



INTRODUCTION TO RELATIONAL DATABASES IN SQL

Better data quality with constraints

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Integrity constraints

1. **Attribute constraints**, e.g. data types on columns (Chapter 2)
2. **Key constraints**, e.g. primary keys (Chapter 3)
3. **Referential integrity constraints**, enforced through foreign keys (Chapter 4)



Why constraints?

- Constraints give the data structure
- Constraints help with consistency, and thus data quality
- Data quality is a business advantage / data science prerequisite
- Enforcing is difficult, but PostgreSQL helps



Data types as attribute constraints

Name	Aliases	Description
<code>bigint</code>	<code>int8</code>	signed eight-byte integer
<code>bigserial</code>	<code>serial8</code>	autoincrementing eight-byte integer
<code>bit [(n)]</code>		fixed-length bit string
<code>bit varying [(n)]</code>	<code>varbit [(n)]</code>	variable-length bit string
<code>boolean</code>	<code>bool</code>	logical Boolean (true/false)
<code>box</code>		rectangular box on a plane
<code>bytea</code>		binary data ("byte array")
<code>character [(n)]</code>	<code>char [(n)]</code>	fixed-length character string
<code>character varying [(n)]</code>	<code>varchar [(n)]</code>	variable-length character string
<code>cidr</code>		IPv4 or IPv6 network address

From the [PostgreSQL documentation](#).

Dealing with data types (casting)

```
CREATE TABLE weather (  
  temperature integer,  
  wind_speed text);
```

```
SELECT temperature * wind_speed AS wind_chill  
FROM weather;
```

operator does not exist: integer * text
HINT: No operator matches the given name and argument type(s).
You might need to add explicit type casts.

```
SELECT temperature * CAST(wind_speed AS integer) AS wind_chill  
FROM weather;
```



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Let's practice!



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Working with data types

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Working with data types

- Enforced on columns (i.e. attributes)
- Define the so-called "domain" of a column
- Define what operations are possible
- Enforce consistent storage of values



The most common types

- text: character strings of any length
- varchar [(x)]: a maximum of n characters
- char [(x)]: a fixed-length string of n characters
- boolean: can only take three states, e.g. TRUE, FALSE and NULL (unknown)

From the [PostgreSQL documentation](#).



The most common types (cont'd.)

- `date`, `time` and `timestamp`: various formats for date and time calculations
- `numeric`: arbitrary precision numbers, e.g. `3.1457`
- `integer`: whole numbers in the range of `-2147483648` and `+2147483647`

From the [PostgreSQL documentation](#).



Specifying types upon table creation

```
CREATE TABLE students (  
  ssn integer,  
  name varchar(64),  
  dob date,  
  average_grade numeric(3, 2), -- e.g. 5.54  
  tuition_paid boolean  
);
```



Alter types after table creation

```
ALTER TABLE students  
ALTER COLUMN name  
TYPE varchar(128);
```

```
ALTER TABLE students  
ALTER COLUMN average_grade  
TYPE integer  
-- Turns 5.54 into 6, not 5, before type conversion  
USING ROUND(average_grade);
```



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Let's apply this!



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The not-null and unique constraints

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The not-null constraint

- Disallow NULL values in a certain column
- Must hold true for the current state
- Must hold true for any future state



What does NULL mean?

- unknown
- does not exist
- does not apply
- ...



What does NULL mean? An example

```
CREATE TABLE students (  
  ssn integer not null,  
  lastname varchar(64) not null,  
  home_phone integer,  
  office_phone integer  
);
```

```
NULL != NULL
```



How to add or remove a not-null constraint

When creating a table...

```
CREATE TABLE students (  
  ssn integer not null,  
  lastname varchar(64) not null,  
  home_phone integer,  
  office_phone integer  
);
```

After the table has been created...

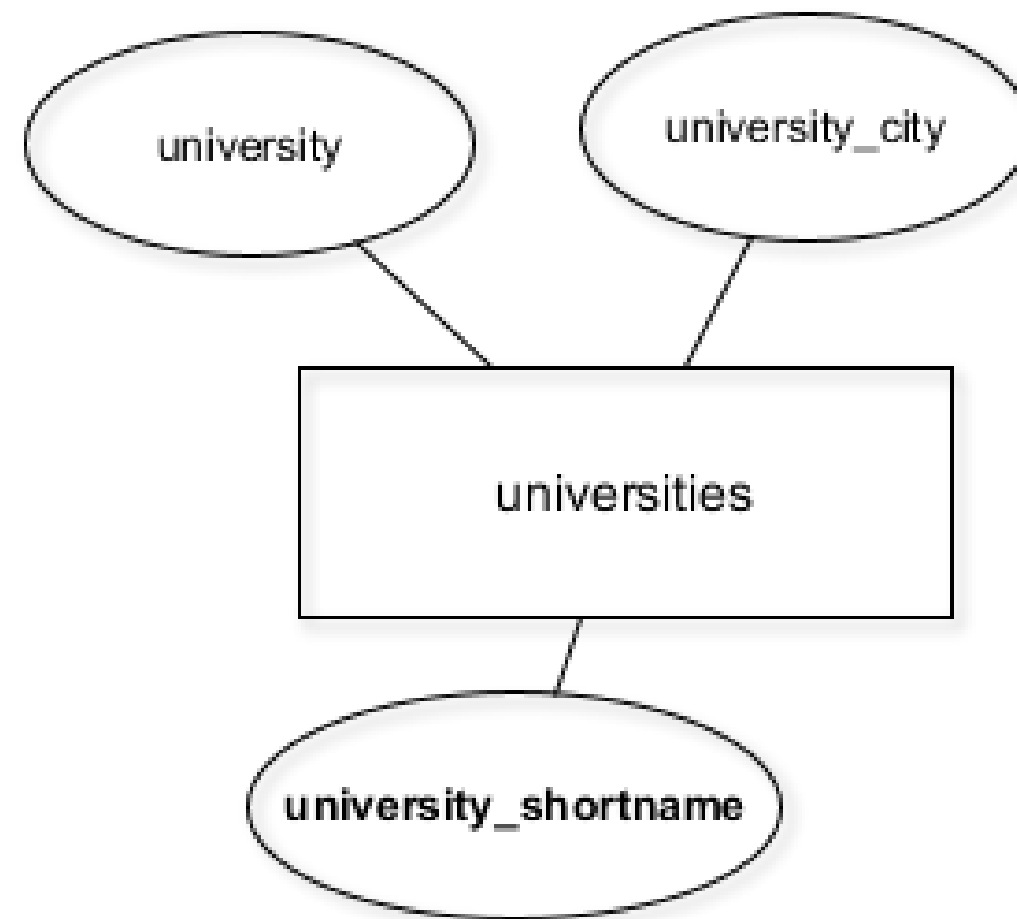
```
ALTER TABLE students  
ALTER COLUMN home_phone  
SET NOT NULL;
```

```
ALTER TABLE students  
ALTER COLUMN ssn  
DROP NOT NULL;
```



The unique constraint

- Disallow duplicate values in a column
- Must hold true for the current state
- Must hold true for any future state





Adding unique constraints

```
CREATE TABLE table_name (  
  column_name UNIQUE  
);
```

```
ALTER TABLE table_name  
ADD CONSTRAINT some_name UNIQUE(column_name);
```



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**Let's apply this to the
database!**