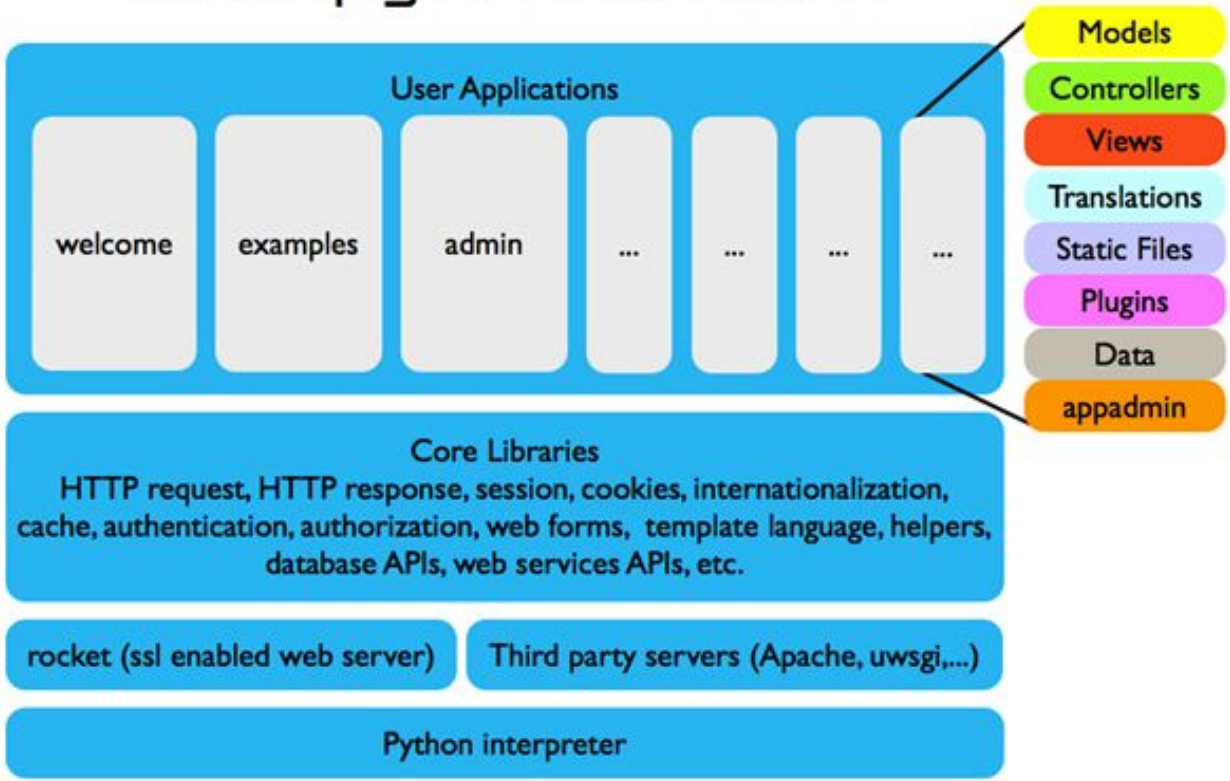
SED Final Project web2py

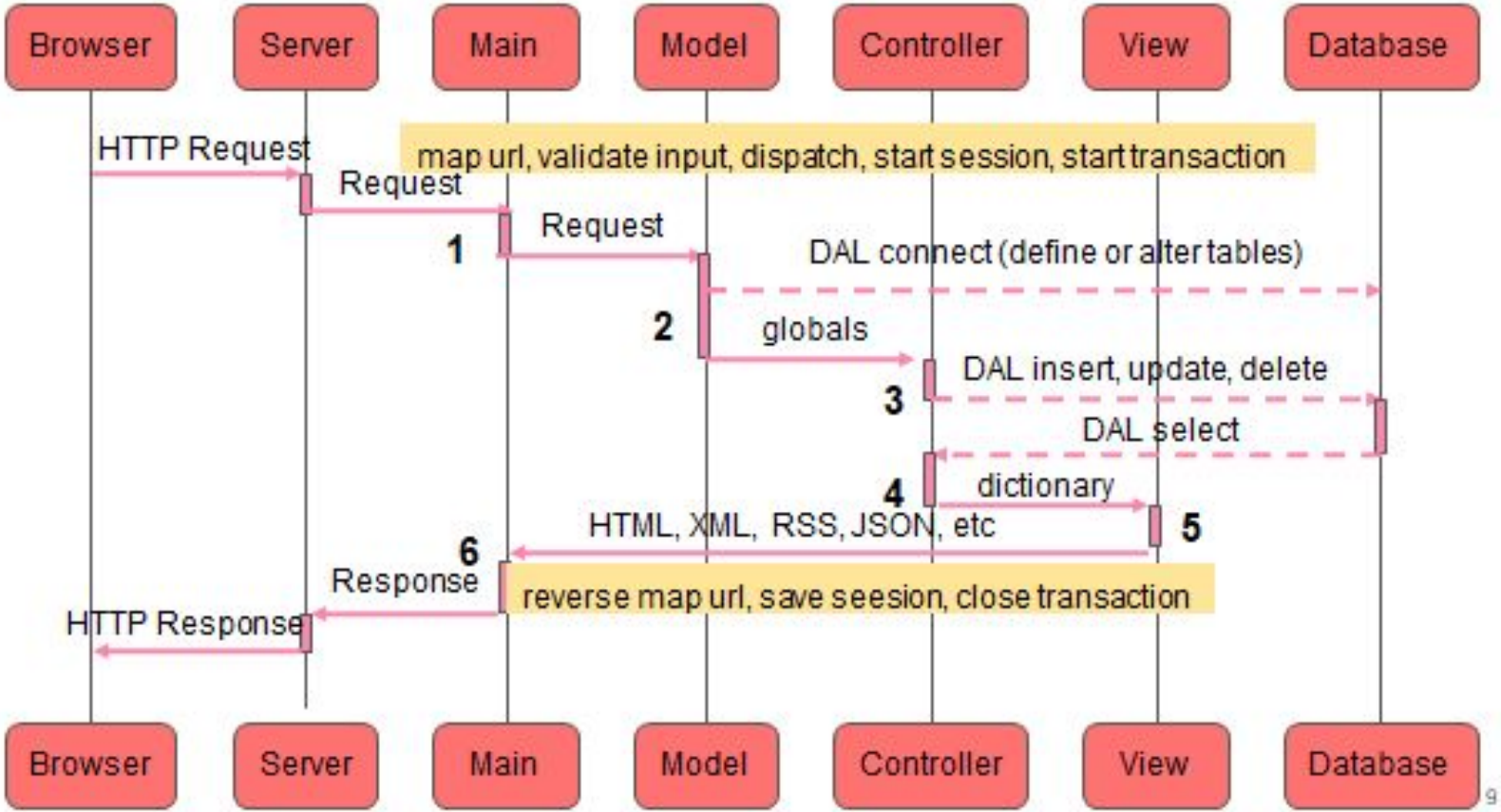
Team2

Outline

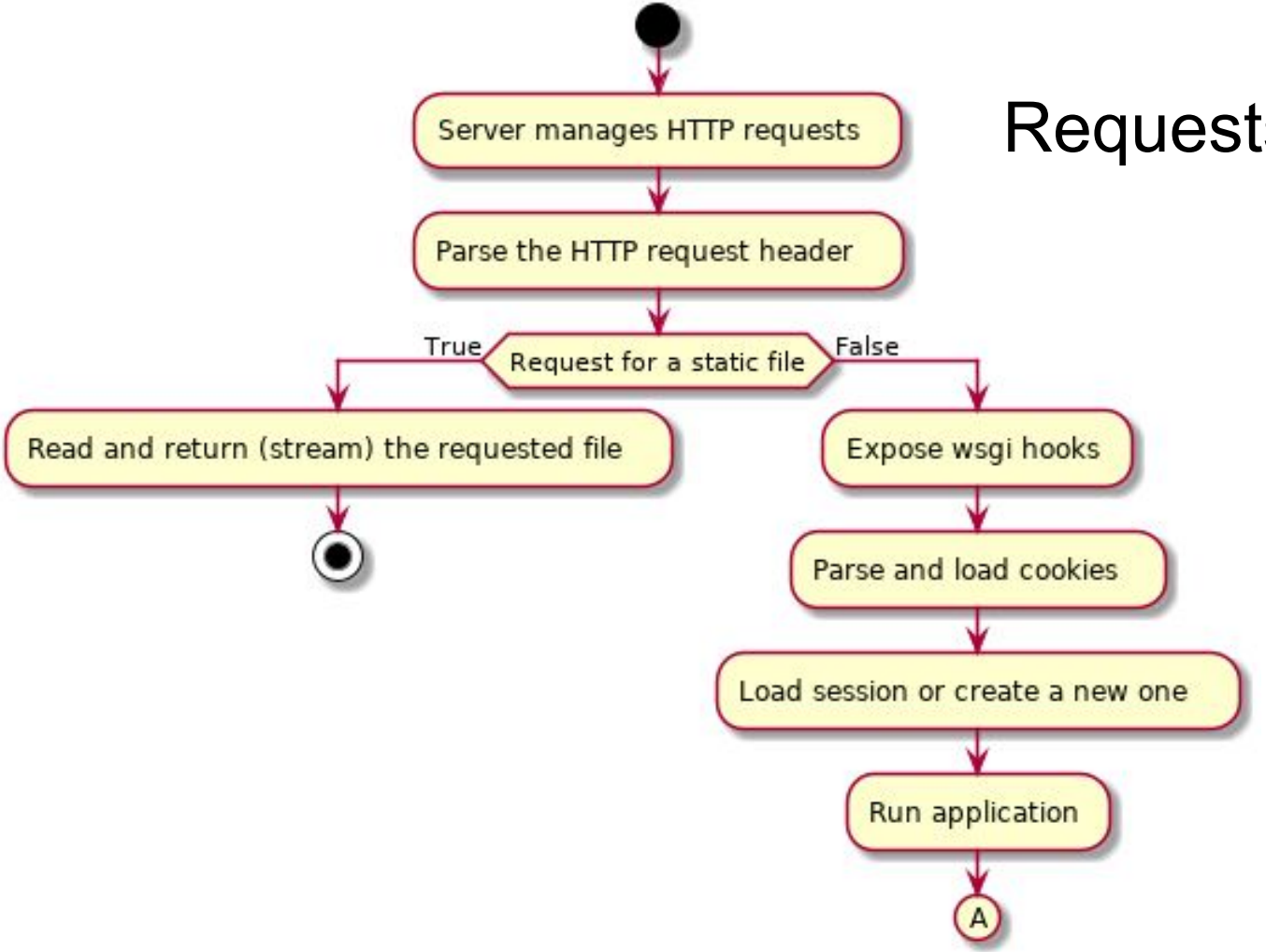
- **Briefly introduce web2py**
- Request to Controller
  - Server
  - Rewrite and parsing incoming URLs
  - WSGI hooks
  - Cookies & Session
  - Run Application
- Services
- Views
- Cron & Scheduler
- PyDAL
- Conclusion

web2py Architecture

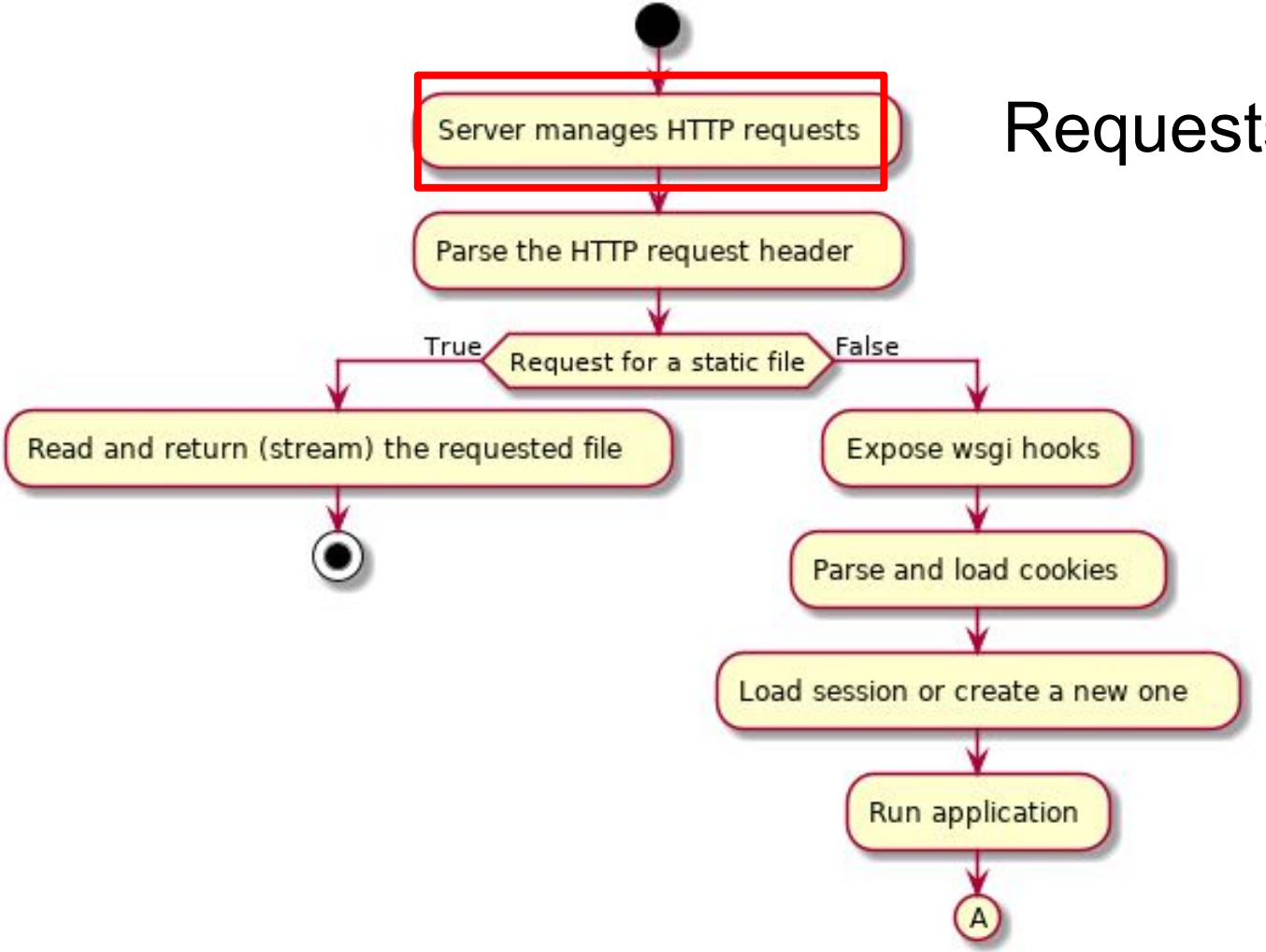



Browser
Server
Main
Model
Controller
View
Database
HTTP Request
map url, validate input, dispatch, start session, start transaction
Request
Request
1
DAL connect (define or alter tables)
2
globals
DAL insert, update, delete
3
DAL select
4
dictionary
HTML, XML, RSS, JSON, etc
5
6
Response
reverse map url, save seesion, close transaction
HTTP Response
Browser
Server
Main
Model
Controller
View
Database

Requests to controller



Requests to controller

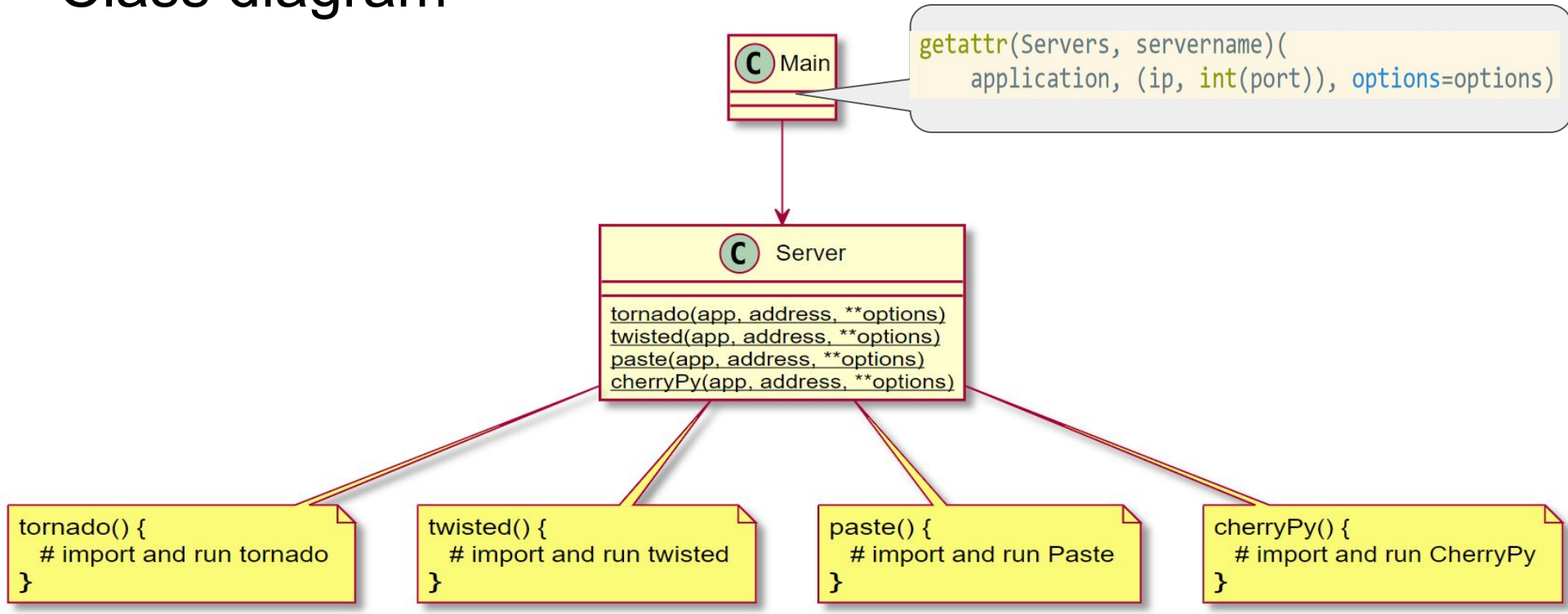


Server

- web2py includes a built-in server Rocket.
- web2py can also be runned with WSGI compatible servers:
  E.g. paste, tornado, twisted, etc.
- Run anyserver.py to start

```
python anyserver.py -s tornado -i 127.0.0.1 -p 8000 -l -P
```

Class diagram



Code

```
def paste(app, address, **options):
    options = {}
    from paste import httpserver
    from paste.translogger import TransLogger
    httpserver.serve(app, host=address[0], port=address[1], **options)

def cherrypy(app, address, **options):
    ...
def twisted(app, address, **options):
    ...
def tornado(app, address, **options):
    ...
...
```

Adapter

Adaptee

Adapter

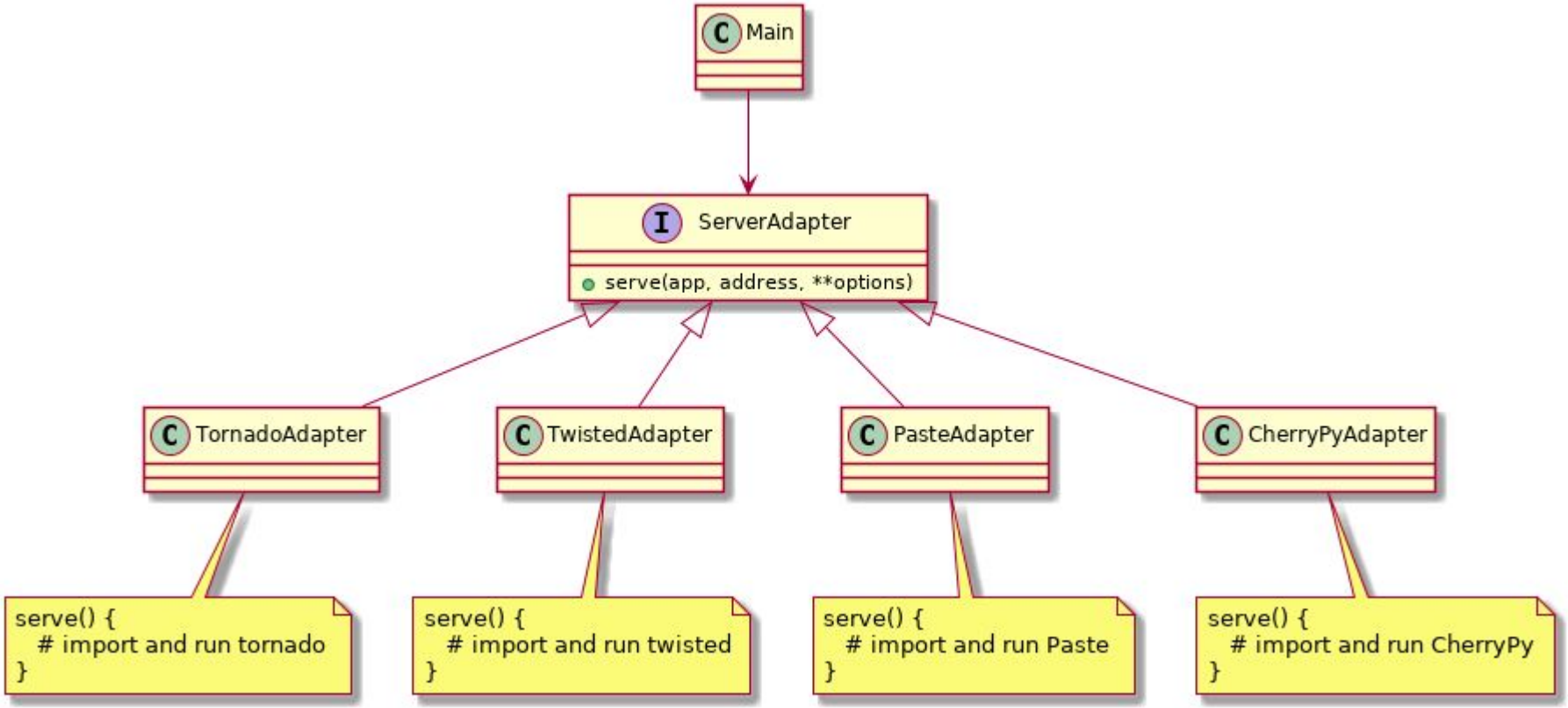
Adapter

Adapter

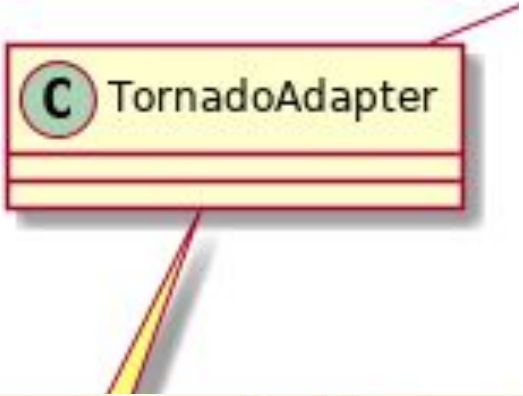
Interface of adapter:

```
def serve(app, address, **options):
```

Adapter class diagram -- refactored



Adapter class diagram -- refactored (cont.)



Object Adapter Pattern

Adaptee

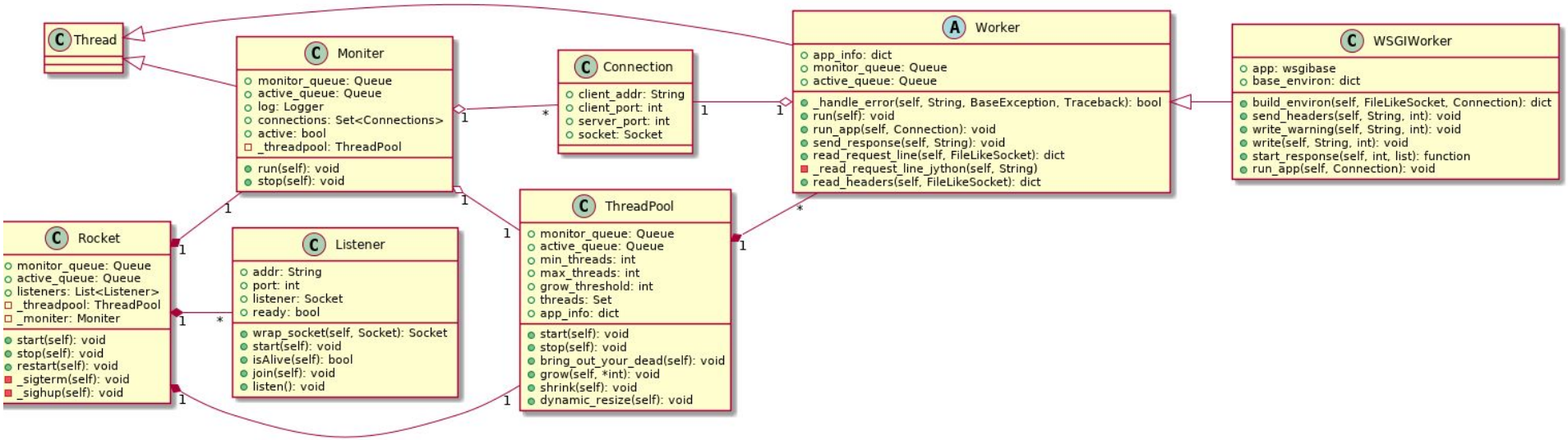
```
def serve(app, address, **options):
    import tornado.wsgi
    import tornado.httpserver
    import tornado.ioloop
    container = tornado.wsgi.WSGIContainer(app)
    server = tornado.httpserver.HTTPServer(container)
    server.listen(address=address[0], port=address[1])
    tornado.ioloop.IOLoop.instance().start()
```

Rocket server

- Rocket is a lightweight open source server

  According to Rocket's documentation:
  "*The HTTP 1.1 specification allows for a number of corner-case behaviors that are not regularly used. Because Rocket seeks to be **fast and small**, some of these features have been left out on purpose.*"
- Included in web2py as the default web server

Design of Rocket: class diagram



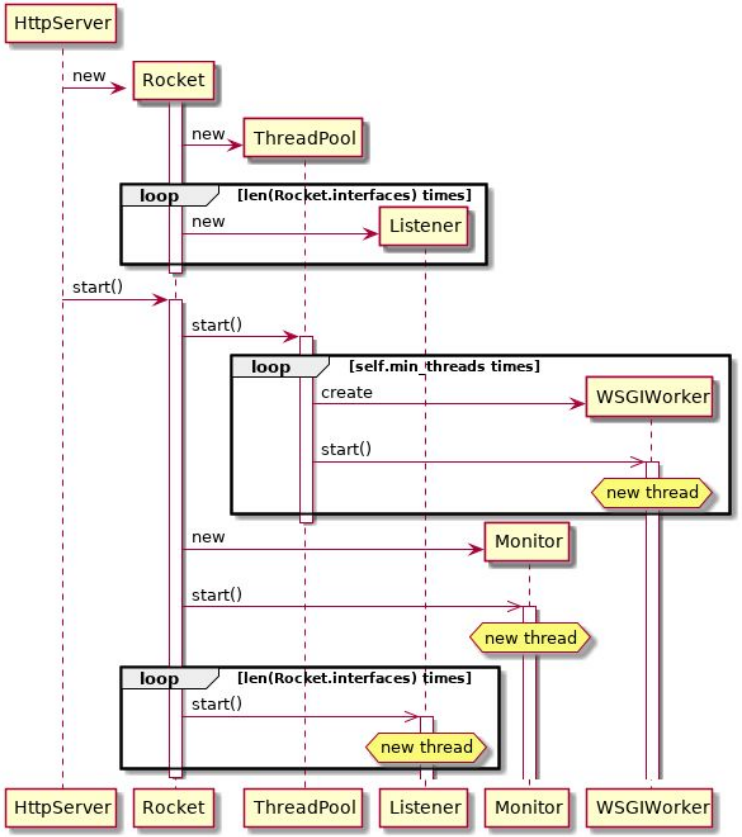
Rocket: responsibility of each class

- Listener: listens on an interface and accepts incoming connections.
- Worker (subclass of Thread): Reads request headers & contents from socket.
- WSGIWorker (subclass of Worker): It implements run_app() and is responsible of executing the WSGI application.
- ThreadPool: pool of worker threads.
- Monitor: It monitors connections; manages the size of ThreadPool.

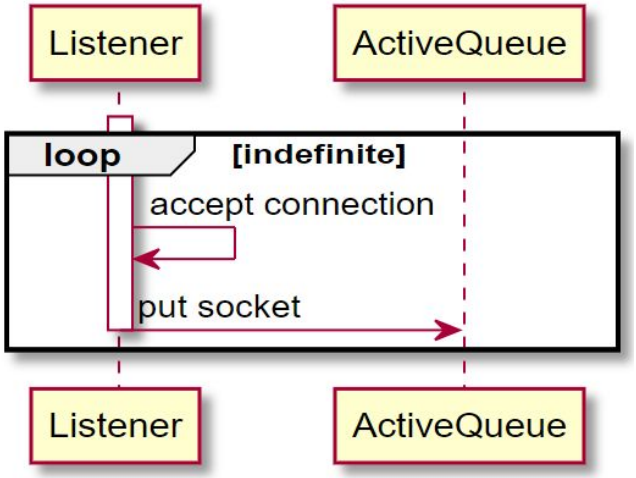
Rocket: two queues

- Active queue:
  Active connections are put into this queue by Listeners, and retrieved from this queue by Workers
- Monitor queue:
  Timeout connections are put into this queue, and are monitored by the monitor class.

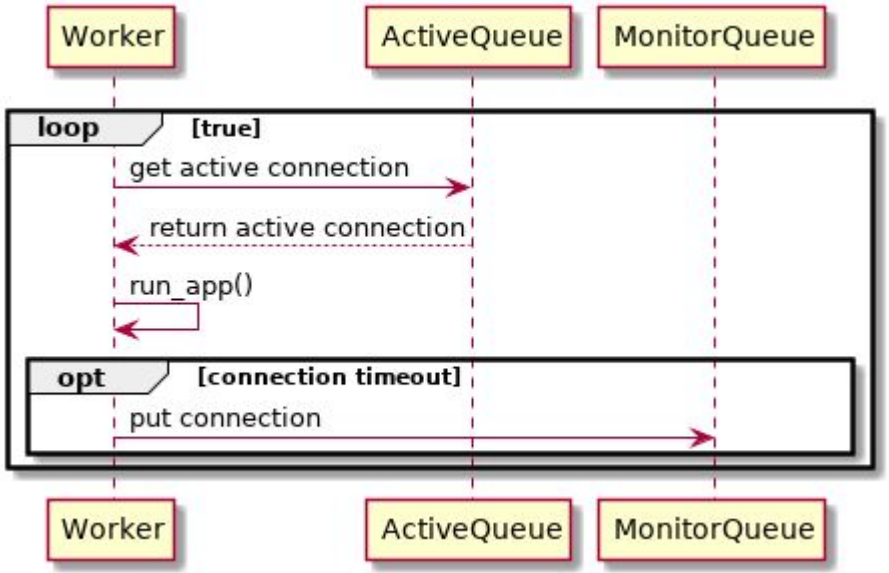
Sequence diagram: start-up



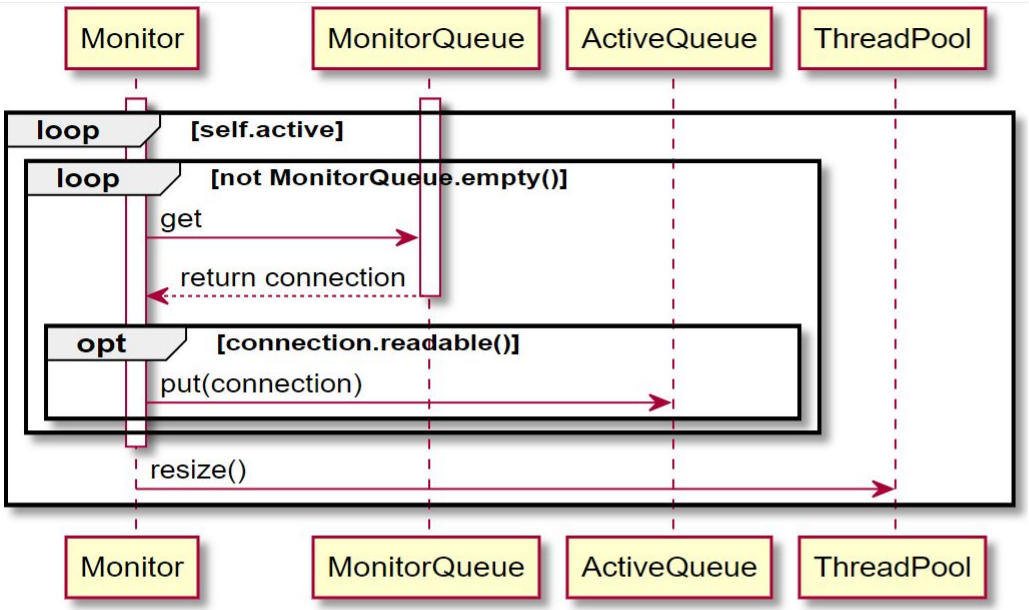
Sequence diagram: listening for incoming connections



Sequence diagram: process connection

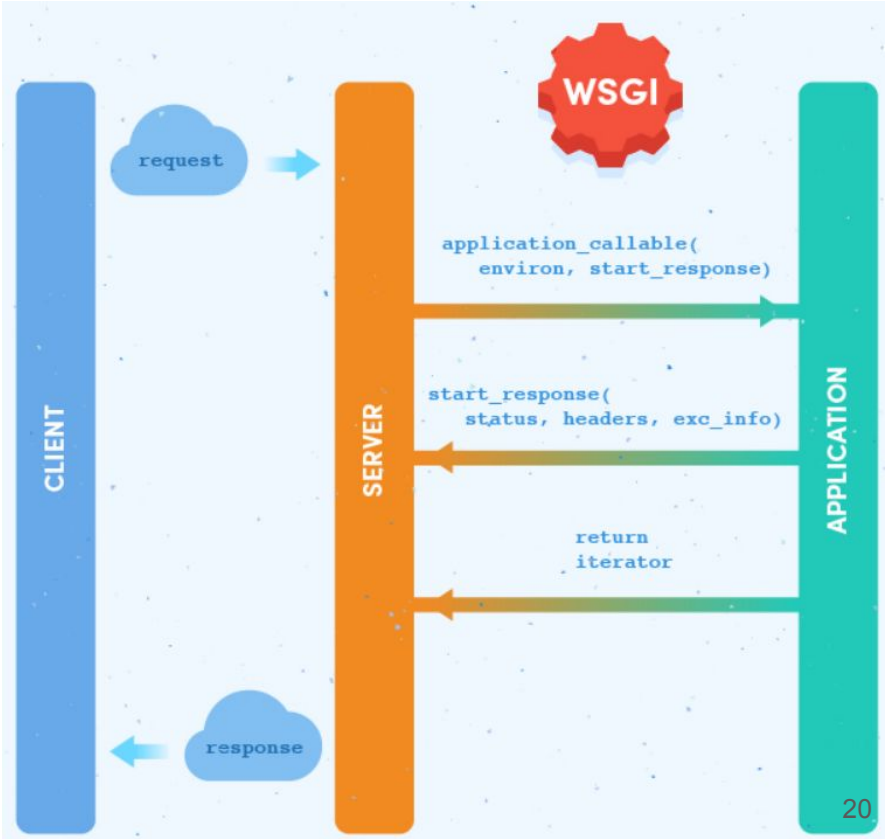


Sequence diagram: monitor connection status

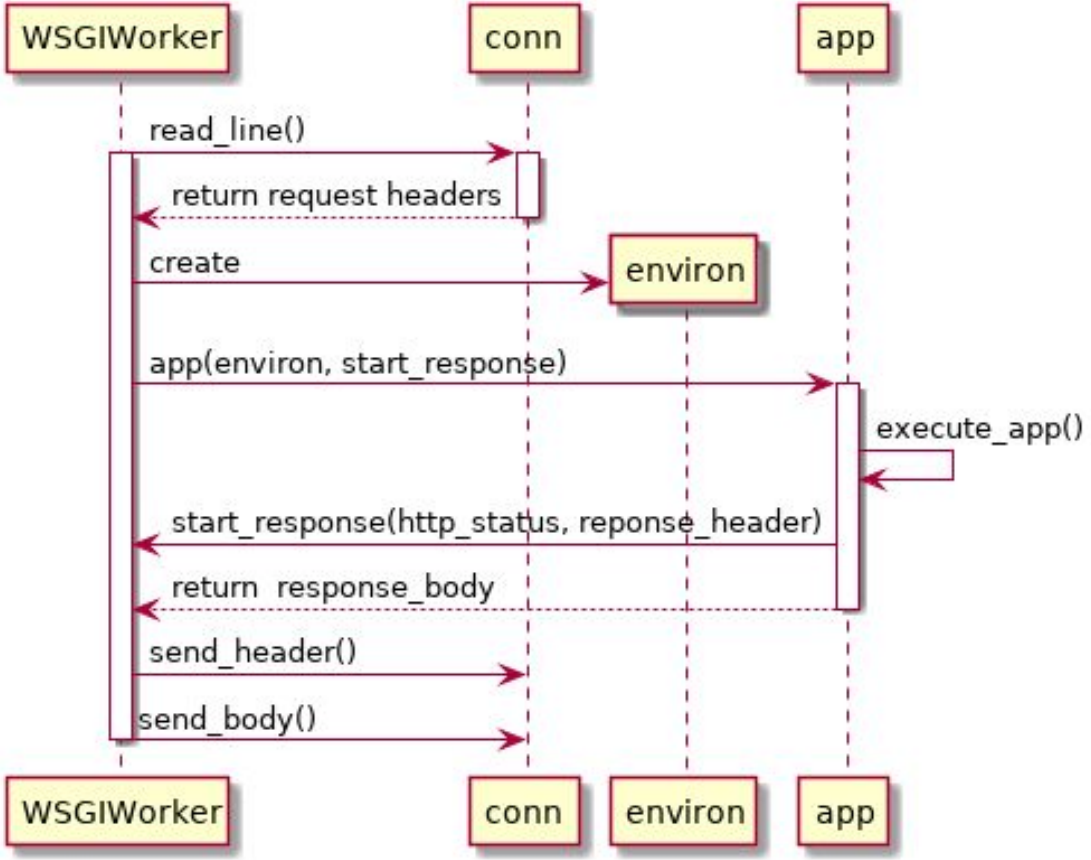


WSGI (Web Server Gateway Interface)

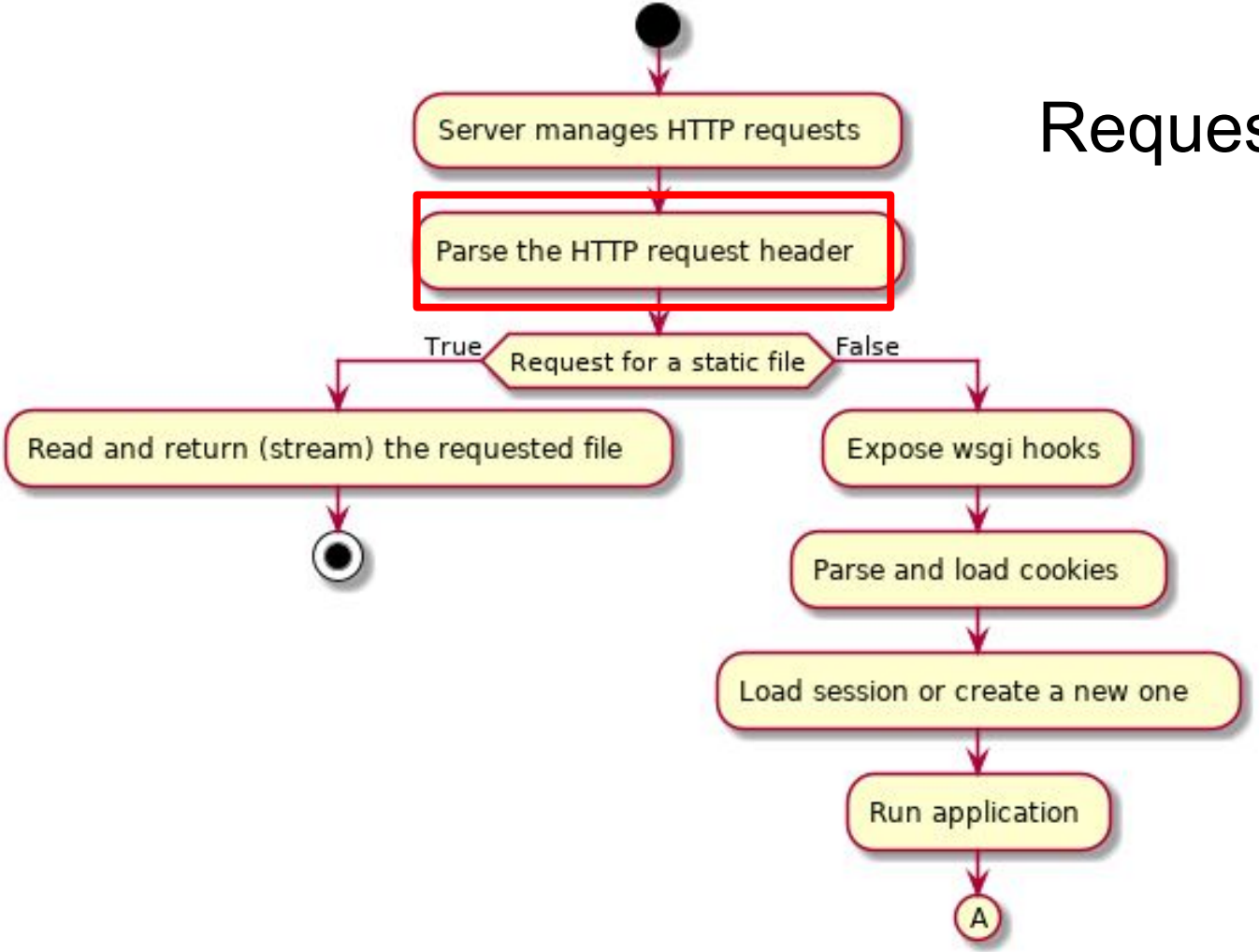
- A simple **calling convention** for web servers to forward requests to web applications or frameworks written in the Python programming language



Sequence diagram: running the WSGI application



Request to controller



Rewrite and parsing incoming URLs

- URL Rewrite
  - Motivation to rewrite incoming URLs
    - Handle legacy URLs
    - Simplify paths and make them shorter
  - Two distinct URL rewrite systems
    - The parameter-based system
    - The pattern-based system

Rewrite and parsing incoming URLs (cont.)

- Parameter-based system
  - Omit default application, controller and function names from externally-visible URLs (those created by the URL() function)
  - Map domains (and/or ports) to applications or controllers
  - Embed a language selector in the URL

```
routers = dict(
  BASE  = dict(default_application='myapp'),
)
```

The application name is no longer part of the URL

```
routers = dict(
  BASE  = dict(
      domains = {
          'domain1.com' : 'app1',
          'domain2.com' : 'app2',
```

Domain mapping

Rewrite and parsing incoming URLs (cont.)

- Pattern-based system
  - Provide some additional flexibility for more complex cases
    - Instead of defining routers as dictionaries of routing parameters, you define two lists (or tuples) of 2-tuples
      - Each tuple contains two elements: the pattern to be replaced and the string that replaces it

```
routes_in = (
  ('/testme', '/examples/default/index'),
)
routes_out = (
  ('/examples/default/index', '/testme'),
)
```

To the visitor, all links to the page URL looks like /testme.

```
routes_in = (
  ('/(?P<any>.*)', '/init/\g<any>'),
)
routes_out = (
  ('/init/(?P<any>.*)', '/\g<any>'),
)
```

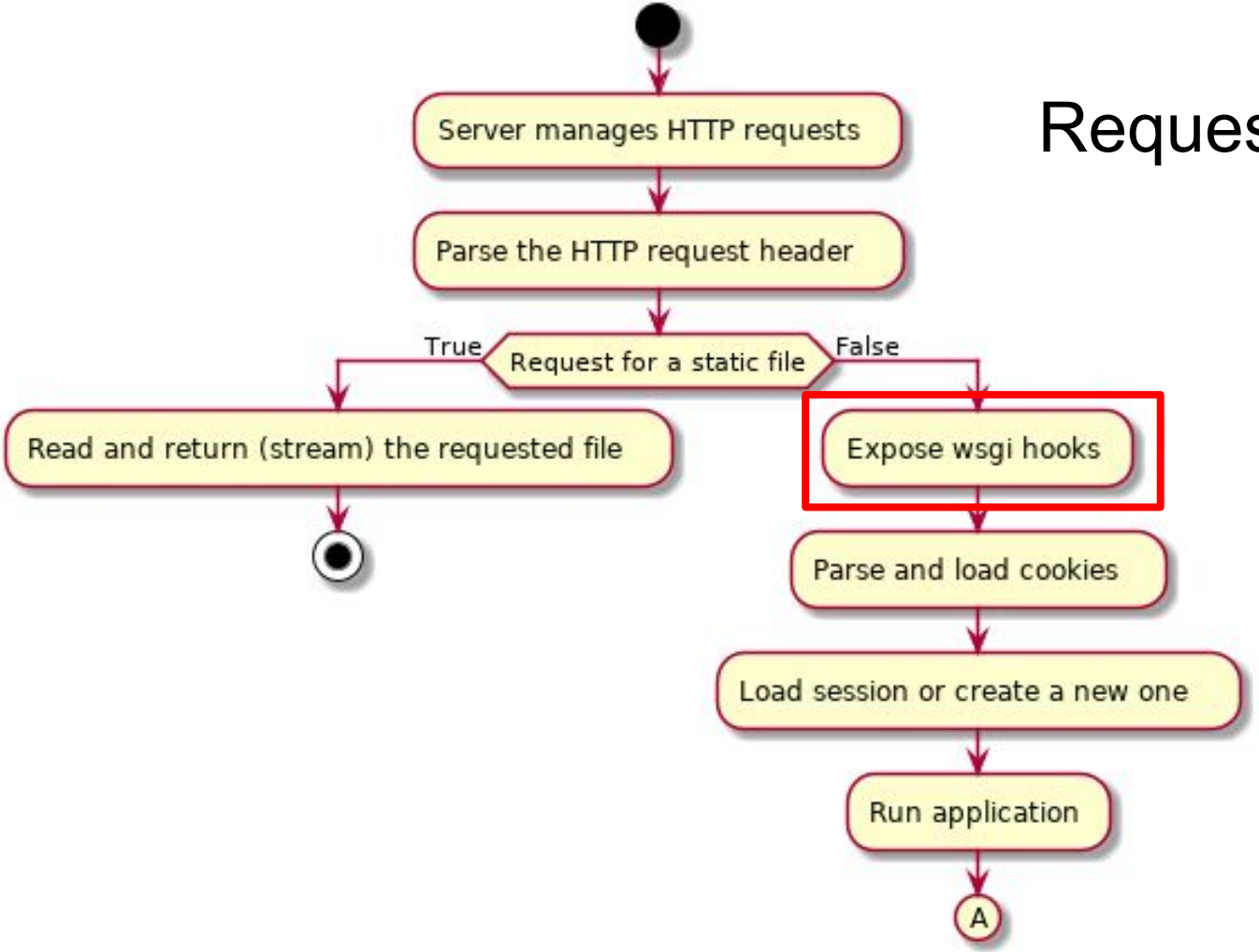
Get rid of the application prefix from the URLs

Rewrite and parsing incoming URLs

- URL Parsing
  - For static pages:
    - /<application>/static/<file>
  - For dynamic pages:
    - /<a:application>[/<c:controller>[/<f:function>[.<e:ext>][/<s:args>]]]

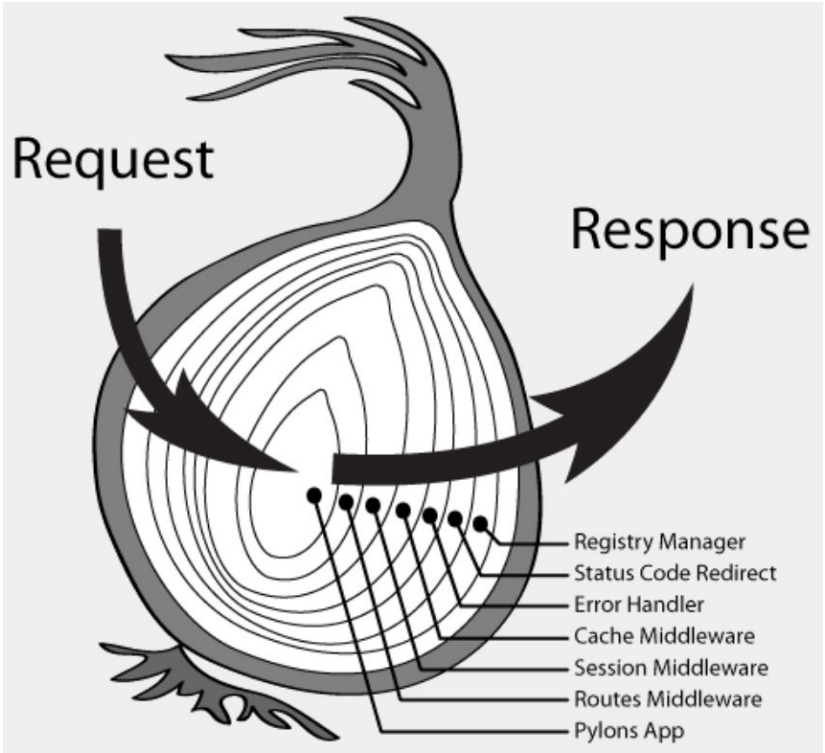
```
request.application = match.group('a') or routes.default_application
request.controller = match.group('c') or routes.default_controller
request.function = match.group('f') or routes.default_function
request.raw_extension = match.group('e')
request.extension = request.raw_extension or 'html'
```

Request to controller



WSGI (Web Server Gateway Interface) (cont.)

- Some developers have pushed WSGI to its limits as a protocol for middleware communications and develop web applications as an onion with many layers (each layer being a WSGI middleware developed independently of the entire framework)



WSGI (Web Server Gateway Interface) (cont.)

- web2py does not adopt this structure internally. This is because they feel the core functionality of a frameworks (handling cookies, session, errors, transactions, dispatching) can be better optimized for **speed** and **security** if they are handled by a **single** comprehensive layer.

```
def wsgibase(environ, responder):
    """
    The gluon wsgi application. The first function called when a page
    is requested (static or dynamic). It can be called by paste.httpserver
    or by apache mod_wsgi (or any WSGI-compatible server).
```

web2py at its core is a WSGI application: gluon.main.wsgibase

WSGI (Web Server Gateway Interface) (cont.)

- wsgibase (a single comprehensive layer)
  - Register Manager
    ```
    environment = build_environment(request, response, session)
    ```
    - Keep track of which of the Pylons global variables should be used in each thread of execution
  - Status Code Redirect
    ```
    http_response, new_environ = try_rewrite_on_error(
        http_response, request, environ, ticket)
    ```
    - Catch responses with certain HTTP status codes and internally redirects the request to the error controller
  - Error Handler
    ```
    e = RestrictedError('Framework', '', '', locals())
    ```
    - Catch any exceptions that have occurred during the processing of a request

WSGI (Web Server Gateway Interface) (cont.)

- wsgibase (a single comprehensive layer)
  - Cache Middleware
    - Provide the caching facility
    - This allows it to be used as a decorator for caching actions and views.

```
@cache(request.env.path_info, time_expire=5, cache_model=cache.ram)
def cache_controller_in_ram():…
```

  - Session Middleware
    - Provide the session functionality

```
if not env.web2py_disable_session:
    session.connect(request, response)
```

  - Routes Middleware
    - Match a URL against the route map

```
(static_file, version, environ) = url_in(request, environ)
```

Third party WSGI applications and middleware

- web2py allows you to use third party WSGI applications and middleware in **three** ways (and their combinations)
  - External middleware
  - Internal middleware
  - Calling WSGI applications

Third party WSGI applications and middleware (cont.)

- External middleware (Add any third party middleware)

❏ wsgibase is wrapped by the middleware function appfactory

❏ In a similar fashion you can add any third party middleware

```
def appfactory(wsgiapp=wsgibase,
               logfilename='httpserver.log',
               profiler_dir=None,
               profilerfilename=None):
    """
    generates a wsgi application that does logging and profiling and calls
    wsgibase

    Args:…

    """
    if profilerfilename is not None:…
    if profiler_dir:…

    def app_with_logging(environ, responder):…

    return app_with_logging
```

```
app_info = {'wsgi_app': appfactory(wsgibase,
                                   log_filename,
                                   profiler_dir)}
```

Third party WSGI applications and middleware (cont.)

- request.wsgi
  - A hook that allows you to call third party WSGI applications from inside actions or decorate functions with WSGI middleware

```
# ################################################
# expose wsgi hooks for convenience
# ################################################

request.wsgi = LazyWSGI(environ, request, response)
```

```
class LazyWSGI(object):
    def __init__(self, environ, request, response):…

    @property
    def environ(self):…

    def start_response(self, status='200', headers=[], exec_info=None):

    def middleware(self, *middleware_apps):…
```

Third party WSGI applications and middleware (cont.)

- Internal middleware
  - You can use a web2py decorator to apply the middleware to the action in your controllers

```
class MyMiddleware:
    """converts output to upper case"""
    def __init__(self,app):
        self.app = app
    def __call__(self, environ, start_response):
        items = self.app(environ, start_response)
        return [item.upper() for item in items]

@request.wsgi.middleware(MyMiddleware)
def index():
    return 'hello world'
```

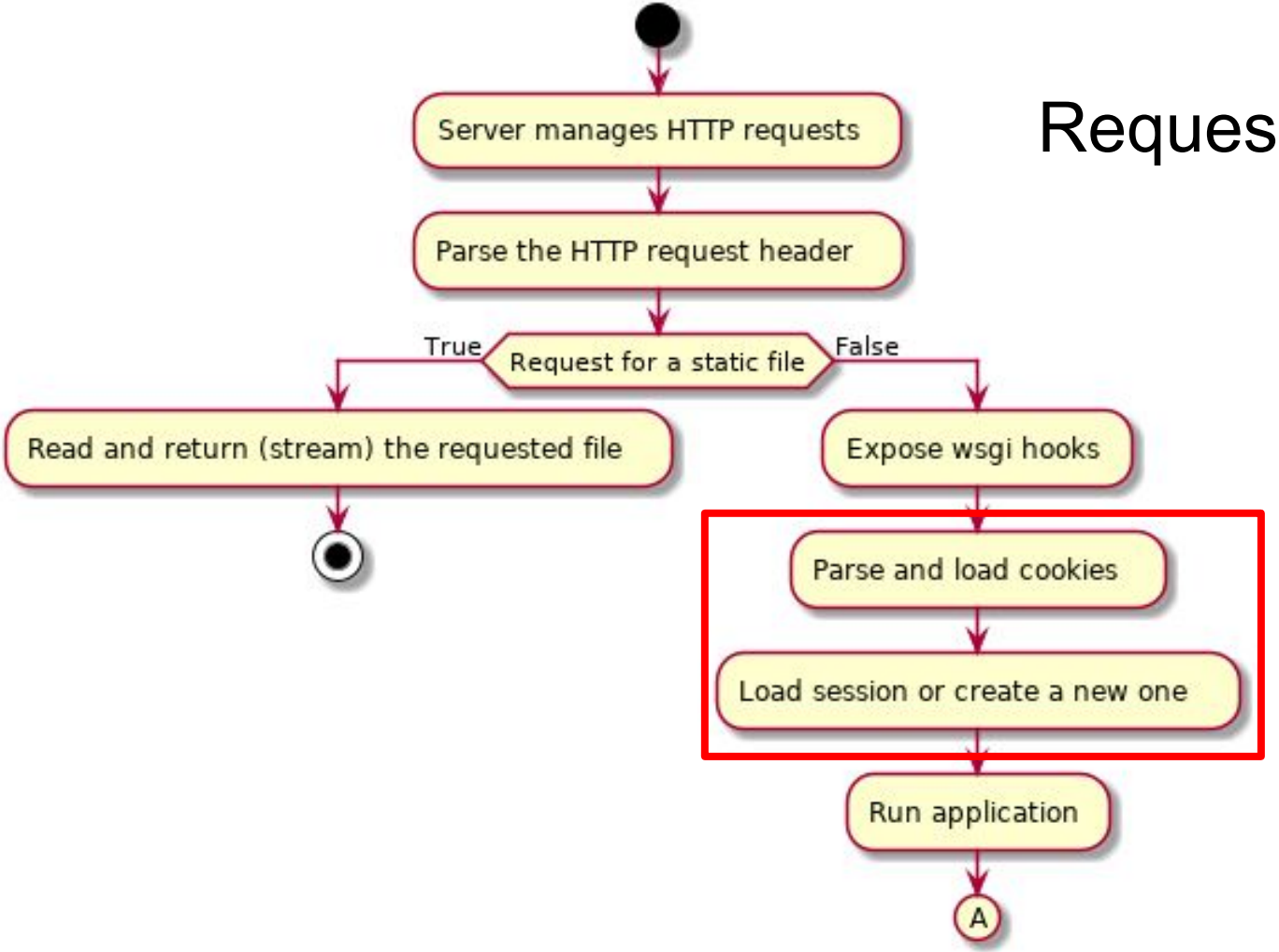
Third party WSGI applications and middleware (cont.)

- Calling WSGI applications
  - Call WSGI app from a web2py action
  - An example:

```
def test_wsgi_app(environ, start_response):
    """this is a test WSGI app"""
    status = '200 OK'
    response_headers = [('Content-type', 'text/plain'),
                        ('Content-Length', '13')]
    start_response(status, response_headers)
    return ['hello world!\n']

def index():
    """a test action that calls the previous app and escapes outpu
t"""
    items = test_wsgi_app(request.wsgi.environ,
                          request.wsgi.start_response)
    for item in items:
        response.write(item, escape=False)
    return response.body.getvalue()
```

Request to controller



Cookies & Session

- Use the Python cookies modules for handling cookies
- Session is an instance of the **Storage class**
  - ❏ Trying to access an attribute/key that has not been set does not raise an exception; it returns None instead
- By default sessions are stored on the filesystem and a session cookie is used to store and to retrieve the session.id

```
if env.http_cookie:
    for single_cookie in env.http_cookie.split(';'):
        single_cookie = single_cookie.strip()
        if single_cookie:
            try:
                request.cookies.load(single_cookie)
            except Cookie.CookieError:
                pass  # single invalid cookie ignore
```

Load cookies

```
if not env.web2py_disable_session:
    session.connect(request, response)
```

Try to load `session` or create new `session` file

Storage: the ubiquitous web2py class

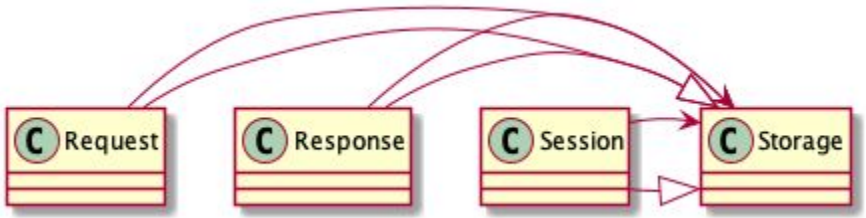
- Extends the Python `dict` class
- Basically a dictionary, except that the item values can be accessed as attributes
- Unlike `dict`, trying to access a item/attribute that has not been set, it returns None instead of raising an exception


```
request[env]
request[cookies]
request[vars]
request[restful()]
```

```
request.env
request.cookies
request.vars
request.restful()
```

Storage: the ubiquitous web2py class

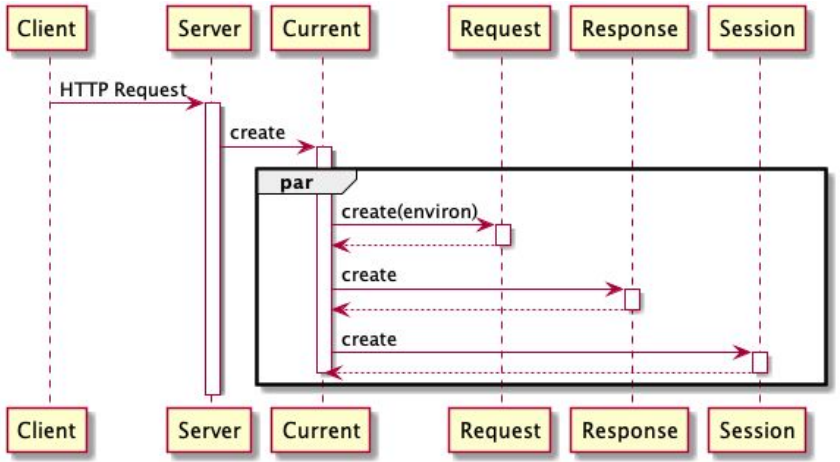
- Multiple instances throughout web2py: Request, Response, Session, env, vars, global_settings, user, router, etc., and these instances can include other Storage items/attributes
- Instead of segregating implementation from interface, web2py often opts to check if one Storage attribute exists



Current Container

- A thread-local container that stores some global objects `request, response, session, T, cache`, etc.
- Modules can only access them when they are called from an application

```
current = threading.local() # thread-local storage for request-scope globa
```



Current Container

- Different users can call the same action index concurrently, which calls the function in the module
  - Yet with no conflicts because `current.request` is a different object in different threads
- `current` and `import` create a powerful mechanism to build extensible and reusable modules for applications

```
auth = Auth(db)
from gluon import current
current.auth = auth
```

Now all modules can access `current.auth`!

Cookies & Session

- **Cookies** and **Session** are dealt within `main`, the main WSGI application that performs all common tasks and wraps user applications
- Session cookies enable the website to keep track of user movement from page to page
  - In web2py, sessions are stored on the filesystem and a session cookie is used to store and retrieve the `session_id` by default
  - Cookies from the browser are in `request.cookies` and those sent by the server are in `response.cookies`

```
cookies = request.cookies
```

```
response.cookies[response.session_id_name] = response.session_id
response.cookies[response.session_id_name]['path'] = '/'
```

Session

- An instance of **Storage**: whatever is stored can be retrieved as an attribute
- The dispatcher decides which of the installed action will handle the request and maps the path in the URL into a function call

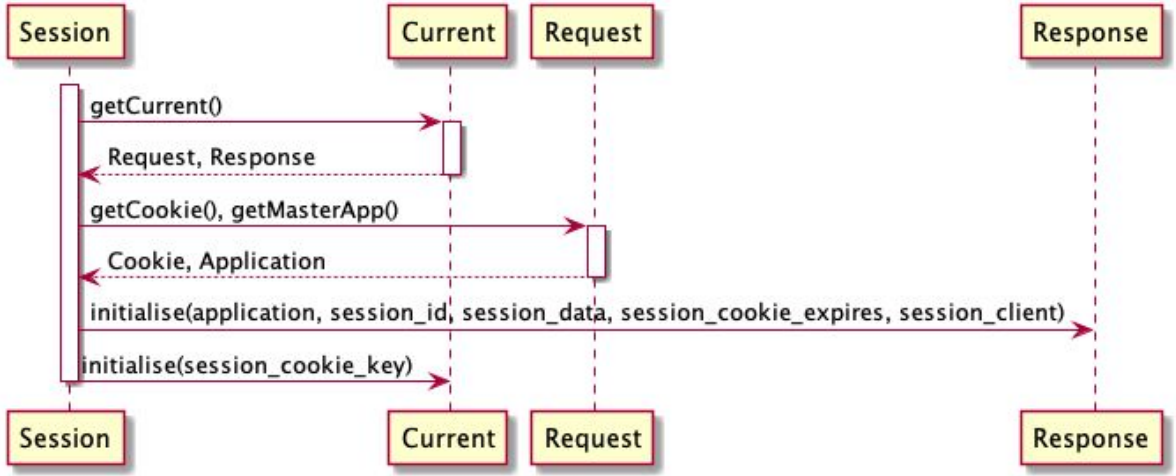
```
# [controller].py
def index():
    images = db().select(db.image.ALL, orderby=db.image.title)
    return dict(images=images)
```

```
[application]/[controller]/index
```

- Static files - stored in the application's `static` subfolder
  - Handled directly, while large files are streamed directly to the client
- Anything else - mapped into an action, where `session` comes into play before the action is called

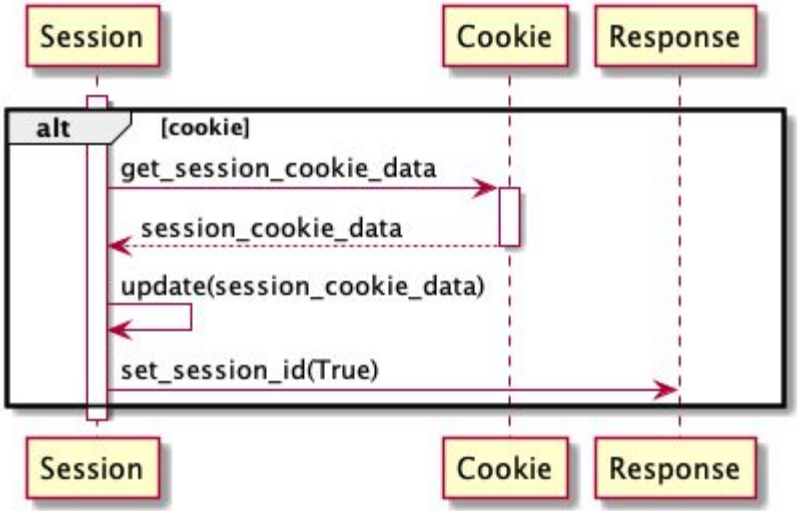
Connect Session

- Try to load `session` or create new session file
  - Parse cookies
  - If the request header contains a session cookie for the app, the session object is retrieved
  - If not, a session id is created (but the session file is not saved until later)



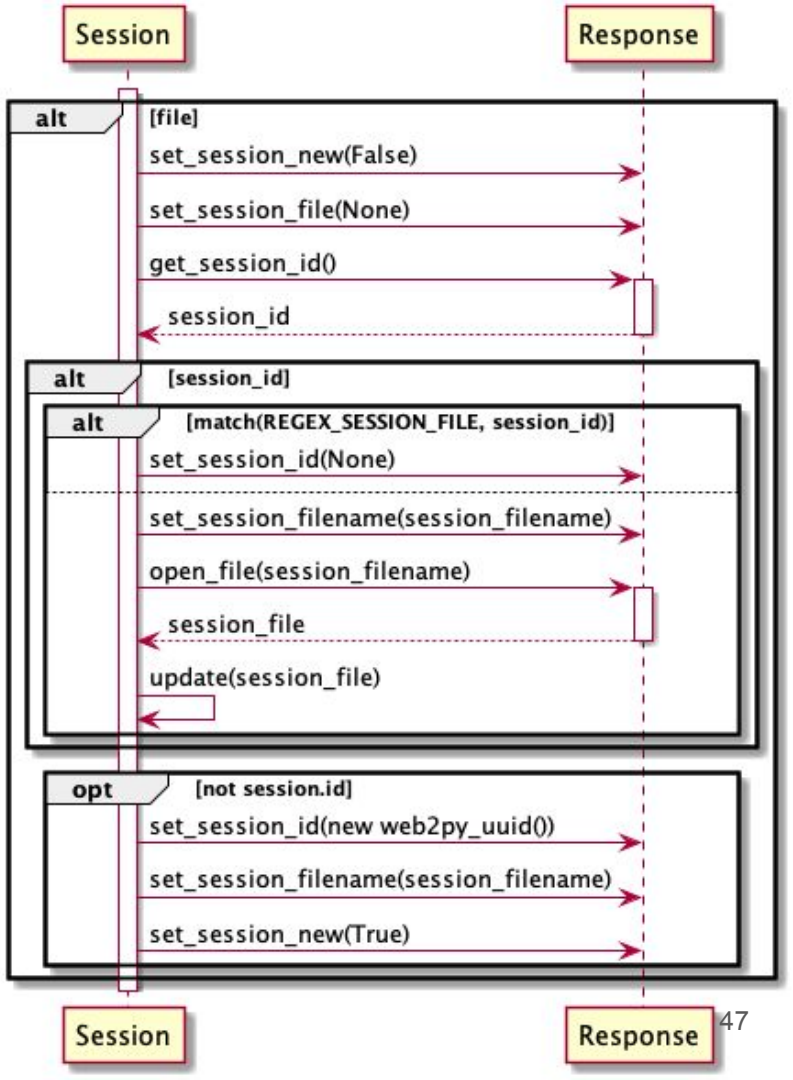
Connect Session

- Store session in cookie
  - Check if there is session data in cookies



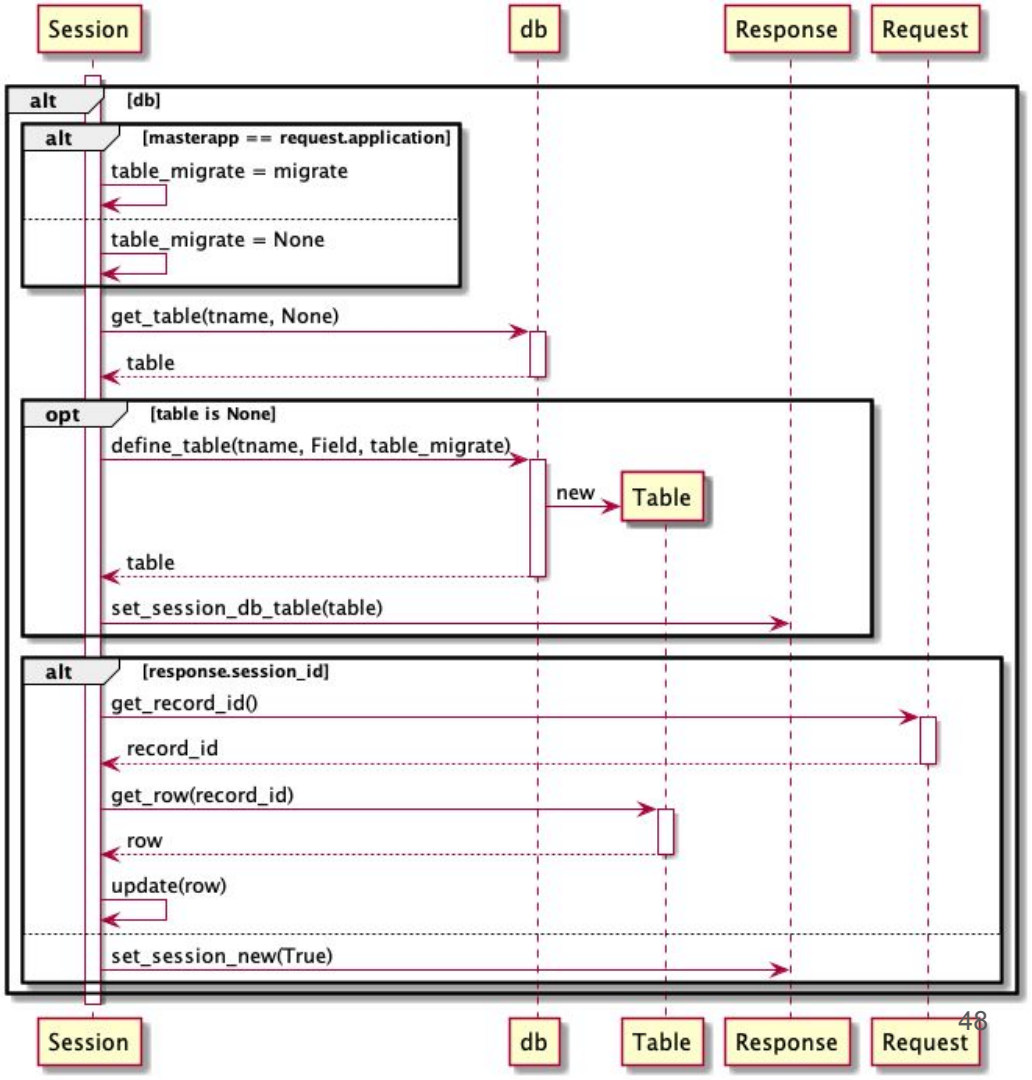
Connect Session

- Store session in filesystem
  - Check if `session_id` points to a valid session filename
  - `check_client`: if True, sessions can only come from the same ip. Used to detect cookie attacks
  - `separate`: if True, creates a folder with the 2 initials of session_id. Useful when file system access becomes a bottleneck.



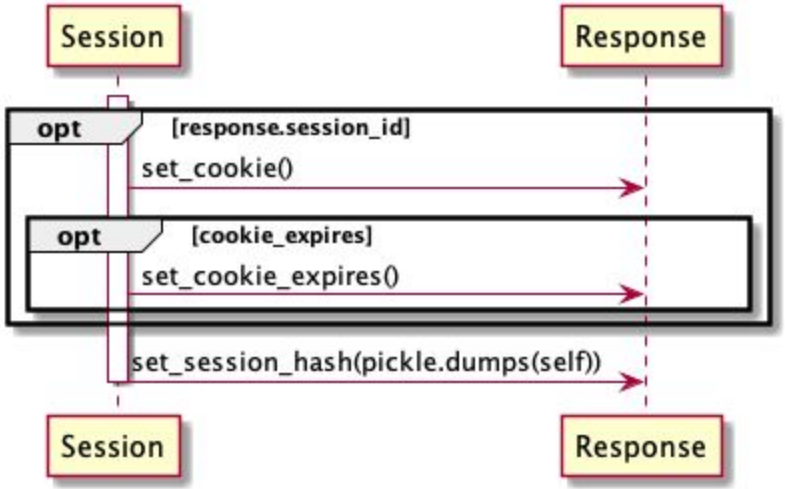
Connect Session

- Store session in db
  - `masterapp`: point to another app's session
  - `migrate`: passed to the underlying db
  - Get session data out of the database



Connect Session

- Wrap up
  - Set cookies if we know the session_id so user can set cookie attributes in controllers/models
  - `cookies_expires`: cookie may be reset later



Forget & Secure Session

- Session.forget()
  - Tell web2py not to save the session
  - Prevent the session file from being written
  - Used in controllers whose actions are called often and do not need to track user activity

```
def forget(self, response=None):
    self._close(response)
    self._forget = True
```

- Session.secure()
  - Tell web2py to save the session cookie to be a secure cookie
  - Prevent the browser from sending the session cookie back to the server unless over an https connection
  - Set if the app is going over https

```
def secure(self):
    self._secure = True
```

Cookie Expiration

- Session.connect()
  - User-defined cookie expiration time
- Session.renew()
  - Clear all session data if session expires
  - example: AuthAPI

```
if cookie_expires:
    response.cookies[response.session_id_name]['expires'] = \
        cookie_expires.strftime(FMT)
```

```
# if we have auth info
#    if not expired it, used it
#    if expired, clear the session
# else, only clear auth info in the session
if auth:
    delta = datetime.timedelta(days=0, seconds=auth.expiration)
    if auth.last_visit and auth.last_visit + delta > now:
        self.user = auth.user
        # this is a trick to speed up sessions to avoid many writes
        if (now - auth.last_visit).seconds > (auth.expiration // 10):
    else:
        self.user = None
        if session.auth:…
        session.renew(clear_session=True)
else:
    self.user = None
    if session.auth:…
```

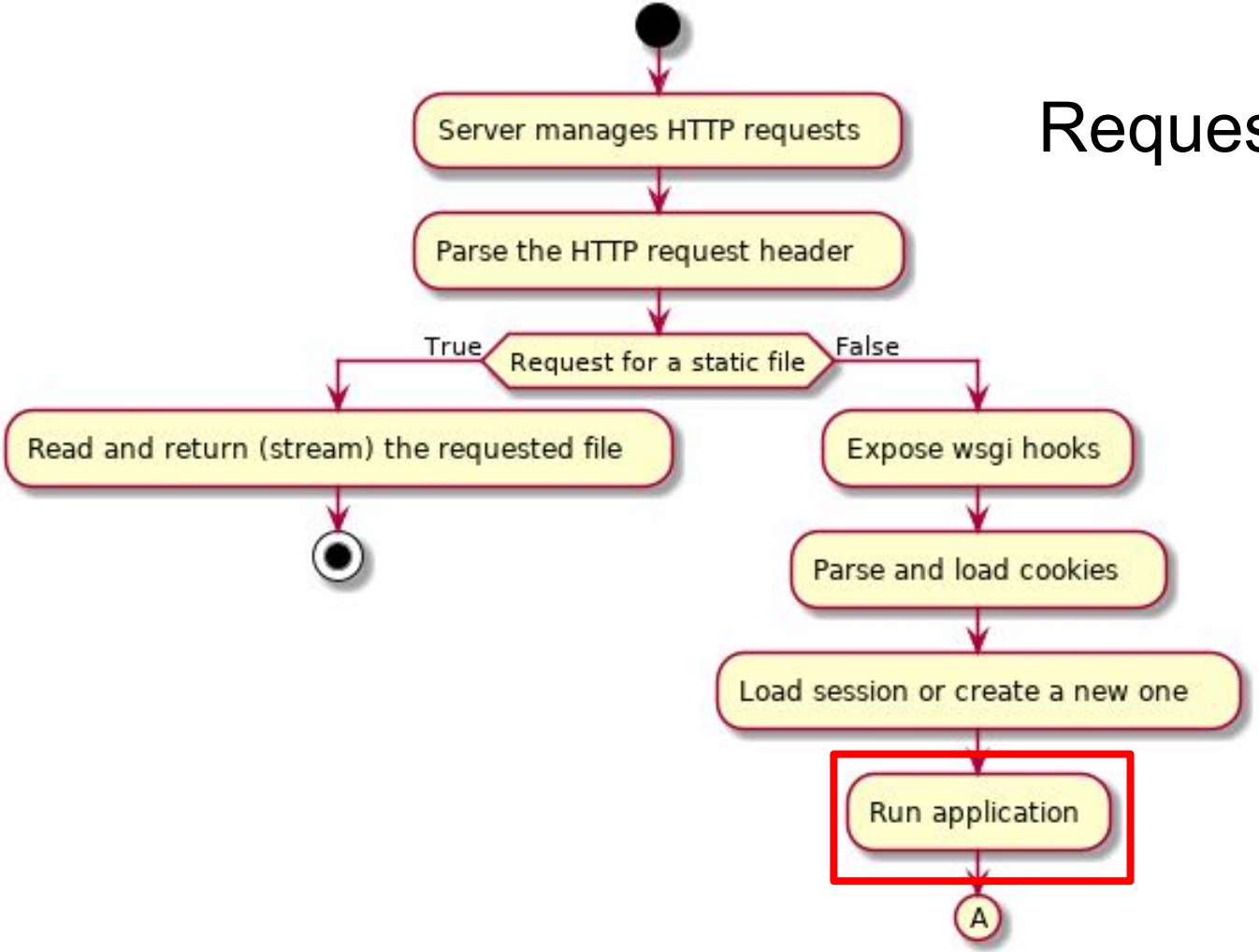
Cookie Expiration

- Session.clear_session_cookies()
  - Expire session data saved in cookies
  - Delete session in cookies
- Session.save_session_id_cookie()
  - Expire session data if there is no session cookie key
  - Copy the expiration information of session cookie to response
  - Used when session is stored in database or filesystem

```
def clear_session_cookies(self):
if response.session_data_name in cookies:
    rcookies[response.session_data_name] = 'expired'
    rcookies[response.session_data_name]['path'] = '/'
    rcookies[response.session_data_name]['expires'] = PAST
if response.session_id_name in rcookies:
    del rcookies[response.session_id_name]
```

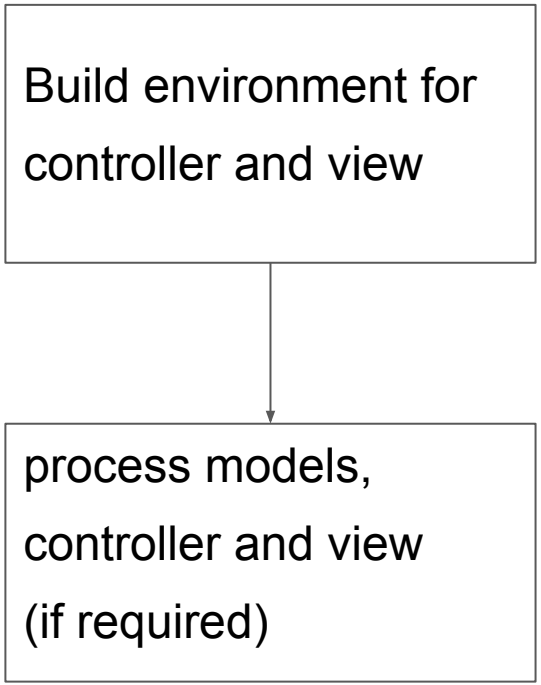
```
def save_session_id_cookie(self):
if not current._session_cookie_key:
    if response.session_data_name in cookies:
        rcookies[response.session_data_name] = 'expired'
        rcookies[response.session_data_name]['path'] = '/'
        rcookies[response.session_data_name]['expires'] = PAST
if response.session_id:
    rcookies[response.session_id_name] = response.session_id
    rcookies[response.session_id_name]['path'] = '/'
    expires = response.session_cookie_expires
    if isinstance(expires, datetime.datetime):
        expires = expires.strftime(FMT)
    if expires:
        rcookies[response.session_id_name]['expires'] = expires
```

Request to controller



Run Application

- Build environment for controller and view
  - web2py model and controller files are not Python modules
    - models and controllers are designed to be executed in a prepared environment that has been pre-populated with web2py global objects (request, response, session, cache and T) and helper functions.



Run Application (cont.)

- The controller and the view are executed in different copies of the same environment
  - The view does not see the controller, but it sees the models and it sees the variables returned by the controller action function
- The view is only called if the action returns a dictionary

```
run_models_in(environment)
response._view_environment = copy.copy(environment)
page = run_controller_in(request.controller, request.function, environment)
if isinstance(page, dict):
    response._vars = page
    response._view_environment.update(page)
    page = run_view_in(response._view_environment)
```

Execute application code in restricted environment

- Application code is compiled and executed with exec() in a try...except... block
- Any error in the application code is catched, and the error information is stored into a database table

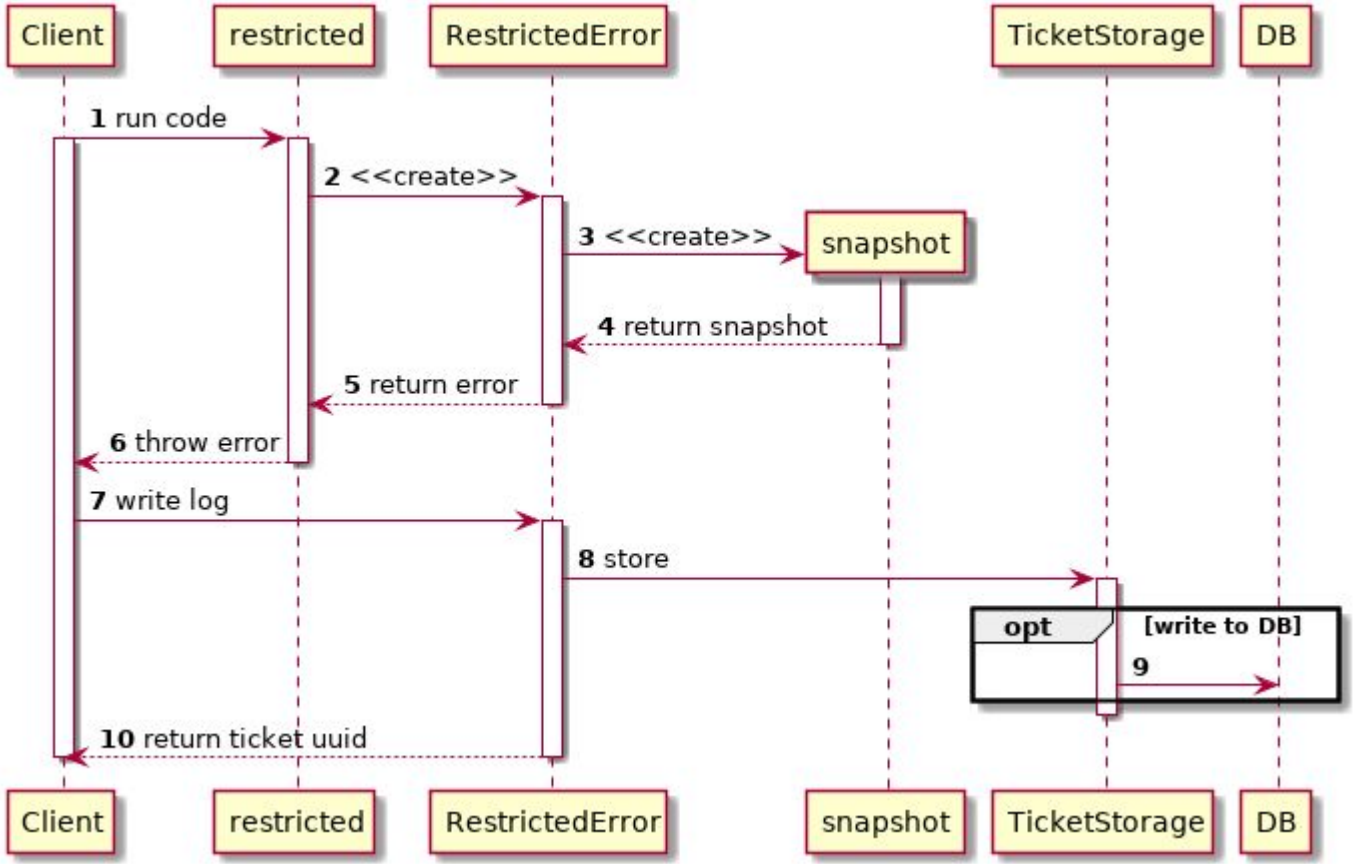
```
def restricted(ccode, environment=None, layer='Unknown', scode=None):

    ...
    try:
        exec(ccode, environment)
        ...

    except Exception as error:
        # extract the exception type and value (used as output message)
        etype, evalue, tb = sys.exc_info()
        ...

        # Save source code in ticket when available
        scode = scode if scode else ccode
        raise RestrictedError(layer, scode, output, environment)
```

Sequence diagram of handling error



Outline

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  - Cookies & Session
  - Run Application
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- Views
- Cron & Scheduler
- PyDAL
- Conclusion

Restful Web Services

- A client communicates with the resource by making an HTTP request to the URL that identifies the resource and using the HTTP method POST/GET/PUT/DELETE to pass instructions to the resource
  - For example, we might want to send a GET request to

```
http://127.0.0.1/myapp/default/simple_rest/persons.json
```

  - To create a restful action in web2py

```
def simple_rest():
    return locals()
```

- `request.restful` provides a very useful decorator that can be used to change default web2py behaviour

Restful

-

```
def restful(self, ignore_extension=False):
    def wrapper(action, request=self):
        def f(_action=action, *a, **b):
            request.is_restful = True
            env = request.env
            is_json = env.content_type == 'application/json'
            method = env.request_method
            if not ignore_extension and len(request.args) and '.' in request.args[-1]:
                request.args[-1], _, request.extension = request.args[-1].rpartition('.')
                current.response.headers['Content-Type'] = \
                    contenttype('.' + request.extension.lower())
            rest_action = _action().get(method, None)
            if not (rest_action and method == method.upper()
                    and callable(rest_action)):
                raise HTTP(405, "method not allowed")
            try:
                res = rest_action(*request.args, **request.vars)
                if is_json and not isinstance(res, str):
                    res = json(res)
                return res
            except TypeError as e:
                exc_type, exc_value, exc_traceback = sys.exc_info()
                if len(traceback.extract_tb(exc_traceback)) == 1:
                    raise HTTP(400, "invalid arguments")
                else:
                    raise
        f.__doc__ = action.__doc__
        f.__name__ = action.__name__
        return f
    return wrapper
```

Restful Web Services

- web2py uses inner functions to define factory functions
  - A function that creates other objects (functions)
- Add function request.restful() dynamically to another object or class

```
other_request.restful = types.MethodType(request.restful.__func__, other_request)
```

```
def restful(self, ignore_extension=False):
    def wrapper(action, request=self):
        def f(_action=action, *a, **b):
            request.is_restful = True
            env = request.env
            is_json = env.content_type == 'application/json'
            method = env.request_method
            if not ignore_extension and len(request.args) and '.' in request.args[-1]:
                request.args[-1], _, request.extension = request.args[-1].rpartition('.')
                current.response.headers['Content-Type'] = \
                    contenttype('.' + request.extension.lower())
            rest_action = _action().get(method, None)
            if not (rest_action and method == method.upper()
                    and callable(rest_action)):
                raise HTTP(405, "method not allowed")
                                                                    st.vars)
                if is_json and not isinstance(res, str):
                    res = json(res)
                return res
            except TypeError as e:
                exc_type, exc_value, exc_traceback = sys.exc_info()
                if len(traceback.extract_tb(exc_traceback)) == 1:
                    raise HTTP(400, "invalid arguments")
                else:
                    raise
        f.__doc__ = action.__doc__
        f.__name__ = action.__name__
        return f
    return wrapper
```

Restful Web Services

- Modify restful action in web2py

```
def simple_rest():
    return locals()
```


- @request.restful() decorator
  - Make sure that the extension (.html, .xml, .json) is stored in request.extension
  - Map the request method into the corresponding function within the action (GET, POST, PUT, DELETE)
  - Pass request.args and request.vars to the selected function

```
@request.restful()
def rest():
    def GET(*args,**vars):
        patterns = [
            "/friends[person]",
            "/{person.name}/:field",
            "/{person.name}/pets[pet.ownedby]",
            "/{person.name}/pets[pet.ownedby]/
            {pet.name}",
            "/{person.name}/pets[pet.ownedby]/
            {pet.name}/:field",
            ("/dogs[pet]", db.pet.info=='dog'),
            ("/dogs[pet]/{pet.name.startswith}",
             db.pet.info=='dog'),
            ]
        parser = db.parse_as_rest(patterns,args,
        vars)
        if parser.status == 200:
            return dict(content=parser.response)
        else:
            raise HTTP(parser.status,
            parser.error)

    def POST(table_name,**vars):
        if table_name == 'person':
            return db.person.validate_and_insert
            (**vars)
        elif table_name == 'pet':
            return db.pet.validate_and_insert
            (**vars)
        else:
            raise HTTP(400)
    return locals()
```

Remote Procedure Calls

- web2py provides a mechanism to turn any function into a web service
  - Work for a fixed set of protocols; not easily extensible
  - May take arguments or be defined in a model instead of controller
  - Decorate functions to expose as a service

```
http://127.0.0.1:8000/app/default/call/run/myfunction?a=10&b=11
http://127.0.0.1:8000/app/default/call/run/myfunction/10/11
```

```
http://127.0.0.1:8000/app/default/call/xml/myfunction/10/11
```

```
http://127.0.0.1:8000/app/default/call/json/myfunction/10/11
```

```
http://127.0.0.1:8000/app/default/call/jsonrpc/myfunction/10/11
```

```
http://127.0.0.1:8000/app/default/call/xmlrpc/myfunction/10/11
```

```python
from gluon.tools import Service
service = Service()
@service.run
def myfunction(a,b):
    return a + b
# expose service handler in the controller
def call():
    return service()

service = Service()
@service.xml
def myfunction(a,b):
    return a + b
def call():
    return service()

service = Service()
@service.json
def myfunction(a,b):
    return [{a: b}]
def call():
    return service()

service = Service()
@service.jsonrpc
def myfunction(a,b):
    return a + b
def call():
    return service()

service = Service()
@service.xmlrpc
def myfunctionc(a,b):
    return a + b
def call():
```

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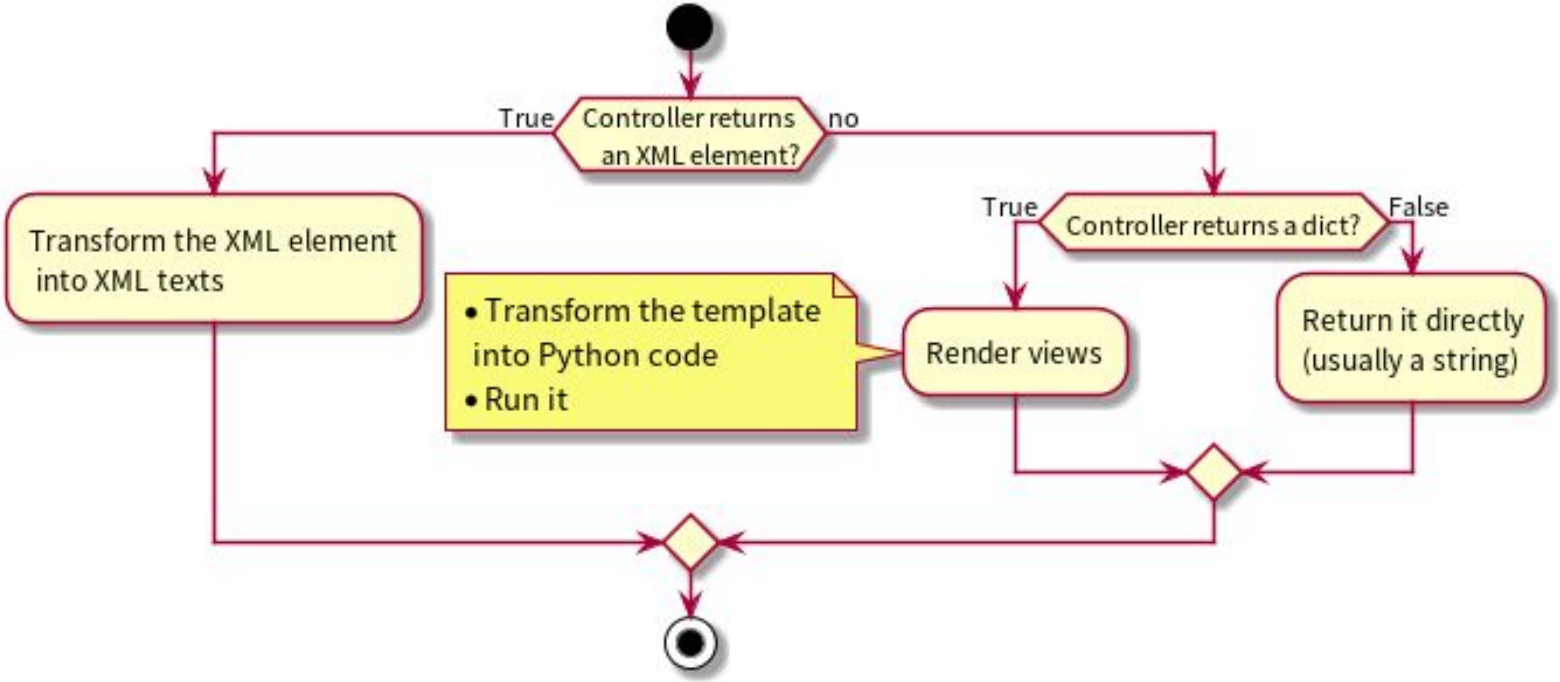
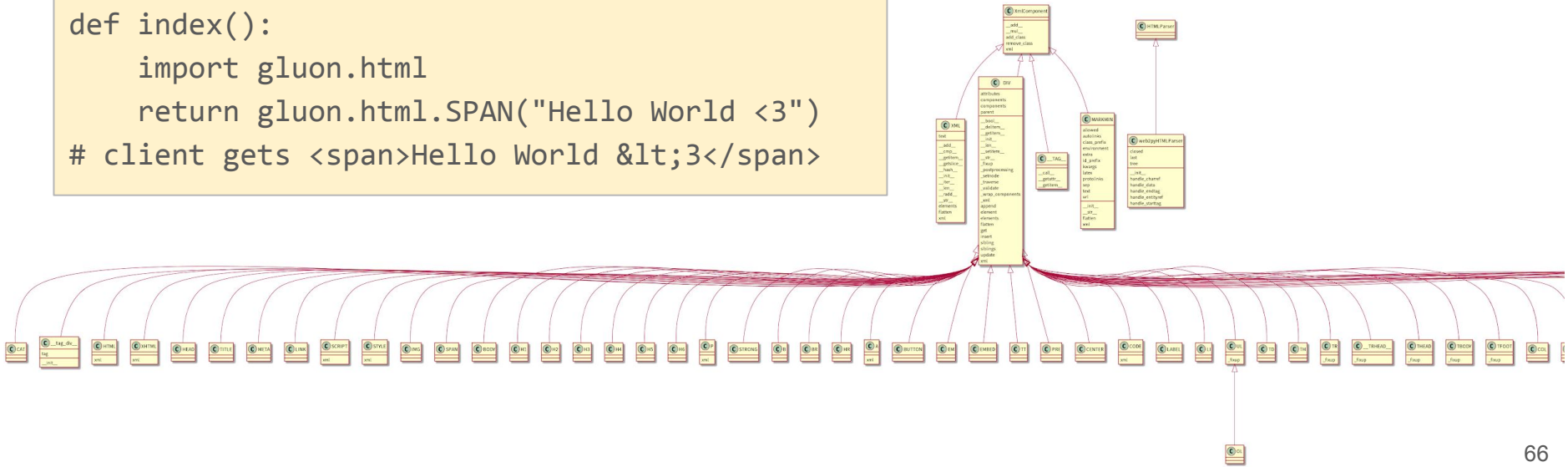
How the Client Gets Data



XML Elements: Helpers for HTML Tag

- Create HTML tags with Python functions
- Doing miscellaneous stuffs (e.g., escaping)

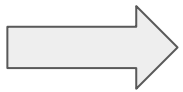
```
def index():
    import gluon.html
    return gluon.html.SPAN("Hello World <3")
# client gets <span>Hello World &lt;3</span>
```



Yet Another Template Language (YATL)

- A template language similar to Django's templates or Flask's Jinja2
- Allow using control flow statements of Python
- A template can extend another one
- Often used with HTML tag helpers to generate HTML with ease
- The main class, TemplateParser, does both parsing and transformation to Python

```
{{ if authenticated: }}
{{=T("Good!")}}
{{ else: }}
{{=T("Oops")}}
{{ pass }}
```



```
if authenticated:
    response.write(T("Good!"))
else:
    response.write(T("Oops"))
    pass
```

Extension of Templates

layout.html

```
<html><head>
{{ block head }}
<title>{{ block title }}web2py view{{ end }}</title>
{{ end }}
</head><body></body></html>
```

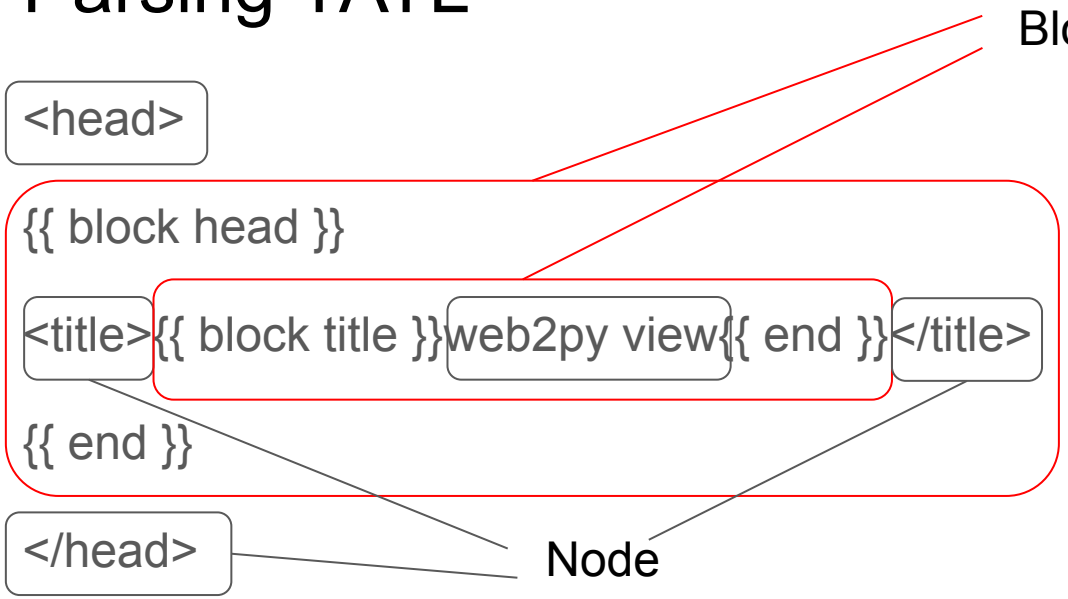
- `block`: contents that can be replaced
- `super`: place the content from the base
- `extends`: for template reuse

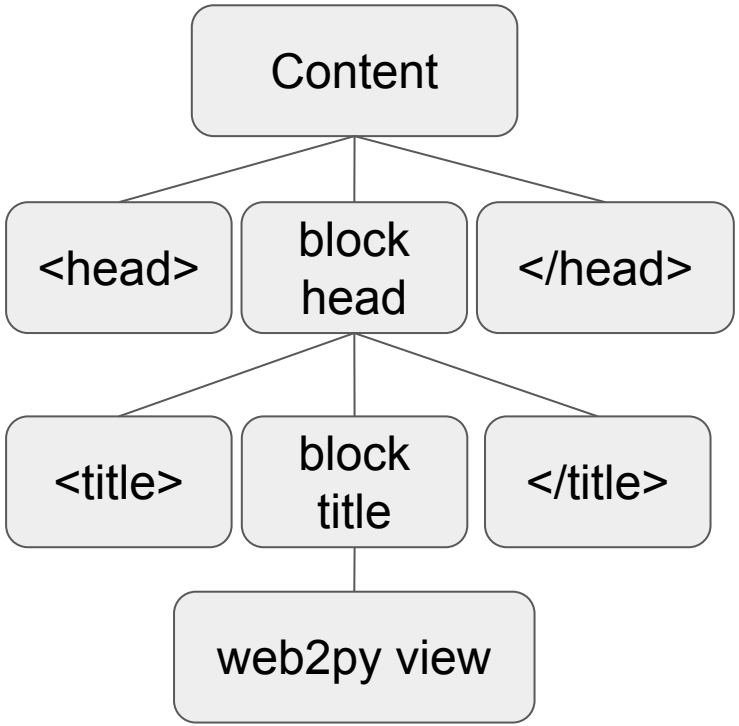
index.html

```
{{ extends "layout.html" }}
{{ block head }}
{{ super }}
<link rel="stylesheet" href="index.css" />
{{ end }}
{{ block title }}Index{{ end }}
```

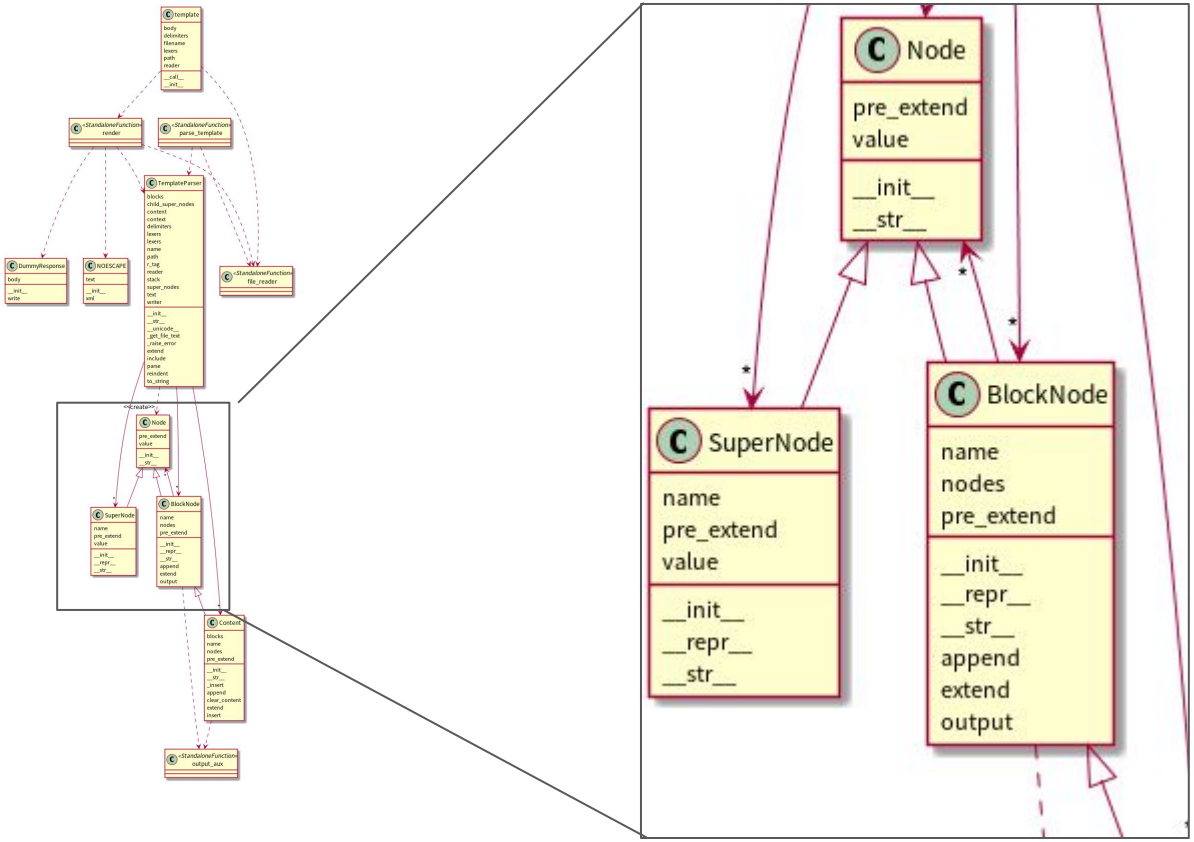
```
<html><head>
<title>Index</title>
<link rel="stylesheet" href="index.css" />
</head><body></body></html>
```

Parsing YATL





Class Diagram for YATL



Composite Pattern

How the Parser works

```
if name == 'block' and not value.startswith('='):
    # Make a new node with name.
    node = BlockNode(name=value.strip(),
                     pre_extend=pre_extend,
                     delimiters=self.delimiters)
    # Append this node to our active node
    top.append(node)
    # Make sure to add the node to the stack.
    # so anything after this gets added
    # to this node. This allows us to
    # "nest" nodes.
    stack.append(node)
elif name == 'end' and not value.startswith('='):
    # We are done with this node.
    # Save an instance of it
    self.blocks[top.name] = top
    # Pop it.
    stack.pop()
elif name == 'super' and not value.startswith('='):
    # Get our correct target name
    # If they just called {{super}} without a name
    # attempt to assume the top blocks name.
    if value:
        target_node = value
    else:
        target_node = top.name
    # Create a SuperNode instance
    node = SuperNode(name=target_node,
                     pre_extend=pre_extend)
    # Add this to our list to be taken care of
    self.super_nodes.append(node)
    # And put in in the tree
    top.append(node)
```

For `{{ block }}`

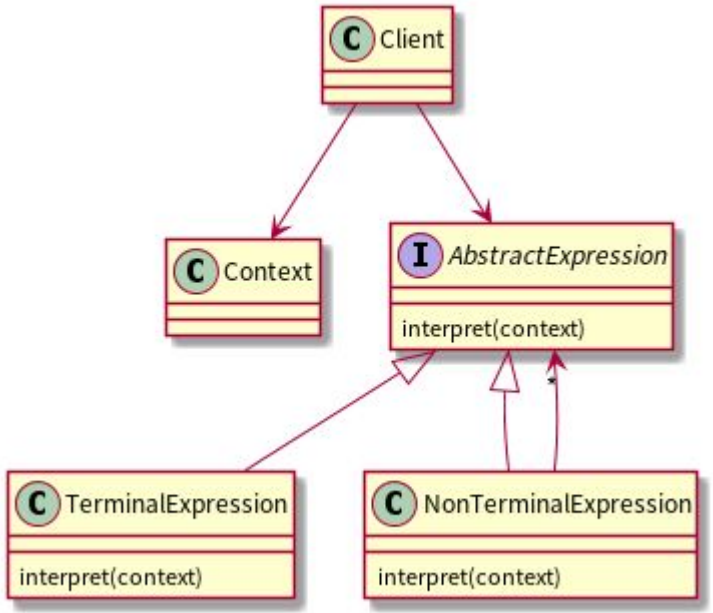
For `{{ end }}`

For `{{ super }}`

Problem: need to change the parser whenever a expression changes

No Interpreter Pattern

- Encapsulate what varies
  - Actions for different nodes to different Expression classes
- Abstract common behaviors
  - An AbstractExpression class for various Expression classes

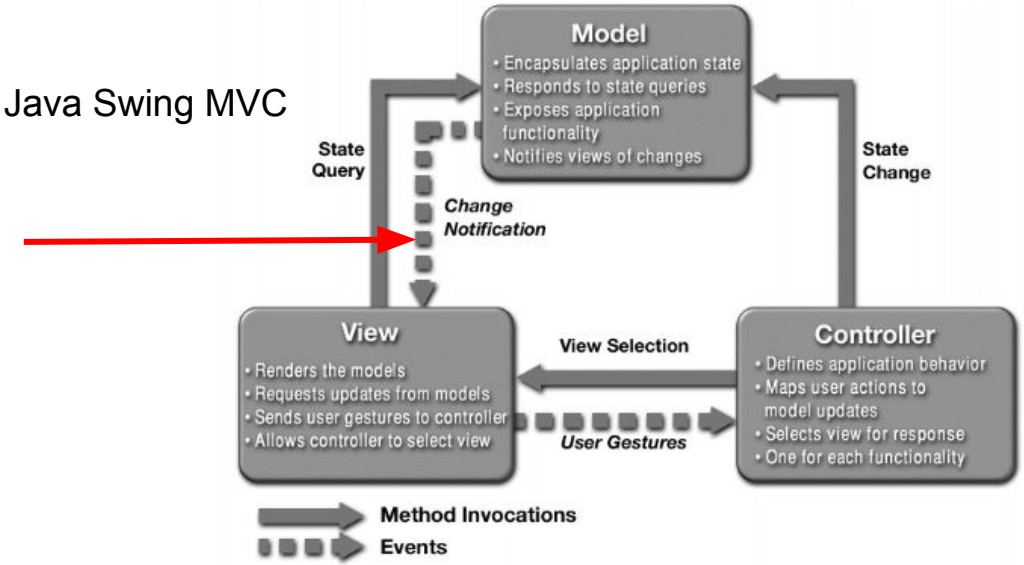


No Observer Pattern

- MVC frameworks use the observer pattern
- But what web2py returns to the client are static HTML
- Actually “Model 2”

Where the observer pattern appears, but web2py does not implement it.

Java Swing MVC



Languages.py

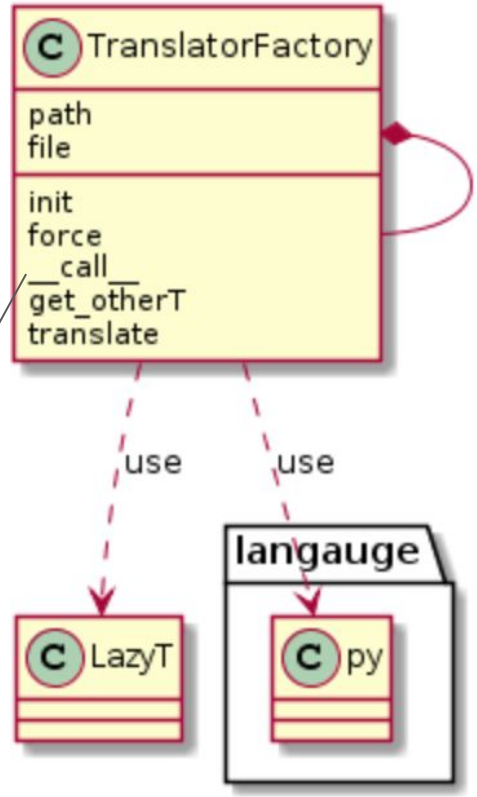
```
T = languages.TranslatorFactory(self.langpath, self.http_accept_language)
```

```
self.assertEqual(str(T('Hello World')),
                 'Salve Mondo')
```

- Translation system
- Only one class named TranslatorFactory is used
- Its work is translating key words into appointed language
- TranslatorFactory is not factory pattern, but like an initial design

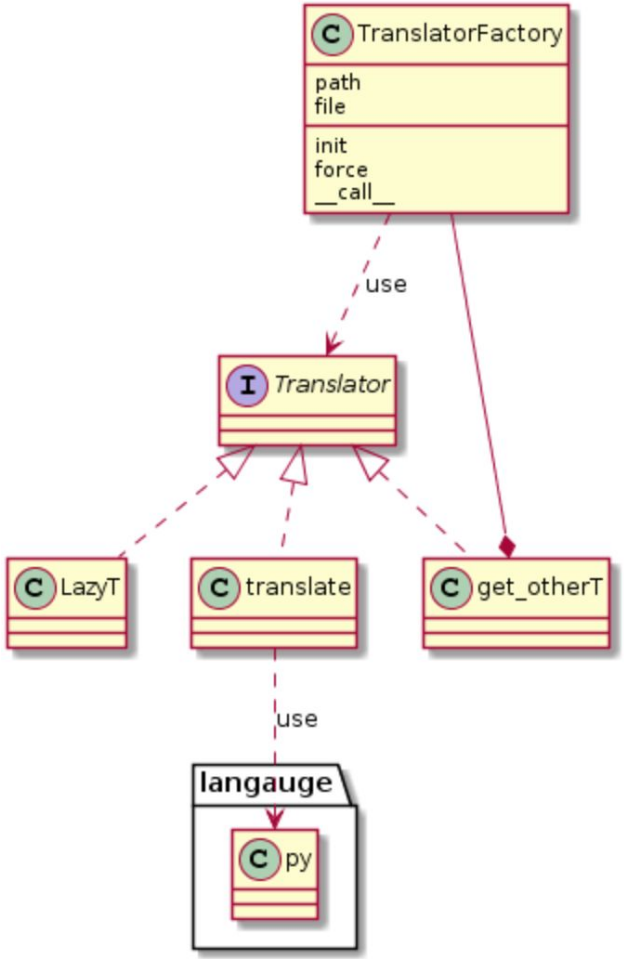
Languages.py

```python
if lazy is None:
    lazy = self.lazy
if not language and not ns:
    if lazy:
        return lazyT(message, symbols, self)
    else:
        return self.translate(message, symbols)
else:
    if ns:
        if ns != self.ns:
            self.langpath = os.path.join(self.langpath, ns)
        if self.ns is None:
            self.ns = ns
    otherT = self.__get_otherT__(language, ns)
    return otherT(message, symbols, lazy=lazy)
```



Languages.py

- Re-design with strategy pattern
- Because of Python's property , omitting the interface is allowed



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Time-Based Job Scheduler - Cron

- Provides the ability for applications to execute tasks at preset times
- Running periodical tasks in the background
    - Each task runs in its own process
    - Can’t control how many tasks are running
- Three types of cron
    - Softcorn
    - Hardcorn
    - External corn

Time-Based Job Scheduler - Cron(cont.)

- Call classes or methods directly by options

```
if options.with_cron:
    if options.soft_cron:
if global_settings.web2py_crontype == 'soft':
    cmd_opts = global_settings.cmd_options
    newcron.softcron(global_settings.applications_parent,
                     apps=cmd_opts and cmd_opts.crontabs)
```

Time-Based Job Scheduler - Cron(cont.)

- Build 2 pools at initialization (while web2py uses only 1 pool)

```
# set size of cron thread pools
newcron.dancer_size(options.min_threads)
newcron.launcher_size(options.cron_threads)
```

- For softcorn

```
_dancer = SimplePool(5, worker_cls=SoftWorker)
```

```
if not _dancer((applications_parent, apps)):
```

- For hardcorn

```
_launcher = SimplePool(5, worker_cls=Worker)
```

```
if not _launcher(commands):
```

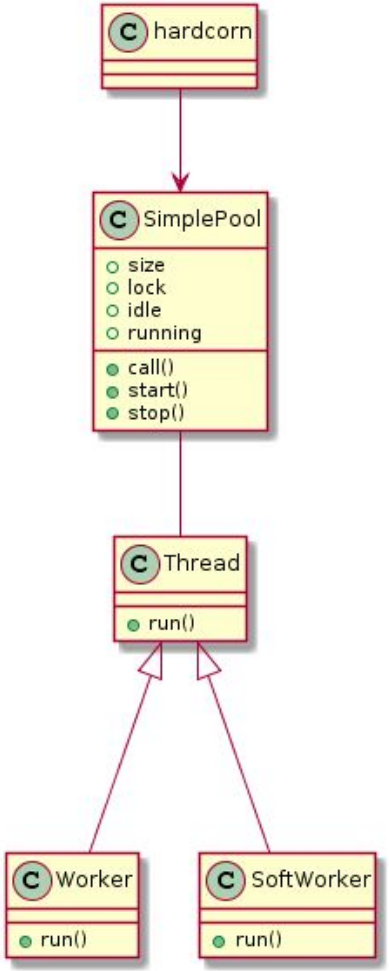
Class Diagram of Cron

- A simplepool contains instances of

  Worker or SoftWorker

```
class SimplePool(object):
    """
    Very simple thread pool,
    (re)uses a maximum number of threads to launch cron tasks.

    Pool size can be incremented after initialization,
    this allows delayed configuration of a global instance
    for the case you do not want to use lazy initialization.
    """
```

- Lazy initialization
- Object pool pattern



Lazy Initialization and Object Pool

- Create an object when it is called and no other objects are available

```
if len(self.running) == self.size:
    # no worker available
    return False
idle_num = len(self.idle)
if idle_num:
    # use an existing (idle) thread
    t = self.idle.pop(0)
else:
    # create a new thread
    t = self.worker_cls(self)
```

- Reuse the created object
  - Creating a thread consumes many resources

Scheduler

```
class Scheduler(threading.Thread):
    """Scheduler object
```

- An optional and independent class in web2py
- Access information from PyDAL
- Dependency injection - property Injection

```
current = threading.local()
```

```
from gluon import current
current._scheduler = self
```

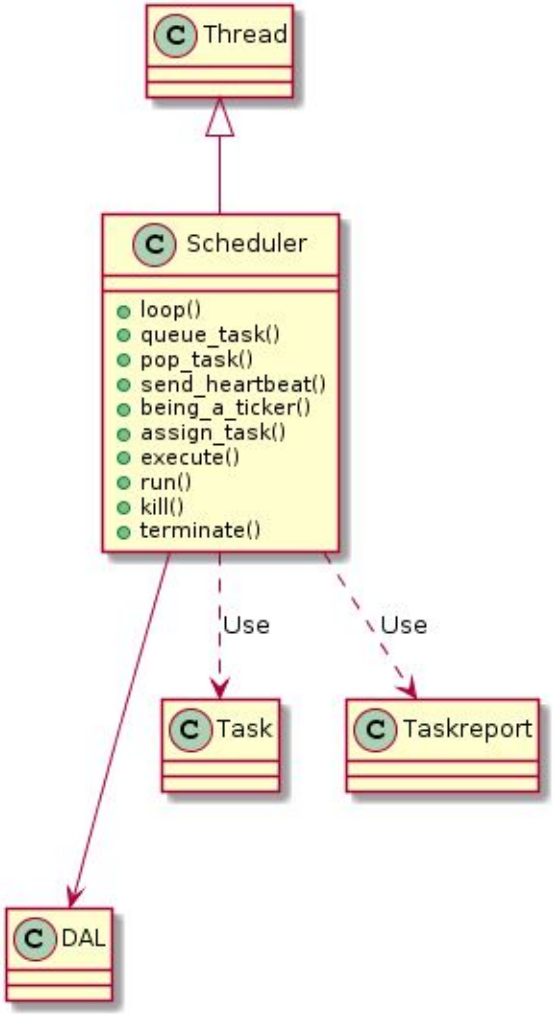
- Monitor each worker & assign tasks to each worker
- What about the original web2py? (without Scheduler)
  - Task may stuck at worker
  - Can’t access the progress of tasks

Class Diagram of Scheduler

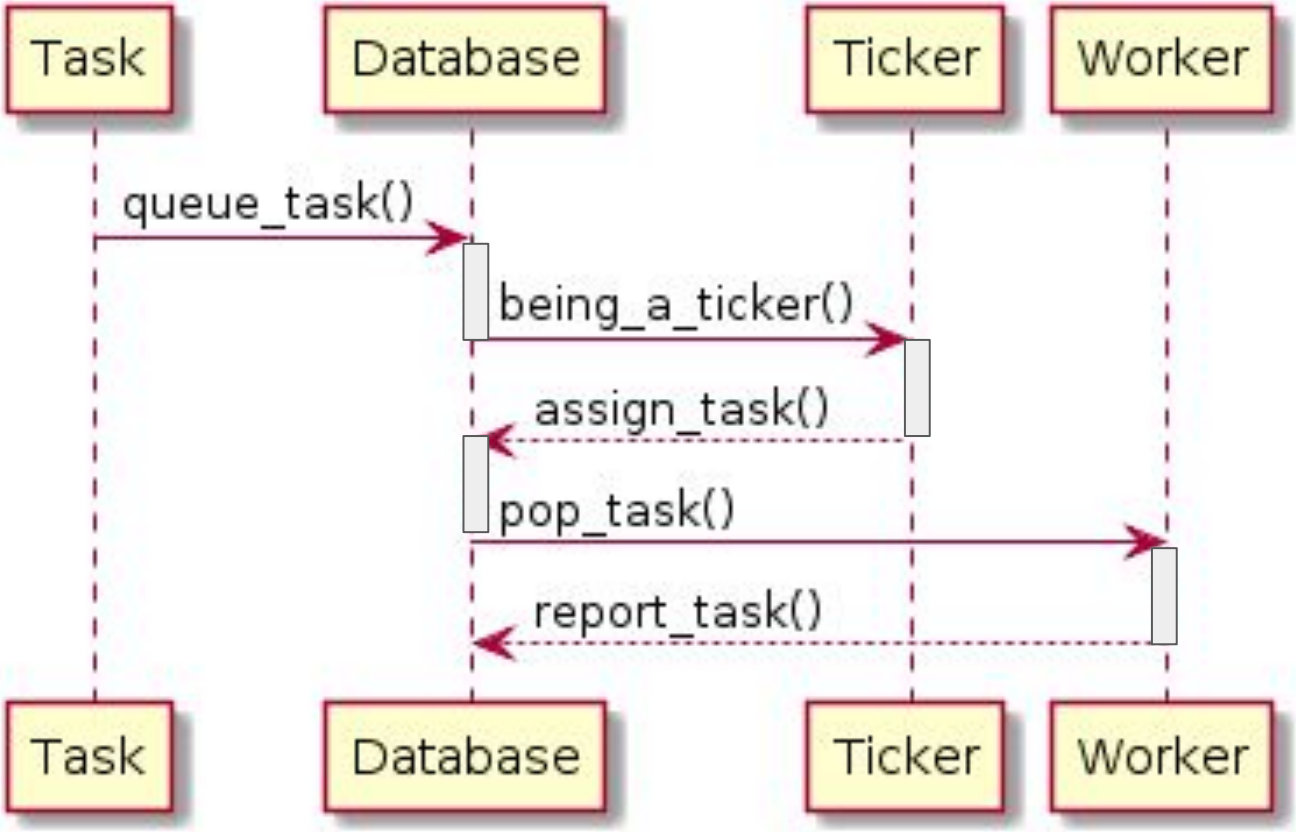
- The number of running processes (worker)

  is fixed

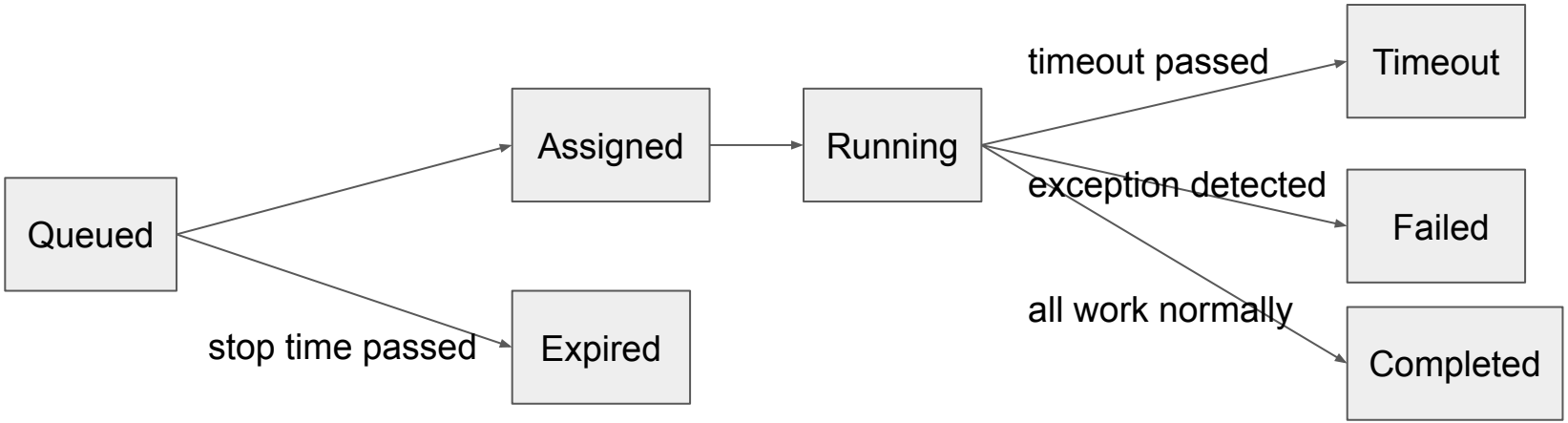
- They can run on different machines
- Check all workers after a heartbeat
- Any worker may be a ticker
- Only ticker can assign tasks to other workers



Sequence Diagram of Scheduler



Task State Transition




```
class Task(object):
    """Defines a "task" object that gets passed from the main thread to the
    executor's one
    """
```

Outline

- Briefly introduce web2py
- Request to Controller
  - Server
  - Rewrite and parsing incoming URLs
  - WSGI hooks
  - Cookies & Session
  - Run Application
- Services
- Views
- Cron & Scheduler
- **PyDAL**
- Conclusion

PyDAL outline

- PyDAL introduction
- PyDAL workflow
- conclusion

What is PyDAL

- PyDAL stands for Python Data Abstraction Layer
- A Python module that can access different types of databases
- Written by web2py author and can be used alone

```
from pydal import DAL, Field
db = DAL('sqlite://storage.sqlite', pool_size=10)
db.define_table('person', Field('name'), Field('age', 'integer'))
db.person.insert(name="Alex", age="19")
query = db.person.name.startswith('A')
rows = db(query).select()
print(rows[0].age) # >>> 19
db.commit()
```

Person

id	name	age
1	Alex	10
...	...	...

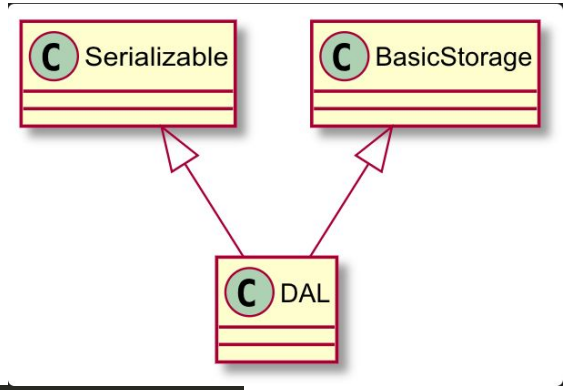
DAL

- Able to access different types of databases
  - SQLite, MySQL, Oracle, MongoDB, PostgreSQL, MSSQL, FireBird, ...

```
from pydal import DAL, Field
db = DAL('sqlite://storage.sqlite', pool_size=10)
db.define_table('person', Field('name'), Field('age', 'integer'))
db.person.insert(name="Alex", age="19")
query = db.person.name.startswith('A')
rows = db(query).select()
print(rows[0].age) # >>> 19
db.commit()
```

```
db = DAL('sqlite://storage.sqlite', pool_size=10)
db = DAL('postgres://username:password@localhost/test', pool_size=10)
```

DAL class




```
class DAL(with_metaclass(MetaDAL, Serializable, BasicStorage)):
```

```
class Serializable(object):
    def as_dict(self, flat=False, sanitize=True):
        return self.__dict__

    def as_xml(self, sanitize=True):
        return serializers.xml(self.as_dict(flat=True, sanitize=sanitize))

    def as_json(self, sanitize=True):
        return serializers.json(self.as_dict(flat=True, sanitize=sanitize))

    def as_yaml(self, sanitize=True):
        return serializers.yaml(self.as_dict(flat=True, sanitize=sanitize))
```

```
class BasicStorage(object):
    def __init__(self, *args, **kwargs):
        return self.__dict__.__init__(*args, **kwargs)

    def __getitem__(self, key):
        return self.__dict__.__getitem__(str(key))

    __setitem__ = object.__setattr__
```

```
db.person.insert(name="Alex", age="19")
db['person'].insert(name="Bob", age="20")
```

parse

```
db = DAL('sqlite://storage.sqlite', pool_size=10)
```

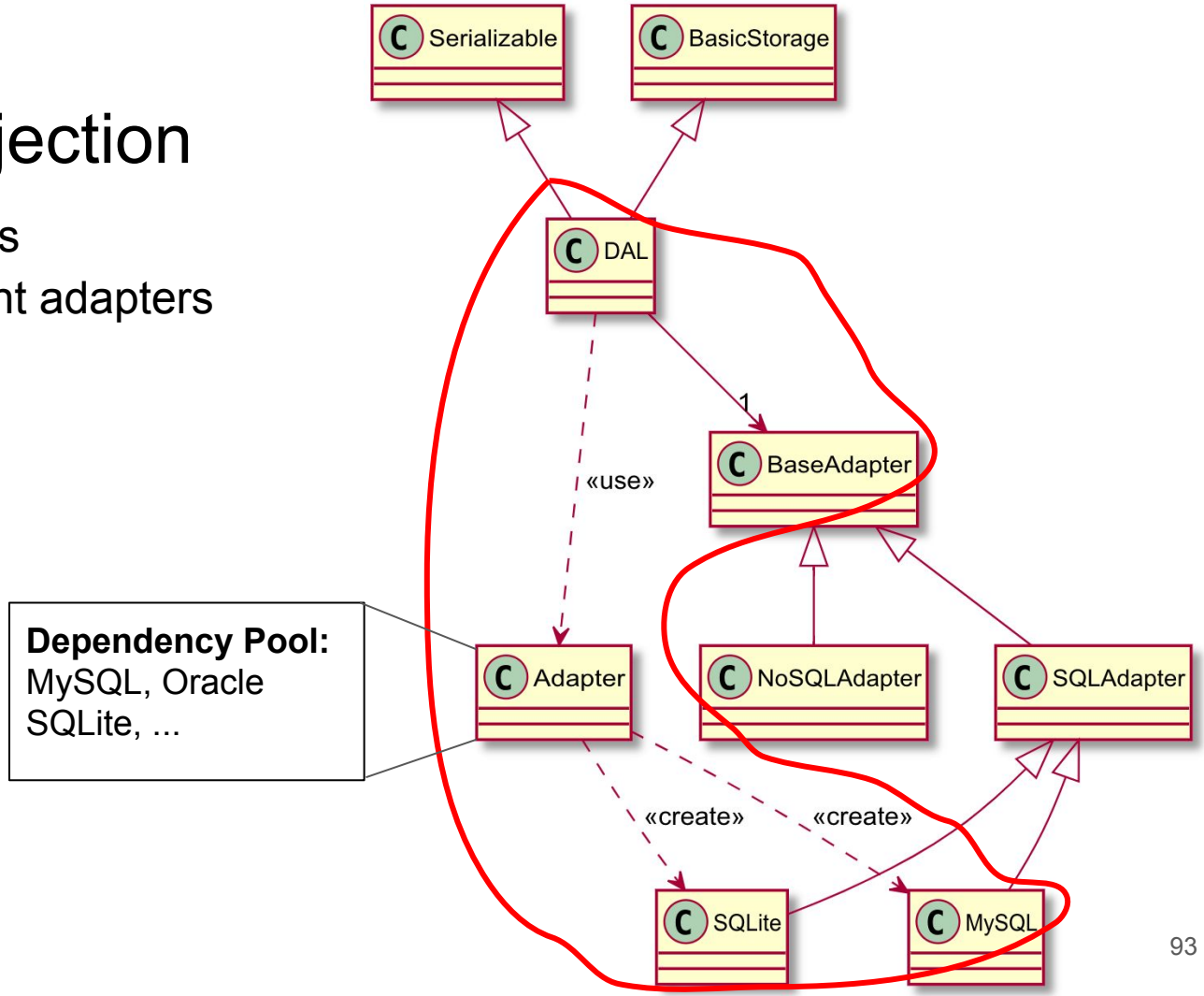
```
if uri:
    uris = isinstance(uri, (list, tuple)) and uri or [uri]
    connected = False
    for k in range(attempts):
        for uri in uris:
            try:
                from .adapters import adapters
                if is_jdbc and not uri.startswith('jdbc:'):
                    uri = 'jdbc:' + uri
                self._dbname = REGEX_DBNAME.match(uri).group()
                # notice that driver args or {} else driver_args
                # defaults to {} global, not correct
                kwargs = dict(db=self,
                              uri=uri,
                              pool_size=pool_size,
                              folder=folder,
                              db_codec=db_codec,
                              credential_decoder=credential_decoder,
                              driver_args=driver_args or {},
                              adapter_args=adapter_args or {},
                              do_connect=do_connect,
                              after_connection=after_connection,
                              entity_quoting=entity_quoting)
                adapter = adapters.get_for(self._dbname)
                self._adapter = adapter(**kwargs)
```

```
class Adapters(Dispatcher):
    def register_for(self, *uris):
        def wrap(dispatch_class):
            for uri in uris:
                self._registry_[uri] = dispatch_class
            return dispatch_class
        return wrap

    def get_for(self, uri):
        try:
            return self._registry_[uri]
        except KeyError:
            raise SyntaxError(
                'Adapter not found for %s' % uri
            )

adapters = Adapters('adapters')
```

```
@adapters.register_for('sqlite', 'sqlite:memory')
class SQLite(SQLAdapter):
    dbengine = 'sqlite'
    drivers = ('sqlite2', 'sqlite3')

    def _initialize_(self, do_connect):
```

Dependency Injection

- Inject a SQLite class
- Adapter has different adapters

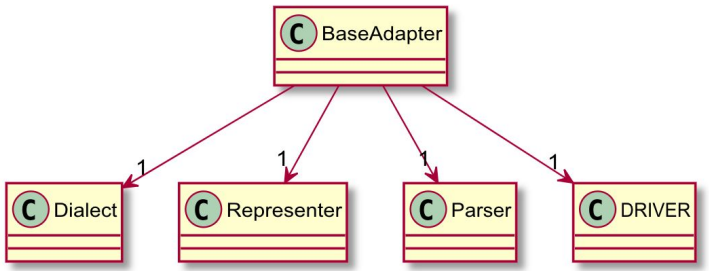


What adapters can do

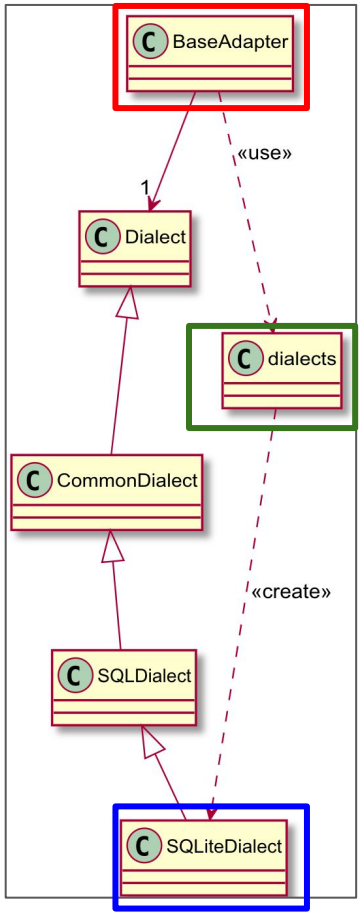
- Translate all fields' operations into its own dialect (SQLiteDialect)
- Connect to the database via specific module (from sqlite3 import dbapi2)
- Parse response string using (if needed) based on its own parser (SQLiteParser)
- Extra query (ST_Geomtry) using its representers (SQLiteRepresenter)

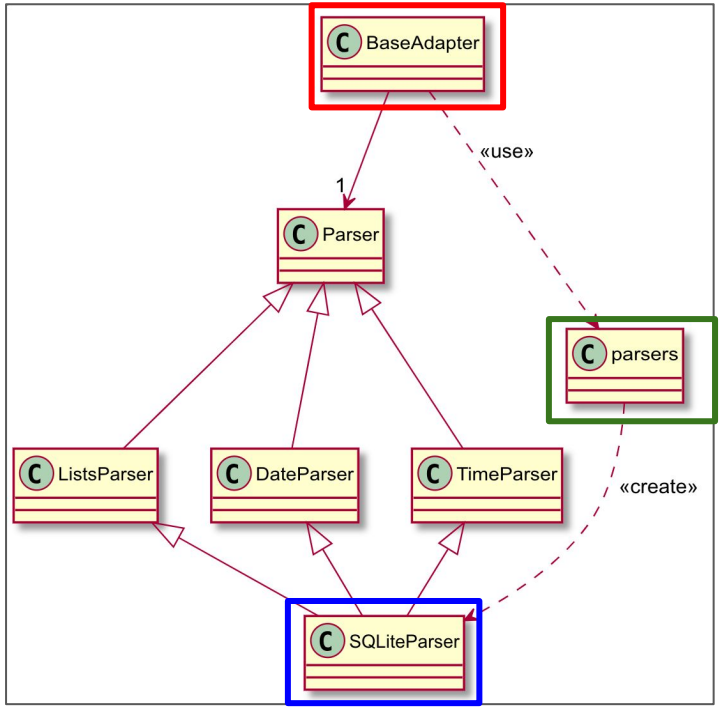
```
class BaseAdapter(with_metaclass(AdapterMeta, ConnectionPool)):
```

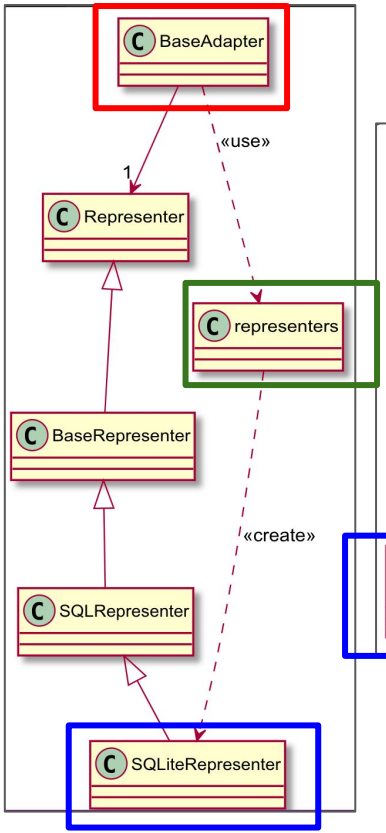
```
def _load_dependencies(self):
    from ..dialects import dialects
    from ..parsers import parsers
    from ..representers import representers
    self.dialect = dialects.get_for(self)
    self.parser = parsers.get_for(self)
    self.representer = representers.get_for(self)
```

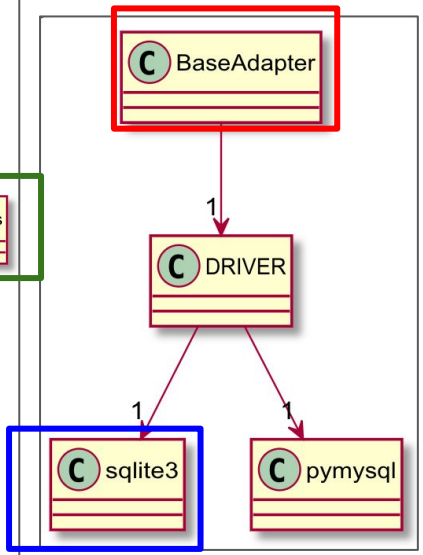


Injection of Dialect, Parserm, Representer, Connection module



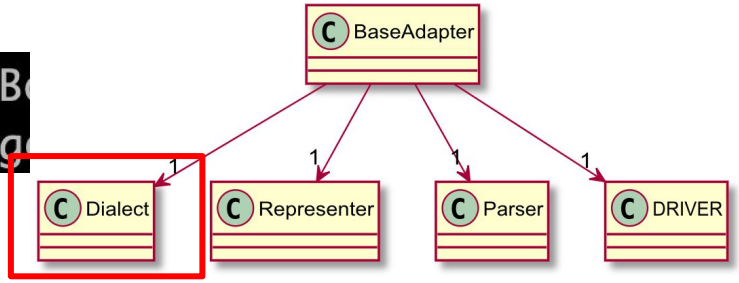




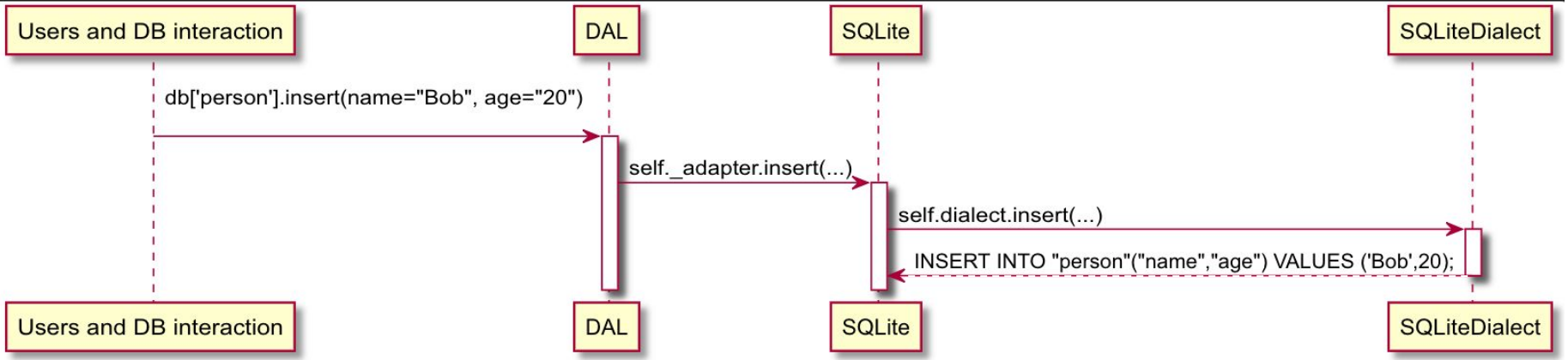


Dialect

```
>>> db['person'].insert(name="B
INSERT INTO "person"("name","ag
```



- Map types and operations into specific strings
- Prepare query strings



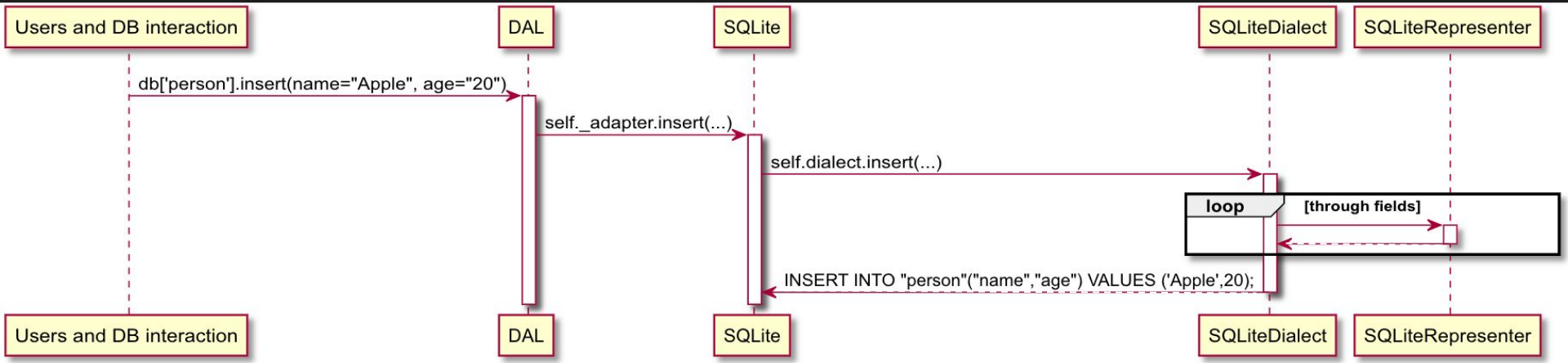

```
@sqltype_for('float')
def type_float(self):
    return 'FLOAT'

@sqltype_for('double')
def type_double(self):
    return 'DOUBLE'
```

```
        whr = ' %s' % self.where(where)
    return 'UPDATE %s SET %s%s;' % (tablename, values, whr)

def delete(self, table, where=None):
    tablename = self.writing_alias(table)
    whr = ''
    if where:
        whr = ' %s' % self.where(where)
    return 'DELETE FROM %s%s;' % (tablename, whr)
```

Representer

```
>>> db['person'].insert(name="Apple", age="20")
representer Apple string
representer 20 integer
```

- Type definition (string, int)

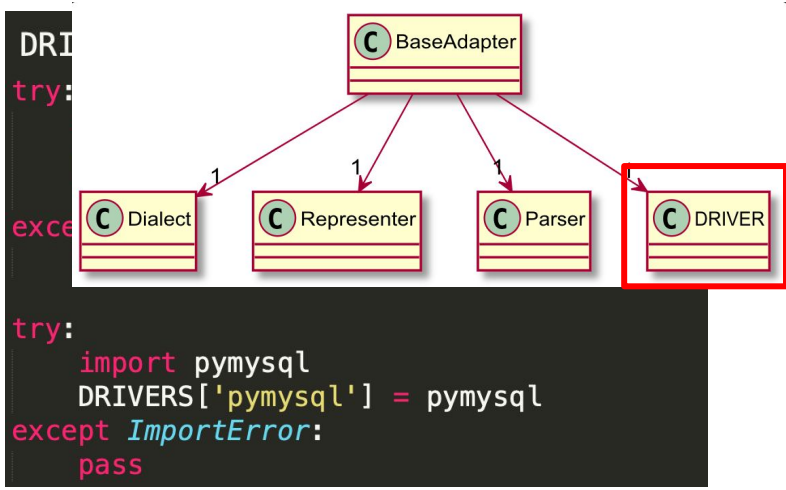



```
    @for_type('integer', adapt=False)
    def _integer(self, value):
        return str(long(value))
```

```
@for_type('geometry', adapt=False)
def _geometry(self, value, srid):
    return "ST_GeomFromText('%s',%s)" % (value, srid)
```

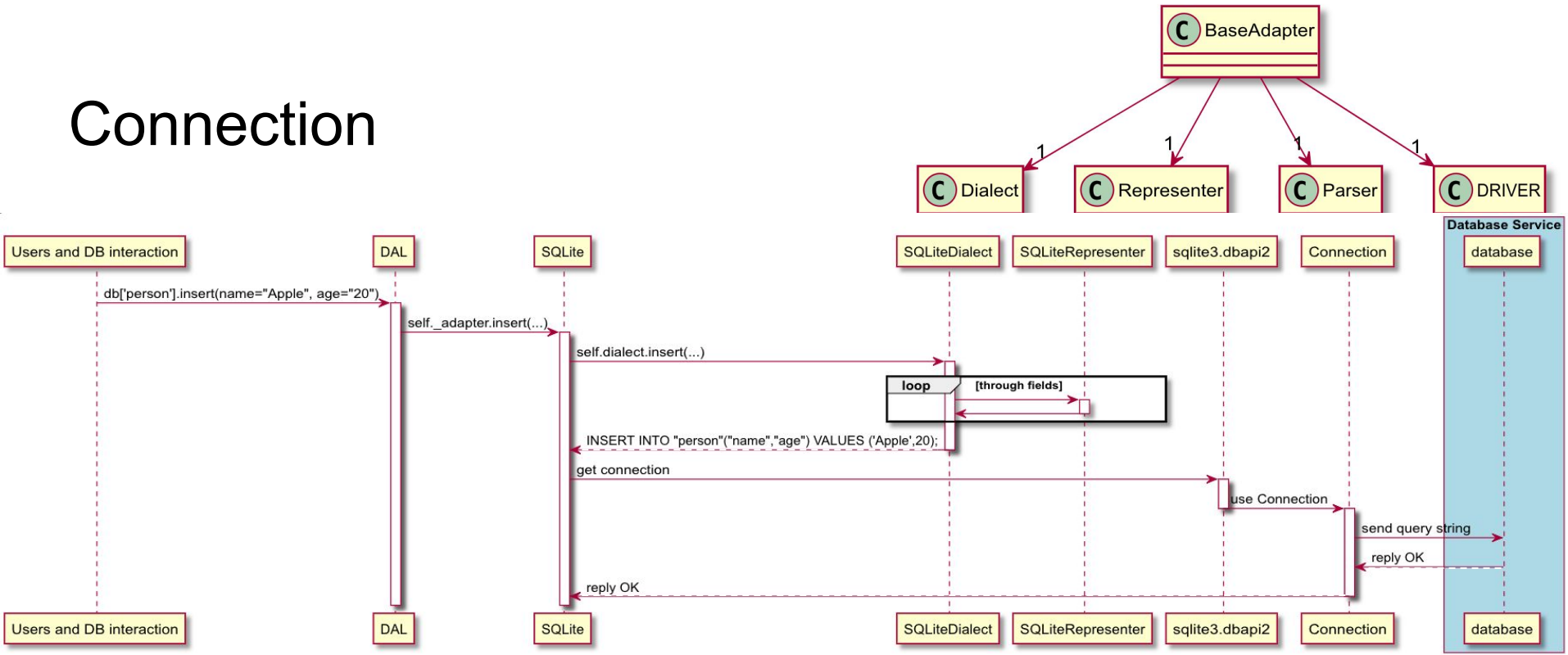
DRIVER

- Connect to database
- Send requesta and receive responses




```
class BaseAdapter(with_metaclass(AdapterMeta, ConnectionPool)):
def find_driver(self):
    if getattr(self, 'driver', None) is not None:
        return
    requested_driver = self._driver_from_uri() or \
        self.adapter_args.get('driver')
    if requested_driver:
        if requested_driver in self._available_drivers:
            self.driver_name = requested_driver
            self.driver = self.db._drivers_available[requested_driver]
        else:
            raise RuntimeError(
                'Driver %s is not available' % requested_driver)
```

Connection

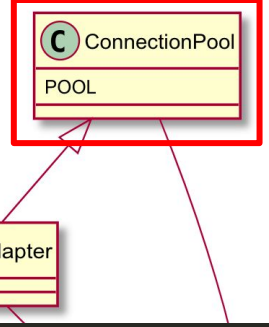



```
        ...
        ret = SQLEndTran(SQL_HANDLE_DBC, self.dbc_h, SQL_COMMIT)
        ...
    def rollback(self):
        ...
        ret = SQLEndTran(SQL_HANDLE_DBC, self.dbc_h, SQL_ROLLBACK)
        ...
...
```

ConnectionPool

- Instantiate a connection beforehand
- Pop up an available worke

```
def _build_cursor(self):
    rv = Cursor(self.connection)
    self.cursors[id(rv.cursor)] = rv
    return rv
```



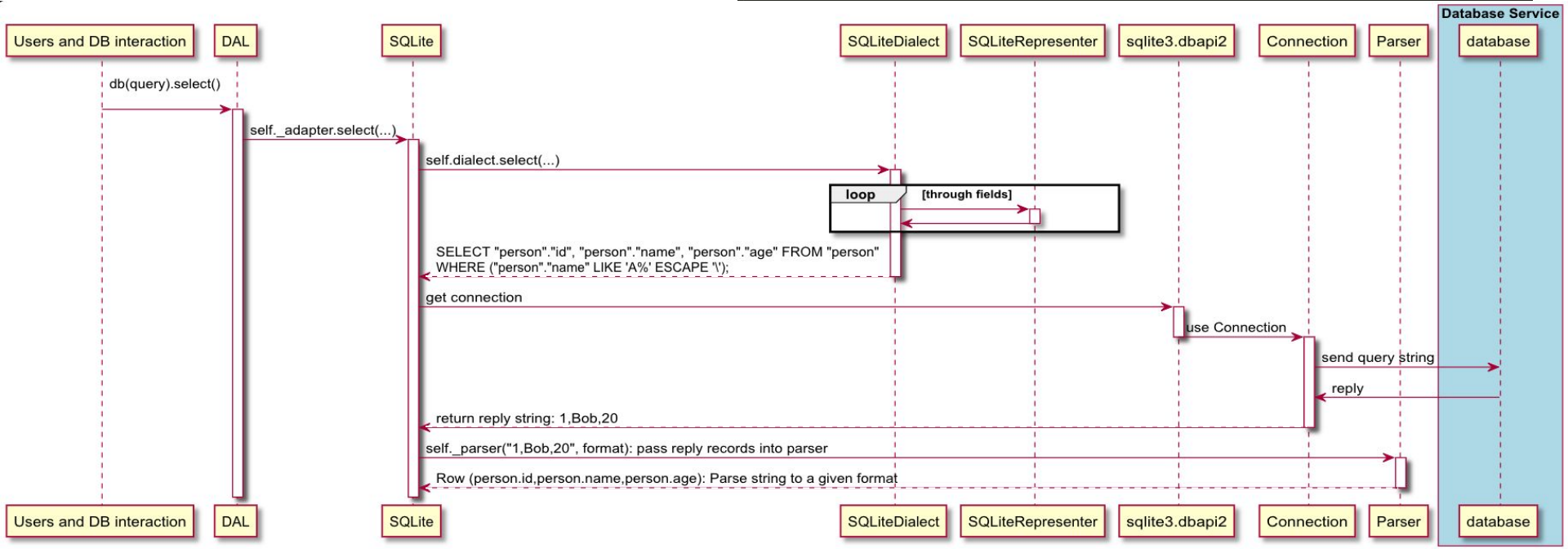

```
class ConnectionPool(object):
    POOLS = {}
    check_active_connection = True

    def __init__(self):
        _iid_ = str(id(self))
        self._connection_thname_ = '_pydal_
        self._cursors_thname_ = '_pydal_cu
```

```
def _get_or_build_free_cursor(se
    for handler in itervalues(se
        if handler.available:
            return handler
    return self._build_cursor()
```

```
# The Cursor Class.
class Cursor:
    def __init__(self, conx, row_type_callable=None):
        """ Initialize self.stmt_h, which is the handle of a statement
        A statement is actually the basis of a python"cursor" object
        """
        self.stmt_h = ctypes.c_void_p()
        self.connection = conx
        self.ansi = conx.ansi
        self.row_type_callable = row_type_callable or TupleRow
        self.statement = None
        self._last_param_types = None
        self._ParamBufferList = []
        self._ColBufferList = []
        self._row_type = None
        self._buf_cvt_func = []
        self.rowcount = -1
        self.description = None
        self.autocommit = None
        self._ColTypeCodeList = []
        self._outputsize = {}
        self._inputsizers = []
        self.arraysize = 1
        ret = ODBC_API.SQLAllocHandle(SQL_HANDLE_STMT, self.connection.dbc_h, ADDR
        check_success(self, ret)
```

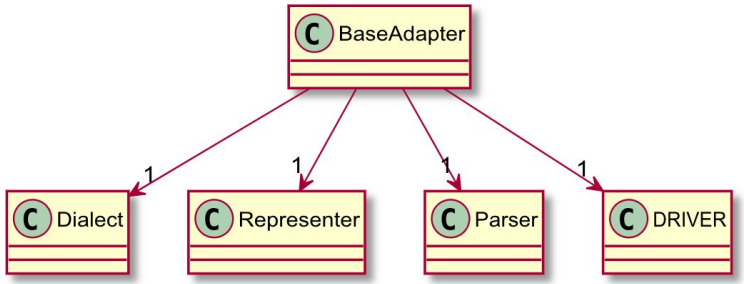
Parser

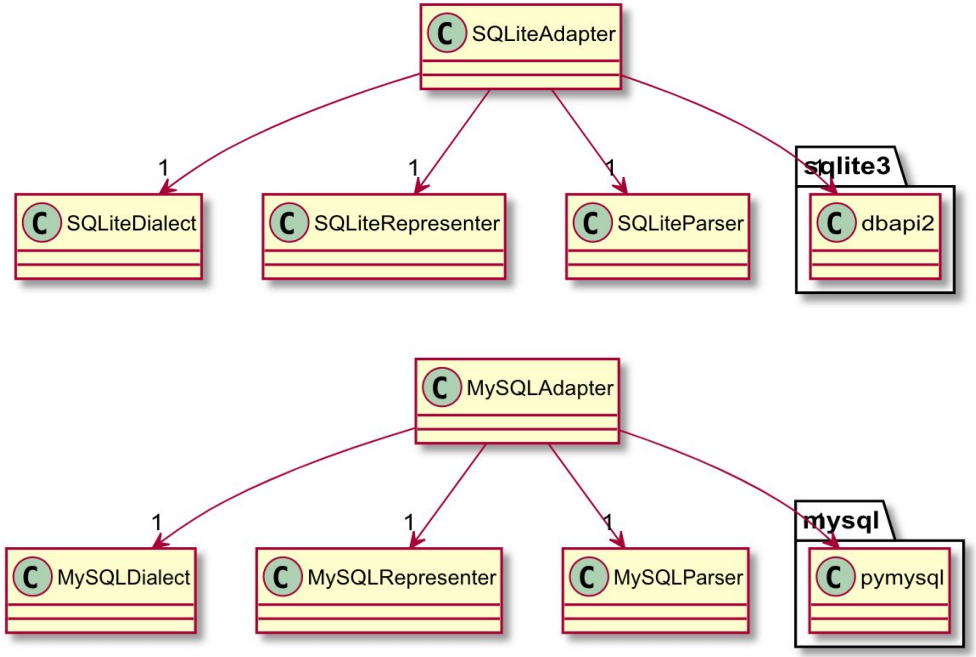
```
class BasicParser(Parser):
    @for_type('id')
    def _id(self, value):
        return long(value)
```

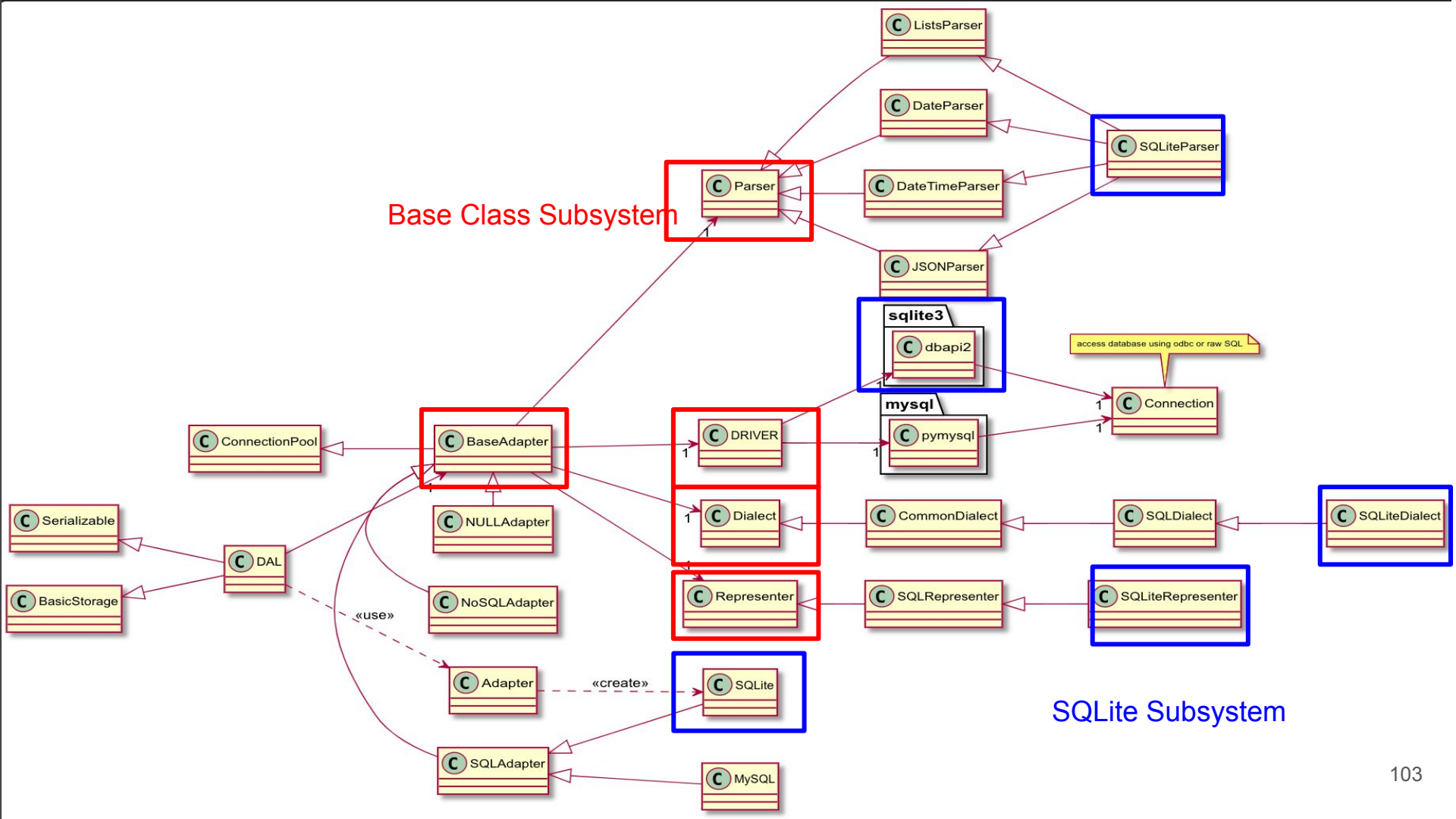



```
            fields_virtual, fields_lazy)
        for row in rows
    ]
    rowsobj = self.db.Rows(self.db, new_rows, colnames, rawrows=rows,
            fields=fields)
    print(rowsobj, 'here')
```

Subsystem


BaseAdapter
1
Dialect
1
Representer
1
Parser
1
DRIVER


SQLiteAdapter
1
SQLiteDialect
1
SQLiteRepresenter
1
SQLiteParser
sqlite3
dbapi2
MySQLAdapter
1
MySQLDialect
1
MySQLRepresenter
1
MySQLParser
mysql
pymysql


ListsParser
DateParser
SQLiteParser
Parser
DateTimeParser
Base Class Subsystem
JSONParser
sqlite3
dbapi2
access database using odbc or raw SQL
mysql
Connection
pymysql
ConnectionPool
BaseAdapter
DRIVER
Serializable
DAL
NULLAdapter
Dialect
CommonDialect
SQLDialect
SQLiteDialect
BasicStorage
NoSQLAdapter
Representer
SQLRepresenter
SQLiteRepresenter
«use»
Adapter
«create»
SQLite
SQLAdapter
MySQL
SQLite Subsystem

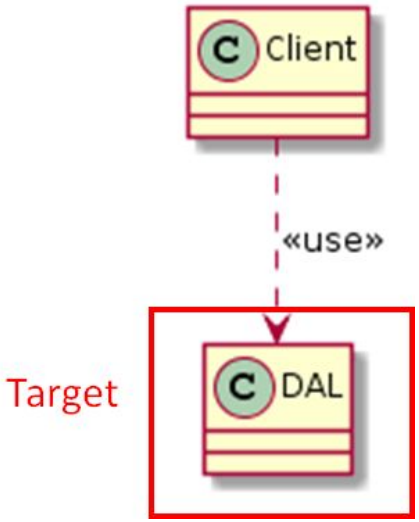
Database Abstraction Layer (DAL)

```
289             db.define_table(
290                 settings.table_user_name,
291                 Field('first_name', length=128, default='',
292                       label=self.messages.label_first_name,
293                       requires=is_not_empty),
294                 Field('last_name', length=128, default='',
295                       label=self.messages.label_last_name,
296                       requires=is_not_empty),
297                 Field('email', length=512, default='',
298                       label=self.messages.label_email,
299                       requires=is_unique_email),
300                 Field('username', length=128, default='',
301                       label=self.messages.label_username,
302                       requires=is_unique_username),
303                 Field(passfield, 'password', length=512,
304                       readable=False, label=self.messages.label_password,
305                       requires=[is_crypted]),
306                 Field('registration_key', length=512,
307                       writable=False, readable=False, default='',
308                       label=self.messages.label_registration_key),
309                 Field('reset_password_key', length=512,
310                       writable=False, readable=False, default='',
311                       label=self.messages.label_reset_password_key),
312                 Field('registration_id', length=512,
313                       writable=False, readable=False, default='',
314                       label=self.messages.label_registration_id),
315                 *extra_fields,
316                 **dict(
317                     migrate=self._get_migrate(settings.table_user_name,
318                                               migrate),
319                     fake_migrate=fake_migrate,
320                     format='%(username)s'))
```

Maps Python objects into database objects

```
185             while True:
186                 ordered = set(item for item, dep in nested_dict.items() if not dep)
187                 if not ordered:
188                     break
189                 rtn.append(ordered)
190                 nested_dict = dict(
191                     (item, (dep - ordered)) for item, dep in nested_dict.items()
192                     if item not in ordered
193                 )
194             assert not nested_dict, "A cyclic dependency exists amongst %r" % nested_dict
195             db.commit()
196             return rtn
197         except:
198             db.rollback()
199             return None
```

Target



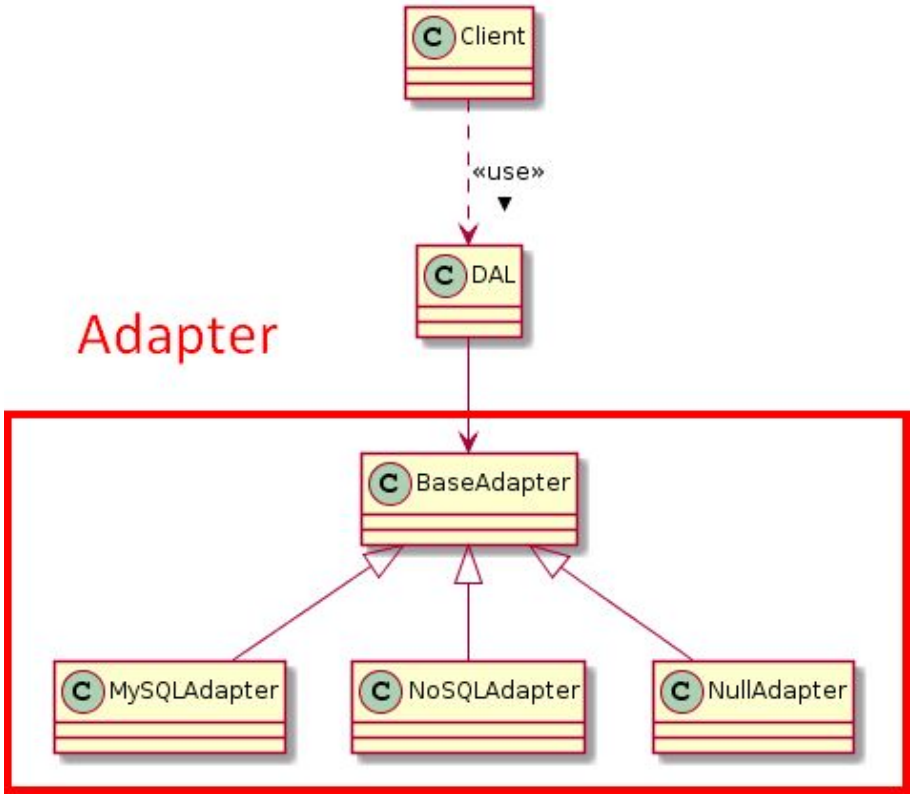

```
chris@chris:~$ python3
Python 3.4.3 (default, Nov 12 2018, 22:25:49)
[GCC 4.8.4] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import pydal
>>> from pydal import DAL
>>> from pydal import Field
>>> db = DAL('sqlite://storage.db', pool_size=6)
>>> db.define_table('person', Field('name'), format='%(name)s')
<Table person (id, name)>
>>> db.person.insert(name="Alex")
1
>>> db.commit()
>>> db.rollback()
>>>
```

Initialization

```
class DAL(with_metaclass(MetaDAL, Serializable, BasicStorage)):
```

```
def __init__(self, uri='sqlite://dummy.db',
             pool_size=0, folder=None,
             db_codec='UTF-8', check_reserved=None,
             migrate=True, fake_migrate=False,
             migrate_enabled=True, fake_migrate_all=False,
             decode_credentials=False, driver_args=None,
             adapter_args=None, attempts=5, auto_import=False,
             bigint_id=False, debug=False, lazy_tables=False,
             db_uid=None, do_connect=True,
             after_connection=None, tables=None, ignore_field_case=True,
             entity_quoting=True, table_hash=None):
```

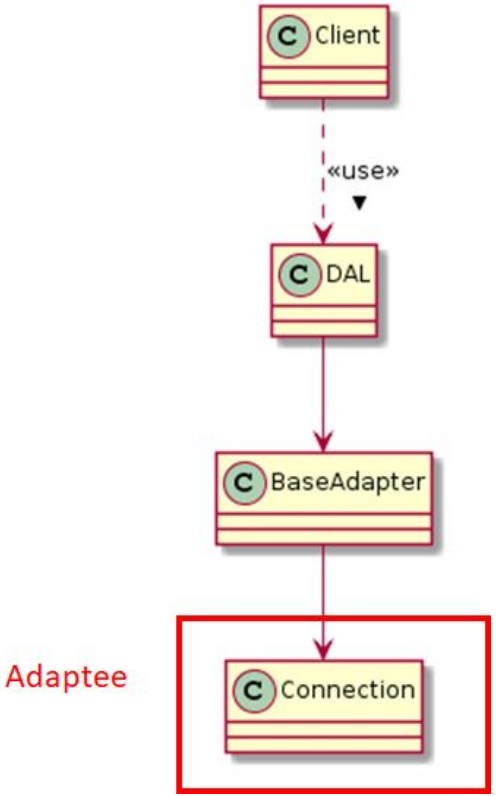
Adapter




```
kwargs = dict(db=self,
              uri=uri,
              pool_size=pool_size,
              folder=folder,
              db_codec=db_codec,
              credential_decoder=credential_decoder,
              driver_args=driver_args or {},
              adapter_args=adapter_args or {},
              do_connect=do_connect,
              after_connection=after_connection,
              entity_quoting=entity_quoting)
adapter = adapters.get_for(self._dbname)
self._adapter = adapter(**kwargs)
```

```
def commit(self):
    self._adapter.commit()

def rollback(self):
    self._adapter.rollback()

def close(self):
    self._adapter.close()
    if self._db_uid in THREAD_LOCAL._pydal_db_instances_:
        db_group = THREAD_LOCAL._pydal_db_instances_[self._db_uid]
        db_group.remove(self)
        if not db_group:
            del THREAD_LOCAL._pydal_db_instances_[self._db_uid]
    self._adapter._clean_tlocals()
```

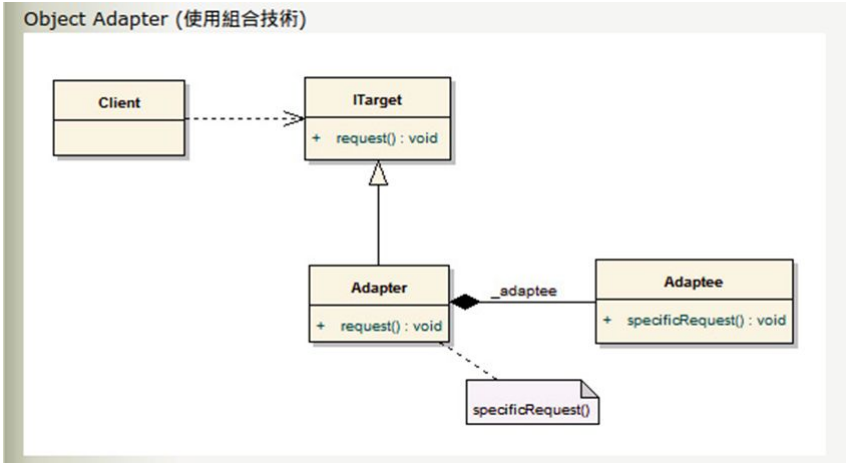
Adaptee

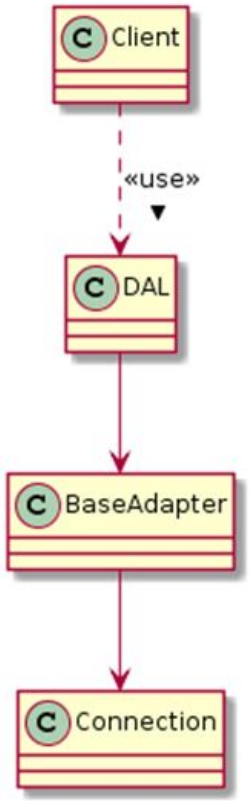



```python
@with_connection
def commit(self):
    return self.connection.commit()

@with_connection
def rollback(self):
    return self.connection.rollback()

@with_connection
def prepare(self, key):
    self.connection.prepare()

@with_connection
def commit_prepared(self, key):
    self.connection.commit()

@with_connection
def rollback_prepared(self, key):
    self.connection.rollback()
```

Adapter Pattern

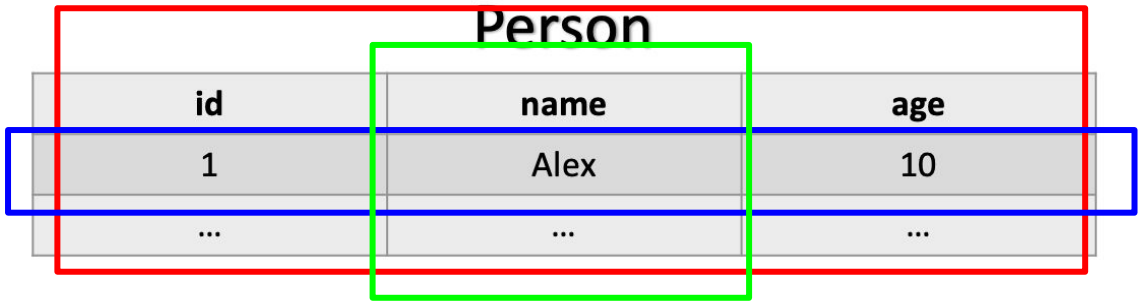
Object Adapter





Table, Row, Field

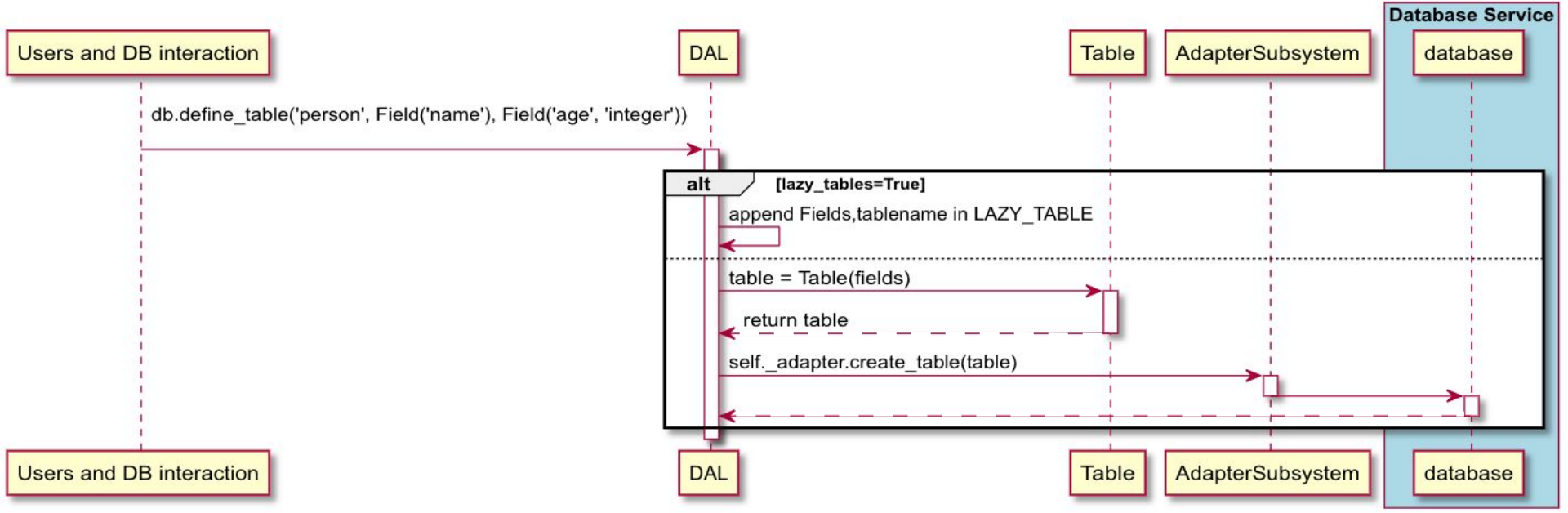
- PyDAL has classes like
  - Table
  - Row
  - Field

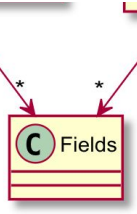



```
from pydal import DAL, Field
db = DAL('sqlite://storage.sqlite', pool_size=10)
db.define_table('person', Field('name'), Field('age', 'integer'))
db.person.insert(name="Alex", age="19")
query = db.person.name.startswith('A')
rows = db(query).select()
print(rows[0].age) # >>> 19
db.commit()
```

Define Table

```
class DAL(with_metaclass(MetaDAL, Serializable, BasicStorage)):
    def define_table(self, tablename, *fields, **kwargs):
        if self._lazy_tables:
            if tablename not in self._LAZY_TABLES or redefine:
                self._LAZY_TABLES[tablename] = (tablename, fields, kwargs)
```






```
tr__(self, key):
ct.__getattribute__(self, '_lazy_tables') and \
 key in object.__getattribute__(self, '_LAZY_TABLES'):
lename, fields, kwargs = self._LAZY_TABLES.pop(key)
urn self.lazy_define_table(tablename, *fields, **kwargs)
BasicStorage.__getattribute__(self, key)
```

Get records

- Parser returns

  includes lots of

```
def parse(self, rows, fields, colnames, blob_decode=True, cacheable=False):
    (fields_virtual, fields_lazy, tmps) = \
        self._parse_expand_colnames(fields)
    new_rows = [
        self._parse(
            row, tmps, fields, colnames, blob_decode, cacheable,
            fields_virtual, fields_lazy)
        for row in rows
    ]
    rowsobj = self.db.Rows(self.db, new_rows, colnames, rawrows=rows,
            fields=fields)
    print(rowsobj, 'here')
```

```
from pydal import DAL, Field
db = DAL('sqlite://storage.sqlite', pool_size=10)
db.define_table('person', Field('name'), Field('age', 'integer'))
db.person.insert(name="Alex", age="19")
query = db.person.name.startswith('A')
rows = db(query).select()
print(rows[0].age) # >>> 19
db.commit()
```

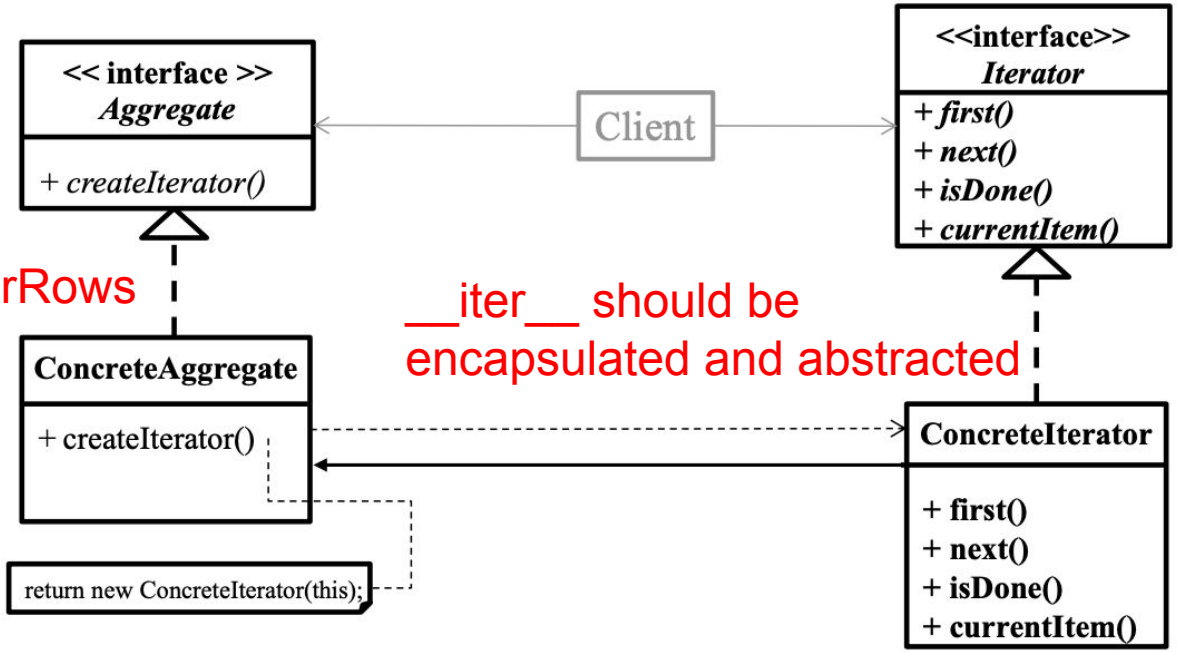
Iterate records

```
class Rows(BasicRows):
    def __init__(self, db=None, records=[],
                 rawrows=None, fields=[]):
        self.db = db
        self.records = records
        self.fields = fields
        self.colnames = colnames
        self.compact = compact
        self.response = rawrows

    def __iter__(self):
        """
        Iterator over records
        """
        for i in xrange(len(self)):
            yield self[i]
```

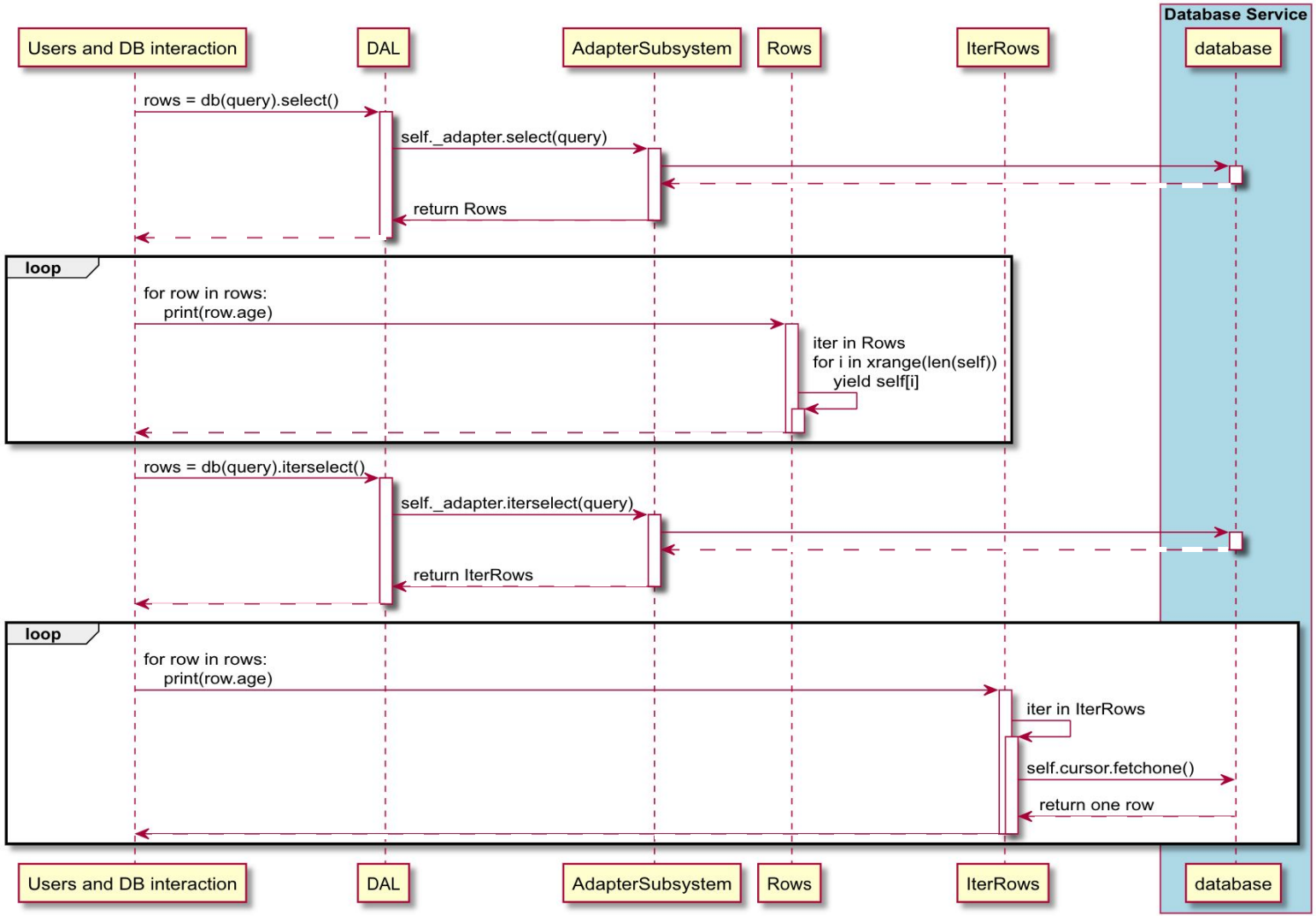
```
class IterRows(BasicRows):
    def __iter__(self):
        if self._head:
            yield self._head
        try:
            row = next(self)
            while row is not None:
                yield row
                row = next(self)
        except StopIteration:
            # Iterator is over, adjust the cursor logic
            self.db._adapter.close_cursor(self.cursor)
            return
        return

    def next(self):
        db_row = self.cursor.fetchone()
        print(db_row)
        if db_row is None:
            raise StopIteration
        row = self.db._adapter._parse(db_row, self.tmps, self.fields,
                                      self.colnames, self.blob_decode,
                                      self.cacheable, self.fields_virtual,
                                      self.fields_lazy)
        if self.compact:
            # The following is to translate
            # <Row {'t0': {'id': 1L, 'name': 'web2py'}}>
            # in
            # <Row {'id': 1L, 'name': 'web2py'}>
            # normally accomplished by Rows.__get_item__
            keys = list(row.keys())
            if len(keys) == 1 and keys[0] != '_extra':
                row = row[keys[0]]
        return row
```

Iterator Pattern Structure$_1$

BasicRows



```
from

db =
db.d
db.p
db.p
db.p
quer

# ha
rows
# ho
rows

for

for
```



PyDAL vs ORM

Person

id	name	age
1	Alex	10
...	...	...

```
class Person {
    id,
    name,
    age
}
```

Parse return string to **Row**
Aggregate all rows to **Rows**

PyDAL conclusion

- Use adapter to connect DAL with database
- Use dependency injection to inject different adapters
- Has connection pool to hold intialized connections
- Lazy table mechanism
- Different iteration implementation
- Not ORM

Conclusion (web2py)

- Model 2 architecture
- Most of design are **initial design**, web2py is hard to maintain. Breaking down the system into definable elements is difficult because it is not loosely coupled
- Provides some interesting mechanisms with Python
  e.g. dynamically typed, function decorators, Storage

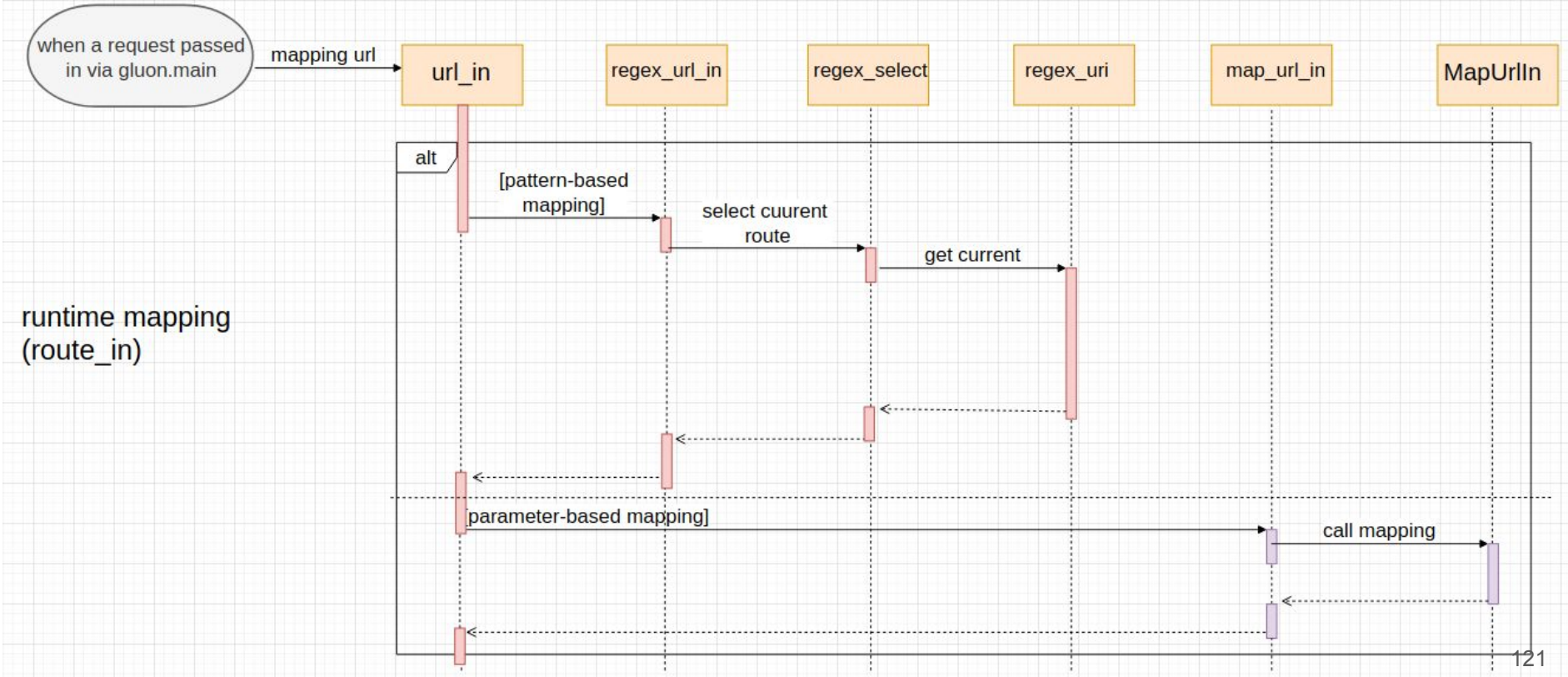
Conclusion (SED)

- Differences between Python and Java make design patterns not completely the same
- The importance of code design. It enables better maintainability for applications
- Cooperation among team members - implementing codes together
- Better understanding of processes and designs of web frameworks
- The concept of design process for changes can be applied to various scenarios
- A life-changing experience

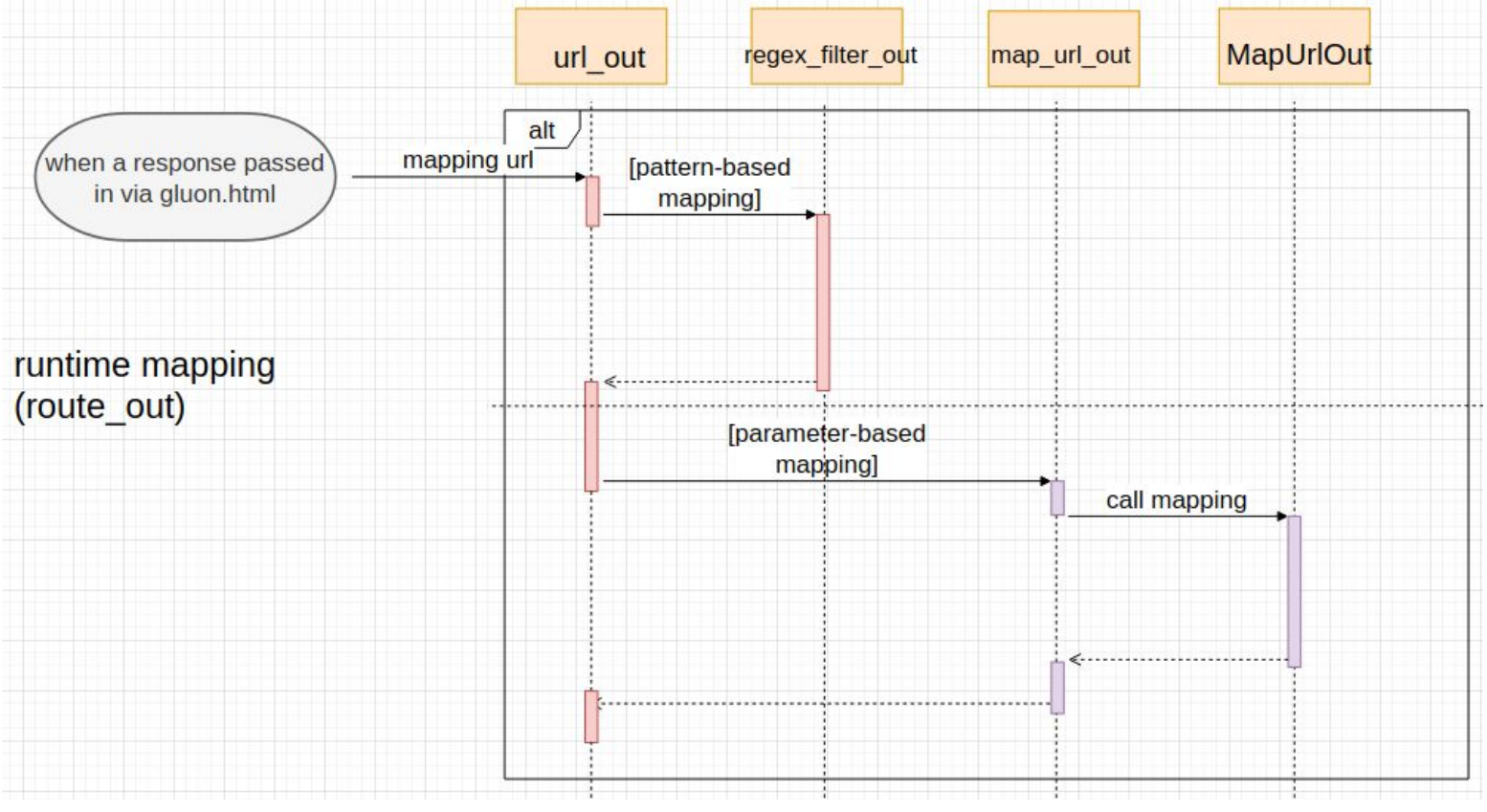
Merry Christmas !!!

Thank you

Appendix


when a request passed in via gluon.main
mapping url
url_in
regex_url_in
regex_select
regex_uri
map_url_in
MapUrlIn
alt
[pattern-based mapping]
select cuurent route
get current
[parameter-based mapping]
call mapping
runtime mapping (route_in)

Appendix


url_out
regex_filter_out
map_url_out
MapUrlOut
when a response passed in via gluon.html
alt
mapping url
[pattern-based mapping]
runtime mapping (route_out)
[parameter-based mapping]
call mapping