///slave2.db"),
}

from sqlalchemy.orm import Session, sessionmaker
import random

class RoutingSession(Session):
    def get_bind(self, mapper=None, clause=None):
        if mapper and issubclass(mapper.class_, MyOtherClass):
            return engines['other']
        elif self._flushing:
            return engines['master']
        else:
            return engines[
                random.choice(['slave1','slave2'])
            ]
```

The above `Session` class is plugged in using the `class_` argument to `sessionmaker()`:

```
Session = sessionmaker(class_=RoutingSession)
```

This approach can be combined with multiple `MetaData` objects, using an approach such as that of using the declarative `__abstract__` keyword, described at *__abstract__*.

Horizontal Partitioning

Horizontal partitioning partitions the rows of a single table (or a set of tables) across multiple databases.

See the "sharding" example: *Horizontal Sharding*.

2.6.11 Sessions API

Session and sessionmaker()

sqlalchemy.orm.session.**sessionmaker**(*bind=None*, *class_=None*, *autoflush=True*, *autocommit=False*, *expire_on_commit=True*, ***kwargs*)

Generate a custom-configured `Session` class.

The returned object is a subclass of `Session`, which, when instantiated with no arguments, uses the keyword arguments configured here as its constructor arguments.

It is intended that the `sessionmaker()` function be called within the global scope of an application, and the returned class be made available to the rest of the application as the single class used to instantiate sessions.

e.g.:

```
# global scope
Session = sessionmaker(autoflush=False)

# later, in a local scope, create and use a session:
sess = Session()
```

Any keyword arguments sent to the constructor itself will override the "configured" keywords:

```
Session = sessionmaker()

# bind an individual session to a connection
sess = Session(bind=connection)
```

The class also includes a special classmethod `configure()`, which allows additional configurational options to take place after the custom `Session` class has been generated. This is useful particularly for defining the specific `Engine` (or engines) to which new instances of `Session` should be bound:

```
Session = sessionmaker()
Session.configure(bind=create_engine('sqlite:///foo.db'))

sess = Session()
```

For options, see the constructor options for `Session`.

class sqlalchemy.orm.session.**Session**(*bind=None*, *autoflush=True*, *expire_on_commit=True*, *_enable_transaction_accounting=True*, *autocommit=False*, *twophase=False*, *weak_identity_map=True*, *binds=None*, *extension=None*, *query_cls=<class 'sqlalchemy.orm.query.Query'>*)

Manages persistence operations for ORM-mapped objects.

The Session's usage paradigm is described at *Using the Session*.

__init__(*bind=None*, *autoflush=True*, *expire_on_commit=True*, *_enable_transaction_accounting=True*, *autocommit=False*, *twophase=False*, *weak_identity_map=True*, *binds=None*, *extension=None*, *query_cls=<class 'sqlalchemy.orm.query.Query'>*)

Construct a new Session.

See also the `sessionmaker()` function which is used to generate a `Session`-producing callable with a given set of arguments.

Parameters

- **autocommit** – Defaults to `False`. When `True`, the `Session` does not keep a persistent transaction running, and will acquire connections from the engine on an as-needed basis,

returning them immediately after their use. Flushes will begin and commit (or possibly rollback) their own transaction if no transaction is present. When using this mode, the *session.begin()* method may be used to begin a transaction explicitly.

Leaving it on its default value of `False` means that the `Session` will acquire a connection and begin a transaction the first time it is used, which it will maintain persistently until `rollback()`, `commit()`, or `close()` is called. When the transaction is released by any of these methods, the `Session` is ready for the next usage, which will again acquire and maintain a new connection/transaction.

- **autoflush** – When `True`, all query operations will issue a `flush()` call to this `Session` before proceeding. This is a convenience feature so that `flush()` need not be called repeatedly in order for database queries to retrieve results. It's typical that `autoflush` is used in conjunction with `autocommit=False`. In this scenario, explicit calls to `flush()` are rarely needed; you usually only need to call `commit()` (which flushes) to finalize changes.
- **bind** – An optional `Engine` or `Connection` to which this `Session` should be bound. When specified, all SQL operations performed by this session will execute via this connectable.
- **binds** –

  An optional dictionary which contains more granular "bind" information than the `bind` parameter provides. This dictionary can map individual `Table` instances as well as `Mapper` instances to individual `Engine` or `Connection` objects. Operations which proceed relative to a particular `Mapper` will consult this dictionary for the direct `Mapper` instance as well as the mapper's `mapped_table` attribute in order to locate an connectable to use. The full resolution is described in the `get_bind()` method of `Session`. Usage looks like:

  ```
  Session = sessionmaker(binds={
      SomeMappedClass: create_engine('postgresql://engine1'),
      somemapper: create_engine('postgresql://engine2'),
      some_table: create_engine('postgresql://engine3'),
      })
  ```

  Also see the `Session.bind_mapper()` and `Session.bind_table()` methods.
- **class_** – Specify an alternate class other than `sqlalchemy.orm.session.Session` which should be used by the returned class. This is the only argument that is local to the `sessionmaker()` function, and is not sent directly to the constructor for `Session`.
- **_enable_transaction_accounting** – Defaults to `True`. A legacy-only flag which when `False` disables *all* 0.5-style object accounting on transaction boundaries, including auto-expiry of instances on rollback and commit, maintenance of the "new" and "deleted" lists upon rollback, and autoflush of pending changes upon begin(), all of which are interdependent.
- **expire_on_commit** – Defaults to `True`. When `True`, all instances will be fully expired after each `commit()`, so that all attribute/object access subsequent to a completed transaction will load from the most recent database state.
- **extension** – An optional `SessionExtension` instance, or a list of such instances, which will receive pre- and post- commit and flush events, as well as a post-rollback event. **Deprecated.** Please see `SessionEvents`.
- **query_cls** – Class which should be used to create new Query objects, as returned by the `query()` method. Defaults to `Query`.

- **twophase** – When `True`, all transactions will be started as a "two phase" transaction, i.e. using the "two phase" semantics of the database in use along with an XID. During a `commit()`, after `flush()` has been issued for all attached databases, the `prepare()` method on each database's `TwoPhaseTransaction` will be called. This allows each database to roll back the entire transaction, before each transaction is committed.
- **weak_identity_map** – Defaults to `True` - when set to `False`, objects placed in the `Session` will be strongly referenced until explicitly removed or the `Session` is closed. **Deprecated** - this option is obsolete.

add(*instance*)
Place an object in the `Session`.

Its state will be persisted to the database on the next flush operation.

Repeated calls to `add()` will be ignored. The opposite of `add()` is `expunge()`.

add_all(*instances*)
Add the given collection of instances to this `Session`.

begin(*subtransactions=False*, *nested=False*)
Begin a transaction on this Session.

If this Session is already within a transaction, either a plain transaction or nested transaction, an error is raised, unless `subtransactions=True` or `nested=True` is specified.

The `subtransactions=True` flag indicates that this `begin()` can create a subtransaction if a transaction is already in progress. For documentation on subtransactions, please see *Using Subtransactions with Autocommit*.

The `nested` flag begins a SAVEPOINT transaction and is equivalent to calling `begin_nested()`. For documentation on SAVEPOINT transactions, please see *Using SAVEPOINT*.

begin_nested()
Begin a *nested* transaction on this Session.

The target database(s) must support SQL SAVEPOINTs or a SQLAlchemy-supported vendor implementation of the idea.

For documentation on SAVEPOINT transactions, please see *Using SAVEPOINT*.

bind_mapper(*mapper*, *bind*)
Bind operations for a mapper to a Connectable.

mapper A mapper instance or mapped class

bind Any Connectable: a `Engine` or `Connection`.

All subsequent operations involving this mapper will use the given *bind*.

bind_table(*table*, *bind*)
Bind operations on a Table to a Connectable.

table A `Table` instance

bind Any Connectable: a `Engine` or `Connection`.

All subsequent operations involving this `Table` will use the given *bind*.

close()
Close this Session.

This clears all items and ends any transaction in progress.

If this session were created with `autocommit=False`, a new transaction is immediately begun. Note that this new transaction does not use any connection resources until they are first needed.

classmethod close_all()
Close *all* sessions in memory.

commit()
Flush pending changes and commit the current transaction.

If no transaction is in progress, this method raises an InvalidRequestError.

By default, the `Session` also expires all database loaded state on all ORM-managed attributes after transaction commit. This so that subsequent operations load the most recent data from the database. This behavior can be disabled using the `expire_on_commit=False` option to `sessionmaker()` or the `Session` constructor.

If a subtransaction is in effect (which occurs when begin() is called multiple times), the subtransaction will be closed, and the next call to `commit()` will operate on the enclosing transaction.

For a session configured with autocommit=False, a new transaction will be begun immediately after the commit, but note that the newly begun transaction does *not* use any connection resources until the first SQL is actually emitted.

connection(*mapper=None*, *clause=None*, *bind=None*, *close_with_result=False*, ***kw*)
Return a `Connection` object corresponding to this `Session` object's transactional state.

If this `Session` is configured with `autocommit=False`, either the `Connection` corresponding to the current transaction is returned, or if no transaction is in progress, a new one is begun and the `Connection` returned (note that no transactional state is established with the DBAPI until the first SQL statement is emitted).

Alternatively, if this `Session` is configured with `autocommit=True`, an ad-hoc `Connection` is returned using `Engine.contextual_connect()` on the underlying `Engine`.

Ambiguity in multi-bind or unbound `Session` objects can be resolved through any of the optional keyword arguments. This ultimately makes usage of the `get_bind()` method for resolution.

Parameters

- **bind** – Optional `Engine` to be used as the bind. If this engine is already involved in an ongoing transaction, that connection will be used. This argument takes precedence over `mapper`, `clause`.
- **mapper** – Optional `mapper()` mapped class, used to identify the appropriate bind. This argument takes precedence over `clause`.
- **clause** – A `ClauseElement` (i.e. `select()`, `text()`, etc.) which will be used to locate a bind, if a bind cannot otherwise be identified.
- **close_with_result** – Passed to `Engine.connect()`, indicating the `Connection` should be considered "single use", automatically closing when the first result set is closed. This flag only has an effect if this `Session` is configured with `autocommit=True` and does not already have a transaction in progress.
- ****kw** – Additional keyword arguments are sent to `get_bind()`, allowing additional arguments to be passed to custom implementations of `get_bind()`.

delete(*instance*)
Mark an instance as deleted.

The database delete operation occurs upon `flush()`.

deleted
The set of all instances marked as 'deleted' within this `Session`

dirty
The set of all persistent instances considered dirty.

E.g.:

```
some_mapped_object in session.dirty
```

Instances are considered dirty when they were modified but not deleted.

Note that this 'dirty' calculation is 'optimistic'; most attribute-setting or collection modification operations will mark an instance as 'dirty' and place it in this set, even if there is no net change to the attribute's value. At flush time, the value of each attribute is compared to its previously saved value, and if there's no net change, no SQL operation will occur (this is a more expensive operation so it's only done at flush time).

To check if an instance has actionable net changes to its attributes, use the `Session.is_modified()` method.

execute(*clause*, *params=None*, *mapper=None*, *bind=None*, ***kw*)
Execute a SQL expression construct or string statement within the current transaction.

Returns a `ResultProxy` representing results of the statement execution, in the same manner as that of an `Engine` or `Connection`.

E.g.:

```
result = session.execute(
            user_table.select().where(user_table.c.id == 5)
        )
```

`execute()` accepts any executable clause construct, such as `select()`, `insert()`, `update()`, `delete()`, and `text()`. Plain SQL strings can be passed as well, which in the case of `Session.execute()` only will be interpreted the same as if it were passed via a `text()` construct. That is, the following usage:

```
result = session.execute(
            "SELECT * FROM user WHERE id=:param",
            {"param":5}
        )
```

is equivalent to:

```
from sqlalchemy import text
result = session.execute(
            text("SELECT * FROM user WHERE id=:param"),
            {"param":5}
        )
```

The second positional argument to `Session.execute()` is an optional parameter set. Similar to that of `Connection.execute()`, whether this is passed as a single dictionary, or a list of dictionaries, determines whether the DBAPI cursor's `execute()` or `executemany()` is used to execute the statement. An INSERT construct may be invoked for a single row:

```
result = session.execute(users.insert(), {"id": 7, "name": "somename"})
```

or for multiple rows:

```
result = session.execute(users.insert(), [
                        {"id": 7, "name": "somename7"},
                        {"id": 8, "name": "somename8"},
                        {"id": 9, "name": "somename9"}
                    ])
```

The statement is executed within the current transactional context of this `Session`. The `Connection` which is used to execute the statement can also be acquired directly by calling the `Session.connection()` method. Both methods use a rule-based resolution scheme in order to determine the `Connection`, which in the average case is derived directly from the "bind" of the `Session` itself, and in other cases can be based on the `mapper()` and `Table` objects passed to the method; see the documentation for `Session.get_bind()` for a full description of this scheme.

The `Session.execute()` method does *not* invoke autoflush.

The `ResultProxy` returned by the `Session.execute()` method is returned with the "close_with_result" flag set to true; the significance of this flag is that if this `Session` is autocommitting and does not have a transaction-dedicated `Connection` available, a temporary `Connection` is established for the statement execution, which is closed (meaning, returned to the connection pool) when the `ResultProxy` has consumed all available data. This applies *only* when the `Session` is configured with autocommit=True and no transaction has been started.

Parameters

- **clause** – An executable statement (i.e. an `Executable` expression such as `expression.select()`) or string SQL statement to be executed.
- **params** – Optional dictionary, or list of dictionaries, containing bound parameter values. If a single dictionary, single-row execution occurs; if a list of dictionaries, an "executemany" will be invoked. The keys in each dictionary must correspond to parameter names present in the statement.
- **mapper** – Optional `mapper()` or mapped class, used to identify the appropriate bind. This argument takes precedence over `clause` when locating a bind. See `Session.get_bind()` for more details.
- **bind** – Optional `Engine` to be used as the bind. If this engine is already involved in an ongoing transaction, that connection will be used. This argument takes precedence over `mapper` and `clause` when locating a bind.
- ****kw** – Additional keyword arguments are sent to `Session.get_bind()` to allow extensibility of "bind" schemes.

See also:

SQL Expression Language Tutorial - Tutorial on using Core SQL constructs.

Working with Engines and Connections - Further information on direct statement execution.

`Connection.execute()` - core level statement execution method, which is `Session.execute()` ultimately uses in order to execute the statement.

expire(*instance*, *attribute_names=None*)
Expire the attributes on an instance.

Marks the attributes of an instance as out of date. When an expired attribute is next accessed, a query will be issued to the `Session` object's current transactional context in order to load all expired attributes for the given instance. Note that a highly isolated transaction will return the same values as were previously read in that same transaction, regardless of changes in database state outside of that transaction.

To expire all objects in the `Session` simultaneously, use `Session.expire_all()`.

The Session object's default behavior is to expire all state whenever the Session.rollback() or Session.commit() methods are called, so that new state can be loaded for the new transaction. For this reason, calling Session.expire() only makes sense for the specific case that a non-ORM SQL statement was emitted in the current transaction.

Parameters

- **instance** – The instance to be refreshed.
- **attribute_names** – optional list of string attribute names indicating a subset of attributes to be expired.

expire_all()
Expires all persistent instances within this Session.

When any attributes on a persistent instance is next accessed, a query will be issued using the Session object's current transactional context in order to load all expired attributes for the given instance. Note that a highly isolated transaction will return the same values as were previously read in that same transaction, regardless of changes in database state outside of that transaction.

To expire individual objects and individual attributes on those objects, use Session.expire().

The Session object's default behavior is to expire all state whenever the Session.rollback() or Session.commit() methods are called, so that new state can be loaded for the new transaction. For this reason, calling Session.expire_all() should not be needed when autocommit is False, assuming the transaction is isolated.

expunge(*instance*)
Remove the *instance* from this Session.

This will free all internal references to the instance. Cascading will be applied according to the *expunge* cascade rule.

expunge_all()
Remove all object instances from this Session.

This is equivalent to calling expunge(obj) on all objects in this Session.

flush(*objects=None*)
Flush all the object changes to the database.

Writes out all pending object creations, deletions and modifications to the database as INSERTs, DELETEs, UPDATEs, etc. Operations are automatically ordered by the Session's unit of work dependency solver.

Database operations will be issued in the current transactional context and do not affect the state of the transaction, unless an error occurs, in which case the entire transaction is rolled back. You may flush() as often as you like within a transaction to move changes from Python to the database's transaction buffer.

For autocommit Sessions with no active manual transaction, flush() will create a transaction on the fly that surrounds the entire set of operations int the flush.

Parameters **objects** – Optional; restricts the flush operation to operate only on elements that are in the given collection.

This feature is for an extremely narrow set of use cases where particular objects may need to be operated upon before the full flush() occurs. It is not intended for general use.

get_bind(*mapper=None*, *clause=None*)
Return a "bind" to which this Session is bound.

The "bind" is usually an instance of Engine, except in the case where the Session has been explicitly bound directly to a Connection.

For a multiply-bound or unbound Session, the mapper or clause arguments are used to determine the appropriate bind to return.

Note that the "mapper" argument is usually present when Session.get_bind() is called via an ORM operation such as a Session.query(), each individual INSERT/UPDATE/DELETE operation within a Session.flush(), call, etc.

The order of resolution is:

1. if mapper given and session.binds is present, locate a bind based on mapper.
2. if clause given and session.binds is present, locate a bind based on Table objects found in the given clause present in session.binds.
3. if session.bind is present, return that.
4. if clause given, attempt to return a bind linked to the MetaData ultimately associated with the clause.
5. if mapper given, attempt to return a bind linked to the MetaData ultimately associated with the Table or other selectable to which the mapper is mapped.
6. No bind can be found, UnboundExecutionError is raised.

Parameters

- **mapper** – Optional mapper() mapped class or instance of Mapper. The bind can be derived from a Mapper first by consulting the "binds" map associated with this Session, and secondly by consulting the MetaData associated with the Table to which the Mapper is mapped for a bind.
- **clause** – A ClauseElement (i.e. select(), text(), etc.). If the mapper argument is not present or could not produce a bind, the given expression construct will be searched for a bound element, typically a Table associated with bound MetaData.

identity_map = None

A mapping of object identities to objects themselves.

Iterating through Session.identity_map.values() provides access to the full set of persistent objects (i.e., those that have row identity) currently in the session.

See also:

identity_key() - operations involving identity keys.

is_active

True if this Session is in "transaction mode" and is not in "partial rollback" state.

The Session in its default mode of autocommit=False is essentially always in "transaction mode", in that a SessionTransaction is associated with it as soon as it is instantiated. This SessionTransaction is immediately replaced with a new one as soon as it is ended, due to a rollback, commit, or close operation.

"Transaction mode" does *not* indicate whether or not actual database connection resources are in use; the SessionTransaction object coordinates among zero or more actual database transactions, and starts out with none, accumulating individual DBAPI connections as different data sources are used within its scope. The best way to track when a particular Session has actually begun to use DBAPI resources is to implement a listener using the SessionEvents.after_begin() method, which will deliver both the Session as well as the target Connection to a user-defined event listener.

The "partial rollback" state refers to when an "inner" transaction, typically used during a flush, encounters an error and emits a rollback of the DBAPI connection. At this point, the Session is in "partial rollback"

and awaits for the user to call `rollback()`, in order to close out the transaction stack. It is in this "partial rollback" period that the `is_active` flag returns False. After the call to `rollback()`, the `SessionTransaction` is replaced with a new one and `is_active` returns `True` again.

When a `Session` is used in `autocommit=True` mode, the `SessionTransaction` is only instantiated within the scope of a flush call, or when `Session.begin()` is called. So `is_active` will always be `False` outside of a flush or `begin()` block in this mode, and will be `True` within the `begin()` block as long as it doesn't enter "partial rollback" state.

From all the above, it follows that the only purpose to this flag is for application frameworks that wish to detect is a "rollback" is necessary within a generic error handling routine, for `Session` objects that would otherwise be in "partial rollback" mode. In a typical integration case, this is also not necessary as it is standard practice to emit `Session.rollback()` unconditionally within the outermost exception catch.

To track the transactional state of a `Session` fully, use event listeners, primarily the `SessionEvents.after_begin()`, `SessionEvents.after_commit()`, `SessionEvents.after_rollback()` and related events.

is_modified(*instance*, *include_collections=True*, *passive=<symbol 'PASSIVE_OFF>*)

Return `True` if the given instance has locally modified attributes.

This method retrieves the history for each instrumented attribute on the instance and performs a comparison of the current value to its previously committed value, if any.

It is in effect a more expensive and accurate version of checking for the given instance in the `Session.dirty` collection; a full test for each attribute's net "dirty" status is performed.

E.g.:

```
return session.is_modified(someobject, passive=True)
```

Changed in version 0.8: In SQLAlchemy 0.7 and earlier, the `passive` flag should **always** be explicitly set to `True`. The current default value of `attributes.PASSIVE_OFF` for this flag is incorrect, in that it loads unloaded collections and attributes which by definition have no modified state, and furthermore trips off autoflush which then causes all subsequent, possibly modified attributes to lose their modified state. The default value of the flag will be changed in 0.8.

A few caveats to this method apply:

- Instances present in the `Session.dirty` collection may report `False` when tested with this method. This is because the object may have received change events via attribute mutation, thus placing it in `Session.dirty`, but ultimately the state is the same as that loaded from the database, resulting in no net change here.
- Scalar attributes may not have recorded the previously set value when a new value was applied, if the attribute was not loaded, or was expired, at the time the new value was received - in these cases, the attribute is assumed to have a change, even if there is ultimately no net change against its database value. SQLAlchemy in most cases does not need the "old" value when a set event occurs, so it skips the expense of a SQL call if the old value isn't present, based on the assumption that an UPDATE of the scalar value is usually needed, and in those few cases where it isn't, is less expensive on average than issuing a defensive SELECT.

  The "old" value is fetched unconditionally only if the attribute container has the `active_history` flag set to `True`. This flag is set typically for primary key attributes and scalar object references that are not a simple many-to-one. To set this flag for any arbitrary mapped column, use the `active_history` argument with `column_property()`.

  Parameters

  - **instance** – mapped instance to be tested for pending changes.

- **include_collections** – Indicates if multivalued collections should be included in the operation. Setting this to `False` is a way to detect only local-column based properties (i.e. scalar columns or many-to-one foreign keys) that would result in an UPDATE for this instance upon flush.
- **passive** – Indicates if unloaded attributes and collections should be loaded in the course of performing this test. If set to `False`, or left at its default value of `PASSIVE_OFF`, unloaded attributes will be loaded. If set to `True` or `PASSIVE_NO_INITIALIZE`, unloaded collections and attributes will remain unloaded. As noted previously, the existence of this flag here is a bug, as unloaded attributes by definition have no changes, and the load operation also triggers an autoflush which then cancels out subsequent changes. This flag should **always be set to True**.

  Changed in version 0.8: The flag will be deprecated and the default set to `True`.

merge(*instance*, *load=True*, ***kw*)

Copy the state of a given instance into a corresponding instance within this `Session`.

`Session.merge()` examines the primary key attributes of the source instance, and attempts to reconcile it with an instance of the same primary key in the session. If not found locally, it attempts to load the object from the database based on primary key, and if none can be located, creates a new instance. The state of each attribute on the source instance is then copied to the target instance. The resulting target instance is then returned by the method; the original source instance is left unmodified, and un-associated with the `Session` if not already.

This operation cascades to associated instances if the association is mapped with `cascade="merge"`.

See *Merging* for a detailed discussion of merging.

Parameters

- **instance** – Instance to be merged.
- **load** – Boolean, when False, `merge()` switches into a "high performance" mode which causes it to forego emitting history events as well as all database access. This flag is used for cases such as transferring graphs of objects into a `Session` from a second level cache, or to transfer just-loaded objects into the `Session` owned by a worker thread or process without re-querying the database.

  The `load=False` use case adds the caveat that the given object has to be in a "clean" state, that is, has no pending changes to be flushed - even if the incoming object is detached from any `Session`. This is so that when the merge operation populates local attributes and cascades to related objects and collections, the values can be "stamped" onto the target object as is, without generating any history or attribute events, and without the need to reconcile the incoming data with any existing related objects or collections that might not be loaded. The resulting objects from `load=False` are always produced as "clean", so it is only appropriate that the given objects should be "clean" as well, else this suggests a mis-use of the method.

new

The set of all instances marked as 'new' within this `Session`.

no_autoflush

Return a context manager that disables autoflush.

e.g.:

```
with session.no_autoflush:
```

```
some_object = SomeClass()
session.add(some_object)
# won't autoflush
some_object.related_thing = session.query(SomeRelated).first()
```

Operations that proceed within the `with:` block will not be subject to flushes occurring upon query access. This is useful when initializing a series of objects which involve existing database queries, where the uncompleted object should not yet be flushed.

New in version 0.7.6.

classmethod object_session(*instance*)
Return the `Session` to which an object belongs.

prepare()
Prepare the current transaction in progress for two phase commit.

If no transaction is in progress, this method raises an InvalidRequestError.

Only root transactions of two phase sessions can be prepared. If the current transaction is not such, an InvalidRequestError is raised.

prune()
Remove unreferenced instances cached in the identity map.

Deprecated since version 0.7: The non-weak-referencing identity map feature is no longer needed.

Note that this method is only meaningful if "weak_identity_map" is set to False. The default weak identity map is self-pruning.

Removes any object in this Session's identity map that is not referenced in user code, modified, new or scheduled for deletion. Returns the number of objects pruned.

query(**entities*, ***kwargs*)
Return a new `Query` object corresponding to this `Session`.

refresh(*instance*, *attribute_names=None*, *lockmode=None*)
Expire and refresh the attributes on the given instance.

A query will be issued to the database and all attributes will be refreshed with their current database value.

Lazy-loaded relational attributes will remain lazily loaded, so that the instance-wide refresh operation will be followed immediately by the lazy load of that attribute.

Eagerly-loaded relational attributes will eagerly load within the single refresh operation.

Note that a highly isolated transaction will return the same values as were previously read in that same transaction, regardless of changes in database state outside of that transaction - usage of `refresh()` usually only makes sense if non-ORM SQL statement were emitted in the ongoing transaction, or if autocommit mode is turned on.

Parameters

- **attribute_names** – optional. An iterable collection of string attribute names indicating a subset of attributes to be refreshed.
- **lockmode** – Passed to the `Query` as used by `with_lockmode()`.

rollback()
Rollback the current transaction in progress.

If no transaction is in progress, this method is a pass-through.

This method rolls back the current transaction or nested transaction regardless of subtransactions being in effect. All subtransactions up to the first real transaction are closed. Subtransactions occur when begin() is called multiple times.

scalar(*clause*, *params=None*, *mapper=None*, *bind=None*, ***kw*)
Like `execute()` but return a scalar result.

transaction = None
The current active or inactive `SessionTransaction`.

class sqlalchemy.orm.session.**SessionTransaction**(*session*, *parent=None*, *nested=False*)
A `Session`-level transaction.

`SessionTransaction` is a mostly behind-the-scenes object not normally referenced directly by application code. It coordinates among multiple `Connection` objects, maintaining a database transaction for each one individually, committing or rolling them back all at once. It also provides optional two-phase commit behavior which can augment this coordination operation.

The `Session.transaction` attribute of `Session` refers to the current `SessionTransaction` object in use, if any.

A `SessionTransaction` is associated with a `Session` in its default mode of `autocommit=False` immediately, associated with no database connections. As the `Session` is called upon to emit SQL on behalf of various `Engine` or `Connection` objects, a corresponding `Connection` and associated `Transaction` is added to a collection within the `SessionTransaction` object, becoming one of the connection/transaction pairs maintained by the `SessionTransaction`.

The lifespan of the `SessionTransaction` ends when the `Session.commit()`, `Session.rollback()` or `Session.close()` methods are called. At this point, the `SessionTransaction` removes its association with its parent `Session`. A `Session` that is in `autocommit=False` mode will create a new `SessionTransaction` to replace it immediately, whereas a `Session` that's in `autocommit=True` mode will remain without a `SessionTransaction` until the `Session.begin()` method is called.

Another detail of `SessionTransaction` behavior is that it is capable of "nesting". This means that the `begin()` method can be called while an existing `SessionTransaction` is already present, producing a new `SessionTransaction` that temporarily replaces the parent `SessionTransaction`. When a `SessionTransaction` is produced as nested, it assigns itself to the `Session.transaction` attribute. When it is ended via `Session.commit()` or `Session.rollback()`, it restores its parent `SessionTransaction` back onto the `Session.transaction` attribute. The behavior is effectively a stack, where `Session.transaction` refers to the current head of the stack.

The purpose of this stack is to allow nesting of `rollback()` or `commit()` calls in context with various flavors of `begin()`. This nesting behavior applies to when `Session.begin_nested()` is used to emit a SAVEPOINT transaction, and is also used to produce a so-called "subtransaction" which allows a block of code to use a begin/rollback/commit sequence regardless of whether or not its enclosing code block has begun a transaction. The `flush()` method, whether called explicitly or via autoflush, is the primary consumer of the "subtransaction" feature, in that it wishes to guarantee that it works within in a transaction block regardless of whether or not the `Session` is in transactional mode when the method is called.

See also:

`Session.rollback()`

`Session.commit()`

`Session.begin()`

`Session.begin_nested()`

`Session.is_active`

SessionEvents.after_commit()

SessionEvents.after_rollback()

SessionEvents.after_soft_rollback()

Session Utilites

sqlalchemy.orm.session.**make_transient**(*instance*)
Make the given instance 'transient'.

This will remove its association with any session and additionally will remove its "identity key", such that it's as though the object were newly constructed, except retaining its values. It also resets the "deleted" flag on the state if this object had been explicitly deleted by its session.

Attributes which were "expired" or deferred at the instance level are reverted to undefined, and will not trigger any loads.

sqlalchemy.orm.session.**object_session**(*instance*)
Return the Session to which instance belongs.

If the instance is not a mapped instance, an error is raised.

Attribute and State Management Utilities

These functions are provided by the SQLAlchemy attribute instrumentation API to provide a detailed interface for dealing with instances, attribute values, and history. Some of them are useful when constructing event listener functions, such as those described in *events_orm_toplevel*.

sqlalchemy.orm.attributes.**del_attribute**(*instance*, *key*)
Delete the value of an attribute, firing history events.

This function may be used regardless of instrumentation applied directly to the class, i.e. no descriptors are required. Custom attribute management schemes will need to make usage of this method to establish attribute state as understood by SQLAlchemy.

sqlalchemy.orm.attributes.**get_attribute**(*instance*, *key*)
Get the value of an attribute, firing any callables required.

This function may be used regardless of instrumentation applied directly to the class, i.e. no descriptors are required. Custom attribute management schemes will need to make usage of this method to make usage of attribute state as understood by SQLAlchemy.

sqlalchemy.orm.attributes.**get_history**(*obj*, *key*, *passive=<symbol 'PASSIVE_OFF>*)
Return a History record for the given object and attribute key.

Parameters

- **obj** – an object whose class is instrumented by the attributes package.
- **key** – string attribute name.
- **passive** – indicates if the attribute should be loaded from the database if not already present (PASSIVE_NO_FETCH), and if the attribute should be not initialized to a blank value otherwise (PASSIVE_NO_INITIALIZE). Default is PASSIVE_OFF.

sqlalchemy.orm.attributes.**init_collection**(*obj*, *key*)
Initialize a collection attribute and return the collection adapter.

This function is used to provide direct access to collection internals for a previously unloaded attribute. e.g.:

```
collection_adapter = init_collection(someobject, 'elements')
for elem in values:
    collection_adapter.append_without_event(elem)
```

For an easier way to do the above, see `set_committed_value()`.

obj is an instrumented object instance. An InstanceState is accepted directly for backwards compatibility but this usage is deprecated.

`sqlalchemy.orm.attributes.`**`flag_modified`**(*instance*, *key*)
Mark an attribute on an instance as 'modified'.

This sets the 'modified' flag on the instance and establishes an unconditional change event for the given attribute.

`sqlalchemy.orm.attributes.`**`instance_state`**()
Return the `InstanceState` for a given object.

`sqlalchemy.orm.attributes.`**`manager_of_class`**()
Return the `ClassManager` for a given class.

`sqlalchemy.orm.attributes.`**`set_attribute`**(*instance*, *key*, *value*)
Set the value of an attribute, firing history events.

This function may be used regardless of instrumentation applied directly to the class, i.e. no descriptors are required. Custom attribute management schemes will need to make usage of this method to establish attribute state as understood by SQLAlchemy.

`sqlalchemy.orm.attributes.`**`set_committed_value`**(*instance*, *key*, *value*)
Set the value of an attribute with no history events.

Cancels any previous history present. The value should be a scalar value for scalar-holding attributes, or an iterable for any collection-holding attribute.

This is the same underlying method used when a lazy loader fires off and loads additional data from the database. In particular, this method can be used by application code which has loaded additional attributes or collections through separate queries, which can then be attached to an instance as though it were part of its original loaded state.

class `sqlalchemy.orm.attributes.`**`History`**
A 3-tuple of added, unchanged and deleted values, representing the changes which have occurred on an instrumented attribute.

Each tuple member is an iterable sequence.

`added`
Return the collection of items added to the attribute (the first tuple element).

`deleted`
Return the collection of items that have been removed from the attribute (the third tuple element).

`empty`()
Return True if this `History` has no changes and no existing, unchanged state.

`has_changes`()
Return True if this `History` has changes.

`non_added`()
Return a collection of unchanged + deleted.

`non_deleted`()
Return a collection of added + unchanged.

sum()
Return a collection of added + unchanged + deleted.

unchanged
Return the collection of items that have not changed on the attribute (the second tuple element).

sqlalchemy.orm.attributes.**PASSIVE_NO_INITIALIZE = <symbol 'PASSIVE_NO_INITIALIZE>**
Symbol indicating that loader callables should not be fired off, and a non-initialized attribute should remain that way.

sqlalchemy.orm.attributes.**PASSIVE_NO_FETCH = <symbol 'PASSIVE_NO_FETCH>**
Symbol indicating that loader callables should not emit SQL, but a value can be fetched from the current session.

Non-initialized attributes should be initialized to an empty value.

sqlalchemy.orm.attributes.**PASSIVE_NO_FETCH_RELATED = <symbol 'PASSIVE_NO_FETCH_RELATED>**
Symbol indicating that loader callables should not emit SQL for loading a related object, but can refresh the attributes of the local instance in order to locate a related object in the current session.

Non-initialized attributes should be initialized to an empty value.

The unit of work uses this mode to check if history is present on many-to-one attributes with minimal SQL emitted.

sqlalchemy.orm.attributes.**PASSIVE_ONLY_PERSISTENT = <symbol 'PASSIVE_ONLY_PERSISTENT>**
Symbol indicating that loader callables should only fire off for parent objects which are persistent (i.e., have a database identity).

Load operations for the "previous" value of an attribute make use of this flag during change events.

sqlalchemy.orm.attributes.**PASSIVE_OFF = <symbol 'PASSIVE_OFF>**
Symbol indicating that loader callables should be executed normally.

2.7 Querying

This section provides API documentation for the Query object and related constructs.

For an in-depth introduction to querying with the SQLAlchemy ORM, please see the *Object Relational Tutorial*.

2.7.1 The Query Object

Query is produced in terms of a given Session, using the query() function:

```
q = session.query(SomeMappedClass)
```

Following is the full interface for the Query object.

class sqlalchemy.orm.query.**Query**(*entities*, *session=None*)
ORM-level SQL construction object.

Query is the source of all SELECT statements generated by the ORM, both those formulated by end-user query operations as well as by high level internal operations such as related collection loading. It features a generative interface whereby successive calls return a new Query object, a copy of the former with additional criteria and options associated with it.

Query objects are normally initially generated using the query() method of Session. For a full walk-through of Query usage, see the *Object Relational Tutorial*.

add_column(*column*)
Add a column expression to the list of result columns to be returned.

Pending deprecation: `add_column()` will be superseded by `add_columns()`.

add_columns(**column*)
Add one or more column expressions to the list of result columns to be returned.

add_entity(*entity*, *alias=None*)
add a mapped entity to the list of result columns to be returned.

all()
Return the results represented by this `Query` as a list.

This results in an execution of the underlying query.

as_scalar()
Return the full SELECT statement represented by this `Query`, converted to a scalar subquery.

Analogous to `sqlalchemy.sql._SelectBaseMixin.as_scalar()`.

New in version 0.6.5.

autoflush(*setting*)
Return a Query with a specific 'autoflush' setting.

Note that a Session with autoflush=False will not autoflush, even if this flag is set to True at the Query level. Therefore this flag is usually used only to disable autoflush for a specific Query.

column_descriptions
Return metadata about the columns which would be returned by this `Query`.

Format is a list of dictionaries:

```
user_alias = aliased(User, name='user2')
q = sess.query(User, User.id, user_alias)

# this expression:
q.column_descriptions

# would return:
[
    {
        'name':'User',
        'type':User,
        'aliased':False,
        'expr':User,
    },
    {
        'name':'id',
        'type':Integer(),
        'aliased':False,
        'expr':User.id,
    },
    {
        'name':'user2',
        'type':User,
        'aliased':True,
        'expr':user_alias
    }
]
```

correlate(**args*)

Return a `Query` construct which will correlate the given FROM clauses to that of an enclosing `Query` or `select()`.

The method here accepts mapped classes, `aliased()` constructs, and `mapper()` constructs as arguments, which are resolved into expression constructs, in addition to appropriate expression constructs.

The correlation arguments are ultimately passed to `Select.correlate()` after coercion to expression constructs.

The correlation arguments take effect in such cases as when `Query.from_self()` is used, or when a subquery as returned by `Query.subquery()` is embedded in another `select()` construct.

count()

Return a count of rows this Query would return.

This generates the SQL for this Query as follows:

```
SELECT count(1) AS count_1 FROM (
    SELECT <rest of query follows...>
) AS anon_1
```

Changed in version 0.7: The above scheme is newly refined as of 0.7b3.

For fine grained control over specific columns to count, to skip the usage of a subquery or otherwise control of the FROM clause, or to use other aggregate functions, use `func` expressions in conjunction with `query()`, i.e.:

```
from sqlalchemy import func

# count User records, without
# using a subquery.
session.query(func.count(User.id))

# return count of user "id" grouped
# by "name"
session.query(func.count(User.id)).\
        group_by(User.name)

from sqlalchemy import distinct

# count distinct "name" values
session.query(func.count(distinct(User.name)))
```

cte(*name=None*, *recursive=False*)

Return the full SELECT statement represented by this `Query` represented as a common table expression (CTE).

New in version 0.7.6.

Parameters and usage are the same as those of the `_SelectBase.cte()` method; see that method for further details.

Here is the Postgresql WITH RECURSIVE example. Note that, in this example, the `included_parts` cte and the `incl_alias` alias of it are Core selectables, which means the columns are accessed via the `.c.` attribute. The `parts_alias` object is an `orm.aliased()` instance of the `Part` entity, so column-mapped attributes are available directly:

```
from sqlalchemy.orm import aliased

class Part(Base):
```

```
        __tablename__ = 'part'
        part = Column(String, primary_key=True)
        sub_part = Column(String, primary_key=True)
        quantity = Column(Integer)

    included_parts = session.query(
                        Part.sub_part,
                        Part.part,
                        Part.quantity).\
                            filter(Part.part=="our part").\
                            cte(name="included_parts", recursive=True)

    incl_alias = aliased(included_parts, name="pr")
    parts_alias = aliased(Part, name="p")
    included_parts = included_parts.union_all(
        session.query(
            parts_alias.part,
            parts_alias.sub_part,
            parts_alias.quantity).\
                filter(parts_alias.part==incl_alias.c.sub_part)
        )

    q = session.query(
            included_parts.c.sub_part,
            func.sum(included_parts.c.quantity).label('total_quantity')
        ).\
        group_by(included_parts.c.sub_part)
```

See also:

`_SelectBase.cte()`

delete(*synchronize_session='evaluate'*)

Perform a bulk delete query.

Deletes rows matched by this query from the database.

Parameters **synchronize_session** – chooses the strategy for the removal of matched objects from the session. Valid values are:

`False` - don't synchronize the session. This option is the most efficient and is reliable once the session is expired, which typically occurs after a commit(), or explicitly using expire_all(). Before the expiration, objects may still remain in the session which were in fact deleted which can lead to confusing results if they are accessed via get() or already loaded collections.

`'fetch'` - performs a select query before the delete to find objects that are matched by the delete query and need to be removed from the session. Matched objects are removed from the session.

`'evaluate'` - Evaluate the query's criteria in Python straight on the objects in the session. If evaluation of the criteria isn't implemented, an error is raised. In that case you probably want to use the 'fetch' strategy as a fallback.

The expression evaluator currently doesn't account for differing string collations between the database and Python.

Returns the number of rows deleted, excluding any cascades.

The method does *not* offer in-Python cascading of relationships - it is assumed that ON DELETE CASCADE is configured for any foreign key references which require it. The Session needs to be expired

(occurs automatically after commit(), or call expire_all()) in order for the state of dependent objects subject to delete or delete-orphan cascade to be correctly represented.

Note that the `MapperEvents.before_delete()` and `MapperEvents.after_delete()` events are **not** invoked from this method. It instead invokes `SessionEvents.after_bulk_delete()`.

distinct(**criterion*)
Apply a `DISTINCT` to the query and return the newly resulting `Query`.

Parameters ***expr** – optional column expressions. When present, the Postgresql dialect will render a `DISTINCT ON (<expressions>>)` construct.

enable_assertions(*value*)
Control whether assertions are generated.

When set to False, the returned Query will not assert its state before certain operations, including that LIMIT/OFFSET has not been applied when filter() is called, no criterion exists when get() is called, and no "from_statement()" exists when filter()/order_by()/group_by() etc. is called. This more permissive mode is used by custom Query subclasses to specify criterion or other modifiers outside of the usual usage patterns.

Care should be taken to ensure that the usage pattern is even possible. A statement applied by from_statement() will override any criterion set by filter() or order_by(), for example.

enable_eagerloads(*value*)
Control whether or not eager joins and subqueries are rendered.

When set to False, the returned Query will not render eager joins regardless of `joinedload()`, `subqueryload()` options or mapper-level `lazy='joined'/lazy='subquery'` configurations.

This is used primarily when nesting the Query's statement into a subquery or other selectable.

except_(**q*)
Produce an EXCEPT of this Query against one or more queries.

Works the same way as `union()`. See that method for usage examples.

except_all(**q*)
Produce an EXCEPT ALL of this Query against one or more queries.

Works the same way as `union()`. See that method for usage examples.

execution_options(***kwargs*)
Set non-SQL options which take effect during execution.

The options are the same as those accepted by `Connection.execution_options()`.

Note that the `stream_results` execution option is enabled automatically if the `yield_per()` method is used.

filter(**criterion*)
apply the given filtering criterion to a copy of this `Query`, using SQL expressions.

e.g.:

```
session.query(MyClass).filter(MyClass.name == 'some name')
```

Multiple criteria are joined together by AND:

```
session.query(MyClass).\
    filter(MyClass.name == 'some name', MyClass.id > 5)
```

The criterion is any SQL expression object applicable to the WHERE clause of a select. String expressions are coerced into SQL expression constructs via the `text()` construct.

Changed in version 0.7.5: Multiple criteria joined by AND.

See also:

`Query.filter_by()` - filter on keyword expressions.

filter_by(***kwargs*)
apply the given filtering criterion to a copy of this `Query`, using keyword expressions.

e.g.:

```
session.query(MyClass).filter_by(name = 'some name')
```

Multiple criteria are joined together by AND:

```
session.query(MyClass).\
    filter_by(name = 'some name', id = 5)
```

The keyword expressions are extracted from the primary entity of the query, or the last entity that was the target of a call to `Query.join()`.

See also:

`Query.filter()` - filter on SQL expressions.

first()
Return the first result of this `Query` or None if the result doesn't contain any row.

first() applies a limit of one within the generated SQL, so that only one primary entity row is generated on the server side (note this may consist of multiple result rows if join-loaded collections are present).

Calling `first()` results in an execution of the underlying query.

from_self(**entities*)
return a Query that selects from this Query's SELECT statement.

*entities - optional list of entities which will replace those being selected.

from_statement(*statement*)
Execute the given SELECT statement and return results.

This method bypasses all internal statement compilation, and the statement is executed without modification.

The statement argument is either a string, a `select()` construct, or a `text()` construct, and should return the set of columns appropriate to the entity class represented by this `Query`.

get(*ident*)
Return an instance based on the given primary key identifier, or `None` if not found.

E.g.:

```
my_user = session.query(User).get(5)

some_object = session.query(VersionedFoo).get((5, 10))
```

`get()` is special in that it provides direct access to the identity map of the owning `Session`. If the given primary key identifier is present in the local identity map, the object is returned directly from this collection and no SQL is emitted, unless the object has been marked fully expired. If not present, a SELECT is performed in order to locate the object.

`get()` also will perform a check if the object is present in the identity map and marked as expired - a SELECT is emitted to refresh the object as well as to ensure that the row is still present. If not, `ObjectDeletedError` is raised.

`get()` is only used to return a single mapped instance, not multiple instances or individual column constructs, and strictly on a single primary key value. The originating `Query` must be constructed in this way, i.e. against a single mapped entity, with no additional filtering criterion. Loading options via `options()` may be applied however, and will be used if the object is not yet locally present.

A lazy-loading, many-to-one attribute configured by `relationship()`, using a simple foreign-key-to-primary-key criterion, will also use an operation equivalent to `get()` in order to retrieve the target value from the local identity map before querying the database. See *Relationship Loading Techniques* for further details on relationship loading.

Parameters **ident** – A scalar or tuple value representing the primary key. For a composite primary key, the order of identifiers corresponds in most cases to that of the mapped `Table` object's primary key columns. For a `mapper()` that was given the `primary key` argument during construction, the order of identifiers corresponds to the elements present in this collection.

Returns The object instance, or `None`.

group_by(**criterion*)
apply one or more GROUP BY criterion to the query and return the newly resulting `Query`

having(*criterion*)
apply a HAVING criterion to the query and return the newly resulting `Query`.

`having()` is used in conjunction with `group_by()`.

HAVING criterion makes it possible to use filters on aggregate functions like COUNT, SUM, AVG, MAX, and MIN, eg.:

```
q = session.query(User.id).\
            join(User.addresses).\
            group_by(User.id).\
            having(func.count(Address.id) > 2)
```

instances(*cursor*, *_Query__context=None*)
Given a ResultProxy cursor as returned by connection.execute(), return an ORM result as an iterator.

e.g.:

```
result = engine.execute("select * from users")
for u in session.query(User).instances(result):
    print u
```

intersect(**q*)
Produce an INTERSECT of this Query against one or more queries.

Works the same way as `union()`. See that method for usage examples.

intersect_all(**q*)
Produce an INTERSECT ALL of this Query against one or more queries.

Works the same way as `union()`. See that method for usage examples.

join(**props*, ***kwargs*)
Create a SQL JOIN against this `Query` object's criterion and apply generatively, returning the newly resulting `Query`.

Simple Relationship Joins

Consider a mapping between two classes `User` and `Address`, with a relationship `User.addresses` representing a collection of `Address` objects associated with each `User`. The most common usage of `join()` is to create a JOIN along this relationship, using the `User.addresses` attribute as an indicator for how this should occur:

```
q = session.query(User).join(User.addresses)
```

Where above, the call to `join()` along `User.addresses` will result in SQL equivalent to:

```
SELECT user.* FROM user JOIN address ON user.id = address.user_id
```

In the above example we refer to `User.addresses` as passed to `join()` as the *on clause*, that is, it indicates how the "ON" portion of the JOIN should be constructed. For a single-entity query such as the one above (i.e. we start by selecting only from `User` and nothing else), the relationship can also be specified by its string name:

```
q = session.query(User).join("addresses")
```

`join()` can also accommodate multiple "on clause" arguments to produce a chain of joins, such as below where a join across four related entities is constructed:

```
q = session.query(User).join("orders", "items", "keywords")
```

The above would be shorthand for three separate calls to `join()`, each using an explicit attribute to indicate the source entity:

```
q = session.query(User).\
        join(User.orders).\
        join(Order.items).\
        join(Item.keywords)
```

Joins to a Target Entity or Selectable

A second form of `join()` allows any mapped entity or core selectable construct as a target. In this usage, `join()` will attempt to create a JOIN along the natural foreign key relationship between two entities:

```
q = session.query(User).join(Address)
```

The above calling form of `join()` will raise an error if either there are no foreign keys between the two entities, or if there are multiple foreign key linkages between them. In the above calling form, `join()` is called upon to create the "on clause" automatically for us. The target can be any mapped entity or selectable, such as a `Table`:

```
q = session.query(User).join(addresses_table)
```

Joins to a Target with an ON Clause

The third calling form allows both the target entity as well as the ON clause to be passed explicitly. Suppose for example we wanted to join to `Address` twice, using an alias the second time. We use `aliased()` to create a distinct alias of `Address`, and join to it using the `target, onclause` form, so that the alias can be specified explicitly as the target along with the relationship to instruct how the ON clause should proceed:

```
a_alias = aliased(Address)

q = session.query(User).\
        join(User.addresses).\
        join(a_alias, User.addresses).\
        filter(Address.email_address=='ed@foo.com').\
        filter(a_alias.email_address=='ed@bar.com')
```

Where above, the generated SQL would be similar to:

```
SELECT user.* FROM user
    JOIN address ON user.id = address.user_id
    JOIN address AS address_1 ON user.id=address_1.user_id
    WHERE address.email_address = :email_address_1
    AND address_1.email_address = :email_address_2
```

The two-argument calling form of `join()` also allows us to construct arbitrary joins with SQL-oriented "on clause" expressions, not relying upon configured relationships at all. Any SQL expression can be passed as the ON clause when using the two-argument form, which should refer to the target entity in some way as well as an applicable source entity:

```
q = session.query(User).join(Address, User.id==Address.user_id)
```

Changed in version 0.7: In SQLAlchemy 0.6 and earlier, the two argument form of `join()` requires the usage of a tuple: `query(User).join((Address, User.id==Address.user_id))`. This calling form is accepted in 0.7 and further, though is not necessary unless multiple join conditions are passed to a single `join()` call, which itself is also not generally necessary as it is now equivalent to multiple calls (this wasn't always the case).

Advanced Join Targeting and Adaption

There is a lot of flexibility in what the "target" can be when using `join()`. As noted previously, it also accepts `Table` constructs and other selectables such as `alias()` and `select()` constructs, with either the one or two-argument forms:

```
addresses_q = select([Address.user_id]).\
                where(Address.email_address.endswith("@bar.com")).\
                alias()

q = session.query(User).\
            join(addresses_q, addresses_q.c.user_id==User.id)
```

`join()` also features the ability to *adapt* a `relationship()` -driven ON clause to the target selectable. Below we construct a JOIN from `User` to a subquery against `Address`, allowing the relationship denoted by `User.addresses` to *adapt* itself to the altered target:

```
address_subq = session.query(Address).\
                    filter(Address.email_address == 'ed@foo.com').\
                    subquery()

q = session.query(User).join(address_subq, User.addresses)
```

Producing SQL similar to:

```
SELECT user.* FROM user
    JOIN (
        SELECT address.id AS id,
                address.user_id AS user_id,
                address.email_address AS email_address
        FROM address
        WHERE address.email_address = :email_address_1
    ) AS anon_1 ON user.id = anon_1.user_id
```

The above form allows one to fall back onto an explicit ON clause at any time:

```
q = session.query(User).\
        join(address_subq, User.id==address_subq.c.user_id)
```

Controlling what to Join From

While `join()` exclusively deals with the "right" side of the JOIN, we can also control the "left" side, in those cases where it's needed, using `select_from()`. Below we construct a query against `Address` but can still make usage of `User.addresses` as our ON clause by instructing the `Query` to select first from the `User` entity:

```
q = session.query(Address).select_from(User).\
                join(User.addresses).\
                filter(User.name == 'ed')
```

Which will produce SQL similar to:

```
SELECT address.* FROM user
    JOIN address ON user.id=address.user_id
    WHERE user.name = :name_1
```

Constructing Aliases Anonymously

`join()` can construct anonymous aliases using the `aliased=True` flag. This feature is useful when a query is being joined algorithmically, such as when querying self-referentially to an arbitrary depth:

```
q = session.query(Node).\
        join("children", "children", aliased=True)
```

When `aliased=True` is used, the actual "alias" construct is not explicitly available. To work with it, methods such as `Query.filter()` will adapt the incoming entity to the last join point:

```
q = session.query(Node).\
        join("children", "children", aliased=True).\
        filter(Node.name == 'grandchild 1')
```

When using automatic aliasing, the `from_joinpoint=True` argument can allow a multi-node join to be broken into multiple calls to `join()`, so that each path along the way can be further filtered:

```
q = session.query(Node).\
        join("children", aliased=True).\
        filter(Node.name='child 1').\
        join("children", aliased=True, from_joinpoint=True).\
        filter(Node.name == 'grandchild 1')
```

The filtering aliases above can then be reset back to the original `Node` entity using `reset_joinpoint()`:

```
q = session.query(Node).\
        join("children", "children", aliased=True).\
        filter(Node.name == 'grandchild 1').\
        reset_joinpoint().\
        filter(Node.name == 'parent 1)
```

For an example of `aliased=True`, see the distribution example *XML Persistence* which illustrates an XPath-like query system using algorithmic joins.

Parameters

- ***props** – A collection of one or more join conditions, each consisting of a relationship-bound attribute or string relationship name representing an "on clause", or a single target entity, or a tuple in the form of `(target, onclause)`. A special two-argument calling form of the form `target, onclause` is also accepted.

- **aliased=False** – If True, indicate that the JOIN target should be anonymously aliased. Subsequent calls to `filter` and similar will adapt the incoming criterion to the target alias, until `reset_joinpoint()` is called.
- **from_joinpoint=False** – When using `aliased=True`, a setting of True here will cause the join to be from the most recent joined target, rather than starting back from the original FROM clauses of the query.

See also:

Querying with Joins in the ORM tutorial.

Mapping Class Inheritance Hierarchies for details on how `join()` is used for inheritance relationships.

`orm.join()` - a standalone ORM-level join function, used internally by `Query.join()`, which in previous SQLAlchemy versions was the primary ORM-level joining interface.

label(*name*)

Return the full SELECT statement represented by this `Query`, converted to a scalar subquery with a label of the given name.

Analogous to `sqlalchemy.sql._SelectBaseMixin.label()`.

New in version 0.6.5.

limit(*limit*)

Apply a `LIMIT` to the query and return the newly resulting

`Query`.

logger = <logging.Logger object at 0x7fb7a80cacd0>

merge_result(*iterator*, *load=True*)

Merge a result into this `Query` object's Session.

Given an iterator returned by a `Query` of the same structure as this one, return an identical iterator of results, with all mapped instances merged into the session using `Session.merge()`. This is an optimized method which will merge all mapped instances, preserving the structure of the result rows and unmapped columns with less method overhead than that of calling `Session.merge()` explicitly for each value.

The structure of the results is determined based on the column list of this `Query` - if these do not correspond, unchecked errors will occur.

The 'load' argument is the same as that of `Session.merge()`.

For an example of how `merge_result()` is used, see the source code for the example *Beaker Caching*, where `merge_result()` is used to efficiently restore state from a cache back into a target `Session`.

offset(*offset*)

Apply an `OFFSET` to the query and return the newly resulting `Query`.

one()

Return exactly one result or raise an exception.

Raises `sqlalchemy.orm.exc.NoResultFound` if the query selects no rows. Raises `sqlalchemy.orm.exc.MultipleResultsFound` if multiple object identities are returned, or if multiple rows are returned for a query that does not return object identities.

Note that an entity query, that is, one which selects one or more mapped classes as opposed to individual column attributes, may ultimately represent many rows but only one row of unique entity or entities - this is a successful result for one().

Calling `one()` results in an execution of the underlying query.

Changed in version 0.6: `one()` fully fetches all results instead of applying any kind of limit, so that the "unique"-ing of entities does not conceal multiple object identities.

options(**args*)
Return a new Query object, applying the given list of mapper options.

Most supplied options regard changing how column- and relationship-mapped attributes are loaded. See the sections *Deferred Column Loading* and *Relationship Loading Techniques* for reference documentation.

order_by(**criterion*)
apply one or more ORDER BY criterion to the query and return the newly resulting `Query`

All existing ORDER BY settings can be suppressed by passing `None` - this will suppress any ORDER BY configured on mappers as well.

Alternatively, an existing ORDER BY setting on the Query object can be entirely cancelled by passing `False` as the value - use this before calling methods where an ORDER BY is invalid.

outerjoin(**props*, ***kwargs*)
Create a left outer join against this `Query` object's criterion and apply generatively, returning the newly resulting `Query`.

Usage is the same as the `join()` method.

params(**args*, ***kwargs*)
add values for bind parameters which may have been specified in filter().

parameters may be specified using **kwargs, or optionally a single dictionary as the first positional argument. The reason for both is that **kwargs is convenient, however some parameter dictionaries contain unicode keys in which case **kwargs cannot be used.

populate_existing()
Return a `Query` that will expire and refresh all instances as they are loaded, or reused from the current `Session`.

`populate_existing()` does not improve behavior when the ORM is used normally - the `Session` object's usual behavior of maintaining a transaction and expiring all attributes after rollback or commit handles object state automatically. This method is not intended for general use.

prefix_with(**prefixes*)
Apply the prefixes to the query and return the newly resulting `Query`.

Parameters ***prefixes** – optional prefixes, typically strings,

not using any commas. In particular is useful for MySQL keywords.

e.g.:

```
query = sess.query(User.name).\
    prefix_with('HIGH_PRIORITY').\
    prefix_with('SQL_SMALL_RESULT', 'ALL')
```

Would render:

```
SELECT HIGH_PRIORITY SQL_SMALL_RESULT ALL users.name AS users_name
FROM users
```

New in version 0.7.7.

reset_joinpoint()
Return a new `Query`, where the "join point" has been reset back to the base FROM entities of the query.

This method is usually used in conjunction with the `aliased=True` feature of the `join()` method. See the example in `join()` for how this is used.

scalar()
Return the first element of the first result or None if no rows present. If multiple rows are returned, raises MultipleResultsFound.

```
>>> session.query(Item).scalar()
<Item>
>>> session.query(Item.id).scalar()
1
>>> session.query(Item.id).filter(Item.id < 0).scalar()
None
>>> session.query(Item.id, Item.name).scalar()
1
>>> session.query(func.count(Parent.id)).scalar()
20
```

This results in an execution of the underlying query.

select_from(**from_obj*)
Set the FROM clause of this `Query` explicitly.

Sending a mapped class or entity here effectively replaces the "left edge" of any calls to `join()`, when no joinpoint is otherwise established - usually, the default "join point" is the leftmost entity in the `Query` object's list of entities to be selected.

Mapped entities or plain `Table` or other selectables can be sent here which will form the default FROM clause.

See the example in `join()` for a typical usage of `select_from()`.

slice(*start*, *stop*)
apply LIMIT/OFFSET to the `Query` based on a " "range and return the newly resulting `Query`.

statement
The full SELECT statement represented by this Query.

The statement by default will not have disambiguating labels applied to the construct unless with_labels(True) is called first.

subquery(*name=None*)
return the full SELECT statement represented by this `Query`, embedded within an `Alias`.

Eager JOIN generation within the query is disabled.

The statement will not have disambiguating labels applied to the list of selected columns unless the `Query.with_labels()` method is used to generate a new `Query` with the option enabled.

Parameters **name** – string name to be assigned as the alias; this is passed through to `FromClause.alias()`. If `None`, a name will be deterministically generated at compile time.

union(**q*)
Produce a UNION of this Query against one or more queries.

e.g.:

```
q1 = sess.query(SomeClass).filter(SomeClass.foo=='bar')
q2 = sess.query(SomeClass).filter(SomeClass.bar=='foo')

q3 = q1.union(q2)
```

The method accepts multiple Query objects so as to control the level of nesting. A series of `union()` calls such as:

```
x.union(y).union(z).all()
```

will nest on each `union()`, and produces:

```
SELECT * FROM (SELECT * FROM (SELECT * FROM X UNION
                SELECT * FROM y) UNION SELECT * FROM Z)
```

Whereas:

```
x.union(y, z).all()
```

produces:

```
SELECT * FROM (SELECT * FROM X UNION SELECT * FROM y UNION
                SELECT * FROM Z)
```

Note that many database backends do not allow ORDER BY to be rendered on a query called within UNION, EXCEPT, etc. To disable all ORDER BY clauses including those configured on mappers, issue `query.order_by(None)` - the resulting `Query` object will not render ORDER BY within its SELECT statement.

union_all(**q*)
Produce a UNION ALL of this Query against one or more queries.

Works the same way as `union()`. See that method for usage examples.

update(*values*, *synchronize_session='evaluate'*)
Perform a bulk update query.

Updates rows matched by this query in the database.

Parameters

- **values** – a dictionary with attributes names as keys and literal values or sql expressions as values.
- **synchronize_session** – chooses the strategy to update the attributes on objects in the session. Valid values are:

  `False` - don't synchronize the session. This option is the most efficient and is reliable once the session is expired, which typically occurs after a commit(), or explicitly using expire_all(). Before the expiration, updated objects may still remain in the session with stale values on their attributes, which can lead to confusing results.

  `'fetch'` - performs a select query before the update to find objects that are matched by the update query. The updated attributes are expired on matched objects.

  `'evaluate'` - Evaluate the Query's criteria in Python straight on the objects in the session. If evaluation of the criteria isn't implemented, an exception is raised.

  The expression evaluator currently doesn't account for differing string collations between the database and Python.

Returns the number of rows matched by the update.

The method does *not* offer in-Python cascading of relationships - it is assumed that ON UPDATE CASCADE is configured for any foreign key references which require it.

The Session needs to be expired (occurs automatically after commit(), or call expire_all()) in order for the state of dependent objects subject foreign key cascade to be correctly represented.

Note that the MapperEvents.before_update() and MapperEvents.after_update() events are **not** invoked from this method. It instead invokes SessionEvents.after_bulk_update().

value(*column*)
Return a scalar result corresponding to the given column expression.

values(**columns*)
Return an iterator yielding result tuples corresponding to the given list of columns

whereclause
A readonly attribute which returns the current WHERE criterion for this Query.

This returned value is a SQL expression construct, or None if no criterion has been established.

with_entities(**entities*)
Return a new Query replacing the SELECT list with the given entities.

e.g.:

```
# Users, filtered on some arbitrary criterion
# and then ordered by related email address
q = session.query(User).\
            join(User.address).\
            filter(User.name.like('%ed%')).\
            order_by(Address.email)

# given *only* User.id==5, Address.email, and 'q', what
# would the *next* User in the result be ?
subq = q.with_entities(Address.email).\
            order_by(None).\
            filter(User.id==5).\
            subquery()
q = q.join((subq, subq.c.email < Address.email)).\
            limit(1)
```

New in version 0.6.5.

with_hint(*selectable*, *text*, *dialect_name='*'*)
Add an indexing hint for the given entity or selectable to this Query.

Functionality is passed straight through to with_hint(), with the addition that selectable can be a Table, Alias, or ORM entity / mapped class /etc.

with_labels()
Apply column labels to the return value of Query.statement.

Indicates that this Query's *statement* accessor should return a SELECT statement that applies labels to all columns in the form <tablename>_<columnname>; this is commonly used to disambiguate columns from multiple tables which have the same name.

When the *Query* actually issues SQL to load rows, it always uses column labeling.

with_lockmode(*mode*)
Return a new Query object with the specified locking mode.

Parameters **mode** – a string representing the desired locking mode. A corresponding value is passed to the for_update parameter of select() when the query is executed. Valid values are:

'update' - passes for_update=True, which translates to FOR UPDATE (standard SQL, supported by most dialects)

`'update_nowait'` - passes `for_update='nowait'`, which translates to `FOR UPDATE NOWAIT` (supported by Oracle, PostgreSQL 8.1 upwards)

`'read'` - passes `for_update='read'`, which translates to `LOCK IN SHARE MODE` (for MySQL), and `FOR SHARE` (for PostgreSQL)

`'read_nowait'` - passes `for_update='read_nowait'`, which translates to `FOR SHARE NOWAIT` (supported by PostgreSQL).

New in version 0.7.7: `FOR SHARE` and `FOR SHARE NOWAIT` (PostgreSQL).

with_parent(*instance*, *property=None*)

Add filtering criterion that relates the given instance to a child object or collection, using its attribute state as well as an established `relationship()` configuration.

The method uses the `with_parent()` function to generate the clause, the result of which is passed to `Query.filter()`.

Parameters are the same as `with_parent()`, with the exception that the given property can be None, in which case a search is performed against this `Query` object's target mapper.

with_polymorphic(*cls_or_mappers*, *selectable=None*, *discriminator=None*)

Load columns for descendant mappers of this Query's mapper.

Using this method will ensure that each descendant mapper's tables are included in the FROM clause, and will allow filter() criterion to be used against those tables. The resulting instances will also have those columns already loaded so that no "post fetch" of those columns will be required.

Parameters

- **cls_or_mappers** – a single class or mapper, or list of class/mappers, which inherit from this Query's mapper. Alternatively, it may also be the string `'*'`, in which case all descending mappers will be added to the FROM clause.
- **selectable** – a table or select() statement that will be used in place of the generated FROM clause. This argument is required if any of the desired mappers use concrete table inheritance, since SQLAlchemy currently cannot generate UNIONs among tables automatically. If used, the `selectable` argument must represent the full set of tables and columns mapped by every desired mapper. Otherwise, the unaccounted mapped columns will result in their table being appended directly to the FROM clause which will usually lead to incorrect results.
- **discriminator** – a column to be used as the "discriminator" column for the given selectable. If not given, the polymorphic_on attribute of the mapper will be used, if any. This is useful for mappers that don't have polymorphic loading behavior by default, such as concrete table mappers.

with_session(*session*)

Return a `Query` that will use the given `Session`.

with_transformation(*fn*)

Return a new `Query` object transformed by the given function.

E.g.:

```
def filter_something(criterion):
    def transform(q):
        return q.filter(criterion)
    return transform

q = q.with_transformation(filter_something(x==5))
```

This allows ad-hoc recipes to be created for `Query` objects. See the example at *Building Transformers*.

New in version 0.7.4.

yield_per(*count*)
Yield only `count` rows at a time.

WARNING: use this method with caution; if the same instance is present in more than one batch of rows, end-user changes to attributes will be overwritten.

In particular, it's usually impossible to use this setting with eagerly loaded collections (i.e. any lazy='joined' or 'subquery') since those collections will be cleared for a new load when encountered in a subsequent result batch. In the case of 'subquery' loading, the full result for all rows is fetched which generally defeats the purpose of `yield_per()`.

Also note that while `yield_per()` will set the `stream_results` execution option to True, currently this is only understood by `psycopg2` dialect which will stream results using server side cursors instead of pre-buffer all rows for this query. Other DBAPIs pre-buffer all rows before making them available.

2.7.2 ORM-Specific Query Constructs

class sqlalchemy.orm.**aliased**

The public name of the `AliasedClass` class.

class sqlalchemy.orm.util.**AliasedClass**(*cls*, *alias=None*, *name=None*, *adapt_on_names=False*)
Represents an "aliased" form of a mapped class for usage with Query.

The ORM equivalent of a `sqlalchemy.sql.expression.alias()` construct, this object mimics the mapped class using a __getattr__ scheme and maintains a reference to a real `Alias` object.

Usage is via the `aliased()` synonym:

```
# find all pairs of users with the same name
user_alias = aliased(User)
session.query(User, user_alias).\
                join((user_alias, User.id > user_alias.id)).\
                filter(User.name==user_alias.name)
```

The resulting object is an instance of `AliasedClass`, however it implements a `__getattribute__()` scheme which will proxy attribute access to that of the ORM class being aliased. All classmethods on the mapped entity should also be available here, including hybrids created with the *Hybrid Attributes* extension, which will receive the `AliasedClass` as the "class" argument when classmethods are called.

Parameters

- **cls** – ORM mapped entity which will be "wrapped" around an alias.
- **alias** – a selectable, such as an `alias()` or `select()` construct, which will be rendered in place of the mapped table of the ORM entity. If left as `None`, an ordinary `Alias` of the ORM entity's mapped table will be generated.
- **name** – A name which will be applied both to the `Alias` if one is generated, as well as the name present in the "named tuple" returned by the `Query` object when results are returned.
- **adapt_on_names** – if True, more liberal "matching" will be used when mapping the mapped columns of the ORM entity to those of the given selectable - a name-based match will be performed if the given selectable doesn't otherwise have a column that corresponds to one on the entity. The use case for this is when associating an entity with some derived selectable such as one that uses aggregate functions:

```
class UnitPrice(Base):
    __tablename__ = 'unit_price'
    ...
    unit_id = Column(Integer)
    price = Column(Numeric)

aggregated_unit_price = Session.query(
                            func.sum(UnitPrice.price).label('price')
                        ).group_by(UnitPrice.unit_id).subquery()

aggregated_unit_price = aliased(UnitPrice, alias=aggregated_unit_price, adapt_on_nam
```

Above, functions on `aggregated_unit_price` which refer to `.price` will return the `fund.sum(UnitPrice.price).label('price')` column, as it is matched on the name "price". Ordinarily, the "price" function wouldn't have any "column correspondence" to the actual `UnitPrice.price` column as it is not a proxy of the original.

New in version 0.7.3.

`sqlalchemy.orm.`**`join`**(*left*, *right*, *onclause=None*, *isouter=False*, *join_to_left=True*)

Produce an inner join between left and right clauses.

`orm.join()` is an extension to the core join interface provided by `sql.expression.join()`, where the left and right selectables may be not only core selectable objects such as `Table`, but also mapped classes or `AliasedClass` instances. The "on" clause can be a SQL expression, or an attribute or string name referencing a configured `relationship()`.

`join_to_left` indicates to attempt aliasing the ON clause, in whatever form it is passed, to the selectable passed as the left side. If False, the onclause is used as is.

`orm.join()` is not commonly needed in modern usage, as its functionality is encapsulated within that of the `Query.join()` method, which features a significant amount of automation beyond `orm.join()` by itself. Explicit usage of `orm.join()` with `Query` involves usage of the `Query.select_from()` method, as in:

```
from sqlalchemy.orm import join
session.query(User).\
    select_from(join(User, Address, User.addresses)).\
    filter(Address.email_address=='foo@bar.com')
```

In modern SQLAlchemy the above join can be written more succinctly as:

```
session.query(User).\
        join(User.addresses).\
        filter(Address.email_address=='foo@bar.com')
```

See `Query.join()` for information on modern usage of ORM level joins.

`sqlalchemy.orm.`**`outerjoin`**(*left*, *right*, *onclause=None*, *join_to_left=True*)

Produce a left outer join between left and right clauses.

This is the "outer join" version of the `orm.join()` function, featuring the same behavior except that an OUTER JOIN is generated. See that function's documentation for other usage details.

`sqlalchemy.orm.`**`with_parent`**(*instance*, *prop*)

Create filtering criterion that relates this query's primary entity to the given related instance, using established `relationship()` configuration.

The SQL rendered is the same as that rendered when a lazy loader would fire off from the given parent on that attribute, meaning that the appropriate state is taken from the parent object in Python without the need to render joins to the parent table in the rendered statement.

Changed in version 0.6.4: This method accepts parent instances in all persistence states, including transient, persistent, and detached. Only the requisite primary key/foreign key attributes need to be populated. Previous versions didn't work with transient instances.

Parameters

- **instance** – An instance which has some `relationship()`.
- **property** – String property name, or class-bound attribute, which indicates what relationship from the instance should be used to reconcile the parent/child relationship.

2.8 Relationship Loading Techniques

A big part of SQLAlchemy is providing a wide range of control over how related objects get loaded when querying. This behavior can be configured at mapper construction time using the `lazy` parameter to the `relationship()` function, as well as by using options with the `Query` object.

2.8.1 Using Loader Strategies: Lazy Loading, Eager Loading

By default, all inter-object relationships are **lazy loading**. The scalar or collection attribute associated with a `relationship()` contains a trigger which fires the first time the attribute is accessed. This trigger, in all but one case, issues a SQL call at the point of access in order to load the related object or objects:

```
>>> jack.addresses
SELECT addresses.id AS addresses_id, addresses.email_address AS addresses_email_address,
addresses.user_id AS addresses_user_id
FROM addresses
WHERE ? = addresses.user_id
[5]
[<Address(u'jack@google.com')>, <Address(u'j25@yahoo.com')>]
```

The one case where SQL is not emitted is for a simple many-to-one relationship, when the related object can be identified by its primary key alone and that object is already present in the current `Session`.

This default behavior of "load upon attribute access" is known as "lazy" or "select" loading - the name "select" because a "SELECT" statement is typically emitted when the attribute is first accessed.

In the *Object Relational Tutorial*, we introduced the concept of **Eager Loading**. We used an `option` in conjunction with the `Query` object in order to indicate that a relationship should be loaded at the same time as the parent, within a single SQL query. This option, known as `joinedload()`, connects a JOIN (by default a LEFT OUTER join) to the statement and populates the scalar/collection from the same result set as that of the parent:

```
>>> jack = session.query(User).\
... options(joinedload('addresses')).\
... filter_by(name='jack').all()
SELECT addresses_1.id AS addresses_1_id, addresses_1.email_address AS addresses_1_email_address,
addresses_1.user_id AS addresses_1_user_id, users.id AS users_id, users.name AS users_name,
users.fullname AS users_fullname, users.password AS users_password
FROM users LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = ?
['jack']
```

In addition to "joined eager loading", a second option for eager loading exists, called "subquery eager loading". This kind of eager loading emits an additional SQL statement for each collection requested, aggregated across all parent objects:

```
>>> jack = session.query(User).\
... options(subqueryload('addresses')).\
... filter_by(name='jack').all()
SELECT users.id AS users_id, users.name AS users_name, users.fullname AS users_fullname,
users.password AS users_password
FROM users
WHERE users.name = ?
('jack',)
SELECT addresses.id AS addresses_id, addresses.email_address AS addresses_email_address,
addresses.user_id AS addresses_user_id, anon_1.users_id AS anon_1_users_id
FROM (SELECT users.id AS users_id
FROM users
WHERE users.name = ?) AS anon_1 JOIN addresses ON anon_1.users_id = addresses.user_id
ORDER BY anon_1.users_id, addresses.id
('jack',)
```

The default **loader strategy** for any `relationship()` is configured by the `lazy` keyword argument, which defaults to `select` - this indicates a "select" statement . Below we set it as `joined` so that the `children` relationship is eager loading, using a join:

```
# load the 'children' collection using LEFT OUTER JOIN
mapper(Parent, parent_table, properties={
    'children': relationship(Child, lazy='joined')
})
```

We can also set it to eagerly load using a second query for all collections, using `subquery`:

```
# load the 'children' attribute using a join to a subquery
mapper(Parent, parent_table, properties={
    'children': relationship(Child, lazy='subquery')
})
```

When querying, all three choices of loader strategy are available on a per-query basis, using the `joinedload()`, `subqueryload()` and `lazyload()` query options:

```
# set children to load lazily
session.query(Parent).options(lazyload('children')).all()

# set children to load eagerly with a join
session.query(Parent).options(joinedload('children')).all()

# set children to load eagerly with a second statement
session.query(Parent).options(subqueryload('children')).all()
```

To reference a relationship that is deeper than one level, separate the names by periods:

```
session.query(Parent).options(joinedload('foo.bar.bat')).all()
```

When using dot-separated names with `joinedload()` or `subqueryload()`, the option applies **only** to the actual attribute named, and **not** its ancestors. For example, suppose a mapping from `A` to `B` to `C`, where the relationships, named `atob` and `btoc`, are both lazy-loading. A statement like the following:

```
session.query(A).options(joinedload('atob.btoc')).all()
```

will load only A objects to start. When the atob attribute on each A is accessed, the returned B objects will *eagerly* load their C objects.

Therefore, to modify the eager load to load both atob as well as btoc, place joinedloads for both:

```
session.query(A).options(joinedload('atob'), joinedload('atob.btoc')).all()
```

or more succinctly just use joinedload_all() or subqueryload_all():

```
session.query(A).options(joinedload_all('atob.btoc')).all()
```

There are two other loader strategies available, **dynamic loading** and **no loading**; these are described in *Working with Large Collections*.

2.8.2 Default Loading Strategies

New in version 0.7.5: Default loader strategies as a new feature.

Each of joinedload(), subqueryload(), lazyload(), and noload() can be used to set the default style of relationship() loading for a particular query, affecting all relationship() -mapped attributes not otherwise specified in the Query. This feature is available by passing the string '*' as the argument to any of these options:

```
session.query(MyClass).options(lazyload('*'))
```

Above, the lazyload('*') option will supercede the lazy setting of all relationship() constructs in use for that query, except for those which use the 'dynamic' style of loading. If some relationships specify lazy='joined' or lazy='subquery', for example, using default_strategy(lazy='select') will unilaterally cause all those relationships to use 'select' loading.

The option does not supercede loader options stated in the query, such as eagerload(), subqueryload(), etc. The query below will still use joined loading for the widget relationship:

```
session.query(MyClass).options(
                            lazyload('*'),
                            joinedload(MyClass.widget)
                        )
```

If multiple '*' options are passed, the last one overrides those previously passed.

2.8.3 The Zen of Eager Loading

The philosophy behind loader strategies is that any set of loading schemes can be applied to a particular query, and *the results don't change* - only the number of SQL statements required to fully load related objects and collections changes. A particular query might start out using all lazy loads. After using it in context, it might be revealed that particular attributes or collections are always accessed, and that it would be more efficient to change the loader strategy for these. The strategy can be changed with no other modifications to the query, the results will remain identical, but fewer SQL statements would be emitted. In theory (and pretty much in practice), nothing you can do to the Query would make it load a different set of primary or related objects based on a change in loader strategy.

How joinedload() in particular achieves this result of not impacting entity rows returned in any way is that it creates an anonymous alias of the joins it adds to your query, so that they can't be referenced by other parts of the query. For example, the query below uses joinedload() to create a LEFT OUTER JOIN from users to

addresses, however the ORDER BY added against Address.email_address is not valid - the Address entity is not named in the query:

```
>>> jack = session.query(User).\
... options(joinedload(User.addresses)).\
... filter(User.name=='jack').\
... order_by(Address.email_address).all()
SELECT addresses_1.id AS addresses_1_id, addresses_1.email_address AS addresses_1_email_address,
addresses_1.user_id AS addresses_1_user_id, users.id AS users_id, users.name AS users_name,
users.fullname AS users_fullname, users.password AS users_password
FROM users LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = ? ORDER BY addresses.email_address   <-- this part is wrong !
['jack']
```

Above, ORDER BY addresses.email_address is not valid since addresses is not in the FROM list. The correct way to load the User records and order by email address is to use Query.join():

```
>>> jack = session.query(User).\
... join(User.addresses).\
... filter(User.name=='jack').\
... order_by(Address.email_address).all()

SELECT users.id AS users_id, users.name AS users_name,
users.fullname AS users_fullname, users.password AS users_password
FROM users JOIN addresses ON users.id = addresses.user_id
WHERE users.name = ? ORDER BY addresses.email_address
['jack']
```

The statement above is of course not the same as the previous one, in that the columns from addresses are not included in the result at all. We can add joinedload() back in, so that there are two joins - one is that which we are ordering on, the other is used anonymously to load the contents of the User.addresses collection:

```
>>> jack = session.query(User).\
... join(User.addresses).\
... options(joinedload(User.addresses)).\
... filter(User.name=='jack').\
... order_by(Address.email_address).all()
SELECT addresses_1.id AS addresses_1_id, addresses_1.email_address AS addresses_1_email_address,
addresses_1.user_id AS addresses_1_user_id, users.id AS users_id, users.name AS users_name,
users.fullname AS users_fullname, users.password AS users_password
FROM users JOIN addresses ON users.id = addresses.user_id
LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = ? ORDER BY addresses.email_address
['jack']
```

What we see above is that our usage of Query.join() is to supply JOIN clauses we'd like to use in subsequent query criterion, whereas our usage of joinedload() only concerns itself with the loading of the User.addresses collection, for each User in the result. In this case, the two joins most probably appear redundant - which they are. If we wanted to use just one JOIN for collection loading as well as ordering, we use the contains_eager() option, described in *Routing Explicit Joins/Statements into Eagerly Loaded Collections* below. But to see why joinedload() does what it does, consider if we were **filtering** on a particular Address:

```
>>> jack = session.query(User).\
... join(User.addresses).\
... options(joinedload(User.addresses)).\
... filter(User.name=='jack').\
```

```
... filter(Address.email_address=='someaddress@foo.com').\
... all()
SELECT addresses_1.id AS addresses_1_id, addresses_1.email_address AS addresses_1_email_address,
addresses_1.user_id AS addresses_1_user_id, users.id AS users_id, users.name AS users_name,
users.fullname AS users_fullname, users.password AS users_password
FROM users JOIN addresses ON users.id = addresses.user_id
LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = ? AND addresses.email_address = ?
['jack', 'someaddress@foo.com']
```

Above, we can see that the two JOINs have very different roles. One will match exactly one row, that of the join of `User` and `Address` where `Address.email_address=='someaddress@foo.com'`. The other LEFT OUTER JOIN will match *all* `Address` rows related to `User`, and is only used to populate the `User.addresses` collection, for those `User` objects that are returned.

By changing the usage of `joinedload()` to another style of loading, we can change how the collection is loaded completely independently of SQL used to retrieve the actual `User` rows we want. Below we change `joinedload()` into `subqueryload()`:

```
>>> jack = session.query(User).\
... join(User.addresses).\
... options(subqueryload(User.addresses)).\
... filter(User.name=='jack').\
... filter(Address.email_address=='someaddress@foo.com').\
... all()
SELECT users.id AS users_id, users.name AS users_name,
users.fullname AS users_fullname, users.password AS users_password
FROM users JOIN addresses ON users.id = addresses.user_id
WHERE users.name = ? AND addresses.email_address = ?
['jack', 'someaddress@foo.com']

# ... subqueryload() emits a SELECT in order
# to load all address records ...
```

When using joined eager loading, if the query contains a modifier that impacts the rows returned externally to the joins, such as when using DISTINCT, LIMIT, OFFSET or equivalent, the completed statement is first wrapped inside a subquery, and the joins used specifically for joined eager loading are applied to the subquery. SQLAlchemy's joined eager loading goes the extra mile, and then ten miles further, to absolutely ensure that it does not affect the end result of the query, only the way collections and related objects are loaded, no matter what the format of the query is.

2.8.4 What Kind of Loading to Use ?

Which type of loading to use typically comes down to optimizing the tradeoff between number of SQL executions, complexity of SQL emitted, and amount of data fetched. Lets take two examples, a `relationship()` which references a collection, and a `relationship()` that references a scalar many-to-one reference.

- One to Many Collection
- When using the default lazy loading, if you load 100 objects, and then access a collection on each of them, a total of 101 SQL statements will be emitted, although each statement will typically be a simple SELECT without any joins.
- When using joined loading, the load of 100 objects and their collections will emit only one SQL statement. However, the total number of rows fetched will be equal to the sum of the size of all the collections, plus one extra row for each parent object that has an empty collection. Each row will also contain the full set of columns represented by the parents, repeated for each collection item - SQLAlchemy does not re-fetch these columns

other than those of the primary key, however most DBAPIs (with some exceptions) will transmit the full data of each parent over the wire to the client connection in any case. Therefore joined eager loading only makes sense when the size of the collections are relatively small. The LEFT OUTER JOIN can also be performance intensive compared to an INNER join.

- When using subquery loading, the load of 100 objects will emit two SQL statements. The second statement will fetch a total number of rows equal to the sum of the size of all collections. An INNER JOIN is used, and a minimum of parent columns are requested, only the primary keys. So a subquery load makes sense when the collections are larger.
- When multiple levels of depth are used with joined or subquery loading, loading collections-within- collections will multiply the total number of rows fetched in a cartesian fashion. Both forms of eager loading always join from the original parent class.
- Many to One Reference
- When using the default lazy loading, a load of 100 objects will like in the case of the collection emit as many as 101 SQL statements. However - there is a significant exception to this, in that if the many-to-one reference is a simple foreign key reference to the target's primary key, each reference will be checked first in the current identity map using `Query.get()`. So here, if the collection of objects references a relatively small set of target objects, or the full set of possible target objects have already been loaded into the session and are strongly referenced, using the default of *lazy='select'* is by far the most efficient way to go.
- When using joined loading, the load of 100 objects will emit only one SQL statement. The join will be a LEFT OUTER JOIN, and the total number of rows will be equal to 100 in all cases. If you know that each parent definitely has a child (i.e. the foreign key reference is NOT NULL), the joined load can be configured with `innerjoin=True`, which is usually specified within the `relationship()`. For a load of objects where there are many possible target references which may have not been loaded already, joined loading with an INNER JOIN is extremely efficient.
- Subquery loading will issue a second load for all the child objects, so for a load of 100 objects there would be two SQL statements emitted. There's probably not much advantage here over joined loading, however, except perhaps that subquery loading can use an INNER JOIN in all cases whereas joined loading requires that the foreign key is NOT NULL.

2.8.5 Routing Explicit Joins/Statements into Eagerly Loaded Collections

The behavior of `joinedload()` is such that joins are created automatically, using anonymous aliases as targets, the results of which are routed into collections and scalar references on loaded objects. It is often the case that a query already includes the necessary joins which represent a particular collection or scalar reference, and the joins added by the joinedload feature are redundant - yet you'd still like the collections/references to be populated.

For this SQLAlchemy supplies the `contains_eager()` option. This option is used in the same manner as the `joinedload()` option except it is assumed that the `Query` will specify the appropriate joins explicitly. Below it's used with a `from_statement` load:

```
# mapping is the users->addresses mapping
mapper(User, users_table, properties={
    'addresses': relationship(Address, addresses_table)
})

# define a query on USERS with an outer join to ADDRESSES
statement = users_table.outerjoin(addresses_table).select().apply_labels()

# construct a Query object which expects the "addresses" results
query = session.query(User).options(contains_eager('addresses'))
```

```
# get results normally
r = query.from_statement(statement)
```

It works just as well with an inline `Query.join()` or `Query.outerjoin()`:

```
session.query(User).outerjoin(User.addresses).options(contains_eager(User.addresses)).all()
```

If the "eager" portion of the statement is "aliased", the `alias` keyword argument to `contains_eager()` may be used to indicate it. This is a string alias name or reference to an actual `Alias` (or other selectable) object:

```
# use an alias of the Address entity
adalias = aliased(Address)

# construct a Query object which expects the "addresses" results
query = session.query(User).\
    outerjoin(adalias, User.addresses).\
    options(contains_eager(User.addresses, alias=adalias))

# get results normally
r = query.all()
SELECT users.user_id AS users_user_id, users.user_name AS users_user_name, adalias.address_id AS adal
adalias.user_id AS adalias_user_id, adalias.email_address AS adalias_email_address, (...other columns
FROM users LEFT OUTER JOIN email_addresses AS email_addresses_1 ON users.user_id = email_addresses_1.
```

The `alias` argument is used only as a source of columns to match up to the result set. You can use it to match up the result to arbitrary label names in a string SQL statement, by passing a `select()` which links those labels to the mapped `Table`:

```
# label the columns of the addresses table
eager_columns = select([
                    addresses.c.address_id.label('a1'),
                    addresses.c.email_address.label('a2'),
                    addresses.c.user_id.label('a3')])

# select from a raw SQL statement which uses those label names for the
# addresses table.  contains_eager() matches them up.
query = session.query(User).\
    from_statement("select users.*, addresses.address_id as a1, "
            "addresses.email_address as a2, addresses.user_id as a3 "
            "from users left outer join addresses on users.user_id=addresses.user_id").\
    options(contains_eager(User.addresses, alias=eager_columns))
```

The path given as the argument to `contains_eager()` needs to be a full path from the starting entity. For example if we were loading `Users->orders->Order->items->Item`, the string version would look like:

```
query(User).options(contains_eager('orders', 'items'))
```

Or using the class-bound descriptor:

```
query(User).options(contains_eager(User.orders, Order.items))
```

2.8.6 Relation Loader API

sqlalchemy.orm.**contains_alias**(*alias*)
Return a MapperOption that will indicate to the query that the main table has been aliased.

This is used in the very rare case that contains_eager() is being used in conjunction with a user-defined SELECT statement that aliases the parent table. E.g.:

```
# define an aliased UNION called 'ulist'
statement = users.select(users.c.user_id==7).\
                union(users.select(users.c.user_id>7)).\
                alias('ulist')

# add on an eager load of "addresses"
statement = statement.outerjoin(addresses).\
                select().apply_labels()

# create query, indicating "ulist" will be an
# alias for the main table, "addresses"
# property should be eager loaded
query = session.query(User).options(
                        contains_alias('ulist'),
                        contains_eager('addresses'))

# then get results via the statement
results = query.from_statement(statement).all()
```

Parameters **alias** – is the string name of an alias, or a Alias object representing the alias.

sqlalchemy.orm.**contains_eager**(**keys*, ***kwargs*)
Return a MapperOption that will indicate to the query that the given attribute should be eagerly loaded from columns currently in the query.

Used with options().

The option is used in conjunction with an explicit join that loads the desired rows, i.e.:

```
sess.query(Order).\
        join(Order.user).\
        options(contains_eager(Order.user))
```

The above query would join from the Order entity to its related User entity, and the returned Order objects would have the Order.user attribute pre-populated.

contains_eager() also accepts an *alias* argument, which is the string name of an alias, an alias() construct, or an aliased() construct. Use this when the eagerly-loaded rows are to come from an aliased table:

```
user_alias = aliased(User)
sess.query(Order).\
        join((user_alias, Order.user)).\
        options(contains_eager(Order.user, alias=user_alias))
```

See also eagerload() for the "automatic" version of this functionality.

For additional examples of contains_eager() see *Routing Explicit Joins/Statements into Eagerly Loaded Collections*.

sqlalchemy.orm.**eagerload**(**args*, ***kwargs*)
A synonym for joinedload().

sqlalchemy.orm.**eagerload_all**(**args*, ***kwargs*)
A synonym for joinedload_all()

sqlalchemy.orm.**immediateload**(**keys*)
Return a MapperOption that will convert the property of the given name or series of mapped attributes into an immediate load.

The "immediate" load means the attribute will be fetched with a separate SELECT statement per parent in the same way as lazy loading - except the loader is guaranteed to be called at load time before the parent object is returned in the result.

The normal behavior of lazy loading applies - if the relationship is a simple many-to-one, and the child object is already present in the Session, no SELECT statement will be emitted.

Used with options().

See also: lazyload(), eagerload(), subqueryload()

New in version 0.6.5.

sqlalchemy.orm.**joinedload**(**keys*, ***kw*)
Return a MapperOption that will convert the property of the given name or series of mapped attributes into an joined eager load.

Changed in version 0.6beta3: This function is known as eagerload() in all versions of SQLAlchemy prior to version 0.6beta3, including the 0.5 and 0.4 series. eagerload() will remain available for the foreseeable future in order to enable cross-compatibility.

Used with options().

examples:

```
# joined-load the "orders" collection on "User"
query(User).options(joinedload(User.orders))

# joined-load the "keywords" collection on each "Item",
# but not the "items" collection on "Order" - those
# remain lazily loaded.
query(Order).options(joinedload(Order.items, Item.keywords))

# to joined-load across both, use joinedload_all()
query(Order).options(joinedload_all(Order.items, Item.keywords))

# set the default strategy to be 'joined'
query(Order).options(joinedload('*'))
```

joinedload() also accepts a keyword argument *innerjoin=True* which indicates using an inner join instead of an outer:

```
query(Order).options(joinedload(Order.user, innerjoin=True))
```

Note: The join created by joinedload() is anonymously aliased such that it **does not affect the query results**. An Query.order_by() or Query.filter() call **cannot** reference these aliased tables - so-called "user space" joins are constructed using Query.join(). The rationale for this is that joinedload() is only applied in order to affect how related objects or collections are loaded as an optimizing detail - it can be added or removed with no impact on actual results. See the section *The Zen of Eager Loading* for a detailed description of how this is used, including how to use a single explicit JOIN for filtering/ordering and eager loading simultaneously.

See also: subqueryload(), lazyload()

sqlalchemy.orm.**joinedload_all**(**keys*, ***kw*)

Return a MapperOption that will convert all properties along the given dot-separated path or series of mapped attributes into an joined eager load.

Changed in version 0.6beta3: This function is known as eagerload_all() in all versions of SQLAlchemy prior to version 0.6beta3, including the 0.5 and 0.4 series. eagerload_all() will remain available for the foreseeable future in order to enable cross-compatibility.

Used with options().

For example:

```
query.options(joinedload_all('orders.items.keywords')).
```

will set all of orders, orders.items, and orders.items.keywords to load in one joined eager load.

Individual descriptors are accepted as arguments as well:

```
query.options(joinedload_all(User.orders, Order.items, Item.keywords))
```

The keyword arguments accept a flag *innerjoin=True|False* which will override the value of the *innerjoin* flag specified on the relationship().

See also: subqueryload_all(), lazyload()

sqlalchemy.orm.**lazyload**(**keys*)

Return a MapperOption that will convert the property of the given name or series of mapped attributes into a lazy load.

Used with options().

See also: eagerload(), subqueryload(), immediateload()

sqlalchemy.orm.**noload**(**keys*)

Return a MapperOption that will convert the property of the given name or series of mapped attributes into a non-load.

Used with options().

See also: lazyload(), eagerload(), subqueryload(), immediateload()

sqlalchemy.orm.**subqueryload**(**keys*)

Return a MapperOption that will convert the property of the given name or series of mapped attributes into an subquery eager load.

Used with options().

examples:

```
# subquery-load the "orders" collection on "User"
query(User).options(subqueryload(User.orders))

# subquery-load the "keywords" collection on each "Item",
# but not the "items" collection on "Order" - those
# remain lazily loaded.
query(Order).options(subqueryload(Order.items, Item.keywords))

# to subquery-load across both, use subqueryload_all()
query(Order).options(subqueryload_all(Order.items, Item.keywords))

# set the default strategy to be 'subquery'
query(Order).options(subqueryload('*'))
```

See also: joinedload(), lazyload()

sqlalchemy.orm.**subqueryload_all**(**keys*)
Return a MapperOption that will convert all properties along the given dot-separated path or series of mapped attributes into a subquery eager load.

Used with options().

For example:

```
query.options(subqueryload_all('orders.items.keywords'))...
```

will set all of orders, orders.items, and orders.items.keywords to load in one subquery eager load.

Individual descriptors are accepted as arguments as well:

```
query.options(subqueryload_all(User.orders, Order.items,
Item.keywords))
```

See also: joinedload_all(), lazyload(), immediateload()

2.9 ORM Events

The ORM includes a wide variety of hooks available for subscription.

New in version 0.7: The event supercedes the previous system of "extension" classes.

For an introduction to the event API, see *Events*. Non-ORM events such as those regarding connections and low-level statement execution are described in *Core Events*.

2.9.1 Attribute Events

class sqlalchemy.orm.events.**AttributeEvents**
Define events for object attributes.

These are typically defined on the class-bound descriptor for the target class.

e.g.:

```
from sqlalchemy import event

def my_append_listener(target, value, initiator):
    print "received append event for target: %s" % target

event.listen(MyClass.collection, 'append', my_append_listener)
```

Listeners have the option to return a possibly modified version of the value, when the retval=True flag is passed to listen():

```
def validate_phone(target, value, oldvalue, initiator):
    "Strip non-numeric characters from a phone number"

    return re.sub(r'(?![0-9])', '', value)

# setup listener on UserContact.phone attribute, instructing
# it to use the return value
listen(UserContact.phone, 'set', validate_phone, retval=True)
```

A validation function like the above can also raise an exception such as `ValueError` to halt the operation.

Several modifiers are available to the `listen()` function.

Parameters

- **active_history=False** – When True, indicates that the "set" event would like to receive the "old" value being replaced unconditionally, even if this requires firing off database loads. Note that `active_history` can also be set directly via `column_property()` and `relationship()`.
- **propagate=False** – When True, the listener function will be established not just for the class attribute given, but for attributes of the same name on all current subclasses of that class, as well as all future subclasses of that class, using an additional listener that listens for instrumentation events.
- **raw=False** – When True, the "target" argument to the event will be the `InstanceState` management object, rather than the mapped instance itself.
- **retval=False** – when True, the user-defined event listening must return the "value" argument from the function. This gives the listening function the opportunity to change the value that is ultimately used for a "set" or "append" event.

append(*target*, *value*, *initiator*)

Receive a collection append event.

Parameters

- **target** – the object instance receiving the event. If the listener is registered with `raw=True`, this will be the `InstanceState` object.
- **value** – the value being appended. If this listener is registered with `retval=True`, the listener function must return this value, or a new value which replaces it.
- **initiator** – the attribute implementation object which initiated this event.

Returns if the event was registered with `retval=True`, the given value, or a new effective value, should be returned.

remove(*target*, *value*, *initiator*)

Receive a collection remove event.

Parameters

- **target** – the object instance receiving the event. If the listener is registered with `raw=True`, this will be the `InstanceState` object.
- **value** – the value being removed.
- **initiator** – the attribute implementation object which initiated this event.

Returns No return value is defined for this event.

set(*target*, *value*, *oldvalue*, *initiator*)

Receive a scalar set event.

Parameters

- **target** – the object instance receiving the event. If the listener is registered with `raw=True`, this will be the `InstanceState` object.
- **value** – the value being set. If this listener is registered with `retval=True`, the listener function must return this value, or a new value which replaces it.

- **oldvalue** – the previous value being replaced. This may also be the symbol `NEVER_SET` or `NO_VALUE`. If the listener is registered with `active_history=True`, the previous value of the attribute will be loaded from the database if the existing value is currently unloaded or expired.
- **initiator** – the attribute implementation object which initiated this event.

Returns if the event was registered with `retval=True`, the given value, or a new effective value, should be returned.

2.9.2 Mapper Events

class `sqlalchemy.orm.events.`**`MapperEvents`**

Define events specific to mappings.

e.g.:

```
from sqlalchemy import event

def my_before_insert_listener(mapper, connection, target):
    # execute a stored procedure upon INSERT,
    # apply the value to the row to be inserted
    target.calculated_value = connection.scalar(
                                  "select my_special_function(%d)"
                                  % target.special_number)

# associate the listener function with SomeMappedClass,
# to execute during the "before_insert" hook
event.listen(SomeMappedClass, 'before_insert', my_before_insert_listener)
```

Available targets include mapped classes, instances of `Mapper` (i.e. returned by `mapper()`, `class_mapper()` and similar), as well as the `Mapper` class and `mapper()` function itself for global event reception:

```
from sqlalchemy.orm import mapper

def some_listener(mapper, connection, target):
    log.debug("Instance %s being inserted" % target)

# attach to all mappers
event.listen(mapper, 'before_insert', some_listener)
```

Mapper events provide hooks into critical sections of the mapper, including those related to object instrumentation, object loading, and object persistence. In particular, the persistence methods `before_insert()`, and `before_update()` are popular places to augment the state being persisted - however, these methods operate with several significant restrictions. The user is encouraged to evaluate the `SessionEvents.before_flush()` and `SessionEvents.after_flush()` methods as more flexible and user-friendly hooks in which to apply additional database state during a flush.

When using `MapperEvents`, several modifiers are available to the `event.listen()` function.

Parameters

- **propagate=False** – When True, the event listener should be applied to all inheriting mappers as well as the mapper which is the target of this listener.
- **raw=False** – When True, the "target" argument passed to applicable event listener functions will be the instance's `InstanceState` management object, rather than the mapped instance itself.

- **retval=False** – when True, the user-defined event function must have a return value, the purpose of which is either to control subsequent event propagation, or to otherwise alter the operation in progress by the mapper. Possible return values are:
  - `sqlalchemy.orm.interfaces.EXT_CONTINUE` - continue event processing normally.
  - `sqlalchemy.orm.interfaces.EXT_STOP` - cancel all subsequent event handlers in the chain.
  - other values - the return value specified by specific listeners, such as `translate_row()` or `create_instance()`.

after_configured()
Called after a series of mappers have been configured.

This corresponds to the `orm.configure_mappers()` call, which note is usually called automatically as mappings are first used.

Theoretically this event is called once per application, but is actually called any time new mappers have been affected by a `orm.configure_mappers()` call. If new mappings are constructed after existing ones have already been used, this event can be called again.

after_delete(*mapper*, *connection*, *target*)
Receive an object instance after a DELETE statement has been emitted corresponding to that instance.

This event is used to emit additional SQL statements on the given connection as well as to perform application specific bookkeeping related to a deletion event.

The event is often called for a batch of objects of the same class after their DELETE statements have been emitted at once in a previous step.

> **Warning:** Mapper-level flush events are designed to operate **on attributes local to the immediate object being handled and via SQL operations with the given** `Connection` **only.** Handlers here should **not** make alterations to the state of the `Session` overall, and in general should not affect any `relationship()` -mapped attributes, as session cascade rules will not function properly, nor is it always known if the related class has already been handled. Operations that **are not supported in mapper events** include:
> - `Session.add()`
> - `Session.delete()`
> - Mapped collection append, add, remove, delete, discard, etc.
> - Mapped relationship attribute set/del events, i.e. `someobject.related = someotherobject`
>
> Operations which manipulate the state of the object relative to other objects are better handled:
> - In the `__init__()` method of the mapped object itself, or another method designed to establish some particular state.
> - In a `@validates` handler, see *Simple Validators*
> - Within the `SessionEvents.before_flush()` event.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **connection** – the `Connection` being used to emit DELETE statements for this instance. This provides a handle into the current transaction on the target database specific to this instance.
- **target** – the mapped instance being deleted. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

Returns No return value is supported by this event.

after_insert(*mapper*, *connection*, *target*)
Receive an object instance after an INSERT statement is emitted corresponding to that instance.

This event is used to modify in-Python-only state on the instance after an INSERT occurs, as well as to emit additional SQL statements on the given connection.

The event is often called for a batch of objects of the same class after their INSERT statements have been emitted at once in a previous step. In the extremely rare case that this is not desirable, the `mapper()` can be configured with `batch=False`, which will cause batches of instances to be broken up into individual (and more poorly performing) event->persist->event steps.

Warning: Mapper-level flush events are designed to operate **on attributes local to the immediate object being handled and via SQL operations with the given `Connection` only.** Handlers here should **not** make alterations to the state of the `Session` overall, and in general should not affect any `relationship()` -mapped attributes, as session cascade rules will not function properly, nor is it always known if the related class has already been handled. Operations that **are not supported in mapper events** include:

- `Session.add()`
- `Session.delete()`
- Mapped collection append, add, remove, delete, discard, etc.
- Mapped relationship attribute set/del events, i.e. `someobject.related = someotherobject`

Operations which manipulate the state of the object relative to other objects are better handled:

- In the `__init__()` method of the mapped object itself, or another method designed to establish some particular state.
- In a `@validates` handler, see *Simple Validators*
- Within the `SessionEvents.before_flush()` event.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **connection** – the `Connection` being used to emit INSERT statements for this instance. This provides a handle into the current transaction on the target database specific to this instance.
- **target** – the mapped instance being persisted. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

Returns No return value is supported by this event.

after_update(*mapper*, *connection*, *target*)
Receive an object instance after an UPDATE statement is emitted corresponding to that instance.

This event is used to modify in-Python-only state on the instance after an UPDATE occurs, as well as to emit additional SQL statements on the given connection.

This method is called for all instances that are marked as "dirty", *even those which have no net changes to their column-based attributes*, and for which no UPDATE statement has proceeded. An object is marked as dirty when any of its column-based attributes have a "set attribute" operation called or when any of its collections are modified. If, at update time, no column-based attributes have any net changes, no UPDATE statement will be issued. This means that an instance being sent to `after_update()` is *not* a guarantee that an UPDATE statement has been issued.

To detect if the column-based attributes on the object have net changes, and therefore resulted in an UPDATE statement, use `object_session(instance).is_modified(instance, include_collections=False)`.

The event is often called for a batch of objects of the same class after their UPDATE statements have been emitted at once in a previous step. In the extremely rare case that this is not desirable, the `mapper()` can be configured with `batch=False`, which will cause batches of instances to be broken up into individual (and more poorly performing) event->persist->event steps.

Warning: Mapper-level flush events are designed to operate **on attributes local to the immediate object being handled and via SQL operations with the given `Connection` only.** Handlers here should **not** make alterations to the state of the `Session` overall, and in general should not affect any `relationship()` -mapped attributes, as session cascade rules will not function properly, nor is it always known if the related class has already been handled. Operations that **are not supported in mapper events** include:

- `Session.add()`
- `Session.delete()`
- Mapped collection append, add, remove, delete, discard, etc.
- Mapped relationship attribute set/del events, i.e. `someobject.related = someotherobject`

Operations which manipulate the state of the object relative to other objects are better handled:

- In the `__init__()` method of the mapped object itself, or another method designed to establish some particular state.
- In a `@validates` handler, see *Simple Validators*
- Within the `SessionEvents.before_flush()` event.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **connection** – the `Connection` being used to emit UPDATE statements for this instance. This provides a handle into the current transaction on the target database specific to this instance.
- **target** – the mapped instance being persisted. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

Returns No return value is supported by this event.

`append_result`(*mapper*, *context*, *row*, *target*, *result*, ***flags*)

Receive an object instance before that instance is appended to a result list.

This is a rarely used hook which can be used to alter the construction of a result list returned by `Query`.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **context** – the `QueryContext`, which includes a handle to the current `Query` in progress as well as additional state information.
- **row** – the result row being handled. This may be an actual `RowProxy` or may be a dictionary containing `Column` objects as keys.
- **target** – the mapped instance being populated. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.
- **result** – a list-like object where results are being appended.
- ****flags** – Additional state information about the current handling of the row.

Returns If this method is registered with `retval=True`, a return value of `EXT_STOP` will prevent the instance from being appended to the given result list, whereas a return value

of EXT_CONTINUE will result in the default behavior of appending the value to the result list.

before_delete(*mapper*, *connection*, *target*)

Receive an object instance before a DELETE statement is emitted corresponding to that instance.

This event is used to emit additional SQL statements on the given connection as well as to perform application specific bookkeeping related to a deletion event.

The event is often called for a batch of objects of the same class before their DELETE statements are emitted at once in a later step.

Warning: Mapper-level flush events are designed to operate **on attributes local to the immediate object being handled and via SQL operations with the given** Connection **only.** Handlers here should **not** make alterations to the state of the Session overall, and in general should not affect any relationship() -mapped attributes, as session cascade rules will not function properly, nor is it always known if the related class has already been handled. Operations that **are not supported in mapper events** include:

- Session.add()
- Session.delete()
- Mapped collection append, add, remove, delete, discard, etc.
- Mapped relationship attribute set/del events, i.e. someobject.related = someotherobject

Operations which manipulate the state of the object relative to other objects are better handled:

- In the __init__() method of the mapped object itself, or another method designed to establish some particular state.
- In a @validates handler, see *Simple Validators*
- Within the SessionEvents.before_flush() event.

Parameters

- **mapper** – the Mapper which is the target of this event.
- **connection** – the Connection being used to emit DELETE statements for this instance. This provides a handle into the current transaction on the target database specific to this instance.
- **target** – the mapped instance being deleted. If the event is configured with raw=True, this will instead be the InstanceState state-management object associated with the instance.

Returns No return value is supported by this event.

before_insert(*mapper*, *connection*, *target*)

Receive an object instance before an INSERT statement is emitted corresponding to that instance.

This event is used to modify local, non-object related attributes on the instance before an INSERT occurs, as well as to emit additional SQL statements on the given connection.

The event is often called for a batch of objects of the same class before their INSERT statements are emitted at once in a later step. In the extremely rare case that this is not desirable, the mapper() can be configured with batch=False, which will cause batches of instances to be broken up into individual (and more poorly performing) event->persist->event steps.

Warning: Mapper-level flush events are designed to operate **on attributes local to the immediate object being handled and via SQL operations with the given** `Connection` **only.** Handlers here should **not** make alterations to the state of the `Session` overall, and in general should not affect any `relationship()` -mapped attributes, as session cascade rules will not function properly, nor is it always known if the related class has already been handled. Operations that **are not supported in mapper events** include:

- `Session.add()`
- `Session.delete()`
- Mapped collection append, add, remove, delete, discard, etc.
- Mapped relationship attribute set/del events, i.e. `someobject.related = someotherobject`

Operations which manipulate the state of the object relative to other objects are better handled:

- In the `__init__()` method of the mapped object itself, or another method designed to establish some particular state.
- In a `@validates` handler, see *Simple Validators*
- Within the `SessionEvents.before_flush()` event.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **connection** – the `Connection` being used to emit INSERT statements for this instance. This provides a handle into the current transaction on the target database specific to this instance.
- **target** – the mapped instance being persisted. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

Returns No return value is supported by this event.

before_update(*mapper*, *connection*, *target*)

Receive an object instance before an UPDATE statement is emitted corresponding to that instance.

This event is used to modify local, non-object related attributes on the instance before an UPDATE occurs, as well as to emit additional SQL statements on the given connection.

This method is called for all instances that are marked as "dirty", *even those which have no net changes to their column-based attributes*. An object is marked as dirty when any of its column-based attributes have a "set attribute" operation called or when any of its collections are modified. If, at update time, no column-based attributes have any net changes, no UPDATE statement will be issued. This means that an instance being sent to `before_update()` is *not* a guarantee that an UPDATE statement will be issued, although you can affect the outcome here by modifying attributes so that a net change in value does exist.

To detect if the column-based attributes on the object have net changes, and will therefore generate an UPDATE statement, use `object_session(instance).is_modified(instance, include_collections=False)`.

The event is often called for a batch of objects of the same class before their UPDATE statements are emitted at once in a later step. In the extremely rare case that this is not desirable, the `mapper()` can be configured with `batch=False`, which will cause batches of instances to be broken up into individual (and more poorly performing) event->persist->event steps.

Warning: Mapper-level flush events are designed to operate **on attributes local to the immediate object being handled and via SQL operations with the given** `Connection` **only.** Handlers here should **not** make alterations to the state of the `Session` overall, and in general should not affect any `relationship()` -mapped attributes, as session cascade rules will not function properly, nor is it always known if the related class has already been handled. Operations that **are not supported in mapper events** include:

- `Session.add()`
- `Session.delete()`
- Mapped collection append, add, remove, delete, discard, etc.
- Mapped relationship attribute set/del events, i.e. `someobject.related = someotherobject`

Operations which manipulate the state of the object relative to other objects are better handled:

- In the `__init__()` method of the mapped object itself, or another method designed to establish some particular state.
- In a `@validates` handler, see *Simple Validators*
- Within the `SessionEvents.before_flush()` event.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **connection** – the `Connection` being used to emit UPDATE statements for this instance. This provides a handle into the current transaction on the target database specific to this instance.
- **target** – the mapped instance being persisted. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

Returns No return value is supported by this event.

`create_instance` (*mapper*, *context*, *row*, *class_*)

Receive a row when a new object instance is about to be created from that row.

The method can choose to create the instance itself, or it can return EXT_CONTINUE to indicate normal object creation should take place. This listener is typically registered with `retval=True`.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **context** – the `QueryContext`, which includes a handle to the current `Query` in progress as well as additional state information.
- **row** – the result row being handled. This may be an actual `RowProxy` or may be a dictionary containing `Column` objects as keys.
- **class_** – the mapped class.

Returns When configured with `retval=True`, the return value should be a newly created instance of the mapped class, or `EXT_CONTINUE` indicating that default object construction should take place.

`instrument_class` (*mapper*, *class_*)

Receive a class when the mapper is first constructed, before instrumentation is applied to the mapped class.

This event is the earliest phase of mapper construction. Most attributes of the mapper are not yet initialized.

This listener can generally only be applied to the `Mapper` class overall.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **class_** – the mapped class.

mapper_configured(*mapper*, *class_*)
Called when the mapper for the class is fully configured.

This event is the latest phase of mapper construction, and is invoked when the mapped classes are first used, so that relationships between mappers can be resolved. When the event is called, the mapper should be in its final state.

While the configuration event normally occurs automatically, it can be forced to occur ahead of time, in the case where the event is needed before any actual mapper usage, by using the `configure_mappers()` function.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **class_** – the mapped class.

populate_instance(*mapper*, *context*, *row*, *target*, ***flags*)
Receive an instance before that instance has its attributes populated.

This usually corresponds to a newly loaded instance but may also correspond to an already-loaded instance which has unloaded attributes to be populated. The method may be called many times for a single instance, as multiple result rows are used to populate eagerly loaded collections.

Most usages of this hook are obsolete. For a generic "object has been newly created from a row" hook, use `InstanceEvents.load()`.

Parameters

- **mapper** – the `Mapper` which is the target of this event.
- **context** – the `QueryContext`, which includes a handle to the current `Query` in progress as well as additional state information.
- **row** – the result row being handled. This may be an actual `RowProxy` or may be a dictionary containing `Column` objects as keys.
- **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

Returns When configured with `retval=True`, a return value of `EXT_STOP` will bypass instance population by the mapper. A value of `EXT_CONTINUE` indicates that default instance population should take place.

translate_row(*mapper*, *context*, *row*)
Perform pre-processing on the given result row and return a new row instance.

This listener is typically registered with `retval=True`. It is called when the mapper first receives a row, before the object identity or the instance itself has been derived from that row. The given row may or may not be a `RowProxy` object - it will always be a dictionary-like object which contains mapped columns as keys. The returned object should also be a dictionary-like object which recognizes mapped columns as keys.

Parameters

- **mapper** – the `Mapper` which is the target of this event.

- **context** – the `QueryContext`, which includes a handle to the current `Query` in progress as well as additional state information.
- **row** – the result row being handled. This may be an actual `RowProxy` or may be a dictionary containing `Column` objects as keys.

Returns When configured with `retval=True`, the function should return a dictionary-like row object, or `EXT_CONTINUE`, indicating the original row should be used.

2.9.3 Instance Events

class `sqlalchemy.orm.events.`**`InstanceEvents`**

Define events specific to object lifecycle.

e.g.:

```
from sqlalchemy import event

def my_load_listener(target, context):
    print "on load!"

event.listen(SomeMappedClass, 'load', my_load_listener)
```

Available targets include mapped classes, instances of `Mapper` (i.e. returned by `mapper()`, `class_mapper()` and similar), as well as the `Mapper` class and `mapper()` function itself for global event reception:

```
from sqlalchemy.orm import mapper

def some_listener(target, context):
    log.debug("Instance %s being loaded" % target)

# attach to all mappers
event.listen(mapper, 'load', some_listener)
```

Instance events are closely related to mapper events, but are more specific to the instance and its instrumentation, rather than its system of persistence.

When using `InstanceEvents`, several modifiers are available to the `event.listen()` function.

Parameters

- **propagate=False** – When True, the event listener should be applied to all inheriting mappers as well as the mapper which is the target of this listener.
- **raw=False** – When True, the "target" argument passed to applicable event listener functions will be the instance's `InstanceState` management object, rather than the mapped instance itself.

`expire`(*target*, *attrs*)

Receive an object instance after its attributes or some subset have been expired.

'keys' is a list of attribute names. If None, the entire state was expired.

Parameters

- **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

- **attrs** – iterable collection of attribute names which were expired, or None if all attributes were expired.

first_init(*manager*, *cls*)
Called when the first instance of a particular mapping is called.

init(*target*, *args*, *kwargs*)
Receive an instance when it's constructor is called.

This method is only called during a userland construction of an object. It is not called when an object is loaded from the database.

init_failure(*target*, *args*, *kwargs*)
Receive an instance when it's constructor has been called, and raised an exception.

This method is only called during a userland construction of an object. It is not called when an object is loaded from the database.

load(*target*, *context*)
Receive an object instance after it has been created via `__new__`, and after initial attribute population has occurred.

This typically occurs when the instance is created based on incoming result rows, and is only called once for that instance's lifetime.

Note that during a result-row load, this method is called upon the first row received for this instance. Note that some attributes and collections may or may not be loaded or even initialized, depending on what's present in the result rows.

Parameters

- **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.
- **context** – the `QueryContext` corresponding to the current `Query` in progress. This argument may be `None` if the load does not correspond to a `Query`, such as during `Session.merge()`.

pickle(*target*, *state_dict*)
Receive an object instance when its associated state is being pickled.

Parameters

- **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.
- **state_dict** – the dictionary returned by `InstanceState.__getstate__`, containing the state to be pickled.

refresh(*target*, *context*, *attrs*)
Receive an object instance after one or more attributes have been refreshed from a query.

Parameters

- **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.
- **context** – the `QueryContext` corresponding to the current `Query` in progress.
- **attrs** – iterable collection of attribute names which were populated, or None if all column-mapped, non-deferred attributes were populated.

resurrect (*target*)
Receive an object instance as it is 'resurrected' from garbage collection, which occurs when a "dirty" state falls out of scope.

Parameters **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.

unpickle (*target*, *state_dict*)
Receive an object instance after it's associated state has been unpickled.

Parameters

- **target** – the mapped instance. If the event is configured with `raw=True`, this will instead be the `InstanceState` state-management object associated with the instance.
- **state_dict** – the dictionary sent to `InstanceState.__setstate__`, containing the state dictionary which was pickled.

2.9.4 Session Events

class sqlalchemy.orm.events.**SessionEvents**
Define events specific to `Session` lifecycle.

e.g.:

```
from sqlalchemy import event
from sqlalchemy.orm import sessionmaker

def my_before_commit(session):
    print "before commit!"

Session = sessionmaker()

event.listen(Session, "before_commit", my_before_commit)
```

The `listen()` function will accept `Session` objects as well as the return result of `sessionmaker()` and `scoped_session()`.

Additionally, it accepts the `Session` class which will apply listeners to all `Session` instances globally.

after_attach (*session*, *instance*)
Execute after an instance is attached to a session.

This is called after an add, delete or merge.

after_begin (*session*, *transaction*, *connection*)
Execute after a transaction is begun on a connection

Parameters

- **session** – The target `Session`.
- **transaction** – The `SessionTransaction`.
- **connection** – The `Connection` object which will be used for SQL statements.

after_bulk_delete (*session*, *query*, *query_context*, *result*)
Execute after a bulk delete operation to the session.

This is called as a result of the `Query.delete()` method.

Parameters

- **query** – the `Query` object that this update operation was called upon.
- **query_context** – The `QueryContext` object, corresponding to the invocation of an ORM query.
- **result** – the `ResultProxy` returned as a result of the bulk DELETE operation.

after_bulk_update(*session*, *query*, *query_context*, *result*)
Execute after a bulk update operation to the session.

This is called as a result of the `Query.update()` method.

Parameters

- **query** – the `Query` object that this update operation was called upon.
- **query_context** – The `QueryContext` object, corresponding to the invocation of an ORM query.
- **result** – the `ResultProxy` returned as a result of the bulk UPDATE operation.

after_commit(*session*)
Execute after a commit has occurred.

Note that this may not be per-flush if a longer running transaction is ongoing.

Parameters **session** – The target `Session`.

after_flush(*session*, *flush_context*)
Execute after flush has completed, but before commit has been called.

Note that the session's state is still in pre-flush, i.e. 'new', 'dirty', and 'deleted' lists still show pre-flush state as well as the history settings on instance attributes.

Parameters

- **session** – The target `Session`.
- **flush_context** – Internal `UOWTransaction` object which handles the details of the flush.

after_flush_postexec(*session*, *flush_context*)
Execute after flush has completed, and after the post-exec state occurs.

This will be when the 'new', 'dirty', and 'deleted' lists are in their final state. An actual commit() may or may not have occurred, depending on whether or not the flush started its own transaction or participated in a larger transaction.

Parameters

- **session** – The target `Session`.
- **flush_context** – Internal `UOWTransaction` object which handles the details of the flush.

after_rollback(*session*)
Execute after a real DBAPI rollback has occurred.

Note that this event only fires when the *actual* rollback against the database occurs - it does *not* fire each time the `Session.rollback()` method is called, if the underlying DBAPI transaction has already been rolled back. In many cases, the `Session` will not be in an "active" state during this event, as the current transaction is not valid. To acquire a `Session` which is active after the outermost rollback has proceeded, use the `SessionEvents.after_soft_rollback()` event, checking the `Session.is_active` flag.

Parameters **session** – The target `Session`.

after_soft_rollback(*session*, *previous_transaction*)
Execute after any rollback has occurred, including "soft" rollbacks that don't actually emit at the DBAPI level.

This corresponds to both nested and outer rollbacks, i.e. the innermost rollback that calls the DBAPI's rollback() method, as well as the enclosing rollback calls that only pop themselves from the transaction stack.

The given `Session` can be used to invoke SQL and `Session.query()` operations after an outermost rollback by first checking the `Session.is_active` flag:

```
@event.listens_for(Session, "after_soft_rollback")
def do_something(session, previous_transaction):
    if session.is_active:
        session.execute("select * from some_table")
```

Parameters

- **session** – The target `Session`.
- **previous_transaction** – The `SessionTransaction` transactional marker object which was just closed. The current `SessionTransaction` for the given `Session` is available via the `Session.transaction` attribute.

New in version 0.7.3.

before_commit(*session*)
Execute before commit is called.

Note that this may not be per-flush if a longer running transaction is ongoing.

Parameters **session** – The target `Session`.

before_flush(*session*, *flush_context*, *instances*)
Execute before flush process has started.

Parameters

- **session** – The target `Session`.
- **flush_context** – Internal `UOWTransaction` object which handles the details of the flush.
- **instances** – Usually `None`, this is the collection of objects which can be passed to the `Session.flush()` method (note this usage is deprecated).

2.9.5 Instrumentation Events

class `sqlalchemy.orm.events.`**InstrumentationEvents**
Events related to class instrumentation events.

The listeners here support being established against any new style class, that is any object that is a subclass of 'type'. Events will then be fired off for events against that class as well as all subclasses. 'type' itself is also accepted as a target in which case the events fire for all classes.

attribute_instrument(*cls*, *key*, *inst*)
Called when an attribute is instrumented.

class_instrument(*cls*)
Called after the given class is instrumented.

To get at the `ClassManager`, use `manager_of_class()`.

class_uninstrument(*cls*)
Called before the given class is uninstrumented.

To get at the `ClassManager`, use `manager_of_class()`.

2.9.6 Alternate Class Instrumentation

class sqlalchemy.orm.interfaces.**InstrumentationManager**(*class_*)
User-defined class instrumentation extension.

`InstrumentationManager` can be subclassed in order to change how class instrumentation proceeds. This class exists for the purposes of integration with other object management frameworks which would like to entirely modify the instrumentation methodology of the ORM, and is not intended for regular usage. For interception of class instrumentation events, see `InstrumentationEvents`.

For an example of `InstrumentationManager`, see the example *Attribute Instrumentation*.

The API for this class should be considered as semi-stable, and may change slightly with new releases.

dict_getter(*class_*)

dispose(*class_*, *manager*)

get_instance_dict(*class_*, *instance*)

initialize_instance_dict(*class_*, *instance*)

install_descriptor(*class_*, *key*, *inst*)

install_member(*class_*, *key*, *implementation*)

install_state(*class_*, *instance*, *state*)

instrument_attribute(*class_*, *key*, *inst*)

instrument_collection_class(*class_*, *key*, *collection_class*)

manage(*class_*, *manager*)

manager_getter(*class_*)

post_configure_attribute(*class_*, *key*, *inst*)

remove_state(*class_*, *instance*)

state_getter(*class_*)

uninstall_descriptor(*class_*, *key*)

uninstall_member(*class_*, *key*)

2.10 ORM Extensions

SQLAlchemy has a variety of ORM extensions available, which add additional functionality to the core behavior.

The extensions build almost entirely on public core and ORM APIs and users should be encouraged to read their source code to further their understanding of their behavior. In particular the "Horizontal Sharding", "Hybrid Attributes", and "Mutation Tracking" extensions are very succinct.

2.10.1 Association Proxy

`associationproxy` is used to create a read/write view of a target attribute across a relationship. It essentially conceals the usage of a "middle" attribute between two endpoints, and can be used to cherry-pick fields from a collection of related objects or to reduce the verbosity of using the association object pattern. Applied creatively, the association proxy allows the construction of sophisticated collections and dictionary views of virtually any geometry, persisted to the database using standard, transparently configured relational patterns.

Simplifying Scalar Collections

Consider a many-to-many mapping between two classes, `User` and `Keyword`. Each `User` can have any number of `Keyword` objects, and vice-versa (the many-to-many pattern is described at *Many To Many*):

```
from sqlalchemy import Column, Integer, String, ForeignKey, Table
from sqlalchemy.orm import relationship
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(64))
    kw = relationship("Keyword", secondary=lambda: userkeywords_table)

    def __init__(self, name):
        self.name = name

class Keyword(Base):
    __tablename__ = 'keyword'
    id = Column(Integer, primary_key=True)
    keyword = Column('keyword', String(64))

    def __init__(self, keyword):
        self.keyword = keyword

userkeywords_table = Table('userkeywords', Base.metadata,
    Column('user_id', Integer, ForeignKey("user.id"),
           primary_key=True),
    Column('keyword_id', Integer, ForeignKey("keyword.id"),
           primary_key=True)
)
```

Reading and manipulating the collection of "keyword" strings associated with `User` requires traversal from each collection element to the `.keyword` attribute, which can be awkward:

```
>>> user = User('jek')
>>> user.kw.append(Keyword('cheese inspector'))
>>> print(user.kw)
[<__main__.Keyword object at 0x12bf830>]
>>> print(user.kw[0].keyword)
cheese inspector
>>> print([keyword.keyword for keyword in user.kw])
['cheese inspector']
```

The `association_proxy` is applied to the `User` class to produce a "view" of the `kw` relationship, which only exposes the string value of `.keyword` associated with each `Keyword` object:

```
from sqlalchemy.ext.associationproxy import association_proxy

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(64))
    kw = relationship("Keyword", secondary=lambda: userkeywords_table)

    def __init__(self, name):
        self.name = name

    # proxy the 'keyword' attribute from the 'kw' relationship
    keywords = association_proxy('kw', 'keyword')
```

We can now reference the `.keywords` collection as a listing of strings, which is both readable and writable. New `Keyword` objects are created for us transparently:

```
>>> user = User('jek')
>>> user.keywords.append('cheese inspector')
>>> user.keywords
['cheese inspector']
>>> user.keywords.append('snack ninja')
>>> user.kw
[<__main__.Keyword object at 0x12cdd30>, <__main__.Keyword object at 0x12cde30>]
```

The `AssociationProxy` object produced by the `association_proxy()` function is an instance of a Python descriptor. It is always declared with the user-defined class being mapped, regardless of whether Declarative or classical mappings via the `mapper()` function are used.

The proxy functions by operating upon the underlying mapped attribute or collection in response to operations, and changes made via the proxy are immediately apparent in the mapped attribute, as well as vice versa. The underlying attribute remains fully accessible.

When first accessed, the association proxy performs introspection operations on the target collection so that its behavior corresponds correctly. Details such as if the locally proxied attribute is a collection (as is typical) or a scalar reference, as well as if the collection acts like a set, list, or dictionary is taken into account, so that the proxy should act just like the underlying collection or attribute does.

Creation of New Values

When a list append() event (or set add(), dictionary __setitem__(), or scalar assignment event) is intercepted by the association proxy, it instantiates a new instance of the "intermediary" object using its constructor, passing as a single argument the given value. In our example above, an operation like:

```
user.keywords.append('cheese inspector')
```

Is translated by the association proxy into the operation:

```
user.kw.append(Keyword('cheese inspector'))
```

The example works here because we have designed the constructor for `Keyword` to accept a single positional argument, `keyword`. For those cases where a single-argument constructor isn't feasible, the association proxy's creational behavior can be customized using the `creator` argument, which references a callable (i.e. Python function) that will produce a new object instance given the singular argument. Below we illustrate this using a lambda as is typical:

```
class User(Base):
    # ...

    # use Keyword(keyword=kw) on append() events
    keywords = association_proxy('kw', 'keyword',
                    creator=lambda kw: Keyword(keyword=kw))
```

The `creator` function accepts a single argument in the case of a list- or set- based collection, or a scalar attribute. In the case of a dictionary-based collection, it accepts two arguments, "key" and "value". An example of this is below in *Proxying to Dictionary Based Collections*.

Simplifying Association Objects

The "association object" pattern is an extended form of a many-to-many relationship, and is described at *Association Object*. Association proxies are useful for keeping "association objects" out the way during regular use.

Suppose our `userkeywords` table above had additional columns which we'd like to map explicitly, but in most cases we don't require direct access to these attributes. Below, we illustrate a new mapping which introduces the `UserKeyword` class, which is mapped to the `userkeywords` table illustrated earlier. This class adds an additional column `special_key`, a value which we occasionally want to access, but not in the usual case. We create an association proxy on the `User` class called `keywords`, which will bridge the gap from the `user_keywords` collection of `User` to the `.keyword` attribute present on each `UserKeyword`:

```
from sqlalchemy import Column, Integer, String, ForeignKey
from sqlalchemy.orm import relationship, backref

from sqlalchemy.ext.associationproxy import association_proxy
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(64))

    # association proxy of "user_keywords" collection
    # to "keyword" attribute
    keywords = association_proxy('user_keywords', 'keyword')

    def __init__(self, name):
        self.name = name

class UserKeyword(Base):
    __tablename__ = 'user_keyword'
    user_id = Column(Integer, ForeignKey('user.id'), primary_key=True)
    keyword_id = Column(Integer, ForeignKey('keyword.id'), primary_key=True)
    special_key = Column(String(50))

    # bidirectional attribute/collection of "user"/"user_keywords"
    user = relationship(User,
```

```
                backref=backref("user_keywords",
                                cascade="all, delete-orphan")
            )

    # reference to the "Keyword" object
    keyword = relationship("Keyword")

    def __init__(self, keyword=None, user=None, special_key=None):
        self.user = user
        self.keyword = keyword
        self.special_key = special_key

class Keyword(Base):
    __tablename__ = 'keyword'
    id = Column(Integer, primary_key=True)
    keyword = Column('keyword', String(64))

    def __init__(self, keyword):
        self.keyword = keyword

    def __repr__(self):
        return 'Keyword(%s)' % repr(self.keyword)
```

With the above configuration, we can operate upon the `.keywords` collection of each `User` object, and the usage of `UserKeyword` is concealed:

```
>>> user = User('log')
>>> for kw in (Keyword('new_from_blammo'), Keyword('its_big')):
...     user.keywords.append(kw)
...
>>> print(user.keywords)
[Keyword('new_from_blammo'), Keyword('its_big')]
```

Where above, each `.keywords.append()` operation is equivalent to:

```
>>> user.user_keywords.append(UserKeyword(Keyword('its_heavy')))
```

The `UserKeyword` association object has two attributes here which are populated; the `.keyword` attribute is populated directly as a result of passing the `Keyword` object as the first argument. The `.user` argument is then assigned as the `UserKeyword` object is appended to the `User.user_keywords` collection, where the bidirectional relationship configured between `User.user_keywords` and `UserKeyword.user` results in a population of the `UserKeyword.user` attribute. The `special_key` argument above is left at its default value of `None`.

For those cases where we do want `special_key` to have a value, we create the `UserKeyword` object explicitly. Below we assign all three attributes, where the assignment of `.user` has the effect of the `UserKeyword` being appended to the `User.user_keywords` collection:

```
>>> UserKeyword(Keyword('its_wood'), user, special_key='my special key')
```

The association proxy returns to us a collection of `Keyword` objects represented by all these operations:

```
>>> user.keywords
[Keyword('new_from_blammo'), Keyword('its_big'), Keyword('its_heavy'), Keyword('its_wood')]
```

Proxying to Dictionary Based Collections

The association proxy can proxy to dictionary based collections as well. SQLAlchemy mappings usually use the `attribute_mapped_collection()` collection type to create dictionary collections, as well as the extended techniques described in *Custom Dictionary-Based Collections*.

The association proxy adjusts its behavior when it detects the usage of a dictionary-based collection. When new values are added to the dictionary, the association proxy instantiates the intermediary object by passing two arguments to the creation function instead of one, the key and the value. As always, this creation function defaults to the constructor of the intermediary class, and can be customized using the `creator` argument.

Below, we modify our `UserKeyword` example such that the `User.user_keywords` collection will now be mapped using a dictionary, where the `UserKeyword.special_key` argument will be used as the key for the dictionary. We then apply a `creator` argument to the `User.keywords` proxy so that these values are assigned appropriately when new elements are added to the dictionary:

```
from sqlalchemy import Column, Integer, String, ForeignKey
from sqlalchemy.orm import relationship, backref
from sqlalchemy.ext.associationproxy import association_proxy
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm.collections import attribute_mapped_collection

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(64))

    # proxy to 'user_keywords', instantiating UserKeyword
    # assigning the new key to 'special_key', values to
    # 'keyword'.
    keywords = association_proxy('user_keywords', 'keyword',
                    creator=lambda k, v:
                                UserKeyword(special_key=k, keyword=v)
                )

    def __init__(self, name):
        self.name = name

class UserKeyword(Base):
    __tablename__ = 'user_keyword'
    user_id = Column(Integer, ForeignKey('user.id'), primary_key=True)
    keyword_id = Column(Integer, ForeignKey('keyword.id'), primary_key=True)
    special_key = Column(String)

    # bidirectional user/user_keywords relationships, mapping
    # user_keywords with a dictionary against "special_key" as key.
    user = relationship(User, backref=backref(
                    "user_keywords",
                    collection_class=attribute_mapped_collection("special_key"),
                    cascade="all, delete-orphan"
                    )
                )
    keyword = relationship("Keyword")

class Keyword(Base):
    __tablename__ = 'keyword'
```

```
    id = Column(Integer, primary_key=True)
    keyword = Column('keyword', String(64))

    def __init__(self, keyword):
        self.keyword = keyword

    def __repr__(self):
        return 'Keyword(%s)' % repr(self.keyword)
```

We illustrate the `.keywords` collection as a dictionary, mapping the `UserKeyword.string_key` value to `Keyword` objects:

```
>>> user = User('log')

>>> user.keywords['sk1'] = Keyword('kw1')
>>> user.keywords['sk2'] = Keyword('kw2')

>>> print(user.keywords)
{'sk1': Keyword('kw1'), 'sk2': Keyword('kw2')}
```

Composite Association Proxies

Given our previous examples of proxying from relationship to scalar attribute, proxying across an association object, and proxying dictionaries, we can combine all three techniques together to give `User` a `keywords` dictionary that deals strictly with the string value of `special_key` mapped to the string `keyword`. Both the `UserKeyword` and `Keyword` classes are entirely concealed. This is achieved by building an association proxy on `User` that refers to an association proxy present on `UserKeyword`:

```
from sqlalchemy import Column, Integer, String, ForeignKey
from sqlalchemy.orm import relationship, backref

from sqlalchemy.ext.associationproxy import association_proxy
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm.collections import attribute_mapped_collection

Base = declarative_base()

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(64))

    # the same 'user_keywords'->'keyword' proxy as in
    # the basic dictionary example
    keywords = association_proxy(
                'user_keywords',
                'keyword',
                creator=lambda k, v:
                            UserKeyword(special_key=k, keyword=v)
                )

    def __init__(self, name):
        self.name = name

class UserKeyword(Base):
```

```
    __tablename__ = 'user_keyword'
    user_id = Column(Integer, ForeignKey('user.id'), primary_key=True)
    keyword_id = Column(Integer, ForeignKey('keyword.id'),
                                                    primary_key=True)
    special_key = Column(String)
    user = relationship(User, backref=backref(
            "user_keywords",
            collection_class=attribute_mapped_collection("special_key"),
            cascade="all, delete-orphan"
            )
        )

    # the relationship to Keyword is now called
    # 'kw'
    kw = relationship("Keyword")

    # 'keyword' is changed to be a proxy to the
    # 'keyword' attribute of 'Keyword'
    keyword = association_proxy('kw', 'keyword')

class Keyword(Base):
    __tablename__ = 'keyword'
    id = Column(Integer, primary_key=True)
    keyword = Column('keyword', String(64))

    def __init__(self, keyword):
        self.keyword = keyword
```

`User.keywords` is now a dictionary of string to string, where `UserKeyword` and `Keyword` objects are created and removed for us transparently using the association proxy. In the example below, we illustrate usage of the assignment operator, also appropriately handled by the association proxy, to apply a dictionary value to the collection at once:

```
>>> user = User('log')
>>> user.keywords = {
...     'sk1':'kw1',
...     'sk2':'kw2'
... }
>>> print(user.keywords)
{'sk1': 'kw1', 'sk2': 'kw2'}

>>> user.keywords['sk3'] = 'kw3'
>>> del user.keywords['sk2']
>>> print(user.keywords)
{'sk1': 'kw1', 'sk3': 'kw3'}

>>> # illustrate un-proxied usage
... print(user.user_keywords['sk3'].kw)
<__main__.Keyword object at 0x12ceb90>
```

One caveat with our example above is that because `Keyword` objects are created for each dictionary set operation, the example fails to maintain uniqueness for the `Keyword` objects on their string name, which is a typical requirement for a tagging scenario such as this one. For this use case the recipe UniqueObject, or a comparable creational strategy, is recommended, which will apply a "lookup first, then create" strategy to the constructor of the `Keyword` class, so that an already existing `Keyword` is returned if the given name is already present.

Querying with Association Proxies

The AssociationProxy features simple SQL construction capabilities which relate down to the underlying relationship() in use as well as the target attribute. For example, the RelationshipProperty.Comparator.any() and RelationshipProperty.Comparator.has() operations are available, and will produce a "nested" EXISTS clause, such as in our basic association object example:

```
>>> print(session.query(User).filter(User.keywords.any(keyword='jek')))
SELECT user.id AS user_id, user.name AS user_name
FROM user
WHERE EXISTS (SELECT 1
FROM user_keyword
WHERE user.id = user_keyword.user_id AND (EXISTS (SELECT 1
FROM keyword
WHERE keyword.id = user_keyword.keyword_id AND keyword.keyword = :keyword_1)))
```

For a proxy to a scalar attribute, __eq__() is supported:

```
>>> print(session.query(UserKeyword).filter(UserKeyword.keyword == 'jek'))
SELECT user_keyword.*
FROM user_keyword
WHERE EXISTS (SELECT 1
    FROM keyword
    WHERE keyword.id = user_keyword.keyword_id AND keyword.keyword = :keyword_1)
```

and .contains() is available for a proxy to a scalar collection:

```
>>> print(session.query(User).filter(User.keywords.contains('jek')))
SELECT user.*
FROM user
WHERE EXISTS (SELECT 1
FROM userkeywords, keyword
WHERE user.id = userkeywords.user_id
    AND keyword.id = userkeywords.keyword_id
    AND keyword.keyword = :keyword_1)
```

AssociationProxy can be used with Query.join() somewhat manually using the attr attribute in a star-args context:

```
q = session.query(User).join(*User.keywords.attr)
```

New in version 0.7.3: attr attribute in a star-args context.

attr is composed of AssociationProxy.local_attr and AssociationProxy.remote_attr, which are just synonyms for the actual proxied attributes, and can also be used for querying:

```
uka = aliased(UserKeyword)
ka = aliased(Keyword)
q = session.query(User).\
        join(uka, User.keywords.local_attr).\
        join(ka, User.keywords.remote_attr)
```

New in version 0.7.3: AssociationProxy.local_attr and AssociationProxy.remote_attr, synonyms for the actual proxied attributes, and usable for querying.

API Documentation

sqlalchemy.ext.associationproxy.**association_proxy**(*target_collection*, *attr*, ***kw*)

Return a Python property implementing a view of a target attribute which references an attribute on members of the target.

The returned value is an instance of AssociationProxy.

Implements a Python property representing a relationship as a collection of simpler values, or a scalar value. The proxied property will mimic the collection type of the target (list, dict or set), or, in the case of a one to one relationship, a simple scalar value.

Parameters

- **target_collection** – Name of the attribute we'll proxy to. This attribute is typically mapped by relationship() to link to a target collection, but can also be a many-to-one or non-scalar relationship.
- **attr** – Attribute on the associated instance or instances we'll proxy for.

  For example, given a target collection of [obj1, obj2], a list created by this proxy property would look like [getattr(obj1, *attr*), getattr(obj2, *attr*)]

  If the relationship is one-to-one or otherwise uselist=False, then simply: getattr(obj, *attr*)
- **creator** – optional.

  When new items are added to this proxied collection, new instances of the class collected by the target collection will be created. For list and set collections, the target class constructor will be called with the 'value' for the new instance. For dict types, two arguments are passed: key and value.

  If you want to construct instances differently, supply a *creator* function that takes arguments as above and returns instances.

  For scalar relationships, creator() will be called if the target is None. If the target is present, set operations are proxied to setattr() on the associated object.

  If you have an associated object with multiple attributes, you may set up multiple association proxies mapping to different attributes. See the unit tests for examples, and for examples of how creator() functions can be used to construct the scalar relationship on-demand in this situation.
- ****kw** – Passes along any other keyword arguments to AssociationProxy.

class sqlalchemy.ext.associationproxy.**AssociationProxy**(*target_collection*, *attr*, *creator=None*, *getset_factory=None*, *proxy_factory=None*, *proxy_bulk_set=None*)

A descriptor that presents a read/write view of an object attribute.

__init__(*target_collection*, *attr*, *creator=None*, *getset_factory=None*, *proxy_factory=None*, *proxy_bulk_set=None*)

Construct a new AssociationProxy.

The association_proxy() function is provided as the usual entrypoint here, though AssociationProxy can be instantiated and/or subclassed directly.

Parameters

- **target_collection** – Name of the collection we'll proxy to, usually created with relationship().

- **attr** – Attribute on the collected instances we'll proxy for. For example, given a target collection of [obj1, obj2], a list created by this proxy property would look like [getattr(obj1, attr), getattr(obj2, attr)]
- **creator** – Optional. When new items are added to this proxied collection, new instances of the class collected by the target collection will be created. For list and set collections, the target class constructor will be called with the 'value' for the new instance. For dict types, two arguments are passed: key and value.

  If you want to construct instances differently, supply a 'creator' function that takes arguments as above and returns instances.
- **getset_factory** – Optional. Proxied attribute access is automatically handled by routines that get and set values based on the *attr* argument for this proxy.

  If you would like to customize this behavior, you may supply a *getset_factory* callable that produces a tuple of *getter* and *setter* functions. The factory is called with two arguments, the abstract type of the underlying collection and this proxy instance.
- **proxy_factory** – Optional. The type of collection to emulate is determined by sniffing the target collection. If your collection type can't be determined by duck typing or you'd like to use a different collection implementation, you may supply a factory function to produce those collections. Only applicable to non-scalar relationships.
- **proxy_bulk_set** – Optional, use with proxy_factory. See the _set() method for details.

any(*criterion=None*, ***kwargs*)
Produce a proxied 'any' expression using EXISTS.

This expression will be a composed product using the `RelationshipProperty.Comparator.any()` and/or `RelationshipProperty.Comparator.has()` operators of the underlying proxied attributes.

attr
Return a tuple of `(local_attr, remote_attr)`.

This attribute is convenient when specifying a join using `Query.join()` across two relationships:

```
sess.query(Parent).join(*Parent.proxied.attr)
```

New in version 0.7.3.

See also:

`AssociationProxy.local_attr`

`AssociationProxy.remote_attr`

contains(*obj*)
Produce a proxied 'contains' expression using EXISTS.

This expression will be a composed product using the `RelationshipProperty.Comparator.any()`, `RelationshipProperty.Comparator.has()`, and/or `RelationshipProperty.Comparator.contain` operators of the underlying proxied attributes.

has(*criterion=None*, ***kwargs*)
Produce a proxied 'has' expression using EXISTS.

This expression will be a composed product using the `RelationshipProperty.Comparator.any()` and/or `RelationshipProperty.Comparator.has()` operators of the underlying proxied attributes.

local_attr
The 'local' MapperProperty referenced by this AssociationProxy.

New in version 0.7.3.

See also:

AssociationProxy.attr

AssociationProxy.remote_attr

remote_attr
The 'remote' MapperProperty referenced by this AssociationProxy.

New in version 0.7.3.

See also:

AssociationProxy.attr

AssociationProxy.local_attr

scalar
Return True if this AssociationProxy proxies a scalar relationship on the local side.

target_class
The intermediary class handled by this AssociationProxy.

Intercepted append/set/assignment events will result in the generation of new instances of this class.

2.10.2 Declarative

Synopsis

SQLAlchemy object-relational configuration involves the combination of Table, mapper(), and class objects to define a mapped class. declarative allows all three to be expressed at once within the class declaration. As much as possible, regular SQLAlchemy schema and ORM constructs are used directly, so that configuration between "classical" ORM usage and declarative remain highly similar.

As a simple example:

```
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class SomeClass(Base):
    __tablename__ = 'some_table'
    id = Column(Integer, primary_key=True)
    name =  Column(String(50))
```

Above, the declarative_base() callable returns a new base class from which all mapped classes should inherit. When the class definition is completed, a new Table and mapper() will have been generated.

The resulting table and mapper are accessible via __table__ and __mapper__ attributes on the SomeClass class:

```
# access the mapped Table
SomeClass.__table__
```

```
# access the Mapper
SomeClass.__mapper__
```

Defining Attributes

In the previous example, the `Column` objects are automatically named with the name of the attribute to which they are assigned.

To name columns explicitly with a name distinct from their mapped attribute, just give the column a name. Below, column "some_table_id" is mapped to the "id" attribute of *SomeClass*, but in SQL will be represented as "some_table_id":

```
class SomeClass(Base):
    __tablename__ = 'some_table'
    id = Column("some_table_id", Integer, primary_key=True)
```

Attributes may be added to the class after its construction, and they will be added to the underlying `Table` and `mapper()` definitions as appropriate:

```
SomeClass.data = Column('data', Unicode)
SomeClass.related = relationship(RelatedInfo)
```

Classes which are constructed using declarative can interact freely with classes that are mapped explicitly with `mapper()`.

It is recommended, though not required, that all tables share the same underlying `MetaData` object, so that string-configured `ForeignKey` references can be resolved without issue.

Accessing the MetaData

The `declarative_base()` base class contains a `MetaData` object where newly defined `Table` objects are collected. This object is intended to be accessed directly for `MetaData`-specific operations. Such as, to issue CREATE statements for all tables:

```
engine = create_engine('sqlite://')
Base.metadata.create_all(engine)
```

`declarative_base()` can also receive a pre-existing `MetaData` object, which allows a declarative setup to be associated with an already existing traditional collection of `Table` objects:

```
mymetadata = MetaData()
Base = declarative_base(metadata=mymetadata)
```

Configuring Relationships

Relationships to other classes are done in the usual way, with the added feature that the class specified to `relationship()` may be a string name. The "class registry" associated with `Base` is used at mapper compilation time to resolve the name into the actual class object, which is expected to have been defined once the mapper configuration is used:

```
class User(Base):
    __tablename__ = 'users'

    id = Column(Integer, primary_key=True)
    name = Column(String(50))
    addresses = relationship("Address", backref="user")

class Address(Base):
    __tablename__ = 'addresses'

    id = Column(Integer, primary_key=True)
    email = Column(String(50))
    user_id = Column(Integer, ForeignKey('users.id'))
```

Column constructs, since they are just that, are immediately usable, as below where we define a primary join condition on the `Address` class using them:

```
class Address(Base):
    __tablename__ = 'addresses'

    id = Column(Integer, primary_key=True)
    email = Column(String(50))
    user_id = Column(Integer, ForeignKey('users.id'))
    user = relationship(User, primaryjoin=user_id == User.id)
```

In addition to the main argument for `relationship()`, other arguments which depend upon the columns present on an as-yet undefined class may also be specified as strings. These strings are evaluated as Python expressions. The full namespace available within this evaluation includes all classes mapped for this declarative base, as well as the contents of the `sqlalchemy` package, including expression functions like `desc()` and `func`:

```
class User(Base):
    # ....
    addresses = relationship("Address",
                          order_by="desc(Address.email)",
                          primaryjoin="Address.user_id==User.id")
```

As an alternative to string-based attributes, attributes may also be defined after all classes have been created. Just add them to the target class after the fact:

```
User.addresses = relationship(Address,
                          primaryjoin=Address.user_id==User.id)
```

Configuring Many-to-Many Relationships

Many-to-many relationships are also declared in the same way with declarative as with traditional mappings. The `secondary` argument to `relationship()` is as usual passed a `Table` object, which is typically declared in the traditional way. The `Table` usually shares the `MetaData` object used by the declarative base:

```
keywords = Table(
    'keywords', Base.metadata,
    Column('author_id', Integer, ForeignKey('authors.id')),
    Column('keyword_id', Integer, ForeignKey('keywords.id'))
    )
```

```
class Author(Base):
    __tablename__ = 'authors'
    id = Column(Integer, primary_key=True)
    keywords = relationship("Keyword", secondary=keywords)
```

Like other `relationship()` arguments, a string is accepted as well, passing the string name of the table as defined in the `Base.metadata.tables` collection:

```
class Author(Base):
    __tablename__ = 'authors'
    id = Column(Integer, primary_key=True)
    keywords = relationship("Keyword", secondary="keywords")
```

As with traditional mapping, its generally not a good idea to use a `Table` as the "secondary" argument which is also mapped to a class, unless the `relationship` is declared with `viewonly=True`. Otherwise, the unit-of-work system may attempt duplicate INSERT and DELETE statements against the underlying table.

Defining SQL Expressions

See *SQL Expressions as Mapped Attributes* for examples on declaratively mapping attributes to SQL expressions.

Table Configuration

Table arguments other than the name, metadata, and mapped Column arguments are specified using the `__table_args__` class attribute. This attribute accommodates both positional as well as keyword arguments that are normally sent to the `Table` constructor. The attribute can be specified in one of two forms. One is as a dictionary:

```
class MyClass(Base):
    __tablename__ = 'sometable'
    __table_args__ = {'mysql_engine':'InnoDB'}
```

The other, a tuple, where each argument is positional (usually constraints):

```
class MyClass(Base):
    __tablename__ = 'sometable'
    __table_args__ = (
            ForeignKeyConstraint(['id'], ['remote_table.id']),
            UniqueConstraint('foo'),
            )
```

Keyword arguments can be specified with the above form by specifying the last argument as a dictionary:

```
class MyClass(Base):
    __tablename__ = 'sometable'
    __table_args__ = (
            ForeignKeyConstraint(['id'], ['remote_table.id']),
            UniqueConstraint('foo'),
            {'autoload':True}
            )
```

Using a Hybrid Approach with __table__

As an alternative to __tablename__, a direct Table construct may be used. The Column objects, which in this case require their names, will be added to the mapping just like a regular mapping to a table:

```
class MyClass(Base):
    __table__ = Table('my_table', Base.metadata,
        Column('id', Integer, primary_key=True),
        Column('name', String(50))
    )
```

__table__ provides a more focused point of control for establishing table metadata, while still getting most of the benefits of using declarative. An application that uses reflection might want to load table metadata elsewhere and pass it to declarative classes:

```
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()
Base.metadata.reflect(some_engine)

class User(Base):
    __table__ = metadata.tables['user']

class Address(Base):
    __table__ = metadata.tables['address']
```

Some configuration schemes may find it more appropriate to use __table__, such as those which already take advantage of the data-driven nature of Table to customize and/or automate schema definition.

Note that when the __table__ approach is used, the object is immediately usable as a plain Table within the class declaration body itself, as a Python class is only another syntactical block. Below this is illustrated by using the id column in the primaryjoin condition of a relationship():

```
class MyClass(Base):
    __table__ = Table('my_table', Base.metadata,
        Column('id', Integer, primary_key=True),
        Column('name', String(50))
    )

    widgets = relationship(Widget,
                primaryjoin=Widget.myclass_id==__table__.c.id)
```

Similarly, mapped attributes which refer to __table__ can be placed inline, as below where we assign the name column to the attribute _name, generating a synonym for name:

```
from sqlalchemy.ext.declarative import synonym_for

class MyClass(Base):
    __table__ = Table('my_table', Base.metadata,
        Column('id', Integer, primary_key=True),
        Column('name', String(50))
    )

    _name = __table__.c.name

    @synonym_for("_name")
```

```
    def name(self):
        return "Name: %s" % _name
```

Using Reflection with Declarative

It's easy to set up a `Table` that uses `autoload=True` in conjunction with a mapped class:

```
class MyClass(Base):
    __table__ = Table('mytable', Base.metadata,
                      autoload=True, autoload_with=some_engine)
```

However, one improvement that can be made here is to not require the `Engine` to be available when classes are being first declared. To achieve this, use the example described at *Declarative Reflection* to build a declarative base that sets up mappings only after a special `prepare(engine)` step is called:

```
Base = declarative_base(cls=DeclarativeReflectedBase)

class Foo(Base):
    __tablename__ = 'foo'
    bars = relationship("Bar")

class Bar(Base):
    __tablename__ = 'bar'

    # illustrate overriding of "bar.foo_id" to have
    # a foreign key constraint otherwise not
    # reflected, such as when using MySQL
    foo_id = Column(Integer, ForeignKey('foo.id'))

Base.prepare(e)
```

Mapper Configuration

Declarative makes use of the `mapper()` function internally when it creates the mapping to the declared table. The options for `mapper()` are passed directly through via the `__mapper_args__` class attribute. As always, arguments which reference locally mapped columns can reference them directly from within the class declaration:

```
from datetime import datetime

class Widget(Base):
    __tablename__ = 'widgets'

    id = Column(Integer, primary_key=True)
    timestamp = Column(DateTime, nullable=False)

    __mapper_args__ = {
                    'version_id_col': timestamp,
                    'version_id_generator': lambda v:datetime.now()
                }
```

Inheritance Configuration

Declarative supports all three forms of inheritance as intuitively as possible. The `inherits` mapper keyword argument is not needed as declarative will determine this from the class itself. The various "polymorphic" keyword arguments are specified using `__mapper_args__`.

Joined Table Inheritance

Joined table inheritance is defined as a subclass that defines its own table:

```
class Person(Base):
    __tablename__ = 'people'
    id = Column(Integer, primary_key=True)
    discriminator = Column('type', String(50))
    __mapper_args__ = {'polymorphic_on': discriminator}

class Engineer(Person):
    __tablename__ = 'engineers'
    __mapper_args__ = {'polymorphic_identity': 'engineer'}
    id = Column(Integer, ForeignKey('people.id'), primary_key=True)
    primary_language = Column(String(50))
```

Note that above, the `Engineer.id` attribute, since it shares the same attribute name as the `Person.id` attribute, will in fact represent the `people.id` and `engineers.id` columns together, with the "Engineer.id" column taking precedence if queried directly. To provide the `Engineer` class with an attribute that represents only the `engineers.id` column, give it a different attribute name:

```
class Engineer(Person):
    __tablename__ = 'engineers'
    __mapper_args__ = {'polymorphic_identity': 'engineer'}
    engineer_id = Column('id', Integer, ForeignKey('people.id'),
                                                primary_key=True)
    primary_language = Column(String(50))
```

Changed in version 0.7: joined table inheritance favors the subclass column over that of the superclass, such as querying above for `Engineer.id`. Prior to 0.7 this was the reverse.

Single Table Inheritance

Single table inheritance is defined as a subclass that does not have its own table; you just leave out the `__table__` and `__tablename__` attributes:

```
class Person(Base):
    __tablename__ = 'people'
    id = Column(Integer, primary_key=True)
    discriminator = Column('type', String(50))
    __mapper_args__ = {'polymorphic_on': discriminator}

class Engineer(Person):
    __mapper_args__ = {'polymorphic_identity': 'engineer'}
    primary_language = Column(String(50))
```

When the above mappers are configured, the `Person` class is mapped to the `people` table *before* the `primary_language` column is defined, and this column will not be included in its own mapping. When `Engineer` then defines the `primary_language` column, the column is added to the `people` table so that it is included in the mapping for `Engineer` and is also part of the table's full set of columns. Columns which are not mapped to `Person` are also excluded from any other single or joined inheriting classes using the `exclude_properties` mapper argument. Below, `Manager` will have all the attributes of `Person` and `Manager` but *not* the `primary_language` attribute of `Engineer`:

```
class Manager(Person):
    __mapper_args__ = {'polymorphic_identity': 'manager'}
    golf_swing = Column(String(50))
```

The attribute exclusion logic is provided by the `exclude_properties` mapper argument, and declarative's default behavior can be disabled by passing an explicit `exclude_properties` collection (empty or otherwise) to the `__mapper_args__`.

Concrete Table Inheritance

Concrete is defined as a subclass which has its own table and sets the `concrete` keyword argument to `True`:

```
class Person(Base):
    __tablename__ = 'people'
    id = Column(Integer, primary_key=True)
    name = Column(String(50))

class Engineer(Person):
    __tablename__ = 'engineers'
    __mapper_args__ = {'concrete':True}
    id = Column(Integer, primary_key=True)
    primary_language = Column(String(50))
    name = Column(String(50))
```

Usage of an abstract base class is a little less straightforward as it requires usage of `polymorphic_union()`, which needs to be created with the `Table` objects before the class is built:

```
engineers = Table('engineers', Base.metadata,
                Column('id', Integer, primary_key=True),
                Column('name', String(50)),
                Column('primary_language', String(50))
            )
managers = Table('managers', Base.metadata,
                Column('id', Integer, primary_key=True),
                Column('name', String(50)),
                Column('golf_swing', String(50))
            )

punion = polymorphic_union({
    'engineer':engineers,
    'manager':managers
}, 'type', 'punion')

class Person(Base):
    __table__ = punion
    __mapper_args__ = {'polymorphic_on':punion.c.type}
```

```
class Engineer(Person):
    __table__ = engineers
    __mapper_args__ = {'polymorphic_identity':'engineer', 'concrete':True}

class Manager(Person):
    __table__ = managers
    __mapper_args__ = {'polymorphic_identity':'manager', 'concrete':True}
```

Using the Concrete Helpers Helper classes provides a simpler pattern for concrete inheritance. With these objects, the `__declare_last__` helper is used to configure the "polymorphic" loader for the mapper after all subclasses have been declared.

New in version 0.7.3.

An abstract base can be declared using the `AbstractConcreteBase` class:

```
from sqlalchemy.ext.declarative import AbstractConcreteBase

class Employee(AbstractConcreteBase, Base):
    pass
```

To have a concrete `employee` table, use `ConcreteBase` instead:

```
from sqlalchemy.ext.declarative import ConcreteBase

class Employee(ConcreteBase, Base):
    __tablename__ = 'employee'
    employee_id = Column(Integer, primary_key=True)
    name = Column(String(50))
    __mapper_args__ = {
                    'polymorphic_identity':'employee',
                    'concrete':True}
```

Either `Employee` base can be used in the normal fashion:

```
class Manager(Employee):
    __tablename__ = 'manager'
    employee_id = Column(Integer, primary_key=True)
    name = Column(String(50))
    manager_data = Column(String(40))
    __mapper_args__ = {
                    'polymorphic_identity':'manager',
                    'concrete':True}

class Engineer(Employee):
    __tablename__ = 'engineer'
    employee_id = Column(Integer, primary_key=True)
    name = Column(String(50))
    engineer_info = Column(String(40))
    __mapper_args__ = {'polymorphic_identity':'engineer',
                    'concrete':True}
```

Mixin and Custom Base Classes

A common need when using declarative is to share some functionality, such as a set of common columns, some common table options, or other mapped properties, across many classes. The standard Python idioms for this is to have the classes inherit from a base which includes these common features.

When using declarative, this idiom is allowed via the usage of a custom declarative base class, as well as a "mixin" class which is inherited from in addition to the primary base. Declarative includes several helper features to make this work in terms of how mappings are declared. An example of some commonly mixed-in idioms is below:

```
from sqlalchemy.ext.declarative import declared_attr

class MyMixin(object):

    @declared_attr
    def __tablename__(cls):
        return cls.__name__.lower()

    __table_args__ = {'mysql_engine': 'InnoDB'}
    __mapper_args__= {'always_refresh': True}

    id =  Column(Integer, primary_key=True)

class MyModel(MyMixin, Base):
    name = Column(String(1000))
```

Where above, the class MyModel will contain an "id" column as the primary key, a __tablename__ attribute that derives from the name of the class itself, as well as __table_args__ and __mapper_args__ defined by the MyMixin mixin class.

There's no fixed convention over whether MyMixin precedes Base or not. Normal Python method resolution rules apply, and the above example would work just as well with:

```
class MyModel(Base, MyMixin):
    name = Column(String(1000))
```

This works because Base here doesn't define any of the variables that MyMixin defines, i.e. __tablename__, __table_args__, id, etc. If the Base did define an attribute of the same name, the class placed first in the inherits list would determine which attribute is used on the newly defined class.

Augmenting the Base

In addition to using a pure mixin, most of the techniques in this section can also be applied to the base class itself, for patterns that should apply to all classes derived from a particular base. This is achieved using the cls argument of the declarative_base() function:

```
from sqlalchemy.ext.declarative import declared_attr

class Base(object):
    @declared_attr
    def __tablename__(cls):
        return cls.__name__.lower()

    __table_args__ = {'mysql_engine': 'InnoDB'}
```

```
    id =  Column(Integer, primary_key=True)

from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base(cls=Base)

class MyModel(Base):
    name = Column(String(1000))
```

Where above, `MyModel` and all other classes that derive from `Base` will have a table name derived from the class name, an `id` primary key column, as well as the "InnoDB" engine for MySQL.

Mixing in Columns

The most basic way to specify a column on a mixin is by simple declaration:

```
class TimestampMixin(object):
    created_at = Column(DateTime, default=func.now())

class MyModel(TimestampMixin, Base):
    __tablename__ = 'test'

    id =  Column(Integer, primary_key=True)
    name = Column(String(1000))
```

Where above, all declarative classes that include `TimestampMixin` will also have a column `created_at` that applies a timestamp to all row insertions.

Those familiar with the SQLAlchemy expression language know that the object identity of clause elements defines their role in a schema. Two `Table` objects `a` and `b` may both have a column called `id`, but the way these are differentiated is that `a.c.id` and `b.c.id` are two distinct Python objects, referencing their parent tables `a` and `b` respectively.

In the case of the mixin column, it seems that only one `Column` object is explicitly created, yet the ultimate `created_at` column above must exist as a distinct Python object for each separate destination class. To accomplish this, the declarative extension creates a **copy** of each `Column` object encountered on a class that is detected as a mixin.

This copy mechanism is limited to simple columns that have no foreign keys, as a `ForeignKey` itself contains references to columns which can't be properly recreated at this level. For columns that have foreign keys, as well as for the variety of mapper-level constructs that require destination-explicit context, the `declared_attr()` decorator is provided so that patterns common to many classes can be defined as callables:

```
from sqlalchemy.ext.declarative import declared_attr

class ReferenceAddressMixin(object):
    @declared_attr
    def address_id(cls):
        return Column(Integer, ForeignKey('address.id'))

class User(ReferenceAddressMixin, Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
```

Where above, the `address_id` class-level callable is executed at the point at which the `User` class is constructed, and the declarative extension can use the resulting `Column` object as returned by the method without the need to copy it.

Changed in version >: 0.6.5 Rename 0.6.5 `sqlalchemy.util.classproperty` into `declared_attr()`.

Columns generated by `declared_attr()` can also be referenced by `__mapper_args__` to a limited degree, currently by `polymorphic_on` and `version_id_col`, by specifying the classdecorator itself into the dictionary - the declarative extension will resolve them at class construction time:

```
class MyMixin:
    @declared_attr
    def type_(cls):
        return Column(String(50))

    __mapper_args__= {'polymorphic_on':type_}

class MyModel(MyMixin, Base):
    __tablename__='test'
    id =  Column(Integer, primary_key=True)
```

Mixing in Relationships

Relationships created by `relationship()` are provided with declarative mixin classes exclusively using the `declared_attr` approach, eliminating any ambiguity which could arise when copying a relationship and its possibly column-bound contents. Below is an example which combines a foreign key column and a relationship so that two classes `Foo` and `Bar` can both be configured to reference a common target class via many-to-one:

```
class RefTargetMixin(object):
    @declared_attr
    def target_id(cls):
        return Column('target_id', ForeignKey('target.id'))

    @declared_attr
    def target(cls):
        return relationship("Target")

class Foo(RefTargetMixin, Base):
    __tablename__ = 'foo'
    id = Column(Integer, primary_key=True)

class Bar(RefTargetMixin, Base):
    __tablename__ = 'bar'
    id = Column(Integer, primary_key=True)

class Target(Base):
    __tablename__ = 'target'
    id = Column(Integer, primary_key=True)
```

`relationship()` definitions which require explicit primaryjoin, order_by etc. expressions should use the string forms for these arguments, so that they are evaluated as late as possible. To reference the mixin class in these expressions, use the given `cls` to get its name:

```
class RefTargetMixin(object):
    @declared_attr
```

```
    def target_id(cls):
        return Column('target_id', ForeignKey('target.id'))

    @declared_attr
    def target(cls):
        return relationship("Target",
            primaryjoin="Target.id==%s.target_id" % cls.__name__
        )
```

Mixing in deferred(), column_property(), etc.

Like `relationship()`, all `MapperProperty` subclasses such as `deferred()`, `column_property()`, etc. ultimately involve references to columns, and therefore, when used with declarative mixins, have the `declared_attr` requirement so that no reliance on copying is needed:

```
class SomethingMixin(object):

    @declared_attr
    def dprop(cls):
        return deferred(Column(Integer))

class Something(SomethingMixin, Base):
    __tablename__ = "something"
```

Controlling table inheritance with mixins

The `__tablename__` attribute in conjunction with the hierarchy of classes involved in a declarative mixin scenario controls what type of table inheritance, if any, is configured by the declarative extension.

If the `__tablename__` is computed by a mixin, you may need to control which classes get the computed attribute in order to get the type of table inheritance you require.

For example, if you had a mixin that computes `__tablename__` but where you wanted to use that mixin in a single table inheritance hierarchy, you can explicitly specify `__tablename__` as `None` to indicate that the class should not have a table mapped:

```
from sqlalchemy.ext.declarative import declared_attr

class Tablename:
    @declared_attr
    def __tablename__(cls):
        return cls.__name__.lower()

class Person(Tablename, Base):
    id = Column(Integer, primary_key=True)
    discriminator = Column('type', String(50))
    __mapper_args__ = {'polymorphic_on': discriminator}

class Engineer(Person):
    __tablename__ = None
    __mapper_args__ = {'polymorphic_identity': 'engineer'}
    primary_language = Column(String(50))
```

Alternatively, you can make the mixin intelligent enough to only return a `__tablename__` in the event that no table is already mapped in the inheritance hierarchy. To help with this, a `has_inherited_table()` helper function is provided that returns `True` if a parent class already has a mapped table.

As an example, here's a mixin that will only allow single table inheritance:

```
from sqlalchemy.ext.declarative import declared_attr
from sqlalchemy.ext.declarative import has_inherited_table

class Tablename(object):
    @declared_attr
    def __tablename__(cls):
        if has_inherited_table(cls):
            return None
        return cls.__name__.lower()

class Person(Tablename, Base):
    id = Column(Integer, primary_key=True)
    discriminator = Column('type', String(50))
    __mapper_args__ = {'polymorphic_on': discriminator}

class Engineer(Person):
    primary_language = Column(String(50))
    __mapper_args__ = {'polymorphic_identity': 'engineer'}
```

If you want to use a similar pattern with a mix of single and joined table inheritance, you would need a slightly different mixin and use it on any joined table child classes in addition to their parent classes:

```
from sqlalchemy.ext.declarative import declared_attr
from sqlalchemy.ext.declarative import has_inherited_table

class Tablename(object):
    @declared_attr
    def __tablename__(cls):
        if (has_inherited_table(cls) and
            Tablename not in cls.__bases__):
            return None
        return cls.__name__.lower()

class Person(Tablename, Base):
    id = Column(Integer, primary_key=True)
    discriminator = Column('type', String(50))
    __mapper_args__ = {'polymorphic_on': discriminator}

# This is single table inheritance
class Engineer(Person):
    primary_language = Column(String(50))
    __mapper_args__ = {'polymorphic_identity': 'engineer'}

# This is joined table inheritance
class Manager(Tablename, Person):
    id = Column(Integer, ForeignKey('person.id'), primary_key=True)
    preferred_recreation = Column(String(50))
    __mapper_args__ = {'polymorphic_identity': 'engineer'}
```

Combining Table/Mapper Arguments from Multiple Mixins

In the case of `__table_args__` or `__mapper_args__` specified with declarative mixins, you may want to combine some parameters from several mixins with those you wish to define on the class iteself. The `declared_attr` decorator can be used here to create user-defined collation routines that pull from multiple collections:

```
from sqlalchemy.ext.declarative import declared_attr

class MySQLSettings(object):
    __table_args__ = {'mysql_engine':'InnoDB'}

class MyOtherMixin(object):
    __table_args__ = {'info':'foo'}

class MyModel(MySQLSettings, MyOtherMixin, Base):
    __tablename__='my_model'

    @declared_attr
    def __table_args__(cls):
        args = dict()
        args.update(MySQLSettings.__table_args__)
        args.update(MyOtherMixin.__table_args__)
        return args

    id =  Column(Integer, primary_key=True)
```

Creating Indexes with Mixins

To define a named, potentially multicolumn `Index` that applies to all tables derived from a mixin, use the "inline" form of `Index` and establish it as part of `__table_args__`:

```
class MyMixin(object):
    a =  Column(Integer)
    b =  Column(Integer)

    @declared_attr
    def __table_args__(cls):
        return (Index('test_idx_%s' % cls.__tablename__, 'a', 'b'),)

class MyModel(MyMixin, Base):
    __tablename__ = 'atable'
    c =  Column(Integer,primary_key=True)
```

Special Directives

`__declare_last__()`

The `__declare_last__()` hook allows definition of a class level function that is automatically called by the `MapperEvents.after_configured()` event, which occurs after mappings are assumed to be completed and the 'configure' step has finished:

```
class MyClass(Base):
    @classmethod
    def __declare_last__(cls):
        ""
        # do something with mappings
```

New in version 0.7.3.

__abstract__

__abstract__ causes declarative to skip the production of a table or mapper for the class entirely. A class can be added within a hierarchy in the same way as mixin (see *Mixin and Custom Base Classes*), allowing subclasses to extend just from the special class:

```
class SomeAbstractBase(Base):
    __abstract__ = True

    def some_helpful_method(self):
        ""

    @declared_attr
    def __mapper_args__(cls):
        return {"helpful mapper arguments":True}

class MyMappedClass(SomeAbstractBase):
    ""
```

One possible use of __abstract__ is to use a distinct MetaData for different bases:

```
Base = declarative_base()

class DefaultBase(Base):
    __abstract__ = True
    metadata = MetaData()

class OtherBase(Base):
    __abstract__ = True
    metadata = MetaData()
```

Above, classes which inherit from DefaultBase will use one MetaData as the registry of tables, and those which inherit from OtherBase will use a different one. The tables themselves can then be created perhaps within distinct databases:

```
DefaultBase.metadata.create_all(some_engine)
OtherBase.metadata_create_all(some_other_engine)
```

New in version 0.7.3.

Class Constructor

As a convenience feature, the declarative_base() sets a default constructor on classes which takes keyword arguments, and assigns them to the named attributes:

```
e = Engineer(primary_language='python')
```

Sessions

Note that `declarative` does nothing special with sessions, and is only intended as an easier way to configure mappers and `Table` objects. A typical application setup using `scoped_session()` might look like:

```
engine = create_engine('postgresql://scott:tiger@localhost/test')
Session = scoped_session(sessionmaker(autocommit=False,
                                      autoflush=False,
                                      bind=engine))
Base = declarative_base()
```

Mapped instances then make usage of `Session` in the usual way.

API Reference

sqlalchemy.ext.declarative.**declarative_base**(*bind=None*, *metadata=None*, *mapper=None*, *cls=<type 'object'>*, *name='Base'*, *constructor=<function __init__ at 0x7fb7a466c578>*, *class_registry=None*, *metaclass=<class 'sqlalchemy.ext.declarative.DeclarativeMeta'>*)

Construct a base class for declarative class definitions.

The new base class will be given a metaclass that produces appropriate `Table` objects and makes the appropriate `mapper()` calls based on the information provided declaratively in the class and any subclasses of the class.

Parameters

- **bind** – An optional `Connectable`, will be assigned the `bind` attribute on the `MetaData` instance.
- **metadata** – An optional `MetaData` instance. All `Table` objects implicitly declared by subclasses of the base will share this MetaData. A MetaData instance will be created if none is provided. The `MetaData` instance will be available via the *metadata* attribute of the generated declarative base class.
- **mapper** – An optional callable, defaults to `mapper()`. Will be used to map subclasses to their Tables.
- **cls** – Defaults to `object`. A type to use as the base for the generated declarative base class. May be a class or tuple of classes.
- **name** – Defaults to `Base`. The display name for the generated class. Customizing this is not required, but can improve clarity in tracebacks and debugging.
- **constructor** – Defaults to `_declarative_constructor()`, an __init__ implementation that assigns **kwargs for declared fields and relationships to an instance. If `None` is supplied, no __init__ will be provided and construction will fall back to cls.__init__ by way of the normal Python semantics.
- **class_registry** – optional dictionary that will serve as the registry of class names-> mapped classes when string names are used to identify classes inside of `relationship()` and others. Allows two or more declarative base classes to share the same registry of class names for simplified inter-base relationships.

- **metaclass** – Defaults to `DeclarativeMeta`. A metaclass or __metaclass__ compatible callable to use as the meta type of the generated declarative base class.

class sqlalchemy.ext.declarative.**declared_attr**(*fget*, **arg*, ***kw*)

Mark a class-level method as representing the definition of a mapped property or special declarative member name.

Changed in version 0.6.{2,3,4}: `@declared_attr` is available as `sqlalchemy.util.classproperty` for SQLAlchemy versions 0.6.2, 0.6.3, 0.6.4.

@declared_attr turns the attribute into a scalar-like property that can be invoked from the uninstantiated class. Declarative treats attributes specifically marked with @declared_attr as returning a construct that is specific to mapping or declarative table configuration. The name of the attribute is that of what the non-dynamic version of the attribute would be.

@declared_attr is more often than not applicable to mixins, to define relationships that are to be applied to different implementors of the class:

```
class ProvidesUser(object):
    "A mixin that adds a 'user' relationship to classes."

    @declared_attr
    def user(self):
        return relationship("User")
```

It also can be applied to mapped classes, such as to provide a "polymorphic" scheme for inheritance:

```
class Employee(Base):
    id = Column(Integer, primary_key=True)
    type = Column(String(50), nullable=False)

    @declared_attr
    def __tablename__(cls):
        return cls.__name__.lower()

    @declared_attr
    def __mapper_args__(cls):
        if cls.__name__ == 'Employee':
            return {
                    "polymorphic_on":cls.type,
                    "polymorphic_identity":"Employee"
            }
        else:
            return {"polymorphic_identity":cls.__name__}
```

sqlalchemy.ext.declarative.**_declarative_constructor**(*self*, ***kwargs*)

A simple constructor that allows initialization from kwargs.

Sets attributes on the constructed instance using the names and values in `kwargs`.

Only keys that are present as attributes of the instance's class are allowed. These could be, for example, any mapped columns or relationships.

sqlalchemy.ext.declarative.**has_inherited_table**(*cls*)

Given a class, return True if any of the classes it inherits from has a mapped table, otherwise return False.

sqlalchemy.ext.declarative.**synonym_for**(*name*, *map_column=False*)

Decorator, make a Python @property a query synonym for a column.

A decorator version of `synonym()`. The function being decorated is the 'descriptor', otherwise passes its arguments through to synonym():

```
@synonym_for('col')
@property
def prop(self):
    return 'special sauce'
```

The regular `synonym()` is also usable directly in a declarative setting and may be convenient for read/write properties:

```
prop = synonym('col', descriptor=property(_read_prop, _write_prop))
```

sqlalchemy.ext.declarative.**comparable_using**(*comparator_factory*)
Decorator, allow a Python @property to be used in query criteria.

This is a decorator front end to `comparable_property()` that passes through the comparator_factory and the function being decorated:

```
@comparable_using(MyComparatorType)
@property
def prop(self):
    return 'special sauce'
```

The regular `comparable_property()` is also usable directly in a declarative setting and may be convenient for read/write properties:

```
prop = comparable_property(MyComparatorType)
```

sqlalchemy.ext.declarative.**instrument_declarative**(*cls*, *registry*, *metadata*)
Given a class, configure the class declaratively, using the given registry, which can be any dictionary, and MetaData object.

class sqlalchemy.ext.declarative.**AbstractConcreteBase**
A helper class for 'concrete' declarative mappings.

`AbstractConcreteBase` will use the `polymorphic_union()` function automatically, against all tables mapped as a subclass to this class. The function is called via the `__declare_last__()` function, which is essentially a hook for the `MapperEvents.after_configured()` event.

`AbstractConcreteBase` does not produce a mapped table for the class itself. Compare to `ConcreteBase`, which does.

Example:

```
from sqlalchemy.ext.declarative import ConcreteBase

class Employee(AbstractConcreteBase, Base):
    pass

class Manager(Employee):
    __tablename__ = 'manager'
    employee_id = Column(Integer, primary_key=True)
    name = Column(String(50))
    manager_data = Column(String(40))
    __mapper_args__ = {
                        'polymorphic_identity':'manager',
                        'concrete':True}
```

class sqlalchemy.ext.declarative.**ConcreteBase**
A helper class for 'concrete' declarative mappings.

`ConcreteBase` will use the `polymorphic_union()` function automatically, against all tables mapped as a subclass to this class. The function is called via the `__declare_last__()` function, which is essentially

a hook for the `MapperEvents.after_configured()` event.

`ConcreteBase` produces a mapped table for the class itself. Compare to `AbstractConcreteBase`, which does not.

Example:

```
from sqlalchemy.ext.declarative import ConcreteBase

class Employee(ConcreteBase, Base):
    __tablename__ = 'employee'
    employee_id = Column(Integer, primary_key=True)
    name = Column(String(50))
    __mapper_args__ = {
                    'polymorphic_identity':'employee',
                    'concrete':True}

class Manager(Employee):
    __tablename__ = 'manager'
    employee_id = Column(Integer, primary_key=True)
    name = Column(String(50))
    manager_data = Column(String(40))
    __mapper_args__ = {
                    'polymorphic_identity':'manager',
                    'concrete':True}
```

2.10.3 Mutation Tracking

Provide support for tracking of in-place changes to scalar values, which are propagated into ORM change events on owning parent objects.

The `sqlalchemy.ext.mutable` extension replaces SQLAlchemy's legacy approach to in-place mutations of scalar values, established by the `types.MutableType` class as well as the `mutable=True` type flag, with a system that allows change events to be propagated from the value to the owning parent, thereby removing the need for the ORM to maintain copies of values as well as the very expensive requirement of scanning through all "mutable" values on each flush call, looking for changes.

Establishing Mutability on Scalar Column Values

A typical example of a "mutable" structure is a Python dictionary. Following the example introduced in *Column and Data Types*, we begin with a custom type that marshals Python dictionaries into JSON strings before being persisted:

```
from sqlalchemy.types import TypeDecorator, VARCHAR
import json

class JSONEncodedDict(TypeDecorator):
    "Represents an immutable structure as a json-encoded string."

    impl = VARCHAR

    def process_bind_param(self, value, dialect):
        if value is not None:
            value = json.dumps(value)
        return value

    def process_result_value(self, value, dialect):
```

```
        if value is not None:
            value = json.loads(value)
        return value
```

The usage of `json` is only for the purposes of example. The `sqlalchemy.ext.mutable` extension can be used with any type whose target Python type may be mutable, including `PickleType`, `postgresql.ARRAY`, etc.

When using the `sqlalchemy.ext.mutable` extension, the value itself tracks all parents which reference it. Here we will replace the usage of plain Python dictionaries with a dict subclass that implements the `Mutable` mixin:

```
import collections
from sqlalchemy.ext.mutable import Mutable

class MutationDict(Mutable, dict):
    @classmethod
    def coerce(cls, key, value):
        "Convert plain dictionaries to MutationDict."

        if not isinstance(value, MutationDict):
            if isinstance(value, dict):
                return MutationDict(value)

            # this call will raise ValueError
            return Mutable.coerce(key, value)
        else:
            return value

    def __setitem__(self, key, value):
        "Detect dictionary set events and emit change events."

        dict.__setitem__(self, key, value)
        self.changed()

    def __delitem__(self, key):
        "Detect dictionary del events and emit change events."

        dict.__delitem__(self, key)
        self.changed()
```

The above dictionary class takes the approach of subclassing the Python built-in `dict` to produce a dict subclass which routes all mutation events through `__setitem__`. There are many variants on this approach, such as subclassing `UserDict.UserDict`, the newer `collections.MutableMapping`, etc. The part that's important to this example is that the `Mutable.changed()` method is called whenever an in-place change to the datastructure takes place.

We also redefine the `Mutable.coerce()` method which will be used to convert any values that are not instances of `MutationDict`, such as the plain dictionaries returned by the `json` module, into the appropriate type. Defining this method is optional; we could just as well created our `JSONEncodedDict` such that it always returns an instance of `MutationDict`, and additionally ensured that all calling code uses `MutationDict` explicitly. When `Mutable.coerce()` is not overridden, any values applied to a parent object which are not instances of the mutable type will raise a `ValueError`.

Our new `MutationDict` type offers a class method `as_mutable()` which we can use within column metadata to associate with types. This method grabs the given type object or class and associates a listener that will detect all future mappings of this type, applying event listening instrumentation to the mapped attribute. Such as, with classical table metadata:

```
from sqlalchemy import Table, Column, Integer

my_data = Table('my_data', metadata,
    Column('id', Integer, primary_key=True),
    Column('data', MutationDict.as_mutable(JSONEncodedDict))
)
```

Above, `as_mutable()` returns an instance of `JSONEncodedDict` (if the type object was not an instance already), which will intercept any attributes which are mapped against this type. Below we establish a simple mapping against the `my_data` table:

```
from sqlalchemy import mapper

class MyDataClass(object):
    pass

# associates mutation listeners with MyDataClass.data
mapper(MyDataClass, my_data)
```

The `MyDataClass.data` member will now be notified of in place changes to its value.

There's no difference in usage when using declarative:

```
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class MyDataClass(Base):
    __tablename__ = 'my_data'
    id = Column(Integer, primary_key=True)
    data = Column(MutationDict.as_mutable(JSONEncodedDict))
```

Any in-place changes to the `MyDataClass.data` member will flag the attribute as "dirty" on the parent object:

```
>>> from sqlalchemy.orm import Session

>>> sess = Session()
>>> m1 = MyDataClass(data={'value1':'foo'})
>>> sess.add(m1)
>>> sess.commit()

>>> m1.data['value1'] = 'bar'
>>> assert m1 in sess.dirty
True
```

The `MutationDict` can be associated with all future instances of `JSONEncodedDict` in one step, using `associate_with()`. This is similar to `as_mutable()` except it will intercept all occurrences of `MutationDict` in all mappings unconditionally, without the need to declare it individually:

```
MutationDict.associate_with(JSONEncodedDict)

class MyDataClass(Base):
    __tablename__ = 'my_data'
    id = Column(Integer, primary_key=True)
    data = Column(JSONEncodedDict)
```

Supporting Pickling

The key to the sqlalchemy.ext.mutable extension relies upon the placement of a weakref.WeakKeyDictionary upon the value object, which stores a mapping of parent mapped objects keyed to the attribute name under which they are associated with this value. WeakKeyDictionary objects are not picklable, due to the fact that they contain weakrefs and function callbacks. In our case, this is a good thing, since if this dictionary were picklable, it could lead to an excessively large pickle size for our value objects that are pickled by themselves outside of the context of the parent. The developer responsibility here is only to provide a __getstate__ method that excludes the _parents() collection from the pickle stream:

```
class MyMutableType(Mutable):
    def __getstate__(self):
        d = self.__dict__.copy()
        d.pop('_parents', None)
        return d
```

With our dictionary example, we need to return the contents of the dict itself (and also restore them on __setstate__):

```
class MutationDict(Mutable, dict):
    # ....

    def __getstate__(self):
        return dict(self)

    def __setstate__(self, state):
        self.update(state)
```

In the case that our mutable value object is pickled as it is attached to one or more parent objects that are also part of the pickle, the Mutable mixin will re-establish the Mutable._parents collection on each value object as the owning parents themselves are unpickled.

Establishing Mutability on Composites

Composites are a special ORM feature which allow a single scalar attribute to be assigned an object value which represents information "composed" from one or more columns from the underlying mapped table. The usual example is that of a geometric "point", and is introduced in *Composite Column Types*.

Changed in version 0.7: The internals of orm.composite() have been greatly simplified and in-place mutation detection is no longer enabled by default; instead, the user-defined value must detect changes on its own and propagate them to all owning parents. The sqlalchemy.ext.mutable extension provides the helper class MutableComposite, which is a slight variant on the Mutable class.

As is the case with Mutable, the user-defined composite class subclasses MutableComposite as a mixin, and detects and delivers change events to its parents via the MutableComposite.changed() method. In the case of a composite class, the detection is usually via the usage of Python descriptors (i.e. @property), or alternatively via the special Python method __setattr__(). Below we expand upon the Point class introduced in *Composite Column Types* to subclass MutableComposite and to also route attribute set events via __setattr__ to the MutableComposite.changed() method:

```
from sqlalchemy.ext.mutable import MutableComposite

class Point(MutableComposite):
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

```
    def __setattr__(self, key, value):
        "Intercept set events"

        # set the attribute
        object.__setattr__(self, key, value)

        # alert all parents to the change
        self.changed()

    def __composite_values__(self):
        return self.x, self.y

    def __eq__(self, other):
        return isinstance(other, Point) and \
            other.x == self.x and \
            other.y == self.y

    def __ne__(self, other):
        return not self.__eq__(other)
```

The `MutableComposite` class uses a Python metaclass to automatically establish listeners for any usage of `orm.composite()` that specifies our `Point` type. Below, when `Point` is mapped to the `Vertex` class, listeners are established which will route change events from `Point` objects to each of the `Vertex.start` and `Vertex.end` attributes:

```
from sqlalchemy.orm import composite, mapper
from sqlalchemy import Table, Column

vertices = Table('vertices', metadata,
    Column('id', Integer, primary_key=True),
    Column('x1', Integer),
    Column('y1', Integer),
    Column('x2', Integer),
    Column('y2', Integer),
    )

class Vertex(object):
    pass

mapper(Vertex, vertices, properties={
    'start': composite(Point, vertices.c.x1, vertices.c.y1),
    'end': composite(Point, vertices.c.x2, vertices.c.y2)
})
```

Any in-place changes to the `Vertex.start` or `Vertex.end` members will flag the attribute as "dirty" on the parent object:

```
>>> from sqlalchemy.orm import Session

>>> sess = Session()
>>> v1 = Vertex(start=Point(3, 4), end=Point(12, 15))
>>> sess.add(v1)
>>> sess.commit()

>>> v1.end.x = 8
```

```
>>> assert v1 in sess.dirty
True
```

Coercing Mutable Composites

The `MutableBase.coerce()` method is also supported on composite types. In the case of `MutableComposite`, the `MutableBase.coerce()` method is only called for attribute set operations, not load operations. Overriding the `MutableBase.coerce()` method is essentially equivalent to using a `validates()` validation routine for all attributes which make use of the custom composite type:

```
class Point(MutableComposite):
    # other Point methods
    # ...

    def coerce(cls, key, value):
        if isinstance(value, tuple):
            value = Point(*value)
        elif not isinstance(value, Point):
            raise ValueError("tuple or Point expected")
        return value
```

New in version 0.7.10,0.8.0b2: Support for the `MutableBase.coerce()` method in conjunction with objects of type `MutableComposite`.

Supporting Pickling

As is the case with `Mutable`, the `MutableComposite` helper class uses a `weakref.WeakKeyDictionary` available via the `MutableBase._parents()` attribute which isn't picklable. If we need to pickle instances of `Point` or its owning class `Vertex`, we at least need to define a `__getstate__` that doesn't include the `_parents` dictionary. Below we define both a `__getstate__` and a `__setstate__` that package up the minimal form of our `Point` class:

```
class Point(MutableComposite):
    # ...

    def __getstate__(self):
        return self.x, self.y

    def __setstate__(self, state):
        self.x, self.y = state
```

As with `Mutable`, the `MutableComposite` augments the pickling process of the parent's object-relational state so that the `MutableBase._parents()` collection is restored to all `Point` objects.

API Reference

class `sqlalchemy.ext.mutable.`**`MutableBase`**

Common base class to `Mutable` and `MutableComposite`.

`_parents`

Dictionary of parent object->attribute name on the parent.

This attribute is a so-called "memoized" property. It initializes itself with a new `weakref.WeakKeyDictionary` the first time it is accessed, returning the same object upon subsequent access.

classmethod coerce(*key*, *value*)
Given a value, coerce it into the target type.

Can be overridden by custom subclasses to coerce incoming data into a particular type.

By default, raises `ValueError`.

This method is called in different scenarios depending on if the parent class is of type `Mutable` or of type `MutableComposite`. In the case of the former, it is called for both attribute-set operations as well as during ORM loading operations. For the latter, it is only called during attribute-set operations; the mechanics of the `composite()` construct handle coercion during load operations.

Parameters

- **key** – string name of the ORM-mapped attribute being set.
- **value** – the incoming value.

Returns the method should return the coerced value, or raise `ValueError` if the coercion cannot be completed.

class sqlalchemy.ext.mutable.**Mutable**
Bases: `sqlalchemy.ext.mutable.MutableBase`

Mixin that defines transparent propagation of change events to a parent object.

See the example in *Establishing Mutability on Scalar Column Values* for usage information.

classmethod as_mutable(*sqltype*)
Associate a SQL type with this mutable Python type.

This establishes listeners that will detect ORM mappings against the given type, adding mutation event trackers to those mappings.

The type is returned, unconditionally as an instance, so that `as_mutable()` can be used inline:

```
Table('mytable', metadata,
    Column('id', Integer, primary_key=True),
    Column('data', MyMutableType.as_mutable(PickleType))
)
```

Note that the returned type is always an instance, even if a class is given, and that only columns which are declared specifically with that type instance receive additional instrumentation.

To associate a particular mutable type with all occurrences of a particular type, use the `Mutable.associate_with()` classmethod of the particular `Mutable()` subclass to establish a global association.

> **Warning:** The listeners established by this method are *global* to all mappers, and are *not* garbage collected. Only use `as_mutable()` for types that are permanent to an application, not with ad-hoc types else this will cause unbounded growth in memory usage.

classmethod associate_with(*sqltype*)
Associate this wrapper with all future mapped columns of the given type.

This is a convenience method that calls `associate_with_attribute` automatically.

> **Warning:** The listeners established by this method are *global* to all mappers, and are *not* garbage collected. Only use `associate_with()` for types that are permanent to an application, not with ad-hoc types else this will cause unbounded growth in memory usage.

classmethod associate_with_attribute(*attribute*)
Establish this type as a mutation listener for the given mapped descriptor.

changed()
Subclasses should call this method whenever change events occur.

class sqlalchemy.ext.mutable.**MutableComposite**
Bases: `sqlalchemy.ext.mutable.MutableBase`

Mixin that defines transparent propagation of change events on a SQLAlchemy "composite" object to its owning parent or parents.

See the example in *Establishing Mutability on Composites* for usage information.

> **Warning:** The listeners established by the `MutableComposite` class are *global* to all mappers, and are *not* garbage collected. Only use `MutableComposite` for types that are permanent to an application, not with ad-hoc types else this will cause unbounded growth in memory usage.

changed()
Subclasses should call this method whenever change events occur.

2.10.4 Ordering List

A custom list that manages index/position information for contained elements.

author Jason Kirtland

`orderinglist` is a helper for mutable ordered relationships. It will intercept list operations performed on a `relationship()`-managed collection and automatically synchronize changes in list position onto a target scalar attribute.

Example: A `slide` table, where each row refers to zero or more entries in a related `bullet` table. The bullets within a slide are displayed in order based on the value of the `position` column in the `bullet` table. As entries are reordered in memory, the value of the `position` attribute should be updated to reflect the new sort order:

```
Base = declarative_base()

class Slide(Base):
    __tablename__ = 'slide'

    id = Column(Integer, primary_key=True)
    name = Column(String)

    bullets = relationship("Bullet", order_by="Bullet.position")

class Bullet(Base):
    __tablename__ = 'bullet'
    id = Column(Integer, primary_key=True)
    slide_id = Column(Integer, ForeignKey('slide.id'))
    position = Column(Integer)
    text = Column(String)
```

The standard relationship mapping will produce a list-like attribute on each `Slide` containing all related `Bullet` objects, but coping with changes in ordering is not handled automatically. When appending a `Bullet` into `Slide.bullets`, the `Bullet.position` attribute will remain unset until manually assigned. When the `Bullet` is inserted into the middle of the list, the following `Bullet` objects will also need to be renumbered.

The `OrderingList` object automates this task, managing the `position` attribute on all `Bullet` objects in the collection. It is constructed using the `ordering_list()` factory:

```
from sqlalchemy.ext.orderinglist import ordering_list

Base = declarative_base()

class Slide(Base):
    __tablename__ = 'slide'

    id = Column(Integer, primary_key=True)
    name = Column(String)

    bullets = relationship("Bullet", order_by="Bullet.position",
                           collection_class=ordering_list('position'))

class Bullet(Base):
    __tablename__ = 'bullet'
    id = Column(Integer, primary_key=True)
    slide_id = Column(Integer, ForeignKey('slide.id'))
    position = Column(Integer)
    text = Column(String)
```

With the above mapping the `Bullet.position` attribute is managed:

```
s = Slide()
s.bullets.append(Bullet())
s.bullets.append(Bullet())
s.bullets[1].position
>>> 1
s.bullets.insert(1, Bullet())
s.bullets[2].position
>>> 2
```

The `OrderingList` construct only works with **changes** to a collection, and not the initial load from the database, and requires that the list be sorted when loaded. Therefore, be sure to specify `order_by` on the `relationship()` against the target ordering attribute, so that the ordering is correct when first loaded.

> **Warning:** `OrderingList` only provides limited functionality when a primary key column or unique column is the target of the sort. Since changing the order of entries often means that two rows must trade values, this is not possible when the value is constrained by a primary key or unique constraint, since one of the rows would temporarily have to point to a third available value so that the other row could take its old value. `OrderingList` doesn't do any of this for you, nor does SQLAlchemy itself.

`ordering_list()` takes the name of the related object's ordering attribute as an argument. By default, the zero-based integer index of the object's position in the `ordering_list()` is synchronized with the ordering attribute: index 0 will get position 0, index 1 position 1, etc. To start numbering at 1 or some other integer, provide `count_from=1`.

API Reference

sqlalchemy.ext.orderinglist.**ordering_list**(*attr*, *count_from=None*, ***kw*)
Prepares an OrderingList factory for use in mapper definitions.

Returns an object suitable for use as an argument to a Mapper relationship's collection_class option. e.g.:

```
from sqlalchemy.ext.orderinglist import ordering_list

class Slide(Base):
    __tablename__ = 'slide'

    id = Column(Integer, primary_key=True)
    name = Column(String)

    bullets = relationship("Bullet", order_by="Bullet.position",
                           collection_class=ordering_list('position'))
```

Parameters

- **attr** – Name of the mapped attribute to use for storage and retrieval of ordering information
- **count_from** – Set up an integer-based ordering, starting at count_from. For example, ordering_list('pos', count_from=1) would create a 1-based list in SQL, storing the value in the 'pos' column. Ignored if ordering_func is supplied.

Additional arguments are passed to the OrderingList constructor.

sqlalchemy.ext.orderinglist.**count_from_0**(*index*, *collection*)
Numbering function: consecutive integers starting at 0.

sqlalchemy.ext.orderinglist.**count_from_1**(*index*, *collection*)
Numbering function: consecutive integers starting at 1.

sqlalchemy.ext.orderinglist.**count_from_n_factory**(*start*)
Numbering function: consecutive integers starting at arbitrary start.

class sqlalchemy.ext.orderinglist.**OrderingList**(*ordering_attr=None*, *ordering_func=None*, *reorder_on_append=False*)
A custom list that manages position information for its children.

The OrderingList object is normally set up using the ordering_list() factory function, used in conjunction with the relationship() function.

__init__(*ordering_attr=None*, *ordering_func=None*, *reorder_on_append=False*)
A custom list that manages position information for its children.

OrderingList is a collection_class list implementation that syncs position in a Python list with a position attribute on the mapped objects.

This implementation relies on the list starting in the proper order, so be **sure** to put an order_by on your relationship.

Parameters

- **ordering_attr** – Name of the attribute that stores the object's order in the relationship.
- **ordering_func** – Optional. A function that maps the position in the Python list to a value to store in the ordering_attr. Values returned are usually (but need not be!) integers.

An `ordering_func` is called with two positional parameters: the index of the element in the list, and the list itself.

If omitted, Python list indexes are used for the attribute values. Two basic pre-built numbering functions are provided in this module: `count_from_0` and `count_from_1`. For more exotic examples like stepped numbering, alphabetical and Fibonacci numbering, see the unit tests.

- **reorder_on_append** – Default False. When appending an object with an existing (non-None) ordering value, that value will be left untouched unless `reorder_on_append` is true. This is an optimization to avoid a variety of dangerous unexpected database writes.

  SQLAlchemy will add instances to the list via append() when your object loads. If for some reason the result set from the database skips a step in the ordering (say, row '1' is missing but you get '2', '3', and '4'), reorder_on_append=True would immediately renumber the items to '1', '2', '3'. If you have multiple sessions making changes, any of whom happen to load this collection even in passing, all of the sessions would try to "clean up" the numbering in their commits, possibly causing all but one to fail with a concurrent modification error.

  Recommend leaving this with the default of False, and just call `reorder()` if you're doing `append()` operations with previously ordered instances or when doing some housekeeping after manual sql operations.

append(*entity*)
L.append(object) – append object to end

insert(*index*, *entity*)
L.insert(index, object) – insert object before index

pop([*index*]) → item – remove and return item at index (default last).
Raises IndexError if list is empty or index is out of range.

remove(*entity*)
L.remove(value) – remove first occurrence of value. Raises ValueError if the value is not present.

reorder()
Synchronize ordering for the entire collection.

Sweeps through the list and ensures that each object has accurate ordering information set.

2.10.5 Horizontal Sharding

Horizontal sharding support.

Defines a rudimental 'horizontal sharding' system which allows a Session to distribute queries and persistence operations across multiple databases.

For a usage example, see the *Horizontal Sharding* example included in the source distribution.

API Documentation

class sqlalchemy.ext.horizontal_shard.**ShardedSession**(*shard_chooser*, *id_chooser*, *query_chooser*, *shards=None*, *query_cls=<class 'sqlalchemy.ext.horizontal_shard.ShardedQuery'>*, ***kwargs*)

__init__(*shard_chooser*, *id_chooser*, *query_chooser*, *shards=None*, *query_cls=<class 'sqlalchemy.ext.horizontal_shard.ShardedQuery'>*, ***kwargs*)
Construct a ShardedSession.

Parameters

- **shard_chooser** – A callable which, passed a Mapper, a mapped instance, and possibly a SQL clause, returns a shard ID. This id may be based off of the attributes present within the object, or on some round-robin scheme. If the scheme is based on a selection, it should set whatever state on the instance to mark it in the future as participating in that shard.
- **id_chooser** – A callable, passed a query and a tuple of identity values, which should return a list of shard ids where the ID might reside. The databases will be queried in the order of this listing.
- **query_chooser** – For a given Query, returns the list of shard_ids where the query should be issued. Results from all shards returned will be combined together into a single listing.
- **shards** – A dictionary of string shard names to `Engine` objects.

class sqlalchemy.ext.horizontal_shard.**ShardedQuery**(**args*, ***kwargs*)

set_shard(*shard_id*)
return a new query, limited to a single shard ID.

all subsequent operations with the returned query will be against the single shard regardless of other state.

2.10.6 Hybrid Attributes

Define attributes on ORM-mapped classes that have "hybrid" behavior.

"hybrid" means the attribute has distinct behaviors defined at the class level and at the instance level.

The `hybrid` extension provides a special form of method decorator, is around 50 lines of code and has almost no dependencies on the rest of SQLAlchemy. It can, in theory, work with any descriptor-based expression system.

Consider a mapping `Interval`, representing integer `start` and `end` values. We can define higher level functions on mapped classes that produce SQL expressions at the class level, and Python expression evaluation at the instance level. Below, each function decorated with `hybrid_method` or `hybrid_property` may receive `self` as an instance of the class, or as the class itself:

```
from sqlalchemy import Column, Integer
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.orm import Session, aliased
from sqlalchemy.ext.hybrid import hybrid_property, hybrid_method

Base = declarative_base()

class Interval(Base):
    __tablename__ = 'interval'

    id = Column(Integer, primary_key=True)
    start = Column(Integer, nullable=False)
    end = Column(Integer, nullable=False)

    def __init__(self, start, end):
        self.start = start
```

```
        self.end = end

    @hybrid_property
    def length(self):
        return self.end - self.start

    @hybrid_method
    def contains(self,point):
        return (self.start <= point) & (point < self.end)

    @hybrid_method
    def intersects(self, other):
        return self.contains(other.start) | self.contains(other.end)
```

Above, the `length` property returns the difference between the `end` and `start` attributes. With an instance of `Interval`, this subtraction occurs in Python, using normal Python descriptor mechanics:

```
>>> i1 = Interval(5, 10)
>>> i1.length
5
```

When dealing with the `Interval` class itself, the `hybrid_property` descriptor evaluates the function body given the `Interval` class as the argument, which when evaluated with SQLAlchemy expression mechanics returns a new SQL expression:

```
>>> print Interval.length
interval."end" - interval.start

>>> print Session().query(Interval).filter(Interval.length > 10)
SELECT interval.id AS interval_id, interval.start AS interval_start,
interval."end" AS interval_end
FROM interval
WHERE interval."end" - interval.start > :param_1
```

ORM methods such as `filter_by()` generally use `getattr()` to locate attributes, so can also be used with hybrid attributes:

```
>>> print Session().query(Interval).filter_by(length=5)
SELECT interval.id AS interval_id, interval.start AS interval_start,
interval."end" AS interval_end
FROM interval
WHERE interval."end" - interval.start = :param_1
```

The `Interval` class example also illustrates two methods, `contains()` and `intersects()`, decorated with `hybrid_method`. This decorator applies the same idea to methods that `hybrid_property` applies to attributes. The methods return boolean values, and take advantage of the Python `|` and `&` bitwise operators to produce equivalent instance-level and SQL expression-level boolean behavior:

```
>>> i1.contains(6)
True
>>> i1.contains(15)
False
>>> i1.intersects(Interval(7, 18))
True
>>> i1.intersects(Interval(25, 29))
```

```
False

>>> print Session().query(Interval).filter(Interval.contains(15))
SELECT interval.id AS interval_id, interval.start AS interval_start,
interval."end" AS interval_end
FROM interval
WHERE interval.start <= :start_1 AND interval."end" > :end_1

>>> ia = aliased(Interval)
>>> print Session().query(Interval, ia).filter(Interval.intersects(ia))
SELECT interval.id AS interval_id, interval.start AS interval_start,
interval."end" AS interval_end, interval_1.id AS interval_1_id,
interval_1.start AS interval_1_start, interval_1."end" AS interval_1_end
FROM interval, interval AS interval_1
WHERE interval.start <= interval_1.start
    AND interval."end" > interval_1.start
    OR interval.start <= interval_1."end"
    AND interval."end" > interval_1."end"
```

Defining Expression Behavior Distinct from Attribute Behavior

Our usage of the `&` and `|` bitwise operators above was fortunate, considering our functions operated on two boolean values to return a new one. In many cases, the construction of an in-Python function and a SQLAlchemy SQL expression have enough differences that two separate Python expressions should be defined. The `hybrid` decorators define the `hybrid_property.expression()` modifier for this purpose. As an example we'll define the radius of the interval, which requires the usage of the absolute value function:

```
from sqlalchemy import func

class Interval(object):
    # ...

    @hybrid_property
    def radius(self):
        return abs(self.length) / 2

    @radius.expression
    def radius(cls):
        return func.abs(cls.length) / 2
```

Above the Python function `abs()` is used for instance-level operations, the SQL function `ABS()` is used via the `func` object for class-level expressions:

```
>>> i1.radius
2

>>> print Session().query(Interval).filter(Interval.radius > 5)
SELECT interval.id AS interval_id, interval.start AS interval_start,
    interval."end" AS interval_end
FROM interval
WHERE abs(interval."end" - interval.start) / :abs_1 > :param_1
```

Defining Setters

Hybrid properties can also define setter methods. If we wanted `length` above, when set, to modify the endpoint value:

```
class Interval(object):
    # ...

    @hybrid_property
    def length(self):
        return self.end - self.start

    @length.setter
    def length(self, value):
        self.end = self.start + value
```

The `length(self, value)` method is now called upon set:

```
>>> i1 = Interval(5, 10)
>>> i1.length
5
>>> i1.length = 12
>>> i1.end
17
```

Working with Relationships

There's no essential difference when creating hybrids that work with related objects as opposed to column-based data. The need for distinct expressions tends to be greater. Two variants of we'll illustrate are the "join-dependent" hybrid, and the "correlated subquery" hybrid.

Join-Dependent Relationship Hybrid

Consider the following declarative mapping which relates a `User` to a `SavingsAccount`:

```
from sqlalchemy import Column, Integer, ForeignKey, Numeric, String
from sqlalchemy.orm import relationship
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.ext.hybrid import hybrid_property

Base = declarative_base()

class SavingsAccount(Base):
    __tablename__ = 'account'
    id = Column(Integer, primary_key=True)
    user_id = Column(Integer, ForeignKey('user.id'), nullable=False)
    balance = Column(Numeric(15, 5))

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(100), nullable=False)

    accounts = relationship("SavingsAccount", backref="owner")
```

```
    @hybrid_property
    def balance(self):
        if self.accounts:
            return self.accounts[0].balance
        else:
            return None

    @balance.setter
    def balance(self, value):
        if not self.accounts:
            account = Account(owner=self)
        else:
            account = self.accounts[0]
        account.balance = balance

    @balance.expression
    def balance(cls):
        return SavingsAccount.balance
```

The above hybrid property `balance` works with the first `SavingsAccount` entry in the list of accounts for this user. The in-Python getter/setter methods can treat `accounts` as a Python list available on `self`.

However, at the expression level, it's expected that the `User` class will be used in an appropriate context such that an appropriate join to `SavingsAccount` will be present:

```
>>> print Session().query(User, User.balance).\
...     join(User.accounts).filter(User.balance > 5000)
SELECT "user".id AS user_id, "user".name AS user_name,
account.balance AS account_balance
FROM "user" JOIN account ON "user".id = account.user_id
WHERE account.balance > :balance_1
```

Note however, that while the instance level accessors need to worry about whether `self.accounts` is even present, this issue expresses itself differently at the SQL expression level, where we basically would use an outer join:

```
>>> from sqlalchemy import or_
>>> print (Session().query(User, User.balance).outerjoin(User.accounts).
...         filter(or_(User.balance < 5000, User.balance == None)))
SELECT "user".id AS user_id, "user".name AS user_name,
account.balance AS account_balance
FROM "user" LEFT OUTER JOIN account ON "user".id = account.user_id
WHERE account.balance <  :balance_1 OR account.balance IS NULL
```

Correlated Subquery Relationship Hybrid

We can, of course, forego being dependent on the enclosing query's usage of joins in favor of the correlated subquery, which can portably be packed into a single column expression. A correlated subquery is more portable, but often performs more poorly at the SQL level. Using the same technique illustrated at *Using column_property*, we can adjust our `SavingsAccount` example to aggregate the balances for *all* accounts, and use a correlated subquery for the column expression:

```
from sqlalchemy import Column, Integer, ForeignKey, Numeric, String
from sqlalchemy.orm import relationship
from sqlalchemy.ext.declarative import declarative_base
```

```
from sqlalchemy.ext.hybrid import hybrid_property
from sqlalchemy import select, func

Base = declarative_base()

class SavingsAccount(Base):
    __tablename__ = 'account'
    id = Column(Integer, primary_key=True)
    user_id = Column(Integer, ForeignKey('user.id'), nullable=False)
    balance = Column(Numeric(15, 5))

class User(Base):
    __tablename__ = 'user'
    id = Column(Integer, primary_key=True)
    name = Column(String(100), nullable=False)

    accounts = relationship("SavingsAccount", backref="owner")

    @hybrid_property
    def balance(self):
        return sum(acc.balance for acc in self.accounts)

    @balance.expression
    def balance(cls):
        return select([func.sum(SavingsAccount.balance)]).\
                where(SavingsAccount.user_id==cls.id).\
                label('total_balance')
```

The above recipe will give us the `balance` column which renders a correlated SELECT:

```
>>> print s.query(User).filter(User.balance > 400)
SELECT "user".id AS user_id, "user".name AS user_name
FROM "user"
WHERE (SELECT sum(account.balance) AS sum_1
FROM account
WHERE account.user_id = "user".id) > :param_1
```

Building Custom Comparators

The hybrid property also includes a helper that allows construction of custom comparators. A comparator object allows one to customize the behavior of each SQLAlchemy expression operator individually. They are useful when creating custom types that have some highly idiosyncratic behavior on the SQL side.

The example class below allows case-insensitive comparisons on the attribute named `word_insensitive`:

```
from sqlalchemy.ext.hybrid import Comparator, hybrid_property
from sqlalchemy import func, Column, Integer, String
from sqlalchemy.orm import Session
from sqlalchemy.ext.declarative import declarative_base

Base = declarative_base()

class CaseInsensitiveComparator(Comparator):
    def __eq__(self, other):
        return func.lower(self.__clause_element__()) == func.lower(other)
```

```
class SearchWord(Base):
    __tablename__ = 'searchword'
    id = Column(Integer, primary_key=True)
    word = Column(String(255), nullable=False)

    @hybrid_property
    def word_insensitive(self):
        return self.word.lower()

    @word_insensitive.comparator
    def word_insensitive(cls):
        return CaseInsensitiveComparator(cls.word)
```

Above, SQL expressions against `word_insensitive` will apply the `LOWER()` SQL function to both sides:

```
>>> print Session().query(SearchWord).filter_by(word_insensitive="Trucks")
SELECT searchword.id AS searchword_id, searchword.word AS searchword_word
FROM searchword
WHERE lower(searchword.word) = lower(:lower_1)
```

The `CaseInsensitiveComparator` above implements part of the `ColumnOperators` interface. A "coercion" operation like lowercasing can be applied to all comparison operations (i.e. `eq`, `lt`, `gt`, etc.) using `Operators.operate()`:

```
class CaseInsensitiveComparator(Comparator):
    def operate(self, op, other):
        return op(func.lower(self.__clause_element__()), func.lower(other))
```

Hybrid Value Objects

Note in our previous example, if we were to compare the `word_insensitive` attribute of a `SearchWord` instance to a plain Python string, the plain Python string would not be coerced to lower case - the `CaseInsensitiveComparator` we built, being returned by `@word_insensitive.comparator`, only applies to the SQL side.

A more comprehensive form of the custom comparator is to construct a *Hybrid Value Object*. This technique applies the target value or expression to a value object which is then returned by the accessor in all cases. The value object allows control of all operations upon the value as well as how compared values are treated, both on the SQL expression side as well as the Python value side. Replacing the previous `CaseInsensitiveComparator` class with a new `CaseInsensitiveWord` class:

```
class CaseInsensitiveWord(Comparator):
    "Hybrid value representing a lower case representation of a word."

    def __init__(self, word):
        if isinstance(word, basestring):
            self.word = word.lower()
        elif isinstance(word, CaseInsensitiveWord):
            self.word = word.word
        else:
            self.word = func.lower(word)

    def operate(self, op, other):
        if not isinstance(other, CaseInsensitiveWord):
```

```
            other = CaseInsensitiveWord(other)
        return op(self.word, other.word)

    def __clause_element__(self):
        return self.word

    def __str__(self):
        return self.word

    key = 'word'
    "Label to apply to Query tuple results"
```

Above, the `CaseInsensitiveWord` object represents `self.word`, which may be a SQL function, or may be a Python native. By overriding `operate()` and `__clause_element__()` to work in terms of `self.word`, all comparison operations will work against the "converted" form of `word`, whether it be SQL side or Python side. Our `SearchWord` class can now deliver the `CaseInsensitiveWord` object unconditionally from a single hybrid call:

```
class SearchWord(Base):
    __tablename__ = 'searchword'
    id = Column(Integer, primary_key=True)
    word = Column(String(255), nullable=False)

    @hybrid_property
    def word_insensitive(self):
        return CaseInsensitiveWord(self.word)
```

The `word_insensitive` attribute now has case-insensitive comparison behavior universally, including SQL expression vs. Python expression (note the Python value is converted to lower case on the Python side here):

```
>>> print Session().query(SearchWord).filter_by(word_insensitive="Trucks")
SELECT searchword.id AS searchword_id, searchword.word AS searchword_word
FROM searchword
WHERE lower(searchword.word) = :lower_1
```

SQL expression versus SQL expression:

```
>>> sw1 = aliased(SearchWord)
>>> sw2 = aliased(SearchWord)
>>> print Session().query(
...                     sw1.word_insensitive,
...                     sw2.word_insensitive).\
...                         filter(
...                             sw1.word_insensitive > sw2.word_insensitive
...                         )
SELECT lower(searchword_1.word) AS lower_1, lower(searchword_2.word) AS lower_2
FROM searchword AS searchword_1, searchword AS searchword_2
WHERE lower(searchword_1.word) > lower(searchword_2.word)
```

Python only expression:

```
>>> ws1 = SearchWord(word="SomeWord")
>>> ws1.word_insensitive == "sOmEwOrD"
True
>>> ws1.word_insensitive == "XOmEwOrX"
False
```

```
>>> print ws1.word_insensitive
someword
```

The Hybrid Value pattern is very useful for any kind of value that may have multiple representations, such as timestamps, time deltas, units of measurement, currencies and encrypted passwords.

See Also:

Hybrids and Value Agnostic Types - on the techspot.zzzeek.org blog

Value Agnostic Types, Part II - on the techspot.zzzeek.org blog

Building Transformers

A *transformer* is an object which can receive a `Query` object and return a new one. The `Query` object includes a method `with_transformation()` that simply returns a new `Query` transformed by the given function.

We can combine this with the `Comparator` class to produce one type of recipe which can both set up the FROM clause of a query as well as assign filtering criterion.

Consider a mapped class `Node`, which assembles using adjacency list into a hierarchical tree pattern:

```
from sqlalchemy import Column, Integer, ForeignKey
from sqlalchemy.orm import relationship
from sqlalchemy.ext.declarative import declarative_base
Base = declarative_base()

class Node(Base):
    __tablename__ = 'node'
    id =Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('node.id'))
    parent = relationship("Node", remote_side=id)
```

Suppose we wanted to add an accessor `grandparent`. This would return the `parent` of `Node.parent`. When we have an instance of `Node`, this is simple:

```
from sqlalchemy.ext.hybrid import hybrid_property

class Node(Base):
    # ...

    @hybrid_property
    def grandparent(self):
        return self.parent.parent
```

For the expression, things are not so clear. We'd need to construct a `Query` where we `join()` twice along `Node.parent` to get to the `grandparent`. We can instead return a transforming callable that we'll combine with the `Comparator` class to receive any `Query` object, and return a new one that's joined to the `Node.parent` attribute and filtered based on the given criterion:

```
from sqlalchemy.ext.hybrid import Comparator

class GrandparentTransformer(Comparator):
    def operate(self, op, other):
        def transform(q):
            cls = self.__clause_element__()
```

```
            parent_alias = aliased(cls)
            return q.join(parent_alias, cls.parent).\
                        filter(op(parent_alias.parent, other))
        return transform

Base = declarative_base()

class Node(Base):
    __tablename__ = 'node'
    id =Column(Integer, primary_key=True)
    parent_id = Column(Integer, ForeignKey('node.id'))
    parent = relationship("Node", remote_side=id)

    @hybrid_property
    def grandparent(self):
        return self.parent.parent

    @grandparent.comparator
    def grandparent(cls):
        return GrandparentTransformer(cls)
```

The `GrandparentTransformer` overrides the core `Operators.operate()` method at the base of the `Comparator` hierarchy to return a query-transforming callable, which then runs the given comparison operation in a particular context. Such as, in the example above, the `operate` method is called, given the `Operators.eq` callable as well as the right side of the comparison `Node(id=5)`. A function `transform` is then returned which will transform a `Query` first to join to `Node.parent`, then to compare `parent_alias` using `Operators.eq` against the left and right sides, passing into `Query.filter`:

```
>>> from sqlalchemy.orm import Session
>>> session = Session()
>>> session.query(Node).\
...         with_transformation(Node.grandparent==Node(id=5)).\
...         all()
SELECT node.id AS node_id, node.parent_id AS node_parent_id
FROM node JOIN node AS node_1 ON node_1.id = node.parent_id
WHERE :param_1 = node_1.parent_id
```

We can modify the pattern to be more verbose but flexible by separating the "join" step from the "filter" step. The tricky part here is ensuring that successive instances of `GrandparentTransformer` use the same `AliasedClass` object against `Node`. Below we use a simple memoizing approach that associates a `GrandparentTransformer` with each class:

```
class Node(Base):

    # ...

    @grandparent.comparator
    def grandparent(cls):
        # memoize a GrandparentTransformer
        # per class
        if '_gp' not in cls.__dict__:
            cls._gp = GrandparentTransformer(cls)
        return cls._gp

class GrandparentTransformer(Comparator):
```

```
    def __init__(self, cls):
        self.parent_alias = aliased(cls)

    @property
    def join(self):
        def go(q):
            return q.join(self.parent_alias, Node.parent)
        return go

    def operate(self, op, other):
        return op(self.parent_alias.parent, other)


>>> session.query(Node).\
...             with_transformation(Node.grandparent.join).\
...             filter(Node.grandparent==Node(id=5))
SELECT node.id AS node_id, node.parent_id AS node_parent_id
FROM node JOIN node AS node_1 ON node_1.id = node.parent_id
WHERE :param_1 = node_1.parent_id
```

The "transformer" pattern is an experimental pattern that starts to make usage of some functional programming paradigms. While it's only recommended for advanced and/or patient developers, there's probably a whole lot of amazing things it can be used for.

API Reference

class sqlalchemy.ext.hybrid.**hybrid_method**(*func*, *expr=None*)

A decorator which allows definition of a Python object method with both instance-level and class-level behavior.

__init__(*func*, *expr=None*)

Create a new hybrid_method.

Usage is typically via decorator:

```
from sqlalchemy.ext.hybrid import hybrid_method

class SomeClass(object):
    @hybrid_method
    def value(self, x, y):
        return self._value + x + y

    @value.expression
    def value(self, x, y):
        return func.some_function(self._value, x, y)
```

expression(*expr*)

Provide a modifying decorator that defines a SQL-expression producing method.

class sqlalchemy.ext.hybrid.**hybrid_property**(*fget*, *fset=None*, *fdel=None*, *expr=None*)

A decorator which allows definition of a Python descriptor with both instance-level and class-level behavior.

__init__(*fget*, *fset=None*, *fdel=None*, *expr=None*)

Create a new hybrid_property.

Usage is typically via decorator:

```
from sqlalchemy.ext.hybrid import hybrid_property

class SomeClass(object):
    @hybrid_property
    def value(self):
        return self._value

    @value.setter
    def value(self, value):
        self._value = value
```

comparator(*comparator*)
Provide a modifying decorator that defines a custom comparator producing method.

The return value of the decorated method should be an instance of `Comparator`.

deleter(*fdel*)
Provide a modifying decorator that defines a value-deletion method.

expression(*expr*)
Provide a modifying decorator that defines a SQL-expression producing method.

setter(*fset*)
Provide a modifying decorator that defines a value-setter method.

class sqlalchemy.ext.hybrid.**Comparator**(*expression*)
Bases: `sqlalchemy.orm.interfaces.PropComparator`

A helper class that allows easy construction of custom `PropComparator` classes for usage with hybrids.

2.10.7 SqlSoup

Changed in version 0.8: SQLSoup is now its own project. Documentation and project status are available at: http://pypi.python.org/pypi/sqlsoup and http://readthedocs.org/docs/sqlsoup. SQLSoup will no longer be included with SQLAlchemy.

Introduction

SqlSoup provides a convenient way to access existing database tables without having to declare table or mapper classes ahead of time. It is built on top of the SQLAlchemy ORM and provides a super-minimalistic interface to an existing database.

SqlSoup effectively provides a coarse grained, alternative interface to working with the SQLAlchemy ORM, providing a "self configuring" interface for extremely rudimental operations. It's somewhat akin to a "super novice mode" version of the ORM. While SqlSoup can be very handy, users are strongly encouraged to use the full ORM for non-trivial applications.

Suppose we have a database with users, books, and loans tables (corresponding to the PyWebOff dataset, if you're curious).

Creating a SqlSoup gateway is just like creating an SQLAlchemy engine:

```
>>> from sqlalchemy.ext.sqlsoup import SqlSoup
>>> db = SqlSoup('sqlite:///:memory:')
```

or, you can re-use an existing engine:

```
>>> db = SqlSoup(engine)
```

You can optionally specify a schema within the database for your SqlSoup:

```
>>> db.schema = myschemaname
```

Loading objects

Loading objects is as easy as this:

```
>>> users = db.users.all()
>>> users.sort()
>>> users
[
    MappedUsers(name=u'Joe Student',email=u'student@example.edu',
            password=u'student',classname=None,admin=0),
    MappedUsers(name=u'Bhargan Basepair',email=u'basepair@example.edu',
            password=u'basepair',classname=None,admin=1)
]
```

Of course, letting the database do the sort is better:

```
>>> db.users.order_by(db.users.name).all()
[
    MappedUsers(name=u'Bhargan Basepair',email=u'basepair@example.edu',
        password=u'basepair',classname=None,admin=1),
    MappedUsers(name=u'Joe Student',email=u'student@example.edu',
        password=u'student',classname=None,admin=0)
]
```

Field access is intuitive:

```
>>> users[0].email
u'student@example.edu'
```

Of course, you don't want to load all users very often. Let's add a WHERE clause. Let's also switch the order_by to DESC while we're at it:

```
>>> from sqlalchemy import or_, and_, desc
>>> where = or_(db.users.name=='Bhargan Basepair', db.users.email=='student@example.edu')
>>> db.users.filter(where).order_by(desc(db.users.name)).all()
[
    MappedUsers(name=u'Joe Student',email=u'student@example.edu',
        password=u'student',classname=None,admin=0),
    MappedUsers(name=u'Bhargan Basepair',email=u'basepair@example.edu',
        password=u'basepair',classname=None,admin=1)
]
```

You can also use .first() (to retrieve only the first object from a query) or .one() (like .first when you expect exactly one user – it will raise an exception if more were returned):

```
>>> db.users.filter(db.users.name=='Bhargan Basepair').one()
MappedUsers(name=u'Bhargan Basepair',email=u'basepair@example.edu',
        password=u'basepair',classname=None,admin=1)
```

Since name is the primary key, this is equivalent to

```
>>> db.users.get('Bhargan Basepair')
MappedUsers(name=u'Bhargan Basepair',email=u'basepair@example.edu',
    password=u'basepair',classname=None,admin=1)
```

This is also equivalent to

```
>>> db.users.filter_by(name='Bhargan Basepair').one()
MappedUsers(name=u'Bhargan Basepair',email=u'basepair@example.edu',
    password=u'basepair',classname=None,admin=1)
```

filter_by is like filter, but takes kwargs instead of full clause expressions. This makes it more concise for simple queries like this, but you can't do complex queries like the or_ above or non-equality based comparisons this way.

Full query documentation

Get, filter, filter_by, order_by, limit, and the rest of the query methods are explained in detail in *Querying*.

Modifying objects

Modifying objects is intuitive:

```
>>> user = _
>>> user.email = 'basepair+nospam@example.edu'
>>> db.commit()
```

(SqlSoup leverages the sophisticated SQLAlchemy unit-of-work code, so multiple updates to a single object will be turned into a single `UPDATE` statement when you commit.)

To finish covering the basics, let's insert a new loan, then delete it:

```
>>> book_id = db.books.filter_by(title='Regional Variation in Moss').first().id
>>> db.loans.insert(book_id=book_id, user_name=user.name)
MappedLoans(book_id=2,user_name=u'Bhargan Basepair',loan_date=None)

>>> loan = db.loans.filter_by(book_id=2, user_name='Bhargan Basepair').one()
>>> db.delete(loan)
>>> db.commit()
```

You can also delete rows that have not been loaded as objects. Let's do our insert/delete cycle once more, this time using the loans table's delete method. (For SQLAlchemy experts: note that no flush() call is required since this delete acts at the SQL level, not at the Mapper level.) The same where-clause construction rules apply here as to the select methods:

```
>>> db.loans.insert(book_id=book_id, user_name=user.name)
MappedLoans(book_id=2,user_name=u'Bhargan Basepair',loan_date=None)
>>> db.loans.delete(db.loans.book_id==2)
```

You can similarly update multiple rows at once. This will change the book_id to 1 in all loans whose book_id is 2:

```
>>> db.loans.filter_by(db.loans.book_id==2).update({'book_id':1})
>>> db.loans.filter_by(book_id=1).all()
[MappedLoans(book_id=1,user_name=u'Joe Student',
    loan_date=datetime.datetime(2006, 7, 12, 0, 0))]
```

Joins

Occasionally, you will want to pull out a lot of data from related tables all at once. In this situation, it is far more efficient to have the database perform the necessary join. (Here we do not have *a lot of data* but hopefully the concept is still clear.) SQLAlchemy is smart enough to recognize that loans has a foreign key to users, and uses that as the join condition automatically:

```
>>> join1 = db.join(db.users, db.loans, isouter=True)
>>> join1.filter_by(name='Joe Student').all()
[
    MappedJoin(name=u'Joe Student',email=u'student@example.edu',
        password=u'student',classname=None,admin=0,book_id=1,
        user_name=u'Joe Student',loan_date=datetime.datetime(2006, 7, 12, 0, 0))
]
```

If you're unfortunate enough to be using MySQL with the default MyISAM storage engine, you'll have to specify the join condition manually, since MyISAM does not store foreign keys. Here's the same join again, with the join condition explicitly specified:

```
>>> db.join(db.users, db.loans, db.users.name==db.loans.user_name, isouter=True)
<class 'sqlalchemy.ext.sqlsoup.MappedJoin'>
```

You can compose arbitrarily complex joins by combining Join objects with tables or other joins. Here we combine our first join with the books table:

```
>>> join2 = db.join(join1, db.books)
>>> join2.all()
[
    MappedJoin(name=u'Joe Student',email=u'student@example.edu',
        password=u'student',classname=None,admin=0,book_id=1,
        user_name=u'Joe Student',loan_date=datetime.datetime(2006, 7, 12, 0, 0),
        id=1,title=u'Mustards I Have Known',published_year=u'1989',
        authors=u'Jones')
]
```

If you join tables that have an identical column name, wrap your join with *with_labels*, to disambiguate columns with their table name (.c is short for .columns):

```
>>> db.with_labels(join1).c.keys()
[u'users_name', u'users_email', u'users_password',
    u'users_classname', u'users_admin', u'loans_book_id',
    u'loans_user_name', u'loans_loan_date']
```

You can also join directly to a labeled object:

```
>>> labeled_loans = db.with_labels(db.loans)
>>> db.join(db.users, labeled_loans, isouter=True).c.keys()
[u'name', u'email', u'password', u'classname',
    u'admin', u'loans_book_id', u'loans_user_name', u'loans_loan_date']
```

Relationships

You can define relationships on SqlSoup classes:

```
>>> db.users.relate('loans', db.loans)
```

These can then be used like a normal SA property:

```
>>> db.users.get('Joe Student').loans
[MappedLoans(book_id=1,user_name=u'Joe Student',
                loan_date=datetime.datetime(2006, 7, 12, 0, 0))]


>>> db.users.filter(~db.users.loans.any()).all()
[MappedUsers(name=u'Bhargan Basepair',
        email='basepair+nospam@example.edu',
        password=u'basepair',classname=None,admin=1)]
```

relate can take any options that the relationship function accepts in normal mapper definition:

```
>>> del db._cache['users']
>>> db.users.relate('loans', db.loans, order_by=db.loans.loan_date, cascade='all, delete-orphan')
```

Advanced Use

Sessions, Transactions and Application Integration

Note: Please read and understand this section thoroughly before using SqlSoup in any web application.

SqlSoup uses a ScopedSession to provide thread-local sessions. You can get a reference to the current one like this:

```
>>> session = db.session
```

The default session is available at the module level in SQLSoup, via:

```
>>> from sqlalchemy.ext.sqlsoup import Session
```

The configuration of this session is `autoflush=True`, `autocommit=False`. This means when you work with the SqlSoup object, you need to call `db.commit()` in order to have changes persisted. You may also call `db.rollback()` to roll things back.

Since the SqlSoup object's Session automatically enters into a transaction as soon as it's used, it is *essential* that you call `commit()` or `rollback()` on it when the work within a thread completes. This means all the guidelines for web application integration at *Using Thread-Local Scope with Web Applications* must be followed.

The SqlSoup object can have any session or scoped session configured onto it. This is of key importance when integrating with existing code or frameworks such as Pylons. If your application already has a `Session` configured, pass it to your SqlSoup object:

```
>>> from myapplication import Session
>>> db = SqlSoup(session=Session)
```

If the `Session` is configured with `autocommit=True`, use `flush()` instead of `commit()` to persist changes - in this case, the `Session` closes out its transaction immediately and no external management is needed. `rollback()` is also not available. Configuring a new SQLSoup object in "autocommit" mode looks like:

```
>>> from sqlalchemy.orm import scoped_session, sessionmaker
>>> db = SqlSoup('sqlite:///', session=scoped_session(sessionmaker(autoflush=False, expire_on_commit=F
```

Mapping arbitrary Selectables

SqlSoup can map any SQLAlchemy `Selectable` with the map method. Let's map an `expression.select()` object that uses an aggregate function; we'll use the SQLAlchemy `Table` that SqlSoup introspected as the basis. (Since we're not mapping to a simple table or join, we need to tell SQLAlchemy how to find the *primary key* which just needs to be unique within the select, and not necessarily correspond to a *real* PK in the database.):

```
>>> from sqlalchemy import select, func
>>> b = db.books._table
>>> s = select([b.c.published_year, func.count('*').label('n')], from_obj=[b], group_by=[b.c.publishe
>>> s = s.alias('years_with_count')
>>> years_with_count = db.map(s, primary_key=[s.c.published_year])
>>> years_with_count.filter_by(published_year='1989').all()
[MappedBooks(published_year=u'1989',n=1)]
```

Obviously if we just wanted to get a list of counts associated with book years once, raw SQL is going to be less work. The advantage of mapping a Select is reusability, both standalone and in Joins. (And if you go to full SQLAlchemy, you can perform mappings like this directly to your object models.)

An easy way to save mapped selectables like this is to just hang them on your db object:

```
>>> db.years_with_count = years_with_count
```

Python is flexible like that!

Raw SQL

SqlSoup works fine with SQLAlchemy's text construct, described in *Using Text*. You can also execute textual SQL directly using the *execute()* method, which corresponds to the *execute()* method on the underlying *Session*. Expressions here are expressed like `text()` constructs, using named parameters with colons:

```
>>> rp = db.execute('select name, email from users where name like :name order by name', name='%Bharg
>>> for name, email in rp.fetchall(): print name, email
Bhargan Basepair basepair+nospam@example.edu
```

Or you can get at the current transaction's connection using *connection()*. This is the raw connection object which can accept any sort of SQL expression or raw SQL string passed to the database:

```
>>> conn = db.connection()
>>> conn.execute("'select name, email from users where name like ? order by name'", '%Bhargan%')
```

Dynamic table names

You can load a table whose name is specified at runtime with the entity() method:

```
>>> tablename = 'loans'
>>> db.entity(tablename) == db.loans
True
```

entity() also takes an optional schema argument. If none is specified, the default schema is used.

SqlSoup API

class sqlalchemy.ext.sqlsoup.**SqlSoup**(*engine_or_metadata*, *base=<type 'object'>*, *session=None*)

Represent an ORM-wrapped database resource.

__init__(*engine_or_metadata*, *base=<type 'object'>*, *session=None*)

Initialize a new SqlSoup.

Parameters

- **engine_or_metadata** – a string database URL, Engine or MetaData object to associate with. If the argument is a MetaData, it should be *bound* to an Engine.
- **base** – a class which will serve as the default class for returned mapped classes. Defaults to object.
- **session** – a ScopedSession or Session with which to associate ORM operations for this SqlSoup instance. If None, a ScopedSession that's local to this module is used.

bind

The Engine associated with this SqlSoup.

clear()

Synonym for SqlSoup.expunge_all().

commit()

Commit the current transaction.

See Session.commit().

connection()

Return the current Connection in use by the current transaction.

delete(*instance*)

Mark an instance as deleted.

engine

The Engine associated with this SqlSoup.

entity(*attr*, *schema=None*)

Return the named entity from this SqlSoup, or create if not present.

For more generalized mapping, see map_to().

execute(*stmt*, ***params*)
Execute a SQL statement.

The statement may be a string SQL string, an `expression.select()` construct, or an `expression.text()` construct.

expunge(*instance*)
Remove an instance from the `Session`.

See `Session.expunge()`.

expunge_all()
Clear all objects from the current `Session`.

See `Session.expunge_all()`.

flush()
Flush pending changes to the database.

See `Session.flush()`.

join(*left*, *right*, *onclause=None*, *isouter=False*, *base=None*, ***mapper_args*)
Create an `expression.join()` and map to it.

Changed in version 0.6.6: The class and its mapping are not cached and will be discarded once dereferenced.

Parameters

- **left** – a mapped class or table object.
- **right** – a mapped class or table object.
- **onclause** – optional "ON" clause construct..
- **isouter** – if True, the join will be an OUTER join.
- **base** – a Python class which will be used as the base for the mapped class. If `None`, the "base" argument specified by this `SqlSoup` instance's constructor will be used, which defaults to `object`.
- **mapper_args** – Dictionary of arguments which will be passed directly to `orm.mapper()`.

map(*selectable*, *base=None*, ***mapper_args*)
Map a selectable directly.

Changed in version 0.6.6: The class and its mapping are not cached and will be discarded once dereferenced.

Parameters

- **selectable** – an `expression.select()` construct.
- **base** – a Python class which will be used as the base for the mapped class. If `None`, the "base" argument specified by this `SqlSoup` instance's constructor will be used, which defaults to `object`.
- **mapper_args** – Dictionary of arguments which will be passed directly to `orm.mapper()`.

map_to(*attrname*, *tablename=None*, *selectable=None*, *schema=None*, *base=None*, *mapper_args=immutabledict({})*)
Configure a mapping to the given attrname.

This is the "master" method that can be used to create any configuration.

New in version 0.6.6.

Parameters

- **attrname** – String attribute name which will be established as an attribute on this :class:.‘.SqlSoup‘ instance.
- **base** – a Python class which will be used as the base for the mapped class. If `None`, the “base” argument specified by this `SqlSoup` instance’s constructor will be used, which defaults to `object`.
- **mapper_args** – Dictionary of arguments which will be passed directly to `orm.mapper()`.
- **tablename** – String name of a `Table` to be reflected. If a `Table` is already available, use the `selectable` argument. This argument is mutually exclusive versus the `selectable` argument.
- **selectable** – a `Table`, `Join`, or `Select` object which will be mapped. This argument is mutually exclusive versus the `tablename` argument.
- **schema** – String schema name to use if the `tablename` argument is present.

rollback()
Rollback the current transaction.

See `Session.rollback()`.

with_labels(*selectable*, *base=None*, ***mapper_args*)
Map a selectable directly, wrapping the selectable in a subquery with labels.

Changed in version 0.6.6: The class and its mapping are not cached and will be discarded once dereferenced.

Parameters

- **selectable** – an `expression.select()` construct.
- **base** – a Python class which will be used as the base for the mapped class. If `None`, the “base” argument specified by this `SqlSoup` instance’s constructor will be used, which defaults to `object`.
- **mapper_args** – Dictionary of arguments which will be passed directly to `orm.mapper()`.

2.11 Examples

The SQLAlchemy distribution includes a variety of code examples illustrating a select set of patterns, some typical and some not so typical. All are runnable and can be found in the `/examples` directory of the distribution. Each example contains a README in its `__init__.py` file, each of which are listed below.

Additional SQLAlchemy examples, some user contributed, are available on the wiki at http://www.sqlalchemy.org/trac/wiki/UsageRecipes.

2.11.1 Adjacency List

Location: /examples/adjacency_list/ An example of a dictionary-of-dictionaries structure mapped using an adjacency list model.

E.g.:

```
node = TreeNode('rootnode')
node.append('node1')
node.append('node3')
session.add(node)
session.commit()

dump_tree(node)
```

2.11.2 Associations

Location: /examples/association/ Examples illustrating the usage of the "association object" pattern, where an intermediary class mediates the relationship between two classes that are associated in a many-to-many pattern.

This directory includes the following examples:

- basic_association.py - illustrate a many-to-many relationship between an "Order" and a collection of "Item" objects, associating a purchase price with each via an association object called "OrderItem"
- proxied_association.py - same example as basic_association, adding in usage of `sqlalchemy.ext.associationproxy` to make explicit references to "OrderItem" optional.
- dict_of_sets_with_default.py - an advanced association proxy example which illustrates nesting of association proxies to produce multi-level Python collections, in this case a dictionary with string keys and sets of integers as values, which conceal the underlying mapped classes.

2.11.3 Attribute Instrumentation

Location: /examples/custom_attributes/ Two examples illustrating modifications to SQLAlchemy's attribute management system.

`listen_for_events.py` illustrates the usage of `AttributeExtension` to intercept attribute events. It additionally illustrates a way to automatically attach these listeners to all class attributes using a `InstrumentationManager`.

`custom_management.py` illustrates much deeper usage of `InstrumentationManager` as well as collection adaptation, to completely change the underlying method used to store state on an object. This example was developed to illustrate techniques which would be used by other third party object instrumentation systems to interact with SQLAlchemy's event system and is only intended for very intricate framework integrations.

2.11.4 Beaker Caching

Location: /examples/beaker_caching/ Illustrates how to embed Beaker cache functionality within the Query object, allowing full cache control as well as the ability to pull "lazy loaded" attributes from long term cache as well.

In this demo, the following techniques are illustrated:

- Using custom subclasses of Query
- Basic technique of circumventing Query to pull from a custom cache source instead of the database.
- Rudimental caching with Beaker, using "regions" which allow global control over a fixed set of configurations.
- Using custom MapperOption objects to configure options on a Query, including the ability to invoke the options deep within an object graph when lazy loads occur.

E.g.:

```
# query for Person objects, specifying cache
q = Session.query(Person).options(FromCache("default", "all_people"))

# specify that each Person's "addresses" collection comes from
# cache too
q = q.options(RelationshipCache("default", "by_person", Person.addresses))

# query
print q.all()
```

To run, both SQLAlchemy and Beaker (1.4 or greater) must be installed or on the current PYTHONPATH. The demo will create a local directory for datafiles, insert initial data, and run. Running the demo a second time will utilize the cache files already present, and exactly one SQL statement against two tables will be emitted - the displayed result however will utilize dozens of lazyloads that all pull from cache.

The demo scripts themselves, in order of complexity, are run as follows:

```
python examples/beaker_caching/helloworld.py

python examples/beaker_caching/relationship_caching.py

python examples/beaker_caching/advanced.py

python examples/beaker_caching/local_session_caching.py
```

Listing of files:

environment.py - Establish the Session, the Beaker cache manager, data / cache file paths, and configurations, bootstrap fixture data if necessary.

caching_query.py - Represent functions and classes which allow the usage of Beaker caching with SQLAlchemy. Introduces a query option called FromCache.

model.py - The datamodel, which represents Person that has multiple Address objects, each with PostalCode, City, Country

fixture_data.py - creates demo PostalCode, Address, Person objects in the database.

helloworld.py - the basic idea.

relationship_caching.py - Illustrates how to add cache options on relationship endpoints, so that lazyloads load from cache.

advanced.py - Further examples of how to use FromCache. Combines techniques from the first two scripts.

local_session_caching.py - Grok everything so far ? This example creates a new Beaker container that will persist data in a dictionary which is local to the current session. remove() the session and the cache is gone.

2.11.5 Declarative Reflection

Location: /examples/declarative_reflection Illustrates how to mix table reflection with Declarative, such that the reflection process itself can take place **after** all classes are defined. Declarative classes can also override column definitions loaded from the database.

At the core of this example is the ability to change how Declarative assigns mappings to classes. The `__mapper_cls__` special attribute is overridden to provide a function that gathers mapping requirements as they

are established, without actually creating the mapping. Then, a second class-level method `prepare()` is used to iterate through all mapping configurations collected, reflect the tables named within and generate the actual mappers.

New in version 0.7.5: This new example makes usage of the new `autoload_replace` flag on `Table` to allow declared classes to override reflected columns.

Usage example:

```
Base = declarative_base(cls=DeclarativeReflectedBase)

class Foo(Base):
    __tablename__ = 'foo'
    bars = relationship("Bar")

class Bar(Base):
    __tablename__ = 'bar'

    # illustrate overriding of "bar.foo_id" to have
    # a foreign key constraint otherwise not
    # reflected, such as when using MySQL
    foo_id = Column(Integer, ForeignKey('foo.id'))

Base.prepare(e)

s = Session(e)

s.add_all([
    Foo(bars=[Bar(data='b1'), Bar(data='b2')], data='f1'),
    Foo(bars=[Bar(data='b3'), Bar(data='b4')], data='f2')
])
s.commit()
```

2.11.6 Directed Graphs

Location: /examples/graphs/ An example of persistence for a directed graph structure. The graph is stored as a collection of edges, each referencing both a "lower" and an "upper" node in a table of nodes. Basic persistence and querying for lower- and upper- neighbors are illustrated:

```
n2 = Node(2)
n5 = Node(5)
n2.add_neighbor(n5)
print n2.higher_neighbors()
```

2.11.7 Dynamic Relations as Dictionaries

Location: /examples/dynamic_dict/ Illustrates how to place a dictionary-like facade on top of a "dynamic" relation, so that dictionary operations (assuming simple string keys) can operate upon a large collection without loading the full collection at once.

2.11.8 Generic Associations

Location: /examples/generic_associations Illustrates various methods of associating multiple types of parents with a particular child object.

The examples all use the declarative extension along with declarative mixins. Each one presents the identical use case at the end - two classes, `Customer` and `Supplier`, both subclassing the `HasAddresses` mixin, which ensures that the parent class is provided with an `addresses` collection which contains `Address` objects.

The configurations include:

- `table_per_related.py` - illustrates a distinct table per related collection.
- `table_per_association.py` - illustrates a shared collection table, using a table per association.
- `discriminator_on_association.py` - shared collection table and shared association table, including a discriminator column.

The `discriminator_on_association.py` script in particular is a modernized version of the "polymorphic associations" example present in older versions of SQLAlchemy, originally from the blog post at http://techspot.zzzeek.org/2007/05/29/polymorphic-associations-with-sqlalchemy/.

2.11.9 Horizontal Sharding

Location: /examples/sharding A basic example of using the SQLAlchemy Sharding API. Sharding refers to horizontally scaling data across multiple databases.

The basic components of a "sharded" mapping are:

- multiple databases, each assigned a 'shard id'
- a function which can return a single shard id, given an instance to be saved; this is called "shard_chooser"
- a function which can return a list of shard ids which apply to a particular instance identifier; this is called "id_chooser". If it returns all shard ids, all shards will be searched.
- a function which can return a list of shard ids to try, given a particular Query ("query_chooser"). If it returns all shard ids, all shards will be queried and the results joined together.

In this example, four sqlite databases will store information about weather data on a database-per-continent basis. We provide example shard_chooser, id_chooser and query_chooser functions. The query_chooser illustrates inspection of the SQL expression element in order to attempt to determine a single shard being requested.

The construction of generic sharding routines is an ambitious approach to the issue of organizing instances among multiple databases. For a more plain-spoken alternative, the "distinct entity" approach is a simple method of assigning objects to different tables (and potentially database nodes) in an explicit way - described on the wiki at EntityName.

2.11.10 Inheritance Mappings

Location: /examples/inheritance/ Working examples of single-table, joined-table, and concrete-table inheritance as described in *datamapping_inheritance*.

2.11.11 Large Collections

Location: /examples/large_collection/ Large collection example.

Illustrates the options to use with `relationship()` when the list of related objects is very large, including:

- "dynamic" relationships which query slices of data as accessed
- how to use ON DELETE CASCADE in conjunction with `passive_deletes=True` to greatly improve the performance of related collection deletion.

2.11.12 Nested Sets

Location: /examples/nested_sets/ Illustrates a rudimentary way to implement the "nested sets" pattern for hierarchical data using the SQLAlchemy ORM.

2.11.13 Polymorphic Associations

See *Generic Associations* for a modern version of polymorphic associations.

2.11.14 PostGIS Integration

Location: /examples/postgis A naive example illustrating techniques to help embed PostGIS functionality.

This example was originally developed in the hopes that it would be extrapolated into a comprehensive PostGIS integration layer. We are pleased to announce that this has come to fruition as GeoAlchemy.

The example illustrates:

- a DDL extension which allows CREATE/DROP to work in conjunction with AddGeometryColumn/DropGeometryColumn
- a Geometry type, as well as a few subtypes, which convert result row values to a GIS-aware object, and also integrates with the DDL extension.
- a GIS-aware object which stores a raw geometry value and provides a factory for functions such as AsText().
- an ORM comparator which can override standard column methods on mapped objects to produce GIS operators.
- an attribute event listener that intercepts strings and converts to GeomFromText().
- a standalone operator example.

The implementation is limited to only public, well known and simple to use extension points.

E.g.:

```
print session.query(Road).filter(Road.road_geom.intersects(r1.road_geom)).all()
```

2.11.15 Versioned Objects

Location: /examples/versioning Illustrates an extension which creates version tables for entities and stores records for each change. The same idea as Elixir's versioned extension, but more efficient (uses attribute API to get history) and handles class inheritance. The given extensions generate an anonymous "history" class which represents historical versions of the target object.

Usage is illustrated via a unit test module `test_versioning.py`, which can be run via nose:

```
cd examples/versioning
nosetests -v
```

A fragment of example usage, using declarative:

```
from history_meta import Versioned, versioned_session

Base = declarative_base()

class SomeClass(Versioned, Base):
    __tablename__ = 'sometable'

    id = Column(Integer, primary_key=True)
    name = Column(String(50))

    def __eq__(self, other):
        assert type(other) is SomeClass and other.id == self.id

Session = sessionmaker(bind=engine)
versioned_session(Session)

sess = Session()
sc = SomeClass(name='sc1')
sess.add(sc)
sess.commit()

sc.name = 'sc1modified'
sess.commit()

assert sc.version == 2

SomeClassHistory = SomeClass.__history_mapper__.class_

assert sess.query(SomeClassHistory).\
            filter(SomeClassHistory.version == 1).\
            all() \
            == [SomeClassHistory(version=1, name='sc1')]
```

The `Versioned` mixin is designed to work with declarative. To use the extension with classical mappers, the `_history_mapper` function can be applied:

```
from history_meta import _history_mapper

m = mapper(SomeClass, sometable)
_history_mapper(m)

SomeHistoryClass = SomeClass.__history_mapper__.class_
```

2.11.16 Vertical Attribute Mapping

Location: /examples/vertical Illustrates "vertical table" mappings.

A "vertical table" refers to a technique where individual attributes of an object are stored as distinct rows in a table. The "vertical table" technique is used to persist objects which can have a varied set of attributes, at the expense of simple query control and brevity. It is commonly found in content/document management systems in order to represent user-created structures flexibly.

Two variants on the approach are given. In the second, each row references a "datatype" which contains information about the type of information stored in the attribute, such as integer, string, or date.

Example:

```
shrew = Animal(u'shrew')
shrew[u'cuteness'] = 5
shrew[u'weasel-like'] = False
shrew[u'poisonous'] = True

session.add(shrew)
session.flush()

q = (session.query(Animal).
     filter(Animal.facts.any(
       and_(AnimalFact.key == u'weasel-like',
            AnimalFact.value == True))))
print 'weasel-like animals', q.all()
```

2.11.17 XML Persistence

Location: /examples/elementtree/ Illustrates three strategies for persisting and querying XML documents as represented by ElementTree in a relational database. The techniques do not apply any mappings to the ElementTree objects directly, so are compatible with the native cElementTree as well as lxml, and can be adapted to suit any kind of DOM representation system. Querying along xpath-like strings is illustrated as well.

In order of complexity:

- `pickle.py` - Quick and dirty, serialize the whole DOM into a BLOB column. While the example is very brief, it has very limited functionality.
- `adjacency_list.py` - Each DOM node is stored in an individual table row, with attributes represented in a separate table. The nodes are associated in a hierarchy using an adjacency list structure. A query function is introduced which can search for nodes along any path with a given structure of attributes, basically a (very narrow) subset of xpath.
- `optimized_al.py` - Uses the same strategy as `adjacency_list.py`, but associates each DOM row with its owning document row, so that a full document of DOM nodes can be loaded using O(1) queries - the construction of the "hierarchy" is performed after the load in a non-recursive fashion and is much more efficient.

E.g.:

```
# parse an XML file and persist in the database
doc = ElementTree.parse("test.xml")
session.add(Document(file, doc))
session.commit()

# locate documents with a certain path/attribute structure
for document in find_document('/somefile/header/field2[@attr=foo]'):
    # dump the XML
    print document
```

This page has moved to *dep_interfaces_orm_toplevel*.

2.12 ORM Exceptions

SQLAlchemy ORM exceptions.

sqlalchemy.orm.exc.**ConcurrentModificationError**
alias of StaleDataError

exception sqlalchemy.orm.exc.**DetachedInstanceError**
Bases: sqlalchemy.exc.SQLAlchemyError

An attempt to access unloaded attributes on a mapped instance that is detached.

exception sqlalchemy.orm.exc.**FlushError**
Bases: sqlalchemy.exc.SQLAlchemyError

A invalid condition was detected during flush().

exception sqlalchemy.orm.exc.**MultipleResultsFound**
Bases: sqlalchemy.exc.InvalidRequestError

A single database result was required but more than one were found.

sqlalchemy.orm.exc.**NO_STATE = (<type 'exceptions.AttributeError'>, <type 'exceptions.KeyError'>)**
Exception types that may be raised by instrumentation implementations.

exception sqlalchemy.orm.exc.**NoResultFound**
Bases: sqlalchemy.exc.InvalidRequestError

A database result was required but none was found.

exception sqlalchemy.orm.exc.**ObjectDeletedError**(*state*, *msg=None*)
Bases: sqlalchemy.exc.InvalidRequestError

A refresh operation failed to retrieve the database row corresponding to an object's known primary key identity.

A refresh operation proceeds when an expired attribute is accessed on an object, or when Query.get() is used to retrieve an object which is, upon retrieval, detected as expired. A SELECT is emitted for the target row based on primary key; if no row is returned, this exception is raised.

The true meaning of this exception is simply that no row exists for the primary key identifier associated with a persistent object. The row may have been deleted, or in some cases the primary key updated to a new value, outside of the ORM's management of the target object.

exception sqlalchemy.orm.exc.**ObjectDereferencedError**
Bases: sqlalchemy.exc.SQLAlchemyError

An operation cannot complete due to an object being garbage collected.

exception sqlalchemy.orm.exc.**StaleDataError**
Bases: sqlalchemy.exc.SQLAlchemyError

An operation encountered database state that is unaccounted for.

Conditions which cause this to happen include:

- A flush may have attempted to update or delete rows and an unexpected number of rows were matched during the UPDATE or DELETE statement. Note that when version_id_col is used, rows in UPDATE or DELETE statements are also matched against the current known version identifier.
- A mapped object with version_id_col was refreshed, and the version number coming back from the database does not match that of the object itself.
- A object is detached from its parent object, however the object was previously attached to a different parent identity which was garbage collected, and a decision cannot be made if the new parent was really the most recent "parent".

New in version 0.7.4.

exception sqlalchemy.orm.exc.**UnmappedClassError**(*cls*, *msg=None*)
Bases: sqlalchemy.orm.exc.UnmappedError

An mapping operation was requested for an unknown class.

exception sqlalchemy.orm.exc.**UnmappedColumnError**
Bases: sqlalchemy.exc.InvalidRequestError

Mapping operation was requested on an unknown column.

exception sqlalchemy.orm.exc.**UnmappedError**
Bases: sqlalchemy.exc.InvalidRequestError

Base for exceptions that involve expected mappings not present.

exception sqlalchemy.orm.exc.**UnmappedInstanceError**(*obj*, *msg=None*)
Bases: sqlalchemy.orm.exc.UnmappedError

An mapping operation was requested for an unknown instance.

2.13 ORM Internals

Some key internal constructs are listed here.

class sqlalchemy.orm.instrumentation.**ClassManager**(*class_*)
Bases: dict

tracks state information at the class level.

dispose()
Dissasociate this manager from its class.

has_parent(*state*, *key*, *optimistic=False*)
TODO

manage()
Mark this instance as the manager for its class.

original_init
x.__init__(...) initializes x; see help(type(x)) for signature

state_getter()
Return a (instance) -> InstanceState callable.

"state getter" callables should raise either KeyError or AttributeError if no InstanceState could be found for the instance.

unregister()
remove all instrumentation established by this ClassManager.

class sqlalchemy.orm.properties.**ColumnProperty**(**columns*, ***kwargs*)
Bases: sqlalchemy.orm.interfaces.StrategizedProperty

Describes an object attribute that corresponds to a table column.

Public constructor is the orm.column_property() function.

__init__(**columns*, ***kwargs*)
Construct a ColumnProperty.

Note the public constructor is the orm.column_property() function.

Parameters

- ***columns** – The list of *columns* describes a single object property. If there are multiple tables joined together for the mapper, this list represents the equivalent column as it appears across each table.
- **group** –
- **deferred** –
- **comparator_factory** –
- **descriptor** –
- **expire_on_flush** –
- **extension** –

class sqlalchemy.orm.descriptor_props.**CompositeProperty**(*class_*, **attrs*, ***kwargs*)
Bases: sqlalchemy.orm.descriptor_props.DescriptorProperty

do_init()
Initialization which occurs after the CompositeProperty has been associated with its parent mapper.

get_history(*state*, *dict_*, *passive=<symbol 'PASSIVE_OFF>*)
Provided for userland code that uses attributes.get_history().

class sqlalchemy.orm.state.**InstanceState**(*obj*, *manager*)
Bases: object

tracks state information at the instance level.

__call__(*passive*)
__call__ allows the InstanceState to act as a deferred callable for loading expired attributes, which is also serializable (picklable).

commit(*dict_*, *keys*)
Commit attributes.

This is used by a partial-attribute load operation to mark committed those attributes which were refreshed from the database.

Attributes marked as "expired" can potentially remain "expired" after this step if a value was not populated in state.dict.

commit_all(*dict_*, *instance_dict=None*)
commit all attributes unconditionally.

This is used after a flush() or a full load/refresh to remove all pending state from the instance.

•all attributes are marked as "committed"

•the "strong dirty reference" is removed

•the "modified" flag is set to False

•any "expired" markers/callables for attributes loaded are removed.

Attributes marked as "expired" can potentially remain "expired" after this step if a value was not populated in state.dict.

expire_attribute_pre_commit(*dict_*, *key*)
a fast expire that can be called by column loaders during a load.

The additional bookkeeping is finished up in commit_all().

This method is actually called a lot with joined-table loading, when the second table isn't present in the result.

expired_attributes
Return the set of keys which are 'expired' to be loaded by the manager's deferred scalar loader, assuming no pending changes.

see also the `unmodified` collection which is intersected against this set when a refresh operation occurs.

initialize(*key*)
Set this attribute to an empty value or collection, based on the AttributeImpl in use.

reset(*dict_*, *key*)
Remove the given attribute and any callables associated with it.

set_callable(*dict_*, *key*, *callable_*)
Remove the given attribute and set the given callable as a loader.

unloaded
Return the set of keys which do not have a loaded value.

This includes expired attributes and any other attribute that was never populated or modified.

unmodified
Return the set of keys which have no uncommitted changes

unmodified_intersection(*keys*)
Return self.unmodified.intersection(keys).

value_as_iterable(*dict_*, *key*, *passive=<symbol 'PASSIVE_OFF>*)
Return a list of tuples (state, obj) for the given key.

returns an empty list if the value is None/empty/PASSIVE_NO_RESULT

class sqlalchemy.orm.interfaces.**MapperProperty**
Bases: object

Manage the relationship of a `Mapper` to a single class attribute, as well as that attribute as it appears on individual instances of the class, including attribute instrumentation, attribute access, loading behavior, and dependency calculations.

The most common occurrences of `MapperProperty` are the mapped `Column`, which is represented in a mapping as an instance of `ColumnProperty`, and a reference to another class produced by `relationship()`, represented in the mapping as an instance of `RelationshipProperty`.

cascade = ()
The set of 'cascade' attribute names.

This collection is checked before the 'cascade_iterator' method is called.

cascade_iterator(*type_*, *state*, *visited_instances=None*, *halt_on=None*)
Iterate through instances related to the given instance for a particular 'cascade', starting with this MapperProperty.

Return an iterator3-tuples (instance, mapper, state).

Note that the 'cascade' collection on this MapperProperty is checked first for the given type before cascade_iterator is called.

See PropertyLoader for the related instance implementation.

class_attribute
Return the class-bound descriptor corresponding to this MapperProperty.

compare(*operator*, *value*, ***kw*)
Return a compare operation for the columns represented by this `MapperProperty` to the given value,

which may be a column value or an instance. 'operator' is an operator from the operators module, or from sql.Comparator.

By default uses the PropComparator attached to this MapperProperty under the attribute name "comparator".

create_row_processor(*context*, *path*, *reduced_path*, *mapper*, *row*, *adapter*)
Return a 3-tuple consisting of three row processing functions.

do_init()
Perform subclass-specific initialization post-mapper-creation steps.

This is a template method called by the `MapperProperty` object's init() method.

init()
Called after all mappers are created to assemble relationships between mappers and perform other post-mapper-creation initialization steps.

is_primary()
Return True if this `MapperProperty`'s mapper is the primary mapper for its class.

This flag is used to indicate that the `MapperProperty` can define attribute instrumentation for the class at the class level (as opposed to the individual instance level).

merge(*session*, *source_state*, *source_dict*, *dest_state*, *dest_dict*, *load*, *_recursive*)
Merge the attribute represented by this `MapperProperty` from source to destination object

post_instrument_class(*mapper*)
Perform instrumentation adjustments that need to occur after init() has completed.

setup(*context*, *entity*, *path*, *reduced_path*, *adapter*, ***kwargs*)
Called by Query for the purposes of constructing a SQL statement.

Each MapperProperty associated with the target mapper processes the statement referenced by the query context, adding columns and/or criterion as appropriate.

class sqlalchemy.orm.interfaces.**PropComparator**(*prop*, *mapper*, *adapter=None*)
Bases: sqlalchemy.sql.operators.ColumnOperators

Defines comparison operations for MapperProperty objects.

User-defined subclasses of `PropComparator` may be created. The built-in Python comparison and math operator methods, such as `__eq__()`, `__lt__()`, `__add__()`, can be overridden to provide new operator behavior. The custom `PropComparator` is passed to the mapper property via the `comparator_factory` argument. In each case, the appropriate subclass of `PropComparator` should be used:

```
from sqlalchemy.orm.properties import \
                        ColumnProperty,\
                        CompositeProperty,\
                        RelationshipProperty

class MyColumnComparator(ColumnProperty.Comparator):
    pass

class MyCompositeComparator(CompositeProperty.Comparator):
    pass

class MyRelationshipComparator(RelationshipProperty.Comparator):
    pass
```

adapted(*adapter*)
Return a copy of this PropComparator which will use the given adaption function on the local side of generated expressions.

any(*criterion=None*, ***kwargs*)
Return true if this collection contains any member that meets the given criterion.

The usual implementation of `any()` is `RelationshipProperty.Comparator.any()`.

Parameters

- **criterion** – an optional ClauseElement formulated against the member class' table or attributes.
- ****kwargs** – key/value pairs corresponding to member class attribute names which will be compared via equality to the corresponding values.

has(*criterion=None*, ***kwargs*)
Return true if this element references a member which meets the given criterion.

The usual implementation of `has()` is `RelationshipProperty.Comparator.has()`.

Parameters

- **criterion** – an optional ClauseElement formulated against the member class' table or attributes.
- ****kwargs** – key/value pairs corresponding to member class attribute names which will be compared via equality to the corresponding values.

of_type(*class_*)
Redefine this object in terms of a polymorphic subclass.

Returns a new PropComparator from which further criterion can be evaluated.

e.g.:

```
query.join(Company.employees.of_type(Engineer)).\
   filter(Engineer.name=='foo')
```

Parameters **class_** – a class or mapper indicating that criterion will be against this specific subclass.

class sqlalchemy.orm.properties.**RelationshipProperty**(*argument*, *secondary=None*, *primaryjoin=None*, *secondaryjoin=None*, *foreign_keys=None*, *uselist=None*, *order_by=False*, *backref=None*, *back_populates=None*, *post_update=False*, *cascade=False*, *extension=None*, *viewonly=False*, *lazy=True*, *collection_class=None*, *passive_deletes=False*, *passive_updates=True*, *remote_side=None*, *enable_typechecks=True*, *join_depth=None*, *comparator_factory=None*, *single_parent=False*, *innerjoin=False*, *doc=None*, *active_history=False*, *cascade_backrefs=True*, *load_on_pending=False*, *strategy_class=None*, *_local_remote_pairs=None*, *query_class=None*)

Bases: sqlalchemy.orm.interfaces.StrategizedProperty

Describes an object property that holds a single item or list of items that correspond to a related database table.

Public constructor is the orm.relationship() function.

Of note here is the RelationshipProperty.Comparator class, which implements comparison operations for scalar- and collection-referencing mapped attributes.

class Comparator(*prop*, *mapper*, *of_type=None*, *adapter=None*)

Bases: sqlalchemy.orm.interfaces.PropComparator

Produce comparison operations for relationship()-based attributes.

__eq__(*other*)

Implement the == operator.

In a many-to-one context, such as:

```
MyClass.some_prop == <some object>
```

this will typically produce a clause such as:

```
mytable.related_id == <some id>
```

Where <some id> is the primary key of the given object.

The == operator provides partial functionality for non- many-to-one comparisons:

- Comparisons against collections are not supported. Use contains().
- Compared to a scalar one-to-many, will produce a clause that compares the target columns in the parent to the given target.
- Compared to a scalar many-to-many, an alias of the association table will be rendered as well, forming a natural join that is part of the main body of the query. This will not work for queries

that go beyond simple AND conjunctions of comparisons, such as those which use OR. Use explicit joins, outerjoins, or `has()` for more comprehensive non-many-to-one scalar membership tests.

- Comparisons against `None` given in a one-to-many or many-to-many context produce a NOT EXISTS clause.

__init__(*prop*, *mapper*, *of_type=None*, *adapter=None*)
Construction of `RelationshipProperty.Comparator` is internal to the ORM's attribute mechanics.

__ne__(*other*)
Implement the != operator.

In a many-to-one context, such as:

```
MyClass.some_prop != <some object>
```

This will typically produce a clause such as:

```
mytable.related_id != <some id>
```

Where `<some id>` is the primary key of the given object.

The != operator provides partial functionality for non- many-to-one comparisons:

- Comparisons against collections are not supported. Use `contains()` in conjunction with `not_()`.
- Compared to a scalar one-to-many, will produce a clause that compares the target columns in the parent to the given target.
- Compared to a scalar many-to-many, an alias of the association table will be rendered as well, forming a natural join that is part of the main body of the query. This will not work for queries that go beyond simple AND conjunctions of comparisons, such as those which use OR. Use explicit joins, outerjoins, or `has()` in conjunction with `not_()` for more comprehensive non-many-to-one scalar membership tests.
- Comparisons against `None` given in a one-to-many or many-to-many context produce an EXISTS clause.

adapted(*adapter*)
Return a copy of this PropComparator which will use the given adaption function on the local side of generated expressions.

any(*criterion=None*, ***kwargs*)
Produce an expression that tests a collection against particular criterion, using EXISTS.

An expression like:

```
session.query(MyClass).filter(
    MyClass.somereference.any(SomeRelated.x==2)
)
```

Will produce a query like:

```
SELECT * FROM my_table WHERE
EXISTS (SELECT 1 FROM related WHERE related.my_id=my_table.id
AND related.x=2)
```

Because `any()` uses a correlated subquery, its performance is not nearly as good when compared against large target tables as that of using a join.

`any()` is particularly useful for testing for empty collections:

```
session.query(MyClass).filter(
    ~MyClass.somereference.any()
)
```

will produce:

```
SELECT * FROM my_table WHERE
NOT EXISTS (SELECT 1 FROM related WHERE related.my_id=my_table.id)
```

`any()` is only valid for collections, i.e. a `relationship()` that has `uselist=True`. For scalar references, use `has()`.

contains(*other*, ***kwargs*)

Return a simple expression that tests a collection for containment of a particular item.

`contains()` is only valid for a collection, i.e. a `relationship()` that implements one-to-many or many-to-many with `uselist=True`.

When used in a simple one-to-many context, an expression like:

```
MyClass.contains(other)
```

Produces a clause like:

```
mytable.id == <some id>
```

Where `<some id>` is the value of the foreign key attribute on `other` which refers to the primary key of its parent object. From this it follows that `contains()` is very useful when used with simple one-to-many operations.

For many-to-many operations, the behavior of `contains()` has more caveats. The association table will be rendered in the statement, producing an "implicit" join, that is, includes multiple tables in the FROM clause which are equated in the WHERE clause:

```
query(MyClass).filter(MyClass.contains(other))
```

Produces a query like:

```
SELECT * FROM my_table, my_association_table AS
my_association_table_1 WHERE
my_table.id = my_association_table_1.parent_id
AND my_association_table_1.child_id = <some id>
```

Where `<some id>` would be the primary key of `other`. From the above, it is clear that `contains()` will **not** work with many-to-many collections when used in queries that move beyond simple AND conjunctions, such as multiple `contains()` expressions joined by OR. In such cases subqueries or explicit "outer joins" will need to be used instead. See `any()` for a less-performant alternative using EXISTS, or refer to `Query.outerjoin()` as well as *Querying with Joins* for more details on constructing outer joins.

has(*criterion=None*, ***kwargs*)

Produce an expression that tests a scalar reference against particular criterion, using EXISTS.

An expression like:

```
session.query(MyClass).filter(
    MyClass.somereference.has(SomeRelated.x==2)
)
```

Will produce a query like:

```
SELECT * FROM my_table WHERE
EXISTS (SELECT 1 FROM related WHERE related.id==my_table.related_id
AND related.x=2)
```

Because has() uses a correlated subquery, its performance is not nearly as good when compared against large target tables as that of using a join.

has() is only valid for scalar references, i.e. a relationship() that has uselist=False. For collection references, use any().

in_(*other*)
Produce an IN clause - this is not implemented for relationship()-based attributes at this time.

of_type(*cls*)
Produce a construct that represents a particular 'subtype' of attribute for the parent class.

Currently this is usable in conjunction with Query.join() and Query.outerjoin().

RelationshipProperty.**mapper**
Return the targeted Mapper for this RelationshipProperty.

This is a lazy-initializing static attribute.

RelationshipProperty.**table**
Return the selectable linked to this

Deprecated since version 0.7: Use .target

RelationshipProperty object's target Mapper.

class sqlalchemy.orm.descriptor_props.**SynonymProperty**(*name*, *map_column=None*, *descriptor=None*, *comparator_factory=None*, *doc=None*)
Bases: sqlalchemy.orm.descriptor_props.DescriptorProperty

class sqlalchemy.orm.query.**QueryContext**(*query*)
Bases: object

CHAPTER 3

SQLAlchemy Core

The breadth of SQLAlchemy's SQL rendering engine, DBAPI integration, transaction integration, and schema description services are documented here. In contrast to the ORM's domain-centric mode of usage, the SQL Expression Language provides a schema-centric usage paradigm.

3.1 SQL Expression Language Tutorial

The SQLAlchemy Expression Language presents a system of representing relational database structures and expressions using Python constructs. These constructs are modeled to resemble those of the underlying database as closely as possible, while providing a modicum of abstraction of the various implementation differences between database backends. While the constructs attempt to represent equivalent concepts between backends with consistent structures, they do not conceal useful concepts that are unique to particular subsets of backends. The Expression Language therefore presents a method of writing backend-neutral SQL expressions, but does not attempt to enforce that expressions are backend-neutral.

The Expression Language is in contrast to the Object Relational Mapper, which is a distinct API that builds on top of the Expression Language. Whereas the ORM, introduced in *Object Relational Tutorial*, presents a high level and abstracted pattern of usage, which itself is an example of applied usage of the Expression Language, the Expression Language presents a system of representing the primitive constructs of the relational database directly without opinion.

While there is overlap among the usage patterns of the ORM and the Expression Language, the similarities are more superficial than they may at first appear. One approaches the structure and content of data from the perspective of a user-defined domain model which is transparently persisted and refreshed from its underlying storage model. The other approaches it from the perspective of literal schema and SQL expression representations which are explicitly composed into messages consumed individually by the database.

A successful application may be constructed using the Expression Language exclusively, though the application will need to define its own system of translating application concepts into individual database messages and from individual database result sets. Alternatively, an application constructed with the ORM may, in advanced scenarios, make occasional usage of the Expression Language directly in certain areas where specific database interactions are required.

The following tutorial is in doctest format, meaning each >>> line represents something you can type at a Python command prompt, and the following text represents the expected return value. The tutorial has no prerequisites.

3.1.1 Version Check

A quick check to verify that we are on at least **version 0.7** of SQLAlchemy:

```
>>> import sqlalchemy
>>> sqlalchemy.__version__
0.7.0
```

3.1.2 Connecting

For this tutorial we will use an in-memory-only SQLite database. This is an easy way to test things without needing to have an actual database defined anywhere. To connect we use `create_engine()`:

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite:///:memory:', echo=True)
```

The `echo` flag is a shortcut to setting up SQLAlchemy logging, which is accomplished via Python's standard `logging` module. With it enabled, we'll see all the generated SQL produced. If you are working through this tutorial and want less output generated, set it to `False`. This tutorial will format the SQL behind a popup window so it doesn't get in our way; just click the "SQL" links to see what's being generated.

3.1.3 Define and Create Tables

The SQL Expression Language constructs its expressions in most cases against table columns. In SQLAlchemy, a column is most often represented by an object called `Column`, and in all cases a `Column` is associated with a `Table`. A collection of `Table` objects and their associated child objects is referred to as **database metadata**. In this tutorial we will explicitly lay out several `Table` objects, but note that SA can also "import" whole sets of `Table` objects automatically from an existing database (this process is called **table reflection**).

We define our tables all within a catalog called `MetaData`, using the `Table` construct, which resembles regular SQL CREATE TABLE statements. We'll make two tables, one of which represents "users" in an application, and another which represents zero or more "email addreses" for each row in the "users" table:

```
>>> from sqlalchemy import Table, Column, Integer, String, MetaData, ForeignKey
>>> metadata = MetaData()
>>> users = Table('users', metadata,
...     Column('id', Integer, primary_key=True),
...     Column('name', String),
...     Column('fullname', String),
... )

>>> addresses = Table('addresses', metadata,
...   Column('id', Integer, primary_key=True),
...   Column('user_id', None, ForeignKey('users.id')),
...   Column('email_address', String, nullable=False)
...  )
```

All about how to define `Table` objects, as well as how to create them from an existing database automatically, is described in *Schema Definition Language*.

Next, to tell the `MetaData` we'd actually like to create our selection of tables for real inside the SQLite database, we use `create_all()`, passing it the `engine` instance which points to our database. This will check for the presence of each table first before creating, so it's safe to call multiple times:

```
>>> metadata.create_all(engine)
PRAGMA table_info("users")
()
```

```
PRAGMA table_info("addresses")
()
CREATE TABLE users (
    id INTEGER NOT NULL,
    name VARCHAR,
    fullname VARCHAR,
    PRIMARY KEY (id)
)
()
COMMIT
CREATE TABLE addresses (
    id INTEGER NOT NULL,
    user_id INTEGER,
    email_address VARCHAR NOT NULL,
    PRIMARY KEY (id),
    FOREIGN KEY(user_id) REFERENCES users (id)
)
()
COMMIT
```

Note: Users familiar with the syntax of CREATE TABLE may notice that the VARCHAR columns were generated without a length; on SQLite and Postgresql, this is a valid datatype, but on others, it's not allowed. So if running this tutorial on one of those databases, and you wish to use SQLAlchemy to issue CREATE TABLE, a "length" may be provided to the `String` type as below:

```
Column('name', String(50))
```

The length field on `String`, as well as similar precision/scale fields available on `Integer`, `Numeric`, etc. are not referenced by SQLAlchemy other than when creating tables.

Additionally, Firebird and Oracle require sequences to generate new primary key identifiers, and SQLAlchemy doesn't generate or assume these without being instructed. For that, you use the `Sequence` construct:

```
from sqlalchemy import Sequence
Column('id', Integer, Sequence('user_id_seq'), primary_key=True)
```

A full, foolproof `Table` is therefore:

```
users = Table('users', metadata,
   Column('id', Integer, Sequence('user_id_seq'), primary_key=True),
   Column('name', String(50)),
   Column('fullname', String(50)),
   Column('password', String(12))
)
```

We include this more verbose `Table` construct separately to highlight the difference between a minimal construct geared primarily towards in-Python usage only, versus one that will be used to emit CREATE TABLE statements on a particular set of backends with more stringent requirements.

3.1.4 Insert Expressions

The first SQL expression we'll create is the `Insert` construct, which represents an INSERT statement. This is typically created relative to its target table:

```
>>> ins = users.insert()
```

To see a sample of the SQL this construct produces, use the `str()` function:

```
>>> str(ins)
'INSERT INTO users (id, name, fullname) VALUES (:id, :name, :fullname)'
```

Notice above that the INSERT statement names every column in the `users` table. This can be limited by using the `values()` method, which establishes the VALUES clause of the INSERT explicitly:

```
>>> ins = users.insert().values(name='jack', fullname='Jack Jones')
>>> str(ins)
'INSERT INTO users (name, fullname) VALUES (:name, :fullname)'
```

Above, while the `values` method limited the VALUES clause to just two columns, the actual data we placed in `values` didn't get rendered into the string; instead we got named bind parameters. As it turns out, our data *is* stored within our `Insert` construct, but it typically only comes out when the statement is actually executed; since the data consists of literal values, SQLAlchemy automatically generates bind parameters for them. We can peek at this data for now by looking at the compiled form of the statement:

```
>>> ins.compile().params
{'fullname': 'Jack Jones', 'name': 'jack'}
```

3.1.5 Executing

The interesting part of an `Insert` is executing it. In this tutorial, we will generally focus on the most explicit method of executing a SQL construct, and later touch upon some "shortcut" ways to do it. The `engine` object we created is a repository for database connections capable of issuing SQL to the database. To acquire a connection, we use the `connect()` method:

```
>>> conn = engine.connect()
>>> conn
<sqlalchemy.engine.base.Connection object at 0x...>
```

The `Connection` object represents an actively checked out DBAPI connection resource. Lets feed it our `Insert` object and see what happens:

```
>>> result = conn.execute(ins)
INSERT INTO users (name, fullname) VALUES (?, ?)
('jack', 'Jack Jones')
COMMIT
```

So the INSERT statement was now issued to the database. Although we got positional "qmark" bind parameters instead of "named" bind parameters in the output. How come ? Because when executed, the `Connection` used the SQLite **dialect** to help generate the statement; when we use the `str()` function, the statement isn't aware of this dialect, and falls back onto a default which uses named parameters. We can view this manually as follows:

```
>>> ins.bind = engine
>>> str(ins)
'INSERT INTO users (name, fullname) VALUES (?, ?)'
```

What about the `result` variable we got when we called `execute()` ? As the SQLAlchemy `Connection` object references a DBAPI connection, the result, known as a `ResultProxy` object, is analogous to the DBAPI cursor object. In the case of an INSERT, we can get important information from it, such as the primary key values which were generated from our statement:

```
>>> result.inserted_primary_key
[1]
```

The value of `1` was automatically generated by SQLite, but only because we did not specify the `id` column in our `Insert` statement; otherwise, our explicit value would have been used. In either case, SQLAlchemy always knows how to get at a newly generated primary key value, even though the method of generating them is different across different databases; each database's `Dialect` knows the specific steps needed to determine the correct value (or values; note that `inserted_primary_key` returns a list so that it supports composite primary keys).

3.1.6 Executing Multiple Statements

Our insert example above was intentionally a little drawn out to show some various behaviors of expression language constructs. In the usual case, an `Insert` statement is usually compiled against the parameters sent to the `execute()` method on `Connection`, so that there's no need to use the `values` keyword with `Insert`. Lets create a generic `Insert` statement again and use it in the "normal" way:

```
>>> ins = users.insert()
>>> conn.execute(ins, id=2, name='wendy', fullname='Wendy Williams')
INSERT INTO users (id, name, fullname) VALUES (?, ?, ?)
(2, 'wendy', 'Wendy Williams')
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>
```

Above, because we specified all three columns in the the `execute()` method, the compiled `Insert` included all three columns. The `Insert` statement is compiled at execution time based on the parameters we specified; if we specified fewer parameters, the `Insert` would have fewer entries in its VALUES clause.

To issue many inserts using DBAPI's `executemany()` method, we can send in a list of dictionaries each containing a distinct set of parameters to be inserted, as we do here to add some email addresses:

```
>>> conn.execute(addresses.insert(), [
...     {'user_id': 1, 'email_address' : 'jack@yahoo.com'},
...     {'user_id': 1, 'email_address' : 'jack@msn.com'},
...     {'user_id': 2, 'email_address' : 'www@www.org'},
...     {'user_id': 2, 'email_address' : 'wendy@aol.com'},
... ])
INSERT INTO addresses (user_id, email_address) VALUES (?, ?)
((1, 'jack@yahoo.com'), (1, 'jack@msn.com'), (2, 'www@www.org'), (2, 'wendy@aol.com'))
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>
```

Above, we again relied upon SQLite's automatic generation of primary key identifiers for each `addresses` row.

When executing multiple sets of parameters, each dictionary must have the **same** set of keys; i.e. you cant have fewer keys in some dictionaries than others. This is because the `Insert` statement is compiled against the **first** dictionary in the list, and it's assumed that all subsequent argument dictionaries are compatible with that statement.

3.1.7 Selecting

We began with inserts just so that our test database had some data in it. The more interesting part of the data is selecting it ! We'll cover UPDATE and DELETE statements later. The primary construct used to generate SELECT statements is the `select()` function:

```
>>> from sqlalchemy.sql import select
>>> s = select([users])
>>> result = conn.execute(s)
SELECT users.id, users.name, users.fullname
FROM users
()
```

Above, we issued a basic `select()` call, placing the `users` table within the COLUMNS clause of the select, and then executing. SQLAlchemy expanded the `users` table into the set of each of its columns, and also generated a FROM clause for us. The result returned is again a `ResultProxy` object, which acts much like a DBAPI cursor, including methods such as `fetchone()` and `fetchall()`. The easiest way to get rows from it is to just iterate:

```
>>> for row in result:
...     print row
(1, u'jack', u'Jack Jones')
(2, u'wendy', u'Wendy Williams')
(3, u'fred', u'Fred Flintstone')
(4, u'mary', u'Mary Contrary')
```

Above, we see that printing each row produces a simple tuple-like result. We have more options at accessing the data in each row. One very common way is through dictionary access, using the string names of columns:

```
>>> result = conn.execute(s)
SELECT users.id, users.name, users.fullname
FROM users
()

>>> row = result.fetchone()
>>> print "name:", row['name'], "; fullname:", row['fullname']
name: jack ; fullname: Jack Jones
```

Integer indexes work as well:

```
>>> row = result.fetchone()
>>> print "name:", row[1], "; fullname:", row[2]
name: wendy ; fullname: Wendy Williams
```

But another way, whose usefulness will become apparent later on, is to use the `Column` objects directly as keys:

```
>>> for row in conn.execute(s):
...     print "name:", row[users.c.name], "; fullname:", row[users.c.fullname]
SELECT users.id, users.name, users.fullname
FROM users
()
name: jack ; fullname: Jack Jones
name: wendy ; fullname: Wendy Williams
name: fred ; fullname: Fred Flintstone
name: mary ; fullname: Mary Contrary
```

Result sets which have pending rows remaining should be explicitly closed before discarding. While the cursor and connection resources referenced by the `ResultProxy` will be respectively closed and returned to the connection pool when the object is garbage collected, it's better to make it explicit as some database APIs are very picky about such things:

```
>>> result.close()
```

If we'd like to more carefully control the columns which are placed in the COLUMNS clause of the select, we reference individual `Column` objects from our `Table`. These are available as named attributes off the `c` attribute of the `Table` object:

```
>>> s = select([users.c.name, users.c.fullname])
>>> result = conn.execute(s)
SELECT users.name, users.fullname
FROM users
()
>>> for row in result:
...     print row
(u'jack', u'Jack Jones')
(u'wendy', u'Wendy Williams')
(u'fred', u'Fred Flintstone')
(u'mary', u'Mary Contrary')
```

Lets observe something interesting about the FROM clause. Whereas the generated statement contains two distinct sections, a "SELECT columns" part and a "FROM table" part, our `select()` construct only has a list containing columns. How does this work ? Let's try putting *two* tables into our `select()` statement:

```
>>> for row in conn.execute(select([users, addresses])):
...     print row
SELECT users.id, users.name, users.fullname, addresses.id, addresses.user_id, addresses.email_address
FROM users, addresses
()
(1, u'jack', u'Jack Jones', 1, 1, u'jack@yahoo.com')
(1, u'jack', u'Jack Jones', 2, 1, u'jack@msn.com')
(1, u'jack', u'Jack Jones', 3, 2, u'www@www.org')
(1, u'jack', u'Jack Jones', 4, 2, u'wendy@aol.com')
(2, u'wendy', u'Wendy Williams', 1, 1, u'jack@yahoo.com')
(2, u'wendy', u'Wendy Williams', 2, 1, u'jack@msn.com')
(2, u'wendy', u'Wendy Williams', 3, 2, u'www@www.org')
(2, u'wendy', u'Wendy Williams', 4, 2, u'wendy@aol.com')
(3, u'fred', u'Fred Flintstone', 1, 1, u'jack@yahoo.com')
(3, u'fred', u'Fred Flintstone', 2, 1, u'jack@msn.com')
(3, u'fred', u'Fred Flintstone', 3, 2, u'www@www.org')
(3, u'fred', u'Fred Flintstone', 4, 2, u'wendy@aol.com')
(4, u'mary', u'Mary Contrary', 1, 1, u'jack@yahoo.com')
(4, u'mary', u'Mary Contrary', 2, 1, u'jack@msn.com')
(4, u'mary', u'Mary Contrary', 3, 2, u'www@www.org')
(4, u'mary', u'Mary Contrary', 4, 2, u'wendy@aol.com')
```

It placed **both** tables into the FROM clause. But also, it made a real mess. Those who are familiar with SQL joins know that this is a **Cartesian product**; each row from the `users` table is produced against each row from the `addresses` table. So to put some sanity into this statement, we need a WHERE clause. Which brings us to the second argument of `select()`:

```
>>> s = select([users, addresses], users.c.id==addresses.c.user_id)
>>> for row in conn.execute(s):
...     print row
SELECT users.id, users.name, users.fullname, addresses.id, addresses.user_id, addresses.email_address
FROM users, addresses
WHERE users.id = addresses.user_id
()
(1, u'jack', u'Jack Jones', 1, 1, u'jack@yahoo.com')
(1, u'jack', u'Jack Jones', 2, 1, u'jack@msn.com')
(2, u'wendy', u'Wendy Williams', 3, 2, u'www@www.org')
(2, u'wendy', u'Wendy Williams', 4, 2, u'wendy@aol.com')
```

So that looks a lot better, we added an expression to our `select()` which had the effect of adding `WHERE users.id = addresses.user_id` to our statement, and our results were managed down so that the join of `users` and `addresses` rows made sense. But let's look at that expression? It's using just a Python equality operator between two different `Column` objects. It should be clear that something is up. Saying `1==1` produces `True`, and `1==2` produces `False`, not a WHERE clause. So lets see exactly what that expression is doing:

```
>>> users.c.id==addresses.c.user_id
<sqlalchemy.sql.expression._BinaryExpression object at 0x...>
```

Wow, surprise ! This is neither a `True` nor a `False`. Well what is it ?

```
>>> str(users.c.id==addresses.c.user_id)
'users.id = addresses.user_id'
```

As you can see, the == operator is producing an object that is very much like the `Insert` and `select()` objects we've made so far, thanks to Python's `__eq__()` builtin; you call `str()` on it and it produces SQL. By now, one can see that everything we are working with is ultimately the same type of object. SQLAlchemy terms the base class of all of these expressions as `sqlalchemy.sql.ClauseElement`.

3.1.8 Operators

Since we've stumbled upon SQLAlchemy's operator paradigm, let's go through some of its capabilities. We've seen how to equate two columns to each other:

```
>>> print users.c.id==addresses.c.user_id
users.id = addresses.user_id
```

If we use a literal value (a literal meaning, not a SQLAlchemy clause object), we get a bind parameter:

```
>>> print users.c.id==7
users.id = :id_1
```

The `7` literal is embedded in `ClauseElement`; we can use the same trick we did with the `Insert` object to see it:

```
>>> (users.c.id==7).compile().params
{u'id_1': 7}
```

Most Python operators, as it turns out, produce a SQL expression here, like equals, not equals, etc.:

```
>>> print users.c.id != 7
users.id != :id_1

>>> # None converts to IS NULL
>>> print users.c.name == None
users.name IS NULL

>>> # reverse works too
>>> print 'fred' > users.c.name
users.name < :name_1
```

If we add two integer columns together, we get an addition expression:

```
>>> print users.c.id + addresses.c.id
users.id + addresses.id
```

Interestingly, the type of the `Column` is important ! If we use + with two string based columns (recall we put types like `Integer` and `String` on our `Column` objects at the beginning), we get something different:

```
>>> print users.c.name + users.c.fullname
users.name || users.fullname
```

Where `||` is the string concatenation operator used on most databases. But not all of them. MySQL users, fear not:

```
>>> print (users.c.name + users.c.fullname).compile(bind=create_engine('mysql://'))
concat(users.name, users.fullname)
```

The above illustrates the SQL that's generated for an `Engine` that's connected to a MySQL database; the `||` operator now compiles as MySQL's `concat()` function.

If you have come across an operator which really isn't available, you can always use the `op()` method; this generates whatever operator you need:

```
>>> print users.c.name.op('tiddlywinks')('foo')
users.name tiddlywinks :name_1
```

This function can also be used to make bitwise operators explicit. For example:

```
somecolumn.op('&')(0xff)
```

is a bitwise AND of the value in *somecolumn*.

3.1.9 Conjunctions

We'd like to show off some of our operators inside of `select()` constructs. But we need to lump them together a little more, so let's first introduce some conjunctions. Conjunctions are those little words like AND and OR that put things together. We'll also hit upon NOT. AND, OR and NOT can work from the corresponding functions SQLAlchemy provides (notice we also throw in a LIKE):

```
>>> from sqlalchemy.sql import and_, or_, not_
>>> print and_(users.c.name.like('j%'), users.c.id==addresses.c.user_id,
...     or_(addresses.c.email_address=='wendy@aol.com', addresses.c.email_address=='jack@yahoo.com'),
...     not_(users.c.id>5))
```

```
users.name LIKE :name_1 AND users.id = addresses.user_id AND
(addresses.email_address = :email_address_1 OR addresses.email_address = :email_address_2)
AND users.id <= :id_1
```

And you can also use the re-jiggered bitwise AND, OR and NOT operators, although because of Python operator precedence you have to watch your parenthesis:

```
>>> print users.c.name.like('j%') & (users.c.id==addresses.c.user_id) &  \
...     ((addresses.c.email_address=='wendy@aol.com') | (addresses.c.email_address=='jack@yahoo.com')
...     & ~(users.c.id>5)
users.name LIKE :name_1 AND users.id = addresses.user_id AND
(addresses.email_address = :email_address_1 OR addresses.email_address = :email_address_2)
AND users.id <= :id_1
```

So with all of this vocabulary, let's select all users who have an email address at AOL or MSN, whose name starts with a letter between "m" and "z", and we'll also generate a column containing their full name combined with their email address. We will add two new constructs to this statement, `between()` and `label()`. `between()` produces a BETWEEN clause, and `label()` is used in a column expression to produce labels using the `AS` keyword; it's recommended when selecting from expressions that otherwise would not have a name:

```
>>> s = select([(users.c.fullname + ", " + addresses.c.email_address).label('title')],
...         and_(
...             users.c.id==addresses.c.user_id,
...             users.c.name.between('m', 'z'),
...            or_(
...               addresses.c.email_address.like('%@aol.com'),
...               addresses.c.email_address.like('%@msn.com')
...            )
...         )
...     )
>>> print conn.execute(s).fetchall()
SELECT users.fullname || ? || addresses.email_address AS title
FROM users, addresses
WHERE users.id = addresses.user_id AND users.name BETWEEN ? AND ? AND
(addresses.email_address LIKE ? OR addresses.email_address LIKE ?)
(', ', 'm', 'z', '%@aol.com', '%@msn.com')
[(u'Wendy Williams, wendy@aol.com',)]
```

Once again, SQLAlchemy figured out the FROM clause for our statement. In fact it will determine the FROM clause based on all of its other bits; the columns clause, the where clause, and also some other elements which we haven't covered yet, which include ORDER BY, GROUP BY, and HAVING.

3.1.10 Using Text

Our last example really became a handful to type. Going from what one understands to be a textual SQL expression into a Python construct which groups components together in a programmatic style can be hard. That's why SQLAlchemy lets you just use strings too. The `text()` construct represents any textual statement. To use bind parameters with `text()`, always use the named colon format. Such as below, we create a `text()` and execute it, feeding in the bind parameters to the `execute()` method:

```
>>> from sqlalchemy.sql import text
>>> s = text("""SELECT users.fullname || ', ' || addresses.email_address AS title
...             FROM users, addresses
...             WHERE users.id = addresses.user_id AND users.name BETWEEN :x AND :y AND
```

```
...             (addresses.email_address LIKE :e1 OR addresses.email_address LIKE :e2)
...         """)
>>> print conn.execute(s, x='m', y='z', e1='%@aol.com', e2='%@msn.com').fetchall()
SELECT users.fullname || ', ' || addresses.email_address AS title
FROM users, addresses
WHERE users.id = addresses.user_id AND users.name BETWEEN ? AND ? AND
(addresses.email_address LIKE ? OR addresses.email_address LIKE ?)
('m', 'z', '%@aol.com', '%@msn.com')
[(u'Wendy Williams, wendy@aol.com',)]
```

To gain a "hybrid" approach, the *select()* construct accepts strings for most of its arguments. Below we combine the usage of strings with our constructed `select()` object, by using the `select()` object to structure the statement, and strings to provide all the content within the structure. For this example, SQLAlchemy is not given any `Column` or `Table` objects in any of its expressions, so it cannot generate a FROM clause. So we also give it the `from_obj` keyword argument, which is a list of `ClauseElements` (or strings) to be placed within the FROM clause:

```
>>> s = select(["users.fullname || ', ' || addresses.email_address AS title"],
...         and_(
...             "users.id = addresses.user_id",
...              "users.name BETWEEN 'm' AND 'z'",
...              "(addresses.email_address LIKE :x OR addresses.email_address LIKE :y)"
...         ),
...          from_obj=['users', 'addresses']
...     )
>>> print conn.execute(s, x='%@aol.com', y='%@msn.com').fetchall()
SELECT users.fullname || ', ' || addresses.email_address AS title
FROM users, addresses
WHERE users.id = addresses.user_id AND users.name BETWEEN 'm' AND 'z' AND (addresses.email_address LI
('%@aol.com', '%@msn.com')
[(u'Wendy Williams, wendy@aol.com',)]
```

Going from constructed SQL to text, we lose some capabilities. We lose the capability for SQLAlchemy to compile our expression to a specific target database; above, our expression won't work with MySQL since it has no `||` construct. It also becomes more tedious for SQLAlchemy to be made aware of the datatypes in use; for example, if our bind parameters required UTF-8 encoding before going in, or conversion from a Python `datetime` into a string (as is required with SQLite), we would have to add extra information to our `text()` construct. Similar issues arise on the result set side, where SQLAlchemy also performs type-specific data conversion in some cases; still more information can be added to `text()` to work around this. But what we really lose from our statement is the ability to manipulate it, transform it, and analyze it. These features are critical when using the ORM, which makes heavy usage of relational transformations. To show off what we mean, we'll first introduce the ALIAS construct and the JOIN construct, just so we have some juicier bits to play with.

3.1.11 Using Aliases

The alias in SQL corresponds to a "renamed" version of a table or SELECT statement, which occurs anytime you say "SELECT .. FROM sometable AS someothername". The `AS` creates a new name for the table. Aliases are a key construct as they allow any table or subquery to be referenced by a unique name. In the case of a table, this allows the same table to be named in the FROM clause multiple times. In the case of a SELECT statement, it provides a parent name for the columns represented by the statement, allowing them to be referenced relative to this name.

In SQLAlchemy, any `Table`, `select()` construct, or other selectable can be turned into an alias using the `FromClause.alias()` method, which produces a `Alias` construct. As an example, suppose we know that our user `jack` has two particular email addresses. How can we locate jack based on the combination of those two addresses? To accomplish this, we'd use a join to the `addresses` table, once for each address. We create two `Alias` constructs against `addresses`, and then use them both within a `select()` construct:

```
>>> a1 = addresses.alias()
>>> a2 = addresses.alias()
>>> s = select([users], and_(
...         users.c.id==a1.c.user_id,
...         users.c.id==a2.c.user_id,
...         a1.c.email_address=='jack@msn.com',
...         a2.c.email_address=='jack@yahoo.com'
...   ))
>>> print conn.execute(s).fetchall()
SELECT users.id, users.name, users.fullname
FROM users, addresses AS addresses_1, addresses AS addresses_2
WHERE users.id = addresses_1.user_id AND users.id = addresses_2.user_id AND addresses_1.email_address
('jack@msn.com', 'jack@yahoo.com')
[(1, u'jack', u'Jack Jones')]
```

Note that the `Alias` construct generated the names `addresses_1` and `addresses_2` in the final SQL result. The generation of these names is determined by the position of the construct within the statement. If we created a query using only the second `a2` alias, the name would come out as `addresses_1`. The generation of the names is also *deterministic*, meaning the same SQLAlchemy statement construct will produce the identical SQL string each time it is rendered for a particular dialect.

Since on the outside, we refer to the alias using the `Alias` construct itself, we don't need to be concerned about the generated name. However, for the purposes of debugging, it can be specified by passing a string name to the `FromClause.alias()` method:

```
>>> a1 = addresses.alias('a1')
```

Aliases can of course be used for anything which you can SELECT from, including SELECT statements themselves. We can self-join the `users` table back to the `select()` we've created by making an alias of the entire statement. The `correlate(None)` directive is to avoid SQLAlchemy's attempt to "correlate" the inner `users` table with the outer one:

```
>>> a1 = s.correlate(None).alias()
>>> s = select([users.c.name], users.c.id==a1.c.id)
>>> print conn.execute(s).fetchall()
SELECT users.name
FROM users, (SELECT users.id AS id, users.name AS name, users.fullname AS fullname
FROM users, addresses AS addresses_1, addresses AS addresses_2
WHERE users.id = addresses_1.user_id AND users.id = addresses_2.user_id AND addresses_1.email_address
WHERE users.id = anon_1.id
('jack@msn.com', 'jack@yahoo.com')
[(u'jack',)]
```

3.1.12 Using Joins

We're halfway along to being able to construct any SELECT expression. The next cornerstone of the SELECT is the JOIN expression. We've already been doing joins in our examples, by just placing two tables in either the columns clause or the where clause of the `select()` construct. But if we want to make a real "JOIN" or "OUTERJOIN" construct, we use the `join()` and `outerjoin()` methods, most commonly accessed from the left table in the join:

```
>>> print users.join(addresses)
users JOIN addresses ON users.id = addresses.user_id
```

The alert reader will see more surprises; SQLAlchemy figured out how to JOIN the two tables ! The ON condition of the join, as it's called, was automatically generated based on the `ForeignKey` object which we placed on the `addresses` table way at the beginning of this tutorial. Already the `join()` construct is looking like a much better way to join tables.

Of course you can join on whatever expression you want, such as if we want to join on all users who use the same name in their email address as their username:

```
>>> print users.join(addresses, addresses.c.email_address.like(users.c.name + '%'))
users JOIN addresses ON addresses.email_address LIKE users.name || :name_1
```

When we create a `select()` construct, SQLAlchemy looks around at the tables we've mentioned and then places them in the FROM clause of the statement. When we use JOINs however, we know what FROM clause we want, so here we make usage of the `from_obj` keyword argument:

```
>>> s = select([users.c.fullname], from_obj=[
...     users.join(addresses, addresses.c.email_address.like(users.c.name + '%'))
...     ])
>>> print conn.execute(s).fetchall()
SELECT users.fullname
FROM users JOIN addresses ON addresses.email_address LIKE users.name || ?
('%',)
[(u'Jack Jones',), (u'Jack Jones',), (u'Wendy Williams',)]
```

The `outerjoin()` function just creates `LEFT OUTER JOIN` constructs. It's used just like `join()`:

```
>>> s = select([users.c.fullname], from_obj=[users.outerjoin(addresses)])
>>> print s
SELECT users.fullname
FROM users LEFT OUTER JOIN addresses ON users.id = addresses.user_id
```

That's the output `outerjoin()` produces, unless, of course, you're stuck in a gig using Oracle prior to version 9, and you've set up your engine (which would be using `OracleDialect`) to use Oracle-specific SQL:

```
>>> from sqlalchemy.dialects.oracle import dialect as OracleDialect
>>> print s.compile(dialect=OracleDialect(use_ansi=False))
SELECT users.fullname
FROM users, addresses
WHERE users.id = addresses.user_id(+)
```

If you don't know what that SQL means, don't worry ! The secret tribe of Oracle DBAs don't want their black magic being found out ;).

3.1.13 Intro to Generative Selects

We've now gained the ability to construct very sophisticated statements. We can use all kinds of operators, table constructs, text, joins, and aliases. The point of all of this, as mentioned earlier, is not that it's an "easier" or "better" way to write SQL than just writing a SQL statement yourself; the point is that it's better for writing *programmatically generated* SQL which can be morphed and adapted as needed in automated scenarios.

To support this, the `select()` construct we've been working with supports piecemeal construction, in addition to the "all at once" method we've been doing. Suppose you're writing a search function, which receives criterion and then must construct a select from it. To accomplish this, upon each criterion encountered, you apply "generative" criterion

to an existing `select()` construct with new elements, one at a time. We start with a basic `select()` constructed with the shortcut method available on the `users` table:

```
>>> query = users.select()
>>> print query
SELECT users.id, users.name, users.fullname
FROM users
```

We encounter search criterion of "name='jack'". So we apply WHERE criterion stating such:

```
>>> query = query.where(users.c.name=='jack')
```

Next, we encounter that they'd like the results in descending order by full name. We apply ORDER BY, using an extra modifier `desc`:

```
>>> query = query.order_by(users.c.fullname.desc())
```

We also come across that they'd like only users who have an address at MSN. A quick way to tack this on is by using an EXISTS clause, which we correlate to the `users` table in the enclosing SELECT:

```
>>> from sqlalchemy.sql import exists
>>> query = query.where(
...     exists([addresses.c.id],
...         and_(addresses.c.user_id==users.c.id, addresses.c.email_address.like('%@msn.com'))
...     ).correlate(users))
```

And finally, the application also wants to see the listing of email addresses at once; so to save queries, we outerjoin the `addresses` table (using an outer join so that users with no addresses come back as well; since we're programmatic, we might not have kept track that we used an EXISTS clause against the `addresses` table too...). Additionally, since the `users` and `addresses` table both have a column named `id`, let's isolate their names from each other in the COLUMNS clause by using labels:

```
>>> query = query.column(addresses).select_from(users.outerjoin(addresses)).apply_labels()
```

Let's bake for .0001 seconds and see what rises:

```
>>> conn.execute(query).fetchall()
SELECT users.id AS users_id, users.name AS users_name, users.fullname AS users_fullname, addresses.id
FROM users LEFT OUTER JOIN addresses ON users.id = addresses.user_id
WHERE users.name = ? AND (EXISTS (SELECT addresses.id
FROM addresses
WHERE addresses.user_id = users.id AND addresses.email_address LIKE ?)) ORDER BY users.fullname DESC
('jack', '%@msn.com')
[(1, u'jack', u'Jack Jones', 1, 1, u'jack@yahoo.com'), (1, u'jack', u'Jack Jones', 2, 1, u'jack@msn.c
```

The generative approach is about starting small, adding one thing at a time, to arrive with a full statement.

Transforming a Statement

We've seen how methods like `Select.where()` and `_SelectBase.order_by()` are part of the so-called *Generative* family of methods on the `select()` construct, where one `select()` copies itself to return a new one with modifications. SQL constructs also support another form of generative behavior which is the *transformation*.

This is an advanced technique that most core applications won't use directly; however, it is a system which the ORM relies on heavily, and can be useful for any system that deals with generalized behavior of Core SQL constructs.

Using a transformation we can take our `users/addresses` query and replace all occurrences of `addresses` with an alias of itself. That is, anywhere that `addresses` is referred to in the original query, the new query will refer to `addresses_1`, which is selected as `addresses AS addresses_1`. The `FromClause.replace_selectable()` method can achieve this:

```
>>> a1 = addresses.alias()
>>> query = query.replace_selectable(addresses, a1)
>>> print query
SELECT users.id AS users_id, users.name AS users_name, users.fullname AS users_fullname, addresses_1
FROM users LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = :name_1 AND (EXISTS (SELECT addresses_1.id
FROM addresses AS addresses_1
WHERE addresses_1.user_id = users.id AND addresses_1.email_address LIKE :email_address_1)) ORDER BY u
```

For a query such as the above, we can access the columns referred to by the `a1` alias in a result set using the `Column` objects present directly on `a1`:

```
>>> for row in conn.execute(query):
...     print "Name:", row[users.c.name], "; Email Address", row[a1.c.email_address]
SELECT users.id AS users_id, users.name AS users_name, users.fullname AS users_fullname, addresses_1
FROM users LEFT OUTER JOIN addresses AS addresses_1 ON users.id = addresses_1.user_id
WHERE users.name = ? AND (EXISTS (SELECT addresses_1.id
FROM addresses AS addresses_1
WHERE addresses_1.user_id = users.id AND addresses_1.email_address LIKE ?)) ORDER BY users.fullname I
('jack', '%@msn.com')
Name: jack ; Email Address jack@yahoo.com
Name: jack ; Email Address jack@msn.com
```

3.1.14 Everything Else

The concepts of creating SQL expressions have been introduced. What's left are more variants of the same themes. So now we'll catalog the rest of the important things we'll need to know.

Bind Parameter Objects

Throughout all these examples, SQLAlchemy is busy creating bind parameters wherever literal expressions occur. You can also specify your own bind parameters with your own names, and use the same statement repeatedly. The database dialect converts to the appropriate named or positional style, as here where it converts to positional for SQLite:

```
>>> from sqlalchemy.sql import bindparam
>>> s = users.select(users.c.name==bindparam('username'))
>>> conn.execute(s, username='wendy').fetchall()
SELECT users.id, users.name, users.fullname
FROM users
WHERE users.name = ?
('wendy',)
[(2, u'wendy', u'Wendy Williams')]
```

Another important aspect of bind parameters is that they may be assigned a type. The type of the bind parameter will determine its behavior within expressions and also how the data bound to it is processed before being sent off to the database:

```
>>> s = users.select(users.c.name.like(bindparam('username', type_=String) + text("'%'")))
>>> conn.execute(s, username='wendy').fetchall()
SELECT users.id, users.name, users.fullname
FROM users
WHERE users.name LIKE ? || '%'
('wendy',)
[(2, u'wendy', u'Wendy Williams')]
```

Bind parameters of the same name can also be used multiple times, where only a single named value is needed in the execute parameters:

```
>>> s = select([users, addresses],
...     users.c.name.like(bindparam('name', type_=String) + text("'%'")) |
...     addresses.c.email_address.like(bindparam('name', type_=String) + text("'@%'")),
...     from_obj=[users.outerjoin(addresses)])
>>> conn.execute(s, name='jack').fetchall()
SELECT users.id, users.name, users.fullname, addresses.id, addresses.user_id, addresses.email_address
FROM users LEFT OUTER JOIN addresses ON users.id = addresses.user_id
WHERE users.name LIKE ? || '%' OR addresses.email_address LIKE ? || '@%'
('jack', 'jack')
[(1, u'jack', u'Jack Jones', 1, 1, u'jack@yahoo.com'), (1, u'jack', u'Jack Jones', 2, 1, u'jack@msn.c
```

Functions

SQL functions are created using the `func` keyword, which generates functions using attribute access:

```
>>> from sqlalchemy.sql import func
>>> print func.now()
now()

>>> print func.concat('x', 'y')
concat(:param_1, :param_2)
```

By "generates", we mean that **any** SQL function is created based on the word you choose:

```
>>> print func.xyz_my_goofy_function()
xyz_my_goofy_function()
```

Certain function names are known by SQLAlchemy, allowing special behavioral rules to be applied. Some for example are "ANSI" functions, which mean they don't get the parenthesis added after them, such as CURRENT_TIMESTAMP:

```
>>> print func.current_timestamp()
CURRENT_TIMESTAMP
```

Functions are most typically used in the columns clause of a select statement, and can also be labeled as well as given a type. Labeling a function is recommended so that the result can be targeted in a result row based on a string name, and assigning it a type is required when you need result-set processing to occur, such as for Unicode conversion and date conversions. Below, we use the result function `scalar()` to just read the first column of the first row and then close the result; the label, even though present, is not important in this case:

```
>>> print conn.execute(
...     select([func.max(addresses.c.email_address, type_=String).label('maxemail')])
... ).scalar()
SELECT max(addresses.email_address) AS maxemail
FROM addresses
()
www@www.org
```

Databases such as PostgreSQL and Oracle which support functions that return whole result sets can be assembled into selectable units, which can be used in statements. Such as, a database function `calculate()` which takes the parameters `x` and `y`, and returns three columns which we'd like to name `q`, `z` and `r`, we can construct using "lexical" column objects as well as bind parameters:

```
>>> from sqlalchemy.sql import column
>>> calculate = select([column('q'), column('z'), column('r')],
...     from_obj=[func.calculate(bindparam('x'), bindparam('y'))])

>>> print select([users], users.c.id > calculate.c.z)
SELECT users.id, users.name, users.fullname
FROM users, (SELECT q, z, r
FROM calculate(:x, :y))
WHERE users.id > z
```

If we wanted to use our `calculate` statement twice with different bind parameters, the `unique_params()` function will create copies for us, and mark the bind parameters as "unique" so that conflicting names are isolated. Note we also make two separate aliases of our selectable:

```
>>> s = select([users], users.c.id.between(
...     calculate.alias('c1').unique_params(x=17, y=45).c.z,
...     calculate.alias('c2').unique_params(x=5, y=12).c.z))

>>> print s
SELECT users.id, users.name, users.fullname
FROM users, (SELECT q, z, r
FROM calculate(:x_1, :y_1)) AS c1, (SELECT q, z, r
FROM calculate(:x_2, :y_2)) AS c2
WHERE users.id BETWEEN c1.z AND c2.z

>>> s.compile().params
{u'x_2': 5, u'y_2': 12, u'y_1': 45, u'x_1': 17}
```

See also `sqlalchemy.sql.expression.func`.

Window Functions

Any `FunctionElement`, including functions generated by `func`, can be turned into a "window function", that is an OVER clause, using the `over()` method:

```
>>> s = select([users.c.id, func.row_number().over(order_by=users.c.name)])
>>> print s
SELECT users.id, row_number() OVER (ORDER BY users.name) AS anon_1
FROM users
```

Unions and Other Set Operations

Unions come in two flavors, UNION and UNION ALL, which are available via module level functions:

```
>>> from sqlalchemy.sql import union
>>> u = union(
...     addresses.select(addresses.c.email_address=='foo@bar.com'),
...     addresses.select(addresses.c.email_address.like('%@yahoo.com')),
... ).order_by(addresses.c.email_address)

>>> print conn.execute(u).fetchall()
SELECT addresses.id, addresses.user_id, addresses.email_address
FROM addresses
WHERE addresses.email_address = ? UNION SELECT addresses.id, addresses.user_id, addresses.email_addre
FROM addresses
WHERE addresses.email_address LIKE ? ORDER BY addresses.email_address
('foo@bar.com', '%@yahoo.com')
[(1, 1, u'jack@yahoo.com')]
```

Also available, though not supported on all databases, are `intersect()`, `intersect_all()`, `except_()`, and `except_all()`:

```
>>> from sqlalchemy.sql import except_
>>> u = except_(
...     addresses.select(addresses.c.email_address.like('%@%.com')),
...     addresses.select(addresses.c.email_address.like('%@msn.com'))
... )

>>> print conn.execute(u).fetchall()
SELECT addresses.id, addresses.user_id, addresses.email_address
FROM addresses
WHERE addresses.email_address LIKE ? EXCEPT SELECT addresses.id, addresses.user_id, addresses.email_a
FROM addresses
WHERE addresses.email_address LIKE ?
('%@%.com', '%@msn.com')
[(1, 1, u'jack@yahoo.com'), (4, 2, u'wendy@aol.com')]
```

A common issue with so-called "compound" selectables arises due to the fact that they nest with parenthesis. SQLite in particular doesn't like a statement that starts with parenthesis. So when nesting a "compound" inside a "compound", it's often necessary to apply `.alias().select()` to the first element of the outermost compound, if that element is also a compound. For example, to nest a "union" and a "select" inside of "except_", SQLite will want the "union" to be stated as a subquery:

```
>>> u = except_(
...     union(
...           addresses.select(addresses.c.email_address.like('%@yahoo.com')),
...           addresses.select(addresses.c.email_address.like('%@msn.com'))
...      ).alias().select(),   # apply subquery here
...     addresses.select(addresses.c.email_address.like('%@msn.com'))
... )
>>> print conn.execute(u).fetchall()
SELECT anon_1.id, anon_1.user_id, anon_1.email_address
FROM (SELECT addresses.id AS id, addresses.user_id AS user_id,
addresses.email_address AS email_address FROM addresses
WHERE addresses.email_address LIKE ? UNION SELECT addresses.id AS id,
addresses.user_id AS user_id, addresses.email_address AS email_address
```

```
FROM addresses WHERE addresses.email_address LIKE ?) AS anon_1 EXCEPT
SELECT addresses.id, addresses.user_id, addresses.email_address
FROM addresses
WHERE addresses.email_address LIKE ?
('%@yahoo.com', '%@msn.com', '%@msn.com')
[(1, 1, u'jack@yahoo.com')]
```

Scalar Selects

To embed a SELECT in a column expression, use `as_scalar()`:

```
>>> print conn.execute(select([
...        users.c.name,
...        select([func.count(addresses.c.id)], users.c.id==addresses.c.user_id).as_scalar()
...    ])).fetchall()
SELECT users.name, (SELECT count(addresses.id) AS count_1
FROM addresses
WHERE users.id = addresses.user_id) AS anon_1
FROM users
()
[(u'jack', 2), (u'wendy', 2), (u'fred', 0), (u'mary', 0)]
```

Alternatively, applying a `label()` to a select evaluates it as a scalar as well:

```
>>> print conn.execute(select([
...        users.c.name,
...        select([func.count(addresses.c.id)], users.c.id==addresses.c.user_id).label('address_count'
...    ])).fetchall()
SELECT users.name, (SELECT count(addresses.id) AS count_1
FROM addresses
WHERE users.id = addresses.user_id) AS address_count
FROM users
()
[(u'jack', 2), (u'wendy', 2), (u'fred', 0), (u'mary', 0)]
```

Correlated Subqueries

Notice in the examples on "scalar selects", the FROM clause of each embedded select did not contain the `users` table in its FROM clause. This is because SQLAlchemy automatically attempts to correlate embedded FROM objects to that of an enclosing query. To disable this, or to specify explicit FROM clauses to be correlated, use `correlate()`:

```
>>> s = select([users.c.name], users.c.id==select([users.c.id]).correlate(None))
>>> print s
SELECT users.name
FROM users
WHERE users.id = (SELECT users.id
FROM users)

>>> s = select([users.c.name, addresses.c.email_address], users.c.id==
...        select([users.c.id], users.c.id==addresses.c.user_id).correlate(addresses)
...    )
>>> print s
SELECT users.name, addresses.email_address
```

```
FROM users, addresses
WHERE users.id = (SELECT users.id
FROM users
WHERE users.id = addresses.user_id)
```

Ordering, Grouping, Limiting, Offset...ing...

The `select()` function can take keyword arguments `order_by`, `group_by` (as well as `having`), `limit`, and `offset`. There's also `distinct=True`. These are all also available as generative functions. `order_by()` expressions can use the modifiers `asc()` or `desc()` to indicate ascending or descending.

```
>>> s = select([addresses.c.user_id, func.count(addresses.c.id)]).\
...     group_by(addresses.c.user_id).having(func.count(addresses.c.id)>1)
>>> print conn.execute(s).fetchall()
SELECT addresses.user_id, count(addresses.id) AS count_1
FROM addresses GROUP BY addresses.user_id
HAVING count(addresses.id) > ?
(1,)
[(1, 2), (2, 2)]

>>> s = select([addresses.c.email_address, addresses.c.id]).distinct().\
...     order_by(addresses.c.email_address.desc(), addresses.c.id)
>>> conn.execute(s).fetchall()
SELECT DISTINCT addresses.email_address, addresses.id
FROM addresses ORDER BY addresses.email_address DESC, addresses.id
()
[(u'www@www.org', 3), (u'wendy@aol.com', 4), (u'jack@yahoo.com', 1), (u'jack@msn.com', 2)]

>>> s = select([addresses]).offset(1).limit(1)
>>> print conn.execute(s).fetchall()
SELECT addresses.id, addresses.user_id, addresses.email_address
FROM addresses
LIMIT 1 OFFSET 1
()
[(2, 1, u'jack@msn.com')]
```

3.1.15 Inserts and Updates

Finally, we're back to INSERT for some more detail. The `insert()` construct provides a `values()` method which can be used to send any value or clause expression to the VALUES portion of the INSERT:

```
# insert from a function
users.insert().values(id=12, name=func.upper('jack'))

# insert from a concatenation expression
addresses.insert().values(email_address = name + '@' + host)
```

`values()` can be mixed with per-execution values:

```
conn.execute(
    users.insert().values(name=func.upper('jack')),
    fullname='Jack Jones'
)
```

bindparam() constructs can be passed, however the names of the table's columns are reserved for the "automatic" generation of bind names:

```
users.insert().values(id=bindparam('_id'), name=bindparam('_name'))

# insert many rows at once:
conn.execute(
    users.insert().values(id=bindparam('_id'), name=bindparam('_name')),
    [
        {'_id':1, '_name':'name1'},
        {'_id':2, '_name':'name2'},
        {'_id':3, '_name':'name3'},
    ]
)
```

An UPDATE statement is emitted using the update() construct. These work much like an INSERT, except there is an additional WHERE clause that can be specified:

```
>>> # change 'jack' to 'ed'
>>> conn.execute(users.update().
...                    where(users.c.name=='jack').
...                    values(name='ed')
...                )
UPDATE users SET name=? WHERE users.name = ?
('ed', 'jack')
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>

>>> # use bind parameters
>>> u = users.update().\
...             where(users.c.name==bindparam('oldname')).\
...             values(name=bindparam('newname'))
>>> conn.execute(u, oldname='jack', newname='ed')
UPDATE users SET name=? WHERE users.name = ?
('ed', 'jack')
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>

>>> # with binds, you can also update many rows at once
>>> conn.execute(u,
...     {'oldname':'jack', 'newname':'ed'},
...     {'oldname':'wendy', 'newname':'mary'},
...     {'oldname':'jim', 'newname':'jake'},
...     )
UPDATE users SET name=? WHERE users.name = ?
[('ed', 'jack'), ('mary', 'wendy'), ('jake', 'jim')]
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>

>>> # update a column to an expression.:
>>> conn.execute(users.update().
...                     values(fullname="Fullname: " + users.c.name)
...                 )
UPDATE users SET fullname=(? || users.name)
('Fullname: ',)
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>
```

Correlated Updates

A correlated update lets you update a table using selection from another table, or the same table:

```
>>> s = select([addresses.c.email_address], addresses.c.user_id==users.c.id).limit(1)
>>> conn.execute(users.update().values(fullname=s))
UPDATE users SET fullname=(SELECT addresses.email_address
FROM addresses
WHERE addresses.user_id = users.id
LIMIT 1 OFFSET 0)
()
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>
```

Multiple Table Updates

New in version 0.7.4.

The Postgresql, Microsoft SQL Server, and MySQL backends all support UPDATE statements that refer to multiple tables. For PG and MSSQL, this is the "UPDATE FROM" syntax, which updates one table at a time, but can reference additional tables in an additional "FROM" clause that can then be referenced in the WHERE clause directly. On MySQL, multiple tables can be embedded into a single UPDATE statement separated by a comma. The SQLAlchemy `update()` construct supports both of these modes implicitly, by specifying multiple tables in the WHERE clause:

```
stmt = users.update().\
        values(name='ed wood').\
        where(users.c.id==addresses.c.id).\
        where(addresses.c.email_address.startswith('ed%'))
conn.execute(stmt)
```

The resulting SQL from the above statement would render as:

```
UPDATE users SET name=:name FROM addresses
WHERE users.id = addresses.id AND
addresses.email_address LIKE :email_address_1 || '%%'
```

When using MySQL, columns from each table can be assigned to in the SET clause directly, using the dictionary form passed to `Update.values()`:

```
stmt = users.update().\
        values({
            users.c.name:'ed wood',
            addresses.c.email_address:'ed.wood@foo.com'
        }).\
        where(users.c.id==addresses.c.id).\
        where(addresses.c.email_address.startswith('ed%'))
```

The tables are referenced explicitly in the SET clause:

```
UPDATE users, addresses SET addresses.email_address=%s,
        users.name=%s WHERE users.id = addresses.id
        AND addresses.email_address LIKE concat(%s, '%%')
```

SQLAlchemy doesn't do anything special when these constructs are used on a non-supporting database. The `UPDATE FROM` syntax generates by default when multiple tables are present, and the statement will be rejected by the database if this syntax is not supported.

3.1.16 Deletes

Finally, a delete. This is accomplished easily enough using the `delete()` construct:

```
>>> conn.execute(addresses.delete())
DELETE FROM addresses
()
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>

>>> conn.execute(users.delete().where(users.c.name > 'm'))
DELETE FROM users WHERE users.name > ?
('m',)
COMMIT
<sqlalchemy.engine.base.ResultProxy object at 0x...>
```

3.1.17 Further Reference

Expression Language Reference: *SQL Statements and Expressions API*

Database Metadata Reference: *Schema Definition Language*

Engine Reference: *Engine Configuration*

Connection Reference: *Working with Engines and Connections*

Types Reference: *Column and Data Types*

3.2 SQL Statements and Expressions API

This section presents the API reference for the SQL Expression Language. For a full introduction to its usage, see *SQL Expression Language Tutorial*.

3.2.1 Functions

The expression package uses functions to construct SQL expressions. The return value of each function is an object instance which is a subclass of `ClauseElement`.

`sqlalchemy.sql.expression.`**`alias`**(*selectable*, *name=None*)

Return an `Alias` object.

An `Alias` represents any `FromClause` with an alternate name assigned within SQL, typically using the `AS` clause when generated, e.g. `SELECT * FROM table AS aliasname`.

Similar functionality is available via the `alias()` method available on all `FromClause` subclasses.

When an `Alias` is created from a `Table` object, this has the effect of the table being rendered as `tablename AS aliasname` in a SELECT statement.

For `select()` objects, the effect is that of creating a named subquery, i.e. `(select ...) AS aliasname`.

The `name` parameter is optional, and provides the name to use in the rendered SQL. If blank, an "anonymous" name will be deterministically generated at compile time. Deterministic means the name is guaranteed to be unique against other constructs used in the same statement, and will also be the same name for each successive compilation of the same statement object.

Parameters

- **selectable** – any `FromClause` subclass, such as a table, select statement, etc.
- **name** – string name to be assigned as the alias. If `None`, a name will be deterministically generated at compile time.

`sqlalchemy.sql.expression.`**`and_`**`(`*`*clauses`*`)`
Join a list of clauses together using the `AND` operator.

The `&` operator is also overloaded on all `_CompareMixin` subclasses to produce the same result.

`sqlalchemy.sql.expression.`**`asc`**`(`*`column`*`)`
Return an ascending `ORDER BY` clause element.

e.g.:

```
someselect.order_by(asc(table1.mycol))
```

produces:

```
ORDER BY mycol ASC
```

`sqlalchemy.sql.expression.`**`between`**`(`*`ctest`*`, `*`cleft`*`, `*`cright`*`)`
Return a `BETWEEN` predicate clause.

Equivalent of SQL `clausetest BETWEEN clauseleft AND clauseright`.

The `between()` method on all `_CompareMixin` subclasses provides similar functionality.

`sqlalchemy.sql.expression.`**`bindparam`**`(`*`key`*`, `*`value=None`*`, `*`type_=None`*`, `*`unique=False`*`, `*`required=False`*`, `*`callable_=None`*`)`
Create a bind parameter clause with the given key.

Parameters

- **key** – the key for this bind param. Will be used in the generated SQL statement for dialects that use named parameters. This value may be modified when part of a compilation operation, if other `_BindParamClause` objects exist with the same key, or if its length is too long and truncation is required.
- **value** – Initial value for this bind param. This value may be overridden by the dictionary of parameters sent to statement compilation/execution.
- **callable_** – A callable function that takes the place of "value". The function will be called at statement execution time to determine the ultimate value. Used for scenarios where the actual bind value cannot be determined at the point at which the clause construct is created, but embedded bind values are still desirable.
- **type_** – A `TypeEngine` object that will be used to pre-process the value corresponding to this `_BindParamClause` at execution time.
- **unique** – if True, the key name of this BindParamClause will be modified if another `_BindParamClause` of the same name already has been located within the containing `ClauseElement`.

- **required** – a value is required at execution time.

sqlalchemy.sql.expression.**case**(*whens*, *value=None*, *else_=None*)
Produce a CASE statement.

whens A sequence of pairs, or alternatively a dict, to be translated into "WHEN / THEN" clauses.

value Optional for simple case statements, produces a column expression as in "CASE <expr> WHEN ..."

else_ Optional as well, for case defaults produces the "ELSE" portion of the "CASE" statement.

The expressions used for THEN and ELSE, when specified as strings, will be interpreted as bound values. To specify textual SQL expressions for these, use the literal_column() construct.

The expressions used for the WHEN criterion may only be literal strings when "value" is present, i.e. CASE table.somecol WHEN "x" THEN "y". Otherwise, literal strings are not accepted in this position, and either the text(<string>) or literal(<string>) constructs must be used to interpret raw string values.

Usage examples:

```
case([(orderline.c.qty > 100, item.c.specialprice),
      (orderline.c.qty > 10, item.c.bulkprice)
    ], else_=item.c.regularprice)
case(value=emp.c.type, whens={
        'engineer': emp.c.salary * 1.1,
        'manager':  emp.c.salary * 3,
    })
```

Using literal_column(), to allow for databases that do not support bind parameters in the then clause. The type can be specified which determines the type of the case() construct overall:

```
case([(orderline.c.qty > 100,
        literal_column("'greaterthan100'", String)),
      (orderline.c.qty > 10, literal_column("'greaterthan10'",
        String))
    ], else_=literal_column("'lethan10'", String))
```

sqlalchemy.sql.expression.**cast**(*clause*, *totype*, ***kwargs*)
Return a CAST function.

Equivalent of SQL CAST(clause AS totype).

Use with a TypeEngine subclass, i.e:

```
cast(table.c.unit_price * table.c.qty, Numeric(10,4))
```

or:

```
cast(table.c.timestamp, DATE)
```

sqlalchemy.sql.expression.**column**(*text*, *type_=None*)
Return a textual column clause, as would be in the columns clause of a SELECT statement.

The object returned is an instance of ColumnClause, which represents the "syntactical" portion of the schema-level Column object. It is often used directly within select() constructs or with lightweight table() constructs.

Note that the column() function is not part of the sqlalchemy namespace. It must be imported from the sql package:

```
from sqlalchemy.sql import table, column
```

Parameters

- **text** – the name of the column. Quoting rules will be applied to the clause like any other column name. For textual column constructs that are not to be quoted, use the `literal_column()` function.
- **type_** – an optional `TypeEngine` object which will provide result-set translation for this column.

See `ColumnClause` for further examples.

`sqlalchemy.sql.expression.`**`collate`**(*expression*, *collation*)
Return the clause `expression COLLATE collation`.

e.g.:

```
collate(mycolumn, 'utf8_bin')
```

produces:

```
mycolumn COLLATE utf8_bin
```

`sqlalchemy.sql.expression.`**`delete`**(*table*, *whereclause=None*, ***kwargs*)
Represent a `DELETE` statement via the `Delete` SQL construct.

Similar functionality is available via the `delete()` method on `Table`.

Parameters

- **table** – The table to be updated.
- **whereclause** – A `ClauseElement` describing the `WHERE` condition of the `UPDATE` statement. Note that the `where()` generative method may be used instead.

See also:

Deletes - SQL Expression Tutorial

`sqlalchemy.sql.expression.`**`desc`**(*column*)
Return a descending `ORDER BY` clause element.

e.g.:

```
someselect.order_by(desc(table1.mycol))
```

produces:

```
ORDER BY mycol DESC
```

`sqlalchemy.sql.expression.`**`distinct`**(*expr*)
Return a `DISTINCT` clause.

e.g.:

```
distinct(a)
```

renders:

```
DISTINCT a
```

`sqlalchemy.sql.expression.`**`except_`**(**selects*, ***kwargs*)
Return an `EXCEPT` of multiple selectables.

The returned object is an instance of `CompoundSelect`.

***selects** a list of `Select` instances.

****kwargs** available keyword arguments are the same as those of `select()`.

sqlalchemy.sql.expression.**except_all**(**selects*, ***kwargs*)
Return an `EXCEPT ALL` of multiple selectables.

The returned object is an instance of `CompoundSelect`.

***selects** a list of `Select` instances.

****kwargs** available keyword arguments are the same as those of `select()`.

sqlalchemy.sql.expression.**exists**(**args*, ***kwargs*)
Return an `EXISTS` clause as applied to a `Select` object.

Calling styles are of the following forms:

```
# use on an existing select()
s = select([table.c.col1]).where(table.c.col2==5)
s = exists(s)

# construct a select() at once
exists(['*'], **select_arguments).where(criterion)

# columns argument is optional, generates "EXISTS (SELECT *)"
# by default.
exists().where(table.c.col2==5)
```

sqlalchemy.sql.expression.**extract**(*field*, *expr*)
Return the clause `extract(field FROM expr)`.

sqlalchemy.sql.expression.**false**()
Return a `_False` object, which compiles to `false`, or the boolean equivalent for the target dialect.

sqlalchemy.sql.expression.**func = <sqlalchemy.sql.expression._FunctionGenerator object at 0x7fb7aa7bbc50>**
Generate SQL function expressions.

`func` is a special object instance which generates SQL functions based on name-based attributes, e.g.:

```
>>> print func.count(1)
count(:param_1)
```

The element is a column-oriented SQL element like any other, and is used in that way:

```
>>> print select([func.count(table.c.id)])
SELECT count(sometable.id) FROM sometable
```

Any name can be given to `func`. If the function name is unknown to SQLAlchemy, it will be rendered exactly as is. For common SQL functions which SQLAlchemy is aware of, the name may be interpreted as a *generic function* which will be compiled appropriately to the target database:

```
>>> print func.current_timestamp()
CURRENT_TIMESTAMP
```

To call functions which are present in dot-separated packages, specify them in the same manner:

```
>>> print func.stats.yield_curve(5, 10)
stats.yield_curve(:yield_curve_1, :yield_curve_2)
```

SQLAlchemy can be made aware of the return type of functions to enable type-specific lexical and result-based behavior. For example, to ensure that a string-based function returns a Unicode value and is similarly treated as a string in expressions, specify `Unicode` as the type:

```
>>> print func.my_string(u'hi', type_=Unicode) + ' ' + \
... func.my_string(u'there', type_=Unicode)
my_string(:my_string_1) || :my_string_2 || my_string(:my_string_3)
```

The object returned by a `func` call is an instance of `Function`. This object meets the "column" interface, including comparison and labeling functions. The object can also be passed the `execute()` method of a `Connection` or `Engine`, where it will be wrapped inside of a SELECT statement first:

```
print connection.execute(func.current_timestamp()).scalar()
```

A function can also be "bound" to a `Engine` or `Connection` using the `bind` keyword argument, providing an execute() as well as a scalar() method:

```
myfunc = func.current_timestamp(bind=some_engine)
print myfunc.scalar()
```

Functions which are interpreted as "generic" functions know how to calculate their return type automatically. For a listing of known generic functions, see *Generic Functions*.

sqlalchemy.sql.expression.**insert**(*table*, *values=None*, *inline=False*, ***kwargs*)

Represent an `INSERT` statement via the `Insert` SQL construct.

Similar functionality is available via the `insert()` method on `Table`.

Parameters

- **table** – The table to be inserted into.
- **values** – A dictionary which specifies the column specifications of the `INSERT`, and is optional. If left as None, the column specifications are determined from the bind parameters used during the compile phase of the `INSERT` statement. If the bind parameters also are None during the compile phase, then the column specifications will be generated from the full list of table columns. Note that the `values()` generative method may also be used for this.
- **prefixes** – A list of modifier keywords to be inserted between INSERT and INTO. Alternatively, the `prefix_with()` generative method may be used.
- **inline** – if True, SQL defaults will be compiled 'inline' into the statement and not pre-executed.

If both *values* and compile-time bind parameters are present, the compile-time bind parameters override the information specified within *values* on a per-key basis.

The keys within *values* can be either `Column` objects or their string identifiers. Each key may reference one of:

•a literal data value (i.e. string, number, etc.);

•a Column object;

•a SELECT statement.

If a `SELECT` statement is specified which references this `INSERT` statement's table, the statement will be correlated against the `INSERT` statement.

See also:

Insert Expressions - SQL Expression Tutorial

Inserts and Updates - SQL Expression Tutorial

sqlalchemy.sql.expression.**intersect**(**selects*, ***kwargs*)

Return an `INTERSECT` of multiple selectables.

The returned object is an instance of CompoundSelect.

***selects** a list of Select instances.

****kwargs** available keyword arguments are the same as those of select().

sqlalchemy.sql.expression.**intersect_all**(**selects*, ***kwargs*)
Return an INTERSECT ALL of multiple selectables.

The returned object is an instance of CompoundSelect.

***selects** a list of Select instances.

****kwargs** available keyword arguments are the same as those of select().

sqlalchemy.sql.expression.**join**(*left*, *right*, *onclause=None*, *isouter=False*)
Return a JOIN clause element (regular inner join).

The returned object is an instance of Join.

Similar functionality is also available via the join() method on any FromClause.

Parameters

- **left** – The left side of the join.
- **right** – The right side of the join.
- **onclause** – Optional criterion for the ON clause, is derived from foreign key relationships established between left and right otherwise.

To chain joins together, use the FromClause.join() or FromClause.outerjoin() methods on the resulting Join object.

sqlalchemy.sql.expression.**label**(*name*, *obj*)
Return a _Label object for the given ColumnElement.

A label changes the name of an element in the columns clause of a SELECT statement, typically via the AS SQL keyword.

This functionality is more conveniently available via the label() method on ColumnElement.

name label name

obj a ColumnElement.

sqlalchemy.sql.expression.**literal**(*value*, *type_=None*)
Return a literal clause, bound to a bind parameter.

Literal clauses are created automatically when non- ClauseElement objects (such as strings, ints, dates, etc.) are used in a comparison operation with a _CompareMixin subclass, such as a Column object. Use this function to force the generation of a literal clause, which will be created as a _BindParamClause with a bound value.

Parameters

- **value** – the value to be bound. Can be any Python object supported by the underlying DB-API, or is translatable via the given type argument.
- **type_** – an optional TypeEngine which will provide bind-parameter translation for this literal.

sqlalchemy.sql.expression.**literal_column**(*text*, *type_=None*)
Return a textual column expression, as would be in the columns clause of a SELECT statement.

The object returned supports further expressions in the same way as any other column object, including comparison, math and string operations. The type_ parameter is important to determine proper expression behavior (such as, '+' means string concatenation or numerical addition based on the type).

Parameters

- **text** – the text of the expression; can be any SQL expression. Quoting rules will not be applied. To specify a column-name expression which should be subject to quoting rules, use the `column()` function.
- **type_** – an optional `TypeEngine` object which will provide result-set translation and additional expression semantics for this column. If left as None the type will be NullType.

`sqlalchemy.sql.expression.`**`not_`**`(`*clause*`)`
Return a negation of the given clause, i.e. `NOT(clause)`.

The ~ operator is also overloaded on all `_CompareMixin` subclasses to produce the same result.

`sqlalchemy.sql.expression.`**`null`**`()`
Return a `_Null` object, which compiles to `NULL`.

`sqlalchemy.sql.expression.`**`nullsfirst`**`(`*column*`)`
Return a NULLS FIRST `ORDER BY` clause element.

e.g.:

```
someselect.order_by(desc(table1.mycol).nullsfirst())
```

produces:

```
ORDER BY mycol DESC NULLS FIRST
```

`sqlalchemy.sql.expression.`**`nullslast`**`(`*column*`)`
Return a NULLS LAST `ORDER BY` clause element.

e.g.:

```
someselect.order_by(desc(table1.mycol).nullslast())
```

produces:

```
ORDER BY mycol DESC NULLS LAST
```

`sqlalchemy.sql.expression.`**`or_`**`(`**clauses*`)`
Join a list of clauses together using the `OR` operator.

The | operator is also overloaded on all `_CompareMixin` subclasses to produce the same result.

`sqlalchemy.sql.expression.`**`outparam`**`(`*key*, *type_=None*`)`
Create an 'OUT' parameter for usage in functions (stored procedures), for databases which support them.

The `outparam` can be used like a regular function parameter. The "output" value will be available from the `ResultProxy` object via its `out_parameters` attribute, which returns a dictionary containing the values.

`sqlalchemy.sql.expression.`**`outerjoin`**`(`*left*, *right*, *onclause=None*`)`
Return an `OUTER JOIN` clause element.

The returned object is an instance of `Join`.

Similar functionality is also available via the `outerjoin()` method on any `FromClause`.

Parameters

- **left** – The left side of the join.

- **right** – The right side of the join.
- **onclause** – Optional criterion for the ON clause, is derived from foreign key relationships established between left and right otherwise.

To chain joins together, use the FromClause.join() or FromClause.outerjoin() methods on the resulting Join object.

sqlalchemy.sql.expression.**over**(*func*, *partition_by=None*, *order_by=None*)
Produce an OVER clause against a function.

Used against aggregate or so-called "window" functions, for database backends that support window functions.

E.g.:

```
from sqlalchemy import over
over(func.row_number(), order_by='x')
```

Would produce "ROW_NUMBER() OVER(ORDER BY x)".

Parameters

- **func** – a FunctionElement construct, typically generated by func.
- **partition_by** – a column element or string, or a list of such, that will be used as the PARTITION BY clause of the OVER construct.
- **order_by** – a column element or string, or a list of such, that will be used as the ORDER BY clause of the OVER construct.

This function is also available from the func construct itself via the FunctionElement.over() method.

New in version 0.7.

sqlalchemy.sql.expression.**select**(*columns=None*, *whereclause=None*, *from_obj=[]*, ***kwargs*)
Returns a SELECT clause element.

Similar functionality is also available via the select() method on any FromClause.

The returned object is an instance of Select.

All arguments which accept ClauseElement arguments also accept string arguments, which will be converted as appropriate into either text() or literal_column() constructs.

See also:

Selecting - Core Tutorial description of select().

Parameters

- **columns** – A list of ClauseElement objects, typically ColumnElement objects or subclasses, which will form the columns clause of the resulting statement. For all members which are instances of Selectable, the individual ColumnElement members of the Selectable will be added individually to the columns clause. For example, specifying a Table instance will result in all the contained Column objects within to be added to the columns clause.

  This argument is not present on the form of select() available on Table.
- **whereclause** – A ClauseElement expression which will be used to form the WHERE clause.
- **from_obj** – A list of ClauseElement objects which will be added to the FROM clause of the resulting statement. Note that "from" objects are automatically located within the columns and whereclause ClauseElements. Use this parameter to explicitly specify

"from" objects which are not automatically locatable. This could include `Table` objects that aren't otherwise present, or `Join` objects whose presence will supercede that of the `Table` objects already located in the other clauses.

- **autocommit** – Deprecated. Use .execution_options(autocommit=<True|False>) to set the autocommit option.
- **bind=None** – an `Engine` or `Connection` instance to which the resulting `Select` object will be bound. The `Select` object will otherwise automatically bind to whatever `Connectable` instances can be located within its contained `ClauseElement` members.
- **correlate=True** – indicates that this `Select` object should have its contained `FromClause` elements "correlated" to an enclosing `Select` object. This means that any `ClauseElement` instance within the "froms" collection of this `Select` which is also present in the "froms" collection of an enclosing select will not be rendered in the `FROM` clause of this select statement.
- **distinct=False** – when `True`, applies a `DISTINCT` qualifier to the columns clause of the resulting statement.

  The boolean argument may also be a column expression or list of column expressions - this is a special calling form which is understood by the Postgresql dialect to render the `DISTINCT ON (<columns>)` syntax.

  `distinct` is also available via the `distinct()` generative method.

  Note: The `distinct` keyword's acceptance of a string argument for usage with MySQL is deprecated. Use the `prefixes` argument or `prefix_with()`.

- **for_update=False** – when `True`, applies `FOR UPDATE` to the end of the resulting statement.

  Certain database dialects also support alternate values for this parameter:

  – With the MySQL dialect, the value `"read"` translates to `LOCK IN SHARE MODE`.

  – With the Oracle and Postgresql dialects, the value `"nowait"` translates to `FOR UPDATE NOWAIT`.

  – With the Postgresql dialect, the values "read" and `"read_nowait"` translate to `FOR SHARE` and `FOR SHARE NOWAIT`, respectively.

  New in version 0.7.7.
- **group_by** – a list of `ClauseElement` objects which will comprise the `GROUP BY` clause of the resulting select.
- **having** – a `ClauseElement` that will comprise the `HAVING` clause of the resulting select when `GROUP BY` is used.
- **limit=None** – a numerical value which usually compiles to a `LIMIT` expression in the resulting select. Databases that don't support `LIMIT` will attempt to provide similar functionality.
- **offset=None** – a numeric value which usually compiles to an `OFFSET` expression in the resulting select. Databases that don't support `OFFSET` will attempt to provide similar functionality.
- **order_by** – a scalar or list of `ClauseElement` objects which will comprise the `ORDER BY` clause of the resulting select.

- **prefixes** – a list of strings or `ClauseElement` objects to include directly after the SELECT keyword in the generated statement, for dialect-specific query features. `prefixes` is also available via the `prefix_with()` generative method.
- **use_labels=False** – when `True`, the statement will be generated using labels for each column in the columns clause, which qualify each column with its parent table's (or aliases) name so that name conflicts between columns in different tables don't occur. The format of the label is <tablename>_<column>. The "c" collection of the resulting `Select` object will use these names as well for targeting column members.

  use_labels is also available via the `apply_labels()` generative method.

`sqlalchemy.sql.expression.`**`subquery`**(*alias*, **args*, ***kwargs*)

Return an `Alias` object derived from a `Select`.

name alias name

*args, **kwargs

all other arguments are delivered to the `select()` function.

`sqlalchemy.sql.expression.`**`table`**(*name*, **columns*)

Represent a textual table clause.

The object returned is an instance of `TableClause`, which represents the "syntactical" portion of the schema-level `Table` object. It may be used to construct lightweight table constructs.

Note that the `table()` function is not part of the `sqlalchemy` namespace. It must be imported from the `sql` package:

```
from sqlalchemy.sql import table, column
```

Parameters

- **name** – Name of the table.
- **columns** – A collection of `column()` constructs.

See `TableClause` for further examples.

`sqlalchemy.sql.expression.`**`text`**(*text*, *bind=None*, **args*, ***kwargs*)

Create a SQL construct that is represented by a literal string.

E.g.:

```
t = text("SELECT * FROM users")
result = connection.execute(t)
```

The advantages `text()` provides over a plain string are backend-neutral support for bind parameters, per-statement execution options, as well as bind parameter and result-column typing behavior, allowing SQLAlchemy type constructs to play a role when executing a statement that is specified literally.

Bind parameters are specified by name, using the format `:name`. E.g.:

```
t = text("SELECT * FROM users WHERE id=:user_id")
result = connection.execute(t, user_id=12)
```

To invoke SQLAlchemy typing logic for bind parameters, the `bindparams` list allows specification of `bindparam()` constructs which specify the type for a given name:

```
t = text("SELECT id FROM users WHERE updated_at>:updated",
             bindparams=[bindparam('updated', DateTime())]
         )
```

Typing during result row processing is also an important concern. Result column types are specified using the `typemap` dictionary, where the keys match the names of columns. These names are taken from what the DBAPI returns as `cursor.description`:

```
t = text("SELECT id, name FROM users",
        typemap={
            'id':Integer,
            'name':Unicode
        }
)
```

The `text()` construct is used internally for most cases when a literal string is specified for part of a larger query, such as within `select()`, `update()`, `insert()` or `delete()`. In those cases, the same bind parameter syntax is applied:

```
s = select([users.c.id, users.c.name]).where("id=:user_id")
result = connection.execute(s, user_id=12)
```

Using `text()` explicitly usually implies the construction of a full, standalone statement. As such, SQLAlchemy refers to it as an `Executable` object, and it supports the `Executable.execution_options()` method. For example, a `text()` construct that should be subject to "autocommit" can be set explicitly so using the `autocommit` option:

```
t = text("EXEC my_procedural_thing()").\
        execution_options(autocommit=True)
```

Note that SQLAlchemy's usual "autocommit" behavior applies to `text()` constructs - that is, statements which begin with a phrase such as `INSERT`, `UPDATE`, `DELETE`, or a variety of other phrases specific to certain backends, will be eligible for autocommit if no transaction is in progress.

Parameters

- **text** – the text of the SQL statement to be created. use `:<param>` to specify bind parameters; they will be compiled to their engine-specific format.
- **autocommit** – Deprecated. Use .execution_options(autocommit=<True|False>) to set the autocommit option.
- **bind** – an optional connection or engine to be used for this text query.
- **bindparams** – a list of `bindparam()` instances which can be used to define the types and/or initial values for the bind parameters within the textual statement; the keynames of the bindparams must match those within the text of the statement. The types will be used for pre-processing on bind values.
- **typemap** – a dictionary mapping the names of columns represented in the columns clause of a `SELECT` statement to type objects, which will be used to perform post-processing on columns within the result set. This argument applies to any expression that returns result sets.

`sqlalchemy.sql.expression.`**`true`**`()`
Return a `_True` object, which compiles to `true`, or the boolean equivalent for the target dialect.

`sqlalchemy.sql.expression.`**`tuple_`**`(*expr)`
Return a SQL tuple.

Main usage is to produce a composite IN construct:

```
tuple_(table.c.col1, table.c.col2).in_(
    [(1, 2), (5, 12), (10, 19)]
)
```

Warning: The composite IN construct is not supported by all backends, and is currently known to work on Postgresql and MySQL, but not SQLite. Unsupported backends will raise a subclass of `DBAPIError` when such an expression is invoked.

sqlalchemy.sql.expression.**type_coerce**(*expr*, *type_*)

Coerce the given expression into the given type, on the Python side only.

`type_coerce()` is roughly similar to `cast()`, except no "CAST" expression is rendered - the given type is only applied towards expression typing and against received result values.

e.g.:

```
from sqlalchemy.types import TypeDecorator
import uuid

class AsGuid(TypeDecorator):
    impl = String

    def process_bind_param(self, value, dialect):
        if value is not None:
            return str(value)
        else:
            return None

    def process_result_value(self, value, dialect):
        if value is not None:
            return uuid.UUID(value)
        else:
            return None

conn.execute(
    select([type_coerce(mytable.c.ident, AsGuid)]).\
            where(
                type_coerce(mytable.c.ident, AsGuid) ==
                uuid.uuid3(uuid.NAMESPACE_URL, 'bar')
            )
)
```

sqlalchemy.sql.expression.**union**(**selects*, ***kwargs*)

Return a `UNION` of multiple selectables.

The returned object is an instance of `CompoundSelect`.

A similar `union()` method is available on all `FromClause` subclasses.

***selects** a list of `Select` instances.

****kwargs** available keyword arguments are the same as those of `select()`.

sqlalchemy.sql.expression.**union_all**(**selects*, ***kwargs*)

Return a `UNION ALL` of multiple selectables.

The returned object is an instance of `CompoundSelect`.

A similar `union_all()` method is available on all `FromClause` subclasses.

***selects** a list of `Select` instances.

****kwargs** available keyword arguments are the same as those of `select()`.

sqlalchemy.sql.expression.**update**(*table*, *whereclause=None*, *values=None*, *inline=False*, ***kwargs*)

Represent an UPDATE statement via the Update SQL construct.

E.g.:

```
from sqlalchemy import update

stmt = update(users).where(users.c.id==5).\
        values(name='user #5')
```

Similar functionality is available via the update() method on Table:

```
stmt = users.update().\
            where(users.c.id==5).\
            values(name='user #5')
```

Parameters

- **table** – A Table object representing the database table to be updated.
- **whereclause** – Optional SQL expression describing the WHERE condition of the UPDATE statement. Modern applications may prefer to use the generative where() method to specify the WHERE clause.

  The WHERE clause can refer to multiple tables. For databases which support this, an UPDATE FROM clause will be generated, or on MySQL, a multi-table update. The statement will fail on databases that don't have support for multi-table update statements. A SQL-standard method of referring to additional tables in the WHERE clause is to use a correlated subquery:

  ```
  users.update().values(name='ed').where(
          users.c.name==select([addresses.c.email_address]).\
                      where(addresses.c.user_id==users.c.id).\
                      as_scalar()
          )
  ```

  Changed in version 0.7.4: The WHERE clause can refer to multiple tables.

- **values** – Optional dictionary which specifies the SET conditions of the UPDATE. If left as None, the SET conditions are determined from those parameters passed to the statement during the execution and/or compilation of the statement. When compiled standalone without any parameters, the SET clause generates for all columns.

  Modern applications may prefer to use the generative Update.values() method to set the values of the UPDATE statement.

- **inline** – if True, SQL defaults present on Column objects via the default keyword will be compiled 'inline' into the statement and not pre-executed. This means that their values will not be available in the dictionary returned from ResultProxy.last_updated_params().

If both values and compile-time bind parameters are present, the compile-time bind parameters override the information specified within values on a per-key basis.

The keys within values can be either Column objects or their string identifiers (specifically the "key" of the Column, normally but not necessarily equivalent to its "name"). Normally, the Column objects used here are expected to be part of the target Table that is the table to be updated. However when using MySQL, a multiple-table UPDATE statement can refer to columns from any of the tables referred to in the WHERE clause.

The values referred to in `values` are typically:

- a literal data value (i.e. string, number, etc.)
- a SQL expression, such as a related `Column`, a scalar-returning `select()` construct, etc.

When combining `select()` constructs within the values clause of an `update()` construct, the subquery represented by the `select()` should be *correlated* to the parent table, that is, providing criterion which links the table inside the subquery to the outer table being updated:

```
users.update().values(
        name=select([addresses.c.email_address]).\
                where(addresses.c.user_id==users.c.id).\
                as_scalar()
    )
```

See also:

Inserts and Updates - SQL Expression Language Tutorial

3.2.2 Classes

class sqlalchemy.sql.expression.**Alias**(*selectable*, *name=None*)
Bases: sqlalchemy.sql.expression.FromClause

Represents an table or selectable alias (AS).

Represents an alias, as typically applied to any table or sub-select within a SQL statement using the `AS` keyword (or without the keyword on certain databases such as Oracle).

This object is constructed from the `alias()` module level function as well as the `FromClause.alias()` method available on all `FromClause` subclasses.

class sqlalchemy.sql.expression.**_BindParamClause**(*key*, *value*, *type_=None*, *unique=False*, *callable_=None*, *isoutparam=False*, *required=False*, *_compared_to_operator=None*, *_compared_to_type=None*)
Bases: sqlalchemy.sql.expression.ColumnElement

Represent a bind parameter.

Public constructor is the `bindparam()` function.

__init__(*key*, *value*, *type_=None*, *unique=False*, *callable_=None*, *isoutparam=False*, *required=False*, *_compared_to_operator=None*, *_compared_to_type=None*)
Construct a _BindParamClause.

Parameters

- **key** – the key for this bind param. Will be used in the generated SQL statement for dialects that use named parameters. This value may be modified when part of a compilation operation, if other `_BindParamClause` objects exist with the same key, or if its length is too long and truncation is required.
- **value** – Initial value for this bind param. This value may be overridden by the dictionary of parameters sent to statement compilation/execution.
- **callable_** – A callable function that takes the place of "value". The function will be called at statement execution time to determine the ultimate value. Used for scenarios where the actual bind value cannot be determined at the point at which the clause construct is created, but embedded bind values are still desirable.

- **type_** – A `TypeEngine` object that will be used to pre-process the value corresponding to this `_BindParamClause` at execution time.
- **unique** – if True, the key name of this BindParamClause will be modified if another `_BindParamClause` of the same name already has been located within the containing `ClauseElement`.
- **required** – a value is required at execution time.
- **isoutparam** – if True, the parameter should be treated like a stored procedure "OUT" parameter.

compare(*other*, ***kw*)
Compare this `_BindParamClause` to the given clause.

effective_value
Return the value of this bound parameter, taking into account if the `callable` parameter was set.

The `callable` value will be evaluated and returned if present, else `value`.

class sqlalchemy.sql.expression.**ClauseElement**
Bases: `sqlalchemy.sql.visitors.Visitable`

Base class for elements of a programmatically constructed SQL expression.

compare(*other*, ***kw*)
Compare this ClauseElement to the given ClauseElement.

Subclasses should override the default behavior, which is a straight identity comparison.

**kw are arguments consumed by subclass compare() methods and may be used to modify the criteria for comparison. (see `ColumnElement`)

compile(*bind=None*, *dialect=None*, ***kw*)
Compile this SQL expression.

The return value is a `Compiled` object. Calling `str()` or `unicode()` on the returned value will yield a string representation of the result. The `Compiled` object also can return a dictionary of bind parameter names and values using the `params` accessor.

Parameters

- **bind** – An `Engine` or `Connection` from which a `Compiled` will be acquired. This argument takes precedence over this `ClauseElement`'s bound engine, if any.
- **column_keys** – Used for INSERT and UPDATE statements, a list of column names which should be present in the VALUES clause of the compiled statement. If `None`, all columns from the target table object are rendered.
- **dialect** – A `Dialect` instance from which a `Compiled` will be acquired. This argument takes precedence over the *bind* argument as well as this `ClauseElement`'s bound engine, if any.
- **inline** – Used for INSERT statements, for a dialect which does not support inline retrieval of newly generated primary key columns, will force the expression used to create the new primary key value to be rendered inline within the INSERT statement's VALUES clause. This typically refers to Sequence execution but may also refer to any server-side default generation function associated with a primary key *Column*.

execute(**multiparams*, ***params*)
Compile and execute this `ClauseElement`.

Deprecated since version 0.7: Only SQL expressions which subclass `Executable` may provide the `execute()` method.

get_children(***kwargs*)
Return immediate child elements of this ClauseElement.

This is used for visit traversal.

**kwargs may contain flags that change the collection that is returned, for example to return a subset of items in order to cut down on larger traversals, or to return child items from a different context (such as schema-level collections instead of clause-level).

params(**optionaldict*, ***kwargs*)
Return a copy with bindparam() elements replaced.

Returns a copy of this ClauseElement with bindparam() elements replaced with values taken from the given dictionary:

```
>>> clause = column('x') + bindparam('foo')
>>> print clause.compile().params
{'foo':None}
>>> print clause.params({'foo':7}).compile().params
{'foo':7}
```

scalar(**multiparams*, ***params*)
Compile and execute this ClauseElement, returning

Deprecated since version 0.7: Only SQL expressions which subclass Executable may provide the scalar() method.

the result's scalar representation.

self_group(*against=None*)
Apply a 'grouping' to this ClauseElement.

This method is overridden by subclasses to return a "grouping" construct, i.e. parenthesis. In particular it's used by "binary" expressions to provide a grouping around themselves when placed into a larger expression, as well as by select() constructs when placed into the FROM clause of another select(). (Note that subqueries should be normally created using the Select.alias() method, as many platforms require nested SELECT statements to be named).

As expressions are composed together, the application of self_group() is automatic - end-user code should never need to use this method directly. Note that SQLAlchemy's clause constructs take operator precedence into account - so parenthesis might not be needed, for example, in an expression like x OR (y AND z) - AND takes precedence over OR.

The base self_group() method of ClauseElement just returns self.

unique_params(**optionaldict*, ***kwargs*)
Return a copy with bindparam() elements replaced.

Same functionality as params(), except adds *unique=True* to affected bind parameters so that multiple statements can be used.

class sqlalchemy.sql.expression.**ClauseList**(**clauses*, ***kwargs*)
Bases: sqlalchemy.sql.expression.ClauseElement

Describe a list of clauses, separated by an operator.

By default, is comma-separated, such as a column listing.

compare(*other*, ***kw*)
Compare this ClauseList to the given ClauseList, including a comparison of all the clause items.

class sqlalchemy.sql.expression.**ColumnClause**(*text*, *selectable=None*, *type_=None*, *is_literal=False*)
Bases: sqlalchemy.sql.expression._Immutable, sqlalchemy.sql.expression.ColumnElement

Represents a generic column expression from any textual string.

This includes columns associated with tables, aliases and select statements, but also any arbitrary text. May or may not be bound to an underlying `Selectable`.

`ColumnClause` is constructed by itself typically via the `column()` function. It may be placed directly into constructs such as `select()` constructs:

```
from sqlalchemy.sql import column, select

c1, c2 = column("c1"), column("c2")
s = select([c1, c2]).where(c1==5)
```

There is also a variant on `column()` known as `literal_column()` - the difference is that in the latter case, the string value is assumed to be an exact expression, rather than a column name, so that no quoting rules or similar are applied:

```
from sqlalchemy.sql import literal_column, select

s = select([literal_column("5 + 7")])
```

`ColumnClause` can also be used in a table-like fashion by combining the `column()` function with the `table()` function, to produce a "lightweight" form of table metadata:

```
from sqlalchemy.sql import table, column

user = table("user",
        column("id"),
        column("name"),
        column("description"),
)
```

The above construct can be created in an ad-hoc fashion and is not associated with any `schema.MetaData`, unlike it's more full fledged `schema.Table` counterpart.

Parameters

- **text** – the text of the element.
- **selectable** – parent selectable.
- **type** – `types.TypeEngine` object which can associate this `ColumnClause` with a type.
- **is_literal** – if True, the `ColumnClause` is assumed to be an exact expression that will be delivered to the output with no quoting rules applied regardless of case sensitive settings. the `literal_column()` function is usually used to create such a `ColumnClause`.

class sqlalchemy.sql.expression.**ColumnCollection**(**cols*)
Bases: sqlalchemy.util._collections.OrderedProperties

An ordered dictionary that stores a list of ColumnElement instances.

Overrides the `__eq__()` method to produce SQL clauses between sets of correlated columns.

add(*column*)
Add a column to this collection.

The key attribute of the column will be used as the hash key for this dictionary.

replace(*column*)
add the given column to this collection, removing unaliased versions of this column as well as existing columns with the same key.

e.g.:

```
t = Table('sometable', metadata, Column('col1', Integer))
t.columns.replace(Column('col1', Integer, key='columnone'))
```

will remove the original 'col1' from the collection, and add the new column under the name 'columnname'.

Used by schema.Column to override columns during table reflection.

class sqlalchemy.sql.expression.**ColumnElement**

Bases: sqlalchemy.sql.expression.ClauseElement, sqlalchemy.sql.expression._CompareMixin

Represent an element that is usable within the "column clause" portion of a SELECT statement.

This includes columns associated with tables, aliases, and subqueries, expressions, function calls, SQL keywords such as NULL, literals, etc. ColumnElement is the ultimate base class for all such elements.

ColumnElement supports the ability to be a *proxy* element, which indicates that the ColumnElement may be associated with a Selectable which was derived from another Selectable. An example of a "derived" Selectable is an Alias of a Table.

A ColumnElement, by subclassing the _CompareMixin mixin class, provides the ability to generate new ClauseElement objects using Python expressions. See the _CompareMixin docstring for more details.

anon_label

provides a constant 'anonymous label' for this ColumnElement.

This is a label() expression which will be named at compile time. The same label() is returned each time anon_label is called so that expressions can reference anon_label multiple times, producing the same label name at compile time.

the compiler uses this function automatically at compile time for expressions that are known to be 'unnamed' like binary expressions and function calls.

compare(*other*, *use_proxies=False*, *equivalents=None*, ***kw*)

Compare this ColumnElement to another.

Special arguments understood:

Parameters

- **use_proxies** – when True, consider two columns that share a common base column as equivalent (i.e. shares_lineage())
- **equivalents** – a dictionary of columns as keys mapped to sets of columns. If the given "other" column is present in this dictionary, if any of the columns in the corresponding set() pass the comparison test, the result is True. This is used to expand the comparison to other columns that may be known to be equivalent to this one via foreign key or other criterion.

shares_lineage(*othercolumn*)

Return True if the given ColumnElement has a common ancestor to this ColumnElement.

class sqlalchemy.sql.expression.**_CompareMixin**

Bases: sqlalchemy.sql.operators.ColumnOperators

Defines comparison and math operations for ClauseElement instances.

See ColumnOperators and Operators for descriptions of all operations.

asc()

See ColumnOperators.asc().

between(*cleft*, *cright*)
See ColumnOperators.between().

collate(*collation*)
See ColumnOperators.collate().

contains(*other*, *escape=None*)
See ColumnOperators.contains().

desc()
See ColumnOperators.desc().

distinct()
See ColumnOperators.distinct().

endswith(*other*, *escape=None*)
See ColumnOperators.endswith().

in_(*other*)
See ColumnOperators.in_().

label(*name*)
Produce a column label, i.e. <columnname> AS <name>.

This is a shortcut to the label() function.

if 'name' is None, an anonymous label name will be generated.

match(*other*)
See ColumnOperators.match().

nullsfirst()
See ColumnOperators.nullsfirst().

nullslast()
See ColumnOperators.nullslast().

op(*operator*)
See ColumnOperators.op().

startswith(*other*, *escape=None*)
See ColumnOperators.startswith().

class sqlalchemy.sql.operators.**ColumnOperators**
Bases: sqlalchemy.sql.operators.Operators

Defines comparison and math operations.

By default all methods call down to Operators.operate() or Operators.reverse_operate() passing in the appropriate operator function from the Python builtin operator module or a SQLAlchemy-specific operator function from sqlalchemy.expression.operators. For example the __eq__ function:

```
def __eq__(self, other):
    return self.operate(operators.eq, other)
```

Where operators.eq is essentially:

```
def eq(a, b):
    return a == b
```

A SQLAlchemy construct like ColumnElement ultimately overrides Operators.operate() and others to return further ClauseElement constructs, so that the == operation above is replaced by a clause construct.

The docstrings here will describe column-oriented behavior of each operator. For ORM-based operators on related objects and collections, see `RelationshipProperty.Comparator`.

__eq__(*other*)
Implement the == operator.

In a column context, produces the clause `a = b`. If the target is `None`, produces `a IS NULL`.

__ne__(*other*)
Implement the != operator.

In a column context, produces the clause `a != b`. If the target is `None`, produces `a IS NOT NULL`.

__gt__(*other*)
Implement the > operator.

In a column context, produces the clause `a > b`.

__ge__(*other*)
Implement the >= operator.

In a column context, produces the clause `a >= b`.

__lt__(*other*)
Implement the < operator.

In a column context, produces the clause `a < b`.

__le__(*other*)
Implement the <= operator.

In a column context, produces the clause `a <= b`.

__neg__()
Implement the − operator.

In a column context, produces the clause `-a`.

__add__(*other*)
Implement the + operator.

In a column context, produces the clause `a + b` if the parent object has non-string affinity. If the parent object has a string affinity, produces the concatenation operator, `a || b` - see `concat()`.

__mul__(*other*)
Implement the * operator.

In a column context, produces the clause `a * b`.

__div__(*other*)
Implement the / operator.

In a column context, produces the clause `a / b`.

__truediv__(*other*)
Implement the // operator.

In a column context, produces the clause `a / b`.

__sub__(*other*)
Implement the − operator.

In a column context, produces the clause `a - b`.

__radd__(*other*)
Implement the + operator in reverse.

See `__add__()`.

__rsub__(*other*)
Implement the − operator in reverse.

See `__sub__()`.

__rtruediv__(*other*)
Implement the `//` operator in reverse.

See `__truediv__()`.

__rdiv__(*other*)
Implement the `/` operator in reverse.

See `__div__()`.

__rmul__(*other*)
Implement the `*` operator in reverse.

See `__mul__()`.

__mod__(*other*)
Implement the `%` operator.

In a column context, produces the clause `a % b`.

__eq__(*other*)
Implement the == operator.

In a column context, produces the clause `a = b`. If the target is `None`, produces `a IS NULL`.

__init__
inherited from the `object.__init__` *attribute of* `object`

x.__init__(...) initializes x; see help(type(x)) for signature

__le__(*other*)
Implement the <= operator.

In a column context, produces the clause `a <= b`.

__lt__(*other*)
Implement the < operator.

In a column context, produces the clause `a < b`.

__ne__(*other*)
Implement the != operator.

In a column context, produces the clause `a != b`. If the target is `None`, produces `a IS NOT NULL`.

asc()
Produce a `asc()` clause against the parent object.

between(*cleft*, *cright*)
Produce a `between()` clause against the parent object, given the lower and upper range.

collate(*collation*)
Produce a `collate()` clause against the parent object, given the collation string.

concat(*other*)
Implement the 'concat' operator.

In a column context, produces the clause `a || b`, or uses the `concat()` operator on MySQL.

contains(*other*, ***kwargs*)
Implement the 'contains' operator.

In a column context, produces the clause `LIKE '%<other>%'`

desc()
Produce a `desc()` clause against the parent object.

distinct()
Produce a `distinct()` clause against the parent object.

endswith(*other*, ***kwargs*)
Implement the 'endswith' operator.

In a column context, produces the clause `LIKE '%<other>'`

ilike(*other*, *escape=None*)
Implement the `ilike` operator.

In a column context, produces the clause `a ILIKE other`.

in_(*other*)
Implement the `in` operator.

In a column context, produces the clause `a IN other`. "other" may be a tuple/list of column expressions, or a `select()` construct.

is_(*other*)
Implement the `IS` operator.

Normally, `IS` is generated automatically when comparing to a value of `None`, which resolves to `NULL`. However, explicit usage of `IS` may be desirable if comparing to boolean values on certain platforms.

New in version 0.7.9.

See also:

`ColumnOperators.isnot()`

isnot(*other*)
Implement the `IS NOT` operator.

Normally, `IS NOT` is generated automatically when comparing to a value of `None`, which resolves to `NULL`. However, explicit usage of `IS NOT` may be desirable if comparing to boolean values on certain platforms.

New in version 0.7.9.

See also:

`ColumnOperators.is_()`

like(*other*, *escape=None*)
Implement the `like` operator.

In a column context, produces the clause `a LIKE other`.

match(*other*, ***kwargs*)
Implements the 'match' operator.

In a column context, this produces a MATCH clause, i.e. `MATCH '<other>'`. The allowed contents of `other` are database backend specific.

nullsfirst()
Produce a `nullsfirst()` clause against the parent object.

nullslast()
Produce a `nullslast()` clause against the parent object.

op(*opstring*)
inherited from the `Operators.op()` *method of* `Operators`

produce a generic operator function.

e.g.:

```
somecolumn.op("*")(5)
```

produces:

```
somecolumn * 5
```

Parameters operator – a string which will be output as the infix operator between this `ClauseElement` and the expression passed to the generated function.

This function can also be used to make bitwise operators explicit. For example:

```
somecolumn.op('&')(0xff)
```

is a bitwise AND of the value in somecolumn.

operate(*op*, **other*, ***kwargs*)
inherited from the `Operators.operate()` *method of* `Operators`

Operate on an argument.

This is the lowest level of operation, raises `NotImplementedError` by default.

Overriding this on a subclass can allow common behavior to be applied to all operations. For example, overriding `ColumnOperators` to apply `func.lower()` to the left and right side:

```
class MyComparator(ColumnOperators):
    def operate(self, op, other):
        return op(func.lower(self), func.lower(other))
```

Parameters

- **op** – Operator callable.
- ***other** – the 'other' side of the operation. Will be a single scalar for most operations.
- ****kwargs** – modifiers. These may be passed by special operators such as `ColumnOperators.contains()`.

reverse_operate(*op*, *other*, ***kwargs*)
inherited from the `Operators.reverse_operate()` *method of* `Operators`

Reverse operate on an argument.

Usage is the same as `operate()`.

startswith(*other*, ***kwargs*)
Implement the `startwith` operator.

In a column context, produces the clause `LIKE '<other>%'`

timetuple = None
Hack, allows datetime objects to be compared on the LHS.

class sqlalchemy.sql.expression.**CompoundSelect**(*keyword*, **selects*, ***kwargs*)
Bases: sqlalchemy.sql.expression._SelectBase

Forms the basis of `UNION`, `UNION ALL`, and other SELECT-based set operations.

class sqlalchemy.sql.expression.**CTE**(*selectable*, *name=None*, *recursive=False*, *_cte_alias=None*, *_restates=frozenset([])*)
Bases: sqlalchemy.sql.expression.Alias

Represent a Common Table Expression.

The `CTE` object is obtained using the `_SelectBase.cte()` method from any selectable. See that method for complete examples.

New in version 0.7.6.

class sqlalchemy.sql.expression.**Delete**(*table*, *whereclause*, *bind=None*, *returning=None*, ***kwargs*)
Bases: sqlalchemy.sql.expression.UpdateBase

Represent a DELETE construct.

The `Delete` object is created using the `delete()` function.

where(*whereclause*)
Add the given WHERE clause to a newly returned delete construct.

class sqlalchemy.sql.expression.**Executable**
Bases: sqlalchemy.sql.expression._Generative

Mark a ClauseElement as supporting execution.

`Executable` is a superclass for all "statement" types of objects, including `select()`, `delete()`, `update()`, `insert()`, `text()`.

bind
Returns the `Engine` or `Connection` to which this `Executable` is bound, or None if none found.

This is a traversal which checks locally, then checks among the "from" clauses of associated objects until a bound engine or connection is found.

execute(**multiparams*, ***params*)
Compile and execute this `Executable`.

execution_options(***kw*)
Set non-SQL options for the statement which take effect during execution.

Execution options can be set on a per-statement or per `Connection` basis. Additionally, the `Engine` and ORM `Query` objects provide access to execution options which they in turn configure upon connections.

The `execution_options()` method is generative. A new instance of this statement is returned that contains the options:

```
statement = select([table.c.x, table.c.y])
statement = statement.execution_options(autocommit=True)
```

Note that only a subset of possible execution options can be applied to a statement - these include "autocommit" and "stream_results", but not "isolation_level" or "compiled_cache". See `Connection.execution_options()` for a full list of possible options.

See also:

`Connection.execution_options()`

`Query.execution_options()`

scalar(**multiparams*, ***params*)
Compile and execute this `Executable`, returning the result's scalar representation.

class sqlalchemy.sql.expression.**FunctionElement**(**clauses*, ***kwargs*)
Bases: `sqlalchemy.sql.expression.Executable`, `sqlalchemy.sql.expression.ColumnElement`, `sqlalchemy.sql.expression.FromClause`

Base for SQL function-oriented constructs.

__init__(**clauses*, ***kwargs*)
Construct a `FunctionElement`.

clauses
Return the underlying `ClauseList` which contains the arguments for this `FunctionElement`.

columns
Fulfill the 'columns' contract of `ColumnElement`.

Returns a single-element list consisting of this object.

execute()
Execute this `FunctionElement` against an embedded 'bind'.

This first calls `select()` to produce a SELECT construct.

Note that `FunctionElement` can be passed to the `Connectable.execute()` method of `Connection` or `Engine`.

over(*partition_by=None*, *order_by=None*)
Produce an OVER clause against this function.

Used against aggregate or so-called "window" functions, for database backends that support window functions.

The expression:

```
func.row_number().over(order_by='x')
```

is shorthand for:

```
from sqlalchemy import over
over(func.row_number(), order_by='x')
```

See `over()` for a full description.

New in version 0.7.

scalar()
Execute this `FunctionElement` against an embedded 'bind' and return a scalar value.

This first calls `select()` to produce a SELECT construct.

Note that `FunctionElement` can be passed to the `Connectable.scalar()` method of `Connection` or `Engine`.

select()
Produce a select() construct against this FunctionElement.

This is shorthand for:

```
s = select([function_element])
```

class sqlalchemy.sql.expression.**Function**(*name*, **clauses*, ***kw*)
Bases: sqlalchemy.sql.expression.FunctionElement

Describe a named SQL function.

See the superclass FunctionElement for a description of public methods.

__init__(*name*, **clauses*, ***kw*)
Construct a Function.

The func construct is normally used to construct new Function instances.

class sqlalchemy.sql.expression.**FromClause**
Bases: sqlalchemy.sql.expression.Selectable

Represent an element that can be used within the FROM clause of a SELECT statement.

alias(*name=None*)
return an alias of this FromClause.

This is shorthand for calling:

```
from sqlalchemy import alias
a = alias(self, name=name)
```

See alias() for details.

c
attrgetter(attr, ...) –> attrgetter object

Return a callable object that fetches the given attribute(s) from its operand. After f = attrgetter('name'), the call f(r) returns r.name. After g = attrgetter('name', 'date'), the call g(r) returns (r.name, r.date). After h = attrgetter('name.first', 'name.last'), the call h(r) returns (r.name.first, r.name.last).

columns
Return the collection of Column objects contained by this FromClause.

correspond_on_equivalents(*column*, *equivalents*)
Return corresponding_column for the given column, or if None search for a match in the given dictionary.

corresponding_column(*column*, *require_embedded=False*)
Given a ColumnElement, return the exported ColumnElement object from this Selectable which corresponds to that original Column via a common ancestor column.

Parameters

- **column** – the target ColumnElement to be matched
- **require_embedded** – only return corresponding columns for

the given ColumnElement, if the given ColumnElement is actually present within a sub-element of this FromClause. Normally the column will match if it merely shares a common ancestor with one of the exported columns of this FromClause.

count(*whereclause=None*, ***params*)
return a SELECT COUNT generated against this FromClause.

description
a brief description of this FromClause.

Used primarily for error message formatting.

foreign_keys
Return the collection of ForeignKey objects which this FromClause references.

is_derived_from(*fromclause*)
Return True if this FromClause is 'derived' from the given FromClause.

An example would be an Alias of a Table is derived from that Table.

join(*right*, *onclause=None*, *isouter=False*)
return a join of this `FromClause` against another `FromClause`.

outerjoin(*right*, *onclause=None*)
return an outer join of this `FromClause` against another `FromClause`.

primary_key
Return the collection of Column objects which comprise the primary key of this FromClause.

replace_selectable(*old*, *alias*)
replace all occurrences of FromClause 'old' with the given Alias object, returning a copy of this `FromClause`.

select(*whereclause=None*, ***params*)
return a SELECT of this `FromClause`.

class sqlalchemy.sql.expression.**Insert**(*table*, *values=None*, *inline=False*, *bind=None*, *prefixes=None*, *returning=None*, ***kwargs*)
Bases: `sqlalchemy.sql.expression.ValuesBase`

Represent an INSERT construct.

The `Insert` object is created using the `insert()` function.

See also:

Insert Expressions

prefix_with(*clause*)
Add a word or expression between INSERT and INTO. Generative.

If multiple prefixes are supplied, they will be separated with spaces.

returning(**cols*)
Add a RETURNING or equivalent clause to this statement.

The given list of columns represent columns within the table that is the target of the INSERT, UPDATE, or DELETE. Each element can be any column expression. `Table` objects will be expanded into their individual columns.

Upon compilation, a RETURNING clause, or database equivalent, will be rendered within the statement. For INSERT and UPDATE, the values are the newly inserted/updated values. For DELETE, the values are those of the rows which were deleted.

Upon execution, the values of the columns to be returned are made available via the result set and can be iterated using `fetchone()` and similar. For DBAPIs which do not natively support returning values (i.e. cx_oracle), SQLAlchemy will approximate this behavior at the result level so that a reasonable amount of behavioral neutrality is provided.

Note that not all databases/DBAPIs support RETURNING. For those backends with no support, an exception is raised upon compilation and/or execution. For those who do support it, the functionality across

backends varies greatly, including restrictions on executemany() and other statements which return multiple rows. Please read the documentation notes for the database in use in order to determine the availability of RETURNING.

values(**args*, ***kwargs*)
specify the VALUES clause for an INSERT statement, or the SET clause for an UPDATE.

Parameters

- ****kwargs** – key value pairs representing the string key of a `Column` mapped to the value to be rendered into the VALUES or SET clause:

```
users.insert().values(name="some name")

users.update().where(users.c.id==5).values(name="some name")
```

- ***args** – A single dictionary can be sent as the first positional argument. This allows non-string based keys, such as Column objects, to be used:

```
users.insert().values({users.c.name : "some name"})

users.update().where(users.c.id==5).values({users.c.name : "some name"})
```

See also:

Inserts and Updates - SQL Expression Language Tutorial

`insert()` - produce an `INSERT` statement

`update()` - produce an `UPDATE` statement

class sqlalchemy.sql.expression.**Join**(*left*, *right*, *onclause=None*, *isouter=False*)
Bases: `sqlalchemy.sql.expression.FromClause`

represent a `JOIN` construct between two `FromClause` elements.

The public constructor function for `Join` is the module-level `join()` function, as well as the `join()` method available off all `FromClause` subclasses.

__init__(*left*, *right*, *onclause=None*, *isouter=False*)
Construct a new `Join`.

The usual entrypoint here is the `join()` function or the `FromClause.join()` method of any `FromClause` object.

alias(*name=None*)
return an alias of this `Join`.

Used against a `Join` object, `alias()` calls the `select()` method first so that a subquery against a `select()` construct is generated. the `select()` construct also has the `correlate` flag set to `False` and will not auto-correlate inside an enclosing `select()` construct.

The equivalent long-hand form, given a `Join` object `j`, is:

```
from sqlalchemy import select, alias
j = alias(
    select([j.left, j.right]).\
        select_from(j).\
        with_labels(True).\
        correlate(False),
    name=name
)
```

See alias() for further details on aliases.

select(*whereclause=None*, *fold_equivalents=False*, ***kwargs*)
Create a Select from this Join.

The equivalent long-hand form, given a Join object j, is:

```
from sqlalchemy import select
j = select([j.left, j.right], **kw).\
            where(whereclause).\
            select_from(j)
```

Parameters

- **whereclause** – the WHERE criterion that will be sent to the select() function
- **fold_equivalents** – based on the join criterion of this Join, do not include repeat column names in the column list of the resulting select, for columns that are calculated to be "equivalent" based on the join criterion of this Join. This will recursively apply to any joins directly nested by this one as well.
- ****kwargs** – all other kwargs are sent to the underlying select() function.

class sqlalchemy.sql.expression.**Operators**
Base of comparison and logical operators.

Implements base methods operate() and reverse_operate(), as well as __and__(), __or__(), __invert__().

Usually is used via its most common subclass ColumnOperators.

__and__(*other*)
Implement the & operator.

When used with SQL expressions, results in an AND operation, equivalent to and_(), that is:

```
a & b
```

is equivalent to:

```
from sqlalchemy import and_
and_(a, b)
```

Care should be taken when using & regarding operator precedence; the & operator has the highest precedence. The operands should be enclosed in parenthesis if they contain further sub expressions:

```
(a == 2) & (b == 4)
```

__or__(*other*)
Implement the | operator.

When used with SQL expressions, results in an OR operation, equivalent to or_(), that is:

```
a | b
```

is equivalent to:

```
from sqlalchemy import or_
or_(a, b)
```

Care should be taken when using | regarding operator precedence; the | operator has the highest precedence. The operands should be enclosed in parenthesis if they contain further sub expressions:

```
(a == 2) | (b == 4)
```

__invert__()
Implement the ~ operator.

When used with SQL expressions, results in a NOT operation, equivalent to `not_()`, that is:

```
~a
```

is equivalent to:

```
from sqlalchemy import not_
not_(a)
```

op(*opstring*)
produce a generic operator function.

e.g.:

```
somecolumn.op("*")(5)
```

produces:

```
somecolumn * 5
```

Parameters operator – a string which will be output as the infix operator between this `ClauseElement` and the expression passed to the generated function.

This function can also be used to make bitwise operators explicit. For example:

```
somecolumn.op('&')(0xff)
```

is a bitwise AND of the value in somecolumn.

operate(*op*, **other*, ***kwargs*)
Operate on an argument.

This is the lowest level of operation, raises `NotImplementedError` by default.

Overriding this on a subclass can allow common behavior to be applied to all operations. For example, overriding `ColumnOperators` to apply `func.lower()` to the left and right side:

```
class MyComparator(ColumnOperators):
    def operate(self, op, other):
        return op(func.lower(self), func.lower(other))
```

Parameters

- **op** – Operator callable.
- ***other** – the 'other' side of the operation. Will be a single scalar for most operations.
- ****kwargs** – modifiers. These may be passed by special operators such as `ColumnOperators.contains()`.

reverse_operate(*op*, *other*, ***kwargs*)
Reverse operate on an argument.

Usage is the same as `operate()`.

class sqlalchemy.sql.expression.**Select**(*columns*, *whereclause=None*, *from_obj=None*, *distinct=False*, *having=None*, *correlate=True*, *prefixes=None*, ***kwargs*)

Bases: sqlalchemy.sql.expression._SelectBase

Represents a SELECT statement.

See also:

select() - the function which creates a Select object.

Selecting - Core Tutorial description of select().

__init__(*columns*, *whereclause=None*, *from_obj=None*, *distinct=False*, *having=None*, *correlate=True*, *prefixes=None*, ***kwargs*)

Construct a Select object.

The public constructor for Select is the select() function; see that function for argument descriptions.

Additional generative and mutator methods are available on the _SelectBase superclass.

append_column(*column*)

append the given column expression to the columns clause of this select() construct.

append_correlation(*fromclause*)

append the given correlation expression to this select() construct.

append_from(*fromclause*)

append the given FromClause expression to this select() construct's FROM clause.

append_having(*having*)

append the given expression to this select() construct's HAVING criterion.

The expression will be joined to existing HAVING criterion via AND.

append_prefix(*clause*)

append the given columns clause prefix expression to this select() construct.

append_whereclause(*whereclause*)

append the given expression to this select() construct's WHERE criterion.

The expression will be joined to existing WHERE criterion via AND.

column(*column*)

return a new select() construct with the given column expression added to its columns clause.

correlate(**fromclauses*)

return a new select() construct which will correlate the given FROM clauses to that of an enclosing select(), if a match is found.

By "match", the given fromclause must be present in this select's list of FROM objects and also present in an enclosing select's list of FROM objects.

Calling this method turns off the select's default behavior of "auto-correlation". Normally, select() auto-correlates all of its FROM clauses to those of an embedded select when compiled.

If the fromclause is None, correlation is disabled for the returned select().

distinct(**expr*)

Return a new select() construct which will apply DISTINCT to its columns clause.

Parameters ***expr** – optional column expressions. When present, the Postgresql dialect will render a DISTINCT ON (<expressions>>) construct.

except_(*other*, ***kwargs*)

return a SQL EXCEPT of this select() construct against the given selectable.

except_all(*other*, ***kwargs*)
return a SQL EXCEPT ALL of this select() construct against the given selectable.

froms
Return the displayed list of FromClause elements.

get_children(*column_collections=True*, ***kwargs*)
return child elements as per the ClauseElement specification.

having(*having*)
return a new select() construct with the given expression added to its HAVING clause, joined to the existing clause via AND, if any.

inner_columns
an iterator of all ColumnElement expressions which would be rendered into the columns clause of the resulting SELECT statement.

intersect(*other*, ***kwargs*)
return a SQL INTERSECT of this select() construct against the given selectable.

intersect_all(*other*, ***kwargs*)
return a SQL INTERSECT ALL of this select() construct against the given selectable.

locate_all_froms
return a Set of all FromClause elements referenced by this Select.

This set is a superset of that returned by the `froms` property, which is specifically for those FromClause elements that would actually be rendered.

prefix_with(**expr*)
return a new select() construct which will apply the given expressions, typically strings, to the start of its columns clause, not using any commas. In particular is useful for MySQL keywords.

e.g.:

```
select(['a', 'b']).prefix_with('HIGH_PRIORITY',
                       'SQL_SMALL_RESULT',
                       'ALL')
```

Would render:

```
SELECT HIGH_PRIORITY SQL_SMALL_RESULT ALL a, b
```

select_from(*fromclause*)
return a new `select()` construct with the given FROM expression merged into its list of FROM objects.

E.g.:

```
table1 = table('t1', column('a'))
table2 = table('t2', column('b'))
s = select([table1.c.a]).\
    select_from(
        table1.join(table2, table1.c.a==table2.c.b)
    )
```

The "from" list is a unique set on the identity of each element, so adding an already present `Table` or other selectable will have no effect. Passing a `Join` that refers to an already present `Table` or other selectable will have the effect of concealing the presence of that selectable as an individual element in the rendered FROM list, instead rendering it into a JOIN clause.

While the typical purpose of `Select.select_from()` is to replace the default, derived FROM clause with a join, it can also be called with individual table elements, multiple times if desired, in the case that the FROM clause cannot be fully derived from the columns clause:

```
select([func.count('*')]).select_from(table1)
```

self_group(*against=None*)
return a 'grouping' construct as per the ClauseElement specification.

This produces an element that can be embedded in an expression. Note that this method is called automatically as needed when constructing expressions and should not require explicit use.

union(*other*, ***kwargs*)
return a SQL UNION of this select() construct against the given selectable.

union_all(*other*, ***kwargs*)
return a SQL UNION ALL of this select() construct against the given selectable.

where(*whereclause*)
return a new select() construct with the given expression added to its WHERE clause, joined to the existing clause via AND, if any.

with_hint(*selectable*, *text*, *dialect_name='*'*)
Add an indexing hint for the given selectable to this `Select`.

The text of the hint is rendered in the appropriate location for the database backend in use, relative to the given `Table` or `Alias` passed as the `selectable` argument. The dialect implementation typically uses Python string substitution syntax with the token `%(name)s` to render the name of the table or alias. E.g. when using Oracle, the following:

```
select([mytable]).\
    with_hint(mytable, "+ index(%(name)s ix_mytable)")
```

Would render SQL as:

```
select /*+ index(mytable ix_mytable) */ ... from mytable
```

The `dialect_name` option will limit the rendering of a particular hint to a particular backend. Such as, to add hints for both Oracle and Sybase simultaneously:

```
select([mytable]).\
    with_hint(mytable, "+ index(%(name)s ix_mytable)", 'oracle').\
    with_hint(mytable, "WITH INDEX ix_mytable", 'sybase')
```

with_only_columns(*columns*)
Return a new `select()` construct with its columns clause replaced with the given columns.

Changed in version 0.7.3: Due to a bug fix, this method has a slight behavioral change as of version 0.7.3. Prior to version 0.7.3, the FROM clause of a `select()` was calculated upfront and as new columns were added; in 0.7.3 and later it's calculated at compile time, fixing an issue regarding late binding of columns to parent tables. This changes the behavior of `Select.with_only_columns()` in that FROM clauses no longer represented in the new list are dropped, but this behavior is more consistent in that the FROM clauses are consistently derived from the current columns clause. The original intent of this method is to allow trimming of the existing columns list to be fewer columns than originally present; the use case of replacing the columns list with an entirely different one hadn't been anticipated until 0.7.3 was released; the usage guidelines below illustrate how this should be done.

This method is exactly equivalent to as if the original `select()` had been called with the given columns clause. I.e. a statement:

```
s = select([table1.c.a, table1.c.b])
s = s.with_only_columns([table1.c.b])
```

should be exactly equivalent to:

```
s = select([table1.c.b])
```

This means that FROM clauses which are only derived from the column list will be discarded if the new column list no longer contains that FROM:

```
>>> table1 = table('t1', column('a'), column('b'))
>>> table2 = table('t2', column('a'), column('b'))
>>> s1 = select([table1.c.a, table2.c.b])
>>> print s1
SELECT t1.a, t2.b FROM t1, t2
>>> s2 = s1.with_only_columns([table2.c.b])
>>> print s2
SELECT t2.b FROM t1
```

The preferred way to maintain a specific FROM clause in the construct, assuming it won't be represented anywhere else (i.e. not in the WHERE clause, etc.) is to set it using `Select.select_from()`:

```
>>> s1 = select([table1.c.a, table2.c.b]).\
...          select_from(table1.join(table2, table1.c.a==table2.c.a))
>>> s2 = s1.with_only_columns([table2.c.b])
>>> print s2
SELECT t2.b FROM t1 JOIN t2 ON t1.a=t2.a
```

Care should also be taken to use the correct set of column objects passed to `Select.with_only_columns()`. Since the method is essentially equivalent to calling the `select()` construct in the first place with the given columns, the columns passed to `Select.with_only_columns()` should usually be a subset of those which were passed to the `select()` construct, not those which are available from the `.c` collection of that `select()`. That is:

```
s = select([table1.c.a, table1.c.b]).select_from(table1)
s = s.with_only_columns([table1.c.b])
```

and **not**:

```
# usually incorrect
s = s.with_only_columns([s.c.b])
```

The latter would produce the SQL:

```
SELECT b
FROM (SELECT t1.a AS a, t1.b AS b
FROM t1), t1
```

Since the `select()` construct is essentially being asked to select both from `table1` as well as itself.

class sqlalchemy.sql.expression.**Selectable**

Bases: sqlalchemy.sql.expression.ClauseElement

mark a class as being selectable

class sqlalchemy.sql.expression.**_SelectBase**(*use_labels=False*, *for_update=False*, *limit=None*, *offset=None*, *order_by=None*, *group_by=None*, *bind=None*, *autocommit=None*)

Bases: sqlalchemy.sql.expression.Executable, sqlalchemy.sql.expression.FromClause

Base class for `Select` and `CompoundSelects`.

append_group_by(**clauses*)

Append the given GROUP BY criterion applied to this selectable.

The criterion will be appended to any pre-existing GROUP BY criterion.

append_order_by(**clauses*)
Append the given ORDER BY criterion applied to this selectable.

The criterion will be appended to any pre-existing ORDER BY criterion.

apply_labels()
return a new selectable with the 'use_labels' flag set to True.

This will result in column expressions being generated using labels against their table name, such as "SELECT somecolumn AS tablename_somecolumn". This allows selectables which contain multiple FROM clauses to produce a unique set of column names regardless of name conflicts among the individual FROM clauses.

as_scalar()
return a 'scalar' representation of this selectable, which can be used as a column expression.

Typically, a select statement which has only one column in its columns clause is eligible to be used as a scalar expression.

The returned object is an instance of `_ScalarSelect`.

autocommit()
return a new selectable with the 'autocommit' flag set to

Deprecated since version 0.6: `autocommit()` is deprecated. Use `Executable.execution_options()` with the 'autocommit' flag.

True.

cte(*name=None*, *recursive=False*)
Return a new `CTE`, or Common Table Expression instance.

Common table expressions are a SQL standard whereby SELECT statements can draw upon secondary statements specified along with the primary statement, using a clause called "WITH". Special semantics regarding UNION can also be employed to allow "recursive" queries, where a SELECT statement can draw upon the set of rows that have previously been selected.

SQLAlchemy detects `CTE` objects, which are treated similarly to `Alias` objects, as special elements to be delivered to the FROM clause of the statement as well as to a WITH clause at the top of the statement.

New in version 0.7.6.

Parameters

- **name** – name given to the common table expression. Like `_FromClause.alias()`, the name can be left as `None` in which case an anonymous symbol will be used at query compile time.
- **recursive** – if `True`, will render `WITH RECURSIVE`. A recursive common table expression is intended to be used in conjunction with UNION ALL in order to derive rows from those already selected.

The following examples illustrate two examples from Postgresql's documentation at http://www.postgresql.org/docs/8.4/static/queries-with.html.

Example 1, non recursive:

```
from sqlalchemy import Table, Column, String, Integer, MetaData, \
    select, func

metadata = MetaData()
```

```
orders = Table('orders', metadata,
    Column('region', String),
    Column('amount', Integer),
    Column('product', String),
    Column('quantity', Integer)
)

regional_sales = select([
                    orders.c.region,
                    func.sum(orders.c.amount).label('total_sales')
                ]).group_by(orders.c.region).cte("regional_sales")


top_regions = select([regional_sales.c.region]).\
        where(
            regional_sales.c.total_sales >
            select([
                func.sum(regional_sales.c.total_sales)/10
            ])
        ).cte("top_regions")

statement = select([
            orders.c.region,
            orders.c.product,
            func.sum(orders.c.quantity).label("product_units"),
            func.sum(orders.c.amount).label("product_sales")
    ]).where(orders.c.region.in_(
        select([top_regions.c.region])
    )).group_by(orders.c.region, orders.c.product)

result = conn.execute(statement).fetchall()
```

Example 2, WITH RECURSIVE:

```
from sqlalchemy import Table, Column, String, Integer, MetaData, \
    select, func

metadata = MetaData()

parts = Table('parts', metadata,
    Column('part', String),
    Column('sub_part', String),
    Column('quantity', Integer),
)

included_parts = select([
                    parts.c.sub_part,
                    parts.c.part,
                    parts.c.quantity]).\
                    where(parts.c.part=='our part').\
                    cte(recursive=True)


incl_alias = included_parts.alias()
parts_alias = parts.alias()
included_parts = included_parts.union_all(
    select([
        parts_alias.c.part,
```

```
            parts_alias.c.sub_part,
            parts_alias.c.quantity
        ]).
            where(parts_alias.c.part==incl_alias.c.sub_part)
    )

    statement = select([
                included_parts.c.sub_part,
                func.sum(included_parts.c.quantity).label('total_quantity')
            ]).                    select_from(included_parts.join(parts,
                        included_parts.c.part==parts.c.part)).\
            group_by(included_parts.c.sub_part)

    result = conn.execute(statement).fetchall()
```

See also:

`orm.query.Query.cte()` - ORM version of `_SelectBase.cte()`.

group_by(**clauses*)
return a new selectable with the given list of GROUP BY criterion applied.

The criterion will be appended to any pre-existing GROUP BY criterion.

label(*name*)
return a 'scalar' representation of this selectable, embedded as a subquery with a label.

See also `as_scalar()`.

limit(*limit*)
return a new selectable with the given LIMIT criterion applied.

offset(*offset*)
return a new selectable with the given OFFSET criterion applied.

order_by(**clauses*)
return a new selectable with the given list of ORDER BY criterion applied.

The criterion will be appended to any pre-existing ORDER BY criterion.

class sqlalchemy.sql.expression.**TableClause**(*name*, **columns*)
Bases: sqlalchemy.sql.expression._Immutable, `sqlalchemy.sql.expression.FromClause`

Represents a minimal "table" construct.

The constructor for `TableClause` is the `table()` function. This produces a lightweight table object that has only a name and a collection of columns, which are typically produced by the `column()` function:

```
from sqlalchemy.sql import table, column

user = table("user",
        column("id"),
        column("name"),
        column("description"),
)
```

The `TableClause` construct serves as the base for the more commonly used `Table` object, providing the usual set of `FromClause` services including the `.c.` collection and statement generation methods.

It does **not** provide all the additional schema-level services of `Table`, including constraints, references to other tables, or support for `MetaData`-level services. It's useful on its own as an ad-hoc construct used to generate quick SQL statements when a more fully fledged `Table` is not on hand.

count(*whereclause=None*, ***params*)
return a SELECT COUNT generated against this `TableClause`.

delete(*whereclause=None*, ***kwargs*)
Generate a `delete()` construct against this `TableClause`.

E.g.:

```
table.delete().where(table.c.id==7)
```

See `delete()` for argument and usage information.

insert(*values=None*, *inline=False*, ***kwargs*)
Generate an `insert()` construct against this `TableClause`.

E.g.:

```
table.insert().values(name='foo')
```

See `insert()` for argument and usage information.

update(*whereclause=None*, *values=None*, *inline=False*, ***kwargs*)
Generate an `update()` construct against this `TableClause`.

E.g.:

```
table.update().where(table.c.id==7).values(name='foo')
```

See `update()` for argument and usage information.

class sqlalchemy.sql.expression.**Update**(*table*, *whereclause*, *values=None*, *inline=False*, *bind=None*, *returning=None*, ***kwargs*)
Bases: `sqlalchemy.sql.expression.ValuesBase`

Represent an Update construct.

The `Update` object is created using the `update()` function.

where(*whereclause*)
return a new update() construct with the given expression added to its WHERE clause, joined to the existing clause via AND, if any.

class sqlalchemy.sql.expression.**UpdateBase**
Bases: `sqlalchemy.sql.expression.Executable`, `sqlalchemy.sql.expression.ClauseElement`

Form the base for `INSERT`, `UPDATE`, and `DELETE` statements.

bind
Return a 'bind' linked to this `UpdateBase` or a `Table` associated with it.

params(**arg*, ***kw*)
Set the parameters for the statement.

This method raises `NotImplementedError` on the base class, and is overridden by `ValuesBase` to provide the SET/VALUES clause of UPDATE and INSERT.

returning(**cols*)
Add a RETURNING or equivalent clause to this statement.

The given list of columns represent columns within the table that is the target of the INSERT, UPDATE, or DELETE. Each element can be any column expression. `Table` objects will be expanded into their individual columns.

Upon compilation, a RETURNING clause, or database equivalent, will be rendered within the statement. For INSERT and UPDATE, the values are the newly inserted/updated values. For DELETE, the values are those of the rows which were deleted.

Upon execution, the values of the columns to be returned are made available via the result set and can be iterated using `fetchone()` and similar. For DBAPIs which do not natively support returning values (i.e. cx_oracle), SQLAlchemy will approximate this behavior at the result level so that a reasonable amount of behavioral neutrality is provided.

Note that not all databases/DBAPIs support RETURNING. For those backends with no support, an exception is raised upon compilation and/or execution. For those who do support it, the functionality across backends varies greatly, including restrictions on executemany() and other statements which return multiple rows. Please read the documentation notes for the database in use in order to determine the availability of RETURNING.

with_hint(*text*, *selectable=None*, *dialect_name='*'*)
Add a table hint for a single table to this INSERT/UPDATE/DELETE statement.

Note: `UpdateBase.with_hint()` currently applies only to Microsoft SQL Server. For MySQL INSERT hints, use `Insert.prefix_with()`. UPDATE/DELETE hints for MySQL will be added in a future release.

The text of the hint is rendered in the appropriate location for the database backend in use, relative to the `Table` that is the subject of this statement, or optionally to that of the given `Table` passed as the `selectable` argument.

The `dialect_name` option will limit the rendering of a particular hint to a particular backend. Such as, to add a hint that only takes effect for SQL Server:

```
mytable.insert().with_hint("WITH (PAGLOCK)", dialect_name="mssql")
```

New in version 0.7.6.

Parameters

- **text** – Text of the hint.
- **selectable** – optional `Table` that specifies an element of the FROM clause within an UPDATE or DELETE to be the subject of the hint - applies only to certain backends.
- **dialect_name** – defaults to `*`, if specified as the name of a particular dialect, will apply these hints only when that dialect is in use.

class sqlalchemy.sql.expression.**ValuesBase**(*table*, *values*)
Bases: `sqlalchemy.sql.expression.UpdateBase`

Supplies support for `ValuesBase.values()` to INSERT and UPDATE constructs.

values(**args*, ***kwargs*)
specify the VALUES clause for an INSERT statement, or the SET clause for an UPDATE.

Parameters

- ****kwargs** – key value pairs representing the string key of a `Column` mapped to the value to be rendered into the VALUES or SET clause:

```
users.insert().values(name="some name")

users.update().where(users.c.id==5).values(name="some name")
```

- ***args** – A single dictionary can be sent as the first positional argument. This allows non-string based keys, such as Column objects, to be used:

```
users.insert().values({users.c.name : "some name"})

users.update().where(users.c.id==5).values({users.c.name : "some name"})
```

See also:

Inserts and Updates - SQL Expression Language Tutorial

`insert()` - produce an `INSERT` statement

`update()` - produce an `UPDATE` statement

3.2.3 Generic Functions

SQL functions which are known to SQLAlchemy with regards to database-specific rendering, return types and argument behavior. Generic functions are invoked like all SQL functions, using the `func` attribute:

```
select([func.count()]).select_from(sometable)
```

Note that any name not known to `func` generates the function name as is - there is no restriction on what SQL functions can be called, known or unknown to SQLAlchemy, built-in or user defined. The section here only describes those functions where SQLAlchemy already knows what argument and return types are in use.

class sqlalchemy.sql.functions.**AnsiFunction**(***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

class sqlalchemy.sql.functions.**GenericFunction**(*type_=None*, *args=()*, ***kwargs*)
Bases: sqlalchemy.sql.expression.Function

class sqlalchemy.sql.functions.**ReturnTypeFromArgs**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

Define a function whose return type is the same as its arguments.

class sqlalchemy.sql.functions.**char_length**(*arg*, ***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

class sqlalchemy.sql.functions.**coalesce**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.ReturnTypeFromArgs

class sqlalchemy.sql.functions.**concat**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

class sqlalchemy.sql.functions.**count**(*expression=None*, ***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

The ANSI COUNT aggregate function. With no arguments, emits COUNT *.

class sqlalchemy.sql.functions.**current_date**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**current_time**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**current_timestamp**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**current_user**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**localtime**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**localtimestamp**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**max**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.ReturnTypeFromArgs

class sqlalchemy.sql.functions.**min**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.ReturnTypeFromArgs

class sqlalchemy.sql.functions.**next_value**(*seq*, ***kw*)
Bases: sqlalchemy.sql.expression.Function

Represent the 'next value', given a Sequence as it's single argument.

Compiles into the appropriate function on each backend, or will raise NotImplementedError if used on a backend that does not provide support for sequences.

name = 'next_value'

type = Integer()

class sqlalchemy.sql.functions.**now**(*type_=None*, *args=()*, ***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

class sqlalchemy.sql.functions.**random**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.GenericFunction

class sqlalchemy.sql.functions.**session_user**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**sum**(**args*, ***kwargs*)
Bases: sqlalchemy.sql.functions.ReturnTypeFromArgs

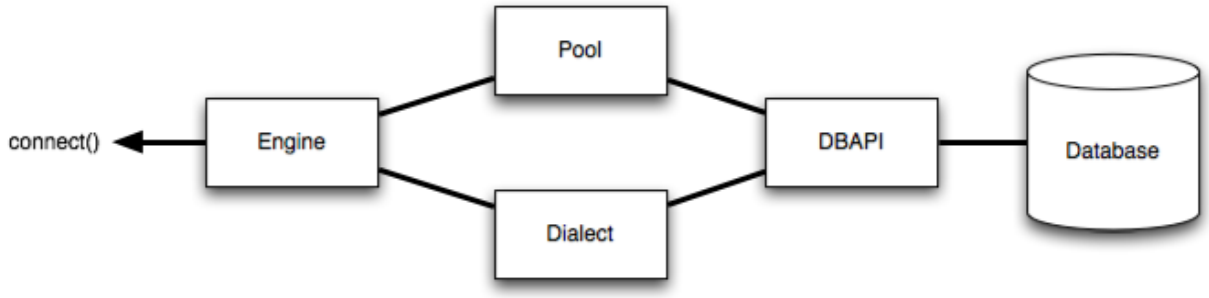
class sqlalchemy.sql.functions.**sysdate**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

class sqlalchemy.sql.functions.**user**(***kwargs*)
Bases: sqlalchemy.sql.functions.AnsiFunction

3.3 Engine Configuration

The **Engine** is the starting point for any SQLAlchemy application. It's "home base" for the actual database and its DBAPI, delivered to the SQLAlchemy application through a connection pool and a **Dialect**, which describes how to talk to a specific kind of database/DBAPI combination.

The general structure can be illustrated as follows:



Where above, an `Engine` references both a `Dialect` and a `Pool`, which together interpret the DBAPI's module functions as well as the behavior of the database.

Creating an engine is just a matter of issuing a single call, `create_engine()`:

```
from sqlalchemy import create_engine
engine = create_engine('postgresql://scott:tiger@localhost:5432/mydatabase')
```

The above engine creates a `Dialect` object tailored towards PostgreSQL, as well as a `Pool` object which will establish a DBAPI connection at `localhost:5432` when a connection request is first received. Note that the `Engine` and its underlying `Pool` do **not** establish the first actual DBAPI connection until the `Engine.connect()` method is called, or an operation which is dependent on this method such as `Engine.execute()` is invoked. In this way, `Engine` and `Pool` can be said to have a *lazy initialization* behavior.

The `Engine`, once created, can either be used directly to interact with the database, or can be passed to a `Session` object to work with the ORM. This section covers the details of configuring an `Engine`. The next section, *Working with Engines and Connections*, will detail the usage API of the `Engine` and similar, typically for non-ORM applications.

3.3.1 Supported Databases

SQLAlchemy includes many `Dialect` implementations for various backends; each is described as its own package in the *sqlalchemy.dialects_toplevel* package. A SQLAlchemy dialect always requires that an appropriate DBAPI driver is installed.

The table below summarizes the state of DBAPI support in SQLAlchemy 0.7. The values translate as:

- yes / Python platform - The SQLAlchemy dialect is mostly or fully operational on the target platform.
- yes / OS platform - The DBAPI supports that platform.
- no / Python platform - The DBAPI does not support that platform, or there is no SQLAlchemy dialect support.
- no / OS platform - The DBAPI does not support that platform.
- partial - the DBAPI is partially usable on the target platform but has major unresolved issues.
- development - a development version of the dialect exists, but is not yet usable.
- thirdparty - the dialect itself is maintained by a third party, who should be consulted for information on current support.
- * - indicates the given DBAPI is the "default" for SQLAlchemy, i.e. when just the database name is specified

Driver	Connect string	Py2K	Py3K	Jython	Unix
DB2/Informix IDS					
					Continue

Table 3.1 – continued from previous page

Driver	Connect string	Py2K	Py3K	Jython	Unix
ibm-db	thirdparty	thirdparty	thirdparty	thirdparty	thirdparty
Drizzle *(docs)*					
mysql-python	`drizzle+mysqldb*`	yes	development	no	yes
Firebird / Interbase *(docs)*					
kinterbasdb	`firebird+kinterbasdb*`	yes	development	no	yes
Informix *(docs)*					
informixdb	`informix+informixdb*`	yes	development	no	unknown
MaxDB *(docs)*					
sapdb	`maxdb+sapdb*`	development	development	no	yes
Microsoft Access *(docs)*					
pyodbc	`access+pyodbc*`	development	development	no	unknown
Microsoft SQL Server *(docs)*					
adodbapi	`mssql+adodbapi`	development	development	no	no
jTDS JDBC Driver	`mssql+zxjdbc`	no	no	development	yes
mxodbc	`mssql+mxodbc`	yes	development	no	yes with FreeT
pyodbc	`mssql+pyodbc*`	yes	development	no	yes with FreeT
pymssql	`mssql+pymssql`	yes	development	no	yes
MySQL *(docs)*					
MySQL Connector/J	`mysql+zxjdbc`	no	no	yes	yes
MySQL Connector/Python	`mysql+mysqlconnector`	yes	development	no	yes
mysql-python	`mysql+mysqldb*`	yes	development	no	yes
OurSQL	`mysql+oursql`	yes	yes	no	yes
pymysql	`mysql+pymysql`	yes	development	no	yes
rdbms (Google Appengine)	`mysql+gaerdbms`	yes	development	no	no
Oracle *(docs)*					
cx_oracle	`oracle+cx_oracle*`	yes	development	no	yes
Oracle JDBC Driver	`oracle+zxjdbc`	no	no	yes	yes
Postgresql *(docs)*					
pg8000	`postgresql+pg8000`	yes	yes	no	yes
PostgreSQL JDBC Driver	`postgresql+zxjdbc`	no	no	yes	yes
psycopg2	`postgresql+psycopg2*`	yes	yes	no	yes
pypostgresql	`postgresql+pypostgresql`	no	yes	no	yes
SQLite *(docs)*					
pysqlite	`sqlite+pysqlite*`	yes	yes	no	yes
sqlite3	`sqlite+pysqlite*`	yes	yes	no	yes
Sybase ASE *(docs)*					
mxodbc	`sybase+mxodbc`	development	development	no	yes
pyodbc	`sybase+pyodbc*`	partial	development	no	unknown
python-sybase	`sybase+pysybase`	yes [1]	development	no	yes

Further detail on dialects is available at *Dialects*.

3.3.2 Engine Creation API

Keyword options can also be specified to `create_engine()`, following the string URL as follows:

```
db = create_engine('postgresql://...', encoding='latin1', echo=True)
```

[1] The Sybase dialect currently lacks the ability to reflect tables.

sqlalchemy.**create_engine**(**args*, ***kwargs*)

Create a new Engine instance.

The standard calling form is to send the URL as the first positional argument, usually a string that indicates database dialect and connection arguments. Additional keyword arguments may then follow it which establish various options on the resulting Engine and its underlying Dialect and Pool constructs.

The string form of the URL is dialect+driver://user:password@host/dbname[?key=value..], where dialect is a database name such as mysql, oracle, postgresql, etc., and driver the name of a DBAPI, such as psycopg2, pyodbc, cx_oracle, etc. Alternatively, the URL can be an instance of URL.

**kwargs takes a wide variety of options which are routed towards their appropriate components. Arguments may be specific to the Engine, the underlying Dialect, as well as the Pool. Specific dialects also accept keyword arguments that are unique to that dialect. Here, we describe the parameters that are common to most create_engine() usage.

Once established, the newly resulting Engine will request a connection from the underlying Pool once Engine.connect() is called, or a method which depends on it such as Engine.execute() is invoked. The Pool in turn will establish the first actual DBAPI connection when this request is received. The create_engine() call itself does **not** establish any actual DBAPI connections directly.

See also:

Engine Configuration

Working with Engines and Connections

Parameters

- **assert_unicode** – Deprecated. This flag sets an engine-wide default value for the assert_unicode flag on the String type - see that type for further details.
- **connect_args** – a dictionary of options which will be passed directly to the DBAPI's connect() method as additional keyword arguments. See the example at *Custom DBAPI connect() arguments*.
- **convert_unicode=False** – if set to True, sets the default behavior of convert_unicode on the String type to True, regardless of a setting of False on an individual String type, thus causing all String -based columns to accommodate Python unicode objects. This flag is useful as an engine-wide setting when using a DBAPI that does not natively support Python unicode objects and raises an error when one is received (such as pyodbc with FreeTDS).

  See String for further details on what this flag indicates.
- **creator** – a callable which returns a DBAPI connection. This creation function will be passed to the underlying connection pool and will be used to create all new database connections. Usage of this function causes connection parameters specified in the URL argument to be bypassed.
- **echo=False** – if True, the Engine will log all statements as well as a repr() of their parameter lists to the engines logger, which defaults to sys.stdout. The echo attribute of Engine can be modified at any time to turn logging on and off. If set to the string "debug", result rows will be printed to the standard output as well. This flag ultimately controls a Python logger; see *Configuring Logging* for information on how to configure logging directly.
- **echo_pool=False** – if True, the connection pool will log all checkouts/checkins to the logging stream, which defaults to sys.stdout. This flag ultimately controls a Python logger; see *Configuring Logging* for information on how to configure logging directly.

- **encoding** – Defaults to `utf-8`. This is the string encoding used by SQLAlchemy for string encode/decode operations which occur within SQLAlchemy, **outside of the DBAPI.** Most modern DBAPIs feature some degree of direct support for Python `unicode` objects, what you see in Python 2 as a string of the form `u'some string'`. For those scenarios where the DBAPI is detected as not supporting a Python `unicode` object, this encoding is used to determine the source/destination encoding. It is **not used** for those cases where the DBAPI handles unicode directly.

  To properly configure a system to accommodate Python `unicode` objects, the DBAPI should be configured to handle unicode to the greatest degree as is appropriate - see the notes on unicode pertaining to the specific target database in use at *Dialects*.

  Areas where string encoding may need to be accommodated outside of the DBAPI include zero or more of:

  – the values passed to bound parameters, corresponding to the `Unicode` type or the `String` type when `convert_unicode` is `True`;

  – the values returned in result set columns corresponding to the `Unicode` type or the `String` type when `convert_unicode` is `True`;

  – the string SQL statement passed to the DBAPI's `cursor.execute()` method;

  – the string names of the keys in the bound parameter dictionary passed to the DBAPI's `cursor.execute()` as well as `cursor.setinputsizes()` methods;

  – the string column names retrieved from the DBAPI's `cursor.description` attribute.

  When using Python 3, the DBAPI is required to support *all* of the above values as Python `unicode` objects, which in Python 3 are just known as `str`. In Python 2, the DBAPI does not specify unicode behavior at all, so SQLAlchemy must make decisions for each of the above values on a per-DBAPI basis - implementations are completely inconsistent in their behavior.

- **execution_options** – Dictionary execution options which will be applied to all connections. See `execution_options()`

- **implicit_returning=True** – When `True`, a RETURNING- compatible construct, if available, will be used to fetch newly generated primary key values when a single row INSERT statement is emitted with no existing returning() clause. This applies to those backends which support RETURNING or a compatible construct, including Postgresql, Firebird, Oracle, Microsoft SQL Server. Set this to `False` to disable the automatic usage of RETURNING.

- **label_length=None** – optional integer value which limits the size of dynamically generated column labels to that many characters. If less than 6, labels are generated as "_(counter)". If `None`, the value of `dialect.max_identifier_length` is used instead.

- **listeners** – A list of one or more `PoolListener` objects which will receive connection pool events.

- **logging_name** – String identifier which will be used within the "name" field of logging records generated within the "sqlalchemy.engine" logger. Defaults to a hexstring of the object's id.

- **max_overflow=10** – the number of connections to allow in connection pool "overflow", that is connections that can be opened above and beyond the pool_size setting, which defaults to five. this is only used with `QueuePool`.

- **module=None** – reference to a Python module object (the module itself, not its string name). Specifies an alternate DBAPI module to be used by the engine's dialect. Each sub-dialect references a specific DBAPI which will be imported before first connect. This parameter causes the import to be bypassed, and the given module to be used instead. Can be used for testing of DBAPIs as well as to inject "mock" DBAPI implementations into the `Engine`.
- **pool=None** – an already-constructed instance of `Pool`, such as a `QueuePool` instance. If non-None, this pool will be used directly as the underlying connection pool for the engine, bypassing whatever connection parameters are present in the URL argument. For information on constructing connection pools manually, see *Connection Pooling*.
- **poolclass=None** – a `Pool` subclass, which will be used to create a connection pool instance using the connection parameters given in the URL. Note this differs from `pool` in that you don't actually instantiate the pool in this case, you just indicate what type of pool to be used.
- **pool_logging_name** – String identifier which will be used within the "name" field of logging records generated within the "sqlalchemy.pool" logger. Defaults to a hexstring of the object's id.
- **pool_size=5** – the number of connections to keep open inside the connection pool. This used with `QueuePool` as well as `SingletonThreadPool`. With `QueuePool`, a `pool_size` setting of 0 indicates no limit; to disable pooling, set `poolclass` to `NullPool` instead.
- **pool_recycle=-1** – this setting causes the pool to recycle connections after the given number of seconds has passed. It defaults to -1, or no timeout. For example, setting to 3600 means connections will be recycled after one hour. Note that MySQL in particular will disconnect automatically if no activity is detected on a connection for eight hours (although this is configurable with the MySQLDB connection itself and the server configuration as well).
- **pool_reset_on_return='rollback'** – set the "reset on return" behavior of the pool, which is whether `rollback()`, `commit()`, or nothing is called upon connections being returned to the pool. See the docstring for `reset_on_return` at `Pool`.

  New in version 0.7.6.
- **pool_timeout=30** – number of seconds to wait before giving up on getting a connection from the pool. This is only used with `QueuePool`.
- **strategy='plain'** – selects alternate engine implementations. Currently available are:
  - the `threadlocal` strategy, which is described in *Using the Threadlocal Execution Strategy*;
  - the `mock` strategy, which dispatches all statement execution to a function passed as the argument `executor`. See example in the FAQ.
- **executor=None** – a function taking arguments `(sql, *multiparams, **params)`, to which the `mock` strategy will dispatch all statement execution. Used only by `strategy='mock'`.

`sqlalchemy.`**`engine_from_config`**(*configuration*, *prefix='sqlalchemy.'*, ***kwargs*)

Create a new Engine instance using a configuration dictionary.

The dictionary is typically produced from a config file where keys are prefixed, such as sqlalchemy.url, sqlalchemy.echo, etc. The 'prefix' argument indicates the prefix to be searched for.

A select set of keyword arguments will be "coerced" to their expected type based on string values. In a future release, this functionality will be expanded and include dialect-specific arguments.

3.3.3 Database Urls

SQLAlchemy indicates the source of an Engine strictly via RFC-1738 style URLs, combined with optional keyword arguments to specify options for the Engine. The form of the URL is:

```
dialect+driver://username:password@host:port/database
```

Dialect names include the identifying name of the SQLAlchemy dialect which include `sqlite`, `mysql`, `postgresql`, `oracle`, `mssql`, and `firebird`. The drivername is the name of the DBAPI to be used to connect to the database using all lowercase letters. If not specified, a "default" DBAPI will be imported if available - this default is typically the most widely known driver available for that backend (i.e. cx_oracle, pysqlite/sqlite3, psycopg2, mysqldb). For Jython connections, specify the *zxjdbc* driver, which is the JDBC-DBAPI bridge included with Jython.

Postgresql

The Postgresql dialect uses psycopg2 as the default DBAPI:

```
# default
engine = create_engine('postgresql://scott:tiger@localhost/mydatabase')

# psycopg2
engine = create_engine('postgresql+psycopg2://scott:tiger@localhost/mydatabase')

# pg8000
engine = create_engine('postgresql+pg8000://scott:tiger@localhost/mydatabase')

# Jython
engine = create_engine('postgresql+zxjdbc://scott:tiger@localhost/mydatabase')
```

More notes on connecting to Postgresql at *PostgreSQL*.

MySQL

The MySQL dialect uses mysql-python as the default DBAPI:

```
# default
engine = create_engine('mysql://scott:tiger@localhost/foo')

# mysql-python
engine = create_engine('mysql+mysqldb://scott:tiger@localhost/foo')

# OurSQL
engine = create_engine('mysql+oursql://scott:tiger@localhost/foo')
```

More notes on connecting to MySQL at *MySQL*.

Oracle

cx_oracle is usualjy used here:

```
engine = create_engine('oracle://scott:tiger@127.0.0.1:1521/sidname')

engine = create_engine('oracle+cx_oracle://scott:tiger@tnsname')
```

More notes on connecting to Oracle at *Oracle*.

Microsoft SQL Server

There are a few drivers for SQL Server, currently PyODBC is the most solid:

```
engine = create_engine('mssql+pyodbc://mydsn')
```

More notes on connecting to SQL Server at *Microsoft SQL Server*.

SQLite

SQLite connects to file based databases. The same URL format is used, omitting the hostname, and using the "file" portion as the filename of the database. This has the effect of four slashes being present for an absolute file path:

```
# sqlite://<nohostname>/<path>
# where <path> is relative:
engine = create_engine('sqlite:///foo.db')

# or absolute, starting with a slash:
engine = create_engine('sqlite:////absolute/path/to/foo.db')
```

To use a SQLite `:memory:` database, specify an empty URL:

```
engine = create_engine('sqlite://')
```

More notes on connecting to SQLite at *SQLite*.

Others

See *Dialects*, the top-level page for all dialect documentation.

URL API

class `sqlalchemy.engine.url.`**`URL`**(*drivername*, *username=None*, *password=None*, *host=None*, *port=None*, *database=None*, *query=None*)

Represent the components of a URL used to connect to a database.

This object is suitable to be passed directly to a `create_engine()` call. The fields of the URL are parsed from a string by the `module-level make_url()` function. the string format of the URL is an RFC-1738-style string.

All initialization parameters are available as public attributes.

Parameters

- **drivername** – the name of the database backend. This name will correspond to a module in sqlalchemy/databases or a third party plug-in.
- **username** – The user name.
- **password** – database password.
- **host** – The name of the host.
- **port** – The port number.
- **database** – The database name.
- **query** – A dictionary of options to be passed to the dialect and/or the DBAPI upon connect.

get_dialect()
Return the SQLAlchemy database dialect class corresponding to this URL's driver name.

translate_connect_args(*names*=[ ], ***kw*)
Translate url attributes into a dictionary of connection arguments.

Returns attributes of this url (*host*, *database*, *username*, *password*, *port*) as a plain dictionary. The attribute names are used as the keys by default. Unset or false attributes are omitted from the final dictionary.

Parameters

- ****kw** – Optional, alternate key names for url attributes.
- **names** – Deprecated. Same purpose as the keyword-based alternate names, but correlates the name to the original positionally.

3.3.4 Pooling

The `Engine` will ask the connection pool for a connection when the `connect()` or `execute()` methods are called. The default connection pool, `QueuePool`, will open connections to the database on an as-needed basis. As concurrent statements are executed, `QueuePool` will grow its pool of connections to a default size of five, and will allow a default "overflow" of ten. Since the `Engine` is essentially "home base" for the connection pool, it follows that you should keep a single `Engine` per database established within an application, rather than creating a new one for each connection.

Note: `QueuePool` is not used by default for SQLite engines. See *SQLite* for details on SQLite connection pool usage.

For more information on connection pooling, see *Connection Pooling*.

3.3.5 Custom DBAPI connect() arguments

Custom arguments used when issuing the `connect()` call to the underlying DBAPI may be issued in three distinct ways. String-based arguments can be passed directly from the URL string as query arguments:

```
db = create_engine('postgresql://scott:tiger@localhost/test?argument1=foo&argument2=bar')
```

If SQLAlchemy's database connector is aware of a particular query argument, it may convert its type from string to its proper type.

`create_engine()` also takes an argument `connect_args` which is an additional dictionary that will be passed to `connect()`. This can be used when arguments of a type other than string are required, and SQLAlchemy's database connector has no type conversion logic present for that parameter:

```
db = create_engine('postgresql://scott:tiger@localhost/test', connect_args = {'argument1':17, 'argume
```

The most customizable connection method of all is to pass a `creator` argument, which specifies a callable that returns a DBAPI connection:

```
def connect():
    return psycopg.connect(user='scott', host='localhost')

db = create_engine('postgresql://', creator=connect)
```

3.3.6 Configuring Logging

Python's standard logging module is used to implement informational and debug log output with SQLAlchemy. This allows SQLAlchemy's logging to integrate in a standard way with other applications and libraries. The `echo` and `echo_pool` flags that are present on `create_engine()`, as well as the `echo_uow` flag used on `Session`, all interact with regular loggers.

This section assumes familiarity with the above linked logging module. All logging performed by SQLAlchemy exists underneath the `sqlalchemy` namespace, as used by `logging.getLogger('sqlalchemy')`. When logging has been configured (i.e. such as via `logging.basicConfig()`), the general namespace of SA loggers that can be turned on is as follows:

- `sqlalchemy.engine` - controls SQL echoing. set to `logging.INFO` for SQL query output, `logging.DEBUG` for query + result set output.
- `sqlalchemy.dialects` - controls custom logging for SQL dialects. See the documentation of individual dialects for details.
- `sqlalchemy.pool` - controls connection pool logging. set to `logging.INFO` or lower to log connection pool checkouts/checkins.
- `sqlalchemy.orm` - controls logging of various ORM functions. set to `logging.INFO` for information on mapper configurations.

For example, to log SQL queries using Python logging instead of the `echo=True` flag:

```
import logging

logging.basicConfig()
logging.getLogger('sqlalchemy.engine').setLevel(logging.INFO)
```

By default, the log level is set to `logging.WARN` within the entire `sqlalchemy` namespace so that no log operations occur, even within an application that has logging enabled otherwise.

The `echo` flags present as keyword arguments to `create_engine()` and others as well as the `echo` property on `Engine`, when set to `True`, will first attempt to ensure that logging is enabled. Unfortunately, the `logging` module provides no way of determining if output has already been configured (note we are referring to if a logging configuration has been set up, not just that the logging level is set). For this reason, any `echo=True` flags will result in a call to `logging.basicConfig()` using sys.stdout as the destination. It also sets up a default format using the level name, timestamp, and logger name. Note that this configuration has the affect of being configured **in addition** to any existing logger configurations. Therefore, **when using Python logging, ensure all echo flags are set to False at all times**, to avoid getting duplicate log lines.

The logger name of instance such as an Engine or Pool defaults to using a truncated hex identifier string. To set this to a specific name, use the "logging_name" and "pool_logging_name" keyword arguments with sqlalchemy.create_engine().

Note: The SQLAlchemy Engine conserves Python function call overhead by only emitting log statements when the current logging level is detected as logging.INFO or logging.DEBUG. It only checks this level when a new connection is procured from the connection pool. Therefore when changing the logging configuration for an already-running application, any Connection that's currently active, or more commonly a Session object that's active in a transaction, won't log any SQL according to the new configuration until a new Connection is procured (in the case of Session, this is after the current transaction ends and a new one begins).

3.4 Working with Engines and Connections

This section details direct usage of the Engine, Connection, and related objects. Its important to note that when using the SQLAlchemy ORM, these objects are not generally accessed; instead, the Session object is used as the interface to the database. However, for applications that are built around direct usage of textual SQL statements and/or SQL expression constructs without involvement by the ORM's higher level management services, the Engine and Connection are king (and queen?) - read on.

3.4.1 Basic Usage

Recall from *Engine Configuration* that an Engine is created via the create_engine() call:

```
engine = create_engine('mysql://scott:tiger@localhost/test')
```

The typical usage of create_engine() is once per particular database URL, held globally for the lifetime of a single application process. A single Engine manages many individual DBAPI connections on behalf of the process and is intended to be called upon in a concurrent fashion. The Engine is **not** synonymous to the DBAPI connect function, which represents just one connection resource - the Engine is most efficient when created just once at the module level of an application, not per-object or per-function call.

For a multiple-process application that uses the os.fork system call, or for example the Python multiprocessing module, it's usually required that a separate Engine be used for each child process. This is because the Engine maintains a reference to a connection pool that ultimately references DBAPI connections - these tend to not be portable across process boundaries. An Engine that is configured not to use pooling (which is achieved via the usage of NullPool) does not have this requirement.

The engine can be used directly to issue SQL to the database. The most generic way is first procure a connection resource, which you get via the connect method:

```
connection = engine.connect()
result = connection.execute("select username from users")
for row in result:
    print "username:", row['username']
connection.close()
```

The connection is an instance of Connection, which is a **proxy** object for an actual DBAPI connection. The DBAPI connection is retrieved from the connection pool at the point at which Connection is created.

The returned result is an instance of ResultProxy, which references a DBAPI cursor and provides a largely compatible interface with that of the DBAPI cursor. The DBAPI cursor will be closed by the ResultProxy when all of

its result rows (if any) are exhausted. A `ResultProxy` that returns no rows, such as that of an UPDATE statement (without any returned rows), releases cursor resources immediately upon construction.

When the `close()` method is called, the referenced DBAPI connection is *released* to the connection pool. From the perspective of the database itself, nothing is actually "closed", assuming pooling is in use. The pooling mechanism issues a `rollback()` call on the DBAPI connection so that any transactional state or locks are removed, and the connection is ready for its next usage.

The above procedure can be performed in a shorthand way by using the `execute()` method of `Engine` itself:

```
result = engine.execute("select username from users")
for row in result:
    print "username:", row['username']
```

Where above, the `execute()` method acquires a new `Connection` on its own, executes the statement with that object, and returns the `ResultProxy`. In this case, the `ResultProxy` contains a special flag known as `close_with_result`, which indicates that when its underlying DBAPI cursor is closed, the `Connection` object itself is also closed, which again returns the DBAPI connection to the connection pool, releasing transactional resources.

If the `ResultProxy` potentially has rows remaining, it can be instructed to close out its resources explicitly:

```
result.close()
```

If the `ResultProxy` has pending rows remaining and is dereferenced by the application without being closed, Python garbage collection will ultimately close out the cursor as well as trigger a return of the pooled DBAPI connection resource to the pool (SQLAlchemy achieves this by the usage of weakref callbacks - *never* the `__del__` method) - however it's never a good idea to rely upon Python garbage collection to manage resources.

Our example above illustrated the execution of a textual SQL string. The `execute()` method can of course accommodate more than that, including the variety of SQL expression constructs described in *SQL Expression Language Tutorial*.

3.4.2 Using Transactions

Note: This section describes how to use transactions when working directly with `Engine` and `Connection` objects. When using the SQLAlchemy ORM, the public API for transaction control is via the `Session` object, which makes usage of the `Transaction` object internally. See *Managing Transactions* for further information.

The `Connection` object provides a `begin()` method which returns a `Transaction` object. This object is usually used within a try/except clause so that it is guaranteed to invoke `Transaction.rollback()` or `Transaction.commit()`:

```
connection = engine.connect()
trans = connection.begin()
try:
    r1 = connection.execute(table1.select())
    connection.execute(table1.insert(), col1=7, col2='this is some data')
    trans.commit()
except:
    trans.rollback()
    raise
```

The above block can be created more succinctly using context managers, either given an `Engine`:

```
# runs a transaction
with engine.begin() as connection:
    r1 = connection.execute(table1.select())
    connection.execute(table1.insert(), col1=7, col2='this is some data')
```

Or from the `Connection`, in which case the `Transaction` object is available as well:

```
with connection.begin() as trans:
    r1 = connection.execute(table1.select())
    connection.execute(table1.insert(), col1=7, col2='this is some data')
```

Nesting of Transaction Blocks

The `Transaction` object also handles "nested" behavior by keeping track of the outermost begin/commit pair. In this example, two functions both issue a transaction on a `Connection`, but only the outermost `Transaction` object actually takes effect when it is committed.

```
# method_a starts a transaction and calls method_b
def method_a(connection):
    trans = connection.begin() # open a transaction
    try:
        method_b(connection)
        trans.commit()  # transaction is committed here
    except:
        trans.rollback() # this rolls back the transaction unconditionally
        raise

# method_b also starts a transaction
def method_b(connection):
    trans = connection.begin() # open a transaction - this runs in the context of method_a's transact
    try:
        connection.execute("insert into mytable values ('bat', 'lala')")
        connection.execute(mytable.insert(), col1='bat', col2='lala')
        trans.commit()  # transaction is not committed yet
    except:
        trans.rollback() # this rolls back the transaction unconditionally
        raise

# open a Connection and call method_a
conn = engine.connect()
method_a(conn)
conn.close()
```

Above, `method_a` is called first, which calls `connection.begin()`. Then it calls `method_b`. When `method_b` calls `connection.begin()`, it just increments a counter that is decremented when it calls `commit()`. If either `method_a` or `method_b` calls `rollback()`, the whole transaction is rolled back. The transaction is not committed until `method_a` calls the `commit()` method. This "nesting" behavior allows the creation of functions which "guarantee" that a transaction will be used if one was not already available, but will automatically participate in an enclosing transaction if one exists.

3.4.3 Understanding Autocommit

The previous transaction example illustrates how to use `Transaction` so that several executions can take part in the same transaction. What happens when we issue an INSERT, UPDATE or DELETE call without using `Transaction`? While some DBAPI implementations provide various special "non-transactional" modes, the core behavior of DBAPI per PEP-0249 is that a *transaction is always in progress*, providing only `rollback()` and `commit()` methods but no `begin()`. SQLAlchemy assumes this is the case for any given DBAPI.

Given this requirement, SQLAlchemy implements its own "autocommit" feature which works completely consistently across all backends. This is achieved by detecting statements which represent data-changing operations, i.e. INSERT, UPDATE, DELETE, as well as data definition language (DDL) statements such as CREATE TABLE, ALTER TABLE, and then issuing a COMMIT automatically if no transaction is in progress. The detection is based on the presence of the `autocommit=True` execution option on the statement. If the statement is a text-only statement and the flag is not set, a regular expression is used to detect INSERT, UPDATE, DELETE, as well as a variety of other commands for a particular backend:

```
conn = engine.connect()
conn.execute("INSERT INTO users VALUES (1, 'john')")  # autocommits
```

The "autocommit" feature is only in effect when no `Transaction` has otherwise been declared. This means the feature is not generally used with the ORM, as the `Session` object by default always maintains an ongoing `Transaction`.

Full control of the "autocommit" behavior is available using the generative `Connection.execution_options()` method provided on `Connection`, `Engine`, `Executable`, using the "autocommit" flag which will turn on or off the autocommit for the selected scope. For example, a `text()` construct representing a stored procedure that commits might use it so that a SELECT statement will issue a COMMIT:

```
engine.execute(text("SELECT my_mutating_procedure()").execution_options(autocommit=True))
```

3.4.4 Connectionless Execution, Implicit Execution

Recall from the first section we mentioned executing with and without explicit usage of `Connection`. "Connectionless" execution refers to the usage of the `execute()` method on an object which is not a `Connection`. This was illustrated using the `execute()` method of `Engine`:

```
result = engine.execute("select username from users")
for row in result:
    print "username:", row['username']
```

In addition to "connectionless" execution, it is also possible to use the `execute()` method of any `Executable` construct, which is a marker for SQL expression objects that support execution. The SQL expression object itself references an `Engine` or `Connection` known as the **bind**, which it uses in order to provide so-called "implicit" execution services.

Given a table as below:

```
from sqlalchemy import MetaData, Table, Column, Integer

meta = MetaData()
users_table = Table('users', meta,
    Column('id', Integer, primary_key=True),
```

```
    Column('name', String(50))
)
```

Explicit execution delivers the SQL text or constructed SQL expression to the `execute()` method of `Connection`:

```
engine = create_engine('sqlite:///file.db')
connection = engine.connect()
result = connection.execute(users_table.select())
for row in result:
    # ....
connection.close()
```

Explicit, connectionless execution delivers the expression to the `execute()` method of `Engine`:

```
engine = create_engine('sqlite:///file.db')
result = engine.execute(users_table.select())
for row in result:
    # ....
result.close()
```

Implicit execution is also connectionless, and makes usage of the `execute()` method on the expression itself. This method is provided as part of the `Executable` class, which refers to a SQL statement that is sufficient for being invoked against the database. The method makes usage of the assumption that either an `Engine` or `Connection` has been **bound** to the expression object. By "bound" we mean that the special attribute `MetaData.bind` has been used to associate a series of `Table` objects and all SQL constructs derived from them with a specific engine:

```
engine = create_engine('sqlite:///file.db')
meta.bind = engine
result = users_table.select().execute()
for row in result:
    # ....
result.close()
```

Above, we associate an `Engine` with a `MetaData` object using the special attribute `MetaData.bind`. The `select()` construct produced from the `Table` object has a method `execute()`, which will search for an `Engine` that's "bound" to the `Table`.

Overall, the usage of "bound metadata" has three general effects:

- SQL statement objects gain an `Executable.execute()` method which automatically locates a "bind" with which to execute themselves.
- The ORM `Session` object supports using "bound metadata" in order to establish which `Engine` should be used to invoke SQL statements on behalf of a particular mapped class, though the `Session` also features its own explicit system of establishing complex `Engine`/ mapped class configurations.
- The `MetaData.create_all()`, `Metadata.drop_all()`, `Table.create()`, `Table.drop()`, and "autoload" features all make usage of the bound `Engine` automatically without the need to pass it explicitly.

Note: The concepts of "bound metadata" and "implicit execution" are not emphasized in modern SQLAlchemy. While they offer some convenience, they are no longer required by any API and are never necessary.

In applications where multiple `Engine` objects are present, each one logically associated with a certain set of tables (i.e. *vertical sharding*), the "bound metadata" technique can be used so that individual `Table` can refer to the appropriate `Engine` automatically; in particular this is supported within the ORM via the `Session` object as a means to

associate Table objects with an appropriate Engine, as an alternative to using the bind arguments accepted directly by the Session.

However, the "implicit execution" technique is not at all appropriate for use with the ORM, as it bypasses the transactional context maintained by the Session.

Overall, in the *vast majority* of cases, "bound metadata" and "implicit execution" are **not useful**. While "bound metadata" has a marginal level of usefulness with regards to ORM configuration, "implicit execution" is a very old usage pattern that in most cases is more confusing than it is helpful, and its usage is discouraged. Both patterns seem to encourage the overuse of expedient "short cuts" in application design which lead to problems later on.

Modern SQLAlchemy usage, especially the ORM, places a heavy stress on working within the context of a transaction at all times; the "implicit execution" concept makes the job of associating statement execution with a particular transaction much more difficult. The Executable.execute() method on a particular SQL statement usually implies that the execution is not part of any particular transaction, which is usually not the desired effect.

In both "connectionless" examples, the Connection is created behind the scenes; the ResultProxy returned by the execute() call references the Connection used to issue the SQL statement. When the ResultProxy is closed, the underlying Connection is closed for us, resulting in the DBAPI connection being returned to the pool with transactional resources removed.

3.4.5 Using the Threadlocal Execution Strategy

The "threadlocal" engine strategy is an optional feature which can be used by non-ORM applications to associate transactions with the current thread, such that all parts of the application can participate in that transaction implicitly without the need to explicitly reference a Connection.

Note: The "threadlocal" feature is generally discouraged. It's designed for a particular pattern of usage which is generally considered as a legacy pattern. It has **no impact** on the "thread safety" of SQLAlchemy components or one's application. It also should not be used when using an ORM Session object, as the Session itself represents an ongoing transaction and itself handles the job of maintaining connection and transactional resources.

Enabling threadlocal is achieved as follows:

```
db = create_engine('mysql://localhost/test', strategy='threadlocal')
```

The above Engine will now acquire a Connection using connection resources derived from a thread-local variable whenever Engine.execute() or Engine.contextual_connect() is called. This connection resource is maintained as long as it is referenced, which allows multiple points of an application to share a transaction while using connectionless execution:

```
def call_operation1():
    engine.execute("insert into users values (?, ?)", 1, "john")

def call_operation2():
    users.update(users.c.user_id==5).execute(name='ed')

db.begin()
try:
    call_operation1()
    call_operation2()
    db.commit()
except:
    db.rollback()
```

Explicit execution can be mixed with connectionless execution by using the `Engine.connect` method to acquire a `Connection` that is not part of the threadlocal scope:

```
db.begin()
conn = db.connect()
try:
    conn.execute(log_table.insert(), message="Operation started")
    call_operation1()
    call_operation2()
    db.commit()
    conn.execute(log_table.insert(), message="Operation succeeded")
except:
    db.rollback()
    conn.execute(log_table.insert(), message="Operation failed")
finally:
    conn.close()
```

To access the `Connection` that is bound to the threadlocal scope, call `Engine.contextual_connect()`:

```
conn = db.contextual_connect()
call_operation3(conn)
conn.close()
```

Calling `close()` on the "contextual" connection does not *release* its resources until all other usages of that resource are closed as well, including that any ongoing transactions are rolled back or committed.

3.4.6 Connection / Engine API

class sqlalchemy.engine.base.**Connection**(*engine*, *connection=None*, *close_with_result=False*, *_branch=False*, *_execution_options=None*)

Bases: sqlalchemy.engine.base.Connectable

Provides high-level functionality for a wrapped DB-API connection.

Provides execution support for string-based SQL statements as well as `ClauseElement`, `Compiled` and `DefaultGenerator` objects. Provides a `begin()` method to return `Transaction` objects.

The Connection object is **not** thread-safe. While a Connection can be shared among threads using properly synchronized access, it is still possible that the underlying DBAPI connection may not support shared access between threads. Check the DBAPI documentation for details.

The Connection object represents a single dbapi connection checked out from the connection pool. In this state, the connection pool has no affect upon the connection, including its expiration or timeout state. For the connection pool to properly manage connections, connections should be returned to the connection pool (i.e. `connection.close()`) whenever the connection is not in use.

__init__(*engine*, *connection=None*, *close_with_result=False*, *_branch=False*, *_execution_options=None*)

Construct a new Connection.

The constructor here is not public and is only called only by an `Engine`. See `Engine.connect()` and `Engine.contextual_connect()` methods.

begin()

Begin a transaction and return a transaction handle.

The returned object is an instance of `Transaction`. This object represents the "scope" of the transaction, which completes when either the `Transaction.rollback()` or `Transaction.commit()` method is called.

Nested calls to `begin()` on the same `Connection` will return new `Transaction` objects that represent an emulated transaction within the scope of the enclosing transaction, that is:

```
trans = conn.begin()    # outermost transaction
trans2 = conn.begin()   # "nested"
trans2.commit()         # does nothing
trans.commit()          # actually commits
```

Calls to `Transaction.commit()` only have an effect when invoked via the outermost `Transaction` object, though the `Transaction.rollback()` method of any of the `Transaction` objects will roll back the transaction.

See also:

`Connection.begin_nested()` - use a SAVEPOINT

`Connection.begin_twophase()` - use a two phase /XID transaction

`Engine.begin()` - context manager available from `Engine`.

begin_nested()
Begin a nested transaction and return a transaction handle.

The returned object is an instance of `NestedTransaction`.

Nested transactions require SAVEPOINT support in the underlying database. Any transaction in the hierarchy may `commit` and `rollback`, however the outermost transaction still controls the overall `commit` or `rollback` of the transaction of a whole.

See also `Connection.begin()`, `Connection.begin_twophase()`.

begin_twophase(*xid=None*)
Begin a two-phase or XA transaction and return a transaction handle.

The returned object is an instance of `TwoPhaseTransaction`, which in addition to the methods provided by `Transaction`, also provides a `prepare()` method.

Parameters **xid** – the two phase transaction id. If not supplied, a random id will be generated.

See also `Connection.begin()`, `Connection.begin_twophase()`.

close()
Close this `Connection`.

This results in a release of the underlying database resources, that is, the DBAPI connection referenced internally. The DBAPI connection is typically restored back to the connection-holding `Pool` referenced by the `Engine` that produced this `Connection`. Any transactional state present on the DBAPI connection is also unconditionally released via the DBAPI connection's `rollback()` method, regardless of any `Transaction` object that may be outstanding with regards to this `Connection`.

After `close()` is called, the `Connection` is permanently in a closed state, and will allow no further operations.

closed
Return True if this connection is closed.

connect()
Returns self.

This Connectable interface method returns self, allowing Connections to be used interchangeably with Engines in most situations that require a bind.

connection
The underlying DB-API connection managed by this Connection.

contextual_connect(***kwargs*)
Returns self.

This Connectable interface method returns self, allowing Connections to be used interchangeably with Engines in most situations that require a bind.

create(*entity*, ***kwargs*)
Emit CREATE statements for the given schema entity.

Deprecated since version 0.7: Use the create() method on the given schema object directly, i.e. Table.create(), Index.create(), MetaData.create_all()

detach()
Detach the underlying DB-API connection from its connection pool.

This Connection instance will remain usable. When closed, the DB-API connection will be literally closed and not returned to its pool. The pool will typically lazily create a new connection to replace the detached connection.

This method can be used to insulate the rest of an application from a modified state on a connection (such as a transaction isolation level or similar). Also see PoolListener for a mechanism to modify connection state when connections leave and return to their connection pool.

drop(*entity*, ***kwargs*)
Emit DROP statements for the given schema entity.

Deprecated since version 0.7: Use the drop() method on the given schema object directly, i.e. Table.drop(), Index.drop(), MetaData.drop_all()

execute(*object*, **multiparams*, ***params*)
Executes the a SQL statement construct and returns a ResultProxy.

Parameters

- **object** – The statement to be executed. May be one of:
  - a plain string
  - any ClauseElement construct that is also a subclass of Executable, such as a select() construct
  - a FunctionElement, such as that generated by func, will be automatically wrapped in a SELECT statement, which is then executed.
  - a DDLElement object
  - a DefaultGenerator object
  - a Compiled object
- ***multiparams/**params** – represent bound parameter values to be used in the execution. Typically, the format is either a collection of one or more dictionaries passed to *multiparams:

```
conn.execute(
    table.insert(),
    {"id":1, "value":"v1"},
```

```
    {"id":2, "value":"v2"}
)
```

...or individual key/values interpreted by **params:

```
conn.execute(
    table.insert(), id=1, value="v1"
)
```

In the case that a plain SQL string is passed, and the underlying DBAPI accepts positional bind parameters, a collection of tuples or individual values in *multiparams may be passed:

```
conn.execute(
    "INSERT INTO table (id, value) VALUES (?, ?)",
    (1, "v1"), (2, "v2")
)

conn.execute(
    "INSERT INTO table (id, value) VALUES (?, ?)",
    1, "v1"
)
```

Note above, the usage of a question mark "?" or other symbol is contingent upon the "paramstyle" accepted by the DBAPI in use, which may be any of "qmark", "named", "pyformat", "format", "numeric". See pep-249 for details on paramstyle.

To execute a textual SQL statement which uses bound parameters in a DBAPI-agnostic way, use the `text()` construct.

execution_options(***opt*)

Set non-SQL options for the connection which take effect during execution.

The method returns a copy of this `Connection` which references the same underlying DBAPI connection, but also defines the given execution options which will take effect for a call to `execute()`. As the new `Connection` references the same underlying resource, it is probably best to ensure that the copies would be discarded immediately, which is implicit if used as in:

```
result = connection.execution_options(stream_results=True).\
                    execute(stmt)
```

`Connection.execution_options()` accepts all options as those accepted by `Executable.execution_options()`. Additionally, it includes options that are applicable only to `Connection`.

Parameters

- **autocommit** – Available on: Connection, statement. When True, a COMMIT will be invoked after execution when executed in 'autocommit' mode, i.e. when an explicit transaction is not begun on the connection. Note that DBAPI connections by default are always in a transaction - SQLAlchemy uses rules applied to different kinds of statements to determine if COMMIT will be invoked in order to provide its "autocommit" feature. Typically, all INSERT/UPDATE/DELETE statements as well as CREATE/DROP statements have autocommit behavior enabled; SELECT constructs do not. Use this option when invoking a SELECT or other specific SQL construct where COMMIT is desired (typically when calling stored procedures and such), and an explicit transaction is not in progress.

- **compiled_cache** – Available on: Connection. A dictionary where `Compiled` objects will be cached when the `Connection` compiles a clause expression into a `Compiled` object. It is the user's responsibility to manage the size of this dictionary, which will have keys corresponding to the dialect, clause element, the column names within the VALUES or SET clause of an INSERT or UPDATE, as well as the "batch" mode for an INSERT or UPDATE statement. The format of this dictionary is not guaranteed to stay the same in future releases.

  Note that the ORM makes use of its own "compiled" caches for some operations, including flush operations. The caching used by the ORM internally supersedes a cache dictionary specified here.

- **isolation_level** – Available on: Connection. Set the transaction isolation level for the lifespan of this connection. Valid values include those string values accepted by the `isolation_level` parameter passed to `create_engine()`, and are database specific, including those for *SQLite*, *PostgreSQL* - see those dialect's documentation for further info.

  Note that this option necessarily affects the underlying DBAPI connection for the lifespan of the originating `Connection`, and is not per-execution. This setting is not removed until the underlying DBAPI connection is returned to the connection pool, i.e. the `Connection.close()` method is called.

- **no_parameters** – When `True`, if the final parameter list or dictionary is totally empty, will invoke the statement on the cursor as `cursor.execute(statement)`, not passing the parameter collection at all. Some DBAPIs such as psycopg2 and mysql-python consider percent signs as significant only when parameters are present; this option allows code to generate SQL containing percent signs (and possibly other characters) that is neutral regarding whether it's executed by the DBAPI or piped into a script that's later invoked by command line tools.

  New in version 0.7.6.

- **stream_results** – Available on: Connection, statement. Indicate to the dialect that results should be "streamed" and not pre-buffered, if possible. This is a limitation of many DBAPIs. The flag is currently understood only by the psycopg2 dialect.

in_transaction()
Return True if a transaction is in progress.

info
A collection of per-DB-API connection instance properties.

invalidate(*exception=None*)
Invalidate the underlying DBAPI connection associated with this Connection.

The underlying DB-API connection is literally closed (if possible), and is discarded. Its source connection pool will typically lazily create a new connection to replace it.

Upon the next usage, this Connection will attempt to reconnect to the pool with a new connection.

Transactions in progress remain in an "opened" state (even though the actual transaction is gone); these must be explicitly rolled back before a reconnect on this Connection can proceed. This is to prevent applications from accidentally continuing their transactional operations in a non-transactional state.

invalidated
Return True if this connection was invalidated.

reflecttable(*table*, *include_columns=None*)
Load table description from the database.

Deprecated since version 0.7: Use autoload=True with `Table`, or use the `Inspector` object.

Given a `Table` object, reflect its columns and properties from the database, populating the given `Table` object with attributes.. If include_columns (a list or set) is specified, limit the autoload to the given column names.

The default implementation uses the `Inspector` interface to provide the output, building upon the granular table/column/ constraint etc. methods of `Dialect`.

run_callable(*callable_*, **args*, ***kwargs*)
Given a callable object or function, execute it, passing a `Connection` as the first argument.

The given *args and **kwargs are passed subsequent to the `Connection` argument.

This function, along with `Engine.run_callable()`, allows a function to be run with a `Connection` or `Engine` object without the need to know which one is being dealt with.

scalar(*object*, **multiparams*, ***params*)
Executes and returns the first column of the first row.

The underlying result/cursor is closed after execution.

transaction(*callable_*, **args*, ***kwargs*)
Execute the given function within a transaction boundary.

The function is passed this `Connection` as the first argument, followed by the given *args and **kwargs, e.g.:

```
def do_something(conn, x, y):
    conn.execute("some statement", {'x':x, 'y':y})

conn.transaction(do_something, 5, 10)
```

The operations inside the function are all invoked within the context of a single `Transaction`. Upon success, the transaction is committed. If an exception is raised, the transaction is rolled back before propagating the exception.

Note: The `transaction()` method is superseded by the usage of the Python `with:` statement, which can be used with `Connection.begin()`:

```
with conn.begin():
    conn.execute("some statement", {'x':5, 'y':10})
```

As well as with `Engine.begin()`:

```
with engine.begin() as conn:
    conn.execute("some statement", {'x':5, 'y':10})
```

See also:

`Engine.begin()` - engine-level transactional context

`Engine.transaction()` - engine-level version of `Connection.transaction()`

class sqlalchemy.engine.base.**Connectable**
Bases: object

Interface for an object which supports execution of SQL constructs.

The two implementations of `Connectable` are `Connection` and `Engine`.

Connectable must also implement the 'dialect' member which references a `Dialect` instance.

connect(***kwargs*)
Return a Connection object.

Depending on context, this may be self if this object is already an instance of Connection, or a newly procured Connection if this object is an instance of Engine.

contextual_connect()
Return a Connection object which may be part of an ongoing context.

Depending on context, this may be self if this object is already an instance of Connection, or a newly procured Connection if this object is an instance of Engine.

create(*entity*, ***kwargs*)
Emit CREATE statements for the given schema entity.

Deprecated since version 0.7: Use the create() method on the given schema object directly, i.e. Table.create(), Index.create(), MetaData.create_all()

drop(*entity*, ***kwargs*)
Emit DROP statements for the given schema entity.

Deprecated since version 0.7: Use the drop() method on the given schema object directly, i.e. Table.drop(), Index.drop(), MetaData.drop_all()

execute(*object*, **multiparams*, ***params*)
Executes the given construct and returns a ResultProxy.

scalar(*object*, **multiparams*, ***params*)
Executes and returns the first column of the first row.

The underlying cursor is closed after execution.

class sqlalchemy.engine.base.**Engine**(*pool*, *dialect*, *url*, *logging_name=None*, *echo=None*, *proxy=None*, *execution_options=None*)
Bases: sqlalchemy.engine.base.Connectable, sqlalchemy.log.Identified

Connects a Pool and Dialect together to provide a source of database connectivity and behavior.

An Engine object is instantiated publicly using the create_engine() function.

See also:

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begin(*close_with_result=False*)
Return a context manager delivering a Connection with a Transaction established.

E.g.:

```
with engine.begin() as conn:
    conn.execute("insert into table (x, y, z) values (1, 2, 3)")
    conn.execute("my_special_procedure(5)")
```

Upon successful operation, the Transaction is committed. If an error is raised, the Transaction is rolled back.

The close_with_result flag is normally False, and indicates that the Connection will be closed when the operation is complete. When set to True, it indicates the Connection is in "single use" mode, where the ResultProxy returned by the first call to Connection.execute() will close the Connection when that ResultProxy has exhausted all result rows.

New in version 0.7.6.

See also:

`Engine.connect()` - procure a `Connection` from an `Engine`.

`Connection.begin()` - start a `Transaction` for a particular `Connection`.

connect(***kwargs*)
Return a new `Connection` object.

The `Connection` object is a facade that uses a DBAPI connection internally in order to communicate with the database. This connection is procured from the connection-holding `Pool` referenced by this `Engine`. When the `close()` method of the `Connection` object is called, the underlying DBAPI connection is then returned to the connection pool, where it may be used again in a subsequent call to `connect()`.

contextual_connect(*close_with_result=False*, ***kwargs*)
Return a `Connection` object which may be part of some ongoing context.

By default, this method does the same thing as `Engine.connect()`. Subclasses of `Engine` may override this method to provide contextual behavior.

Parameters close_with_result – When True, the first `ResultProxy` created by the `Connection` will call the `Connection.close()` method of that connection as soon as any pending result rows are exhausted. This is used to supply the "connectionless execution" behavior provided by the `Engine.execute()` method.

create(*entity*, *connection=None*, ***kwargs*)
Emit CREATE statements for the given schema entity.

Deprecated since version 0.7: Use the create() method on the given schema object directly, i.e. `Table.create()`, `Index.create()`, `MetaData.create_all()`

dispose()
Dispose of the connection pool used by this `Engine`.

A new connection pool is created immediately after the old one has been disposed. This new pool, like all SQLAlchemy connection pools, does not make any actual connections to the database until one is first requested.

This method has two general use cases:

- When a dropped connection is detected, it is assumed that all connections held by the pool are potentially dropped, and the entire pool is replaced.
- An application may want to use `dispose()` within a test suite that is creating multiple engines.

It is critical to note that `dispose()` does **not** guarantee that the application will release all open database connections - only those connections that are checked into the pool are closed. Connections which remain checked out or have been detached from the engine are not affected.

driver
Driver name of the `Dialect` in use by this `Engine`.

drop(*entity*, *connection=None*, ***kwargs*)
Emit DROP statements for the given schema entity.

Deprecated since version 0.7: Use the drop() method on the given schema object directly, i.e. `Table.drop()`, `Index.drop()`, `MetaData.drop_all()`

execute(*statement*, **multiparams*, ***params*)
Executes the given construct and returns a `ResultProxy`.

The arguments are the same as those used by `Connection.execute()`.

Here, a Connection is acquired using the contextual_connect() method, and the statement executed with that connection. The returned ResultProxy is flagged such that when the ResultProxy is exhausted and its underlying cursor is closed, the Connection created here will also be closed, which allows its associated DBAPI connection resource to be returned to the connection pool.

func
Deprecated since version 0.7: Use func to create function constructs.

name
String name of the Dialect in use by this Engine.

raw_connection()
Return a "raw" DBAPI connection from the connection pool.

The returned object is a proxied version of the DBAPI connection object used by the underlying driver in use. The object will have all the same behavior as the real DBAPI connection, except that its close() method will result in the connection being returned to the pool, rather than being closed for real.

This method provides direct DBAPI connection access for special situations. In most situations, the Connection object should be used, which is procured using the Engine.connect() method.

reflecttable(*table*, *connection=None*, *include_columns=None*)
Load table description from the database.

Deprecated since version 0.7: Use autoload=True with Table, or use the Inspector object.

Uses the given Connection, or if None produces its own Connection, and passes the table and include_columns arguments onto that Connection object's Connection.reflecttable() method. The Table object is then populated with new attributes.

run_callable(*callable_*, **args*, ***kwargs*)
Given a callable object or function, execute it, passing a Connection as the first argument.

The given *args and **kwargs are passed subsequent to the Connection argument.

This function, along with Connection.run_callable(), allows a function to be run with a Connection or Engine object without the need to know which one is being dealt with.

table_names(*schema=None*, *connection=None*)
Return a list of all table names available in the database.

Parameters

- **schema** – Optional, retrieve names from a non-default schema.
- **connection** – Optional, use a specified connection. Default is the contextual_connect for this Engine.

text(*text*, **args*, ***kwargs*)
Return a text() construct,

Deprecated since version 0.7: Use expression.text() to create text constructs.

bound to this engine.

This is equivalent to:

```
text("SELECT * FROM table", bind=engine)
```

transaction(*callable_*, **args*, ***kwargs*)
Execute the given function within a transaction boundary.

The function is passed a Connection newly procured from Engine.contextual_connect() as the first argument, followed by the given *args and **kwargs.

e.g.:

```
def do_something(conn, x, y):
    conn.execute("some statement", {'x':x, 'y':y})

engine.transaction(do_something, 5, 10)
```

The operations inside the function are all invoked within the context of a single `Transaction`. Upon success, the transaction is committed. If an exception is raised, the transaction is rolled back before propagating the exception.

Note: The `transaction()` method is superseded by the usage of the Python `with:` statement, which can be used with `Engine.begin()`:

```
with engine.begin() as conn:
    conn.execute("some statement", {'x':5, 'y':10})
```

See also:

`Engine.begin()` - engine-level transactional context

`Connection.transaction()` - connection-level version of `Engine.transaction()`

update_execution_options(***opt*)
Update the default execution_options dictionary of this `Engine`.

The given keys/values in **opt are added to the default execution options that will be used for all connections. The initial contents of this dictionary can be sent via the `execution_options` parameter to `create_engine()`.

See `Connection.execution_options()` for more details on execution options.

class sqlalchemy.engine.base.**NestedTransaction**(*connection*, *parent*)
Bases: `sqlalchemy.engine.base.Transaction`

Represent a 'nested', or SAVEPOINT transaction.

A new `NestedTransaction` object may be procured using the `Connection.begin_nested()` method.

The interface is the same as that of `Transaction`.

class sqlalchemy.engine.base.**ResultProxy**(*context*)
Wraps a DB-API cursor object to provide easier access to row columns.

Individual columns may be accessed by their integer position, case-insensitive column name, or by `schema.Column` object. e.g.:

```
row = fetchone()

col1 = row[0]    # access via integer position

col2 = row['col2']   # access via name

col3 = row[mytable.c.mycol] # access via Column object.
```

`ResultProxy` also handles post-processing of result column data using `TypeEngine` objects, which are referenced from the originating SQL statement that produced this result set.

close(*_autoclose_connection=True*)
Close this ResultProxy.

Closes the underlying DBAPI cursor corresponding to the execution.

Note that any data cached within this ResultProxy is still available. For some types of results, this may include buffered rows.

If this ResultProxy was generated from an implicit execution, the underlying Connection will also be closed (returns the underlying DBAPI connection to the connection pool.)

This method is called automatically when:

- all result rows are exhausted using the fetchXXX() methods.
- cursor.description is None.

fetchall()
Fetch all rows, just like DB-API `cursor.fetchall()`.

fetchmany(*size=None*)
Fetch many rows, just like DB-API `cursor.fetchmany(size=cursor.arraysize)`.

If rows are present, the cursor remains open after this is called. Else the cursor is automatically closed and an empty list is returned.

fetchone()
Fetch one row, just like DB-API `cursor.fetchone()`.

If a row is present, the cursor remains open after this is called. Else the cursor is automatically closed and None is returned.

first()
Fetch the first row and then close the result set unconditionally.

Returns None if no row is present.

inserted_primary_key
Return the primary key for the row just inserted.

The return value is a list of scalar values corresponding to the list of primary key columns in the target table.

This only applies to single row `insert()` constructs which did not explicitly specify `Insert.returning()`.

Note that primary key columns which specify a server_default clause, or otherwise do not qualify as "autoincrement" columns (see the notes at `Column`), and were generated using the database-side default, will appear in this list as `None` unless the backend supports "returning" and the insert statement executed with the "implicit returning" enabled.

is_insert
True if this `ResultProxy` is the result of a executing an expression language compiled `expression.insert()` construct.

When True, this implies that the `inserted_primary_key` attribute is accessible, assuming the statement did not include a user defined "returning" construct.

keys()
Return the current set of string keys for rows.

last_inserted_ids()
Return the primary key for the row just inserted.

Deprecated since version 0.6: Use `ResultProxy.inserted_primary_key`

last_inserted_params()
Return the collection of inserted parameters from this execution.

last_updated_params()
Return the collection of updated parameters from this execution.

lastrow_has_defaults()
Return `lastrow_has_defaults()` from the underlying ExecutionContext.

See ExecutionContext for details.

lastrowid
return the 'lastrowid' accessor on the DBAPI cursor.

This is a DBAPI specific method and is only functional for those backends which support it, for statements where it is appropriate. It's behavior is not consistent across backends.

Usage of this method is normally unnecessary; the `inserted_primary_key` attribute provides a tuple of primary key values for a newly inserted row, regardless of database backend.

postfetch_cols()
Return `postfetch_cols()` from the underlying ExecutionContext.

See ExecutionContext for details.

returns_rows
True if this `ResultProxy` returns rows.

I.e. if it is legal to call the methods `fetchone()`, `fetchmany()` `fetchall()`.

rowcount
Return the 'rowcount' for this result.

The 'rowcount' reports the number of rows *matched* by the WHERE criterion of an UPDATE or DELETE statement.

Note: Notes regarding `ResultProxy.rowcount`:

- This attribute returns the number of rows *matched*, which is not necessarily the same as the number of rows that were actually *modified* - an UPDATE statement, for example, may have no net change on a given row if the SET values given are the same as those present in the row already. Such a row would be matched but not modified. On backends that feature both styles, such as MySQL, rowcount is configured by default to return the match count in all cases.
- `ResultProxy.rowcount` is *only* useful in conjunction with an UPDATE or DELETE statement. Contrary to what the Python DBAPI says, it does *not* return the number of rows available from the results of a SELECT statement as DBAPIs cannot support this functionality when rows are unbuffered.
- `ResultProxy.rowcount` may not be fully implemented by all dialects. In particular, most DBAPIs do not support an aggregate rowcount result from an executemany call. The `ResultProxy.supports_sane_rowcount()` and `ResultProxy.supports_sane_multi_rowcount()` methods will report from the dialect if each usage is known to be supported.
- Statements that use RETURNING may not return a correct rowcount.

---

scalar()
Fetch the first column of the first row, and close the result set.

Returns None if no row is present.

supports_sane_multi_rowcount()
Return `supports_sane_multi_rowcount` from the dialect.

See `ResultProxy.rowcount` for background.

supports_sane_rowcount()
Return supports_sane_rowcount from the dialect.

See ResultProxy.rowcount for background.

class sqlalchemy.engine.base.**RowProxy**(*parent*, *row*, *processors*, *keymap*)
Proxy values from a single cursor row.

Mostly follows "ordered dictionary" behavior, mapping result values to the string-based column name, the integer position of the result in the row, as well as Column instances which can be mapped to the original Columns that produced this result set (for results that correspond to constructed SQL expressions).

has_key(*key*)
Return True if this RowProxy contains the given key.

items()
Return a list of tuples, each tuple containing a key/value pair.

keys()
Return the list of keys as strings represented by this RowProxy.

class sqlalchemy.engine.base.**Transaction**(*connection*, *parent*)
Bases: object

Represent a database transaction in progress.

The Transaction object is procured by calling the begin() method of Connection:

```
from sqlalchemy import create_engine
engine = create_engine("postgresql://scott:tiger@localhost/test")
connection = engine.connect()
trans = connection.begin()
connection.execute("insert into x (a, b) values (1, 2)")
trans.commit()
```

The object provides rollback() and commit() methods in order to control transaction boundaries. It also implements a context manager interface so that the Python with statement can be used with the Connection.begin() method:

```
with connection.begin():
    connection.execute("insert into x (a, b) values (1, 2)")
```

The Transaction object is **not** threadsafe.

See also: Connection.begin(), Connection.begin_twophase(), Connection.begin_nested().

close()
Close this Transaction.

If this transaction is the base transaction in a begin/commit nesting, the transaction will rollback(). Otherwise, the method returns.

This is used to cancel a Transaction without affecting the scope of an enclosing transaction.

commit()
Commit this Transaction.

rollback()
Roll back this Transaction.

class sqlalchemy.engine.base.**TwoPhaseTransaction**(*connection*, *xid*)
Bases: sqlalchemy.engine.base.Transaction

Represent a two-phase transaction.

A new TwoPhaseTransaction object may be procured using the Connection.begin_twophase() method.

The interface is the same as that of Transaction with the addition of the prepare() method.

prepare()
Prepare this TwoPhaseTransaction.

After a PREPARE, the transaction can be committed.

3.5 Connection Pooling

A connection pool is a standard technique used to maintain long running connections in memory for efficient re-use, as well as to provide management for the total number of connections an application might use simultaneously.

Particularly for server-side web applications, a connection pool is the standard way to maintain a "pool" of active database connections in memory which are reused across requests.

SQLAlchemy includes several connection pool implementations which integrate with the Engine. They can also be used directly for applications that want to add pooling to an otherwise plain DBAPI approach.

3.5.1 Connection Pool Configuration

The Engine returned by the create_engine() function in most cases has a QueuePool integrated, pre-configured with reasonable pooling defaults. If you're reading this section only to learn how to enable pooling - congratulations! You're already done.

The most common QueuePool tuning parameters can be passed directly to create_engine() as keyword arguments: pool_size, max_overflow, pool_recycle and pool_timeout. For example:

```
engine = create_engine('postgresql://me@localhost/mydb',
                       pool_size=20, max_overflow=0)
```

In the case of SQLite, the SingletonThreadPool or NullPool are selected by the dialect to provide greater compatibility with SQLite's threading and locking model, as well as to provide a reasonable default behavior to SQLite "memory" databases, which maintain their entire dataset within the scope of a single connection.

All SQLAlchemy pool implementations have in common that none of them "pre create" connections - all implementations wait until first use before creating a connection. At that point, if no additional concurrent checkout requests for more connections are made, no additional connections are created. This is why it's perfectly fine for create_engine() to default to using a QueuePool of size five without regard to whether or not the application really needs five connections queued up - the pool would only grow to that size if the application actually used five connections concurrently, in which case the usage of a small pool is an entirely appropriate default behavior.

3.5.2 Switching Pool Implementations

The usual way to use a different kind of pool with create_engine() is to use the poolclass argument. This argument accepts a class imported from the sqlalchemy.pool module, and handles the details of building the pool for you. Common options include specifying QueuePool with SQLite:

```
from sqlalchemy.pool import QueuePool
engine = create_engine('sqlite:///file.db', poolclass=QueuePool)
```

Disabling pooling using `NullPool`:

```
from sqlalchemy.pool import NullPool
engine = create_engine(
          'postgresql+psycopg2://scott:tiger@localhost/test',
          poolclass=NullPool)
```

3.5.3 Using a Custom Connection Function

All `Pool` classes accept an argument `creator` which is a callable that creates a new connection. `create_engine()` accepts this function to pass onto the pool via an argument of the same name:

```
import sqlalchemy.pool as pool
import psycopg2

def getconn():
    c = psycopg2.connect(username='ed', host='127.0.0.1', dbname='test')
    # do things with 'c' to set up
    return c

engine = create_engine('postgresql+psycopg2://', creator=getconn)
```

For most "initialize on connection" routines, it's more convenient to use the `PoolEvents` event hooks, so that the usual URL argument to `create_engine()` is still usable. `creator` is there as a last resort for when a DBAPI has some form of `connect` that is not at all supported by SQLAlchemy.

3.5.4 Constructing a Pool

To use a `Pool` by itself, the `creator` function is the only argument that's required and is passed first, followed by any additional options:

```
import sqlalchemy.pool as pool
import psycopg2

def getconn():
    c = psycopg2.connect(username='ed', host='127.0.0.1', dbname='test')
    return c

mypool = pool.QueuePool(getconn, max_overflow=10, pool_size=5)
```

DBAPI connections can then be procured from the pool using the `Pool.connect()` function. The return value of this method is a DBAPI connection that's contained within a transparent proxy:

```
# get a connection
conn = mypool.connect()

# use it
cursor = conn.cursor()
cursor.execute("select foo")
```

The purpose of the transparent proxy is to intercept the `close()` call, such that instead of the DBAPI connection being closed, its returned to the pool:

```
# "close" the connection.  Returns
# it to the pool.
conn.close()
```

The proxy also returns its contained DBAPI connection to the pool when it is garbage collected, though it's not deterministic in Python that this occurs immediately (though it is typical with cPython).

The `close()` step also performs the important step of calling the `rollback()` method of the DBAPI connection. This is so that any existing transaction on the connection is removed, not only ensuring that no existing state remains on next usage, but also so that table and row locks are released as well as that any isolated data snapshots are removed. This behavior can be disabled using the `reset_on_return` option of `Pool`.

A particular pre-created `Pool` can be shared with one or more engines by passing it to the `pool` argument of `create_engine()`:

```
e = create_engine('postgresql://', pool=mypool)
```

3.5.5 Pool Events

Connection pools support an event interface that allows hooks to execute upon first connect, upon each new connection, and upon checkout and checkin of connections. See `PoolEvents` for details.

3.5.6 Dealing with Disconnects

The connection pool has the ability to refresh individual connections as well as its entire set of connections, setting the previously pooled connections as "invalid". A common use case is allow the connection pool to gracefully recover when the database server has been restarted, and all previously established connections are no longer functional. There are two approaches to this.

Disconnect Handling - Optimistic

The most common approach is to let SQLAlchemy handle disconnects as they occur, at which point the pool is refreshed. This assumes the `Pool` is used in conjunction with a `Engine`. The `Engine` has logic which can detect disconnection events and refresh the pool automatically.

When the `Connection` attempts to use a DBAPI connection, and an exception is raised that corresponds to a "disconnect" event, the connection is invalidated. The `Connection` then calls the `Pool.recreate()` method, effectively invalidating all connections not currently checked out so that they are replaced with new ones upon next checkout:

```
from sqlalchemy import create_engine, exc
e = create_engine(...)
c = e.connect()

try:
    # suppose the database has been restarted.
    c.execute("SELECT * FROM table")
    c.close()
except exc.DBAPIError, e:
    # an exception is raised, Connection is invalidated.
    if e.connection_invalidated:
        print "Connection was invalidated!"
```

```
# after the invalidate event, a new connection
# starts with a new Pool
c = e.connect()
c.execute("SELECT * FROM table")
```

The above example illustrates that no special intervention is needed, the pool continues normally after a disconnection event is detected. However, an exception is raised. In a typical web application using an ORM Session, the above condition would correspond to a single request failing with a 500 error, then the web application continuing normally beyond that. Hence the approach is "optimistic" in that frequent database restarts are not anticipated.

Setting Pool Recycle

An additional setting that can augment the "optimistic" approach is to set the pool recycle parameter. This parameter prevents the pool from using a particular connection that has passed a certain age, and is appropriate for database backends such as MySQL that automatically close connections that have been stale after a particular period of time:

```
from sqlalchemy import create_engine
e = create_engine("mysql://scott:tiger@localhost/test", pool_recycle=3600)
```

Above, any DBAPI connection that has been open for more than one hour will be invalidated and replaced, upon next checkout. Note that the invalidation **only** occurs during checkout - not on any connections that are held in a checked out state. `pool_recycle` is a function of the `Pool` itself, independent of whether or not an `Engine` is in use.

Disconnect Handling - Pessimistic

At the expense of some extra SQL emitted for each connection checked out from the pool, a "ping" operation established by a checkout event handler can detect an invalid connection before it's used:

```
from sqlalchemy import exc
from sqlalchemy import event
from sqlalchemy.pool import Pool

@event.listens_for(Pool, "checkout")
def ping_connection(dbapi_connection, connection_record, connection_proxy):
    cursor = dbapi_connection.cursor()
    try:
        cursor.execute("SELECT 1")
    except:
        # optional - dispose the whole pool
        # instead of invalidating one at a time
        # connection_proxy._pool.dispose()

        # raise DisconnectionError - pool will try
        # connecting again up to three times before raising.
        raise exc.DisconnectionError()
    cursor.close()
```

Above, the `Pool` object specifically catches `DisconnectionError` and attempts to create a new DBAPI connection, up to three times, before giving up and then raising `InvalidRequestError`, failing the connection. This recipe will ensure that a new `Connection` will succeed even if connections in the pool have gone stale, provided that the database server is actually running. The expense is that of an additional execution performed per checkout. When using the ORM `Session`, there is one connection checkout per transaction, so the expense is fairly low. The ping approach above also works with straight connection pool usage, that is, even if no `Engine` were involved.

The event handler can be tested using a script like the following, restarting the database server at the point at which the script pauses for input:

```
from sqlalchemy import create_engine
e = create_engine("mysql://scott:tiger@localhost/test", echo_pool=True)
c1 = e.connect()
c2 = e.connect()
c3 = e.connect()
c1.close()
c2.close()
c3.close()

# pool size is now three.

print "Restart the server"
raw_input()

for i in xrange(10):
    c = e.connect()
    print c.execute("select 1").fetchall()
    c.close()
```

3.5.7 API Documentation - Available Pool Implementations

class sqlalchemy.pool.**Pool**(*creator*, *recycle=-1*, *echo=None*, *use_threadlocal=False*, *logging_name=None*, *reset_on_return=True*, *listeners=None*, *events=None*, *_dispatch=None*)

Abstract base class for connection pools.

__init__(*creator*, *recycle=-1*, *echo=None*, *use_threadlocal=False*, *logging_name=None*, *reset_on_return=True*, *listeners=None*, *events=None*, *_dispatch=None*)

Construct a Pool.

Parameters

- **creator** – a callable function that returns a DB-API connection object. The function will be called with parameters.
- **recycle** – If set to non -1, number of seconds between connection recycling, which means upon checkout, if this timeout is surpassed the connection will be closed and replaced with a newly opened connection. Defaults to -1.
- **logging_name** – String identifier which will be used within the "name" field of logging records generated within the "sqlalchemy.pool" logger. Defaults to a hexstring of the object's id.
- **echo** – If True, connections being pulled and retrieved from the pool will be logged to the standard output, as well as pool sizing information. Echoing can also be achieved by enabling logging for the "sqlalchemy.pool" namespace. Defaults to False.
- **use_threadlocal** – If set to True, repeated calls to `connect()` within the same application thread will be guaranteed to return the same connection object, if one has already been retrieved from the pool and has not been returned yet. Offers a slight performance advantage at the cost of individual transactions by default. The `unique_connection()` method is provided to bypass the threadlocal behavior installed into `connect()`.

- **reset_on_return** – If true, reset the database state of connections returned to the pool. This is typically a ROLLBACK to release locks and transaction resources. Disable at your own peril. Defaults to True.
- **events** – a list of 2-tuples, each of the form `(callable, target)` which will be passed to event.listen() upon construction. Provided here so that event listeners can be assigned via `create_engine` before dialect-level listeners are applied.
- **listeners** – Deprecated. A list of `PoolListener`-like objects or dictionaries of callables that receive events when DB-API connections are created, checked out and checked in to the pool. This has been superseded by `listen()`.

connect()
Return a DBAPI connection from the pool.

The connection is instrumented such that when its `close()` method is called, the connection will be returned to the pool.

dispose()
Dispose of this pool.

This method leaves the possibility of checked-out connections remaining open, as it only affects connections that are idle in the pool.

See also the `Pool.recreate()` method.

recreate()
Return a new `Pool`, of the same class as this one and configured with identical creation arguments.

This method is used in conjunection with `dispose()` to close out an entire `Pool` and create a new one in its place.

class sqlalchemy.pool.**QueuePool**(*creator*, *pool_size=5*, *max_overflow=10*, *timeout=30*, ***kw*)
Bases: `sqlalchemy.pool.Pool`

A `Pool` that imposes a limit on the number of open connections.

`QueuePool` is the default pooling implementation used for all `Engine` objects, unless the SQLite dialect is in use.

__init__(*creator*, *pool_size=5*, *max_overflow=10*, *timeout=30*, ***kw*)
Construct a QueuePool.

Parameters

- **creator** – a callable function that returns a DB-API connection object. The function will be called with parameters.
- **pool_size** – The size of the pool to be maintained, defaults to 5. This is the largest number of connections that will be kept persistently in the pool. Note that the pool begins with no connections; once this number of connections is requested, that number of connections will remain. `pool_size` can be set to 0 to indicate no size limit; to disable pooling, use a `NullPool` instead.
- **max_overflow** – The maximum overflow size of the pool. When the number of checked-out connections reaches the size set in pool_size, additional connections will be returned up to this limit. When those additional connections are returned to the pool, they are disconnected and discarded. It follows then that the total number of simultaneous connections the pool will allow is pool_size + *max_overflow*, and the total number of "sleeping" connections the pool will allow is pool_size. *max_overflow* can be set to -1 to indicate no overflow limit; no limit will be placed on the total number of concurrent connections. Defaults to 10.

- **timeout** – The number of seconds to wait before giving up on returning a connection. Defaults to 30.
- **recycle** – If set to non -1, number of seconds between connection recycling, which means upon checkout, if this timeout is surpassed the connection will be closed and replaced with a newly opened connection. Defaults to -1.
- **echo** – If True, connections being pulled and retrieved from the pool will be logged to the standard output, as well as pool sizing information. Echoing can also be achieved by enabling logging for the "sqlalchemy.pool" namespace. Defaults to False.
- **use_threadlocal** – If set to True, repeated calls to `connect()` within the same application thread will be guaranteed to return the same connection object, if one has already been retrieved from the pool and has not been returned yet. Offers a slight performance advantage at the cost of individual transactions by default. The `unique_connection()` method is provided to bypass the threadlocal behavior installed into `connect()`.
- **reset_on_return** – Determine steps to take on connections as they are returned to the pool. reset_on_return can have any of these values:
  - 'rollback' - call rollback() on the connection, to release locks and transaction resources. This is the default value. The vast majority of use cases should leave this value set.
  - True - same as 'rollback', this is here for backwards compatibility.
  - 'commit' - call commit() on the connection, to release locks and transaction resources. A commit here may be desirable for databases that cache query plans if a commit is emitted, such as Microsoft SQL Server. However, this value is more dangerous than 'rollback' because any data changes present on the transaction are committed unconditionally.
  - None - don't do anything on the connection. This setting should only be made on a database that has no transaction support at all, namely MySQL MyISAM. By not doing anything, performance can be improved. This setting should **never be selected** for a database that supports transactions, as it will lead to deadlocks and stale state.
  - False - same as None, this is here for backwards compatibility.

  Changed in version 0.7.6: `reset_on_return` accepts values.
- **listeners** – A list of `PoolListener`-like objects or dictionaries of callables that receive events when DB-API connections are created, checked out and checked in to the pool.

class `sqlalchemy.pool.`**`SingletonThreadPool`**(*creator*, *pool_size=5*, ***kw*)

Bases: `sqlalchemy.pool.Pool`

A Pool that maintains one connection per thread.

Maintains one connection per each thread, never moving a connection to a thread other than the one which it was created in.

Options are the same as those of `Pool`, as well as:

Parameters **pool_size** – The number of threads in which to maintain connections at once. Defaults to five.

`SingletonThreadPool` is used by the SQLite dialect automatically when a memory-based database is used. See *SQLite*.

__init__(*creator*, *pool_size=5*, ***kw*)

class sqlalchemy.pool.**AssertionPool**(**args*, ***kw*)
Bases: sqlalchemy.pool.Pool

A Pool that allows at most one checked out connection at any given time.

This will raise an exception if more than one connection is checked out at a time. Useful for debugging code that is using more connections than desired.

Changed in version 0.7: AssertionPool also logs a traceback of where the original connection was checked out, and reports this in the assertion error raised.

class sqlalchemy.pool.**NullPool**(*creator*, *recycle=-1*, *echo=None*, *use_threadlocal=False*, *logging_name=None*, *reset_on_return=True*, *listeners=None*, *events=None*, *_dispatch=None*)
Bases: sqlalchemy.pool.Pool

A Pool which does not pool connections.

Instead it literally opens and closes the underlying DB-API connection per each connection open/close.

Reconnect-related functions such as recycle and connection invalidation are not supported by this Pool implementation, since no connections are held persistently.

Changed in version 0.7: NullPool is used by the SQlite dialect automatically when a file-based database is used. See *SQLite*.

class sqlalchemy.pool.**StaticPool**(*creator*, *recycle=-1*, *echo=None*, *use_threadlocal=False*, *logging_name=None*, *reset_on_return=True*, *listeners=None*, *events=None*, *_dispatch=None*)
Bases: sqlalchemy.pool.Pool

A Pool of exactly one connection, used for all requests.

Reconnect-related functions such as recycle and connection invalidation (which is also used to support auto-reconnect) are not currently supported by this Pool implementation but may be implemented in a future release.

3.5.8 Pooling Plain DB-API Connections

Any **PEP 249** DB-API module can be "proxied" through the connection pool transparently. Usage of the DB-API is exactly as before, except the connect() method will consult the pool. Below we illustrate this with psycopg2:

```
import sqlalchemy.pool as pool
import psycopg2 as psycopg

psycopg = pool.manage(psycopg)

# then connect normally
connection = psycopg.connect(database='test', username='scott',
                             password='tiger')
```

This produces a _DBProxy object which supports the same connect() function as the original DB-API module. Upon connection, a connection proxy object is returned, which delegates its calls to a real DB-API connection object. This connection object is stored persistently within a connection pool (an instance of Pool) that corresponds to the exact connection arguments sent to the connect() function.

The connection proxy supports all of the methods on the original connection object, most of which are proxied via __getattr__(). The close() method will return the connection to the pool, and the cursor() method will

return a proxied cursor object. Both the connection proxy and the cursor proxy will also return the underlying connection to the pool after they have both been garbage collected, which is detected via weakref callbacks (`__del__` is not used).

Additionally, when connections are returned to the pool, a `rollback()` is issued on the connection unconditionally. This is to release any locks still held by the connection that may have resulted from normal activity.

By default, the `connect()` method will return the same connection that is already checked out in the current thread. This allows a particular connection to be used in a given thread without needing to pass it around between functions. To disable this behavior, specify `use_threadlocal=False` to the `manage()` function.

`sqlalchemy.pool.`**`manage`**(*module*, ***params*)

Return a proxy for a DB-API module that automatically pools connections.

Given a DB-API 2.0 module and pool management parameters, returns a proxy for the module that will automatically pool connections, creating new connection pools for each distinct set of connection arguments sent to the decorated module's connect() function.

Parameters

- **module** – a DB-API 2.0 database module
- **poolclass** – the class used by the pool module to provide pooling. Defaults to `QueuePool`.
- ****params** – will be passed through to *poolclass*

`sqlalchemy.pool.`**`clear_managers`**()

Remove all current DB-API 2.0 managers.

All pools and connections are disposed.

3.6 Schema Definition Language

3.6.1 Describing Databases with MetaData

The core of SQLAlchemy's query and object mapping operations are supported by *database metadata*, which is comprised of Python objects that describe tables and other schema-level objects. These objects are at the core of three major types of operations - issuing CREATE and DROP statements (known as *DDL*), constructing SQL queries, and expressing information about structures that already exist within the database.

Database metadata can be expressed by explicitly naming the various components and their properties, using constructs such as `Table`, `Column`, `ForeignKey` and `Sequence`, all of which are imported from the `sqlalchemy.schema` package. It can also be generated by SQLAlchemy using a process called *reflection*, which means you start with a single object such as `Table`, assign it a name, and then instruct SQLAlchemy to load all the additional information related to that name from a particular engine source.

A key feature of SQLAlchemy's database metadata constructs is that they are designed to be used in a *declarative* style which closely resembles that of real DDL. They are therefore most intuitive to those who have some background in creating real schema generation scripts.

A collection of metadata entities is stored in an object aptly named `MetaData`:

```
from sqlalchemy import *

metadata = MetaData()
```

MetaData is a container object that keeps together many different features of a database (or multiple databases) being described.

To represent a table, use the Table class. Its two primary arguments are the table name, then the MetaData object which it will be associated with. The remaining positional arguments are mostly Column objects describing each column:

```
user = Table('user', metadata,
    Column('user_id', Integer, primary_key = True),
    Column('user_name', String(16), nullable = False),
    Column('email_address', String(60)),
    Column('password', String(20), nullable = False)
)
```

Above, a table called user is described, which contains four columns. The primary key of the table consists of the user_id column. Multiple columns may be assigned the primary_key=True flag which denotes a multi-column primary key, known as a *composite* primary key.

Note also that each column describes its datatype using objects corresponding to genericized types, such as Integer and String. SQLAlchemy features dozens of types of varying levels of specificity as well as the ability to create custom types. Documentation on the type system can be found at *types*.

Accessing Tables and Columns

The MetaData object contains all of the schema constructs we've associated with it. It supports a few methods of accessing these table objects, such as the sorted_tables accessor which returns a list of each Table object in order of foreign key dependency (that is, each table is preceded by all tables which it references):

```
>>> for t in metadata.sorted_tables:
...     print t.name
user
user_preference
invoice
invoice_item
```

In most cases, individual Table objects have been explicitly declared, and these objects are typically accessed directly as module-level variables in an application. Once a Table has been defined, it has a full set of accessors which allow inspection of its properties. Given the following Table definition:

```
employees = Table('employees', metadata,
    Column('employee_id', Integer, primary_key=True),
    Column('employee_name', String(60), nullable=False),
    Column('employee_dept', Integer, ForeignKey("departments.department_id"))
)
```

Note the ForeignKey object used in this table - this construct defines a reference to a remote table, and is fully described in *Defining Foreign Keys*. Methods of accessing information about this table include:

```
# access the column "EMPLOYEE_ID":
employees.columns.employee_id

# or just
employees.c.employee_id

# via string
```

```
employees.c['employee_id']

# iterate through all columns
for c in employees.c:
    print c

# get the table's primary key columns
for primary_key in employees.primary_key:
    print primary_key

# get the table's foreign key objects:
for fkey in employees.foreign_keys:
    print fkey

# access the table's MetaData:
employees.metadata

# access the table's bound Engine or Connection, if its MetaData is bound:
employees.bind

# access a column's name, type, nullable, primary key, foreign key
employees.c.employee_id.name
employees.c.employee_id.type
employees.c.employee_id.nullable
employees.c.employee_id.primary_key
employees.c.employee_dept.foreign_keys

# get the "key" of a column, which defaults to its name, but can
# be any user-defined string:
employees.c.employee_name.key

# access a column's table:
employees.c.employee_id.table is employees

# get the table related by a foreign key
list(employees.c.employee_dept.foreign_keys)[0].column.table
```

Creating and Dropping Database Tables

Once you've defined some `Table` objects, assuming you're working with a brand new database one thing you might want to do is issue CREATE statements for those tables and their related constructs (as an aside, it's also quite possible that you *don't* want to do this, if you already have some preferred methodology such as tools included with your database or an existing scripting system - if that's the case, feel free to skip this section - SQLAlchemy has no requirement that it be used to create your tables).

The usual way to issue CREATE is to use `create_all()` on the `MetaData` object. This method will issue queries that first check for the existence of each individual table, and if not found will issue the CREATE statements:

```
engine = create_engine('sqlite:///:memory:')

metadata = MetaData()

user = Table('user', metadata,
    Column('user_id', Integer, primary_key = True),
    Column('user_name', String(16), nullable = False),
    Column('email_address', String(60), key='email'),
    Column('password', String(20), nullable = False)
```

```
    )

    user_prefs = Table('user_prefs', metadata,
        Column('pref_id', Integer, primary_key=True),
        Column('user_id', Integer, ForeignKey("user.user_id"), nullable=False),
        Column('pref_name', String(40), nullable=False),
        Column('pref_value', String(100))
    )

    metadata.create_all(engine)
    PRAGMA table_info(user){}
    CREATE TABLE user(
            user_id INTEGER NOT NULL PRIMARY KEY,
            user_name VARCHAR(16) NOT NULL,
            email_address VARCHAR(60),
            password VARCHAR(20) NOT NULL
    )
    PRAGMA table_info(user_prefs){}
    CREATE TABLE user_prefs(
            pref_id INTEGER NOT NULL PRIMARY KEY,
            user_id INTEGER NOT NULL REFERENCES user(user_id),
            pref_name VARCHAR(40) NOT NULL,
            pref_value VARCHAR(100)
    )
```

`create_all()` creates foreign key constraints between tables usually inline with the table definition itself, and for this reason it also generates the tables in order of their dependency. There are options to change this behavior such that `ALTER TABLE` is used instead.

Dropping all tables is similarly achieved using the `drop_all()` method. This method does the exact opposite of `create_all()` - the presence of each table is checked first, and tables are dropped in reverse order of dependency.

Creating and dropping individual tables can be done via the `create()` and `drop()` methods of `Table`. These methods by default issue the CREATE or DROP regardless of the table being present:

```
engine = create_engine('sqlite:///:memory:')

meta = MetaData()

employees = Table('employees', meta,
    Column('employee_id', Integer, primary_key=True),
    Column('employee_name', String(60), nullable=False, key='name'),
    Column('employee_dept', Integer, ForeignKey("departments.department_id"))
)
employees.create(engine)
CREATE TABLE employees(
employee_id SERIAL NOT NULL PRIMARY KEY,
employee_name VARCHAR(60) NOT NULL,
employee_dept INTEGER REFERENCES departments(department_id)
)
{}
```

`drop()` method:

```
employees.drop(engine)
DROP TABLE employees
{}
```

To enable the "check first for the table existing" logic, add the `checkfirst=True` argument to `create()` or `drop()`:

```
employees.create(engine, checkfirst=True)
employees.drop(engine, checkfirst=False)
```

Altering Schemas through Migrations

While SQLAlchemy directly supports emitting CREATE and DROP statements for schema constructs, the ability to alter those constructs, usually via the ALTER statement as well as other database-specific constructs, is outside of the scope of SQLAlchemy itself. While it's easy enough to emit ALTER statements and similar by hand, such as by passing a string to `Connection.execute()` or by using the `DDL` construct, it's a common practice to automate the maintenance of database schemas in relation to application code using schema migration tools.

There are two major migration tools available for SQLAlchemy:

- Alembic - Written by the author of SQLAlchemy, Alembic features a highly customizable environment and a minimalistic usage pattern, supporting such features as transactional DDL, automatic generation of "candidate" migrations, an "offline" mode which generates SQL scripts, and support for branch resolution.
- SQLAlchemy-Migrate - The original migration tool for SQLAlchemy, SQLAlchemy-Migrate is widely used and continues under active development. SQLAlchemy-Migrate includes features such as SQL script generation, ORM class generation, ORM model comparison, and extensive support for SQLite migrations.

Specifying the Schema Name

Some databases support the concept of multiple schemas. A `Table` can reference this by specifying the `schema` keyword argument:

```
financial_info = Table('financial_info', meta,
    Column('id', Integer, primary_key=True),
    Column('value', String(100), nullable=False),
    schema='remote_banks'
)
```

Within the `MetaData` collection, this table will be identified by the combination of `financial_info` and `remote_banks`. If another table called `financial_info` is referenced without the `remote_banks` schema, it will refer to a different `Table`. `ForeignKey` objects can specify references to columns in this table using the form `remote_banks.financial_info.id`.

The `schema` argument should be used for any name qualifiers required, including Oracle's "owner" attribute and similar. It also can accommodate a dotted name for longer schemes:

```
schema="dbo.scott"
```

Backend-Specific Options

`Table` supports database-specific options. For example, MySQL has different table backend types, including "MyISAM" and "InnoDB". This can be expressed with `Table` using `mysql_engine`:

```
addresses = Table('engine_email_addresses', meta,
    Column('address_id', Integer, primary_key = True),
    Column('remote_user_id', Integer, ForeignKey(users.c.user_id)),
    Column('email_address', String(20)),
    mysql_engine='InnoDB'
)
```

Other backends may support table-level options as well - these would be described in the individual documentation sections for each dialect.

Column, Table, MetaData API

class sqlalchemy.schema.**Column**(**args*, ***kwargs*)

Bases: sqlalchemy.schema.SchemaItem, sqlalchemy.sql.expression.ColumnClause

Represents a column in a database table.

__init__(**args*, ***kwargs*)

Construct a new Column object.

Parameters

- **name** – The name of this column as represented in the database. This argument may be the first positional argument, or specified via keyword.

  Names which contain no upper case characters will be treated as case insensitive names, and will not be quoted unless they are a reserved word. Names with any number of upper case characters will be quoted and sent exactly. Note that this behavior applies even for databases which standardize upper case names as case insensitive such as Oracle.

  The name field may be omitted at construction time and applied later, at any time before the Column is associated with a Table. This is to support convenient usage within the declarative extension.

- **type_** – The column's type, indicated using an instance which subclasses TypeEngine. If no arguments are required for the type, the class of the type can be sent as well, e.g.:

  ```
  # use a type with arguments
  Column('data', String(50))

  # use no arguments
  Column('level', Integer)
  ```

  The type argument may be the second positional argument or specified by keyword.

  There is partial support for automatic detection of the type based on that of a ForeignKey associated with this column, if the type is specified as None. However, this feature is not fully implemented and may not function in all cases.

- ***args** – Additional positional arguments include various SchemaItem derived constructs which will be applied as options to the column. These include instances of Constraint, ForeignKey, ColumnDefault, and Sequence. In some cases an equivalent keyword argument is available such as server_default, default and unique.

- **autoincrement** – This flag may be set to `False` to indicate an integer primary key column that should not be considered to be the "autoincrement" column, that is the integer primary key column which generates values implicitly upon INSERT and whose value is usually returned via the DBAPI cursor.lastrowid attribute. It defaults to `True` to satisfy the common use case of a table with a single integer primary key column. If the table has a composite primary key consisting of more than one integer column, set this flag to True only on the column that should be considered "autoincrement".

  The setting *only* has an effect for columns which are:

  – Integer derived (i.e. INT, SMALLINT, BIGINT).

  – Part of the primary key

  – Are not referenced by any foreign keys, unless the value is specified as `'ignore_fk'`

  New in version 0.7.4.

  – have no server side or client side defaults (with the exception of Postgresql SERIAL).

  The setting has these two effects on columns that meet the above criteria:

  – DDL issued for the column will include database-specific keywords intended to signify this column as an "autoincrement" column, such as AUTO INCREMENT on MySQL, SERIAL on Postgresql, and IDENTITY on MS-SQL. It does *not* issue AUTOINCREMENT for SQLite since this is a special SQLite flag that is not required for autoincrementing behavior. See the SQLite dialect documentation for information on SQLite's AUTOINCREMENT.

  – The column will be considered to be available as cursor.lastrowid or equivalent, for those dialects which "post fetch" newly inserted identifiers after a row has been inserted (SQLite, MySQL, MS-SQL). It does not have any effect in this regard for databases that use sequences to generate primary key identifiers (i.e. Firebird, Postgresql, Oracle).

  Changed in version 0.7.4: `autoincrement` accepts a special value `'ignore_fk'` to indicate that autoincrementing status regardless of foreign key references. This applies to certain composite foreign key setups, such as the one demonstrated in the ORM documentation at *Rows that point to themselves / Mutually Dependent Rows*.

- **default** – A scalar, Python callable, or `ClauseElement` representing the *default value* for this column, which will be invoked upon insert if this column is otherwise not specified in the VALUES clause of the insert. This is a shortcut to using `ColumnDefault` as a positional argument.

  Contrast this argument to `server_default` which creates a default generator on the database side.

- **doc** – optional String that can be used by the ORM or similar to document attributes. This attribute does not render SQL comments (a future attribute 'comment' will achieve that).

- **key** – An optional string identifier which will identify this `Column` object on the `Table`. When a key is provided, this is the only identifier referencing the `Column` within the application, including ORM attribute mapping; the `name` field is used only when rendering SQL.

- **index** – When `True`, indicates that the column is indexed. This is a shortcut for using a `Index` construct on the table. To specify indexes with explicit names or indexes that contain multiple columns, use the `Index` construct instead.
- **info** – A dictionary which defaults to `{}`. A space to store application specific data. This must be a dictionary.
- **nullable** – If set to the default of `True`, indicates the column will be rendered as allowing NULL, else it's rendered as NOT NULL. This parameter is only used when issuing CREATE TABLE statements.
- **onupdate** – A scalar, Python callable, or `ClauseElement` representing a default value to be applied to the column within UPDATE statements, which wil be invoked upon update if this column is not present in the SET clause of the update. This is a shortcut to using `ColumnDefault` as a positional argument with `for_update=True`.
- **primary_key** – If `True`, marks this column as a primary key column. Multiple columns can have this flag set to specify composite primary keys. As an alternative, the primary key of a `Table` can be specified via an explicit `PrimaryKeyConstraint` object.
- **server_default** – A `FetchedValue` instance, str, Unicode or `text()` construct representing the DDL DEFAULT value for the column.

  String types will be emitted as-is, surrounded by single quotes:

  ```
  Column('x', Text, server_default="val")

  x TEXT DEFAULT 'val'
  ```

  A `text()` expression will be rendered as-is, without quotes:

  ```
  Column('y', DateTime, server_default=text('NOW()'))0

  y DATETIME DEFAULT NOW()
  ```

  Strings and text() will be converted into a `DefaultClause` object upon initialization.

  Use `FetchedValue` to indicate that an already-existing column will generate a default value on the database side which will be available to SQLAlchemy for post-fetch after inserts. This construct does not specify any DDL and the implementation is left to the database, such as via a trigger.
- **server_onupdate** – A `FetchedValue` instance representing a database-side default generation function. This indicates to SQLAlchemy that a newly generated value will be available after updates. This construct does not specify any DDL and the implementation is left to the database, such as via a trigger.
- **quote** – Force quoting of this column's name on or off, corresponding to `True` or `False`. When left at its default of `None`, the column identifier will be quoted according to whether the name is case sensitive (identifiers with at least one upper case character are treated as case sensitive), or if it's a reserved word. This flag is only needed to force quoting of a reserved word which is not known by the SQLAlchemy dialect.
- **unique** – When `True`, indicates that this column contains a unique constraint, or if `index` is `True` as well, indicates that the `Index` should be created with the unique

flag. To specify multiple columns in the constraint/index or to specify an explicit name, use the `UniqueConstraint` or `Index` constructs explicitly.

append_foreign_key(*fk*)

copy(***kw*)
Create a copy of this `Column`, unitialized.

This is used in `Table.tometadata`.

get_children(*schema_visitor=False*, ***kwargs*)

references(*column*)
Return True if this Column references the given column via foreign key.

class sqlalchemy.schema.**MetaData**(*bind=None*, *reflect=False*, *schema=None*, *quote_schema=None*)
Bases: `sqlalchemy.schema.SchemaItem`

A collection of `Table` objects and their associated schema constructs.

Holds a collection of `Table` objects as well as an optional binding to an `Engine` or `Connection`. If bound, the `Table` objects in the collection and their columns may participate in implicit SQL execution.

The `Table` objects themselves are stored in the `metadata.tables` dictionary.

The `bind` property may be assigned to dynamically. A common pattern is to start unbound and then bind later when an engine is available:

```
metadata = MetaData()
# define tables
Table('mytable', metadata, ...)
# connect to an engine later, perhaps after loading a URL from a
# configuration file
metadata.bind = an_engine
```

MetaData is a thread-safe object after tables have been explicitly defined or loaded via reflection.

See also:

Describing Databases with MetaData - Introduction to database metadata

__init__(*bind=None*, *reflect=False*, *schema=None*, *quote_schema=None*)
Create a new MetaData object.

Parameters

- **bind** – An Engine or Connection to bind to. May also be a string or URL instance, these are passed to create_engine() and this MetaData will be bound to the resulting engine.
- **reflect** – Optional, automatically load all tables from the bound database. Defaults to False. `bind` is required when this option is set. For finer control over loaded tables, use the `reflect` method of `MetaData`.
- **schema** – The default schema to use for the `Table`, `Sequence`, and other objects associated with this `MetaData`. Defaults to `None`.
- **quote_schema** – Sets the `quote_schema` flag for those `Table`, `Sequence`, and other objects which make usage of the local `schema` name.

New in version 0.7.4: `schema` and `quote_schema` parameters.

append_ddl_listener(*event_name*, *listener*)
Append a DDL event listener to this `MetaData`.

Deprecated. See DDLEvents.

bind
An Engine or Connection to which this MetaData is bound.

Typically, a Engine is assigned to this attribute so that "implicit execution" may be used, or alternatively as a means of providing engine binding information to an ORM Session object:

```
engine = create_engine("someurl://")
metadata.bind = engine
```

See also:

Connectionless Execution, Implicit Execution - background on "bound metadata"

clear()
Clear all Table objects from this MetaData.

create_all(*bind=None*, *tables=None*, *checkfirst=True*)
Create all tables stored in this metadata.

Conditional by default, will not attempt to recreate tables already present in the target database.

Parameters

- **bind** – A Connectable used to access the database; if None, uses the existing bind on this MetaData, if any.
- **tables** – Optional list of Table objects, which is a subset of the total tables in the MetaData (others are ignored).
- **checkfirst** – Defaults to True, don't issue CREATEs for tables already present in the target database.

drop_all(*bind=None*, *tables=None*, *checkfirst=True*)
Drop all tables stored in this metadata.

Conditional by default, will not attempt to drop tables not present in the target database.

Parameters

- **bind** – A Connectable used to access the database; if None, uses the existing bind on this MetaData, if any.
- **tables** – Optional list of Table objects, which is a subset of the total tables in the MetaData (others are ignored).
- **checkfirst** – Defaults to True, only issue DROPs for tables confirmed to be present in the target database.

is_bound()
True if this MetaData is bound to an Engine or Connection.

reflect(*bind=None*, *schema=None*, *views=False*, *only=None*)
Load all available table definitions from the database.

Automatically creates Table entries in this MetaData for any table available in the database but not yet present in the MetaData. May be called multiple times to pick up tables recently added to the database, however no special action is taken if a table in this MetaData no longer exists in the database.

Parameters

- **bind** – A Connectable used to access the database; if None, uses the existing bind on this MetaData, if any.

- **schema** – Optional, query and reflect tables from an alterate schema. If None, the schema associated with this MetaData is used, if any.
- **views** – If True, also reflect views.
- **only** – Optional. Load only a sub-set of available named tables. May be specified as a sequence of names or a callable.

  If a sequence of names is provided, only those tables will be reflected. An error is raised if a table is requested but not available. Named tables already present in this MetaData are ignored.

  If a callable is provided, it will be used as a boolean predicate to filter the list of potential table names. The callable is called with a table name and this MetaData instance as positional arguments and should return a true value for any table to reflect.

remove(*table*)
Remove the given Table object from this MetaData.

sorted_tables
Returns a list of Table objects sorted in order of dependency.

class sqlalchemy.schema.**SchemaItem**
Bases: sqlalchemy.events.SchemaEventTarget, sqlalchemy.sql.visitors.Visitable

Base class for items that define a database schema.

class sqlalchemy.schema.**Table**(**args*, ***kw*)
Bases: sqlalchemy.schema.SchemaItem, sqlalchemy.sql.expression.TableClause

Represent a table in a database.

e.g.:

```
mytable = Table("mytable", metadata,
                Column('mytable_id', Integer, primary_key=True),
                Column('value', String(50))
           )
```

The Table object constructs a unique instance of itself based on its name and optional schema name within the given MetaData object. Calling the Table constructor with the same name and same MetaData argument a second time will return the *same* Table object - in this way the Table constructor acts as a registry function.

See also:

Describing Databases with MetaData - Introduction to database metadata

Constructor arguments are as follows:

Parameters

- **name** – The name of this table as represented in the database.

  This property, along with the *schema*, indicates the *singleton identity* of this table in relation to its parent MetaData. Additional calls to Table with the same name, metadata, and schema name will return the same Table object.

  Names which contain no upper case characters will be treated as case insensitive names, and will not be quoted unless they are a reserved word. Names with any number of upper case characters will be quoted and sent exactly. Note that this behavior applies even for databases which standardize upper case names as case insensitive such as Oracle.

- **metadata** – a `MetaData` object which will contain this table. The metadata is used as a point of association of this table with other tables which are referenced via foreign key. It also may be used to associate this table with a particular `Connectable`.
- ***args** – Additional positional arguments are used primarily to add the list of `Column` objects contained within this table. Similar to the style of a CREATE TABLE statement, other `SchemaItem` constructs may be added here, including `PrimaryKeyConstraint`, and `ForeignKeyConstraint`.
- **autoload** – Defaults to False: the Columns for this table should be reflected from the database. Usually there will be no Column objects in the constructor if this property is set.
- **autoload_replace** – If `True`, when using `autoload=True` and `extend_existing=True`, replace `Column` objects already present in the `Table` that's in the `MetaData` registry with what's reflected. Otherwise, all existing columns will be excluded from the reflection process. Note that this does not impact `Column` objects specified in the same call to `Table` which includes `autoload`, those always take precedence. Defaults to `True`.

  New in version 0.7.5.
- **autoload_with** – If autoload==True, this is an optional Engine or Connection instance to be used for the table reflection. If `None`, the underlying MetaData's bound connectable will be used.
- **extend_existing** – When `True`, indicates that if this `Table` is already present in the given `MetaData`, apply further arguments within the constructor to the existing `Table`.

  If `extend_existing` or `keep_existing` are not set, an error is raised if additional table modifiers are specified when the given `Table` is already present in the `MetaData`.

  Changed in version 0.7.4: `extend_existing` will work in conjunction with `autoload=True` to run a new reflection operation against the database; new `Column` objects will be produced from database metadata to replace those existing with the same name, and additional `Column` objects not present in the `Table` will be added.

  As is always the case with `autoload=True`, `Column` objects can be specified in the same `Table` constructor, which will take precedence. I.e.:

```
Table("mytable", metadata,
            Column('y', Integer),
            extend_existing=True,
            autoload=True,
            autoload_with=engine
        )
```

  The above will overwrite all columns within `mytable` which are present in the database, except for `y` which will be used as is from the above definition. If the `autoload_replace` flag is set to False, no existing columns will be replaced.
- **implicit_returning** – True by default - indicates that RETURNING can be used by default to fetch newly inserted primary key values, for backends which support this. Note that create_engine() also provides an implicit_returning flag.
- **include_columns** – A list of strings indicating a subset of columns to be loaded via the `autoload` operation; table columns who aren't present in this list will not be represented on the resulting `Table` object. Defaults to `None` which indicates all columns should be reflected.

- **info** – A dictionary which defaults to `{}`. A space to store application specific data. This must be a dictionary.
- **keep_existing** – When `True`, indicates that if this Table is already present in the given `MetaData`, ignore further arguments within the constructor to the existing `Table`, and return the `Table` object as originally created. This is to allow a function that wishes to define a new `Table` on first call, but on subsequent calls will return the same `Table`, without any of the declarations (particularly constraints) being applied a second time. Also see extend_existing.

  If extend_existing or keep_existing are not set, an error is raised if additional table modifiers are specified when the given `Table` is already present in the `MetaData`.
- **listeners** – A list of tuples of the form `(<eventname>, <fn>)` which will be passed to `event.listen()` upon construction. This alternate hook to `event.listen()` allows the establishment of a listener function specific to this `Table` before the "autoload" process begins. Particularly useful for the `events.column_reflect()` event:

```
def listen_for_reflect(table, column_info):
    "handle the column reflection event"
    # ...

t = Table(
    'sometable',
    autoload=True,
    listeners=[
        ('column_reflect', listen_for_reflect)
    ])
```

- **mustexist** – When `True`, indicates that this Table must already be present in the given `MetaData` ` collection, else an exception is raised.
- **prefixes** – A list of strings to insert after CREATE in the CREATE TABLE statement. They will be separated by spaces.
- **quote** – Force quoting of this table's name on or off, corresponding to `True` or `False`. When left at its default of `None`, the column identifier will be quoted according to whether the name is case sensitive (identifiers with at least one upper case character are treated as case sensitive), or if it's a reserved word. This flag is only needed to force quoting of a reserved word which is not known by the SQLAlchemy dialect.
- **quote_schema** – same as 'quote' but applies to the schema identifier.
- **schema** – The *schema name* for this table, which is required if the table resides in a schema other than the default selected schema for the engine's database connection. Defaults to `None`.
- **useexisting** – Deprecated. Use extend_existing.

__init__(**args*, ***kw*)
Constructor for `Table`.

This method is a no-op. See the top-level documentation for `Table` for constructor arguments.

add_is_dependent_on(*table*)
Add a 'dependency' for this Table.

This is another Table object which must be created first before this one can, or dropped after this one.

Usually, dependencies between tables are determined via ForeignKey objects. However, for other situations that create dependencies outside of foreign keys (rules, inheriting), this method can manually establish such a link.

append_column(*column*)
Append a `Column` to this `Table`.

The "key" of the newly added `Column`, i.e. the value of its `.key` attribute, will then be available in the `.c` collection of this `Table`, and the column definition will be included in any CREATE TABLE, SELECT, UPDATE, etc. statements generated from this `Table` construct.

Note that this does **not** change the definition of the table as it exists within any underlying database, assuming that table has already been created in the database. Relational databases support the addition of columns to existing tables using the SQL ALTER command, which would need to be emitted for an already-existing table that doesn't contain the newly added column.

append_constraint(*constraint*)
Append a `Constraint` to this `Table`.

This has the effect of the constraint being included in any future CREATE TABLE statement, assuming specific DDL creation events have not been associated with the given `Constraint` object.

Note that this does **not** produce the constraint within the relational database automatically, for a table that already exists in the database. To add a constraint to an existing relational database table, the SQL ALTER command must be used. SQLAlchemy also provides the `AddConstraint` construct which can produce this SQL when invoked as an executable clause.

append_ddl_listener(*event_name*, *listener*)
Append a DDL event listener to this `Table`.

Deprecated. See `DDLEvents`.

bind
Return the connectable associated with this Table.

create(*bind=None*, *checkfirst=False*)
Issue a `CREATE` statement for this `Table`, using the given `Connectable` for connectivity.

See also `MetaData.create_all()`.

drop(*bind=None*, *checkfirst=False*)
Issue a `DROP` statement for this `Table`, using the given `Connectable` for connectivity.

See also `MetaData.drop_all()`.

exists(*bind=None*)
Return True if this table exists.

get_children(*column_collections=True*, *schema_visitor=False*, ***kw*)

key

tometadata(*metadata*, *schema=<symbol 'retain_schema'>*)
Return a copy of this `Table` associated with a different `MetaData`.

E.g.:

```
# create two metadata
meta1 = MetaData('sqlite:///querytest.db')
meta2 = MetaData()

# load 'users' from the sqlite engine
users_table = Table('users', meta1, autoload=True)
```

```
    # create the same Table object for the plain metadata
    users_table_2 = users_table.tometadata(meta2)
```

class sqlalchemy.schema.**ThreadLocalMetaData**

Bases: sqlalchemy.schema.MetaData

A MetaData variant that presents a different `bind` in every thread.

Makes the `bind` property of the MetaData a thread-local value, allowing this collection of tables to be bound to different `Engine` implementations or connections in each thread.

The ThreadLocalMetaData starts off bound to None in each thread. Binds must be made explicitly by assigning to the `bind` property or using `connect()`. You can also re-bind dynamically multiple times per thread, just like a regular `MetaData`.

__init__()

Construct a ThreadLocalMetaData.

bind

The bound Engine or Connection for this thread.

This property may be assigned an Engine or Connection, or assigned a string or URL to automatically create a basic Engine for this bind with `create_engine()`.

dispose()

Dispose all bound engines, in all thread contexts.

is_bound()

True if there is a bind for this thread.

3.6.2 Reflecting Database Objects

A `Table` object can be instructed to load information about itself from the corresponding database schema object already existing within the database. This process is called *reflection*. In the most simple case you need only specify the table name, a `MetaData` object, and the `autoload=True` flag. If the `MetaData` is not persistently bound, also add the `autoload_with` argument:

```
>>> messages = Table('messages', meta, autoload=True, autoload_with=engine)
>>> [c.name for c in messages.columns]
['message_id', 'message_name', 'date']
```

The above operation will use the given engine to query the database for information about the `messages` table, and will then generate `Column`, `ForeignKey`, and other objects corresponding to this information as though the `Table` object were hand-constructed in Python.

When tables are reflected, if a given table references another one via foreign key, a second `Table` object is created within the `MetaData` object representing the connection. Below, assume the table `shopping_cart_items` references a table named `shopping_carts`. Reflecting the `shopping_cart_items` table has the effect such that the `shopping_carts` table will also be loaded:

```
>>> shopping_cart_items = Table('shopping_cart_items', meta, autoload=True, autoload_with=engine)
>>> 'shopping_carts' in meta.tables:
True
```

The `MetaData` has an interesting "singleton-like" behavior such that if you requested both tables individually, `MetaData` will ensure that exactly one `Table` object is created for each distinct table name. The `Table` constructor actually returns to you the already-existing `Table` object if one already exists with the given name. Such as below, we can access the already generated `shopping_carts` table just by naming it:

```
shopping_carts = Table('shopping_carts', meta)
```

Of course, it's a good idea to use `autoload=True` with the above table regardless. This is so that the table's attributes will be loaded if they have not been already. The autoload operation only occurs for the table if it hasn't already been loaded; once loaded, new calls to `Table` with the same name will not re-issue any reflection queries.

Overriding Reflected Columns

Individual columns can be overridden with explicit values when reflecting tables; this is handy for specifying custom datatypes, constraints such as primary keys that may not be configured within the database, etc.:

```
>>> mytable = Table('mytable', meta,
... Column('id', Integer, primary_key=True),   # override reflected 'id' to have primary key
... Column('mydata', Unicode(50)),    # override reflected 'mydata' to be Unicode
... autoload=True)
```

Reflecting Views

The reflection system can also reflect views. Basic usage is the same as that of a table:

```
my_view = Table("some_view", metadata, autoload=True)
```

Above, `my_view` is a `Table` object with `Column` objects representing the names and types of each column within the view "some_view".

Usually, it's desired to have at least a primary key constraint when reflecting a view, if not foreign keys as well. View reflection doesn't extrapolate these constraints.

Use the "override" technique for this, specifying explicitly those columns which are part of the primary key or have foreign key constraints:

```
my_view = Table("some_view", metadata,
                Column("view_id", Integer, primary_key=True),
                Column("related_thing", Integer, ForeignKey("othertable.thing_id")),
                autoload=True
)
```

Reflecting All Tables at Once

The `MetaData` object can also get a listing of tables and reflect the full set. This is achieved by using the `reflect()` method. After calling it, all located tables are present within the `MetaData` object's dictionary of tables:

```
meta = MetaData()
meta.reflect(bind=someengine)
users_table = meta.tables['users']
addresses_table = meta.tables['addresses']
```

`metadata.reflect()` also provides a handy way to clear or delete all the rows in a database:

```
meta = MetaData()
meta.reflect(bind=someengine)
for table in reversed(meta.sorted_tables):
    someengine.execute(table.delete())
```

Fine Grained Reflection with Inspector

A low level interface which provides a backend-agnostic system of loading lists of schema, table, column, and constraint descriptions from a given database is also available. This is known as the "Inspector":

```
from sqlalchemy import create_engine
from sqlalchemy.engine import reflection
engine = create_engine('...')
insp = reflection.Inspector.from_engine(engine)
print insp.get_table_names()
```

class sqlalchemy.engine.reflection.**Inspector**(*bind*)
Bases: object

Performs database schema inspection.

The Inspector acts as a proxy to the reflection methods of the Dialect, providing a consistent interface as well as caching support for previously fetched metadata.

The preferred method to construct an Inspector is via the Inspector.from_engine() method. I.e.:

```
engine = create_engine('...')
insp = Inspector.from_engine(engine)
```

Where above, the Dialect may opt to return an Inspector subclass that provides additional methods specific to the dialect's target database.

__init__(*bind*)
Initialize a new Inspector.

Parameters bind – a Connectable, which is typically an instance of Engine or Connection.

For a dialect-specific instance of Inspector, see Inspector.from_engine()

default_schema_name
Return the default schema name presented by the dialect for the current engine's database user.

E.g. this is typically public for Postgresql and dbo for SQL Server.

classmethod from_engine(*bind*)
Construct a new dialect-specific Inspector object from the given engine or connection.

Parameters bind – a Connectable, which is typically an instance of Engine or Connection.

This method differs from direct a direct constructor call of Inspector in that the Dialect is given a chance to provide a dialect-specific Inspector instance, which may provide additional methods.

See the example at Inspector.

get_columns(*table_name*, *schema=None*, ***kw*)
Return information about columns in *table_name*.

Given a string *table_name* and an optional string *schema*, return column information as a list of dicts with these keys:

name the column's name

type TypeEngine

nullable boolean

default the column's default value

attrs dict containing optional column attributes

get_foreign_keys(*table_name*, *schema=None*, ***kw*)
Return information about foreign_keys in *table_name*.

Given a string *table_name*, and an optional string *schema*, return foreign key information as a list of dicts with these keys:

constrained_columns a list of column names that make up the foreign key

referred_schema the name of the referred schema

referred_table the name of the referred table

referred_columns a list of column names in the referred table that correspond to constrained_columns

name optional name of the foreign key constraint.

****kw** other options passed to the dialect's get_foreign_keys() method.

get_indexes(*table_name*, *schema=None*, ***kw*)
Return information about indexes in *table_name*.

Given a string *table_name* and an optional string *schema*, return index information as a list of dicts with these keys:

name the index's name

column_names list of column names in order

unique boolean

****kw** other options passed to the dialect's get_indexes() method.

get_pk_constraint(*table_name*, *schema=None*, ***kw*)
Return information about primary key constraint on *table_name*.

Given a string *table_name*, and an optional string *schema*, return primary key information as a dictionary with these keys:

constrained_columns a list of column names that make up the primary key

name optional name of the primary key constraint.

get_primary_keys(*table_name*, *schema=None*, ***kw*)
Return information about primary keys in *table_name*.

Given a string *table_name*, and an optional string *schema*, return primary key information as a list of column names.

get_schema_names()
Return all schema names.

get_table_names(*schema=None*, *order_by=None*)
Return all table names in *schema*.

Parameters

- **schema** – Optional, retrieve names from a non-default schema.
- **order_by** – Optional, may be the string "foreign_key" to sort the result on foreign key dependencies.

This should probably not return view names or maybe it should return them with an indicator t or v.

get_table_options(*table_name*, *schema=None*, ***kw*)
Return a dictionary of options specified when the table of the given name was created.

This currently includes some options that apply to MySQL tables.

get_view_definition(*view_name*, *schema=None*)
Return definition for *view_name*.

Parameters **schema** – Optional, retrieve names from a non-default schema.

get_view_names(*schema=None*)
Return all view names in *schema*.

Parameters **schema** – Optional, retrieve names from a non-default schema.

reflecttable(*table*, *include_columns*, *exclude_columns=()*)
Given a Table object, load its internal constructs based on introspection.

This is the underlying method used by most dialects to produce table reflection. Direct usage is like:

```
from sqlalchemy import create_engine, MetaData, Table
from sqlalchemy.engine import reflection

engine = create_engine('...')
meta = MetaData()
user_table = Table('user', meta)
insp = Inspector.from_engine(engine)
insp.reflecttable(user_table, None)
```

Parameters

- **table** – a `Table` instance.
- **include_columns** – a list of string column names to include in the reflection process. If `None`, all columns are reflected.

3.6.3 Column Insert/Update Defaults

SQLAlchemy provides a very rich featureset regarding column level events which take place during INSERT and UPDATE statements. Options include:

- Scalar values used as defaults during INSERT and UPDATE operations
- Python functions which execute upon INSERT and UPDATE operations
- SQL expressions which are embedded in INSERT statements (or in some cases execute beforehand)
- SQL expressions which are embedded in UPDATE statements
- Server side default values used during INSERT
- Markers for server-side triggers used during UPDATE

The general rule for all insert/update defaults is that they only take effect if no value for a particular column is passed as an `execute()` parameter; otherwise, the given value is used.

Scalar Defaults

The simplest kind of default is a scalar value used as the default value of a column:

```
Table("mytable", meta,
    Column("somecolumn", Integer, default=12)
)
```

Above, the value "12" will be bound as the column value during an INSERT if no other value is supplied.

A scalar value may also be associated with an UPDATE statement, though this is not very common (as UPDATE statements are usually looking for dynamic defaults):

```
Table("mytable", meta,
    Column("somecolumn", Integer, onupdate=25)
)
```

Python-Executed Functions

The `default` and `onupdate` keyword arguments also accept Python functions. These functions are invoked at the time of insert or update if no other value for that column is supplied, and the value returned is used for the column's value. Below illustrates a crude "sequence" that assigns an incrementing counter to a primary key column:

```
# a function which counts upwards
i = 0
def mydefault():
    global i
    i += 1
    return i

t = Table("mytable", meta,
    Column('id', Integer, primary_key=True, default=mydefault),
)
```

It should be noted that for real "incrementing sequence" behavior, the built-in capabilities of the database should normally be used, which may include sequence objects or other autoincrementing capabilities. For primary key columns, SQLAlchemy will in most cases use these capabilities automatically. See the API documentation for `Column` including the `autoincrement` flag, as well as the section on `Sequence` later in this chapter for background on standard primary key generation techniques.

To illustrate onupdate, we assign the Python `datetime` function `now` to the `onupdate` attribute:

```
import datetime

t = Table("mytable", meta,
    Column('id', Integer, primary_key=True),

    # define 'last_updated' to be populated with datetime.now()
    Column('last_updated', DateTime, onupdate=datetime.datetime.now),
)
```

When an update statement executes and no value is passed for `last_updated`, the `datetime.datetime.now()` Python function is executed and its return value used as the value for `last_updated`. Notice that we provide `now` as the function itself without calling it (i.e. there are no parenthesis following) - SQLAlchemy will execute the function at the time the statement executes.

Context-Sensitive Default Functions

The Python functions used by `default` and `onupdate` may also make use of the current statement's context in order to determine a value. The *context* of a statement is an internal SQLAlchemy object which contains all information about the statement being executed, including its source expression, the parameters associated with it and the cursor. The typical use case for this context with regards to default generation is to have access to the other values being inserted or updated on the row. To access the context, provide a function that accepts a single `context` argument:

```
def mydefault(context):
    return context.current_parameters['counter'] + 12

t = Table('mytable', meta,
    Column('counter', Integer),
    Column('counter_plus_twelve', Integer, default=mydefault, onupdate=mydefault)
)
```

Above we illustrate a default function which will execute for all INSERT and UPDATE statements where a value for `counter_plus_twelve` was otherwise not provided, and the value will be that of whatever value is present in the execution for the `counter` column, plus the number 12.

While the context object passed to the default function has many attributes, the `current_parameters` member is a special member provided only during the execution of a default function for the purposes of deriving defaults from its existing values. For a single statement that is executing many sets of bind parameters, the user-defined function is called for each set of parameters, and `current_parameters` will be provided with each individual parameter set for each execution.

SQL Expressions

The "default" and "onupdate" keywords may also be passed SQL expressions, including select statements or direct function calls:

```
t = Table("mytable", meta,
    Column('id', Integer, primary_key=True),

    # define 'create_date' to default to now()
    Column('create_date', DateTime, default=func.now()),

    # define 'key' to pull its default from the 'keyvalues' table
    Column('key', String(20), default=keyvalues.select(keyvalues.c.type='type1', limit=1)),

    # define 'last_modified' to use the current_timestamp SQL function on update
    Column('last_modified', DateTime, onupdate=func.utc_timestamp())
    )
```

Above, the `create_date` column will be populated with the result of the `now()` SQL function (which, depending on backend, compiles into `NOW()` or `CURRENT_TIMESTAMP` in most cases) during an INSERT statement, and the `key` column with the result of a SELECT subquery from another table. The `last_modified` column will be populated with the value of `UTC_TIMESTAMP()`, a function specific to MySQL, when an UPDATE statement is emitted for this table.

Note that when using `func` functions, unlike when using Python *datetime* functions we *do* call the function, i.e. with parenthesis "()" - this is because what we want in this case is the return value of the function, which is the SQL expression construct that will be rendered into the INSERT or UPDATE statement.

The above SQL functions are usually executed "inline" with the INSERT or UPDATE statement being executed, meaning, a single statement is executed which embeds the given expressions or subqueries within the VALUES or

SET clause of the statement. Although in some cases, the function is "pre-executed" in a SELECT statement of its own beforehand. This happens when all of the following is true:

- the column is a primary key column
- the database dialect does not support a usable `cursor.lastrowid` accessor (or equivalent); this currently includes PostgreSQL, Oracle, and Firebird, as well as some MySQL dialects.
- the dialect does not support the "RETURNING" clause or similar, or the `implicit_returning` flag is set to `False` for the dialect. Dialects which support RETURNING currently include Postgresql, Oracle, Firebird, and MS-SQL.
- the statement is a single execution, i.e. only supplies one set of parameters and doesn't use "executemany" behavior
- the `inline=True` flag is not set on the `Insert()` or `Update()` construct, and the statement has not defined an explicit *returning()* clause.

Whether or not the default generation clause "pre-executes" is not something that normally needs to be considered, unless it is being addressed for performance reasons.

When the statement is executed with a single set of parameters (that is, it is not an "executemany" style execution), the returned `ResultProxy` will contain a collection accessible via `result.postfetch_cols()` which contains a list of all `Column` objects which had an inline-executed default. Similarly, all parameters which were bound to the statement, including all Python and SQL expressions which were pre-executed, are present in the `last_inserted_params()` or `last_updated_params()` collections on `ResultProxy`. The `inserted_primary_key` collection contains a list of primary key values for the row inserted (a list so that single-column and composite-column primary keys are represented in the same format).

Server Side Defaults

A variant on the SQL expression default is the `server_default`, which gets placed in the CREATE TABLE statement during a `create()` operation:

```
t = Table('test', meta,
    Column('abc', String(20), server_default='abc'),
    Column('created_at', DateTime, server_default=text("sysdate"))
)
```

A create call for the above table will produce:

```
CREATE TABLE test (
    abc varchar(20) default 'abc',
    created_at datetime default sysdate
)
```

The behavior of `server_default` is similar to that of a regular SQL default; if it's placed on a primary key column for a database which doesn't have a way to "postfetch" the ID, and the statement is not "inlined", the SQL expression is pre-executed; otherwise, SQLAlchemy lets the default fire off on the database side normally.

Triggered Columns

Columns with values set by a database trigger or other external process may be called out with a marker:

```
t = Table('test', meta,
    Column('abc', String(20), server_default=FetchedValue()),
    Column('def', String(20), server_onupdate=FetchedValue())
)
```

Changed in version 0.8.0b2,0.7.10: The `for_update` argument on `FetchedValue` is set automatically when specified as the `server_onupdate` argument. If using an older version, specify the onupdate above as `server_onupdate=FetchedValue(for_update=True)`.

These markers do not emit a "default" clause when the table is created, however they do set the same internal flags as a static `server_default` clause, providing hints to higher-level tools that a "post-fetch" of these rows should be performed after an insert or update.

Defining Sequences

SQLAlchemy represents database sequences using the `Sequence` object, which is considered to be a special case of "column default". It only has an effect on databases which have explicit support for sequences, which currently includes Postgresql, Oracle, and Firebird. The `Sequence` object is otherwise ignored.

The `Sequence` may be placed on any column as a "default" generator to be used during INSERT operations, and can also be configured to fire off during UPDATE operations if desired. It is most commonly used in conjunction with a single integer primary key column:

```
table = Table("cartitems", meta,
    Column("cart_id", Integer, Sequence('cart_id_seq'), primary_key=True),
    Column("description", String(40)),
    Column("createdate", DateTime())
)
```

Where above, the table "cartitems" is associated with a sequence named "cart_id_seq". When INSERT statements take place for "cartitems", and no value is passed for the "cart_id" column, the "cart_id_seq" sequence will be used to generate a value.

When the `Sequence` is associated with a table, CREATE and DROP statements issued for that table will also issue CREATE/DROP for the sequence object as well, thus "bundling" the sequence object with its parent table.

The `Sequence` object also implements special functionality to accommodate Postgresql's SERIAL datatype. The SERIAL type in PG automatically generates a sequence that is used implicitly during inserts. This means that if a `Table` object defines a `Sequence` on its primary key column so that it works with Oracle and Firebird, the `Sequence` would get in the way of the "implicit" sequence that PG would normally use. For this use case, add the flag `optional=True` to the `Sequence` object - this indicates that the `Sequence` should only be used if the database provides no other option for generating primary key identifiers.

The `Sequence` object also has the ability to be executed standalone like a SQL expression, which has the effect of calling its "next value" function:

```
seq = Sequence('some_sequence')
nextid = connection.execute(seq)
```

Default Objects API

class `sqlalchemy.schema.`**`ColumnDefault`**(*arg*, ***kwargs*)

Bases: `sqlalchemy.schema.DefaultGenerator`

A plain default value on a column.

This could correspond to a constant, a callable function, or a SQL clause.

`ColumnDefault` is generated automatically whenever the `default`, `onupdate` arguments of `Column` are used. A `ColumnDefault` can be passed positionally as well.

For example, the following:

```
Column('foo', Integer, default=50)
```

Is equivalent to:

```
Column('foo', Integer, ColumnDefault(50))
```

class sqlalchemy.schema.**DefaultClause**(*arg*, *for_update=False*, *_reflected=False*)
Bases: `sqlalchemy.schema.FetchedValue`

A DDL-specified DEFAULT column value.

`DefaultClause` is a `FetchedValue` that also generates a "DEFAULT" clause when "CREATE TABLE" is emitted.

`DefaultClause` is generated automatically whenever the `server_default`, `server_onupdate` arguments of `Column` are used. A `DefaultClause` can be passed positionally as well.

For example, the following:

```
Column('foo', Integer, server_default="50")
```

Is equivalent to:

```
Column('foo', Integer, DefaultClause("50"))
```

class sqlalchemy.schema.**DefaultGenerator**(*for_update=False*)
Bases: `sqlalchemy.schema._NotAColumnExpr`, `sqlalchemy.schema.SchemaItem`

Base class for column *default* values.

class sqlalchemy.schema.**FetchedValue**(*for_update=False*)
Bases: `sqlalchemy.schema._NotAColumnExpr`, `sqlalchemy.events.SchemaEventTarget`

A marker for a transparent database-side default.

Use `FetchedValue` when the database is configured to provide some automatic default for a column.

E.g.:

```
Column('foo', Integer, FetchedValue())
```

Would indicate that some trigger or default generator will create a new value for the `foo` column during an INSERT.

class sqlalchemy.schema.**PassiveDefault**(**arg*, ***kw*)
Bases: `sqlalchemy.schema.DefaultClause`

A DDL-specified DEFAULT column value.

Deprecated since version 0.6: `PassiveDefault` is deprecated. Use `DefaultClause`.

class sqlalchemy.schema.**Sequence**(*name*, *start=None*, *increment=None*, *schema=None*, *optional=False*, *quote=None*, *metadata=None*, *quote_schema=None*, *for_update=False*)
Bases: `sqlalchemy.schema.DefaultGenerator`

Represents a named database sequence.

The Sequence object represents the name and configurational parameters of a database sequence. It also represents a construct that can be "executed" by a SQLAlchemy Engine or Connection, rendering the appropriate "next value" function for the target database and returning a result.

The Sequence is typically associated with a primary key column:

```
some_table = Table('some_table', metadata,
    Column('id', Integer, Sequence('some_table_seq'), primary_key=True)
)
```

When CREATE TABLE is emitted for the above Table, if the target platform supports sequences, a CREATE SEQUENCE statement will be emitted as well. For platforms that don't support sequences, the Sequence construct is ignored.

See also: CreateSequence DropSequence

__init__(*name*, *start=None*, *increment=None*, *schema=None*, *optional=False*, *quote=None*, *metadata=None*, *quote_schema=None*, *for_update=False*)

Construct a Sequence object.

Parameters

- **name** – The name of the sequence.
- **start** – the starting index of the sequence. This value is used when the CREATE SEQUENCE command is emitted to the database as the value of the "START WITH" clause. If None, the clause is omitted, which on most platforms indicates a starting value of 1.
- **increment** – the increment value of the sequence. This value is used when the CREATE SEQUENCE command is emitted to the database as the value of the "INCREMENT BY" clause. If None, the clause is omitted, which on most platforms indicates an increment of 1.
- **schema** – Optional schema name for the sequence, if located in a schema other than the default.
- **optional** – boolean value, when True, indicates that this Sequence object only needs to be explicitly generated on backends that don't provide another way to generate primary key identifiers. Currently, it essentially means, "don't create this sequence on the Postgresql backend, where the SERIAL keyword creates a sequence for us automatically".
- **quote** – boolean value, when True or False, explicitly forces quoting of the schema name on or off. When left at its default of None, normal quoting rules based on casing and reserved words take place.
- **metadata** – optional MetaData object which will be associated with this Sequence. A Sequence that is associated with a MetaData gains access to the bind of that MetaData, meaning the Sequence.create() and Sequence.drop() methods will make usage of that engine automatically.

  Changed in version 0.7: Additionally, the appropriate CREATE SEQUENCE/ DROP SEQUENCE DDL commands will be emitted corresponding to this Sequence when MetaData.create_all() and MetaData.drop_all() are invoked.

  Note that when a Sequence is applied to a Column, the Sequence is automatically associated with the MetaData object of that column's parent Table, when that association is made. The Sequence will then be subject to automatic CREATE SEQUENCE/DROP SEQUENCE corresponding to when the Table object itself is created or dropped, rather than that of the MetaData object overall.

- **for_update** – Indicates this `Sequence`, when associated with a `Column`, should be invoked for UPDATE statements on that column's table, rather than for INSERT statements, when no value is otherwise present for that column in the statement.

create(*bind=None*, *checkfirst=True*)
Creates this sequence in the database.

drop(*bind=None*, *checkfirst=True*)
Drops this sequence from the database.

next_value()
Return a `next_value` function element which will render the appropriate increment function for this `Sequence` within any SQL expression.

3.6.4 Defining Constraints and Indexes

Defining Foreign Keys

A *foreign key* in SQL is a table-level construct that constrains one or more columns in that table to only allow values that are present in a different set of columns, typically but not always located on a different table. We call the columns which are constrained the *foreign key* columns and the columns which they are constrained towards the *referenced* columns. The referenced columns almost always define the primary key for their owning table, though there are exceptions to this. The foreign key is the "joint" that connects together pairs of rows which have a relationship with each other, and SQLAlchemy assigns very deep importance to this concept in virtually every area of its operation.

In SQLAlchemy as well as in DDL, foreign key constraints can be defined as additional attributes within the table clause, or for single-column foreign keys they may optionally be specified within the definition of a single column. The single column foreign key is more common, and at the column level is specified by constructing a `ForeignKey` object as an argument to a `Column` object:

```
user_preference = Table('user_preference', metadata,
    Column('pref_id', Integer, primary_key=True),
    Column('user_id', Integer, ForeignKey("user.user_id"), nullable=False),
    Column('pref_name', String(40), nullable=False),
    Column('pref_value', String(100))
)
```

Above, we define a new table `user_preference` for which each row must contain a value in the `user_id` column that also exists in the `user` table's `user_id` column.

The argument to `ForeignKey` is most commonly a string of the form *<tablename>.<columnname>*, or for a table in a remote schema or "owner" of the form *<schemaname>.<tablename>.<columnname>*. It may also be an actual `Column` object, which as we'll see later is accessed from an existing `Table` object via its `c` collection:

```
ForeignKey(user.c.user_id)
```

The advantage to using a string is that the in-python linkage between `user` and `user_preference` is resolved only when first needed, so that table objects can be easily spread across multiple modules and defined in any order.

Foreign keys may also be defined at the table level, using the `ForeignKeyConstraint` object. This object can describe a single- or multi-column foreign key. A multi-column foreign key is known as a *composite* foreign key, and almost always references a table that has a composite primary key. Below we define a table `invoice` which has a composite primary key:

```
invoice = Table('invoice', metadata,
    Column('invoice_id', Integer, primary_key=True),
    Column('ref_num', Integer, primary_key=True),
    Column('description', String(60), nullable=False)
)
```

And then a table `invoice_item` with a composite foreign key referencing `invoice`:

```
invoice_item = Table('invoice_item', metadata,
    Column('item_id', Integer, primary_key=True),
    Column('item_name', String(60), nullable=False),
    Column('invoice_id', Integer, nullable=False),
    Column('ref_num', Integer, nullable=False),
    ForeignKeyConstraint(['invoice_id', 'ref_num'], ['invoice.invoice_id', 'invoice.ref_num'])
)
```

It's important to note that the `ForeignKeyConstraint` is the only way to define a composite foreign key. While we could also have placed individual `ForeignKey` objects on both the `invoice_item.invoice_id` and `invoice_item.ref_num` columns, SQLAlchemy would not be aware that these two values should be paired together - it would be two individual foreign key constraints instead of a single composite foreign key referencing two columns.

Creating/Dropping Foreign Key Constraints via ALTER

In all the above examples, the `ForeignKey` object causes the "REFERENCES" keyword to be added inline to a column definition within a "CREATE TABLE" statement when `create_all()` is issued, and `ForeignKeyConstraint` invokes the "CONSTRAINT" keyword inline with "CREATE TABLE". There are some cases where this is undesireable, particularly when two tables reference each other mutually, each with a foreign key referencing the other. In such a situation at least one of the foreign key constraints must be generated after both tables have been built. To support such a scheme, `ForeignKey` and `ForeignKeyConstraint` offer the flag `use_alter=True`. When using this flag, the constraint will be generated using a definition similar to "ALTER TABLE <tablename> ADD CONSTRAINT <name> ...". Since a name is required, the `name` attribute must also be specified. For example:

```
node = Table('node', meta,
    Column('node_id', Integer, primary_key=True),
    Column('primary_element', Integer,
        ForeignKey('element.element_id', use_alter=True, name='fk_node_element_id')
    )
)

element = Table('element', meta,
    Column('element_id', Integer, primary_key=True),
    Column('parent_node_id', Integer),
    ForeignKeyConstraint(
        ['parent_node_id'],
        ['node.node_id'],
        use_alter=True,
        name='fk_element_parent_node_id'
    )
)
```

ON UPDATE and ON DELETE

Most databases support *cascading* of foreign key values, that is the when a parent row is updated the new value is placed in child rows, or when the parent row is deleted all corresponding child rows are set to null or deleted. In data definition language these are specified using phrases like "ON UPDATE CASCADE", "ON DELETE CASCADE", and "ON DELETE SET NULL", corresponding to foreign key constraints. The phrase after "ON UPDATE" or "ON DELETE" may also other allow other phrases that are specific to the database in use. The `ForeignKey` and `ForeignKeyConstraint` objects support the generation of this clause via the `onupdate` and `ondelete` keyword arguments. The value is any string which will be output after the appropriate "ON UPDATE" or "ON DELETE" phrase:

```
child = Table('child', meta,
    Column('id', Integer,
            ForeignKey('parent.id', onupdate="CASCADE", ondelete="CASCADE"),
            primary_key=True
    )
)

composite = Table('composite', meta,
    Column('id', Integer, primary_key=True),
    Column('rev_id', Integer),
    Column('note_id', Integer),
    ForeignKeyConstraint(
                ['rev_id', 'note_id'],
                ['revisions.id', 'revisions.note_id'],
                onupdate="CASCADE", ondelete="SET NULL"
    )
)
```

Note that these clauses are not supported on SQLite, and require `InnoDB` tables when used with MySQL. They may also not be supported on other databases.

UNIQUE Constraint

Unique constraints can be created anonymously on a single column using the `unique` keyword on `Column`. Explicitly named unique constraints and/or those with multiple columns are created via the `UniqueConstraint` table-level construct.

```
meta = MetaData()
mytable = Table('mytable', meta,

    # per-column anonymous unique constraint
    Column('col1', Integer, unique=True),

    Column('col2', Integer),
    Column('col3', Integer),

    # explicit/composite unique constraint.  'name' is optional.
    UniqueConstraint('col2', 'col3', name='uix_1')
    )
```

CHECK Constraint

Check constraints can be named or unnamed and can be created at the Column or Table level, using the `CheckConstraint` construct. The text of the check constraint is passed directly through to the database, so there is limited "database independent" behavior. Column level check constraints generally should only refer to the column to which they are placed, while table level constraints can refer to any columns in the table.

Note that some databases do not actively support check constraints such as MySQL.

```
meta = MetaData()
mytable = Table('mytable', meta,

    # per-column CHECK constraint
    Column('col1', Integer, CheckConstraint('col1>5')),

    Column('col2', Integer),
    Column('col3', Integer),

    # table level CHECK constraint.  'name' is optional.
    CheckConstraint('col2 > col3 + 5', name='check1')
    )

mytable.create(engine)
CREATE TABLE mytable (
    col1 INTEGER  CHECK (col1>5),
    col2 INTEGER,
    col3 INTEGER,
    CONSTRAINT check1  CHECK (col2 > col3 + 5)
)
```

Setting up Constraints when using the Declarative ORM Extension

The `Table` is the SQLAlchemy Core construct that allows one to define table metadata, which among other things can be used by the SQLAlchemy ORM as a target to map a class. The *Declarative* extension allows the `Table` object to be created automatically, given the contents of the table primarily as a mapping of `Column` objects.

To apply table-level constraint objects such as `ForeignKeyConstraint` to a table defined using Declarative, use the `__table_args__` attribute, described at *Table Configuration*.

Constraints API

class sqlalchemy.schema.**Constraint**(*name=None*, *deferrable=None*, *initially=None*, *_create_rule=None*, ***kw*)

Bases: `sqlalchemy.schema.SchemaItem`

A table-level SQL constraint.

class sqlalchemy.schema.**CheckConstraint**(*sqltext*, *name=None*, *deferrable=None*, *initially=None*, *table=None*, *_create_rule=None*)

Bases: `sqlalchemy.schema.Constraint`

A table- or column-level CHECK constraint.

Can be included in the definition of a Table or Column.

class sqlalchemy.schema.**ColumnCollectionConstraint**(**columns*, ***kw*)

Bases: `sqlalchemy.schema.ColumnCollectionMixin`, `sqlalchemy.schema.Constraint`

A constraint that proxies a ColumnCollection.

class sqlalchemy.schema.**ForeignKey**(*column*, *_constraint=None*, *use_alter=False*, *name=None*, *onupdate=None*, *ondelete=None*, *deferrable=None*, *schema=None*, *initially=None*, *link_to_name=False*)

Bases: sqlalchemy.schema.SchemaItem

Defines a dependency between two columns.

ForeignKey is specified as an argument to a Column object, e.g.:

```
t = Table("remote_table", metadata,
    Column("remote_id", ForeignKey("main_table.id"))
)
```

Note that ForeignKey is only a marker object that defines a dependency between two columns. The actual constraint is in all cases represented by the ForeignKeyConstraint object. This object will be generated automatically when a ForeignKey is associated with a Column which in turn is associated with a Table. Conversely, when ForeignKeyConstraint is applied to a Table, ForeignKey markers are automatically generated to be present on each associated Column, which are also associated with the constraint object.

Note that you cannot define a "composite" foreign key constraint, that is a constraint between a grouping of multiple parent/child columns, using ForeignKey objects. To define this grouping, the ForeignKeyConstraint object must be used, and applied to the Table. The associated ForeignKey objects are created automatically.

The ForeignKey objects associated with an individual Column object are available in the *foreign_keys* collection of that column.

Further examples of foreign key configuration are in *Defining Foreign Keys*.

__init__(*column*, *_constraint=None*, *use_alter=False*, *name=None*, *onupdate=None*, *ondelete=None*, *deferrable=None*, *schema=None*, *initially=None*, *link_to_name=False*)

Construct a column-level FOREIGN KEY.

The ForeignKey object when constructed generates a ForeignKeyConstraint which is associated with the parent Table object's collection of constraints.

Parameters

- **column** – A single target column for the key relationship. A Column object or a column name as a string: tablename.columnkey or schema.tablename.columnkey. columnkey is the key which has been assigned to the column (defaults to the column name itself), unless link_to_name is True in which case the rendered name of the column is used.

  New in version 0.7.4: Note that if the schema name is not included, and the underlying MetaData has a "schema", that value will be used.

- **name** – Optional string. An in-database name for the key if *constraint* is not provided.
- **onupdate** – Optional string. If set, emit ON UPDATE <value> when issuing DDL for this constraint. Typical values include CASCADE, DELETE and RESTRICT.
- **ondelete** – Optional string. If set, emit ON DELETE <value> when issuing DDL for this constraint. Typical values include CASCADE, DELETE and RESTRICT.
- **deferrable** – Optional bool. If set, emit DEFERRABLE or NOT DEFERRABLE when issuing DDL for this constraint.
- **initially** – Optional string. If set, emit INITIALLY <value> when issuing DDL for this constraint.

- **link_to_name** – if True, the string name given in `column` is the rendered name of the referenced column, not its locally assigned `key`.
- **use_alter** – passed to the underlying `ForeignKeyConstraint` to indicate the constraint should be generated/dropped externally from the CREATE TABLE/ DROP TABLE statement. See that classes' constructor for details.

column
Return the target `Column` referenced by this `ForeignKey`.

If this `ForeignKey` was created using a string-based target column specification, this attribute will on first access initiate a resolution process to locate the referenced remote `Column`. The resolution process traverses to the parent `Column`, `Table`, and `MetaData` to proceed - if any of these aren't yet present, an error is raised.

copy(*schema=None*)
Produce a copy of this `ForeignKey` object.

The new `ForeignKey` will not be bound to any `Column`.

This method is usually used by the internal copy procedures of `Column`, `Table`, and `MetaData`.

Parameters **schema** – The returned `ForeignKey` will reference the original table and column name, qualified by the given string schema name.

get_referent(*table*)
Return the `Column` in the given `Table` referenced by this `ForeignKey`.

Returns None if this `ForeignKey` does not reference the given `Table`.

references(*table*)
Return True if the given `Table` is referenced by this `ForeignKey`.

target_fullname
Return a string based 'column specification' for this `ForeignKey`.

This is usually the equivalent of the string-based "tablename.colname" argument first passed to the object's constructor.

class sqlalchemy.schema.**ForeignKeyConstraint**(*columns*, *refcolumns*, *name=None*, *onupdate=None*, *ondelete=None*, *deferrable=None*, *initially=None*, *use_alter=False*, *link_to_name=False*, *table=None*)
Bases: `sqlalchemy.schema.Constraint`

A table-level FOREIGN KEY constraint.

Defines a single column or composite FOREIGN KEY ... REFERENCES constraint. For a no-frills, single column foreign key, adding a `ForeignKey` to the definition of a `Column` is a shorthand equivalent for an unnamed, single column `ForeignKeyConstraint`.

Examples of foreign key configuration are in *Defining Foreign Keys*.

__init__(*columns*, *refcolumns*, *name=None*, *onupdate=None*, *ondelete=None*, *deferrable=None*, *initially=None*, *use_alter=False*, *link_to_name=False*, *table=None*)
Construct a composite-capable FOREIGN KEY.

Parameters

- **columns** – A sequence of local column names. The named columns must be defined and present in the parent Table. The names should match the `key` given to each column (defaults to the name) unless `link_to_name` is True.

- **refcolumns** – A sequence of foreign column names or Column objects. The columns must all be located within the same Table.
- **name** – Optional, the in-database name of the key.
- **onupdate** – Optional string. If set, emit ON UPDATE <value> when issuing DDL for this constraint. Typical values include CASCADE, DELETE and RESTRICT.
- **ondelete** – Optional string. If set, emit ON DELETE <value> when issuing DDL for this constraint. Typical values include CASCADE, DELETE and RESTRICT.
- **deferrable** – Optional bool. If set, emit DEFERRABLE or NOT DEFERRABLE when issuing DDL for this constraint.
- **initially** – Optional string. If set, emit INITIALLY <value> when issuing DDL for this constraint.
- **link_to_name** – if True, the string name given in `column` is the rendered name of the referenced column, not its locally assigned `key`.
- **use_alter** – If True, do not emit the DDL for this constraint as part of the CREATE TABLE definition. Instead, generate it via an ALTER TABLE statement issued after the full collection of tables have been created, and drop it via an ALTER TABLE statement before the full collection of tables are dropped. This is shorthand for the usage of `AddConstraint` and `DropConstraint` applied as "after-create" and "before-drop" events on the MetaData object. This is normally used to generate/drop constraints on objects that are mutually dependent on each other.

class `sqlalchemy.schema.`**`PrimaryKeyConstraint`**(**columns*, ***kw*)
Bases: `sqlalchemy.schema.ColumnCollectionConstraint`

A table-level PRIMARY KEY constraint.

Defines a single column or composite PRIMARY KEY constraint. For a no-frills primary key, adding `primary_key=True` to one or more `Column` definitions is a shorthand equivalent for an unnamed single- or multiple-column PrimaryKeyConstraint.

class `sqlalchemy.schema.`**`UniqueConstraint`**(**columns*, ***kw*)
Bases: `sqlalchemy.schema.ColumnCollectionConstraint`

A table-level UNIQUE constraint.

Defines a single column or composite UNIQUE constraint. For a no-frills, single column constraint, adding `unique=True` to the `Column` definition is a shorthand equivalent for an unnamed, single column UniqueConstraint.

Indexes

Indexes can be created anonymously (using an auto-generated name `ix_<column label>`) for a single column using the inline `index` keyword on `Column`, which also modifies the usage of `unique` to apply the uniqueness to the index itself, instead of adding a separate UNIQUE constraint. For indexes with specific names or which encompass more than one column, use the `Index` construct, which requires a name.

Below we illustrate a `Table` with several `Index` objects associated. The DDL for "CREATE INDEX" is issued right after the create statements for the table:

```
meta = MetaData()
mytable = Table('mytable', meta,
    # an indexed column, with index "ix_mytable_col1"
    Column('col1', Integer, index=True),
```

```
    # a uniquely indexed column with index "ix_mytable_col2"
    Column('col2', Integer, index=True, unique=True),

    Column('col3', Integer),
    Column('col4', Integer),

    Column('col5', Integer),
    Column('col6', Integer),
    )

# place an index on col3, col4
Index('idx_col34', mytable.c.col3, mytable.c.col4)

# place a unique index on col5, col6
Index('myindex', mytable.c.col5, mytable.c.col6, unique=True)

mytable.create(engine)
CREATE TABLE mytable (
    col1 INTEGER,
    col2 INTEGER,
    col3 INTEGER,
    col4 INTEGER,
    col5 INTEGER,
    col6 INTEGER
)
CREATE INDEX ix_mytable_col1 ON mytable (col1)
CREATE UNIQUE INDEX ix_mytable_col2 ON mytable (col2)
CREATE UNIQUE INDEX myindex ON mytable (col5, col6)
CREATE INDEX idx_col34 ON mytable (col3, col4)
```

Note in the example above, the `Index` construct is created externally to the table which it corresponds, using `Column` objects directly. `Index` also supports "inline" definition inside the `Table`, using string names to identify columns:

```
meta = MetaData()
mytable = Table('mytable', meta,
    Column('col1', Integer),

    Column('col2', Integer),

    Column('col3', Integer),
    Column('col4', Integer),

    # place an index on col1, col2
    Index('idx_col12', 'col1', 'col2'),

    # place a unique index on col3, col4
    Index('idx_col34', 'col3', 'col4', unique=True)
)
```

New in version 0.7: Support of "inline" definition inside the `Table` for `Index`.

The `Index` object also supports its own `create()` method:

```
i = Index('someindex', mytable.c.col5)
i.create(engine)
CREATE INDEX someindex ON mytable (col5)
```

class sqlalchemy.schema.**Index**(*name*, **columns*, ***kw*)

Bases: sqlalchemy.schema.ColumnCollectionMixin, sqlalchemy.schema.SchemaItem

A table-level INDEX.

Defines a composite (one or more column) INDEX. For a no-frills, single column index, adding index=True to the Column definition is a shorthand equivalent for an unnamed, single column Index.

See also:

Indexes - General information on Index.

Postgresql-Specific Index Options - PostgreSQL-specific options available for the Index construct.

MySQL Specific Index Options - MySQL-specific options available for the Index construct.

__init__(*name*, **columns*, ***kw*)

Construct an index object.

Parameters

- **name** – The name of the index
- ***columns** – Columns to include in the index. All columns must belong to the same table.
- **unique** – Defaults to False: create a unique index.
- ****kw** – Other keyword arguments may be interpreted by specific dialects.

bind

Return the connectable associated with this Index.

create(*bind=None*)

Issue a CREATE statement for this Index, using the given Connectable for connectivity.

See also MetaData.create_all().

drop(*bind=None*)

Issue a DROP statement for this Index, using the given Connectable for connectivity.

See also MetaData.drop_all().

3.6.5 Customizing DDL

In the preceding sections we've discussed a variety of schema constructs including Table, ForeignKeyConstraint, CheckConstraint, and Sequence. Throughout, we've relied upon the create() and create_all() methods of Table and MetaData in order to issue data definition language (DDL) for all constructs. When issued, a pre-determined order of operations is invoked, and DDL to create each table is created unconditionally including all constraints and other objects associated with it. For more complex scenarios where database-specific DDL is required, SQLAlchemy offers two techniques which can be used to add any DDL based on any condition, either accompanying the standard generation of tables or by itself.

Controlling DDL Sequences

The sqlalchemy.schema package contains SQL expression constructs that provide DDL expressions. For example, to produce a CREATE TABLE statement:

```
from sqlalchemy.schema import CreateTable
engine.execute(CreateTable(mytable))
CREATE TABLE mytable (
    col1 INTEGER,
    col2 INTEGER,
    col3 INTEGER,
    col4 INTEGER,
    col5 INTEGER,
    col6 INTEGER
)
```

Above, the `CreateTable` construct works like any other expression construct (such as `select()`, `table.insert()`, etc.). A full reference of available constructs is in *DDL Expression Constructs API*.

The DDL constructs all extend a common base class which provides the capability to be associated with an individual `Table` or `MetaData` object, to be invoked upon create/drop events. Consider the example of a table which contains a CHECK constraint:

```
users = Table('users', metadata,
              Column('user_id', Integer, primary_key=True),
              Column('user_name', String(40), nullable=False),
              CheckConstraint('length(user_name) >= 8',name="cst_user_name_length")
              )

users.create(engine)
CREATE TABLE users (
    user_id SERIAL NOT NULL,
    user_name VARCHAR(40) NOT NULL,
    PRIMARY KEY (user_id),
    CONSTRAINT cst_user_name_length  CHECK (length(user_name) >= 8)
)
```

The above table contains a column "user_name" which is subject to a CHECK constraint that validates that the length of the string is at least eight characters. When a `create()` is issued for this table, DDL for the `CheckConstraint` will also be issued inline within the table definition.

The `CheckConstraint` construct can also be constructed externally and associated with the `Table` afterwards:

```
constraint = CheckConstraint('length(user_name) >= 8',name="cst_user_name_length")
users.append_constraint(constraint)
```

So far, the effect is the same. However, if we create DDL elements corresponding to the creation and removal of this constraint, and associate them with the `Table` as events, these new events will take over the job of issuing DDL for the constraint. Additionally, the constraint will be added via ALTER:

```
from sqlalchemy import event

event.listen(
    users,
    "after_create",
    AddConstraint(constraint)
)
event.listen(
    users,
    "before_drop",
    DropConstraint(constraint)
```

```
)

users.create(engine)
CREATE TABLE users (
    user_id SERIAL NOT NULL,
    user_name VARCHAR(40) NOT NULL,
    PRIMARY KEY (user_id)
)

ALTER TABLE users ADD CONSTRAINT cst_user_name_length  CHECK (length(user_name) >= 8)

users.drop(engine)
ALTER TABLE users DROP CONSTRAINT cst_user_name_length
DROP TABLE users
```

The real usefulness of the above becomes clearer once we illustrate the `DDLEvent.execute_if()` method. This method returns a modified form of the DDL callable which will filter on criteria before responding to a received event. It accepts a parameter `dialect`, which is the string name of a dialect or a tuple of such, which will limit the execution of the item to just those dialects. It also accepts a `callable_` parameter which may reference a Python callable which will be invoked upon event reception, returning `True` or `False` indicating if the event should proceed.

If our `CheckConstraint` was only supported by Postgresql and not other databases, we could limit its usage to just that dialect:

```
event.listen(
    users,
    'after_create',
    AddConstraint(constraint).execute_if(dialect='postgresql')
)
event.listen(
    users,
    'before_drop',
    DropConstraint(constraint).execute_if(dialect='postgresql')
)
```

Or to any set of dialects:

```
event.listen(
    users,
    "after_create",
    AddConstraint(constraint).execute_if(dialect=('postgresql', 'mysql'))
)
event.listen(
    users,
    "before_drop",
    DropConstraint(constraint).execute_if(dialect=('postgresql', 'mysql'))
)
```

When using a callable, the callable is passed the ddl element, the `Table` or `MetaData` object whose "create" or "drop" event is in progress, and the `Connection` object being used for the operation, as well as additional information as keyword arguments. The callable can perform checks, such as whether or not a given item already exists. Below we define `should_create()` and `should_drop()` callables that check for the presence of our named constraint:

```
def should_create(ddl, target, connection, **kw):
    row = connection.execute("select conname from pg_constraint where conname='%s'" % ddl.element.nar
```

```
    return not bool(row)

def should_drop(ddl, target, connection, **kw):
    return not should_create(ddl, target, connection, **kw)

event.listen(
    users,
    "after_create",
    AddConstraint(constraint).execute_if(callable_=should_create)
)
event.listen(
    users,
    "before_drop",
    DropConstraint(constraint).execute_if(callable_=should_drop)
)

users.create(engine)
CREATE TABLE users (
    user_id SERIAL NOT NULL,
    user_name VARCHAR(40) NOT NULL,
    PRIMARY KEY (user_id)
)

select conname from pg_constraint where conname='cst_user_name_length'
ALTER TABLE users ADD CONSTRAINT cst_user_name_length  CHECK (length(user_name) >= 8)

users.drop(engine)
select conname from pg_constraint where conname='cst_user_name_length'
ALTER TABLE users DROP CONSTRAINT cst_user_name_length
DROP TABLE users
```

Custom DDL

Custom DDL phrases are most easily achieved using the DDL construct. This construct works like all the other DDL elements except it accepts a string which is the text to be emitted:

```
event.listen(
    metadata,
    "after_create",
    DDL("ALTER TABLE users ADD CONSTRAINT "
        "cst_user_name_length "
        " CHECK (length(user_name) >= 8)")
)
```

A more comprehensive method of creating libraries of DDL constructs is to use custom compilation - see *Custom SQL Constructs and Compilation Extension* for details.

DDL Expression Constructs API

class sqlalchemy.schema.**DDLElement**

Bases: sqlalchemy.sql.expression.Executable, sqlalchemy.sql.expression.ClauseElement

Base class for DDL expression constructs.

This class is the base for the general purpose DDL class, as well as the various create/drop clause constructs such as CreateTable, DropTable, AddConstraint, etc.

DDLElement integrates closely with SQLAlchemy events, introduced in *Events*. An instance of one is itself an event receiving callable:

```
event.listen(
    users,
    'after_create',
    AddConstraint(constraint).execute_if(dialect='postgresql')
)
```

See also:

DDL

DDLEvents

Events

Controlling DDL Sequences

__call__(*target*, *bind*, ***kw*)
Execute the DDL as a ddl_listener.

against(*target*)
Return a copy of this DDL against a specific schema item.

bind

callable_ = None

dialect = None

execute(*bind=None*, *target=None*)
Execute this DDL immediately.

Executes the DDL statement in isolation using the supplied Connectable or Connectable assigned to the .bind property, if not supplied. If the DDL has a conditional on criteria, it will be invoked with None as the event.

Parameters

- **bind** – Optional, an Engine or Connection. If not supplied, a valid Connectable must be present in the .bind property.
- **target** – Optional, defaults to None. The target SchemaItem for the execute call. Will be passed to the on callable if any, and may also provide string expansion data for the statement. See execute_at for more information.

execute_at(*event_name*, *target*)
Link execution of this DDL to the DDL lifecycle of a SchemaItem.

Deprecated since version 0.7: See DDLEvents, as well as DDLElement.execute_if().

Links this DDLElement to a Table or MetaData instance, executing it when that schema item is created or dropped. The DDL statement will be executed using the same Connection and transactional context as the Table create/drop itself. The .bind property of this statement is ignored.

Parameters

- **event** – One of the events defined in the schema item's .ddl_events; e.g. 'before-create', 'after-create', 'before-drop' or 'after-drop'

- **target** – The Table or MetaData instance for which this DDLElement will be associated with.

A DDLElement instance can be linked to any number of schema items.

`execute_at` builds on the `append_ddl_listener` interface of `MetaData` and `Table` objects.

Caveat: Creating or dropping a Table in isolation will also trigger any DDL set to `execute_at` that Table's MetaData. This may change in a future release.

execute_if(*dialect=None*, *callable_=None*, *state=None*)
Return a callable that will execute this DDLElement conditionally.

Used to provide a wrapper for event listening:

```
event.listen(
            metadata,
            'before_create',
            DDL("my_ddl").execute_if(dialect='postgresql')
        )
```

Parameters

- **dialect** – May be a string, tuple or a callable predicate. If a string, it will be compared to the name of the executing database dialect:

  ```
  DDL('something').execute_if(dialect='postgresql')
  ```

  If a tuple, specifies multiple dialect names:

  ```
  DDL('something').execute_if(dialect=('postgresql', 'mysql'))
  ```

- **callable** – A callable, which will be invoked with four positional arguments as well as optional keyword arguments:

  ddl This DDL element.

  target The `Table` or `MetaData` object which is the target of this event. May be None if the DDL is executed explicitly.

  bind The `Connection` being used for DDL execution

  tables Optional keyword argument - a list of Table objects which are to be created/ dropped within a MetaData.create_all() or drop_all() method call.

  state Optional keyword argument - will be the `state` argument passed to this function.

  checkfirst Keyword argument, will be True if the 'checkfirst' flag was set during the call to `create()`, `create_all()`, `drop()`, `drop_all()`.

  If the callable returns a true value, the DDL statement will be executed.

- **state** – any value which will be passed to the **callable_** as the `state` keyword argument.

See also:

`DDLEvents`

Events

on = None

target = None

class sqlalchemy.schema.**DDL**(*statement*, *on=None*, *context=None*, *bind=None*)
Bases: sqlalchemy.schema.DDLElement

A literal DDL statement.

Specifies literal SQL DDL to be executed by the database. DDL objects function as DDL event listeners, and can be subscribed to those events listed in DDLEvents, using either Table or MetaData objects as targets. Basic templating support allows a single DDL instance to handle repetitive tasks for multiple tables.

Examples:

```
from sqlalchemy import event, DDL

tbl = Table('users', metadata, Column('uid', Integer))
event.listen(tbl, 'before_create', DDL('DROP TRIGGER users_trigger'))

spow = DDL('ALTER TABLE %(table)s SET secretpowers TRUE')
event.listen(tbl, 'after_create', spow.execute_if(dialect='somedb'))

drop_spow = DDL('ALTER TABLE users SET secretpowers FALSE')
connection.execute(drop_spow)
```

When operating on Table events, the following statement string substitions are available:

```
%(table)s  - the Table name, with any required quoting applied
%(schema)s - the schema name, with any required quoting applied
%(fullname)s - the Table name including schema, quoted if needed
```

The DDL's "context", if any, will be combined with the standard substutions noted above. Keys present in the context will override the standard substitutions.

__init__(*statement*, *on=None*, *context=None*, *bind=None*)
Create a DDL statement.

Parameters

- **statement** – A string or unicode string to be executed. Statements will be processed with Python's string formatting operator. See the context argument and the execute_at method.

  A literal '%' in a statement must be escaped as '%%'.

  SQL bind parameters are not available in DDL statements.

- **on** – Deprecated. See DDLElement.execute_if().

  Optional filtering criteria. May be a string, tuple or a callable predicate. If a string, it will be compared to the name of the executing database dialect:

  ```
  DDL('something', on='postgresql')
  ```

  If a tuple, specifies multiple dialect names:

  ```
  DDL('something', on=('postgresql', 'mysql'))
  ```

  If a callable, it will be invoked with four positional arguments as well as optional keyword arguments:

ddl This DDL element.

event The name of the event that has triggered this DDL, such as 'after-create' Will be None if the DDL is executed explicitly.

target The `Table` or `MetaData` object which is the target of this event. May be None if the DDL is executed explicitly.

connection The `Connection` being used for DDL execution

tables Optional keyword argument - a list of Table objects which are to be created/ dropped within a MetaData.create_all() or drop_all() method call.

If the callable returns a true value, the DDL statement will be executed.

- **context** – Optional dictionary, defaults to None. These values will be available for use in string substitutions on the DDL statement.
- **bind** – Optional. A `Connectable`, used by default when `execute()` is invoked without a bind argument.

See also:

`DDLEvents` `sqlalchemy.event`

class `sqlalchemy.schema.`**`CreateTable`**(*element*, *on=None*, *bind=None*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent a CREATE TABLE statement.

class `sqlalchemy.schema.`**`DropTable`**(*element*, *on=None*, *bind=None*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent a DROP TABLE statement.

class `sqlalchemy.schema.`**`CreateSequence`**(*element*, *on=None*, *bind=None*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent a CREATE SEQUENCE statement.

class `sqlalchemy.schema.`**`DropSequence`**(*element*, *on=None*, *bind=None*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent a DROP SEQUENCE statement.

class `sqlalchemy.schema.`**`CreateIndex`**(*element*, *on=None*, *bind=None*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent a CREATE INDEX statement.

class `sqlalchemy.schema.`**`DropIndex`**(*element*, *on=None*, *bind=None*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent a DROP INDEX statement.

class `sqlalchemy.schema.`**`AddConstraint`**(*element*, **args*, ***kw*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent an ALTER TABLE ADD CONSTRAINT statement.

class `sqlalchemy.schema.`**`DropConstraint`**(*element*, *cascade=False*, ***kw*)
Bases: `sqlalchemy.schema._CreateDropBase`

Represent an ALTER TABLE DROP CONSTRAINT statement.

class sqlalchemy.schema.**CreateSchema**(*name*, *quote=None*, ***kw*)
Bases: sqlalchemy.schema._CreateDropBase

Represent a CREATE SCHEMA statement.

New in version 0.7.4.

The argument here is the string name of the schema.

__init__(*name*, *quote=None*, ***kw*)
Create a new CreateSchema construct.

class sqlalchemy.schema.**DropSchema**(*name*, *quote=None*, *cascade=False*, ***kw*)
Bases: sqlalchemy.schema._CreateDropBase

Represent a DROP SCHEMA statement.

The argument here is the string name of the schema.

New in version 0.7.4.

__init__(*name*, *quote=None*, *cascade=False*, ***kw*)
Create a new DropSchema construct.

3.7 Column and Data Types

SQLAlchemy provides abstractions for most common database data types, and a mechanism for specifying your own custom data types.

The methods and attributes of type objects are rarely used directly. Type objects are supplied to Table definitions and can be supplied as type hints to *functions* for occasions where the database driver returns an incorrect type.

```
>>> users = Table('users', metadata,
...               Column('id', Integer, primary_key=True)
...               Column('login', String(32))
...              )
```

SQLAlchemy will use the Integer and String(32) type information when issuing a CREATE TABLE statement and will use it again when reading back rows SELECTed from the database. Functions that accept a type (such as Column()) will typically accept a type class or instance; Integer is equivalent to Integer() with no construction arguments in this case.

3.7.1 Generic Types

Generic types specify a column that can read, write and store a particular type of Python data. SQLAlchemy will choose the best database column type available on the target database when issuing a CREATE TABLE statement. For complete control over which column type is emitted in CREATE TABLE, such as VARCHAR see SQL Standard Types and the other sections of this chapter.

class sqlalchemy.types.**BigInteger**(**args*, ***kwargs*)
Bases: sqlalchemy.types.Integer

A type for bigger int integers.

Typically generates a BIGINT in DDL, and otherwise acts like a normal Integer on the Python side.

class sqlalchemy.types.**Boolean**(*create_constraint=True*, *name=None*)
Bases: sqlalchemy.types.TypeEngine, sqlalchemy.types.SchemaType

A bool datatype.

Boolean typically uses BOOLEAN or SMALLINT on the DDL side, and on the Python side deals in `True` or `False`.

__init__(*create_constraint=True*, *name=None*)
Construct a Boolean.

Parameters

- **create_constraint** – defaults to True. If the boolean is generated as an int/smallint, also create a CHECK constraint on the table that ensures 1 or 0 as a value.
- **name** – if a CHECK constraint is generated, specify the name of the constraint.

class sqlalchemy.types.**Date**(**args*, ***kwargs*)
Bases: sqlalchemy.types._DateAffinity, sqlalchemy.types.TypeEngine

A type for `datetime.date()` objects.

class sqlalchemy.types.**DateTime**(*timezone=False*)
Bases: sqlalchemy.types._DateAffinity, sqlalchemy.types.TypeEngine

A type for `datetime.datetime()` objects.

Date and time types return objects from the Python `datetime` module. Most DBAPIs have built in support for the datetime module, with the noted exception of SQLite. In the case of SQLite, date and time types are stored as strings which are then converted back to datetime objects when rows are returned.

__init__(*timezone=False*)
Construct a new DateTime.

Parameters **timezone** – boolean. If True, and supported by the

backend, will produce 'TIMESTAMP WITH TIMEZONE'. For backends that don't support timezone aware timestamps, has no effect.

class sqlalchemy.types.**Enum**(**enums*, ***kw*)
Bases: sqlalchemy.types.String, sqlalchemy.types.SchemaType

Generic Enum Type.

The Enum type provides a set of possible string values which the column is constrained towards.

By default, uses the backend's native ENUM type if available, else uses VARCHAR + a CHECK constraint.

See also:
ENUM - PostgreSQL-specific type, which has additional functionality.

__init__(**enums*, ***kw*)
Construct an enum.

Keyword arguments which don't apply to a specific backend are ignored by that backend.

Parameters

- ***enums** – string or unicode enumeration labels. If unicode labels are present, the *convert_unicode* flag is auto-enabled.
- **convert_unicode** – Enable unicode-aware bind parameter and result-set processing for this Enum's data. This is set automatically based on the presence of unicode label strings.

- **metadata** – Associate this type directly with a `MetaData` object. For types that exist on the target database as an independent schema construct (Postgresql), this type will be created and dropped within `create_all()` and `drop_all()` operations. If the type is not associated with any `MetaData` object, it will associate itself with each `Table` in which it is used, and will be created when any of those individual tables are created, after a check is performed for it's existence. The type is only dropped when `drop_all()` is called for that `Table` object's metadata, however.
- **name** – The name of this type. This is required for Postgresql and any future supported database which requires an explicitly named type, or an explicitly named constraint in order to generate the type and/or a table that uses it.
- **native_enum** – Use the database's native ENUM type when available. Defaults to True. When False, uses VARCHAR + check constraint for all backends.
- **schema** – Schemaname of this type. For types that exist on the target database as an independent schema construct (Postgresql), this parameter specifies the named schema in which the type is present.
- **quote** – Force quoting to be on or off on the type's name. If left as the default of *None*, the usual schema-level "case sensitive"/"reserved name" rules are used to determine if this type's name should be quoted.

create(*bind=None*, *checkfirst=False*)
Issue CREATE ddl for this type, if applicable.

drop(*bind=None*, *checkfirst=False*)
Issue DROP ddl for this type, if applicable.

class sqlalchemy.types.**Float**(*precision=None*, *asdecimal=False*, ***kwargs*)
Bases: sqlalchemy.types.Numeric

A type for `float` numbers.

Returns Python `float` objects by default, applying conversion as needed.

__init__(*precision=None*, *asdecimal=False*, ***kwargs*)
Construct a Float.

Parameters

- **precision** – the numeric precision for use in DDL `CREATE TABLE`.
- **asdecimal** – the same flag as that of `Numeric`, but defaults to `False`. Note that setting this flag to `True` results in floating point conversion.
- ****kwargs** – deprecated. Additional arguments here are ignored by the default `Float` type. For database specific floats that support additional arguments, see that dialect's documentation for details, such as `sqlalchemy.dialects.mysql.FLOAT`.

class sqlalchemy.types.**Integer**(**args*, ***kwargs*)
Bases: sqlalchemy.types._DateAffinity, sqlalchemy.types.TypeEngine

A type for `int` integers.

class sqlalchemy.types.**Interval**(*native=True*, *second_precision=None*, *day_precision=None*)
Bases: sqlalchemy.types._DateAffinity, sqlalchemy.types.TypeDecorator

A type for `datetime.timedelta()` objects.

The Interval type deals with `datetime.timedelta` objects. In PostgreSQL, the native `INTERVAL` type is used; for others, the value is stored as a date which is relative to the "epoch" (Jan. 1, 1970).

Note that the `Interval` type does not currently provide date arithmetic operations on platforms which do not support interval types natively. Such operations usually require transformation of both sides of the expression (such as, conversion of both sides into integer epoch values first) which currently is a manual procedure (such as via `func`).

__init__(*native=True*, *second_precision=None*, *day_precision=None*)
Construct an Interval object.

Parameters

- **native** – when True, use the actual INTERVAL type provided by the database, if supported (currently Postgresql, Oracle). Otherwise, represent the interval data as an epoch value regardless.
- **second_precision** – For native interval types which support a "fractional seconds precision" parameter, i.e. Oracle and Postgresql
- **day_precision** – for native interval types which support a "day precision" parameter, i.e. Oracle.

impl
alias of `DateTime`

class sqlalchemy.types.**LargeBinary**(*length=None*)
Bases: sqlalchemy.types._Binary

A type for large binary byte data.

The Binary type generates BLOB or BYTEA when tables are created, and also converts incoming values using the `Binary` callable provided by each DB-API.

__init__(*length=None*)
Construct a LargeBinary type.

Parameters length – optional, a length for the column for use in DDL statements, for those BLOB types that accept a length (i.e. MySQL). It does *not* produce a small BINARY/VARBINARY type - use the BINARY/VARBINARY types specifically for those. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a *length* for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued.

class sqlalchemy.types.**Numeric**(*precision=None*, *scale=None*, *asdecimal=True*)
Bases: sqlalchemy.types._DateAffinity, sqlalchemy.types.TypeEngine

A type for fixed precision numbers.

Typically generates DECIMAL or NUMERIC. Returns `decimal.Decimal` objects by default, applying conversion as needed.

Note: The cdecimal library is a high performing alternative to Python's built-in `decimal.Decimal` type, which performs very poorly in high volume situations. SQLAlchemy 0.7 is tested against `cdecimal` and supports it fully. The type is not necessarily supported by DBAPI implementations however, most of which contain an import for plain `decimal` in their source code, even though some such as psycopg2 provide hooks for alternate adapters. SQLAlchemy imports `decimal` globally as well. While the alternate `Decimal` class can be patched into SQLA's `decimal` module, overall the most straightforward and foolproof way to use "cdecimal" given current DBAPI and Python support is to patch it directly into sys.modules before anything else is imported:

```
import sys
import cdecimal
sys.modules["decimal"] = cdecimal
```

While the global patch is a little ugly, it's particularly important to use just one decimal library at a time since Python Decimal and cdecimal Decimal objects are not currently compatible *with each other*:

```
>>> import cdecimal
>>> import decimal
>>> decimal.Decimal("10") == cdecimal.Decimal("10")
False
```

SQLAlchemy will provide more natural support of cdecimal if and when it becomes a standard part of Python installations and is supported by all DBAPIs.

__init__(*precision=None*, *scale=None*, *asdecimal=True*)
Construct a Numeric.

Parameters

- **precision** – the numeric precision for use in DDL `CREATE TABLE`.
- **scale** – the numeric scale for use in DDL `CREATE TABLE`.
- **asdecimal** – default True. Return whether or not values should be sent as Python Decimal objects, or as floats. Different DBAPIs send one or the other based on datatypes - the Numeric type will ensure that return values are one or the other across DBAPIs consistently.

When using the `Numeric` type, care should be taken to ensure that the asdecimal setting is apppropriate for the DBAPI in use - when Numeric applies a conversion from Decimal->float or float-> Decimal, this conversion incurs an additional performance overhead for all result columns received.

DBAPIs that return Decimal natively (e.g. psycopg2) will have better accuracy and higher performance with a setting of `True`, as the native translation to Decimal reduces the amount of floating- point issues at play, and the Numeric type itself doesn't need to apply any further conversions. However, another DBAPI which returns floats natively *will* incur an additional conversion overhead, and is still subject to floating point data loss - in which case `asdecimal=False` will at least remove the extra conversion overhead.

class `sqlalchemy.types.`**PickleType**(*protocol=2*, *pickler=None*, *mutable=False*, *comparator=None*)
Bases: `sqlalchemy.types.MutableType`, `sqlalchemy.types.TypeDecorator`

Holds Python objects, which are serialized using pickle.

PickleType builds upon the Binary type to apply Python's `pickle.dumps()` to incoming objects, and `pickle.loads()` on the way out, allowing any pickleable Python object to be stored as a serialized binary field.

__init__(*protocol=2*, *pickler=None*, *mutable=False*, *comparator=None*)
Construct a PickleType.

Parameters

- **protocol** – defaults to `pickle.HIGHEST_PROTOCOL`.
- **pickler** – defaults to cPickle.pickle or pickle.pickle if cPickle is not available. May be any object with pickle-compatible `dumps` and ``loads` methods.

- **mutable** – defaults to False; implements `AbstractType.is_mutable()`. When `True`, incoming objects will be compared against copies of themselves using the Python "equals" operator, unless the `comparator` argument is present. See `MutableType` for details on "mutable" type behavior.

  Changed in version 0.7.0: Default changed from `True`.

  Note: This functionality is now superseded by the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking*.

- **comparator** – a 2-arg callable predicate used to compare values of this type. If left as `None`, the Python "equals" operator is used to compare values.

impl
alias of `LargeBinary`

is_mutable()
Return True if the target Python type is 'mutable'.

When this method is overridden, `copy_value()` should also be supplied. The `MutableType` mixin is recommended as a helper.

class sqlalchemy.types.**SchemaType**(***kw*)
Bases: `sqlalchemy.events.SchemaEventTarget`

Mark a type as possibly requiring schema-level DDL for usage.

Supports types that must be explicitly created/dropped (i.e. PG ENUM type) as well as types that are complimented by table or schema level constraints, triggers, and other rules.

`SchemaType` classes can also be targets for the `DDLEvents.before_parent_attach()` and `DDLEvents.after_parent_attach()` events, where the events fire off surrounding the association of the type object with a parent `Column`.

bind

create(*bind=None*, *checkfirst=False*)
Issue CREATE ddl for this type, if applicable.

drop(*bind=None*, *checkfirst=False*)
Issue DROP ddl for this type, if applicable.

class sqlalchemy.types.**SmallInteger**(**args*, ***kwargs*)
Bases: `sqlalchemy.types.Integer`

A type for smaller `int` integers.

Typically generates a `SMALLINT` in DDL, and otherwise acts like a normal `Integer` on the Python side.

class sqlalchemy.types.**String**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: `sqlalchemy.types.Concatenable`, `sqlalchemy.types.TypeEngine`

The base for all string and character types.

In SQL, corresponds to VARCHAR. Can also take Python unicode objects and encode to the database's encoding in bind params (and the reverse for result sets.)

The *length* field is usually required when the *String* type is used within a CREATE TABLE statement, as VARCHAR requires a length on most databases.

__init__(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Create a string-holding type.

Parameters

- **length** – optional, a length for the column for use in DDL statements. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a `length` for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued if a `VARCHAR` with no length is included. Whether the value is interpreted as bytes or characters is database specific.
- **convert_unicode** – When set to `True`, the `String` type will assume that input is to be passed as Python `unicode` objects, and results returned as Python `unicode` objects. If the DBAPI in use does not support Python unicode (which is fewer and fewer these days), SQLAlchemy will encode/decode the value, using the value of the `encoding` parameter passed to `create_engine()` as the encoding.

  When using a DBAPI that natively supports Python unicode objects, this flag generally does not need to be set. For columns that are explicitly intended to store non-ASCII data, the `Unicode` or `UnicodeText` types should be used regardless, which feature the same behavior of `convert_unicode` but also indicate an underlying column type that directly supports unicode, such as `NVARCHAR`.

  For the extremely rare case that Python `unicode` is to be encoded/decoded by SQLAlchemy on a backend that does natively support Python `unicode`, the value `force` can be passed here which will cause SQLAlchemy's encode/decode services to be used unconditionally.
- **assert_unicode** – Deprecated. A warning is emitted when a non-`unicode` object is passed to the `Unicode` subtype of `String`, or the `UnicodeText` subtype of `Text`. See `Unicode` for information on how to control this warning.
- **unicode_error** – Optional, a method to use to handle Unicode conversion errors. Behaves like the `errors` keyword argument to the standard library's `string.decode()` functions. This flag requires that `convert_unicode` is set to `force` - otherwise, SQLAlchemy is not guaranteed to handle the task of unicode conversion. Note that this flag adds significant performance overhead to row-fetching operations for backends that already return unicode objects natively (which most DBAPIs do). This flag should only be used as a last resort for reading strings from a column with varied or corrupted encodings.

class `sqlalchemy.types.`**`Text`**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)

Bases: `sqlalchemy.types.String`

A variably sized string type.

In SQL, usually corresponds to CLOB or TEXT. Can also take Python unicode objects and encode to the database's encoding in bind params (and the reverse for result sets.)

class `sqlalchemy.types.`**`Time`**(*timezone=False*)

Bases: `sqlalchemy.types._DateAffinity`, `sqlalchemy.types.TypeEngine`

A type for `datetime.time()` objects.

class `sqlalchemy.types.`**`Unicode`**(*length=None*, ***kwargs*)

Bases: `sqlalchemy.types.String`

A variable length Unicode string type.

The `Unicode` type is a `String` subclass that assumes input and output as Python `unicode` data, and in that regard is equivalent to the usage of the `convert_unicode` flag with the `String` type. However, unlike plain `String`, it also implies an underlying column type that is explicitly supporting of non-ASCII data, such as `NVARCHAR` on Oracle and SQL Server. This can impact the output of `CREATE TABLE` statements and `CAST`

functions at the dialect level, and can also affect the handling of bound parameters in some specific DBAPI scenarios.

The encoding used by the `Unicode` type is usually determined by the DBAPI itself; most modern DBAPIs feature support for Python `unicode` objects as bound values and result set values, and the encoding should be configured as detailed in the notes for the target DBAPI in the *Dialects* section.

For those DBAPIs which do not support, or are not configured to accommodate Python `unicode` objects directly, SQLAlchemy does the encoding and decoding outside of the DBAPI. The encoding in this scenario is determined by the `encoding` flag passed to `create_engine()`.

When using the `Unicode` type, it is only appropriate to pass Python `unicode` objects, and not plain `str`. If a plain `str` is passed under Python 2, a warning is emitted. If you notice your application emitting these warnings but you're not sure of the source of them, the Python `warnings` filter, documented at http://docs.python.org/library/warnings.html, can be used to turn these warnings into exceptions which will illustrate a stack trace:

```
import warnings
warnings.simplefilter('error')
```

For an application that wishes to pass plain bytestrings and Python `unicode` objects to the `Unicode` type equally, the bytestrings must first be decoded into unicode. The recipe at *Coercing Encoded Strings to Unicode* illustrates how this is done.

See also:

`UnicodeText` - unlengthed textual counterpart to `Unicode`.

__init__(*length=None*, ***kwargs*)

Create a `Unicode` object.

Parameters are the same as that of `String`, with the exception that `convert_unicode` defaults to `True`.

class sqlalchemy.types.**UnicodeText**(*length=None*, ***kwargs*)

Bases: `sqlalchemy.types.Text`

An unbounded-length Unicode string type.

See `Unicode` for details on the unicode behavior of this object.

Like `Unicode`, usage the `UnicodeText` type implies a unicode-capable type being used on the backend, such as `NCLOB`, `NTEXT`.

__init__(*length=None*, ***kwargs*)

Create a Unicode-converting Text type.

Parameters are the same as that of `Text`, with the exception that `convert_unicode` defaults to `True`.

3.7.2 SQL Standard Types

The SQL standard types always create database column types of the same name when `CREATE TABLE` is issued. Some types may not be supported on all databases.

class sqlalchemy.types.**BIGINT**(**args*, ***kwargs*)

Bases: `sqlalchemy.types.BigInteger`

The SQL BIGINT type.

class sqlalchemy.types.**BINARY**(*length=None*)

Bases: `sqlalchemy.types._Binary`

The SQL BINARY type.

class sqlalchemy.types.**BLOB**(*length=None*)
Bases: sqlalchemy.types.LargeBinary

The SQL BLOB type.

class sqlalchemy.types.**BOOLEAN**(*create_constraint=True*, *name=None*)
Bases: sqlalchemy.types.Boolean

The SQL BOOLEAN type.

class sqlalchemy.types.**CHAR**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: sqlalchemy.types.String

The SQL CHAR type.

class sqlalchemy.types.**CLOB**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: sqlalchemy.types.Text

The CLOB type.

This type is found in Oracle and Informix.

class sqlalchemy.types.**DATE**(**args*, ***kwargs*)
Bases: sqlalchemy.types.Date

The SQL DATE type.

class sqlalchemy.types.**DATETIME**(*timezone=False*)
Bases: sqlalchemy.types.DateTime

The SQL DATETIME type.

class sqlalchemy.types.**DECIMAL**(*precision=None*, *scale=None*, *asdecimal=True*)
Bases: sqlalchemy.types.Numeric

The SQL DECIMAL type.

class sqlalchemy.types.**FLOAT**(*precision=None*, *asdecimal=False*, ***kwargs*)
Bases: sqlalchemy.types.Float

The SQL FLOAT type.

sqlalchemy.types.**INT**
alias of INTEGER

class sqlalchemy.types.**INTEGER**(**args*, ***kwargs*)
Bases: sqlalchemy.types.Integer

The SQL INT or INTEGER type.

class sqlalchemy.types.**NCHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.types.Unicode

The SQL NCHAR type.

class sqlalchemy.types.**NVARCHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.types.Unicode

The SQL NVARCHAR type.

class sqlalchemy.types.**NUMERIC**(*precision=None*, *scale=None*, *asdecimal=True*)
Bases: sqlalchemy.types.Numeric

The SQL NUMERIC type.

class sqlalchemy.types.**REAL**(*precision=None*, *asdecimal=False*, ***kwargs*)
Bases: sqlalchemy.types.Float

The SQL REAL type.

class sqlalchemy.types.**SMALLINT**(**args*, ***kwargs*)
Bases: sqlalchemy.types.SmallInteger

The SQL SMALLINT type.

class sqlalchemy.types.**TEXT**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: sqlalchemy.types.Text

The SQL TEXT type.

class sqlalchemy.types.**TIME**(*timezone=False*)
Bases: sqlalchemy.types.Time

The SQL TIME type.

class sqlalchemy.types.**TIMESTAMP**(*timezone=False*)
Bases: sqlalchemy.types.DateTime

The SQL TIMESTAMP type.

class sqlalchemy.types.**VARBINARY**(*length=None*)
Bases: sqlalchemy.types._Binary

The SQL VARBINARY type.

class sqlalchemy.types.**VARCHAR**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: sqlalchemy.types.String

The SQL VARCHAR type.

3.7.3 Vendor-Specific Types

Database-specific types are also available for import from each database's dialect module. See the *sqlalchemy.dialects_toplevel* reference for the database you're interested in.

For example, MySQL has a `BIGINT` type and PostgreSQL has an `INET` type. To use these, import them from the module explicitly:

```
from sqlalchemy.dialects import mysql

table = Table('foo', metadata,
    Column('id', mysql.BIGINT),
    Column('enumerates', mysql.ENUM('a', 'b', 'c'))
)
```

Or some PostgreSQL types:

```
from sqlalchemy.dialects import postgresql

table = Table('foo', metadata,
    Column('ipaddress', postgresql.INET),
    Column('elements', postgresql.ARRAY(String))
)
```

Each dialect provides the full set of typenames supported by that backend within its *__all__* collection, so that a simple *import * or similar will import all supported types as implemented for that backend:

```
from sqlalchemy.dialects.postgresql import *

t = Table('mytable', metadata,
            Column('id', INTEGER, primary_key=True),
            Column('name', VARCHAR(300)),
            Column('inetaddr', INET)
)
```

Where above, the INTEGER and VARCHAR types are ultimately from sqlalchemy.types, and INET is specific to the Postgresql dialect.

Some dialect level types have the same name as the SQL standard type, but also provide additional arguments. For example, MySQL implements the full range of character and string types including additional arguments such as *collation* and *charset*:

```
from sqlalchemy.dialects.mysql import VARCHAR, TEXT

table = Table('foo', meta,
    Column('col1', VARCHAR(200, collation='binary')),
    Column('col2', TEXT(charset='latin1'))
)
```

3.7.4 Custom Types

A variety of methods exist to redefine the behavior of existing types as well as to provide new ones.

Overriding Type Compilation

A frequent need is to force the "string" version of a type, that is the one rendered in a CREATE TABLE statement or other SQL function like CAST, to be changed. For example, an application may want to force the rendering of `BINARY` for all platforms except for one, in which is wants `BLOB` to be rendered. Usage of an existing generic type, in this case `LargeBinary`, is preferred for most use cases. But to control types more accurately, a compilation directive that is per-dialect can be associated with any type:

```
from sqlalchemy.ext.compiler import compiles
from sqlalchemy.types import BINARY

@compiles(BINARY, "sqlite")
def compile_binary_sqlite(type_, compiler, **kw):
    return "BLOB"
```

The above code allows the usage of `types.BINARY`, which will produce the string `BINARY` against all backends except SQLite, in which case it will produce `BLOB`.

See the section *Changing Compilation of Types*, a subsection of *Custom SQL Constructs and Compilation Extension*, for additional examples.

Augmenting Existing Types

The TypeDecorator allows the creation of custom types which add bind-parameter and result-processing behavior to an existing type object. It is used when additional in-Python marshaling of data to and from the database is required.

class sqlalchemy.types.**TypeDecorator**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

Allows the creation of types which add additional functionality to an existing type.

This method is preferred to direct subclassing of SQLAlchemy's built-in types as it ensures that all required functionality of the underlying type is kept in place.

Typical usage:

```
import sqlalchemy.types as types

class MyType(types.TypeDecorator):
    '''Prefixes Unicode values with "PREFIX:" on the way in and
    strips it off on the way out.
    '''

    impl = types.Unicode

    def process_bind_param(self, value, dialect):
        return "PREFIX:" + value

    def process_result_value(self, value, dialect):
        return value[7:]

    def copy(self):
        return MyType(self.impl.length)
```

The class-level "impl" attribute is required, and can reference any TypeEngine class. Alternatively, the load_dialect_impl() method can be used to provide different type classes based on the dialect given; in this case, the "impl" variable can reference TypeEngine as a placeholder.

Types that receive a Python type that isn't similar to the ultimate type used may want to define the TypeDecorator.coerce_compared_value() method. This is used to give the expression system a hint when coercing Python objects into bind parameters within expressions. Consider this expression:

```
mytable.c.somecol + datetime.date(2009, 5, 15)
```

Above, if "somecol" is an Integer variant, it makes sense that we're doing date arithmetic, where above is usually interpreted by databases as adding a number of days to the given date. The expression system does the right thing by not attempting to coerce the "date()" value into an integer-oriented bind parameter.

However, in the case of TypeDecorator, we are usually changing an incoming Python type to something new - TypeDecorator by default will "coerce" the non-typed side to be the same type as itself. Such as below, we define an "epoch" type that stores a date value as an integer:

```
class MyEpochType(types.TypeDecorator):
    impl = types.Integer

    epoch = datetime.date(1970, 1, 1)

    def process_bind_param(self, value, dialect):
```

```
        return (value - self.epoch).days

    def process_result_value(self, value, dialect):
        return self.epoch + timedelta(days=value)
```

Our expression of `somecol + date` with the above type will coerce the "date" on the right side to also be treated as `MyEpochType`.

This behavior can be overridden via the `coerce_compared_value()` method, which returns a type that should be used for the value of the expression. Below we set it such that an integer value will be treated as an `Integer`, and any other value is assumed to be a date and will be treated as a `MyEpochType`:

```
def coerce_compared_value(self, op, value):
    if isinstance(value, int):
        return Integer()
    else:
        return self
```

__init__(**args*, ***kwargs*)
Construct a `TypeDecorator`.

Arguments sent here are passed to the constructor of the class assigned to the `impl` class level attribute, assuming the `impl` is a callable, and the resulting object is assigned to the `self.impl` instance attribute (thus overriding the class attribute of the same name).

If the class level `impl` is not a callable (the unusual case), it will be assigned to the same instance attribute 'as-is', ignoring those arguments passed to the constructor.

Subclasses can override this to customize the generation of `self.impl` entirely.

adapt(*cls*, ***kw*)
inherited from the `TypeEngine.adapt()` *method of* `TypeEngine`

Produce an "adapted" form of this type, given an "impl" class to work with.

This method is used internally to associate generic types with "implementation" types that are specific to a particular dialect.

bind_processor(*dialect*)
Provide a bound value processing function for the given `Dialect`.

This is the method that fulfills the `TypeEngine` contract for bound value conversion. `TypeDecorator` will wrap a user-defined implementation of `process_bind_param()` here.

User-defined code can override this method directly, though its likely best to use `process_bind_param()` so that the processing provided by `self.impl` is maintained.

Parameters **dialect** – Dialect instance in use.

This method is the reverse counterpart to the `result_processor()` method of this class.

coerce_compared_value(*op*, *value*)
Suggest a type for a 'coerced' Python value in an expression.

By default, returns self. This method is called by the expression system when an object using this type is on the left or right side of an expression against a plain Python object which does not yet have a SQLAlchemy type assigned:

```
expr = table.c.somecolumn + 35
```

Where above, if `somecolumn` uses this type, this method will be called with the value `operator.add` and `35`. The return value is whatever SQLAlchemy type should be used for `35` for this particular operation.

compare_values(*x*, *y*)
Given two values, compare them for equality.

By default this calls upon `TypeEngine.compare_values()` of the underlying "impl", which in turn usually uses the Python equals operator ==.

This function is used by the ORM to compare an original-loaded value with an intercepted "changed" value, to determine if a net change has occurred.

compile(*dialect=None*)
inherited from the `TypeEngine.compile()` *method of* `TypeEngine`

Produce a string-compiled form of this `TypeEngine`.

When called with no arguments, uses a "default" dialect to produce a string result.

Parameters **dialect** – a `Dialect` instance.

copy()
Produce a copy of this `TypeDecorator` instance.

This is a shallow copy and is provided to fulfill part of the `TypeEngine` contract. It usually does not need to be overridden unless the user-defined `TypeDecorator` has local state that should be deep-copied.

copy_value(*value*)
Given a value, produce a copy of it.

By default this calls upon `TypeEngine.copy_value()` of the underlying "impl".

`copy_value()` will return the object itself, assuming "mutability" is not enabled. Only the `MutableType` mixin provides a copy function that actually produces a new object. The copying function is used by the ORM when "mutable" types are used, to memoize the original version of an object as loaded from the database, which is then compared to the possibly mutated version to check for changes.

Modern implementations should use the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking* for intercepting in-place changes to values.

dialect_impl(*dialect*)
inherited from the `TypeEngine.dialect_impl()` *method of* `TypeEngine`

Return a dialect-specific implementation for this `TypeEngine`.

get_dbapi_type(*dbapi*)
Return the DBAPI type object represented by this `TypeDecorator`.

By default this calls upon `TypeEngine.get_dbapi_type()` of the underlying "impl".

is_mutable()
Return True if the target Python type is 'mutable'.

This allows systems like the ORM to know if a column value can be considered 'not changed' by comparing the identity of objects alone. Values such as dicts, lists which are serialized into strings are examples of "mutable" column structures.

Note: This functionality is now superseded by the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking*.

---

load_dialect_impl(*dialect*)
Return a `TypeEngine` object corresponding to a dialect.

This is an end-user override hook that can be used to provide differing types depending on the given dialect. It is used by the `TypeDecorator` implementation of `type_engine()` to help determine what type should ultimately be returned for a given `TypeDecorator`.

By default returns `self.impl`.

process_bind_param(*value*, *dialect*)
Receive a bound parameter value to be converted.

Subclasses override this method to return the value that should be passed along to the underlying `TypeEngine` object, and from there to the DBAPI `execute()` method.

The operation could be anything desired to perform custom behavior, such as transforming or serializing data. This could also be used as a hook for validating logic.

This operation should be designed with the reverse operation in mind, which would be the process_result_value method of this class.

Parameters

- **value** – Data to operate upon, of any type expected by this method in the subclass. Can be `None`.
- **dialect** – the `Dialect` in use.

process_result_value(*value*, *dialect*)
Receive a result-row column value to be converted.

Subclasses should implement this method to operate on data fetched from the database.

Subclasses override this method to return the value that should be passed back to the application, given a value that is already processed by the underlying `TypeEngine` object, originally from the DBAPI cursor method `fetchone()` or similar.

The operation could be anything desired to perform custom behavior, such as transforming or serializing data. This could also be used as a hook for validating logic.

Parameters

- **value** – Data to operate upon, of any type expected by this method in the subclass. Can be `None`.
- **dialect** – the `Dialect` in use.

This operation should be designed to be reversible by the "process_bind_param" method of this class.

python_type
inherited from the `TypeEngine.python_type` *attribute of* `TypeEngine`

Return the Python type object expected to be returned by instances of this type, if known.

Basically, for those types which enforce a return type, or are known across the board to do such for all common DBAPIs (like `int` for example), will return that type.

If a return type is not defined, raises `NotImplementedError`.

Note that any type also accommodates NULL in SQL which means you can also get back `None` from any type in practice.

result_processor(*dialect*, *coltype*)
Provide a result value processing function for the given `Dialect`.

This is the method that fulfills the `TypeEngine` contract for result value conversion. `TypeDecorator` will wrap a user-defined implementation of `process_result_value()` here.

User-defined code can override this method directly, though its likely best to use `process_result_value()` so that the processing provided by `self.impl` is maintained.

Parameters

- **dialect** – Dialect instance in use.
- **coltype** – An SQLAlchemy data type

This method is the reverse counterpart to the `bind_processor()` method of this class.

type_engine(*dialect*)
Return a dialect-specific `TypeEngine` instance for this `TypeDecorator`.

In most cases this returns a dialect-adapted form of the `TypeEngine` type represented by `self.impl`. Makes usage of `dialect_impl()` but also traverses into wrapped `TypeDecorator` instances. Behavior can be customized here by overriding `load_dialect_impl()`.

with_variant(*type_*, *dialect_name*)
inherited from the `TypeEngine.with_variant()` *method of* `TypeEngine`

Produce a new type object that will utilize the given type when applied to the dialect of the given name.

e.g.:

```
from sqlalchemy.types import String
from sqlalchemy.dialects import mysql

s = String()

s = s.with_variant(mysql.VARCHAR(collation='foo'), 'mysql')
```

The construction of `TypeEngine.with_variant()` is always from the "fallback" type to that which is dialect specific. The returned type is an instance of `Variant`, which itself provides a `with_variant()` that can be called repeatedly.

Parameters

- **type** – a `TypeEngine` that will be selected as a variant from the originating type, when a dialect of the given name is in use.
- **dialect_name** – base name of the dialect which uses this type. (i.e. `'postgresql'`, `'mysql'`, etc.)

New in version 0.7.2.

TypeDecorator Recipes

A few key `TypeDecorator` recipes follow.

Coercing Encoded Strings to Unicode

A common source of confusion regarding the `Unicode` type is that it is intended to deal *only* with Python `unicode` objects on the Python side, meaning values passed to it as bind parameters must be of the form `u'some string'` if using Python 2 and not 3. The encoding/decoding functions it performs are only to suit what the DBAPI in use requires, and are primarily a private implementation detail.

The use case of a type that can safely receive Python bytestrings, that is strings that contain non-ASCII characters and are not `u''` objects in Python 2, can be achieved using a `TypeDecorator` which coerces as needed:

```
from sqlalchemy.types import TypeDecorator, Unicode

class CoerceUTF8(TypeDecorator):
    """Safely coerce Python bytestrings to Unicode
    before passing off to the database."""

    impl = Unicode

    def process_bind_param(self, value, dialect):
        if isinstance(value, str):
            value = value.decode('utf-8')
        return value
```

Rounding Numerics

Some database connectors like those of SQL Server choke if a Decimal is passed with too many decimal places. Here's a recipe that rounds them down:

```
from sqlalchemy.types import TypeDecorator, Numeric
from decimal import Decimal

class SafeNumeric(TypeDecorator):
    """Adds quantization to Numeric."""

    impl = Numeric

    def __init__(self, *arg, **kw):
        TypeDecorator.__init__(self, *arg, **kw)
        self.quantize_int = -(self.impl.precision - self.impl.scale)
        self.quantize = Decimal(10) ** self.quantize_int

    def process_bind_param(self, value, dialect):
        if isinstance(value, Decimal) and \
            value.as_tuple()[2] < self.quantize_int:
            value = value.quantize(self.quantize)
        return value
```

Backend-agnostic GUID Type

Receives and returns Python uuid() objects. Uses the PG UUID type when using Postgresql, CHAR(32) on other backends, storing them in stringified hex format. Can be modified to store binary in CHAR(16) if desired:

```
from sqlalchemy.types import TypeDecorator, CHAR
from sqlalchemy.dialects.postgresql import UUID
import uuid

class GUID(TypeDecorator):
    """Platform-independent GUID type.

    Uses Postgresql's UUID type, otherwise uses
    CHAR(32), storing as stringified hex values.

    """
    impl = CHAR
```

```
    def load_dialect_impl(self, dialect):
        if dialect.name == 'postgresql':
            return dialect.type_descriptor(UUID())
        else:
            return dialect.type_descriptor(CHAR(32))

    def process_bind_param(self, value, dialect):
        if value is None:
            return value
        elif dialect.name == 'postgresql':
            return str(value)
        else:
            if not isinstance(value, uuid.UUID):
                return "%.32x" % uuid.UUID(value)
            else:
                # hexstring
                return "%.32x" % value

    def process_result_value(self, value, dialect):
        if value is None:
            return value
        else:
            return uuid.UUID(value)
```

Marshal JSON Strings

This type uses `simplejson` to marshal Python data structures to/from JSON. Can be modified to use Python's builtin json encoder:

```
from sqlalchemy.types import TypeDecorator, VARCHAR
import json

class JSONEncodedDict(TypeDecorator):
    """Represents an immutable structure as a json-encoded string.

    Usage::

        JSONEncodedDict(255)

    """

    impl = VARCHAR

    def process_bind_param(self, value, dialect):
        if value is not None:
            value = json.dumps(value)

        return value

    def process_result_value(self, value, dialect):
        if value is not None:
            value = json.loads(value)
        return value
```

Note that the ORM by default will not detect "mutability" on such a type - meaning, in-place changes to values will not be detected and will not be flushed. Without further steps, you instead would need to replace the existing value with

a new one on each parent object to detect changes. Note that there's nothing wrong with this, as many applications may not require that the values are ever mutated once created. For those which do have this requirment, support for mutability is best applied using the `sqlalchemy.ext.mutable` extension - see the example in *Mutation Tracking*.

Creating New Types

The `UserDefinedType` class is provided as a simple base class for defining entirely new database types. Use this to represent native database types not known by SQLAlchemy. If only Python translation behavior is needed, use `TypeDecorator` instead.

class `sqlalchemy.types.`**`UserDefinedType`**(**args*, ***kwargs*)

Bases: `sqlalchemy.types.TypeEngine`

Base for user defined types.

This should be the base of new types. Note that for most cases, `TypeDecorator` is probably more appropriate:

```
import sqlalchemy.types as types

class MyType(types.UserDefinedType):
    def __init__(self, precision = 8):
        self.precision = precision

    def get_col_spec(self):
        return "MYTYPE(%s)" % self.precision

    def bind_processor(self, dialect):
        def process(value):
            return value
        return process

    def result_processor(self, dialect, coltype):
        def process(value):
            return value
        return process
```

Once the type is made, it's immediately usable:

```
table = Table('foo', meta,
    Column('id', Integer, primary_key=True),
    Column('data', MyType(16))
    )
```

`__init__`(**args*, ***kwargs*)

inherited from the `TypeEngine.__init__()` *method of* `TypeEngine`

Support implementations that were passing arguments

`adapt`(*cls*, ***kw*)

inherited from the `TypeEngine.adapt()` *method of* `TypeEngine`

Produce an "adapted" form of this type, given an "impl" class to work with.

This method is used internally to associate generic types with "implementation" types that are specific to a particular dialect.

`adapt_operator`(*op*)

A hook which allows the given operator to be adapted to something new.

See also UserDefinedType._adapt_expression(), an as-yet- semi-public method with greater capability in this regard.

bind_processor(*dialect*)
inherited from the `TypeEngine.bind_processor()` *method of* `TypeEngine`

Return a conversion function for processing bind values.

Returns a callable which will receive a bind parameter value as the sole positional argument and will return a value to send to the DB-API.

If processing is not necessary, the method should return `None`.

Parameters **dialect** – Dialect instance in use.

compare_values(*x*, *y*)
inherited from the `TypeEngine.compare_values()` *method of* `TypeEngine`

Compare two values for equality.

compile(*dialect=None*)
inherited from the `TypeEngine.compile()` *method of* `TypeEngine`

Produce a string-compiled form of this `TypeEngine`.

When called with no arguments, uses a "default" dialect to produce a string result.

Parameters **dialect** – a `Dialect` instance.

copy_value(*value*)
inherited from the `TypeEngine.copy_value()` *method of* `TypeEngine`

dialect_impl(*dialect*)
inherited from the `TypeEngine.dialect_impl()` *method of* `TypeEngine`

Return a dialect-specific implementation for this `TypeEngine`.

get_dbapi_type(*dbapi*)
inherited from the `TypeEngine.get_dbapi_type()` *method of* `TypeEngine`

Return the corresponding type object from the underlying DB-API, if any.

This can be useful for calling `setinputsizes()`, for example.

is_mutable()
inherited from the `TypeEngine.is_mutable()` *method of* `TypeEngine`

Return True if the target Python type is 'mutable'.

This allows systems like the ORM to know if a column value can be considered 'not changed' by comparing the identity of objects alone. Values such as dicts, lists which are serialized into strings are examples of "mutable" column structures.

Note: This functionality is now superseded by the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking*.

When this method is overridden, `copy_value()` should also be supplied. The `MutableType` mixin is recommended as a helper.

python_type
inherited from the `TypeEngine.python_type` *attribute of* `TypeEngine`

Return the Python type object expected to be returned by instances of this type, if known.

Basically, for those types which enforce a return type, or are known across the board to do such for all common DBAPIs (like `int` for example), will return that type.

If a return type is not defined, raises `NotImplementedError`.

Note that any type also accommodates NULL in SQL which means you can also get back `None` from any type in practice.

result_processor(*dialect*, *coltype*)
inherited from the `TypeEngine.result_processor()` *method of* `TypeEngine`

Return a conversion function for processing result row values.

Returns a callable which will receive a result row column value as the sole positional argument and will return a value to return to the user.

If processing is not necessary, the method should return `None`.

Parameters

- **dialect** – Dialect instance in use.
- **coltype** – DBAPI coltype argument received in cursor.description.

with_variant(*type_*, *dialect_name*)
inherited from the `TypeEngine.with_variant()` *method of* `TypeEngine`

Produce a new type object that will utilize the given type when applied to the dialect of the given name.

e.g.:

```
from sqlalchemy.types import String
from sqlalchemy.dialects import mysql

s = String()

s = s.with_variant(mysql.VARCHAR(collation='foo'), 'mysql')
```

The construction of `TypeEngine.with_variant()` is always from the "fallback" type to that which is dialect specific. The returned type is an instance of `Variant`, which itself provides a `with_variant()` that can be called repeatedly.

Parameters

- **type** – a `TypeEngine` that will be selected as a variant from the originating type, when a dialect of the given name is in use.
- **dialect_name** – base name of the dialect which uses this type. (i.e. `'postgresql'`, `'mysql'`, etc.)

New in version 0.7.2.

3.7.5 Base Type API

class `sqlalchemy.types.`**AbstractType**
Bases: `sqlalchemy.sql.visitors.Visitable`

Base for all types - not needed except for backwards compatibility.

__init__
inherited from the `object.__init__` *attribute of* `object`

x.__init__(...) initializes x; see help(type(x)) for signature

class sqlalchemy.types.**TypeEngine**(**args*, ***kwargs*)
Bases: sqlalchemy.types.AbstractType

Base for built-in types.

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

adapt(*cls*, ***kw*)
Produce an "adapted" form of this type, given an "impl" class to work with.

This method is used internally to associate generic types with "implementation" types that are specific to a particular dialect.

bind_processor(*dialect*)
Return a conversion function for processing bind values.

Returns a callable which will receive a bind parameter value as the sole positional argument and will return a value to send to the DB-API.

If processing is not necessary, the method should return `None`.

Parameters **dialect** – Dialect instance in use.

compare_values(*x*, *y*)
Compare two values for equality.

compile(*dialect=None*)
Produce a string-compiled form of this `TypeEngine`.

When called with no arguments, uses a "default" dialect to produce a string result.

Parameters **dialect** – a `Dialect` instance.

copy_value(*value*)

dialect_impl(*dialect*)
Return a dialect-specific implementation for this `TypeEngine`.

get_dbapi_type(*dbapi*)
Return the corresponding type object from the underlying DB-API, if any.

This can be useful for calling `setinputsizes()`, for example.

is_mutable()
Return True if the target Python type is 'mutable'.

This allows systems like the ORM to know if a column value can be considered 'not changed' by comparing the identity of objects alone. Values such as dicts, lists which are serialized into strings are examples of "mutable" column structures.

Note: This functionality is now superseded by the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking*.

When this method is overridden, `copy_value()` should also be supplied. The `MutableType` mixin is recommended as a helper.

python_type
Return the Python type object expected to be returned by instances of this type, if known.

Basically, for those types which enforce a return type, or are known across the board to do such for all common DBAPIs (like `int` for example), will return that type.

If a return type is not defined, raises `NotImplementedError`.

Note that any type also accommodates NULL in SQL which means you can also get back `None` from any type in practice.

result_processor(*dialect*, *coltype*)
Return a conversion function for processing result row values.

Returns a callable which will receive a result row column value as the sole positional argument and will return a value to return to the user.

If processing is not necessary, the method should return `None`.

Parameters

- **dialect** – Dialect instance in use.
- **coltype** – DBAPI coltype argument received in cursor.description.

with_variant(*type_*, *dialect_name*)
Produce a new type object that will utilize the given type when applied to the dialect of the given name.

e.g.:

```
from sqlalchemy.types import String
from sqlalchemy.dialects import mysql

s = String()

s = s.with_variant(mysql.VARCHAR(collation='foo'), 'mysql')
```

The construction of `TypeEngine.with_variant()` is always from the "fallback" type to that which is dialect specific. The returned type is an instance of `Variant`, which itself provides a `with_variant()` that can be called repeatedly.

Parameters

- **type** – a `TypeEngine` that will be selected as a variant from the originating type, when a dialect of the given name is in use.
- **dialect_name** – base name of the dialect which uses this type. (i.e. `'postgresql'`, `'mysql'`, etc.)

New in version 0.7.2.

class sqlalchemy.types.**MutableType**
Bases: `object`

A mixin that marks a `TypeEngine` as representing a mutable Python object type. This functionality is used only by the ORM.

Changed in version 0.7: `MutableType` is superseded by the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking*. This extension provides an event driven approach to in-place mutation detection that does not incur the severe performance penalty of the `MutableType` approach.

"mutable" means that changes can occur in place to a value of this type. Examples includes Python lists, dictionaries, and sets, as well as user-defined objects. The primary need for identification of "mutable" types is by the ORM, which applies special rules to such values in order to guarantee that changes are detected. These rules may have a significant performance impact, described below.

A `MutableType` usually allows a flag called `mutable=False` to enable/disable the "mutability" flag, represented on this class by `is_mutable()`. Examples include `PickleType` and `ARRAY`. Setting this flag to `True` enables mutability-specific behavior by the ORM.

The `copy_value()` and `compare_values()` functions represent a copy and compare function for values of this type - implementing subclasses should override these appropriately.

Warning: The usage of mutable types has significant performance implications when using the ORM. In order to detect changes, the ORM must create a copy of the value when it is first accessed, so that changes to the current value can be compared against the "clean" database-loaded value. Additionally, when the ORM checks to see if any data requires flushing, it must scan through all instances in the session which are known to have "mutable" attributes and compare the current value of each one to its "clean" value. So for example, if the Session contains 6000 objects (a fairly large amount) and autoflush is enabled, every individual execution of `Query` will require a full scan of that subset of the 6000 objects that have mutable attributes, possibly resulting in tens of thousands of additional method calls for every query.
Changed in version 0.7: As of SQLAlchemy 0.7, the `sqlalchemy.ext.mutable` is provided which allows an event driven approach to in-place mutation detection. This approach should now be favored over the usage of `MutableType` with `mutable=True`. `sqlalchemy.ext.mutable` is described in *Mutation Tracking*.

__init__
inherited from the `object.__init__` *attribute of* `object`

x.__init__(...) initializes x; see help(type(x)) for signature

compare_values(*x*, *y*)
Compare *x* == *y*.

copy_value(*value*)
Unimplemented.

is_mutable()
Return True if the target Python type is 'mutable'.

For `MutableType`, this method is set to return `True`.

class sqlalchemy.types.**Concatenable**
Bases: `object`

A mixin that marks a type as supporting 'concatenation', typically strings.

__init__
inherited from the `object.__init__` *attribute of* `object`

x.__init__(...) initializes x; see help(type(x)) for signature

class sqlalchemy.types.**NullType**(**args*, ***kwargs*)
Bases: `sqlalchemy.types.TypeEngine`

An unknown type.

NullTypes will stand in if `Table` reflection encounters a column data type unknown to SQLAlchemy. The resulting columns are nearly fully usable: the DB-API adapter will handle all translation to and from the database data type.

NullType does not have sufficient information to particpate in a `CREATE TABLE` statement and will raise an exception if encountered during a `create()` operation.

class sqlalchemy.types.**Variant**(*base*, *mapping*)
Bases: `sqlalchemy.types.TypeDecorator`

A wrapping type that selects among a variety of implementations based on dialect in use.

The `Variant` type is typically constructed using the `TypeEngine.with_variant()` method.

New in version 0.7.2.

__init__(*base*, *mapping*)
Construct a new `Variant`.

Parameters

- **base** – the base 'fallback' type
- **mapping** – dictionary of string dialect names to `TypeEngine` instances.

with_variant(*type_*, *dialect_name*)
Return a new `Variant` which adds the given type + dialect name to the mapping, in addition to the mapping present in this `Variant`.

Parameters

- **type** – a `TypeEngine` that will be selected as a variant from the originating type, when a dialect of the given name is in use.
- **dialect_name** – base name of the dialect which uses this type. (i.e. `'postgresql'`, `'mysql'`, etc.)

3.8 Events

SQLAlchemy includes an event API which publishes a wide variety of hooks into the internals of both SQLAlchemy Core and ORM.

New in version 0.7: The system supercedes the previous system of "extension", "proxy", and "listener" classes.

3.8.1 Event Registration

Subscribing to an event occurs through a single API point, the `listen()` function. This function accepts a user-defined listening function, a string identifier which identifies the event to be intercepted, and a target. Additional positional and keyword arguments may be supported by specific types of events, which may specify alternate interfaces for the given event function, or provide instructions regarding secondary event targets based on the given target.

The name of an event and the argument signature of a corresponding listener function is derived from a class bound specification method, which exists bound to a marker class that's described in the documentation. For example, the documentation for `PoolEvents.connect()` indicates that the event name is `"connect"` and that a user-defined listener function should receive two positional arguments:

```
from sqlalchemy.event import listen
from sqlalchemy.pool import Pool

def my_on_connect(dbapi_con, connection_record):
    print "New DBAPI connection:", dbapi_con

listen(Pool, 'connect', my_on_connect)
```

3.8.2 Targets

The `listen()` function is very flexible regarding targets. It generally accepts classes, instances of those classes, and related classes or objects from which the appropriate target can be derived. For example, the above mentioned `"connect"` event accepts `Engine` classes and objects as well as `Pool` classes and objects:

```
from sqlalchemy.event import listen
from sqlalchemy.pool import Pool, QueuePool
from sqlalchemy import create_engine
from sqlalchemy.engine import Engine
```

```
import psycopg2

def connect():
    return psycopg2.connect(username='ed', host='127.0.0.1', dbname='test')

my_pool = QueuePool(connect)
my_engine = create_engine('postgresql://ed@localhost/test')

# associate listener with all instances of Pool
listen(Pool, 'connect', my_on_connect)

# associate listener with all instances of Pool
# via the Engine class
listen(Engine, 'connect', my_on_connect)

# associate listener with my_pool
listen(my_pool, 'connect', my_on_connect)

# associate listener with my_engine.pool
listen(my_engine, 'connect', my_on_connect)
```

3.8.3 Modifiers

Some listeners allow modifiers to be passed to `listen()`. These modifiers sometimes provide alternate calling signatures for listeners. Such as with ORM events, some event listeners can have a return value which modifies the subsequent handling. By default, no listener ever requires a return value, but by passing `retval=True` this value can be supported:

```
def validate_phone(target, value, oldvalue, initiator):
    """Strip non-numeric characters from a phone number"""

    return re.sub(r'(?![0-9])', '', value)

# setup listener on UserContact.phone attribute, instructing
# it to use the return value
listen(UserContact.phone, 'set', validate_phone, retval=True)
```

3.8.4 Event Reference

Both SQLAlchemy Core and SQLAlchemy ORM feature a wide variety of event hooks:

- **Core Events** - these are described in *Core Events* and include event hooks specific to connection pool lifecycle, SQL statement execution, transaction lifecycle, and schema creation and teardown.
- **ORM Events** - these are described in *ORM Events*, and include event hooks specific to class and attribute instrumentation, object initialization hooks, attribute on-change hooks, session state, flush, and commit hooks, mapper initialization, object/result population, and per-instance persistence hooks.

3.8.5 API Reference

`sqlalchemy.event.`**`listen`**(*target*, *identifier*, *fn*, **args*, ***kw*)

Register a listener function for the given target.

e.g.:

```
from sqlalchemy import event
from sqlalchemy.schema import UniqueConstraint

def unique_constraint_name(const, table):
    const.name = "uq_%s_%s" % (
        table.name,
        list(const.columns)[0].name
    )
event.listen(
        UniqueConstraint,
        "after_parent_attach",
        unique_constraint_name)
```

sqlalchemy.event.**listens_for**(*target*, *identifier*, **args*, ***kw*)

Decorate a function as a listener for the given target + identifier.

e.g.:

```
from sqlalchemy import event
from sqlalchemy.schema import UniqueConstraint

@event.listens_for(UniqueConstraint, "after_parent_attach")
def unique_constraint_name(const, table):
    const.name = "uq_%s_%s" % (
        table.name,
        list(const.columns)[0].name
    )
```

3.9 Core Events

This section describes the event interfaces provided in SQLAlchemy Core. For an introduction to the event listening API, see *Events*. ORM events are described in *ORM Events*.

New in version 0.7: The event system supercedes the previous system of "extension", "listener", and "proxy" classes.

3.9.1 Connection Pool Events

class sqlalchemy.events.**PoolEvents**

Available events for Pool.

The methods here define the name of an event as well as the names of members that are passed to listener functions.

e.g.:

```
from sqlalchemy import event

def my_on_checkout(dbapi_conn, connection_rec, connection_proxy):
    "handle an on checkout event"

event.listen(Pool, 'checkout', my_on_checkout)
```

In addition to accepting the `Pool` class and `Pool` instances, `PoolEvents` also accepts `Engine` objects and the `Engine` class as targets, which will be resolved to the `.pool` attribute of the given engine or the `Pool` class:

```
engine = create_engine("postgresql://scott:tiger@localhost/test")

# will associate with engine.pool
event.listen(engine, 'checkout', my_on_checkout)
```

checkin(*dbapi_connection*, *connection_record*)
Called when a connection returns to the pool.

Note that the connection may be closed, and may be None if the connection has been invalidated. `checkin` will not be called for detached connections. (They do not return to the pool.)

Parameters

- **dbapi_con** – A raw DB-API connection
- **con_record** – The `_ConnectionRecord` that persistently manages the connection

checkout(*dbapi_connection*, *connection_record*, *connection_proxy*)
Called when a connection is retrieved from the Pool.

Parameters

- **dbapi_con** – A raw DB-API connection
- **con_record** – The `_ConnectionRecord` that persistently manages the connection
- **con_proxy** – The `_ConnectionFairy` which manages the connection for the span of the current checkout.

If you raise a `DisconnectionError`, the current connection will be disposed and a fresh connection retrieved. Processing of all checkout listeners will abort and restart using the new connection.

connect(*dbapi_connection*, *connection_record*)
Called once for each new DB-API connection or Pool's `creator()`.

Parameters

- **dbapi_con** – A newly connected raw DB-API connection (not a SQLAlchemy `Connection` wrapper).
- **con_record** – The `_ConnectionRecord` that persistently manages the connection

first_connect(*dbapi_connection*, *connection_record*)
Called exactly once for the first DB-API connection.

Parameters

- **dbapi_con** – A newly connected raw DB-API connection (not a SQLAlchemy `Connection` wrapper).
- **con_record** – The `_ConnectionRecord` that persistently manages the connection

3.9.2 Connection Events

class sqlalchemy.events.**ConnectionEvents**

Available events for Connection.

The methods here define the name of an event as well as the names of members that are passed to listener functions.

e.g.:

```
from sqlalchemy import event, create_engine

def before_execute(conn, clauseelement, multiparams, params):
    log.info("Received statement: %s" % clauseelement)

engine = create_engine('postgresql://scott:tiger@localhost/test')
event.listen(engine, "before_execute", before_execute)
```

Some events allow modifiers to the listen() function.

Parameters **retval=False** – Applies to the before_execute() and before_cursor_execute() events only. When True, the user-defined event function must have a return value, which is a tuple of parameters that replace the given statement and parameters. See those methods for a description of specific return arguments.

after_cursor_execute(*conn*, *cursor*, *statement*, *parameters*, *context*, *executemany*)

Intercept low-level cursor execute() events.

after_execute(*conn*, *clauseelement*, *multiparams*, *params*, *result*)

Intercept high level execute() events.

before_cursor_execute(*conn*, *cursor*, *statement*, *parameters*, *context*, *executemany*)

Intercept low-level cursor execute() events.

before_execute(*conn*, *clauseelement*, *multiparams*, *params*)

Intercept high level execute() events.

begin(*conn*)

Intercept begin() events.

begin_twophase(*conn*, *xid*)

Intercept begin_twophase() events.

commit(*conn*)

Intercept commit() events.

commit_twophase(*conn*, *xid*, *is_prepared*)

Intercept commit_twophase() events.

dbapi_error(*conn*, *cursor*, *statement*, *parameters*, *context*, *exception*)

Intercept a raw DBAPI error.

This event is called with the DBAPI exception instance received from the DBAPI itself, *before* SQLAlchemy wraps the exception with it's own exception wrappers, and before any other operations are performed on the DBAPI cursor; the existing transaction remains in effect as well as any state on the cursor.

The use case here is to inject low-level exception handling into an Engine, typically for logging and debugging purposes. In general, user code should **not** modify any state or throw any exceptions here as this will interfere with SQLAlchemy's cleanup and error handling routines.

Subsequent to this hook, SQLAlchemy may attempt any number of operations on the connection/cursor, including closing the cursor, rolling back of the transaction in the case of connectionless execution, and

disposing of the entire connection pool if a "disconnect" was detected. The exception is then wrapped in a SQLAlchemy DBAPI exception wrapper and re-thrown.

New in version 0.7.7.

prepare_twophase(*conn*, *xid*)
Intercept prepare_twophase() events.

release_savepoint(*conn*, *name*, *context*)
Intercept release_savepoint() events.

rollback(*conn*)
Intercept rollback() events.

rollback_savepoint(*conn*, *name*, *context*)
Intercept rollback_savepoint() events.

rollback_twophase(*conn*, *xid*, *is_prepared*)
Intercept rollback_twophase() events.

savepoint(*conn*, *name=None*)
Intercept savepoint() events.

3.9.3 Schema Events

class sqlalchemy.events.**DDLEvents**
Define event listeners for schema objects, that is, SchemaItem and SchemaEvent subclasses, including MetaData, Table, Column.

MetaData and Table support events specifically regarding when CREATE and DROP DDL is emitted to the database.

Attachment events are also provided to customize behavior whenever a child schema element is associated with a parent, such as, when a Column is associated with its Table, when a ForeignKeyConstraint is associated with a Table, etc.

Example using the after_create event:

```
from sqlalchemy import event
from sqlalchemy import Table, Column, Metadata, Integer

m = MetaData()
some_table = Table('some_table', m, Column('data', Integer))

def after_create(target, connection, **kw):
    connection.execute("ALTER TABLE %s SET name=foo_%s" %
                               (target.name, target.name))

event.listen(some_table, "after_create", after_create)
```

DDL events integrate closely with the DDL class and the DDLElement hierarchy of DDL clause constructs, which are themselves appropriate as listener callables:

```
from sqlalchemy import DDL
event.listen(
    some_table,
    "after_create",
    DDL("ALTER TABLE %(table)s SET name=foo_%(table)s")
)
```

The methods here define the name of an event as well as the names of members that are passed to listener functions.

See also:

Events

DDLElement

DDL

Controlling DDL Sequences

after_create(*target*, *connection*, ***kw*)

Called after CREATE statments are emitted.

Parameters

- **target** – the MetaData or Table object which is the target of the event.
- **connection** – the Connection where the CREATE statement or statements have been emitted.
- ****kw** – additional keyword arguments relevant to the event. The contents of this dictionary may vary across releases, and include the list of tables being generated for a metadata-level event, the checkfirst flag, and other elements used by internal events.

after_drop(*target*, *connection*, ***kw*)

Called after DROP statments are emitted.

Parameters

- **target** – the MetaData or Table object which is the target of the event.
- **connection** – the Connection where the DROP statement or statements have been emitted.
- ****kw** – additional keyword arguments relevant to the event. The contents of this dictionary may vary across releases, and include the list of tables being generated for a metadata-level event, the checkfirst flag, and other elements used by internal events.

after_parent_attach(*target*, *parent*)

Called after a SchemaItem is associated with a parent SchemaItem.

Parameters

- **target** – the target object
- **parent** – the parent to which the target is being attached.

event.listen() also accepts a modifier for this event:

Parameters **propagate=False** – When True, the listener function will be established for any copies made of the target object, i.e. those copies that are generated when Table.tometadata() is used.

before_create(*target*, *connection*, ***kw*)

Called before CREATE statments are emitted.

Parameters

- **target** – the MetaData or Table object which is the target of the event.
- **connection** – the Connection where the CREATE statement or statements will be emitted.

- ****kw** – additional keyword arguments relevant to the event. The contents of this dictionary may vary across releases, and include the list of tables being generated for a metadata-level event, the checkfirst flag, and other elements used by internal events.

before_drop(*target*, *connection*, ***kw*)
Called before DROP statments are emitted.

Parameters

- **target** – the `MetaData` or `Table` object which is the target of the event.
- **connection** – the `Connection` where the DROP statement or statements will be emitted.
- ****kw** – additional keyword arguments relevant to the event. The contents of this dictionary may vary across releases, and include the list of tables being generated for a metadata-level event, the checkfirst flag, and other elements used by internal events.

before_parent_attach(*target*, *parent*)
Called before a `SchemaItem` is associated with a parent `SchemaItem`.

Parameters

- **target** – the target object
- **parent** – the parent to which the target is being attached.

`event.listen()` also accepts a modifier for this event:

Parameters **propagate=False** – When True, the listener function will be established for any copies made of the target object, i.e. those copies that are generated when `Table.tometadata()` is used.

column_reflect(*table*, *column_info*)
Called for each unit of 'column info' retrieved when a `Table` is being reflected.

The dictionary of column information as returned by the dialect is passed, and can be modified. The dictionary is that returned in each element of the list returned by `reflection.Inspector.get_columns()`.

The event is called before any action is taken against this dictionary, and the contents can be modified. The `Column` specific arguments `info`, `key`, and `quote` can also be added to the dictionary and will be passed to the constructor of `Column`.

Note that this event is only meaningful if either associated with the `Table` class across the board, e.g.:

```
from sqlalchemy.schema import Table
from sqlalchemy import event

def listen_for_reflect(table, column_info):
    "receive a column_reflect event"
    # ...

event.listen(
        Table,
        'column_reflect',
        listen_for_reflect)
```

...or with a specific `Table` instance using the `listeners` argument:

```
def listen_for_reflect(table, column_info):
    "receive a column_reflect event"
    # ...

t = Table(
    'sometable',
    autoload=True,
    listeners=[
        ('column_reflect', listen_for_reflect)
    ])
```

This because the reflection process initiated by `autoload=True` completes within the scope of the constructor for `Table`.

class `sqlalchemy.events.`**SchemaEventTarget**

Base class for elements that are the targets of `DDLEvents` events.

This includes `SchemaItem` as well as `SchemaType`.

3.10 Custom SQL Constructs and Compilation Extension

Provides an API for creation of custom ClauseElements and compilers.

3.10.1 Synopsis

Usage involves the creation of one or more `ClauseElement` subclasses and one or more callables defining its compilation:

```
from sqlalchemy.ext.compiler import compiles
from sqlalchemy.sql.expression import ColumnClause

class MyColumn(ColumnClause):
    pass

@compiles(MyColumn)
def compile_mycolumn(element, compiler, **kw):
    return "[%s]" % element.name
```

Above, `MyColumn` extends `ColumnClause`, the base expression element for named column objects. The `compiles` decorator registers itself with the `MyColumn` class so that it is invoked when the object is compiled to a string:

```
from sqlalchemy import select

s = select([MyColumn('x'), MyColumn('y')])
print str(s)
```

Produces:

```
SELECT [x], [y]
```

3.10.2 Dialect-specific compilation rules

Compilers can also be made dialect-specific. The appropriate compiler will be invoked for the dialect in use:

```
from sqlalchemy.schema import DDLElement

class AlterColumn(DDLElement):

    def __init__(self, column, cmd):
        self.column = column
        self.cmd = cmd

@compiles(AlterColumn)
def visit_alter_column(element, compiler, **kw):
    return "ALTER COLUMN %s ..." % element.column.name

@compiles(AlterColumn, 'postgresql')
def visit_alter_column(element, compiler, **kw):
    return "ALTER TABLE %s ALTER COLUMN %s ..." % (element.table.name, element.column.name)
```

The second `visit_alter_table` will be invoked when any `postgresql` dialect is used.

3.10.3 Compiling sub-elements of a custom expression construct

The `compiler` argument is the `Compiled` object in use. This object can be inspected for any information about the in-progress compilation, including `compiler.dialect`, `compiler.statement` etc. The `SQLCompiler` and `DDLCompiler` both include a `process()` method which can be used for compilation of embedded attributes:

```
from sqlalchemy.sql.expression import Executable, ClauseElement

class InsertFromSelect(Executable, ClauseElement):
    def __init__(self, table, select):
        self.table = table
        self.select = select

@compiles(InsertFromSelect)
def visit_insert_from_select(element, compiler, **kw):
    return "INSERT INTO %s (%s)" % (
        compiler.process(element.table, asfrom=True),
        compiler.process(element.select)
    )

insert = InsertFromSelect(t1, select([t1]).where(t1.c.x>5))
print insert
```

Produces:

```
"INSERT INTO mytable (SELECT mytable.x, mytable.y, mytable.z FROM mytable WHERE mytable.x > :x_1)"
```

Note: The above `InsertFromSelect` construct probably wants to have "autocommit" enabled. See *Enabling Autocommit on a Construct* for this step.

Cross Compiling between SQL and DDL compilers

SQL and DDL constructs are each compiled using different base compilers - `SQLCompiler` and `DDLCompiler`. A common need is to access the compilation rules of SQL expressions from within a DDL expression. The `DDLCompiler` includes an accessor `sql_compiler` for this reason, such as below where we generate a CHECK constraint that embeds a SQL expression:

```
@compiles(MyConstraint)
def compile_my_constraint(constraint, ddlcompiler, **kw):
    return "CONSTRAINT %s CHECK (%s)" % (
        constraint.name,
        ddlcompiler.sql_compiler.process(constraint.expression)
    )
```

3.10.4 Enabling Autocommit on a Construct

Recall from the section *Understanding Autocommit* that the `Engine`, when asked to execute a construct in the absence of a user-defined transaction, detects if the given construct represents DML or DDL, that is, a data modification or data definition statement, which requires (or may require, in the case of DDL) that the transaction generated by the DBAPI be committed (recall that DBAPI always has a transaction going on regardless of what SQLAlchemy does). Checking for this is actually accomplished by checking for the "autocommit" execution option on the construct. When building a construct like an INSERT derivation, a new DDL type, or perhaps a stored procedure that alters data, the "autocommit" option needs to be set in order for the statement to function with "connectionless" execution (as described in *Connectionless Execution, Implicit Execution*).

Currently a quick way to do this is to subclass `Executable`, then add the "autocommit" flag to the `_execution_options` dictionary (note this is a "frozen" dictionary which supplies a generative `union()` method):

```
from sqlalchemy.sql.expression import Executable, ClauseElement

class MyInsertThing(Executable, ClauseElement):
    _execution_options = \
        Executable._execution_options.union({'autocommit': True})
```

More succinctly, if the construct is truly similar to an INSERT, UPDATE, or DELETE, `UpdateBase` can be used, which already is a subclass of `Executable`, `ClauseElement` and includes the `autocommit` flag:

```
from sqlalchemy.sql.expression import UpdateBase

class MyInsertThing(UpdateBase):
    def __init__(self, ...):
        ...
```

DDL elements that subclass `DDLElement` already have the "autocommit" flag turned on.

3.10.5 Changing the default compilation of existing constructs

The compiler extension applies just as well to the existing constructs. When overriding the compilation of a built in SQL construct, the @compiles decorator is invoked upon the appropriate class (be sure to use the class, i.e. `Insert` or `Select`, instead of the creation function such as `insert()` or `select()`).

Within the new compilation function, to get at the "original" compilation routine, use the appropriate visit_XXX method - this because compiler.process() will call upon the overriding routine and cause an endless loop. Such as, to add "prefix" to all insert statements:

```
from sqlalchemy.sql.expression import Insert

@compiles(Insert)
def prefix_inserts(insert, compiler, **kw):
    return compiler.visit_insert(insert.prefix_with("some prefix"), **kw)
```

The above compiler will prefix all INSERT statements with "some prefix" when compiled.

3.10.6 Changing Compilation of Types

`compiler` works for types, too, such as below where we implement the MS-SQL specific 'max' keyword for `String`/`VARCHAR`:

```
@compiles(String, 'mssql')
@compiles(VARCHAR, 'mssql')
def compile_varchar(element, compiler, **kw):
    if element.length == 'max':
        return "VARCHAR('max')"
    else:
        return compiler.visit_VARCHAR(element, **kw)

foo = Table('foo', metadata,
    Column('data', VARCHAR('max'))
)
```

3.10.7 Subclassing Guidelines

A big part of using the compiler extension is subclassing SQLAlchemy expression constructs. To make this easier, the expression and schema packages feature a set of "bases" intended for common tasks. A synopsis is as follows:

- `ClauseElement` - This is the root expression class. Any SQL expression can be derived from this base, and is probably the best choice for longer constructs such as specialized INSERT statements.
- `ColumnElement` - The root of all "column-like" elements. Anything that you'd place in the "columns" clause of a SELECT statement (as well as order by and group by) can derive from this - the object will automatically have Python "comparison" behavior.

  `ColumnElement` classes want to have a `type` member which is expression's return type. This can be established at the instance level in the constructor, or at the class level if its generally constant:

  ```
  class timestamp(ColumnElement):
      type = TIMESTAMP()
  ```

- `FunctionElement` - This is a hybrid of a `ColumnElement` and a "from clause" like object, and represents a SQL function or stored procedure type of call. Since most databases support statements along the line of "SELECT FROM <some function>" `FunctionElement` adds in the ability to be used in the FROM clause of a `select()` construct:

```
from sqlalchemy.sql.expression import FunctionElement

class coalesce(FunctionElement):
    name = 'coalesce'

@compiles(coalesce)
def compile(element, compiler, **kw):
    return "coalesce(%s)" % compiler.process(element.clauses)

@compiles(coalesce, 'oracle')
def compile(element, compiler, **kw):
    if len(element.clauses) > 2:
        raise TypeError("coalesce only supports two arguments on Oracle")
    return "nvl(%s)" % compiler.process(element.clauses)
```

- `DDLElement` - The root of all DDL expressions, like CREATE TABLE, ALTER TABLE, etc. Compilation of `DDLElement` subclasses is issued by a `DDLCompiler` instead of a `SQLCompiler`. `DDLElement` also features `Table` and `MetaData` event hooks via the `execute_at()` method, allowing the construct to be invoked during CREATE TABLE and DROP TABLE sequences.
- `Executable` - This is a mixin which should be used with any expression class that represents a "standalone" SQL statement that can be passed directly to an `execute()` method. It is already implicit within `DDLElement` and `FunctionElement`.

3.10.8 Further Examples

"UTC timestamp" function

A function that works like "CURRENT_TIMESTAMP" except applies the appropriate conversions so that the time is in UTC time. Timestamps are best stored in relational databases as UTC, without time zones. UTC so that your database doesn't think time has gone backwards in the hour when daylight savings ends, without timezones because timezones are like character encodings - they're best applied only at the endpoints of an application (i.e. convert to UTC upon user input, re-apply desired timezone upon display).

For Postgresql and Microsoft SQL Server:

```
from sqlalchemy.sql import expression
from sqlalchemy.ext.compiler import compiles
from sqlalchemy.types import DateTime

class utcnow(expression.FunctionElement):
    type = DateTime()

@compiles(utcnow, 'postgresql')
def pg_utcnow(element, compiler, **kw):
    return "TIMEZONE('utc', CURRENT_TIMESTAMP)"

@compiles(utcnow, 'mssql')
def ms_utcnow(element, compiler, **kw):
    return "GETUTCDATE()"
```

Example usage:

```
from sqlalchemy import (
            Table, Column, Integer, String, DateTime, MetaData
```

```
        )
metadata = MetaData()
event = Table("event", metadata,
    Column("id", Integer, primary_key=True),
    Column("description", String(50), nullable=False),
    Column("timestamp", DateTime, server_default=utcnow())
)
```

"GREATEST" function

The "GREATEST" function is given any number of arguments and returns the one that is of the highest value - it's equivalent to Python's `max` function. A SQL standard version versus a CASE based version which only accommodates two arguments:

```
from sqlalchemy.sql import expression
from sqlalchemy.ext.compiler import compiles
from sqlalchemy.types import Numeric

class greatest(expression.FunctionElement):
    type = Numeric()
    name = 'greatest'

@compiles(greatest)
def default_greatest(element, compiler, **kw):
    return compiler.visit_function(element)

@compiles(greatest, 'sqlite')
@compiles(greatest, 'mssql')
@compiles(greatest, 'oracle')
def case_greatest(element, compiler, **kw):
    arg1, arg2 = list(element.clauses)
    return "CASE WHEN %s > %s THEN %s ELSE %s END" % (
        compiler.process(arg1),
        compiler.process(arg2),
        compiler.process(arg1),
        compiler.process(arg2),
    )
```

Example usage:

```
Session.query(Account).\
        filter(
            greatest(
                Account.checking_balance,
                Account.savings_balance) > 10000
        )
```

"false" expression

Render a "false" constant expression, rendering as "0" on platforms that don't have a "false" constant:

```
from sqlalchemy.sql import expression
from sqlalchemy.ext.compiler import compiles
```

```
class sql_false(expression.ColumnElement):
    pass

@compiles(sql_false)
def default_false(element, compiler, **kw):
    return "false"

@compiles(sql_false, 'mssql')
@compiles(sql_false, 'mysql')
@compiles(sql_false, 'oracle')
def int_false(element, compiler, **kw):
    return "0"
```

Example usage:

```
from sqlalchemy import select, union_all

exp = union_all(
    select([users.c.name, sql_false().label("enrolled")]),
    select([customers.c.name, customers.c.enrolled])
)
```

3.11 Expression Serializer Extension

Serializer/Deserializer objects for usage with SQLAlchemy query structures, allowing "contextual" deserialization.

Any SQLAlchemy query structure, either based on sqlalchemy.sql.* or sqlalchemy.orm.* can be used. The mappers, Tables, Columns, Session etc. which are referenced by the structure are not persisted in serialized form, but are instead re-associated with the query structure when it is deserialized.

Usage is nearly the same as that of the standard Python pickle module:

```
from sqlalchemy.ext.serializer import loads, dumps
metadata = MetaData(bind=some_engine)
Session = scoped_session(sessionmaker())

# ... define mappers

query = Session.query(MyClass).filter(MyClass.somedata=='foo').order_by(MyClass.sortkey)

# pickle the query
serialized = dumps(query)

# unpickle.  Pass in metadata + scoped_session
query2 = loads(serialized, metadata, Session)

print query2.all()
```

Similar restrictions as when using raw pickle apply; mapped classes must be themselves be pickleable, meaning they are importable from a module-level namespace.

The serializer module is only appropriate for query structures. It is not needed for:

- instances of user-defined classes. These contain no references to engines, sessions or expression constructs in the typical case and can be serialized directly.

- Table metadata that is to be loaded entirely from the serialized structure (i.e. is not already declared in the application). Regular pickle.loads()/dumps() can be used to fully dump any `MetaData` object, typically one which was reflected from an existing database at some previous point in time. The serializer module is specifically for the opposite case, where the Table metadata is already present in memory.

`sqlalchemy.ext.serializer.`**`Serializer`**(**args*, ***kw*)

`sqlalchemy.ext.serializer.`**`Deserializer`**(*file*, *metadata=None*, *scoped_session=None*, *engine=None*)

`sqlalchemy.ext.serializer.`**`dumps`**(*obj*, *protocol=0*)

`sqlalchemy.ext.serializer.`**`loads`**(*data*, *metadata=None*, *scoped_session=None*, *engine=None*)

3.12 Deprecated Event Interfaces

This section describes the class-based core event interface introduced in SQLAlchemy 0.5. The ORM analogue is described at *dep_interfaces_orm_toplevel*.

Deprecated since version 0.7: The new event system described in *Events* replaces the extension/proxy/listener system, providing a consistent interface to all events without the need for subclassing.

3.12.1 Execution, Connection and Cursor Events

class `sqlalchemy.interfaces.`**`ConnectionProxy`**

Allows interception of statement execution by Connections.

Note: `ConnectionProxy` is deprecated. Please refer to `ConnectionEvents`.

Either or both of the `execute()` and `cursor_execute()` may be implemented to intercept compiled statement and cursor level executions, e.g.:

```
class MyProxy(ConnectionProxy):
    def execute(self, conn, execute, clauseelement, *multiparams, **params):
        print "compiled statement:", clauseelement
        return execute(clauseelement, *multiparams, **params)

    def cursor_execute(self, execute, cursor, statement, parameters, context, executemany):
        print "raw statement:", statement
        return execute(cursor, statement, parameters, context)
```

The `execute` argument is a function that will fulfill the default execution behavior for the operation. The signature illustrated in the example should be used.

The proxy is installed into an `Engine` via the `proxy` argument:

```
e = create_engine('someurl://', proxy=MyProxy())
```

`begin`(*conn*, *begin*)

Intercept begin() events.

`begin_twophase`(*conn*, *begin_twophase*, *xid*)

Intercept begin_twophase() events.

`commit`(*conn*, *commit*)

Intercept commit() events.

commit_twophase(*conn*, *commit_twophase*, *xid*, *is_prepared*)
Intercept commit_twophase() events.

cursor_execute(*execute*, *cursor*, *statement*, *parameters*, *context*, *executemany*)
Intercept low-level cursor execute() events.

execute(*conn*, *execute*, *clauseelement*, **multiparams*, ***params*)
Intercept high level execute() events.

prepare_twophase(*conn*, *prepare_twophase*, *xid*)
Intercept prepare_twophase() events.

release_savepoint(*conn*, *release_savepoint*, *name*, *context*)
Intercept release_savepoint() events.

rollback(*conn*, *rollback*)
Intercept rollback() events.

rollback_savepoint(*conn*, *rollback_savepoint*, *name*, *context*)
Intercept rollback_savepoint() events.

rollback_twophase(*conn*, *rollback_twophase*, *xid*, *is_prepared*)
Intercept rollback_twophase() events.

savepoint(*conn*, *savepoint*, *name=None*)
Intercept savepoint() events.

3.12.2 Connection Pool Events

class sqlalchemy.interfaces.**PoolListener**
Hooks into the lifecycle of connections in a Pool.

Note: PoolListener is deprecated. Please refer to PoolEvents.

Usage:

```
class MyListener(PoolListener):
    def connect(self, dbapi_con, con_record):
        '''perform connect operations'''
    # etc.

# create a new pool with a listener
p = QueuePool(..., listeners=[MyListener()])

# add a listener after the fact
p.add_listener(MyListener())

# usage with create_engine()
e = create_engine("url://", listeners=[MyListener()])
```

All of the standard connection Pool types can accept event listeners for key connection lifecycle events: creation, pool check-out and check-in. There are no events fired when a connection closes.

For any given DB-API connection, there will be one connect event, *n* number of checkout events, and either *n* or *n - 1* checkin events. (If a Connection is detached from its pool via the detach() method, it won't be checked back in.)

These are low-level events for low-level objects: raw Python DB-API connections, without the conveniences of the SQLAlchemy `Connection` wrapper, `Dialect` services or `ClauseElement` execution. If you execute SQL through the connection, explicitly closing all cursors and other resources is recommended.

Events also receive a `_ConnectionRecord`, a long-lived internal `Pool` object that basically represents a "slot" in the connection pool. `_ConnectionRecord` objects have one public attribute of note: `info`, a dictionary whose contents are scoped to the lifetime of the DB-API connection managed by the record. You can use this shared storage area however you like.

There is no need to subclass `PoolListener` to handle events. Any class that implements one or more of these methods can be used as a pool listener. The `Pool` will inspect the methods provided by a listener object and add the listener to one or more internal event queues based on its capabilities. In terms of efficiency and function call overhead, you're much better off only providing implementations for the hooks you'll be using.

checkin(*dbapi_con*, *con_record*)
Called when a connection returns to the pool.

Note that the connection may be closed, and may be None if the connection has been invalidated. `checkin` will not be called for detached connections. (They do not return to the pool.)

dbapi_con A raw DB-API connection

con_record The `_ConnectionRecord` that persistently manages the connection

checkout(*dbapi_con*, *con_record*, *con_proxy*)
Called when a connection is retrieved from the Pool.

dbapi_con A raw DB-API connection

con_record The `_ConnectionRecord` that persistently manages the connection

con_proxy The `_ConnectionFairy` which manages the connection for the span of the current checkout.

If you raise an `exc.DisconnectionError`, the current connection will be disposed and a fresh connection retrieved. Processing of all checkout listeners will abort and restart using the new connection.

connect(*dbapi_con*, *con_record*)
Called once for each new DB-API connection or Pool's `creator()`.

dbapi_con A newly connected raw DB-API connection (not a SQLAlchemy `Connection` wrapper).

con_record The `_ConnectionRecord` that persistently manages the connection

first_connect(*dbapi_con*, *con_record*)
Called exactly once for the first DB-API connection.

dbapi_con A newly connected raw DB-API connection (not a SQLAlchemy `Connection` wrapper).

con_record The `_ConnectionRecord` that persistently manages the connection

3.13 Core Exceptions

Exceptions used with SQLAlchemy.

The base exception class is `SQLAlchemyError`. Exceptions which are raised as a result of DBAPI exceptions are all subclasses of `DBAPIError`.

exception sqlalchemy.exc.**ArgumentError**
Bases: `sqlalchemy.exc.SQLAlchemyError`

Raised when an invalid or conflicting function argument is supplied.

This error generally corresponds to construction time state errors.

exception sqlalchemy.exc.**CircularDependencyError**(*message*, *cycles*, *edges*, *msg=None*)
Bases: sqlalchemy.exc.SQLAlchemyError

Raised by topological sorts when a circular dependency is detected.

There are two scenarios where this error occurs:

- In a Session flush operation, if two objects are mutually dependent on each other, they can not be inserted or deleted via INSERT or DELETE statements alone; an UPDATE will be needed to post-associate or pre-deassociate one of the foreign key constrained values. The `post_update` flag described at *Rows that point to themselves / Mutually Dependent Rows* can resolve this cycle.
- In a `MetaData.create_all()`, `MetaData.drop_all()`, `MetaData.sorted_tables` operation, two `ForeignKey` or `ForeignKeyConstraint` objects mutually refer to each other. Apply the `use_alter=True` flag to one or both, see *Creating/Dropping Foreign Key Constraints via ALTER*.

exception sqlalchemy.exc.**CompileError**
Bases: sqlalchemy.exc.SQLAlchemyError

Raised when an error occurs during SQL compilation

exception sqlalchemy.exc.**DBAPIError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: sqlalchemy.exc.StatementError

Raised when the execution of a database operation fails.

Wraps exceptions raised by the DB-API underlying the database operation. Driver-specific implementations of the standard DB-API exception types are wrapped by matching sub-types of SQLAlchemy's `DBAPIError` when possible. DB-API's `Error` type maps to `DBAPIError` in SQLAlchemy, otherwise the names are identical. Note that there is no guarantee that different DB-API implementations will raise the same exception type for any given error condition.

`DBAPIError` features `statement` and `params` attributes which supply context regarding the specifics of the statement which had an issue, for the typical case when the error was raised within the context of emitting a SQL statement.

The wrapped exception object is available in the `orig` attribute. Its type and properties are DB-API implementation specific.

exception sqlalchemy.exc.**DataError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: sqlalchemy.exc.DatabaseError

Wraps a DB-API DataError.

exception sqlalchemy.exc.**DatabaseError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: sqlalchemy.exc.DBAPIError

Wraps a DB-API DatabaseError.

exception sqlalchemy.exc.**DisconnectionError**
Bases: sqlalchemy.exc.SQLAlchemyError

A disconnect is detected on a raw DB-API connection.

This error is raised and consumed internally by a connection pool. It can be raised by the `PoolEvents.checkout()` event so that the host pool forces a retry; the exception will be caught three times in a row before the pool gives up and raises `InvalidRequestError` regarding the connection attempt.

class sqlalchemy.exc.**DontWrapMixin**
Bases: object

A mixin class which, when applied to a user-defined Exception class, will not be wrapped inside of `StatementError` if the error is emitted within the process of executing a statement.
E.g.:: from sqlalchemy.exc import DontWrapMixin

class MyCustomException(Exception, DontWrapMixin): pass

class MySpecialType(TypeDecorator): impl = String

def process_bind_param(self, value, dialect):

if value == 'invalid': raise MyCustomException("invalid!")

exception `sqlalchemy.exc.`**IdentifierError**
Bases: `sqlalchemy.exc.SQLAlchemyError`

Raised when a schema name is beyond the max character limit

exception `sqlalchemy.exc.`**IntegrityError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: `sqlalchemy.exc.DatabaseError`

Wraps a DB-API IntegrityError.

exception `sqlalchemy.exc.`**InterfaceError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: `sqlalchemy.exc.DBAPIError`

Wraps a DB-API InterfaceError.

exception `sqlalchemy.exc.`**InternalError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: `sqlalchemy.exc.DatabaseError`

Wraps a DB-API InternalError.

exception `sqlalchemy.exc.`**InvalidRequestError**
Bases: `sqlalchemy.exc.SQLAlchemyError`

SQLAlchemy was asked to do something it can't do.

This error generally corresponds to runtime state errors.

exception `sqlalchemy.exc.`**NoReferenceError**
Bases: `sqlalchemy.exc.InvalidRequestError`

Raised by `ForeignKey` to indicate a reference cannot be resolved.

exception `sqlalchemy.exc.`**NoReferencedColumnError**(*message*, *tname*, *cname*)
Bases: `sqlalchemy.exc.NoReferenceError`

Raised by `ForeignKey` when the referred `Column` cannot be located.

exception `sqlalchemy.exc.`**NoReferencedTableError**(*message*, *tname*)
Bases: `sqlalchemy.exc.NoReferenceError`

Raised by `ForeignKey` when the referred `Table` cannot be located.

exception `sqlalchemy.exc.`**NoSuchColumnError**
Bases: `exceptions.KeyError`, `sqlalchemy.exc.InvalidRequestError`

A nonexistent column is requested from a `RowProxy`.

exception `sqlalchemy.exc.`**NoSuchTableError**
Bases: `sqlalchemy.exc.InvalidRequestError`

Table does not exist or is not visible to a connection.

exception sqlalchemy.exc.**NotSupportedError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: sqlalchemy.exc.DatabaseError

Wraps a DB-API NotSupportedError.

exception sqlalchemy.exc.**OperationalError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: sqlalchemy.exc.DatabaseError

Wraps a DB-API OperationalError.

exception sqlalchemy.exc.**ProgrammingError**(*statement*, *params*, *orig*, *connection_invalidated=False*)
Bases: sqlalchemy.exc.DatabaseError

Wraps a DB-API ProgrammingError.

exception sqlalchemy.exc.**ResourceClosedError**
Bases: sqlalchemy.exc.InvalidRequestError

An operation was requested from a connection, cursor, or other object that's in a closed state.

exception sqlalchemy.exc.**SADeprecationWarning**
Bases: exceptions.DeprecationWarning

Issued once per usage of a deprecated API.

exception sqlalchemy.exc.**SAPendingDeprecationWarning**
Bases: exceptions.PendingDeprecationWarning

Issued once per usage of a deprecated API.

exception sqlalchemy.exc.**SAWarning**
Bases: exceptions.RuntimeWarning

Issued at runtime.

exception sqlalchemy.exc.**SQLAlchemyError**
Bases: exceptions.Exception

Generic error class.

exception sqlalchemy.exc.**StatementError**(*message*, *statement*, *params*, *orig*)
Bases: sqlalchemy.exc.SQLAlchemyError

An error occurred during execution of a SQL statement.

StatementError wraps the exception raised during execution, and features statement and params attributes which supply context regarding the specifics of the statement which had an issue.

The wrapped exception object is available in the orig attribute.

orig = None
The DBAPI exception object.

params = None
The parameter list being used when this exception occurred.

statement = None
The string SQL statement being invoked when this exception occurred.

exception sqlalchemy.exc.**TimeoutError**
Bases: sqlalchemy.exc.SQLAlchemyError

Raised when a connection pool times out on getting a connection.

exception sqlalchemy.exc.**UnboundExecutionError**
Bases: sqlalchemy.exc.InvalidRequestError

SQL was attempted without a database connection to execute it on.

3.14 Core Internals

Some key internal constructs are listed here.

class sqlalchemy.engine.base.**Compiled**(*dialect*, *statement*, *bind=None*)
Bases: object

Represent a compiled SQL or DDL expression.

The __str__ method of the Compiled object should produce the actual text of the statement. Compiled objects are specific to their underlying database dialect, and also may or may not be specific to the columns referenced within a particular set of bind parameters. In no case should the Compiled object be dependent on the actual values of those bind parameters, even though it may reference those values as defaults.

__init__(*dialect*, *statement*, *bind=None*)
Construct a new Compiled object.

Parameters

- **dialect** – Dialect to compile against.
- **statement** – ClauseElement to be compiled.
- **bind** – Optional Engine or Connection to compile this statement against.

compile()
Produce the internal string representation of this element.

Deprecated since version 0.7: Compiled objects now compile within the constructor.

construct_params(*params=None*)
Return the bind params for this compiled object.

Parameters **params** – a dict of string/object pairs whose values will override bind values compiled in to the statement.

execute(**multiparams*, ***params*)
Execute this compiled object.

params
Return the bind params for this compiled object.

process(*obj*, ***kwargs*)

scalar(**multiparams*, ***params*)
Execute this compiled object and return the result's scalar value.

sql_compiler
Return a Compiled that is capable of processing SQL expressions.

If this compiler is one, it would likely just return 'self'.

class sqlalchemy.sql.compiler.**DDLCompiler**(*dialect*, *statement*, *bind=None*)
Bases: sqlalchemy.engine.base.Compiled

define_constraint_remote_table(*constraint*, *table*, *preparer*)
Format the remote table clause of a CREATE CONSTRAINT clause.

class sqlalchemy.engine.default.**DefaultDialect**(*convert_unicode=False*, *assert_unicode=False*, *encoding='utf-8'*, *paramstyle=None*, *dbapi=None*, *implicit_returning=None*, *label_length=None*, ***kwargs*)

Bases: sqlalchemy.engine.base.Dialect

Default implementation of Dialect

colspecs = {}

connect(**cargs*, ***cparams*)

create_connect_args(*url*)

create_xid()
Create a random two-phase transaction ID.

This id will be passed to do_begin_twophase(), do_rollback_twophase(), do_commit_twophase(). Its format is unspecified.

dbapi_type_map = {}

ddl_compiler
alias of DDLCompiler

default_paramstyle = 'named'

description_encoding = 'use_encoding'

dialect_description

do_begin(*connection*)
Implementations might want to put logic here for turning autocommit on/off, etc.

do_commit(*connection*)
Implementations might want to put logic here for turning autocommit on/off, etc.

do_execute(*cursor*, *statement*, *parameters*, *context=None*)

do_execute_no_params(*cursor*, *statement*, *context=None*)

do_executemany(*cursor*, *statement*, *parameters*, *context=None*)

do_release_savepoint(*connection*, *name*)

do_rollback(*connection*)
Implementations might want to put logic here for turning autocommit on/off, etc.

do_rollback_to_savepoint(*connection*, *name*)

do_savepoint(*connection*, *name*)

execute_sequence_format
alias of tuple

execution_ctx_cls
alias of DefaultExecutionContext

get_pk_constraint(*conn*, *table_name*, *schema=None*, ***kw*)
Compatibility method, adapts the result of get_primary_keys() for those dialects which don't implement get_pk_constraint().

classmethod get_pool_class(*url*)

implicit_returning = False

initialize(*connection*)

is_disconnect(*e*, *connection*, *cursor*)

max_identifier_length = 9999

max_index_name_length = None

name = 'default'

on_connect()
return a callable which sets up a newly created DBAPI connection.

This is used to set dialect-wide per-connection options such as isolation modes, unicode modes, etc.

If a callable is returned, it will be assembled into a pool listener that receives the direct DBAPI connection, with all wrappers removed.

If None is returned, no listener will be generated.

postfetch_lastrowid = True

preexecute_autoincrement_sequences = False

preparer
alias of `IdentifierPreparer`

reflection_options = ()

reflecttable(*connection*, *table*, *include_columns*, *exclude_columns=None*)

requires_name_normalize = False

reset_isolation_level(*dbapi_conn*)

returns_unicode_strings = False

sequences_optional = False

server_version_info = None

statement_compiler
alias of `SQLCompiler`

supports_alter = True

supports_default_values = False

supports_empty_insert = True

supports_native_boolean = False

supports_native_decimal = False

supports_native_enum = False

supports_sane_multi_rowcount = True

supports_sane_rowcount = True

supports_sequences = False

supports_unicode_binds = False

supports_unicode_statements = False

supports_views = True

type_compiler
alias of `GenericTypeCompiler`

type_descriptor(*typeobj*)
Provide a database-specific `TypeEngine` object, given the generic object which comes from the types module.

This method looks for a dictionary called `colspecs` as a class or instance-level variable, and passes on to `types.adapt_type()`.

validate_identifier(*ident*)

class sqlalchemy.engine.base.**Dialect**
Bases: `object`

Define the behavior of a specific database and DB-API combination.

Any aspect of metadata definition, SQL query generation, execution, result-set handling, or anything else which varies between databases is defined under the general category of the Dialect. The Dialect acts as a factory for other database-specific object implementations including ExecutionContext, Compiled, DefaultGenerator, and TypeEngine.

All Dialects implement the following attributes:
name identifying name for the dialect from a DBAPI-neutral point of view (i.e. 'sqlite')
driver identifying name for the dialect's DBAPI
positional True if the paramstyle for this Dialect is positional.
paramstyle the paramstyle to be used (some DB-APIs support multiple paramstyles).
convert_unicode True if Unicode conversion should be applied to all `str` types.
encoding type of encoding to use for unicode, usually defaults to 'utf-8'.
statement_compiler a `Compiled` class used to compile SQL statements
ddl_compiler a `Compiled` class used to compile DDL statements
server_version_info a tuple containing a version number for the DB backend in use. This value is only available for supporting dialects, and is typically populated during the initial connection to the database.
default_schema_name the name of the default schema. This value is only available for supporting dialects, and is typically populated during the initial connection to the database.
execution_ctx_cls a `ExecutionContext` class used to handle statement execution
execute_sequence_format either the 'tuple' or 'list' type, depending on what cursor.execute() accepts for the second argument (they vary).
preparer a `IdentifierPreparer` class used to quote identifiers.
supports_alter `True` if the database supports `ALTER TABLE`.
max_identifier_length The maximum length of identifier names.
supports_unicode_statements Indicate whether the DB-API can receive SQL statements as Python unicode strings
supports_unicode_binds Indicate whether the DB-API can receive string bind parameters as Python unicode strings
supports_sane_rowcount Indicate whether the dialect properly implements rowcount for `UPDATE` and `DELETE` statements.
supports_sane_multi_rowcount Indicate whether the dialect properly implements rowcount for `UPDATE` and `DELETE` statements when executed via executemany.
preexecute_autoincrement_sequences True if 'implicit' primary key functions must be executed separately in order to get their value. This is currently oriented towards Postgresql.
implicit_returning use RETURNING or equivalent during INSERT execution in order to load newly generated primary keys and other column defaults in one execution, which are then available via inserted_primary_key. If an insert statement has returning() specified explicitly, the "implicit" functionality is not used and inserted_primary_key will not be available.
dbapi_type_map A mapping of DB-API type objects present in this Dialect's DB-API implementation mapped to TypeEngine implementations used by the dialect.

This is used to apply types to result sets based on the DB-API types present in cursor.description; it only takes effect for result sets against textual statements where no explicit typemap was present.

colspecs A dictionary of TypeEngine classes from sqlalchemy.types mapped to subclasses that are specific to the dialect class. This dictionary is class-level only and is not accessed from the dialect instance itself.

supports_default_values Indicates if the construct `INSERT INTO tablename DEFAULT VALUES` is supported

supports_sequences Indicates if the dialect supports CREATE SEQUENCE or similar.

sequences_optional If True, indicates if the "optional" flag on the Sequence() construct should signal to not generate a CREATE SEQUENCE. Applies only to dialects that support sequences. Currently used only to allow Postgresql SERIAL to be used on a column that specifies Sequence() for usage on other backends.

supports_native_enum Indicates if the dialect supports a native ENUM construct. This will prevent types.Enum from generating a CHECK constraint when that type is used.

supports_native_boolean Indicates if the dialect supports a native boolean construct. This will prevent types.Boolean from generating a CHECK constraint when that type is used.

connect()
return a callable which sets up a newly created DBAPI connection.

The callable accepts a single argument "conn" which is the DBAPI connection itself. It has no return value.

This is used to set dialect-wide per-connection options such as isolation modes, unicode modes, etc.

If a callable is returned, it will be assembled into a pool listener that receives the direct DBAPI connection, with all wrappers removed.

If None is returned, no listener will be generated.

create_connect_args(*url*)
Build DB-API compatible connection arguments.

Given a `URL` object, returns a tuple consisting of a **args*/***kwargs* suitable to send directly to the dbapi's connect function.

create_xid()
Create a two-phase transaction ID.

This id will be passed to do_begin_twophase(), do_rollback_twophase(), do_commit_twophase(). Its format is unspecified.

denormalize_name(*name*)
convert the given name to a case insensitive identifier for the backend if it is an all-lowercase name.

this method is only used if the dialect defines requires_name_normalize=True.

do_begin(*connection*)
Provide an implementation of *connection.begin()*, given a DB-API connection.

do_begin_twophase(*connection*, *xid*)
Begin a two phase transaction on the given connection.

do_commit(*connection*)
Provide an implementation of *connection.commit()*, given a DB-API connection.

do_commit_twophase(*connection*, *xid*, *is_prepared=True*, *recover=False*)
Commit a two phase transaction on the given connection.

do_execute(*cursor*, *statement*, *parameters*, *context=None*)
Provide an implementation of `cursor.execute(statement, parameters)`.

do_execute_no_params(*cursor*, *statement*, *parameters*, *context=None*)
Provide an implementation of `cursor.execute(statement)`.

The parameter collection should not be sent.

do_executemany(*cursor*, *statement*, *parameters*, *context=None*)
Provide an implementation of `cursor.executemany(statement, parameters)`.

do_prepare_twophase(*connection*, *xid*)
Prepare a two phase transaction on the given connection.

do_recover_twophase(*connection*)
Recover list of uncommited prepared two phase transaction identifiers on the given connection.

do_release_savepoint(*connection*, *name*)
Release the named savepoint on a SQL Alchemy connection.

do_rollback(*connection*)
Provide an implementation of *connection.rollback()*, given a DB-API connection.

do_rollback_to_savepoint(*connection*, *name*)
Rollback a SQL Alchemy connection to the named savepoint.

do_rollback_twophase(*connection*, *xid*, *is_prepared=True*, *recover=False*)
Rollback a two phase transaction on the given connection.

do_savepoint(*connection*, *name*)
Create a savepoint with the given name on a SQLAlchemy connection.

get_columns(*connection*, *table_name*, *schema=None*, ***kw*)
Return information about columns in *table_name*.

Given a `Connection`, a string *table_name*, and an optional string *schema*, return column information as a list of dictionaries with these keys:

name the column's name

type [sqlalchemy.types#TypeEngine]

nullable boolean

default the column's default value

autoincrement boolean

sequence

a dictionary of the form {'name' : str, 'start' :int, 'increment': int}

Additional column attributes may be present.

get_foreign_keys(*connection*, *table_name*, *schema=None*, ***kw*)
Return information about foreign_keys in *table_name*.

Given a `Connection`, a string *table_name*, and an optional string *schema*, return foreign key information as a list of dicts with these keys:

name the constraint's name

constrained_columns a list of column names that make up the foreign key

referred_schema the name of the referred schema

referred_table the name of the referred table

referred_columns a list of column names in the referred table that correspond to constrained_columns

get_indexes(*connection*, *table_name*, *schema=None*, ***kw*)
Return information about indexes in *table_name*.

Given a `Connection`, a string *table_name* and an optional string *schema*, return index information as a list of dictionaries with these keys:

name the index's name

column_names list of column names in order

unique boolean

get_isolation_level(*dbapi_conn*)
Given a DBAPI connection, return its isolation level.

get_pk_constraint(*table_name*, *schema=None*, ***kw*)
Return information about the primary key constraint on table_name‘.

Given a string *table_name*, and an optional string *schema*, return primary key information as a dictionary with these keys:

constrained_columns a list of column names that make up the primary key

name optional name of the primary key constraint.

get_primary_keys(*connection*, *table_name*, *schema=None*, ***kw*)
Return information about primary keys in *table_name*.

Given a `Connection`, a string *table_name*, and an optional string *schema*, return primary key information as a list of column names.

get_table_names(*connection*, *schema=None*, ***kw*)
Return a list of table names for *schema*.

get_view_definition(*connection*, *view_name*, *schema=None*, ***kw*)
Return view definition.

Given a `Connection`, a string *view_name*, and an optional string *schema*, return the view definition.

get_view_names(*connection*, *schema=None*, ***kw*)
Return a list of all view names available in the database.

schema: Optional, retrieve names from a non-default schema.

has_sequence(*connection*, *sequence_name*, *schema=None*)
Check the existence of a particular sequence in the database.

Given a `Connection` object and a string *sequence_name*, return True if the given sequence exists in the database, False otherwise.

has_table(*connection*, *table_name*, *schema=None*)
Check the existence of a particular table in the database.

Given a `Connection` object and a string *table_name*, return True if the given table (possibly within the specified *schema*) exists in the database, False otherwise.

initialize(*connection*)
Called during strategized creation of the dialect with a connection.

Allows dialects to configure options based on server version info or other properties.

The connection passed here is a SQLAlchemy Connection object, with full capabilities.

The initalize() method of the base dialect should be called via super().

is_disconnect(*e*, *connection*, *cursor*)
Return True if the given DB-API error indicates an invalid connection

normalize_name(*name*)
convert the given name to lowercase if it is detected as case insensitive.

this method is only used if the dialect defines requires_name_normalize=True.

reflecttable(*connection*, *table*, *include_columns=None*)
Load table description from the database.

Given a `Connection` and a `Table` object, reflect its columns and properties from the database. If include_columns (a list or set) is specified, limit the autoload to the given column names.

The default implementation uses the `Inspector` interface to provide the output, building upon the granular table/column/ constraint etc. methods of `Dialect`.

reset_isolation_level(*dbapi_conn*)
Given a DBAPI connection, revert its isolation to the default.

set_isolation_level(*dbapi_conn*, *level*)
Given a DBAPI connection, set its isolation level.

classmethod type_descriptor(*typeobj*)
Transform a generic type to a dialect-specific type.

Dialect classes will usually use the `adapt_type()` function in the types module to make this job easy.

The returned result is cached *per dialect class* so can contain no dialect-instance state.

class sqlalchemy.engine.default.**DefaultExecutionContext**
Bases: `sqlalchemy.engine.base.ExecutionContext`

compiled = None

connection

create_cursor()

executemany = False

get_insert_default(*column*)

get_lastrowid()
return self.cursor.lastrowid, or equivalent, after an INSERT.

This may involve calling special cursor functions, issuing a new SELECT on the cursor (or a new one), or returning a stored value that was calculated within post_exec().

This function will only be called for dialects which support "implicit" primary key generation, keep preexecute_autoincrement_sequences set to False, and when no explicit id value was bound to the statement.

The function is called once, directly after post_exec() and before the transaction is committed or ResultProxy is generated. If the post_exec() method assigns a value to *self._lastrowid*, the value is used in place of calling get_lastrowid().

Note that this method is *not* equivalent to the `lastrowid` method on `ResultProxy`, which is a direct proxy to the DBAPI `lastrowid` accessor in all cases.

get_result_proxy()

get_update_default(*column*)

handle_dbapi_exception(*e*)

is_crud

isddl = False

isdelete = False

isinsert = False

isupdate = False

lastrow_has_defaults()

no_parameters

post_exec()

post_insert()

postfetch_cols = None

pre_exec()

prefetch_cols = None

result_map = None

rowcount

set_input_sizes(*translate=None*, *exclude_types=None*)
Given a cursor and ClauseParameters, call the appropriate style of `setinputsizes()` on the cursor, using DB-API types from the bind parameter's `TypeEngine` objects.

This method only called by those dialects which require it, currently cx_oracle.

should_autocommit

should_autocommit_text(*statement*)

statement = None

supports_sane_multi_rowcount()

supports_sane_rowcount()

class sqlalchemy.engine.base.**ExecutionContext**
Bases: `object`

A messenger object for a Dialect that corresponds to a single execution.

ExecutionContext should have these data members:
connection Connection object which can be freely used by default value generators to execute SQL. This Connection should reference the same underlying connection/transactional resources of root_connection.
root_connection Connection object which is the source of this ExecutionContext. This Connection may have close_with_result=True set, in which case it can only be used once.
dialect dialect which created this ExecutionContext.
cursor DB-API cursor procured from the connection,
compiled if passed to constructor, sqlalchemy.engine.base.Compiled object being executed,
statement string version of the statement to be executed. Is either passed to the constructor, or must be created from the sql.Compiled object by the time pre_exec() has completed.
parameters bind parameters passed to the execute() method. For compiled statements, this is a dictionary or list of dictionaries. For textual statements, it should be in a format suitable for the dialect's paramstyle (i.e. dict or list of dicts for non positional, list or list of lists/tuples for positional).
isinsert True if the statement is an INSERT.
isupdate True if the statement is an UPDATE.
should_autocommit True if the statement is a "committable" statement.
postfetch_cols a list of Column objects for which a server-side default or inline SQL expression value was fired off. Applies to inserts and updates.

create_cursor()
Return a new cursor generated from this ExecutionContext's connection.

Some dialects may wish to change the behavior of connection.cursor(), such as postgresql which may return a PG "server side" cursor.

get_rowcount()
Return the DBAPI `cursor.rowcount` value, or in some cases an interpreted value.

See `ResultProxy.rowcount` for details on this.

handle_dbapi_exception(*e*)
Receive a DBAPI exception which occurred upon execute, result fetch, etc.

lastrow_has_defaults()
Return True if the last INSERT or UPDATE row contained inlined or database-side defaults.

post_exec()
Called after the execution of a compiled statement.

If a compiled statement was passed to this ExecutionContext, the *last_insert_ids*, *last_inserted_params*, etc. datamembers should be available after this method completes.

pre_exec()
Called before an execution of a compiled statement.

If a compiled statement was passed to this ExecutionContext, the *statement* and *parameters* datamembers must be initialized after this statement is complete.

result()
Return a result object corresponding to this ExecutionContext.

Returns a ResultProxy.

should_autocommit_text(*statement*)
Parse the given textual statement and return True if it refers to a "committable" statement

class sqlalchemy.sql.compiler.**IdentifierPreparer**(*dialect*, *initial_quote=""*, *final_quote=None*, *escape_quote=""*, *omit_schema=False*)

Bases: `object`

Handle quoting and case-folding of identifiers based on options.

__init__(*dialect*, *initial_quote=""*, *final_quote=None*, *escape_quote=""*, *omit_schema=False*)
Construct a new `IdentifierPreparer` object.

initial_quote Character that begins a delimited identifier.

final_quote Character that ends a delimited identifier. Defaults to *initial_quote*.

omit_schema Prevent prepending schema name. Useful for databases that do not support schemae.

format_column(*column*, *use_table=False*, *name=None*, *table_name=None*)
Prepare a quoted column name.

format_schema(*name*, *quote*)
Prepare a quoted schema name.

format_table(*table*, *use_schema=True*, *name=None*)
Prepare a quoted table and schema name.

format_table_seq(*table*, *use_schema=True*)
Format table name and schema as a tuple.

quote_identifier(*value*)
Quote an identifier.

Subclasses should override this to provide database-dependent quoting behavior.

quote_schema(*schema*, *force*)
Quote a schema.

Subclasses should override this to provide database-dependent quoting behavior.

unformat_identifiers(*identifiers*)
Unpack 'schema.table.column'-like strings into components.

class sqlalchemy.sql.compiler.**SQLCompiler**(*dialect*, *statement*, *column_keys=None*, *inline=False*, ***kwargs*)
Bases: sqlalchemy.engine.base.Compiled

Default implementation of Compiled.

Compiles ClauseElements into SQL strings. Uses a similar visit paradigm as visitors.ClauseVisitor but implements its own traversal.

__init__(*dialect*, *statement*, *column_keys=None*, *inline=False*, ***kwargs*)
Construct a new `DefaultCompiler` object.

dialect Dialect to be used

statement ClauseElement to be compiled

column_keys a list of column names to be compiled into an INSERT or UPDATE statement.

ansi_bind_rules = False
SQL 92 doesn't allow bind parameters to be used in the columns clause of a SELECT, nor does it allow ambiguous expressions like "? = ?". A compiler subclass can set this flag to False if the target driver/DB enforces this

construct_params(*params=None*, *_group_number=None*, *_check=True*)
return a dictionary of bind parameter keys and values

default_from()
Called when a SELECT statement has no froms, and no FROM clause is to be appended.

Gives Oracle a chance to tack on a `FROM DUAL` to the string output.

escape_literal_column(*text*)
provide escaping for the literal_column() construct.

get_select_precolumns(*select*)
Called when building a `SELECT` statement, position is just before column list.

isdelete = False
class-level defaults which can be set at the instance level to define if this Compiled instance represents INSERT/UPDATE/DELETE

isinsert = False
class-level defaults which can be set at the instance level to define if this Compiled instance represents INSERT/UPDATE/DELETE

isupdate = False
class-level defaults which can be set at the instance level to define if this Compiled instance represents INSERT/UPDATE/DELETE

label_select_column(*select*, *column*, *asfrom*)
label columns present in a select().

params
Return the bind param dictionary embedded into this compiled object, for those values that are present.

render_literal_value(*value*, *type_*)
Render the value of a bind parameter as a quoted literal.

This is used for statement sections that do not accept bind parameters on the target driver/database.

This should be implemented by subclasses using the quoting services of the DBAPI.

render_table_with_column_in_update_from = False
set to True classwide to indicate the SET clause in a multi-table UPDATE statement should qualify columns with the table name (i.e. MySQL only)

returning = None
holds the "returning" collection of columns if the statement is CRUD and defines returning columns either implicitly or explicitly

returning_precedes_values = False
set to True classwide to generate RETURNING clauses before the VALUES or WHERE clause (i.e. MSSQL)

update_from_clause(*update_stmt*, *from_table*, *extra_froms*, *from_hints*, ***kw*)
Provide a hook to override the generation of an UPDATE..FROM clause.

MySQL and MSSQL override this.

update_limit_clause(*update_stmt*)
Provide a hook for MySQL to add LIMIT to the UPDATE

update_tables_clause(*update_stmt*, *from_table*, *extra_froms*, ***kw*)
Provide a hook to override the initial table clause in an UPDATE statement.

MySQL overrides this.

CHAPTER 4

Dialects

The **dialect** is the system SQLAlchemy uses to communicate with various types of DBAPIs and databases. A compatibility chart of supported backends can be found at *Supported Databases*. The sections that follow contain reference documentation and notes specific to the usage of each backend, as well as notes for the various DBAPIs.

Note that not all backends are fully ported and tested with current versions of SQLAlchemy. The compatibility chart should be consulted to check for current support level.

4.1 Drizzle

Support for the Drizzle database.

Drizzle is a variant of MySQL. Unlike MySQL, Drizzle's default storage engine is InnoDB (transactions, foreign-keys) rather than MyISAM. For more Notable Differences, visit the Drizzle Documentation.

The SQLAlchemy Drizzle dialect leans heavily on the MySQL dialect, so much of the *SQLAlchemy MySQL* documentation is also relevant.

4.1.1 Connecting

See the individual driver sections below for details on connecting.

4.1.2 Drizzle Data Types

As with all SQLAlchemy dialects, all UPPERCASE types that are known to be valid with Drizzle are importable from the top level dialect:

```
from sqlalchemy.dialects.drizzle import \
        BIGINT, BINARY, BLOB, BOOLEAN, CHAR, DATE, DATETIME,
        DECIMAL, DOUBLE, ENUM, FLOAT, INT, INTEGER,
        NUMERIC, TEXT, TIME, TIMESTAMP, VARBINARY, VARCHAR
```

Types which are specific to Drizzle, or have Drizzle-specific construction arguments, are as follows:

class sqlalchemy.dialects.drizzle.**BIGINT**(***kw*)

Bases: sqlalchemy.types.BIGINT

Drizzle BIGINTEGER type.

__init__(***kw*)
Construct a BIGINTEGER.

class sqlalchemy.dialects.drizzle.**CHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.dialects.drizzle.base._StringType, sqlalchemy.types.CHAR

Drizzle CHAR type, for fixed-length character data.

__init__(*length=None*, ***kwargs*)
Construct a CHAR.

Parameters

- **length** – Maximum data length, in characters.
- **binary** – Optional, use the default binary collation for the national character set. This does not affect the type of data stored, use a BINARY type for binary data.
- **collation** – Optional, request a particular collation. Must be compatible with the national character set.

class sqlalchemy.dialects.drizzle.**DECIMAL**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Bases: sqlalchemy.dialects.drizzle.base._NumericType, sqlalchemy.types.DECIMAL

Drizzle DECIMAL type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Construct a DECIMAL.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.

class sqlalchemy.dialects.drizzle.**DOUBLE**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Bases: sqlalchemy.dialects.drizzle.base._FloatType

Drizzle DOUBLE type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Construct a DOUBLE.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.

class sqlalchemy.dialects.drizzle.**ENUM**(**enums*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base.ENUM

Drizzle ENUM type.

__init__(**enums*, ***kw*)
Construct an ENUM.

Example:

Column('myenum', ENUM("foo", "bar", "baz"))

Parameters

- **enums** – The range of valid values for this ENUM. Values will be quoted when generating the schema according to the quoting flag (see below).
- **strict** – Defaults to False: ensure that a given value is in this ENUM's range of permissible values when inserting or updating rows. Note that Drizzle will not raise a fatal error if you attempt to store an out of range value- an alternate value will be stored instead. (See Drizzle ENUM documentation.)
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.
- **quoting** – Defaults to 'auto': automatically determine enum value quoting. If all enum values are surrounded by the same quoting character, then use 'quoted' mode. Otherwise, use 'unquoted' mode.

  'quoted': values in enums are already quoted, they will be used directly when generating the schema - this usage is deprecated.

  'unquoted': values in enums are not quoted, they will be escaped and surrounded by single quotes when generating the schema.

  Previous versions of this type always required manually quoted values to be supplied; future versions will always quote the string literals for you. This is a transitional option.

class sqlalchemy.dialects.drizzle.**FLOAT**(*precision=None*, *scale=None*, *asdecimal=False*, ***kw*)

Bases: sqlalchemy.dialects.drizzle.base._FloatType, sqlalchemy.types.FLOAT

Drizzle FLOAT type.

__init__(*precision=None*, *scale=None*, *asdecimal=False*, ***kw*)

Construct a FLOAT.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.

class sqlalchemy.dialects.drizzle.**INTEGER**(***kw*)

Bases: sqlalchemy.types.INTEGER

Drizzle INTEGER type.

__init__(***kw*)

Construct an INTEGER.

class sqlalchemy.dialects.drizzle.**NUMERIC**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)

Bases: sqlalchemy.dialects.drizzle.base._NumericType, sqlalchemy.types.NUMERIC

Drizzle NUMERIC type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)

Construct a NUMERIC.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.

class sqlalchemy.dialects.drizzle.**REAL**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Bases: sqlalchemy.dialects.drizzle.base._FloatType, sqlalchemy.types.REAL

Drizzle REAL type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Construct a REAL.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.

class sqlalchemy.dialects.drizzle.**TEXT**(*length=None*, ***kw*)
Bases: sqlalchemy.dialects.drizzle.base._StringType, sqlalchemy.types.TEXT

Drizzle TEXT type, for text up to 2^16 characters.

__init__(*length=None*, ***kw*)
Construct a TEXT.

Parameters

- **length** – Optional, if provided the server may optimize storage by substituting the smallest TEXT type sufficient to store `length` characters.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class sqlalchemy.dialects.drizzle.**TIMESTAMP**(*timezone=False*)
Bases: sqlalchemy.types.TIMESTAMP

Drizzle TIMESTAMP type.

__init__(*timezone=False*)
Construct a new DateTime.

Parameters **timezone** – boolean. If True, and supported by the

backend, will produce 'TIMESTAMP WITH TIMEZONE'. For backends that don't support timezone aware timestamps, has no effect.

class sqlalchemy.dialects.drizzle.**VARCHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.dialects.drizzle.base._StringType, sqlalchemy.types.VARCHAR

Drizzle VARCHAR type, for variable-length character data.

__init__(*length=None*, ***kwargs*)
Construct a VARCHAR.

Parameters

- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

4.1.3 MySQL-Python Notes

Support for the Drizzle database via the mysql-python adapter.

MySQL-Python is available at:

http://sourceforge.net/projects/mysql-python

Connecting

Connect string format:

```
drizzle+mysqldb://<user>:<password>@<host>[:<port>]/<dbname>
```

4.2 Firebird

Support for the Firebird database.

Connectivity is usually supplied via the kinterbasdb DBAPI module.

4.2.1 Dialects

Firebird offers two distinct dialects (not to be confused with a SQLAlchemy `Dialect`):

dialect 1 This is the old syntax and behaviour, inherited from Interbase pre-6.0.

dialect 3 This is the newer and supported syntax, introduced in Interbase 6.0.

The SQLAlchemy Firebird dialect detects these versions and adjusts its representation of SQL accordingly. However, support for dialect 1 is not well tested and probably has incompatibilities.

4.2.2 Locking Behavior

Firebird locks tables aggressively. For this reason, a DROP TABLE may hang until other transactions are released. SQLAlchemy does its best to release transactions as quickly as possible. The most common cause of hanging transactions is a non-fully consumed result set, i.e.:

```
result = engine.execute("select * from table")
row = result.fetchone()
return
```

Where above, the `ResultProxy` has not been fully consumed. The connection will be returned to the pool and the transactional state rolled back once the Python garbage collector reclaims the objects which hold onto the connection, which often occurs asynchronously. The above use case can be alleviated by calling `first()` on the `ResultProxy` which will fetch the first row and immediately close all remaining cursor/connection resources.

4.2.3 RETURNING support

Firebird 2.0 supports returning a result set from inserts, and 2.1 extends that to deletes and updates. This is generically exposed by the SQLAlchemy `returning()` method, such as:

```
# INSERT..RETURNING
result = table.insert().returning(table.c.col1, table.c.col2).\
               values(name='foo')
print result.fetchall()

# UPDATE..RETURNING
raises = empl.update().returning(empl.c.id, empl.c.salary).\
              where(empl.c.sales>100).\
              values(dict(salary=empl.c.salary * 1.1))
print raises.fetchall()
```

4.2.4 kinterbasdb

The most common way to connect to a Firebird engine is implemented by kinterbasdb, currently maintained directly by the Firebird people.

The connection URL is of the form `firebird[+kinterbasdb]://user:password@host:port/path/to/db[?key=va`

Kinterbasedb backend specific keyword arguments are:

- type_conv - select the kind of mapping done on the types: by default SQLAlchemy uses 200 with Unicode, datetime and decimal support (see details).
- concurrency_level - set the backend policy with regards to threading issues: by default SQLAlchemy uses policy 1 (see details).
- enable_rowcount - True by default, setting this to False disables the usage of "cursor.rowcount" with the Kinterbasdb dialect, which SQLAlchemy ordinarily calls upon automatically after any UPDATE or DELETE statement. When disabled, SQLAlchemy's ResultProxy will return -1 for result.rowcount. The rationale here is that Kinterbasdb requires a second round trip to the database when .rowcount is called - since SQLA's resultproxy automatically closes the cursor after a non-result-returning statement, rowcount must be called, if at all, before the result object is returned. Additionally, cursor.rowcount may not return correct results with older versions of Firebird, and setting this flag to False will also cause the SQLAlchemy ORM to ignore its usage. The behavior can also be controlled on a per-execution basis using the *enable_rowcount* option with `execution_options()`:

  ```
  conn = engine.connect().execution_options(enable_rowcount=True)
  r = conn.execute(stmt)
  print r.rowcount
  ```

4.3 Informix

Support for the Informix database.

Note: The Informix dialect functions on current SQLAlchemy versions but is not regularly tested, and may have many issues and caveats not currently handled.

4.3.1 informixdb Notes

Support for the informixdb DBAPI.

informixdb is available at:

http://informixdb.sourceforge.net/

Connecting

Sample informix connection:

```
engine = create_engine('informix+informixdb://user:password@host/dbname')
```

4.4 MaxDB

Support for the MaxDB database.

Note: The MaxDB dialect is **non-functional as of SQLAlchemy 0.6**, pending development efforts to bring it up-to-date.

4.4.1 Overview

The `maxdb` dialect is **experimental** and has only been tested on 7.6.03.007 and 7.6.00.037. Of these, **only 7.6.03.007 will work** with SQLAlchemy's ORM. The earlier version has severe `LEFT JOIN` limitations and will return incorrect results from even very simple ORM queries.

Only the native Python DB-API is currently supported. ODBC driver support is a future enhancement.

4.4.2 Connecting

The username is case-sensitive. If you usually connect to the database with sqlcli and other tools in lower case, you likely need to use upper case for DB-API.

4.4.3 Implementation Notes

With the 7.6.00.37 driver and Python 2.5, it seems that all DB-API generated exceptions are broken and can cause Python to crash.

For 'somecol.in_([])' to work, the IN operator's generation must be changed to cast 'NULL' to a numeric, i.e. NUM(NULL). The DB-API doesn't accept a bind parameter there, so that particular generation must inline the NULL value, which depends on [ticket:807].

The DB-API is very picky about where bind params may be used in queries.

Bind params for some functions (e.g. MOD) need type information supplied. The dialect does not yet do this automatically.

Max will occasionally throw up 'bad sql, compile again' exceptions for perfectly valid SQL. The dialect does not currently handle these, more research is needed.

MaxDB 7.5 and Sap DB <= 7.4 reportedly do not support schemas. A very slightly different version of this dialect would be required to support those versions, and can easily be added if there is demand. Some other required components such as an Max-aware 'old oracle style' join compiler (thetas with (+) outer indicators) are already done and available for integration- email the devel list if you're interested in working on this.

Versions tested: 7.6.03.07 and 7.6.00.37, native Python DB-API

- MaxDB has severe limitations on OUTER JOINs, which are essential to ORM eager loading. And rather than raise an error if a SELECT can't be serviced, the database simply returns incorrect results.
- Version 7.6.03.07 seems to JOIN properly, however the docs do not show the OUTER restrictions being lifted (as of this writing), and no changelog is available to confirm either. If you are using a different server version and your tasks require the ORM or any semi-advanced SQL through the SQL layer, running the SQLAlchemy test suite against your database is HIGHLY recommended before you begin.
- Version 7.6.00.37 is LHS/RHS sensitive in *FROM lhs LEFT OUTER JOIN rhs ON lhs.col=rhs.col* vs *rhs.col=lhs.col*!
- Version 7.6.00.37 is confused by *SELECT DISTINCT col as alias FROM t ORDER BY col* - these aliased, DISTINCT, ordered queries need to be re-written to order by the alias name.
- Version 7.6.x supports creating a SAVEPOINT but not its RELEASE.
- MaxDB supports autoincrement-style columns (DEFAULT SERIAL) and independent sequences. When including a DEFAULT SERIAL column in an insert, 0 needs to be inserted rather than NULL to generate a value.
- MaxDB supports ANSI and "old Oracle style" theta joins with (+) outer join indicators.
- The SQLAlchemy dialect is schema-aware and probably won't function correctly on server versions (pre-7.6?). Support for schema-less server versions could be added if there's call.
- ORDER BY is not supported in subqueries. LIMIT is not supported in subqueries. In 7.6.00.37, TOP does work in subqueries, but without limit not so useful. OFFSET does not work in 7.6 despite being in the docs. Row number tricks in WHERE via ROWNO may be possible but it only seems to allow less-than comparison!
- Version 7.6.03.07 can't LIMIT if a derived table is in FROM: *SELECT * FROM (SELECT * FROM a) LIMIT 2*
- MaxDB does not support sql's CAST and can only usefullly cast two types. There isn't much implicit type conversion, so be precise when creating *PassiveDefaults* in DDL generation: *'3'* and *3* aren't the same.

sapdb.dbapi

- As of 2007-10-22 the Python 2.4 and 2.5 compatible versions of the DB-API are no longer available. A forum posting at SAP states that the Python driver will be available again "in the future". The last release from MySQL AB works if you can find it.
- sequence.NEXTVAL skips every other value!
- No rowcount for executemany()
- If an INSERT into a table with a DEFAULT SERIAL column inserts the results of a function *INSERT INTO t VALUES (LENGTH('foo'))*, the cursor won't have the serial id. It needs to be manually yanked from tablename.CURRVAL.
- Super-duper picky about where bind params can be placed. Not smart about converting Python types for some functions, such as *MOD(5, ?)*.
- LONG (text, binary) values in result sets are read-once. The dialect uses a caching RowProxy when these types are present.
- Connection objects seem like they want to be either 'close()'d or garbage collected, but not both. There's a warning issued but it seems harmless.

4.5 Microsoft Access

Support for the Microsoft Access database.

Note: The Access dialect is **non-functional as of SQLAlchemy 0.6**, pending development efforts to bring it up-to-date.

4.6 Microsoft SQL Server

Support for the Microsoft SQL Server database.

4.6.1 Connecting

See the individual driver sections below for details on connecting.

4.6.2 Auto Increment Behavior

`IDENTITY` columns are supported by using SQLAlchemy `schema.Sequence()` objects. In other words:

```
from sqlalchemy import Table, Integer, Sequence, Column

Table('test', metadata,
       Column('id', Integer,
              Sequence('blah',100,10), primary_key=True),
       Column('name', String(20))
     ).create(some_engine)
```

would yield:

```
CREATE TABLE test (
  id INTEGER NOT NULL IDENTITY(100,10) PRIMARY KEY,
  name VARCHAR(20) NULL,
  )
```

Note that the `start` and `increment` values for sequences are optional and will default to 1,1.

Implicit `autoincrement` behavior works the same in MSSQL as it does in other dialects and results in an `IDENTITY` column.

- Support for `SET IDENTITY_INSERT ON` mode (automagic on / off for `INSERT` s)
- Support for auto-fetching of `@@IDENTITY/@@SCOPE_IDENTITY()` on `INSERT`

4.6.3 Collation Support

MSSQL specific string types support a collation parameter that creates a column-level specific collation for the column. The collation parameter accepts a Windows Collation Name or a SQL Collation Name. Supported types are MSChar, MSNChar, MSString, MSNVarchar, MSText, and MSNText. For example:

```
from sqlalchemy.dialects.mssql import VARCHAR
Column('login', VARCHAR(32, collation='Latin1_General_CI_AS'))
```

When such a column is associated with a `Table`, the CREATE TABLE statement for this column will yield:

```
login VARCHAR(32) COLLATE Latin1_General_CI_AS NULL
```

4.6.4 LIMIT/OFFSET Support

MSSQL has no support for the LIMIT or OFFSET keysowrds. LIMIT is supported directly through the `TOP` Transact SQL keyword:

```
select.limit
```

will yield:

```
SELECT TOP n
```

If using SQL Server 2005 or above, LIMIT with OFFSET support is available through the `ROW_NUMBER OVER` construct. For versions below 2005, LIMIT with OFFSET usage will fail.

4.6.5 Nullability

MSSQL has support for three levels of column nullability. The default nullability allows nulls and is explicit in the CREATE TABLE construct:

```
name VARCHAR(20) NULL
```

If `nullable=None` is specified then no specification is made. In other words the database's configured default is used. This will render:

```
name VARCHAR(20)
```

If `nullable` is `True` or `False` then the column will be `NULL` or `NOT NULL` respectively.

4.6.6 Date / Time Handling

DATE and TIME are supported. Bind parameters are converted to datetime.datetime() objects as required by most MSSQL drivers, and results are processed from strings if needed. The DATE and TIME types are not available for MSSQL 2005 and previous - if a server version below 2008 is detected, DDL for these types will be issued as DATETIME.

4.6.7 Compatibility Levels

MSSQL supports the notion of setting compatibility levels at the database level. This allows, for instance, to run a database that is compatible with SQL2000 while running on a SQL2005 database server. `server_version_info` will always return the database server version information (in this case SQL2005) and not the compatibility level information. Because of this, if running under a backwards compatibility mode SQAlchemy may attempt to use T-SQL statements that are unable to be parsed by the database server.

4.6.8 Triggers

SQLAlchemy by default uses OUTPUT INSERTED to get at newly generated primary key values via IDENTITY columns or other server side defaults. MS-SQL does not allow the usage of OUTPUT INSERTED on tables that have triggers. To disable the usage of OUTPUT INSERTED on a per-table basis, specify `implicit_returning=False` for each `Table` which has triggers:

```
Table('mytable', metadata,
    Column('id', Integer, primary_key=True),
    # ...,
    implicit_returning=False
)
```

Declarative form:

```
class MyClass(Base):
    # ...
    __table_args__ = {'implicit_returning':False}
```

This option can also be specified engine-wide using the `implicit_returning=False` argument on `create_engine()`.

4.6.9 Enabling Snapshot Isolation

Not necessarily specific to SQLAlchemy, SQL Server has a default transaction isolation mode that locks entire tables, and causes even mildly concurrent applications to have long held locks and frequent deadlocks. Enabling snapshot isolation for the database as a whole is recommended for modern levels of concurrency support. This is accomplished via the following ALTER DATABASE commands executed at the SQL prompt:

```
ALTER DATABASE MyDatabase SET ALLOW_SNAPSHOT_ISOLATION ON

ALTER DATABASE MyDatabase SET READ_COMMITTED_SNAPSHOT ON
```

Background on SQL Server snapshot isolation is available at http://msdn.microsoft.com/en-us/library/ms175095.aspx.

4.6.10 Scalar Select Comparisons

Deprecated since version 0.8: The MSSQL dialect contains a legacy behavior whereby comparing a scalar select to a value using the = or != operator will resolve to IN or NOT IN, respectively. This behavior will be removed in 0.8 - the `s.in_()/~s.in_()` operators should be used when IN/NOT IN are desired.

For the time being, the existing behavior prevents a comparison between scalar select and another value that actually wants to use =. To remove this behavior in a forwards-compatible way, apply this compilation rule by placing the following code at the module import level:

```
from sqlalchemy.ext.compiler import compiles
from sqlalchemy.sql.expression import _BinaryExpression
from sqlalchemy.sql.compiler import SQLCompiler

@compiles(_BinaryExpression, 'mssql')
def override_legacy_binary(element, compiler, **kw):
    return SQLCompiler.visit_binary(compiler, element, **kw)
```

4.6.11 Known Issues

- No support for more than one `IDENTITY` column per table
- reflection of indexes does not work with versions older than SQL Server 2005

4.6.12 SQL Server Data Types

As with all SQLAlchemy dialects, all UPPERCASE types that are known to be valid with SQL server are importable from the top level dialect, whether they originate from `sqlalchemy.types` or from the local dialect:

```
from sqlalchemy.dialects.mssql import \
    BIGINT, BINARY, BIT, CHAR, DATE, DATETIME, DATETIME2, \
    DATETIMEOFFSET, DECIMAL, FLOAT, IMAGE, INTEGER, MONEY, \
    NCHAR, NTEXT, NUMERIC, NVARCHAR, REAL, SMALLDATETIME, \
    SMALLINT, SMALLMONEY, SQL_VARIANT, TEXT, TIME, \
    TIMESTAMP, TINYINT, UNIQUEIDENTIFIER, VARBINARY, VARCHAR
```

Types which are specific to SQL Server, or have SQL Server-specific construction arguments, are as follows:

class `sqlalchemy.dialects.mssql.`**BIT**(**args*, ***kwargs*)
Bases: `sqlalchemy.types.TypeEngine`

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class `sqlalchemy.dialects.mssql.`**CHAR**(*length=None*, *collation=None*, ***kw*)
Bases: `sqlalchemy.dialects.mssql.base._StringType`, `sqlalchemy.types.CHAR`

MSSQL CHAR type, for fixed-length non-Unicode data with a maximum of 8,000 characters.

__init__(*length=None*, *collation=None*, ***kw*)
Construct a CHAR.

Parameters

- **length** – Optinal, maximum data length, in characters.
- **convert_unicode** – defaults to False. If True, convert `unicode` data sent to the database to a `str` bytestring, and convert bytestrings coming back from the database into `unicode`.

  Bytestrings are encoded using the dialect's `encoding`, which defaults to *utf-8*.

  If False, may be overridden by `sqlalchemy.engine.base.Dialect.convert_unicode`.
- **collation** – Optional, a column-level collation for this string value. Accepts a Windows Collation Name or a SQL Collation Name.

class `sqlalchemy.dialects.mssql.`**DATETIME2**(*precision=None*, ***kw*)
Bases: `sqlalchemy.dialects.mssql.base._DateTimeBase`, `sqlalchemy.types.DateTime`

class `sqlalchemy.dialects.mssql.`**DATETIMEOFFSET**(*precision=None*, ***kwargs*)
Bases: `sqlalchemy.types.TypeEngine`

class `sqlalchemy.dialects.mssql.`**IMAGE**(*length=None*)
Bases: `sqlalchemy.types.LargeBinary`

__init__(*length=None*)
Construct a LargeBinary type.

Parameters length – optional, a length for the column for use in DDL statements, for those BLOB types that accept a length (i.e. MySQL). It does *not* produce a small BINARY/VARBINARY type - use the BINARY/VARBINARY types specifically for those. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a *length* for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued.

class `sqlalchemy.dialects.mssql.`**`MONEY`**(**args*, ***kwargs*)
Bases: `sqlalchemy.types.TypeEngine`

`__init__`(**args*, ***kwargs*)
Support implementations that were passing arguments

class `sqlalchemy.dialects.mssql.`**`NCHAR`**(*length=None*, *collation=None*, ***kw*)
Bases: `sqlalchemy.dialects.mssql.base._StringType`, `sqlalchemy.types.NCHAR`

MSSQL NCHAR type.

For fixed-length unicode character data up to 4,000 characters.

`__init__`(*length=None*, *collation=None*, ***kw*)
Construct an NCHAR.

Parameters

- **length** – Optional, Maximum data length, in characters.
- **collation** – Optional, a column-level collation for this string value. Accepts a Windows Collation Name or a SQL Collation Name.

class `sqlalchemy.dialects.mssql.`**`NTEXT`**(*length=None*, *collation=None*, ***kw*)
Bases: `sqlalchemy.dialects.mssql.base._StringType`, `sqlalchemy.types.UnicodeText`

MSSQL NTEXT type, for variable-length unicode text up to 2^30 characters.

`__init__`(*length=None*, *collation=None*, ***kw*)
Construct a NTEXT.

Parameters collation – Optional, a column-level collation for this string value. Accepts a Windows Collation Name or a SQL Collation Name.

class `sqlalchemy.dialects.mssql.`**`NVARCHAR`**(*length=None*, *collation=None*, ***kw*)
Bases: `sqlalchemy.dialects.mssql.base._StringType`, `sqlalchemy.types.NVARCHAR`

MSSQL NVARCHAR type.

For variable-length unicode character data up to 4,000 characters.

`__init__`(*length=None*, *collation=None*, ***kw*)
Construct a NVARCHAR.

Parameters

- **length** – Optional, Maximum data length, in characters.
- **collation** – Optional, a column-level collation for this string value. Accepts a Windows Collation Name or a SQL Collation Name.

class `sqlalchemy.dialects.mssql.`**`REAL`**(***kw*)
Bases: `sqlalchemy.types.REAL`

class `sqlalchemy.dialects.mssql.`**`SMALLDATETIME`**(*timezone=False*)
Bases: `sqlalchemy.dialects.mssql.base._DateTimeBase`, `sqlalchemy.types.DateTime`

__init__(*timezone=False*)
Construct a new DateTime.

Parameters **timezone** – boolean. If True, and supported by the

backend, will produce 'TIMESTAMP WITH TIMEZONE'. For backends that don't support timezone aware timestamps, has no effect.

class sqlalchemy.dialects.mssql.**SMALLMONEY**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.mssql.**SQL_VARIANT**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.mssql.**TEXT**(*length=None*, *collation=None*, ***kw*)
Bases: sqlalchemy.dialects.mssql.base._StringType, sqlalchemy.types.TEXT

MSSQL TEXT type, for variable-length text up to 2^31 characters.

__init__(*length=None*, *collation=None*, ***kw*)
Construct a TEXT.

Parameters **collation** – Optional, a column-level collation for this string value. Accepts a Windows Collation Name or a SQL Collation Name.

class sqlalchemy.dialects.mssql.**TIME**(*precision=None*, ***kwargs*)
Bases: sqlalchemy.types.TIME

class sqlalchemy.dialects.mssql.**TINYINT**(**args*, ***kwargs*)
Bases: sqlalchemy.types.Integer

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.mssql.**UNIQUEIDENTIFIER**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.mssql.**VARCHAR**(*length=None*, *collation=None*, ***kw*)
Bases: sqlalchemy.dialects.mssql.base._StringType, sqlalchemy.types.VARCHAR

MSSQL VARCHAR type, for variable-length non-Unicode data with a maximum of 8,000 characters.

__init__(*length=None*, *collation=None*, ***kw*)
Construct a VARCHAR.

Parameters

- **length** – Optinal, maximum data length, in characters.
- **convert_unicode** – defaults to False. If True, convert `unicode` data sent to the database to a `str` bytestring, and convert bytestrings coming back from the database into `unicode`.

  Bytestrings are encoded using the dialect's `encoding`, which defaults to *utf-8*.

  If False, may be overridden by `sqlalchemy.engine.base.Dialect.convert_unicode`.

- **collation** – Optional, a column-level collation for this string value. Accepts a Windows Collation Name or a SQL Collation Name.

4.6.13 PyODBC

Support for MS-SQL via pyodbc.

pyodbc is available at:

http://pypi.python.org/pypi/pyodbc/

Connecting

Examples of pyodbc connection string URLs:

- `mssql+pyodbc://mydsn` - connects using the specified DSN named `mydsn`. The connection string that is created will appear like:

```
dsn=mydsn;Trusted_Connection=Yes
```

- `mssql+pyodbc://user:pass@mydsn` - connects using the DSN named `mydsn` passing in the `UID` and `PWD` information. The connection string that is created will appear like:

```
dsn=mydsn;UID=user;PWD=pass
```

- `mssql+pyodbc://user:pass@mydsn/?LANGUAGE=us_english` - connects using the DSN named `mydsn` passing in the `UID` and `PWD` information, plus the additional connection configuration option `LANGUAGE`. The connection string that is created will appear like:

```
dsn=mydsn;UID=user;PWD=pass;LANGUAGE=us_english
```

- `mssql+pyodbc://user:pass@host/db` - connects using a connection that would appear like:

```
DRIVER={SQL Server};Server=host;Database=db;UID=user;PWD=pass
```

- `mssql+pyodbc://user:pass@host:123/db` - connects using a connection string which includes the port information using the comma syntax. This will create the following connection string:

```
DRIVER={SQL Server};Server=host,123;Database=db;UID=user;PWD=pass
```

- `mssql+pyodbc://user:pass@host/db?port=123` - connects using a connection string that includes the port information as a separate `port` keyword. This will create the following connection string:

```
DRIVER={SQL Server};Server=host;Database=db;UID=user;PWD=pass;port=123
```

- `mssql+pyodbc://user:pass@host/db?driver=MyDriver` - connects using a connection string that includes a custom ODBC driver name. This will create the following connection string:

```
DRIVER={MyDriver};Server=host;Database=db;UID=user;PWD=pass
```

If you require a connection string that is outside the options presented above, use the `odbc_connect` keyword to pass in a urlencoded connection string. What gets passed in will be urldecoded and passed directly.

For example:

```
mssql+pyodbc:///?odbc_connect=dsn%3Dmydsn%3BDatabase%3Ddb
```

would create the following connection string:

```
dsn=mydsn;Database=db
```

Encoding your connection string can be easily accomplished through the python shell. For example:

```
>>> import urllib
>>> urllib.quote_plus('dsn=mydsn;Database=db')
'dsn%3Dmydsn%3BDatabase%3Ddb'
```

Unicode Binds

The current state of PyODBC on a unix backend with FreeTDS and/or EasySoft is poor regarding unicode; different OS platforms and versions of UnixODBC versus IODBC versus FreeTDS/EasySoft versus PyODBC itself dramatically alter how strings are received. The PyODBC dialect attempts to use all the information it knows to determine whether or not a Python unicode literal can be passed directly to the PyODBC driver or not; while SQLAlchemy can encode these to bytestrings first, some users have reported that PyODBC mis-handles bytestrings for certain encodings and requires a Python unicode object, while the author has observed widespread cases where a Python unicode is completely misinterpreted by PyODBC, particularly when dealing with the information schema tables used in table reflection, and the value must first be encoded to a bytestring.

It is for this reason that whether or not unicode literals for bound parameters be sent to PyODBC can be controlled using the `supports_unicode_binds` parameter to `create_engine()`. When left at its default of `None`, the PyODBC dialect will use its best guess as to whether or not the driver deals with unicode literals well. When `False`, unicode literals will be encoded first, and when `True` unicode literals will be passed straight through. This is an interim flag that hopefully should not be needed when the unicode situation stabilizes for unix + PyODBC.

New in version 0.7.7: `supports_unicode_binds` parameter to `create_engine()`.

4.6.14 mxODBC

Support for MS-SQL via mxODBC.

mxODBC is available at:

> http://www.egenix.com/

This was tested with mxODBC 3.1.2 and the SQL Server Native Client connected to MSSQL 2005 and 2008 Express Editions.

Connecting

Connection is via DSN:

```
mssql+mxodbc://<username>:<password>@<dsnname>
```

Execution Modes

mxODBC features two styles of statement execution, using the `cursor.execute()` and `cursor.executedirect()` methods (the second being an extension to the DBAPI specification). The former makes use of a particular API call specific to the SQL Server Native Client ODBC driver known SQLDescribeParam, while the latter does not.

mxODBC apparently only makes repeated use of a single prepared statement when SQLDescribeParam is used. The advantage to prepared statement reuse is one of performance. The disadvantage is that SQLDescribeParam has a limited set of scenarios in which bind parameters are understood, including that they cannot be placed within the argument lists of function calls, anywhere outside the FROM, or even within subqueries within the FROM clause - making the usage of bind parameters within SELECT statements impossible for all but the most simplistic statements.

For this reason, the mxODBC dialect uses the "native" mode by default only for INSERT, UPDATE, and DELETE statements, and uses the escaped string mode for all other statements.

This behavior can be controlled via `execution_options()` using the `native_odbc_execute` flag with a value of `True` or `False`, where a value of `True` will unconditionally use native bind parameters and a value of `False` will unconditionally use string-escaped parameters.

4.6.15 pymssql

Support for the pymssql dialect.

This dialect supports pymssql 1.0 and greater.

pymssql is available at:

http://pymssql.sourceforge.net/

Connecting

Sample connect string:

```
mssql+pymssql://<username>:<password>@<freetds_name>
```

Adding "?charset=utf8" or similar will cause pymssql to return strings as Python unicode objects. This can potentially improve performance in some scenarios as decoding of strings is handled natively.

Limitations

pymssql inherits a lot of limitations from FreeTDS, including:

- no support for multibyte schema identifiers
- poor support for large decimals
- poor support for binary fields
- poor support for VARCHAR/CHAR fields over 255 characters

Please consult the pymssql documentation for further information.

4.6.16 zxjdbc Notes

Support for the Microsoft SQL Server database via the zxjdbc JDBC connector.

JDBC Driver

Requires the jTDS driver, available from: http://jtds.sourceforge.net/

Connecting

URLs are of the standard form of `mssql+zxjdbc://user:pass@host:port/dbname[?key=value&key=value...]`.

Additional arguments which may be specified either as query string arguments on the URL, or as keyword arguments to `create_engine()` will be passed as Connection properties to the underlying JDBC driver.

4.6.17 AdoDBAPI

The adodbapi dialect is not implemented for 0.6 at this time.

4.7 MySQL

Support for the MySQL database.

4.7.1 Supported Versions and Features

SQLAlchemy supports MySQL starting with version 4.1 through modern releases. However, no heroic measures are taken to work around major missing SQL features - if your server version does not support sub-selects, for example, they won't work in SQLAlchemy either.

See the official MySQL documentation for detailed information about features supported in any given server release.

4.7.2 Connecting

See the API documentation on individual drivers for details on connecting.

4.7.3 Connection Timeouts

MySQL features an automatic connection close behavior, for connections that have been idle for eight hours or more. To circumvent having this issue, use the `pool_recycle` option which controls the maximum age of any connection:

```
engine = create_engine('mysql+mysqldb://...', pool_recycle=3600)
```

4.7.4 Storage Engines

Most MySQL server installations have a default table type of `MyISAM`, a non-transactional table type. During a transaction, non-transactional storage engines do not participate and continue to store table changes in autocommit mode. For fully atomic transactions as well as support for foreign key constraints, all participating tables must use a transactional engine such as `InnoDB`, `Falcon`, `SolidDB`, *PBXT*, etc.

Storage engines can be elected when creating tables in SQLAlchemy by supplying a `mysql_engine='whatever'` to the `Table` constructor. Any MySQL table creation option can be specified in this syntax:

```
Table('mytable', metadata,
      Column('data', String(32)),
      mysql_engine='InnoDB',
      mysql_charset='utf8'
     )
```

See also:

The InnoDB Storage Engine - on the MySQL website.

4.7.5 Case Sensitivity and Table Reflection

MySQL has inconsistent support for case-sensitive identifier names, basing support on specific details of the underlying operating system. However, it has been observed that no matter what case sensitivity behavior is present, the names of tables in foreign key declarations are *always* received from the database as all-lower case, making it impossible to accurately reflect a schema where inter-related tables use mixed-case identifier names.

Therefore it is strongly advised that table names be declared as all lower case both within SQLAlchemy as well as on the MySQL database itself, especially if database reflection features are to be used.

4.7.6 Transaction Isolation Level

`create_engine()` accepts an `isolation_level` parameter which results in the command `SET SESSION TRANSACTION ISOLATION LEVEL <level>` being invoked for every new connection. Valid values for this parameter are `READ COMMITTED`, `READ UNCOMMITTED`, `REPEATABLE READ`, and `SERIALIZABLE`:

```
engine = create_engine(
                "mysql://scott:tiger@localhost/test",
                isolation_level="READ UNCOMMITTED"
            )
```

New in version 0.7.6.

4.7.7 Keys

Not all MySQL storage engines support foreign keys. For `MyISAM` and similar engines, the information loaded by table reflection will not include foreign keys. For these tables, you may supply a `ForeignKeyConstraint` at reflection time:

```
Table('mytable', metadata,
      ForeignKeyConstraint(['other_id'], ['othertable.other_id']),
      autoload=True
     )
```

When creating tables, SQLAlchemy will automatically set `AUTO_INCREMENT` on an integer primary key column:

```
>>> t = Table('mytable', metadata,
...   Column('mytable_id', Integer, primary_key=True)
... )
>>> t.create()
CREATE TABLE mytable (
        id INTEGER NOT NULL AUTO_INCREMENT,
```

```
        PRIMARY KEY (id)
)
```

You can disable this behavior by supplying `autoincrement=False` to the `Column`. This flag can also be used to enable auto-increment on a secondary column in a multi-column key for some storage engines:

```
Table('mytable', metadata,
      Column('gid', Integer, primary_key=True, autoincrement=False),
      Column('id', Integer, primary_key=True)
     )
```

4.7.8 Ansi Quoting Style

MySQL features two varieties of identifier "quoting style", one using backticks and the other using quotes, e.g. `` `some_identifier` `` vs. `"some_identifier"`. All MySQL dialects detect which version is in use by checking the value of `sql_mode` when a connection is first established with a particular `Engine`. This quoting style comes into play when rendering table and column names as well as when reflecting existing database structures. The detection is entirely automatic and no special configuration is needed to use either quoting style.

Changed in version 0.6: detection of ANSI quoting style is entirely automatic, there's no longer any end-user `create_engine()` options in this regard.

4.7.9 MySQL SQL Extensions

Many of the MySQL SQL extensions are handled through SQLAlchemy's generic function and operator support:

```
table.select(table.c.password==func.md5('plaintext'))
table.select(table.c.username.op('regexp')('^[a-d]'))
```

And of course any valid MySQL statement can be executed as a string as well.

Some limited direct support for MySQL extensions to SQL is currently available.

- SELECT pragma:

  ```
  select(..., prefixes=['HIGH_PRIORITY', 'SQL_SMALL_RESULT'])
  ```

- UPDATE with LIMIT:

  ```
  update(..., mysql_limit=10)
  ```

4.7.10 rowcount Support

SQLAlchemy standardizes the DBAPI `cursor.rowcount` attribute to be the usual definition of "number of rows matched by an UPDATE or DELETE" statement. This is in contradiction to the default setting on most MySQL DBAPI drivers, which is "number of rows actually modified/deleted". For this reason, the SQLAlchemy MySQL dialects always set the `constants.CLIENT.FOUND_ROWS` flag, or whatever is equivalent for the DBAPI in use, on connect, unless the flag value is overridden using DBAPI-specific options (such as `client_flag` for the MySQL-Python driver, `found_rows` for the OurSQL driver).

See also:

`ResultProxy.rowcount`

4.7.11 CAST Support

MySQL documents the CAST operator as available in version 4.0.2. When using the SQLAlchemy `cast()` function, SQLAlchemy will not render the CAST token on MySQL before this version, based on server version detection, instead rendering the internal expression directly.

CAST may still not be desirable on an early MySQL version post-4.0.2, as it didn't add all datatype support until 4.1.1. If your application falls into this narrow area, the behavior of CAST can be controlled using the *Custom SQL Constructs and Compilation Extension* system, as per the recipe below:

```
from sqlalchemy.sql.expression import _Cast
from sqlalchemy.ext.compiler import compiles

@compiles(_Cast, 'mysql')
def _check_mysql_version(element, compiler, **kw):
    if compiler.dialect.server_version_info < (4, 1, 0):
        return compiler.process(element.clause, **kw)
    else:
        return compiler.visit_cast(element, **kw)
```

The above function, which only needs to be declared once within an application, overrides the compilation of the `cast()` construct to check for version 4.1.0 before fully rendering CAST; else the internal element of the construct is rendered directly.

4.7.12 MySQL Specific Index Options

MySQL-specific extensions to the `Index` construct are available.

Index Length

MySQL provides an option to create index entries with a certain length, where "length" refers to the number of characters or bytes in each value which will become part of the index. SQLAlchemy provides this feature via the `mysql_length` parameter:

```
Index('my_index', my_table.c.data, mysql_length=10)
```

Prefix lengths are given in characters for nonbinary string types and in bytes for binary string types. The value passed to the keyword argument will be simply passed through to the underlying CREATE INDEX command, so it *must* be an integer. MySQL only allows a length for an index if it is for a CHAR, VARCHAR, TEXT, BINARY, VARBINARY and BLOB.

Index Types

Some MySQL storage engines permit you to specify an index type when creating an index or primary key constraint. SQLAlchemy provides this feature via the `mysql_using` parameter on `Index`:

```
Index('my_index', my_table.c.data, mysql_using='hash')
```

As well as the `mysql_using` parameter on `PrimaryKeyConstraint`:

```
PrimaryKeyConstraint("data", mysql_using='hash')
```

The value passed to the keyword argument will be simply passed through to the underlying CREATE INDEX or PRIMARY KEY clause, so it *must* be a valid index type for your MySQL storage engine.

More information can be found at:

http://dev.mysql.com/doc/refman/5.0/en/create-index.html

http://dev.mysql.com/doc/refman/5.0/en/create-table.html

4.7.13 MySQL Data Types

As with all SQLAlchemy dialects, all UPPERCASE types that are known to be valid with MySQL are importable from the top level dialect:

```
from sqlalchemy.dialects.mysql import \
        BIGINT, BINARY, BIT, BLOB, BOOLEAN, CHAR, DATE, \
        DATETIME, DECIMAL, DECIMAL, DOUBLE, ENUM, FLOAT, INTEGER, \
        LONGBLOB, LONGTEXT, MEDIUMBLOB, MEDIUMINT, MEDIUMTEXT, NCHAR, \
        NUMERIC, NVARCHAR, REAL, SET, SMALLINT, TEXT, TIME, TIMESTAMP, \
        TINYBLOB, TINYINT, TINYTEXT, VARBINARY, VARCHAR, YEAR
```

Types which are specific to MySQL, or have MySQL-specific construction arguments, are as follows:

class sqlalchemy.dialects.mysql.**BIGINT**(*display_width=None*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base._IntegerType, sqlalchemy.types.BIGINT

MySQL BIGINTEGER type.

__init__(*display_width=None*, ***kw*)
Construct a BIGINTEGER.

Parameters

- **display_width** – Optional, maximum display width for this number.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**BINARY**(*length=None*)
Bases: sqlalchemy.types._Binary

The SQL BINARY type.

class sqlalchemy.dialects.mysql.**BIT**(*length=None*)
Bases: sqlalchemy.types.TypeEngine

MySQL BIT type.

This type is for MySQL 5.0.3 or greater for MyISAM, and 5.0.5 or greater for MyISAM, MEMORY, InnoDB and BDB. For older versions, use a MSTinyInteger() type.

__init__(*length=None*)
Construct a BIT.

Parameters **length** – Optional, number of bits.

class sqlalchemy.dialects.mysql.**BLOB**(*length=None*)
Bases: sqlalchemy.types.LargeBinary

The SQL BLOB type.

__init__(*length=None*)
Construct a LargeBinary type.

Parameters **length** – optional, a length for the column for use in DDL statements, for those BLOB types that accept a length (i.e. MySQL). It does *not* produce a small BINARY/VARBINARY type - use the BINARY/VARBINARY types specifically for those. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a *length* for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued.

class sqlalchemy.dialects.mysql.**BOOLEAN**(*create_constraint=True*, *name=None*)
Bases: sqlalchemy.types.Boolean

The SQL BOOLEAN type.

__init__(*create_constraint=True*, *name=None*)
Construct a Boolean.

Parameters

- **create_constraint** – defaults to True. If the boolean is generated as an int/smallint, also create a CHECK constraint on the table that ensures 1 or 0 as a value.
- **name** – if a CHECK constraint is generated, specify the name of the constraint.

class sqlalchemy.dialects.mysql.**CHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType, sqlalchemy.types.CHAR

MySQL CHAR type, for fixed-length character data.

__init__(*length=None*, ***kwargs*)
Construct a CHAR.

Parameters

- **length** – Maximum data length, in characters.
- **binary** – Optional, use the default binary collation for the national character set. This does not affect the type of data stored, use a BINARY type for binary data.
- **collation** – Optional, request a particular collation. Must be compatible with the national character set.

class sqlalchemy.dialects.mysql.**DATE**(**args*, ***kwargs*)
Bases: sqlalchemy.types.Date

The SQL DATE type.

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.mysql.**DATETIME**(*timezone=False*)
Bases: sqlalchemy.types.DateTime

The SQL DATETIME type.

__init__(*timezone=False*)
Construct a new `DateTime`.

Parameters **timezone** – boolean. If True, and supported by the

backend, will produce 'TIMESTAMP WITH TIMEZONE'. For backends that don't support timezone aware timestamps, has no effect.

class sqlalchemy.dialects.mysql.**DECIMAL**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)

Bases: sqlalchemy.dialects.mysql.base._NumericType, sqlalchemy.types.DECIMAL

MySQL DECIMAL type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)

Construct a DECIMAL.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**DOUBLE**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)

Bases: sqlalchemy.dialects.mysql.base._FloatType

MySQL DOUBLE type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)

Construct a DOUBLE.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**ENUM**(**enums*, ***kw*)

Bases: sqlalchemy.types.Enum, sqlalchemy.dialects.mysql.base._StringType

MySQL ENUM type.

__init__(**enums*, ***kw*)

Construct an ENUM.

Example:

Column('myenum', MSEnum("foo", "bar", "baz"))

Parameters

- **enums** – The range of valid values for this ENUM. Values will be quoted when generating the schema according to the quoting flag (see below).
- **strict** – Defaults to False: ensure that a given value is in this ENUM's range of permissible values when inserting or updating rows. Note that MySQL will not raise a fatal error if you attempt to store an out of range value- an alternate value will be stored instead. (See MySQL ENUM documentation.)

- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **ascii** – Defaults to False: short-hand for the `latin1` character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the `ucs2` character set, generates UNICODE in schema.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.
- **quoting** – Defaults to 'auto': automatically determine enum value quoting. If all enum values are surrounded by the same quoting character, then use 'quoted' mode. Otherwise, use 'unquoted' mode.

  'quoted': values in enums are already quoted, they will be used directly when generating the schema - this usage is deprecated.

  'unquoted': values in enums are not quoted, they will be escaped and surrounded by single quotes when generating the schema.

  Previous versions of this type always required manually quoted values to be supplied; future versions will always quote the string literals for you. This is a transitional option.

class `sqlalchemy.dialects.mysql.`**`FLOAT`**(*precision=None*, *scale=None*, *asdecimal=False*, ***kw*)
Bases: `sqlalchemy.dialects.mysql.base._FloatType`, `sqlalchemy.types.FLOAT`

MySQL FLOAT type.

`__init__`(*precision=None*, *scale=None*, *asdecimal=False*, ***kw*)
Construct a FLOAT.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class `sqlalchemy.dialects.mysql.`**`INTEGER`**(*display_width=None*, ***kw*)
Bases: `sqlalchemy.dialects.mysql.base._IntegerType`, `sqlalchemy.types.INTEGER`

MySQL INTEGER type.

`__init__`(*display_width=None*, ***kw*)
Construct an INTEGER.

Parameters

- **display_width** – Optional, maximum display width for this number.
- **unsigned** – a boolean, optional.

- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**LONGBLOB**(*length=None*)
Bases: sqlalchemy.types._Binary

MySQL LONGBLOB type, for binary data up to 2^32 bytes.

class sqlalchemy.dialects.mysql.**LONGTEXT**(***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType

MySQL LONGTEXT type, for text up to 2^32 characters.

__init__(***kwargs*)
Construct a LONGTEXT.

Parameters

- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **ascii** – Defaults to False: short-hand for the latin1 character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the ucs2 character set, generates UNICODE in schema.
- **national** – Optional. If true, use the server's configured national character set.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class sqlalchemy.dialects.mysql.**MEDIUMBLOB**(*length=None*)
Bases: sqlalchemy.types._Binary

MySQL MEDIUMBLOB type, for binary data up to 2^24 bytes.

class sqlalchemy.dialects.mysql.**MEDIUMINT**(*display_width=None*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base._IntegerType

MySQL MEDIUMINTEGER type.

__init__(*display_width=None*, ***kw*)
Construct a MEDIUMINTEGER

Parameters

- **display_width** – Optional, maximum display width for this number.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**MEDIUMTEXT**(***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType

MySQL MEDIUMTEXT type, for text up to 2^24 characters.

__init__(***kwargs*)
Construct a MEDIUMTEXT.

Parameters

- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **ascii** – Defaults to False: short-hand for the `latin1` character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the `ucs2` character set, generates UNICODE in schema.
- **national** – Optional. If true, use the server's configured national character set.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class sqlalchemy.dialects.mysql.**NCHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType, sqlalchemy.types.NCHAR

MySQL NCHAR type.

For fixed-length character data in the server's configured national character set.

__init__(*length=None*, ***kwargs*)
Construct an NCHAR.

Parameters

- **length** – Maximum data length, in characters.
- **binary** – Optional, use the default binary collation for the national character set. This does not affect the type of data stored, use a BINARY type for binary data.
- **collation** – Optional, request a particular collation. Must be compatible with the national character set.

class sqlalchemy.dialects.mysql.**NUMERIC**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base._NumericType, sqlalchemy.types.NUMERIC

MySQL NUMERIC type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Construct a NUMERIC.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**NVARCHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType, sqlalchemy.types.NVARCHAR

MySQL NVARCHAR type.

For variable-length character data in the server's configured national character set.

__init__(*length=None*, ***kwargs*)
Construct an NVARCHAR.

Parameters

- **length** – Maximum data length, in characters.
- **binary** – Optional, use the default binary collation for the national character set. This does not affect the type of data stored, use a BINARY type for binary data.
- **collation** – Optional, request a particular collation. Must be compatible with the national character set.

class sqlalchemy.dialects.mysql.**REAL**(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base._FloatType, sqlalchemy.types.REAL

MySQL REAL type.

__init__(*precision=None*, *scale=None*, *asdecimal=True*, ***kw*)
Construct a REAL.

Parameters

- **precision** – Total digits in this number. If scale and precision are both None, values are stored to limits allowed by the server.
- **scale** – The number of digits after the decimal point.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**SET**(**values*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base._StringType

MySQL SET type.

__init__(**values*, ***kw*)
Construct a SET.

Example:

```
Column('myset', MSSet("'foo'", "'bar'", "'baz'"))
```

Parameters

- **values** – The range of valid values for this SET. Values will be used exactly as they appear when generating schemas. Strings must be quoted, as in the example above. Single-quotes are suggested for ANSI compatibility and are required for portability to servers with ANSI_QUOTES enabled.
- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.

- **ascii** – Defaults to False: short-hand for the `latin1` character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the `ucs2` character set, generates UNICODE in schema.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class `sqlalchemy.dialects.mysql.`**`SMALLINT`**(*display_width=None*, ***kw*)
Bases: `sqlalchemy.dialects.mysql.base._IntegerType`, `sqlalchemy.types.SMALLINT`

MySQL SMALLINTEGER type.

`__init__`(*display_width=None*, ***kw*)
Construct a SMALLINTEGER.

Parameters

- **display_width** – Optional, maximum display width for this number.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class `sqlalchemy.dialects.mysql.`**`TEXT`**(*length=None*, ***kw*)
Bases: `sqlalchemy.dialects.mysql.base._StringType`, `sqlalchemy.types.TEXT`

MySQL TEXT type, for text up to 2^16 characters.

`__init__`(*length=None*, ***kw*)
Construct a TEXT.

Parameters

- **length** – Optional, if provided the server may optimize storage by substituting the smallest TEXT type sufficient to store `length` characters.
- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **ascii** – Defaults to False: short-hand for the `latin1` character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the `ucs2` character set, generates UNICODE in schema.
- **national** – Optional. If true, use the server's configured national character set.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class `sqlalchemy.dialects.mysql.`**`TIME`**(*timezone=False*)
Bases: `sqlalchemy.types.Time`

The SQL TIME type.

class sqlalchemy.dialects.mysql.**TIMESTAMP**(*timezone=False*)
Bases: sqlalchemy.types.TIMESTAMP

MySQL TIMESTAMP type.

__init__(*timezone=False*)
Construct a new DateTime.

Parameters **timezone** – boolean. If True, and supported by the

backend, will produce 'TIMESTAMP WITH TIMEZONE'. For backends that don't support timezone aware timestamps, has no effect.

class sqlalchemy.dialects.mysql.**TINYBLOB**(*length=None*)
Bases: sqlalchemy.types._Binary

MySQL TINYBLOB type, for binary data up to 2^8 bytes.

class sqlalchemy.dialects.mysql.**TINYINT**(*display_width=None*, ***kw*)
Bases: sqlalchemy.dialects.mysql.base._IntegerType

MySQL TINYINT type.

__init__(*display_width=None*, ***kw*)
Construct a TINYINT.

Note: following the usual MySQL conventions, TINYINT(1) columns reflected during Table(..., autoload=True) are treated as Boolean columns.

Parameters

- **display_width** – Optional, maximum display width for this number.
- **unsigned** – a boolean, optional.
- **zerofill** – Optional. If true, values will be stored as strings left-padded with zeros. Note that this does not effect the values returned by the underlying database API, which continue to be numeric.

class sqlalchemy.dialects.mysql.**TINYTEXT**(***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType

MySQL TINYTEXT type, for text up to 2^8 characters.

__init__(***kwargs*)
Construct a TINYTEXT.

Parameters

- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **ascii** – Defaults to False: short-hand for the latin1 character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the ucs2 character set, generates UNICODE in schema.
- **national** – Optional. If true, use the server's configured national character set.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class sqlalchemy.dialects.mysql.**VARBINARY**(*length=None*)
Bases: sqlalchemy.types._Binary

The SQL VARBINARY type.

class sqlalchemy.dialects.mysql.**VARCHAR**(*length=None*, ***kwargs*)
Bases: sqlalchemy.dialects.mysql.base._StringType, sqlalchemy.types.VARCHAR

MySQL VARCHAR type, for variable-length character data.

__init__(*length=None*, ***kwargs*)
Construct a VARCHAR.

Parameters

- **charset** – Optional, a column-level character set for this string value. Takes precedence to 'ascii' or 'unicode' short-hand.
- **collation** – Optional, a column-level collation for this string value. Takes precedence to 'binary' short-hand.
- **ascii** – Defaults to False: short-hand for the latin1 character set, generates ASCII in schema.
- **unicode** – Defaults to False: short-hand for the ucs2 character set, generates UNICODE in schema.
- **national** – Optional. If true, use the server's configured national character set.
- **binary** – Defaults to False: short-hand, pick the binary collation type that matches the column's character set. Generates BINARY in schema. This does not affect the type of data stored, only the collation of character data.

class sqlalchemy.dialects.mysql.**YEAR**(*display_width=None*)
Bases: sqlalchemy.types.TypeEngine

MySQL YEAR type, for single byte storage of years 1901-2155.

4.7.14 MySQL-Python Notes

Support for the MySQL database via the MySQL-python adapter.

MySQL-Python is available at:

http://sourceforge.net/projects/mysql-python

At least version 1.2.1 or 1.2.2 should be used.

Connecting

Connect string format:

```
mysql+mysqldb://<user>:<password>@<host>[:<port>]/<dbname>
```

Unicode

MySQLdb will accommodate Python unicode objects if the use_unicode=1 parameter, or the charset parameter, is passed as a connection argument.

Without this setting, many MySQL server installations default to a `latin1` encoding for client connections, which has the effect of all data being converted into `latin1`, even if you have `utf8` or another character set configured on your tables and columns. With versions 4.1 and higher, you can change the connection character set either through server configuration or by including the `charset` parameter. The `charset` parameter as received by MySQL-Python also has the side-effect of enabling `use_unicode=1`:

```
# set client encoding to utf8; all strings come back as unicode
create_engine('mysql+mysqldb:///mydb?charset=utf8')
```

Manually configuring `use_unicode=0` will cause MySQL-python to return encoded strings:

```
# set client encoding to utf8; all strings come back as utf8 str
create_engine('mysql+mysqldb:///mydb?charset=utf8&use_unicode=0')
```

Known Issues

MySQL-python version 1.2.2 has a serious memory leak related to unicode conversion, a feature which is disabled via `use_unicode=0`. It is strongly advised to use the latest version of MySQL-Python.

4.7.15 OurSQL Notes

Support for the MySQL database via the oursql adapter.

OurSQL is available at:

http://packages.python.org/oursql/

Connecting

Connect string format:

```
mysql+oursql://<user>:<password>@<host>[:<port>]/<dbname>
```

Unicode

oursql defaults to using `utf8` as the connection charset, but other encodings may be used instead. Like the MySQL-Python driver, unicode support can be completely disabled:

```
# oursql sets the connection charset to utf8 automatically; all strings come
# back as utf8 str
create_engine('mysql+oursql:///mydb?use_unicode=0')
```

To not automatically use `utf8` and instead use whatever the connection defaults to, there is a separate parameter:

```
# use the default connection charset; all strings come back as unicode
create_engine('mysql+oursql:///mydb?default_charset=1')

# use latin1 as the connection charset; all strings come back as unicode
create_engine('mysql+oursql:///mydb?charset=latin1')
```

4.7.16 pymysql Notes

Support for the MySQL database via the pymysql adapter.

pymysql is available at:

http://code.google.com/p/pymysql/

Connecting

Connect string:

```
mysql+pymysql://<username>:<password>@<host>/<dbname>[?<options>]
```

MySQL-Python Compatibility

The pymysql DBAPI is a pure Python port of the MySQL-python (MySQLdb) driver, and targets 100% compatibility. Most behavioral notes for MySQL-python apply to the pymysql driver as well.

4.7.17 MySQL-Connector Notes

Support for the MySQL database via the MySQL Connector/Python adapter.

MySQL Connector/Python is available at:

http://dev.mysql.com/downloads/connector/python/

Connecting

Connect string format:

```
mysql+mysqlconnector://<user>:<password>@<host>[:<port>]/<dbname>
```

4.7.18 Google App Engine Notes

Support for Google Cloud SQL on Google App Engine.

This dialect is based primarily on the `mysql.mysqldb` dialect with minimal changes.

New in version 0.7.8.

Connecting

Connect string format:

```
mysql+gaerdbms:///<dbname>
```

E.g.:

```
create_engine('mysql+gaerdbms:///mydb',
              connect_args={"instance":"instancename"})
```

Pooling

Google App Engine connections appear to be randomly recycled, so the dialect does not pool connections. The `NullPool` implementation is installed within the `Engine` by default.

4.7.19 pyodbc Notes

Support for the MySQL database via the pyodbc adapter.

pyodbc is available at:

http://pypi.python.org/pypi/pyodbc/

Connecting

Connect string:

```
mysql+pyodbc://<username>:<password>@<dsnname>
```

Limitations

The mysql-pyodbc dialect is subject to unresolved character encoding issues which exist within the current ODBC drivers available. (see http://code.google.com/p/pyodbc/issues/detail?id=25). Consider usage of OurSQL, MySQLdb, or MySQL-connector/Python.

4.7.20 zxjdbc Notes

Support for the MySQL database via Jython's zxjdbc JDBC connector.

JDBC Driver

The official MySQL JDBC driver is at http://dev.mysql.com/downloads/connector/j/.

Connecting

Connect string format:

mysql+zxjdbc://<user>:<password>@<hostname>[:<port>]/<database>

Character Sets

SQLAlchemy zxjdbc dialects pass unicode straight through to the zxjdbc/JDBC layer. To allow multiple character sets to be sent from the MySQL Connector/J JDBC driver, by default SQLAlchemy sets its `characterEncoding` connection property to `UTF-8`. It may be overriden via a `create_engine` URL parameter.

4.8 Oracle

Support for the Oracle database.

Oracle version 8 through current (11g at the time of this writing) are supported.

For information on connecting via specific drivers, see the documentation for that driver.

4.8.1 Connect Arguments

The dialect supports several `create_engine()` arguments which affect the behavior of the dialect regardless of driver in use.

- *use_ansi* - Use ANSI JOIN constructs (see the section on Oracle 8). Defaults to `True`. If `False`, Oracle-8 compatible constructs are used for joins.
- *optimize_limits* - defaults to `False`. see the section on LIMIT/OFFSET.
- *use_binds_for_limits* - defaults to `True`. see the section on LIMIT/OFFSET.

4.8.2 Auto Increment Behavior

SQLAlchemy Table objects which include integer primary keys are usually assumed to have "autoincrementing" behavior, meaning they can generate their own primary key values upon INSERT. Since Oracle has no "autoincrement" feature, SQLAlchemy relies upon sequences to produce these values. With the Oracle dialect, *a sequence must always be explicitly specified to enable autoincrement*. This is divergent with the majority of documentation examples which assume the usage of an autoincrement-capable database. To specify sequences, use the sqlalchemy.schema.Sequence object which is passed to a Column construct:

```
t = Table('mytable', metadata,
      Column('id', Integer, Sequence('id_seq'), primary_key=True),
      Column(...), ...
)
```

This step is also required when using table reflection, i.e. autoload=True:

```
t = Table('mytable', metadata,
      Column('id', Integer, Sequence('id_seq'), primary_key=True),
      autoload=True
)
```

4.8.3 Identifier Casing

In Oracle, the data dictionary represents all case insensitive identifier names using UPPERCASE text. SQLAlchemy on the other hand considers an all-lower case identifier name to be case insensitive. The Oracle dialect converts all case insensitive identifiers to and from those two formats during schema level communication, such as reflection of tables and indexes. Using an UPPERCASE name on the SQLAlchemy side indicates a case sensitive identifier, and SQLAlchemy will quote the name - this will cause mismatches against data dictionary data received from Oracle, so unless identifier names have been truly created as case sensitive (i.e. using quoted names), all lowercase names should be used on the SQLAlchemy side.

4.8.4 Unicode

Changed in version 0.6: SQLAlchemy uses the "native unicode" mode provided as of cx_oracle 5. cx_oracle 5.0.2 or greater is recommended for support of NCLOB. If not using cx_oracle 5, the NLS_LANG environment variable needs to be set in order for the oracle client library to use proper encoding, such as "AMERICAN_AMERICA.UTF8".

Also note that Oracle supports unicode data through the NVARCHAR and NCLOB data types. When using the SQLAlchemy Unicode and UnicodeText types, these DDL types will be used within CREATE TABLE statements. Usage of VARCHAR2 and CLOB with unicode text still requires NLS_LANG to be set.

4.8.5 LIMIT/OFFSET Support

Oracle has no support for the LIMIT or OFFSET keywords. SQLAlchemy uses a wrapped subquery approach in conjunction with ROWNUM. The exact methodology is taken from http://www.oracle.com/technology/oramag/oracle/06-sep/o56asktom.html .

There are two options which affect its behavior:

- the "FIRST ROWS()" optimization keyword is not used by default. To enable the usage of this optimization directive, specify `optimize_limits=True` to `create_engine()`.
- the values passed for the limit/offset are sent as bound parameters. Some users have observed that Oracle produces a poor query plan when the values are sent as binds and not rendered literally. To render the limit/offset values literally within the SQL statement, specify `use_binds_for_limits=False` to `create_engine()`.

Some users have reported better performance when the entirely different approach of a window query is used, i.e. ROW_NUMBER() OVER (ORDER BY), to provide LIMIT/OFFSET (note that the majority of users don't observe this). To suit this case the method used for LIMIT/OFFSET can be replaced entirely. See the recipe at http://www.sqlalchemy.org/trac/wiki/UsageRecipes/WindowFunctionsByDefault which installs a select compiler that overrides the generation of limit/offset with a window function.

4.8.6 ON UPDATE CASCADE

Oracle doesn't have native ON UPDATE CASCADE functionality. A trigger based solution is available at http://asktom.oracle.com/tkyte/update_cascade/index.html .

When using the SQLAlchemy ORM, the ORM has limited ability to manually issue cascading updates - specify ForeignKey objects using the "deferrable=True, initially='deferred"' keyword arguments, and specify "passive_updates=False" on each relationship().

4.8.7 Oracle 8 Compatibility

When Oracle 8 is detected, the dialect internally configures itself to the following behaviors:

- the use_ansi flag is set to False. This has the effect of converting all JOIN phrases into the WHERE clause, and in the case of LEFT OUTER JOIN makes use of Oracle's (+) operator.
- the NVARCHAR2 and NCLOB datatypes are no longer generated as DDL when the `Unicode` is used - VARCHAR2 and CLOB are issued instead. This because these types don't seem to work correctly on Oracle 8 even though they are available. The `NVARCHAR` and `NCLOB` types will always generate NVARCHAR2 and NCLOB.
- the "native unicode" mode is disabled when using cx_oracle, i.e. SQLAlchemy encodes all Python unicode objects to "string" before passing in as bind parameters.

4.8.8 Synonym/DBLINK Reflection

When using reflection with Table objects, the dialect can optionally search for tables indicated by synonyms that reference DBLINK-ed tables by passing the flag oracle_resolve_synonyms=True as a keyword argument to the Table construct. If DBLINK is not in use this flag should be left off.

4.8.9 Oracle Data Types

As with all SQLAlchemy dialects, all UPPERCASE types that are known to be valid with Oracle are importable from the top level dialect, whether they originate from `sqlalchemy.types` or from the local dialect:

```
from sqlalchemy.dialects.oracle import \
            BFILE, BLOB, CHAR, CLOB, DATE, DATETIME, \
            DOUBLE_PRECISION, FLOAT, INTERVAL, LONG, NCLOB, \
            NUMBER, NVARCHAR, NVARCHAR2, RAW, TIMESTAMP, VARCHAR, \
            VARCHAR2
```

Types which are specific to Oracle, or have Oracle-specific construction arguments, are as follows:

class sqlalchemy.dialects.oracle.**BFILE**(*length=None*)
Bases: sqlalchemy.types.LargeBinary

__init__(*length=None*)
Construct a LargeBinary type.

Parameters **length** – optional, a length for the column for use in DDL statements, for those BLOB types that accept a length (i.e. MySQL). It does *not* produce a small BINARY/VARBINARY type - use the BINARY/VARBINARY types specifically for those. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a *length* for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued.

class sqlalchemy.dialects.oracle.**DOUBLE_PRECISION**(*precision=None*, *scale=None*, *asdecimal=None*)
Bases: sqlalchemy.types.Numeric

class sqlalchemy.dialects.oracle.**INTERVAL**(*day_precision=None*, *second_precision=None*)
Bases: sqlalchemy.types.TypeEngine

__init__(*day_precision=None*, *second_precision=None*)
Construct an INTERVAL.

Note that only DAY TO SECOND intervals are currently supported. This is due to a lack of support for YEAR TO MONTH intervals within available DBAPIs (cx_oracle and zxjdbc).

Parameters

- **day_precision** – the day precision value. this is the number of digits to store for the day field. Defaults to "2"
- **second_precision** – the second precision value. this is the number of digits to store for the fractional seconds field. Defaults to "6".

class sqlalchemy.dialects.oracle.**NCLOB**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: sqlalchemy.types.Text

__init__(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Create a string-holding type.

Parameters

- **length** – optional, a length for the column for use in DDL statements. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a `length` for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued if a `VARCHAR` with no length is included. Whether the value is interpreted as bytes or characters is database specific.
- **convert_unicode** – When set to `True`, the `String` type will assume that input is to be passed as Python `unicode` objects, and results returned as Python `unicode` objects. If the DBAPI in use does not support Python unicode (which is fewer and fewer these days), SQLAlchemy will encode/decode the value, using the value of the `encoding` parameter passed to `create_engine()` as the encoding.

  When using a DBAPI that natively supports Python unicode objects, this flag generally does not need to be set. For columns that are explicitly intended to store non-ASCII data, the `Unicode` or `UnicodeText` types should be used regardless, which feature the same behavior of `convert_unicode` but also indicate an underlying column type that directly supports unicode, such as `NVARCHAR`.

  For the extremely rare case that Python `unicode` is to be encoded/decoded by SQLAlchemy on a backend that does natively support Python `unicode`, the value `force` can be passed here which will cause SQLAlchemy's encode/decode services to be used unconditionally.
- **assert_unicode** – Deprecated. A warning is emitted when a non-`unicode` object is passed to the `Unicode` subtype of `String`, or the `UnicodeText` subtype of `Text`. See `Unicode` for information on how to control this warning.
- **unicode_error** – Optional, a method to use to handle Unicode conversion errors. Behaves like the `errors` keyword argument to the standard library's `string.decode()` functions. This flag requires that `convert_unicode` is set to `force` - otherwise, SQLAlchemy is not guaranteed to handle the task of unicode conversion. Note that this flag adds significant performance overhead to row-fetching operations for backends that already return unicode objects natively (which most DBAPIs do). This flag should only be used as a last resort for reading strings from a column with varied or corrupted encodings.

class sqlalchemy.dialects.oracle.**NUMBER**(*precision=None*, *scale=None*, *asdecimal=None*)
Bases: `sqlalchemy.types.Numeric`, `sqlalchemy.types.Integer`

class sqlalchemy.dialects.oracle.**LONG**(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Bases: `sqlalchemy.types.Text`

__init__(*length=None*, *convert_unicode=False*, *assert_unicode=None*, *unicode_error=None*, *_warn_on_bytestring=False*)
Create a string-holding type.

Parameters

- **length** – optional, a length for the column for use in DDL statements. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a `length` for use in DDL, and will raise an exception when the `CREATE`

TABLE DDL is issued if a VARCHAR with no length is included. Whether the value is interpreted as bytes or characters is database specific.

- **convert_unicode** – When set to True, the String type will assume that input is to be passed as Python unicode objects, and results returned as Python unicode objects. If the DBAPI in use does not support Python unicode (which is fewer and fewer these days), SQLAlchemy will encode/decode the value, using the value of the encoding parameter passed to create_engine() as the encoding.

  When using a DBAPI that natively supports Python unicode objects, this flag generally does not need to be set. For columns that are explicitly intended to store non-ASCII data, the Unicode or UnicodeText types should be used regardless, which feature the same behavior of convert_unicode but also indicate an underlying column type that directly supports unicode, such as NVARCHAR.

  For the extremely rare case that Python unicode is to be encoded/decoded by SQLAlchemy on a backend that does natively support Python unicode, the value force can be passed here which will cause SQLAlchemy's encode/decode services to be used unconditionally.

- **assert_unicode** – Deprecated. A warning is emitted when a non-unicode object is passed to the Unicode subtype of String, or the UnicodeText subtype of Text. See Unicode for information on how to control this warning.

- **unicode_error** – Optional, a method to use to handle Unicode conversion errors. Behaves like the errors keyword argument to the standard library's string.decode() functions. This flag requires that convert_unicode is set to force - otherwise, SQLAlchemy is not guaranteed to handle the task of unicode conversion. Note that this flag adds significant performance overhead to row-fetching operations for backends that already return unicode objects natively (which most DBAPIs do). This flag should only be used as a last resort for reading strings from a column with varied or corrupted encodings.

class sqlalchemy.dialects.oracle.**RAW**(*length=None*)
Bases: sqlalchemy.types._Binary

4.8.10 cx_Oracle Notes

Support for the Oracle database via the cx_oracle driver.

Driver

The Oracle dialect uses the cx_oracle driver, available at http://cx-oracle.sourceforge.net/ . The dialect has several behaviors which are specifically tailored towards compatibility with this module. Version 5.0 or greater is **strongly** recommended, as SQLAlchemy makes extensive use of the cx_oracle output converters for numeric and string conversions.

Connecting

Connecting with create_engine() uses the standard URL approach of oracle://user:pass@host:port/dbname[?key=valu
If dbname is present, the host, port, and dbname tokens are converted to a TNS name using the cx_oracle makedsn()
function. Otherwise, the host token is taken directly as a TNS name.

Additional arguments which may be specified either as query string arguments on the URL, or as keyword arguments to create_engine() are:

- *allow_twophase* - enable two-phase transactions. Defaults to `True`.
- *arraysize* - set the cx_oracle.arraysize value on cursors, in SQLAlchemy it defaults to 50. See the section on "LOB Objects" below.
- *auto_convert_lobs* - defaults to True, see the section on LOB objects.
- *auto_setinputsizes* - the cx_oracle.setinputsizes() call is issued for all bind parameters. This is required for LOB datatypes but can be disabled to reduce overhead. Defaults to `True`.
- *mode* - This is given the string value of SYSDBA or SYSOPER, or alternatively an integer value. This value is only available as a URL query string argument.
- *threaded* - enable multithreaded access to cx_oracle connections. Defaults to `True`. Note that this is the opposite default of cx_oracle itself.

Unicode

cx_oracle 5 fully supports Python unicode objects. SQLAlchemy will pass all unicode strings directly to cx_oracle, and additionally uses an output handler so that all string based result values are returned as unicode as well. Generally, the `NLS_LANG` environment variable determines the nature of the encoding to be used.

Note that this behavior is disabled when Oracle 8 is detected, as it has been observed that issues remain when passing Python unicodes to cx_oracle with Oracle 8.

LOB Objects

cx_oracle returns oracle LOBs using the cx_oracle.LOB object. SQLAlchemy converts these to strings so that the interface of the Binary type is consistent with that of other backends, and so that the linkage to a live cursor is not needed in scenarios like result.fetchmany() and result.fetchall(). This means that by default, LOB objects are fully fetched unconditionally by SQLAlchemy, and the linkage to a live cursor is broken.

To disable this processing, pass `auto_convert_lobs=False` to `create_engine()`.

Two Phase Transaction Support

Two Phase transactions are implemented using XA transactions, and are known to work in a rudimental fashion with recent versions of cx_Oracle as of SQLAlchemy 0.8.0b2, 0.7.10. However, the mechanism is not yet considered to be robust and should still be regarded as experimental.

In particular, the cx_Oracle DBAPI as recently as 5.1.2 has a bug regarding two phase which prevents a particular DBAPI connection from being consistently usable in both prepared transactions as well as traditional DBAPI usage patterns; therefore once a particular connection is used via `Connection.begin_prepared()`, all subsequent usages of the underlying DBAPI connection must be within the context of prepared transactions.

The default behavior of `Engine` is to maintain a pool of DBAPI connections. Therefore, due to the above glitch, a DBAPI connection that has been used in a two-phase operation, and is then returned to the pool, will not be usable in a non-two-phase context. To avoid this situation, the application can make one of several choices:

- Disable connection pooling using `NullPool`
- Ensure that the particular `Engine` in use is only used for two-phase operations. A `Engine` bound to an ORM `Session` which includes `twophase=True` will consistently use the two-phase transaction style.
- For ad-hoc two-phase operations without disabling pooling, the DBAPI connection in use can be evicted from the connection pool using the `Connection.detach` method.

Changed in version 0.8.0b2,0.7.10: Support for cx_oracle prepared transactions has been implemented and tested.

Precision Numerics

The SQLAlchemy dialect goes through a lot of steps to ensure that decimal numbers are sent and received with full accuracy. An "outputtypehandler" callable is associated with each cx_oracle connection object which detects numeric types and receives them as string values, instead of receiving a Python `float` directly, which is then passed to the Python `Decimal` constructor. The `Numeric` and `Float` types under the cx_oracle dialect are aware of this behavior, and will coerce the `Decimal` to `float` if the `asdecimal` flag is `False` (default on `Float`, optional on `Numeric`).

Because the handler coerces to `Decimal` in all cases first, the feature can detract significantly from performance. If precision numerics aren't required, the decimal handling can be disabled by passing the flag `coerce_to_decimal=False` to `create_engine()`:

```
engine = create_engine("oracle+cx_oracle://dsn",
                       coerce_to_decimal=False)
```

New in version 0.7.6: Add the `coerce_to_decimal` flag.

Another alternative to performance is to use the cdecimal library; see `Numeric` for additional notes.

The handler attempts to use the "precision" and "scale" attributes of the result set column to best determine if subsequent incoming values should be received as `Decimal` as opposed to int (in which case no processing is added). There are several scenarios where OCI does not provide unambiguous data as to the numeric type, including some situations where individual rows may return a combination of floating point and integer values. Certain values for "precision" and "scale" have been observed to determine this scenario. When it occurs, the outputtypehandler receives as string and then passes off to a processing function which detects, for each returned value, if a decimal point is present, and if so converts to `Decimal`, otherwise to int. The intention is that simple int-based statements like "SELECT my_seq.nextval() FROM DUAL" continue to return ints and not `Decimal` objects, and that any kind of floating point value is received as a string so that there is no floating point loss of precision.

The "decimal point is present" logic itself is also sensitive to locale. Under OCI, this is controlled by the NLS_LANG environment variable. Upon first connection, the dialect runs a test to determine the current "decimal" character, which can be a comma "," for european locales. From that point forward the outputtypehandler uses that character to represent a decimal point. Note that cx_oracle 5.0.3 or greater is required when dealing with numerics with locale settings that don't use a period "." as the decimal character.

Changed in version 0.6.6: The outputtypehandler uses a comma "," character to represent a decimal point.

4.8.11 zxjdbc Notes

Support for the Oracle database via the zxjdbc JDBC connector.

JDBC Driver

The official Oracle JDBC driver is at http://www.oracle.com/technology/software/tech/java/sqlj_jdbc/index.html.

4.9 PostgreSQL

Support for the PostgreSQL database.

For information on connecting using specific drivers, see the documentation section regarding that driver.

4.9.1 Sequences/SERIAL

PostgreSQL supports sequences, and SQLAlchemy uses these as the default means of creating new primary key values for integer-based primary key columns. When creating tables, SQLAlchemy will issue the `SERIAL` datatype for integer-based primary key columns, which generates a sequence and server side default corresponding to the column.

To specify a specific named sequence to be used for primary key generation, use the `Sequence()` construct:

```
Table('sometable', metadata,
        Column('id', Integer, Sequence('some_id_seq'), primary_key=True)
    )
```

When SQLAlchemy issues a single INSERT statement, to fulfill the contract of having the "last insert identifier" available, a RETURNING clause is added to the INSERT statement which specifies the primary key columns should be returned after the statement completes. The RETURNING functionality only takes place if Postgresql 8.2 or later is in use. As a fallback approach, the sequence, whether specified explicitly or implicitly via `SERIAL`, is executed independently beforehand, the returned value to be used in the subsequent insert. Note that when an `insert()` construct is executed using "executemany" semantics, the "last inserted identifier" functionality does not apply; no RETURNING clause is emitted nor is the sequence pre-executed in this case.

To force the usage of RETURNING by default off, specify the flag `implicit_returning=False` to `create_engine()`.

4.9.2 Transaction Isolation Level

`create_engine()` accepts an `isolation_level` parameter which results in the command `SET SESSION CHARACTERISTICS AS TRANSACTION ISOLATION LEVEL <level>` being invoked for every new connection. Valid values for this parameter are `READ COMMITTED`, `READ UNCOMMITTED`, `REPEATABLE READ`, and `SERIALIZABLE`:

```
engine = create_engine(
                "postgresql+pg8000://scott:tiger@localhost/test",
                isolation_level="READ UNCOMMITTED"
            )
```

When using the psycopg2 dialect, a psycopg2-specific method of setting transaction isolation level is used, but the API of `isolation_level` remains the same - see *Transaction Isolation Level*.

4.9.3 Remote / Cross-Schema Table Introspection

Tables can be introspected from any accessible schema, including inter-schema foreign key relationships. However, care must be taken when specifying the "schema" argument for a given `Table`, when the given schema is also present in PostgreSQL's `search_path` variable for the current connection.

If a FOREIGN KEY constraint reports that the remote table's schema is within the current `search_path`, the "schema" attribute of the resulting `Table` will be set to `None`, unless the actual schema of the remote table matches that of the referencing table, and the "schema" argument was explicitly stated on the referencing table.

The best practice here is to not use the `schema` argument on `Table` for any schemas that are present in `search_path`. `search_path` defaults to "public", but care should be taken to inspect the actual value using:

```
SHOW search_path;
```

Changed in version 0.7.3: Prior to this version, cross-schema foreign keys when the schemas were also in the `search_path` could make an incorrect assumption if the schemas were explicitly stated on each `Table`.

Background on PG's `search_path` is at: http://www.postgresql.org/docs/9.0/static/ddl-schemas.html#DDL-SCHEMAS-PATH

4.9.4 INSERT/UPDATE...RETURNING

The dialect supports PG 8.2's `INSERT..RETURNING`, `UPDATE..RETURNING` and `DELETE..RETURNING` syntaxes. `INSERT..RETURNING` is used by default for single-row INSERT statements in order to fetch newly generated primary key identifiers. To specify an explicit `RETURNING` clause, use the `_UpdateBase.returning()` method on a per-statement basis:

```
# INSERT..RETURNING
result = table.insert().returning(table.c.col1, table.c.col2).\
    values(name='foo')
print result.fetchall()

# UPDATE..RETURNING
result = table.update().returning(table.c.col1, table.c.col2).\
    where(table.c.name=='foo').values(name='bar')
print result.fetchall()

# DELETE..RETURNING
result = table.delete().returning(table.c.col1, table.c.col2).\
    where(table.c.name=='foo')
print result.fetchall()
```

4.9.5 Postgresql-Specific Index Options

Several extensions to the `Index` construct are available, specific to the PostgreSQL dialect.

Partial Indexes

Partial indexes add criterion to the index definition so that the index is applied to a subset of rows. These can be specified on `Index` using the `postgresql_where` keyword argument:

```
Index('my_index', my_table.c.id, postgresql_where=tbl.c.value > 10)
```

Operator Classes

PostgreSQL allows the specification of an *operator class* for each column of an index (see http://www.postgresql.org/docs/8.3/interactive/indexes-opclass.html). The `Index` construct allows these to be specified via the `postgresql_ops` keyword argument:

```
Index('my_index', my_table.c.id, my_table.c.data,
                        postgresql_ops={
                            'data': 'text_pattern_ops',
                            'id': 'int4_ops'
                        })
```

New in version 0.7.2: `postgresql_ops` keyword argument to `Index` construct.

Note that the keys in the `postgresql_ops` dictionary are the "key" name of the `Column`, i.e. the name used to access it from the `.c` collection of `Table`, which can be configured to be different than the actual name of the column as expressed in the database.

Index Types

PostgreSQL provides several index types: B-Tree, Hash, GiST, and GIN, as well as the ability for users to create their own (see http://www.postgresql.org/docs/8.3/static/indexes-types.html). These can be specified on `Index` using the `postgresql_using` keyword argument:

```
Index('my_index', my_table.c.data, postgresql_using='gin')
```

The value passed to the keyword argument will be simply passed through to the underlying CREATE INDEX command, so it *must* be a valid index type for your version of PostgreSQL.

4.9.6 PostgreSQL Data Types

As with all SQLAlchemy dialects, all UPPERCASE types that are known to be valid with Postgresql are importable from the top level dialect, whether they originate from `sqlalchemy.types` or from the local dialect:

```
from sqlalchemy.dialects.postgresql import \
    ARRAY, BIGINT, BIT, BOOLEAN, BYTEA, CHAR, CIDR, DATE, \
    DOUBLE_PRECISION, ENUM, FLOAT, INET, INTEGER, INTERVAL, \
    MACADDR, NUMERIC, REAL, SMALLINT, TEXT, TIME, TIMESTAMP, \
    UUID, VARCHAR
```

Types which are specific to PostgreSQL, or have PostgreSQL-specific construction arguments, are as follows:

class `sqlalchemy.dialects.postgresql.`**ARRAY**(*item_type*, *mutable=False*, *as_tuple=False*)

Bases: `sqlalchemy.types.MutableType`, `sqlalchemy.types.Concatenable`, `sqlalchemy.types.TypeEngine`

Postgresql ARRAY type.

Represents values as Python lists.

The ARRAY type may not be supported on all DBAPIs. It is known to work on psycopg2 and not pg8000.

__init__(*item_type*, *mutable=False*, *as_tuple=False*)

Construct an ARRAY.

E.g.:

```
Column('myarray', ARRAY(Integer))
```

Arguments are:

Parameters

- **item_type** – The data type of items of this array. Note that dimensionality is irrelevant here, so multi-dimensional arrays like `INTEGER[][]`, are constructed as `ARRAY(Integer)`, not as `ARRAY(ARRAY(Integer))` or such. The type mapping figures out on the fly

- **mutable=False** – Specify whether lists passed to this class should be considered mutable - this enables "mutable types" mode in the ORM. Be sure to read the notes for `MutableType` regarding ORM performance implications.

  Changed in version 0.7.0: Default changed from `True`.

  Changed in version 0.7: This functionality is now superseded by the `sqlalchemy.ext.mutable` extension described in *Mutation Tracking*.

- **as_tuple=False** – Specify whether return results should be converted to tuples from lists. DBAPIs such as psycopg2 return lists by default. When tuples are returned, the results are hashable. This flag can only be set to `True` when `mutable` is set to `False`.

  New in version 0.6.5.

class sqlalchemy.dialects.postgresql.**BIT**(*length=None*, *varying=False*)
Bases: sqlalchemy.types.TypeEngine

class sqlalchemy.dialects.postgresql.**BYTEA**(*length=None*)
Bases: sqlalchemy.types.LargeBinary

__init__(*length=None*)
Construct a LargeBinary type.

Parameters length – optional, a length for the column for use in DDL statements, for those BLOB types that accept a length (i.e. MySQL). It does *not* produce a small BINARY/VARBINARY type - use the BINARY/VARBINARY types specifically for those. May be safely omitted if no `CREATE TABLE` will be issued. Certain databases may require a *length* for use in DDL, and will raise an exception when the `CREATE TABLE` DDL is issued.

class sqlalchemy.dialects.postgresql.**CIDR**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.postgresql.**DOUBLE_PRECISION**(*precision=None*, *asdecimal=False*, ***kwargs*)
Bases: sqlalchemy.types.Float

__init__(*precision=None*, *asdecimal=False*, ***kwargs*)
Construct a Float.

Parameters

- **precision** – the numeric precision for use in DDL `CREATE TABLE`.
- **asdecimal** – the same flag as that of `Numeric`, but defaults to `False`. Note that setting this flag to `True` results in floating point conversion.
- ****kwargs** – deprecated. Additional arguments here are ignored by the default `Float` type. For database specific floats that support additional arguments, see that dialect's documentation for details, such as `sqlalchemy.dialects.mysql.FLOAT`.

class sqlalchemy.dialects.postgresql.**ENUM**(**enums*, ***kw*)
Bases: sqlalchemy.types.Enum

Postgresql ENUM type.

This is a subclass of `types.Enum` which includes support for PG's `CREATE TYPE`.

ENUM is used automatically when using the types.Enum type on PG assuming the native_enum is left as True. However, the ENUM class can also be instantiated directly in order to access some additional Postgresql-specific options, namely finer control over whether or not CREATE TYPE should be emitted.

Note that both types.Enum as well as ENUM feature create/drop methods; the base types.Enum type ultimately delegates to the create() and drop() methods present here.

__init__(**enums*, ***kw*)
Construct an ENUM.

Arguments are the same as that of types.Enum, but also including the following parameters.

Parameters **create_type** – Defaults to True. Indicates that CREATE TYPE should be emitted, after optionally checking for the presence of the type, when the parent table is being created; and additionally that DROP TYPE is called when the table is dropped. When False, no check will be performed and no CREATE TYPE or DROP TYPE is emitted, unless create() or drop() are called directly. Setting to False is helpful when invoking a creation scheme to a SQL file without access to the actual database - the create() and drop() methods can be used to emit SQL to a target bind.

New in version 0.7.4.

create(*bind=None*, *checkfirst=True*)
Emit CREATE TYPE for this ENUM.

If the underlying dialect does not support Postgresql CREATE TYPE, no action is taken.

Parameters

- **bind** – a connectable Engine, Connection, or similar object to emit SQL.
- **checkfirst** – if True, a query against the PG catalog will be first performed to see if the type does not exist already before creating.

drop(*bind=None*, *checkfirst=True*)
Emit DROP TYPE for this ENUM.

If the underlying dialect does not support Postgresql DROP TYPE, no action is taken.

Parameters

- **bind** – a connectable Engine, Connection, or similar object to emit SQL.
- **checkfirst** – if True, a query against the PG catalog will be first performed to see if the type actually exists before dropping.

class sqlalchemy.dialects.postgresql.**INET**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.postgresql.**INTERVAL**(*precision=None*)
Bases: sqlalchemy.types.TypeEngine

Postgresql INTERVAL type.

The INTERVAL type may not be supported on all DBAPIs. It is known to work on psycopg2 and not pg8000 or zxjdbc.

class sqlalchemy.dialects.postgresql.**MACADDR**(**args*, ***kwargs*)
Bases: sqlalchemy.types.TypeEngine

__init__(**args*, ***kwargs*)
Support implementations that were passing arguments

class sqlalchemy.dialects.postgresql.**REAL**(*precision=None*, *asdecimal=False*, ***kwargs*)
Bases: sqlalchemy.types.Float

The SQL REAL type.

__init__(*precision=None*, *asdecimal=False*, ***kwargs*)
Construct a Float.

Parameters

- **precision** – the numeric precision for use in DDL CREATE TABLE.
- **asdecimal** – the same flag as that of Numeric, but defaults to False. Note that setting this flag to True results in floating point conversion.
- ****kwargs** – deprecated. Additional arguments here are ignored by the default Float type. For database specific floats that support additional arguments, see that dialect's documentation for details, such as sqlalchemy.dialects.mysql.FLOAT.

class sqlalchemy.dialects.postgresql.**UUID**(*as_uuid=False*)
Bases: sqlalchemy.types.TypeEngine

Postgresql UUID type.

Represents the UUID column type, interpreting data either as natively returned by the DBAPI or as Python uuid objects.

The UUID type may not be supported on all DBAPIs. It is known to work on psycopg2 and not pg8000.

__init__(*as_uuid=False*)
Construct a UUID type.

Parameters **as_uuid=False** – if True, values will be interpreted as Python uuid objects, converting to/from string via the DBAPI.

4.9.7 psycopg2 Notes

Support for the PostgreSQL database via the psycopg2 driver.

Driver

The psycopg2 driver is available at http://pypi.python.org/pypi/psycopg2/ . The dialect has several behaviors which are specifically tailored towards compatibility with this module.

Note that psycopg1 is **not** supported.

Connecting

URLs are of the form postgresql+psycopg2://user:password@host:port/dbname[?key=value&key=value...

psycopg2-specific keyword arguments which are accepted by create_engine() are:

- *server_side_cursors* - Enable the usage of "server side cursors" for SQL statements which support this feature. What this essentially means from a psycopg2 point of view is that the cursor is created using a name, e.g. connection.cursor('some name'), which has the effect that result rows are not immediately pre-fetched and buffered after statement execution, but are instead left on the server and only retrieved as needed. SQLAlchemy's ResultProxy uses special row-buffering behavior when this feature is enabled, such that groups of 100 rows at a time are fetched over the wire to reduce conversational overhead. Note that the

stream_results=True execution option is a more targeted way of enabling this mode on a per-execution basis.

- *use_native_unicode* - Enable the usage of Psycopg2 "native unicode" mode per connection. True by default.

Unix Domain Connections

psycopg2 supports connecting via Unix domain connections. When the host portion of the URL is omitted, SQLAlchemy passes None to psycopg2, which specifies Unix-domain communication rather than TCP/IP communication:

```
create_engine("postgresql+psycopg2://user:password@/dbname")
```

By default, the socket file used is to connect to a Unix-domain socket in /tmp, or whatever socket directory was specified when PostgreSQL was built. This value can be overridden by passing a pathname to psycopg2, using host as an additional keyword argument:

```
create_engine("postgresql+psycopg2://user:password@/dbname?host=/var/lib/postgresql")
```

See also:

PQconnectdbParams

Per-Statement/Connection Execution Options

The following DBAPI-specific options are respected when used with Connection.execution_options(), Executable.execution_options(), Query.execution_options(), in addition to those not specific to DBAPIs:

- isolation_level - Set the transaction isolation level for the lifespan of a Connection (can only be set on a connection, not a statement or query). This includes the options SERIALIZABLE, READ COMMITTED, READ UNCOMMITTED and REPEATABLE READ.
- stream_results - Enable or disable usage of server side cursors. If None or not set, the server_side_cursors option of the Engine is used.

Unicode

By default, the psycopg2 driver uses the psycopg2.extensions.UNICODE extension, such that the DBAPI receives and returns all strings as Python Unicode objects directly - SQLAlchemy passes these values through without change. Psycopg2 here will encode/decode string values based on the current "client encoding" setting; by default this is the value in the postgresql.conf file, which often defaults to SQL_ASCII. Typically, this can be changed to utf-8, as a more useful default:

```
#client_encoding = sql_ascii # actually, defaults to database
                             # encoding
client_encoding = utf8
```

A second way to affect the client encoding is to set it within Psycopg2 locally. SQLAlchemy will call psycopg2's set_client_encoding() method (see: http://initd.org/psycopg/docs/connection.html#connection.set_client_encoding) on all new connections based on the value passed to create_engine() using the client_encoding parameter:

```
engine = create_engine("postgresql://user:pass@host/dbname", client_encoding='utf8')
```

This overrides the encoding specified in the Postgresql client configuration.

New in version 0.7.3: The psycopg2-specific `client_encoding` parameter to `create_engine()`.

SQLAlchemy can also be instructed to skip the usage of the psycopg2 `UNICODE` extension and to instead utilize it's own unicode encode/decode services, which are normally reserved only for those DBAPIs that don't fully support unicode directly. Passing `use_native_unicode=False` to `create_engine()` will disable usage of `psycopg2.extensions.UNICODE`. SQLAlchemy will instead encode data itself into Python bytestrings on the way in and coerce from bytes on the way back, using the value of the `create_engine()` `encoding` parameter, which defaults to `utf-8`. SQLAlchemy's own unicode encode/decode functionality is steadily becoming obsolete as more DBAPIs support unicode fully along with the approach of Python 3; in modern usage psycopg2 should be relied upon to handle unicode.

Transactions

The psycopg2 dialect fully supports SAVEPOINT and two-phase commit operations.

Transaction Isolation Level

The `isolation_level` parameter of `create_engine()` here makes use psycopg2's `set_isolation_level()` connection method, rather than issuing a `SET SESSION CHARACTERISTICS` command. This because psycopg2 resets the isolation level on each new transaction, and needs to know at the API level what level should be used.

NOTICE logging

The psycopg2 dialect will log Postgresql NOTICE messages via the `sqlalchemy.dialects.postgresql` logger:

```
import logging
logging.getLogger('sqlalchemy.dialects.postgresql').setLevel(logging.INFO)
```

4.9.8 py-postgresql Notes

Support for the PostgreSQL database via py-postgresql.

Connecting

URLs are of the form `postgresql+pypostgresql://user:password@host:port/dbname[?key=value&key=valu`

4.9.9 pg8000 Notes

Support for the PostgreSQL database via the pg8000 driver.

Connecting

URLs are of the form `postgresql+pg8000://user:password@host:port/dbname[?key=value&key=value...]`.

Unicode

pg8000 requires that the postgresql client encoding be configured in the postgresql.conf file in order to use encodings other than ascii. Set this value to the same value as the "encoding" parameter on create_engine(), usually "utf-8".

Interval

Passing data from/to the Interval type is not supported as of yet.

4.9.10 zxjdbc Notes

Support for the PostgreSQL database via the zxjdbc JDBC connector.

JDBC Driver

The official Postgresql JDBC driver is at http://jdbc.postgresql.org/.

4.10 SQLite

Support for the SQLite database.

For information on connecting using a specific driver, see the documentation section regarding that driver.

4.10.1 Date and Time Types

SQLite does not have built-in DATE, TIME, or DATETIME types, and pysqlite does not provide out of the box functionality for translating values between Python *datetime* objects and a SQLite-supported format. SQLAlchemy's own `DateTime` and related types provide date formatting and parsing functionality when SQlite is used. The implementation classes are `DATETIME`, `DATE` and `TIME`. These types represent dates and times as ISO formatted strings, which also nicely support ordering. There's no reliance on typical "libc" internals for these functions so historical dates are fully supported.

4.10.2 Auto Incrementing Behavior

Background on SQLite's autoincrement is at: http://sqlite.org/autoinc.html

Two things to note:

- The AUTOINCREMENT keyword is **not** required for SQLite tables to generate primary key values automatically. AUTOINCREMENT only means that the algorithm used to generate ROWID values should be slightly different.
- SQLite does **not** generate primary key (i.e. ROWID) values, even for one column, if the table has a composite (i.e. multi-column) primary key. This is regardless of the AUTOINCREMENT keyword being present or not.

To specifically render the AUTOINCREMENT keyword on the primary key column when rendering DDL, add the flag `sqlite_autoincrement=True` to the Table construct:

```
Table('sometable', metadata,
        Column('id', Integer, primary_key=True),
        sqlite_autoincrement=True)
```

4.10.3 Transaction Isolation Level

`create_engine()` accepts an `isolation_level` parameter which results in the command `PRAGMA read_uncommitted <level>` being invoked for every new connection. Valid values for this parameter are `SERIALIZABLE` and `READ UNCOMMITTED` corresponding to a value of 0 and 1, respectively. See the section *Serializable Transaction Isolation* for an important workaround when using serializable isolation with Pysqlite.

4.10.4 Database Locking Behavior / Concurrency

Note that SQLite is not designed for a high level of concurrency. The database itself, being a file, is locked completely during write operations and within transactions, meaning exactly one connection has exclusive access to the database during this period - all other connections will be blocked during this time.

The Python DBAPI specification also calls for a connection model that is always in a transaction; there is no BEGIN method, only commit and rollback. This implies that a SQLite DBAPI driver would technically allow only serialized access to a particular database file at all times. The pysqlite driver attempts to ameliorate this by deferring the actual BEGIN statement until the first DML (INSERT, UPDATE, or DELETE) is received within a transaction. While this breaks serializable isolation, it at least delays the exclusive locking inherent in SQLite's design.

SQLAlchemy's default mode of usage with the ORM is known as "autocommit=False", which means the moment the `Session` begins to be used, a transaction is begun. As the `Session` is used, the autoflush feature, also on by default, will flush out pending changes to the database before each query. The effect of this is that a `Session` used in its default mode will often emit DML early on, long before the transaction is actually committed. This again will have the effect of serializing access to the SQLite database. If highly concurrent reads are desired against the SQLite database, it is advised that the autoflush feature be disabled, and potentially even that autocommit be re-enabled, which has the effect of each SQL statement and flush committing changes immediately.

For more information on SQLite's lack of concurrency by design, please see Situations Where Another RDBMS May Work Better - High Concurrency near the bottom of the page.

4.10.5 Foreign Key Support

SQLite supports FOREIGN KEY syntax when emitting CREATE statements for tables, however by default these constraints have no effect on the operation of the table.

Constraint checking on SQLite has three prerequisites:

- At least version 3.6.19 of SQLite must be in use
- The SQLite libary must be compiled *without* the SQLITE_OMIT_FOREIGN_KEY or SQLITE_OMIT_TRIGGER symbols enabled.
- The `PRAGMA foreign_keys = ON` statement must be emitted on all connections before use.

SQLAlchemy allows for the `PRAGMA` statement to be emitted automatically for new connections through the usage of events:

```
from sqlalchemy.engine import Engine
from sqlalchemy import event

@event.listens_for(Engine, "connect")
def set_sqlite_pragma(dbapi_connection, connection_record):
    cursor = dbapi_connection.cursor()
    cursor.execute("PRAGMA foreign_keys=ON")
    cursor.close()
```

See also:

SQLite Foreign Key Support - on the SQLite web site.

Events - SQLAlchemy event API.

4.10.6 SQLite Data Types

As with all SQLAlchemy dialects, all UPPERCASE types that are known to be valid with SQLite are importable from the top level dialect, whether they originate from `sqlalchemy.types` or from the local dialect:

```
from sqlalchemy.dialects.sqlite import \
            BLOB, BOOLEAN, CHAR, DATE, DATETIME, DECIMAL, FLOAT, \
            INTEGER, NUMERIC, SMALLINT, TEXT, TIME, TIMESTAMP, \
            VARCHAR
```

class `sqlalchemy.dialects.sqlite.`**DATETIME**(*storage_format=None*, *regexp=None*, ***kw*)

Represent a Python datetime object in SQLite using a string.

The default string storage format is:

```
"%04d-%02d-%02d %02d:%02d:%02d.%06d" % (value.year,
                        value.month, value.day,
                        value.hour, value.minute,
                        value.second, value.microsecond)
```

e.g.:

```
2011-03-15 12:05:57.10558
```

The storage format can be customized to some degree using the `storage_format` and `regexp` parameters, such as:

```
import re
from sqlalchemy.dialects.sqlite import DATETIME

dt = DATETIME(
        storage_format="%04d/%02d/%02d %02d-%02d-%02d-%06d",
        regexp=re.compile("(\d+)/(\d+)/(\d+) (\d+)-(\d+)-(\d+)(?:-(\d+))?")
    )
```

Parameters

- **storage_format** – format string which will be applied to the tuple `(value.year, value.month, value.day, value.hour, value.minute, value.second, value.microsecond)`, given a Python datetime.datetime() object.
- **regexp** – regular expression which will be applied to incoming result rows. The resulting match object is applied to the Python datetime() constructor via `*map(int, match_obj.groups(0))`.

class `sqlalchemy.dialects.sqlite.`**DATE**(*storage_format=None*, *regexp=None*, ***kw*)

Represent a Python date object in SQLite using a string.

The default string storage format is:

```
"%04d-%02d-%02d" % (value.year, value.month, value.day)
```

e.g.:

```
2011-03-15
```

The storage format can be customized to some degree using the `storage_format` and `regexp` parameters, such as:

```
import re
from sqlalchemy.dialects.sqlite import DATE

d = DATE(
        storage_format="%02d/%02d/%02d",
        regexp=re.compile("(\d+)/(\d+)/(\d+)")
    )
```

Parameters

- **storage_format** – format string which will be applied to the tuple `(value.year, value.month, value.day)`, given a Python datetime.date() object.
- **regexp** – regular expression which will be applied to incoming result rows. The resulting match object is applied to the Python date() constructor via `*map(int, match_obj.groups(0))`.

class sqlalchemy.dialects.sqlite.**TIME**(*storage_format=None*, *regexp=None*, ***kw*)

Represent a Python time object in SQLite using a string.

The default string storage format is:

```
"%02d:%02d:%02d.%06d" % (value.hour, value.minute,
                         value.second,
                          value.microsecond)
```

e.g.:

```
12:05:57.10558
```

The storage format can be customized to some degree using the `storage_format` and `regexp` parameters, such as:

```
import re
from sqlalchemy.dialects.sqlite import TIME

t = TIME(
        storage_format="%02d-%02d-%02d-%06d",
        regexp=re.compile("(\d+)-(\d+)-(\d+)-(?:-(\d+))?")
    )
```

Parameters

- **storage_format** – format string which will be applied to the tuple `(value.hour, value.minute, value.second, value.microsecond)`, given a Python datetime.time() object.

- **regexp** – regular expression which will be applied to incoming result rows. The resulting match object is applied to the Python time() constructor via `*map(int, match_obj.groups(0))`.

4.10.7 Pysqlite

Support for the SQLite database via pysqlite.

Note that pysqlite is the same driver as the `sqlite3` module included with the Python distribution.

Driver

When using Python 2.5 and above, the built in `sqlite3` driver is already installed and no additional installation is needed. Otherwise, the `pysqlite2` driver needs to be present. This is the same driver as `sqlite3`, just with a different name.

The `pysqlite2` driver will be loaded first, and if not found, `sqlite3` is loaded. This allows an explicitly installed pysqlite driver to take precedence over the built in one. As with all dialects, a specific DBAPI module may be provided to `create_engine()` to control this explicitly:

```
from sqlite3 import dbapi2 as sqlite
e = create_engine('sqlite+pysqlite:///file.db', module=sqlite)
```

Full documentation on pysqlite is available at: http://www.initd.org/pub/software/pysqlite/doc/usage-guide.html

Connect Strings

The file specification for the SQLite database is taken as the "database" portion of the URL. Note that the format of a url is:

```
driver://user:pass@host/database
```

This means that the actual filename to be used starts with the characters to the **right** of the third slash. So connecting to a relative filepath looks like:

```
# relative path
e = create_engine('sqlite:///path/to/database.db')
```

An absolute path, which is denoted by starting with a slash, means you need **four** slashes:

```
# absolute path
e = create_engine('sqlite:////path/to/database.db')
```

To use a Windows path, regular drive specifications and backslashes can be used. Double backslashes are probably needed:

```
# absolute path on Windows
e = create_engine('sqlite:///C:\\path\\to\\database.db')
```

The sqlite `:memory:` identifier is the default if no filepath is present. Specify `sqlite://` and nothing else:

```
# in-memory database
e = create_engine('sqlite://')
```

Compatibility with sqlite3 "native" date and datetime types

The pysqlite driver includes the sqlite3.PARSE_DECLTYPES and sqlite3.PARSE_COLNAMES options, which have the effect of any column or expression explicitly cast as "date" or "timestamp" will be converted to a Python date or datetime object. The date and datetime types provided with the pysqlite dialect are not currently compatible with these options, since they render the ISO date/datetime including microseconds, which pysqlite's driver does not. Additionally, SQLAlchemy does not at this time automatically render the "cast" syntax required for the freestanding functions "current_timestamp" and "current_date" to return datetime/date types natively. Unfortunately, pysqlite does not provide the standard DBAPI types in `cursor.description`, leaving SQLAlchemy with no way to detect these types on the fly without expensive per-row type checks.

Keeping in mind that pysqlite's parsing option is not recommended, nor should be necessary, for use with SQLAlchemy, usage of PARSE_DECLTYPES can be forced if one configures "native_datetime=True" on create_engine():

```
engine = create_engine('sqlite://',
                connect_args={'detect_types': sqlite3.PARSE_DECLTYPES|sqlite3.PARSE_COLNAMES},
                native_datetime=True
                )
```

With this flag enabled, the DATE and TIMESTAMP types (but note - not the DATETIME or TIME types...confused yet ?) will not perform any bind parameter or result processing. Execution of "func.current_date()" will return a string. "func.current_timestamp()" is registered as returning a DATETIME type in SQLAlchemy, so this function still receives SQLAlchemy-level result processing.

Threading/Pooling Behavior

Pysqlite's default behavior is to prohibit the usage of a single connection in more than one thread. This is originally intended to work with older versions of SQLite that did not support multithreaded operation under various circumstances. In particular, older SQLite versions did not allow a `:memory:` database to be used in multiple threads under any circumstances.

Pysqlite does include a now-undocumented flag known as `check_same_thread` which will disable this check, however note that pysqlite connections are still not safe to use in concurrently in multiple threads. In particular, any statement execution calls would need to be externally mutexed, as Pysqlite does not provide for thread-safe propagation of error messages among other things. So while even `:memory:` databases can be shared among threads in modern SQLite, Pysqlite doesn't provide enough thread-safety to make this usage worth it.

SQLAlchemy sets up pooling to work with Pysqlite's default behavior:

- When a `:memory:` SQLite database is specified, the dialect by default will use `SingletonThreadPool`. This pool maintains a single connection per thread, so that all access to the engine within the current thread use the same `:memory:` database - other threads would access a different `:memory:` database.
- When a file-based database is specified, the dialect will use `NullPool` as the source of connections. This pool closes and discards connections which are returned to the pool immediately. SQLite file-based connections have extremely low overhead, so pooling is not necessary. The scheme also prevents a connection from being used again in a different thread and works best with SQLite's coarse-grained file locking.

  Changed in version 0.7: Default selection of `NullPool` for SQLite file-based databases. Previous versions select `SingletonThreadPool` by default for all SQLite databases.

Using a Memory Database in Multiple Threads

To use a `:memory:` database in a multithreaded scenario, the same connection object must be shared among threads, since the database exists only within the scope of that connection. The `StaticPool` implementation will maintain a

single connection globally, and the `check_same_thread` flag can be passed to Pysqlite as `False`:

```
from sqlalchemy.pool import StaticPool
engine = create_engine('sqlite://',
                    connect_args={'check_same_thread':False},
                    poolclass=StaticPool)
```

Note that using a `:memory:` database in multiple threads requires a recent version of SQLite.

Using Temporary Tables with SQLite

Due to the way SQLite deals with temporary tables, if you wish to use a temporary table in a file-based SQLite database across multiple checkouts from the connection pool, such as when using an ORM `Session` where the temporary table should continue to remain after `commit()` or `rollback()` is called, a pool which maintains a single connection must be used. Use `SingletonThreadPool` if the scope is only needed within the current thread, or `StaticPool` is scope is needed within multiple threads for this case:

```
# maintain the same connection per thread
from sqlalchemy.pool import SingletonThreadPool
engine = create_engine('sqlite:///mydb.db',
                    poolclass=SingletonThreadPool)


# maintain the same connection across all threads
from sqlalchemy.pool import StaticPool
engine = create_engine('sqlite:///mydb.db',
                    poolclass=StaticPool)
```

Note that `SingletonThreadPool` should be configured for the number of threads that are to be used; beyond that number, connections will be closed out in a non deterministic way.

Unicode

The pysqlite driver only returns Python `unicode` objects in result sets, never plain strings, and accommodates `unicode` objects within bound parameter values in all cases. Regardless of the SQLAlchemy string type in use, string-based result values will by Python `unicode` in Python 2. The `Unicode` type should still be used to indicate those columns that require unicode, however, so that non-`unicode` values passed inadvertently will emit a warning. Pysqlite will emit an error if a non-`unicode` string is passed containing non-ASCII characters.

Serializable Transaction Isolation

The pysqlite DBAPI driver has a long-standing bug in which transactional state is not begun until the first DML statement, that is INSERT, UPDATE or DELETE, is emitted. A SELECT statement will not cause transactional state to begin. While this mode of usage is fine for typical situations and has the advantage that the SQLite database file is not prematurely locked, it breaks serializable transaction isolation, which requires that the database file be locked upon any SQL being emitted.

To work around this issue, the `BEGIN` keyword can be emitted at the start of each transaction. The following recipe establishes a `ConnectionEvents.begin()` handler to achieve this:

```
from sqlalchemy import create_engine, event

engine = create_engine("sqlite:///myfile.db", isolation_level='SERIALIZABLE')
```

```
@event.listens_for(engine, "begin")
def do_begin(conn):
    conn.execute("BEGIN")
```

4.11 Sybase

Support for Sybase Adaptive Server Enterprise (ASE).

Note: The Sybase dialect functions on current SQLAlchemy versions but is not regularly tested, and may have many issues and caveats not currently handled. In particular, the table and database reflection features are not implemented.

4.11.1 python-sybase notes

Support for Sybase via the python-sybase driver.

http://python-sybase.sourceforge.net/

Connect strings are of the form:

```
sybase+pysybase://<username>:<password>@<dsn>/[database name]
```

Unicode Support

The python-sybase driver does not appear to support non-ASCII strings of any kind at this time.

4.11.2 pyodbc notes

Support for Sybase via pyodbc.

http://pypi.python.org/pypi/pyodbc/

Connect strings are of the form:

```
sybase+pyodbc://<username>:<password>@<dsn>/
sybase+pyodbc://<username>:<password>@<host>/<database>
```

Unicode Support

The pyodbc driver currently supports usage of these Sybase types with Unicode or multibyte strings:

```
CHAR
NCHAR
NVARCHAR
TEXT
VARCHAR
```

Currently *not* supported are:

```
UNICHAR
UNITEXT
UNIVARCHAR
```

4.11.3 mxodbc notes

Support for Sybase via mxodbc.

This dialect is a stub only and is likely non functional at this time.

CHAPTER 5

Indices and tables

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