GENERAL ASSEMBLY

INTRO TO DATA SCIENCE

LECTURE 2: INTRO TO DATABASES

Paul Burkard

06/25/2015

LAST TIME:

I. WHAT IS DATA SCIENCE?

II. WHO USES IT?

III. DATA SCIENCE WORKFLOW

IV. WHAT IS MACHINE LEARNING?

V. MACHINE LEARNING PROBLEMS

DATA STORAGE:

I. INTRO TO DATABASES

II. RELATIONAL DATABASES

HANDS-ON: FUN WITH SQL

III. NOSQL DATABASES

PYTHON:

IV: INTRO TO PYTHON

HANDS-ON: PYTHON EXERCISES

I. INTRO TO DATABASES

What is ETL?

- **E**xtract data
- **T**ransform data
- **L**oad data

What are Databases?

Databases are a **structured** data source optimized for efficient **retrieval and storage**

Databases are a **structured** data source optimized for efficient **retrieval and storage**

structured : we will have to define some pre-defined organization strategy

retrieval : the ability to read data out

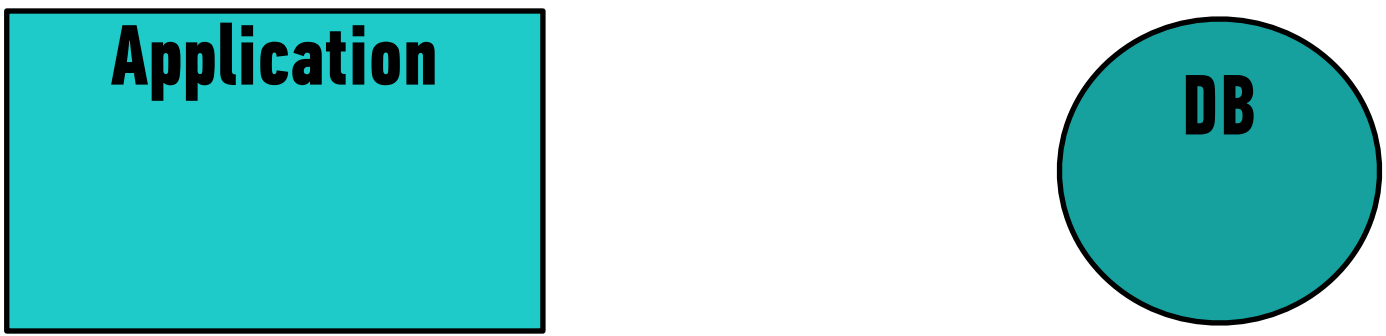
storage: the ability to write data and save it

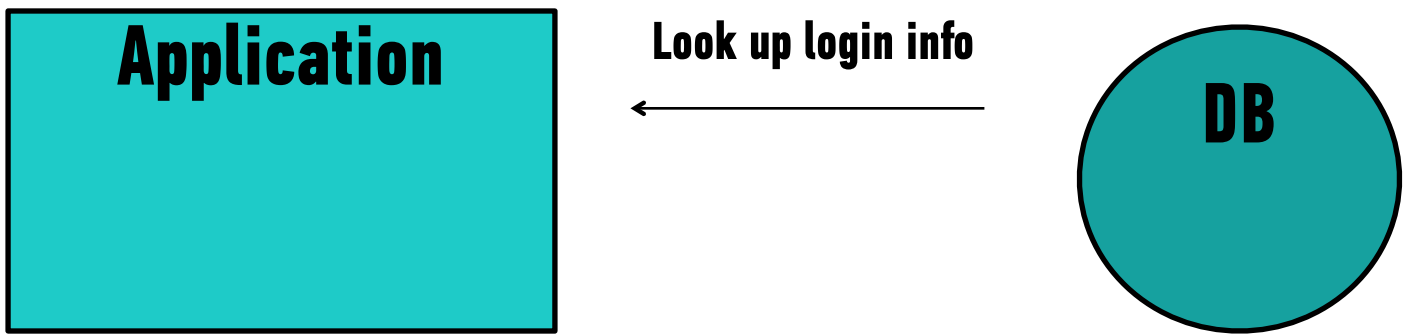
Databases are a **structured** data source optimized for efficient **retrieval and persistent storage**

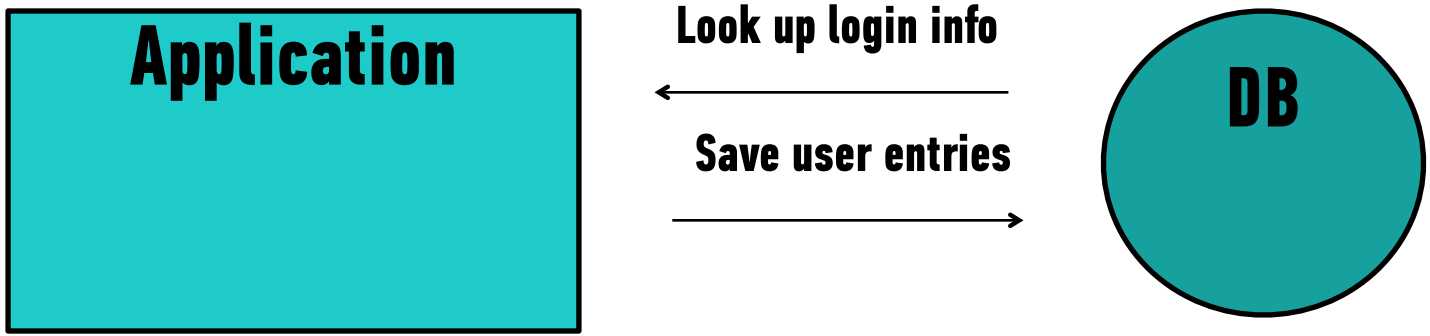
structured : we will have to define some pre-defined organization strategy

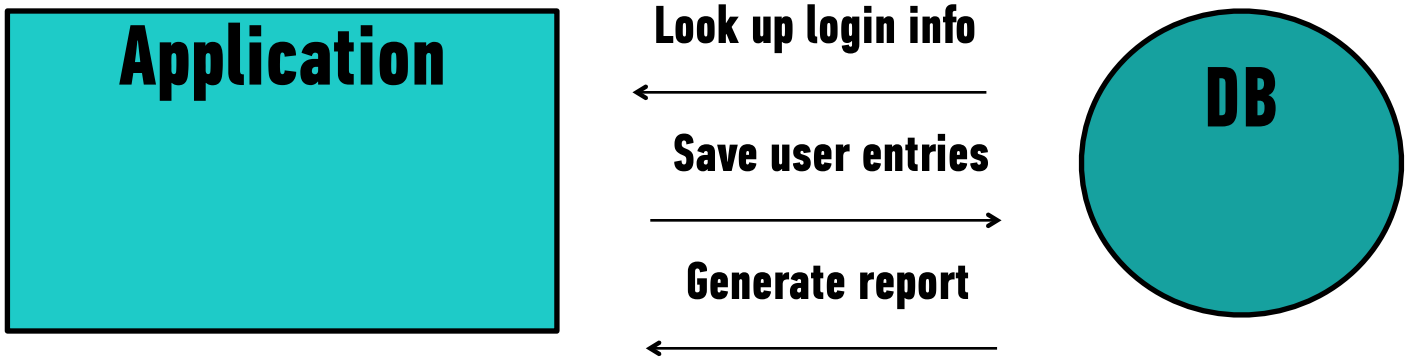
retrieval : the ability to read data our

storage: the ability to write data and save it


Application
DB


Application
Look up login info
DB


Application
Look up login info
Save user entries
DB

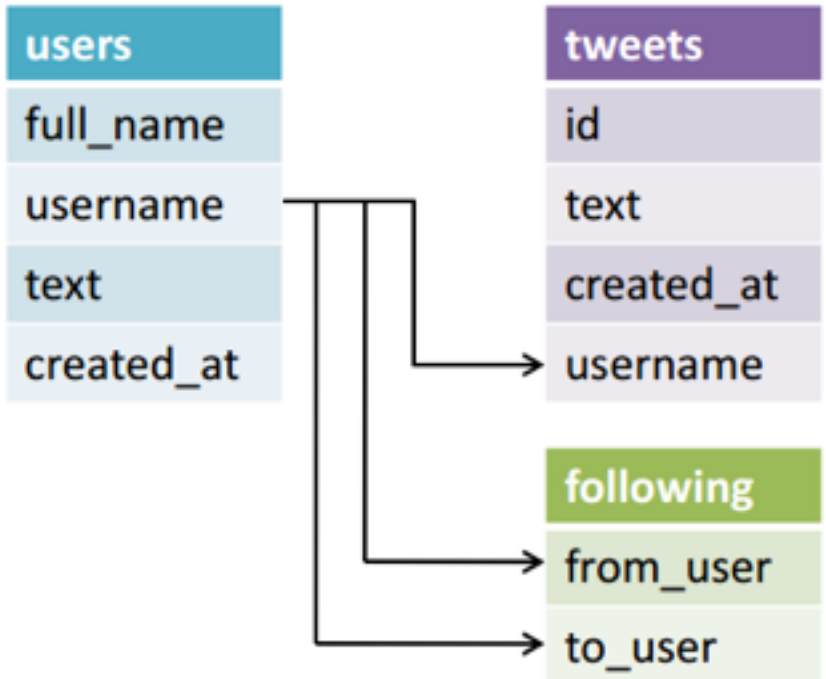

Application
Look up login info
Save user entries
Generate report
DB

II. RELATIONAL DATABASES

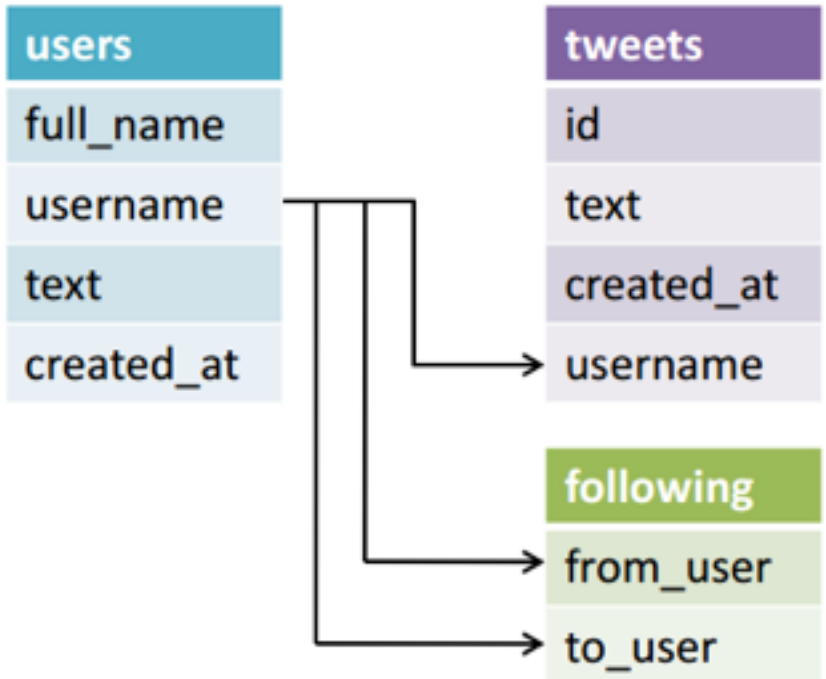
Relational databases are traditionally organized in the following manner:

*A database has **tables** which represent individual entities or objects — "**Relations**"*

*Tables have a predefined **schema** - rules that tell it what columns exist and what they look like*

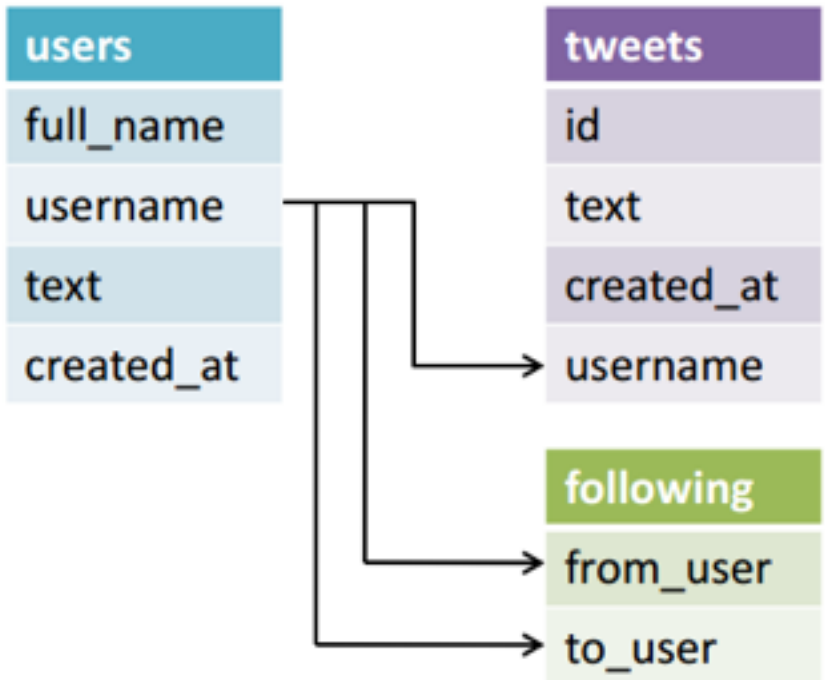

users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user

Each table should have a **primary key** column– a unique identifier for that row


users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user

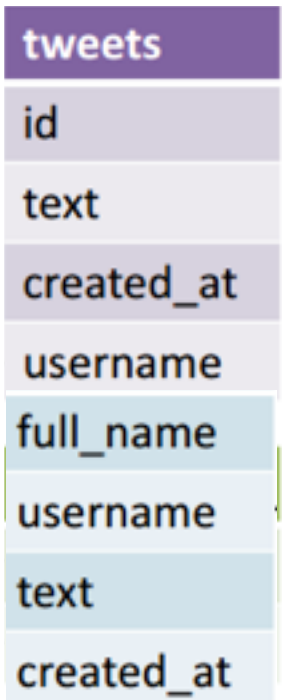
*Each table should have a **primary key** column- a unique identifier for that row*

*Additionally each table can have a **foreign key** column- an id that references a unique entry in another table*


users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user

We could have had a table structure as follows:

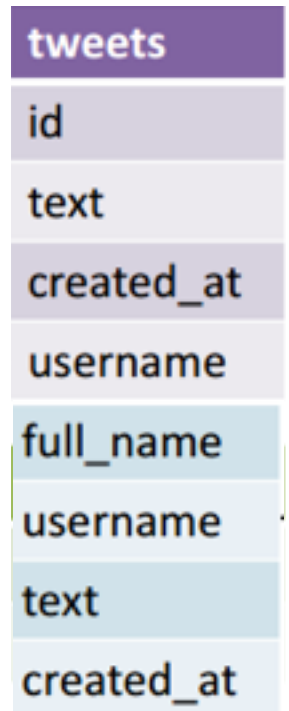
Why is this different?



We could have had a table structure as follow:
Why is this different?

We would repeat the user information on each row.

This is called
denormalization



Normalized Data: Many tables to reduce redundant or repeated data in a table

Denormalized Data:
Wide data, fields are often repeated but removes the need to join together multiple tables

Trade off of speed vs. storage

Q: How do we commonly evaluate databases?

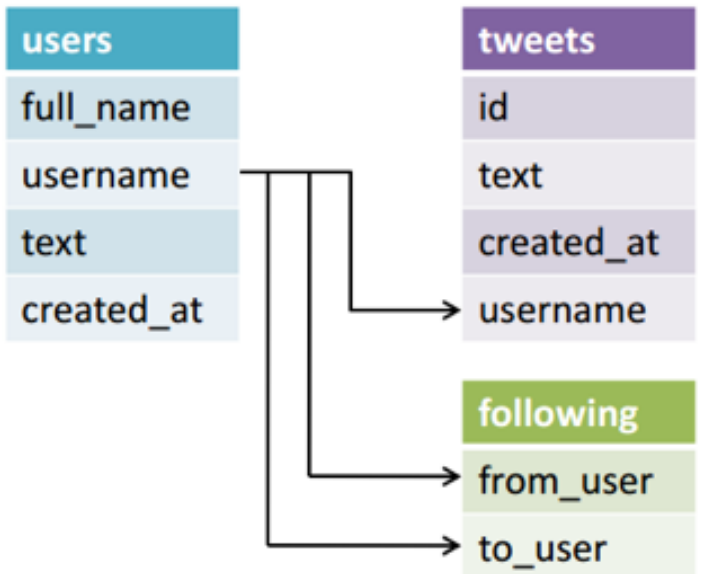
Q: How do we commonly evaluate databases?

read-speed vs. write speed

Q: How do we commonly evaluate databases?

read speed vs. write speed
space considerations
(...and many other criteria)

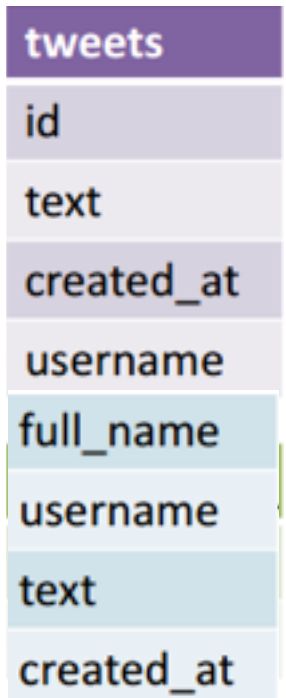
Q: Why are normalized tables (possibly) slower to read?



Q: Why are normalized tables (possibly) slower to read?

A: We'll have to get data from multiple tables to answer some questions.

Q: Why are denormalized tables (possibly) slower to write?



Q: Why are denormalized tables (possibly) slower to write?

A: We'll have to write more information on each write

SQL is a query language to load, retrieve and update data in relational databases

SELECT: *Allows you to* ***retrieve*** *information from a table*

Syntax:

SELECT col1, col2 FROM table WHERE <some condition>

Example:
SELECT poll_title, poll_date FROM polls WHERE romney_pct > obama_pct

GROUP BY: *Allows you to* ***aggregate*** *information from a table*

Syntax:

```
SELECT col1, AVG(col2) FROM table GROUP BY col1
```

Example:

```
SELECT poll_date, AVG(obama_pct) FROM polls GROUP BY poll_date
```

GROUP BY: *Allows you to* ***aggregate*** *information from a table*

Syntax:

SELECT col1, AVG(col2) FROM table GROUP BY col1

There are usually a few common built-in operations:
SUM, AVG, MIN, MAX, COUNT

JOIN: *Allows you to* ***combine*** *multiple tables*

Syntax:

```
SELECT table1.col1, table1.col2, table2.col2
FROM  table1 JOIN table2 ON table1.col1 = table2.col2
```

JOIN: *Allows you to* ***combine*** *multiple tables*

Syntax:

```
SELECT table1.col1, table1.col2, table2.col2
FROM  (JOIN table1, table2 ON table1.col1 = table2.col2)
```

INSERT: *Allows you to* ***add*** *data to tables*

Syntax and Example:

INSERT INTO <table> (col1, col2)
VALUES(...)

INSERT INTO classroom (first_name, last_name)
VALUES('John', 'Doe');

Tutorial: http://www.w3schools.com/sql/default.asp

Other Commands: DISTINCT, ORDER BY, AND/OR, UPDATE, DELETE, LIKE, IN, HAVING, CREATE, DROP, ALTER…

HANDS-ON: FUN WITH SQL

III. NO-SQL DATABASES

NO-SQL databases are a new old trend in databases

NO-SQL databases are a new old trend in databases

*The title **NOSQL** refers to the lack of a relational structure between stored objects*

NO-SQL databases are a new old trend in databases

*The title **NOSQL** refers to the lack of a relational structure between stored objects*

*Most importantly, they often attempt to minimize the need for **JOIN** operations*

Memcached

Apache HBase

Cassandra

MongoDB

Memcached	::	*LiveJournal*
Apache HBase	::	*Google BigTable*
Cassandra	::	*Amazon Dynamo*
MongoDB		

Memcached was:

- developed by LiveJournal

- distributed key-value store (HashMap or Python Dict)

- Support two operations:

get** and **set

Memcached was:

- developed by LiveJournal

- distributed key-value store (HashMap or Python Dict)

*- Support two **very fast** operations:*

get** and **set

Cassandra was

- *developed by Facebook*
- *Messages application and Inbox Search*
- *Key-Value **(-ish)***
  - *supports query by key or value range*
- *Very fast writing speeds*
- *Useful for record keeping, logging*

Modeled after Google's BigTable

*Scalable **Key-Value** Store*

*Built into most **Hadoop** distributions*

***Column-based** for quick Range scans*

*Very fast **point retrieval/update***

Example Use Case: User Profiles

Other examples?

Key Takeaways:

- *Each Database has it's strengths*
- *Choose the right one for **your use case***

DISCUSSION – DATABASES

IV. INTRO TO PYTHON

Q: What is Python?

Q: What is Python?

A: An open source, high-level, dynamic scripting language.

Q: What is Python?

A: An open source, high-level, dynamic scripting language.

open source*: free! (both binaries and source files)*

Q: What is Python?

A: An open source, high-level, dynamic scripting language.

open source*: free! (both binaries and source files)*

high-level*: interpreted (not compiled)*

Q: What is Python?

A: An open source, high-level, dynamic scripting language.

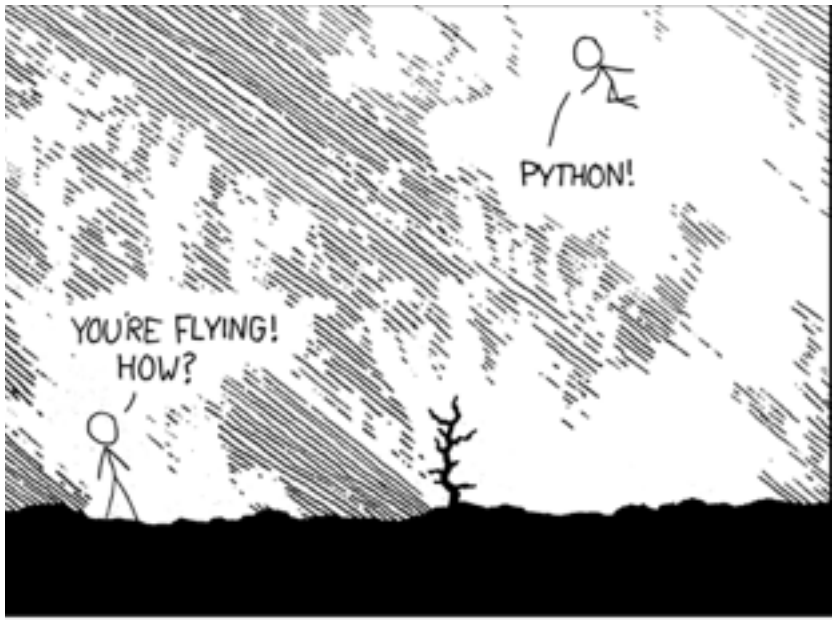
open source*: free! (both binaries and source files)*
high-level*: interpreted (not compiled)*
dynamic*: things that would typically happen at compile time happen at runtime instead (eg, dynamic typing)*

- Created by Guido van Rossum in 1991
- Benevolent Dictator for Life

- Created by Guido van Rossum in 1991
- Benevolent Dictator for Life

- Currently on version 3 ...
  - but most still use 2.7+

WHY PYTHON?


PYTHON!
YOU'RE FLYING!
HOW?


I LEARNED IT LAST NIGHT! EVERYTHING IS SO SIMPLE!
HELLO WORLD IS JUST print "Hello, world!"
I DUNNO... DYNAMIC TYPING? WHITESPACE?
COME JOIN US! PROGRAMMING IS FUN AGAIN! IT'S A WHOLE NEW WORLD UP HERE!
BUT HOW ARE YOU FLYING?
I JUST TYPED import antigravity
THAT'S IT?
... I ALSO SAMPLED EVERYTHING IN THE MEDICINE CABINET FOR COMPARISON.
BUT I THINK THIS IS THE PYTHON.

WHAT ARE THE ADVANTAGES TO PYTHON?

- Batteries Included: Large collection of built in libraries
- Multi-paradigm: many different programming methodologies apply
- Simple and clean syntax

WHAT ARE THE ADVANTAGES TO PYTHON?

- Batteries Included: Large collection of built in libraries
- Multi-paradigm: many different programming methodologies apply
- Simple and clean syntax - *but we have to pay attention to whitespace*

WHAT ARE THE ADVANTAGES TO PYTHON?

- BATTERIES INCLUDED

- Lots of tools built-in to the standard library

- Easy to install new package: pip, easy_install
  - Try
    - > *pip install oauth*
    - > *pip install django*

WHAT ARE THE ADVANTAGES TO PYTHON?

- MULTI-PARADIGM

- Scripting language
- Functional programming
- Object oriented programming

WHAT ARE THE ADVANTAGES TO PYTHON?

- CLEAN SYNTAX

- Java
  - public static void main(String [ ] args)

```
{
    System.out.println(“Hello world”);
}
```

WHAT ARE THE ADVANTAGES TO PYTHON?

- CLEAN SYNTAX

- Python:
  - print “Hello World”

WHAT SETS PYTHON APART?

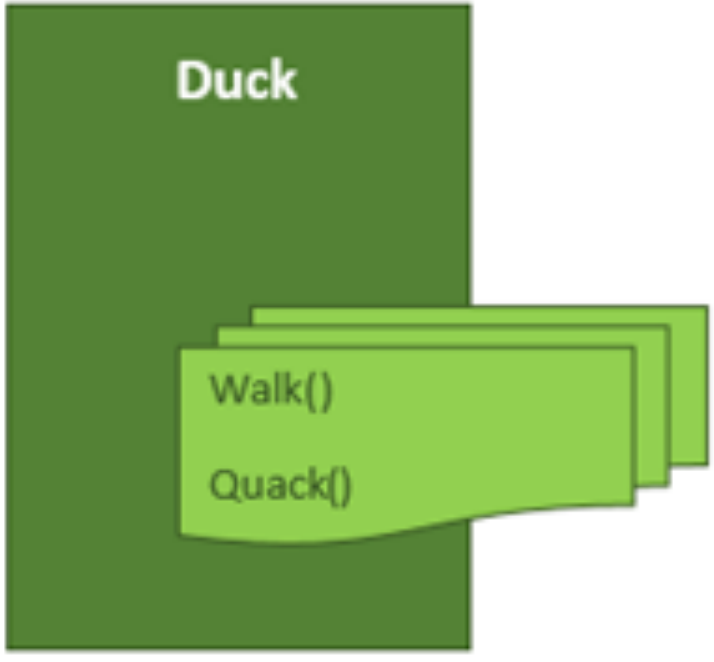
- Type system:
  - Dynamic typing!

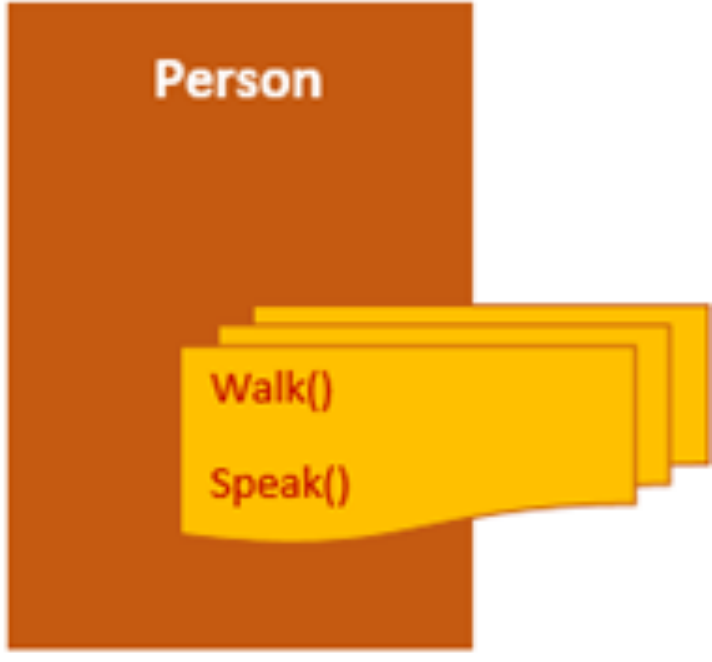
WHAT IS TYPING?

- Need to tell the program WHAT something is:
  - C, Java: double pi = 3.14...
- Can lead to hard to read to code
- But also means safer code

WHAT IS TYPING?

WHAT IS TYPING?





WHAT SETS PYTHON APART?

- Type system:
  - Dynamic typing!

```
>>> x = 1
>>> x
1
>>> x = 'horseshoe'
>>> x
'horseshoe'
>>> _
```

WHAT SETS PYTHON APART?

- Type system:

  Dynamic typing!

- Interpreted language
  - No compilation

PYTHON SYNTAX

SETTING UP VARIABLES

- Python shell is just a complex calculator:
  - 10 * 15
  - x = 5
  - x #prints 5
  - x^2 #prints 25

The most basic data structure is the **None** *type. This is the equivalent of NULL in other languages.*

There are four basic numeric types: **int, float, bool, complex, string**

```
>>> type(1)
<type 'int'>
>>> type(2.5)
<type 'float'>
>>> type(True)
<type 'bool'>
>>> type(2+3j)
<type 'complex'>
```

DATA TYPES

- Lists:

  l = [1, 2, 3]

  l = [‘happy’, ‘sad’, ‘indifferent’]

- Dictionaries (Maps):

  Key-Value datastructure

  d = { ‘first_name’ : ‘Paul’, ‘last_name’: ‘Burkard’}

IF/ELSE STATEMENTS

- If/Else statements allow us to take different paths through depending on some condition:
- x = 5
- if x > 4:
  - print “This number was less than 4”

LOOPING

- Looping allows us to pass through some set of values and perform an operation on each

- l = [“happy”, “sad”, “don’t care”]
- for x in l:
  - print x
  - if x == ‘happy’:

FUNCTIONS

- Functions allow us to save some piece of functionality to reuse later

- def func(x):
  - if x > 4:
    - print “This number is less than 4

    - >> func(6)

Our final example of a data type is the Python **file object**. *This represents an open connection to a file (eg) on your laptop.*

```
>>> with open('output_file.txt', 'w') as f:
...   f.write(my_output)
```

These are particularly easy to use in Python, especially using the with statement context manager, which automatically closes the file handle when it goes out of scope.

Python allows you to define custom **functions** *as you would expect:*

```
>>> def x_minus_3(x):
...     return x - 3
...
>>> x_minus_3(12)
9
```

Functions can optionally return a value with a **return statement** *(as this example does).*

Functions can take a number of **arguments** *as inputs, and these arguments can be specified in two ways:*

As **positional arguments***:*

```
>>> def f(x, y):
...     return x - y
...
>>> f(4,2)
2
>>> f(2,4)
-2
```

Functions can take a number of **arguments** *as inputs, and these arguments can be specified in two ways:*

Or as **keyword arguments***:*

```
>>> def g(arg1=x, arg2=y):
...   return arg1 / float(arg2)
...
>>> g(arg1=10, arg2=5)
2.0
>>> g(arg2=100, arg1=10)
0.1
```

Python supports **classes** *with member attributes and functions:*

```
>>> class Circle():
...   def __init__(self, r=1):
...     self.radius = r
...   def area(self):
...     return 3.14 * self.radius * self.radius
...
>>> c = Circle(4)
>>> c.radius
4
>>> c.area
<bound method Circle.area of <__main__.Circle instance at 0x1060778c0>>
>>> c.area()
50.24
>>> 3.14 * 4 * 4
50.24
```