# CS134:
# Python Types and Expressions

# Announcements & Logistics

- **HW 1** due today at 11 pm (Google form)
- **Lab 1** today/tomorrow on Zoom, due Wed/Thur at 10pm
  - Mon/Tue1:10 pm: Rohit/Jeannie & Steve
  - Mon/Tue 2:35 pm: Steve
  - Goal: Setup computers, gain experience with the workflow and tools
  - Start with some short and sweet Python programs
- **Office hours and TA hours start today**
  - Check calendar on webpage for hours
- **Questions??**

# Last Time

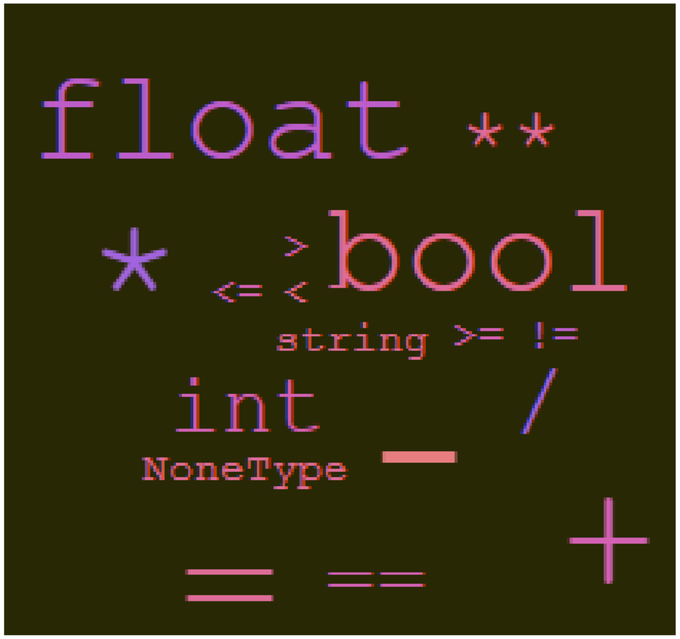
- Discussed course logistics
- Important take-aways:
    - **Setup** your personal machine soon (setup guides on course webpage)
        - If you get stuck, we'll help you in lab!
    - **Review** syllabus and check out course webpage

# Today's Plan

- Discuss **data types** and **variables** in Python
  - `int, float, boolean, string`
- Learn about basic **operators**
  - arithmetic, assignment
- Experiment with built-in Python **functions** and expressions
  - `int(), input(), print()`
- Investigate different ways to run and interact with Python

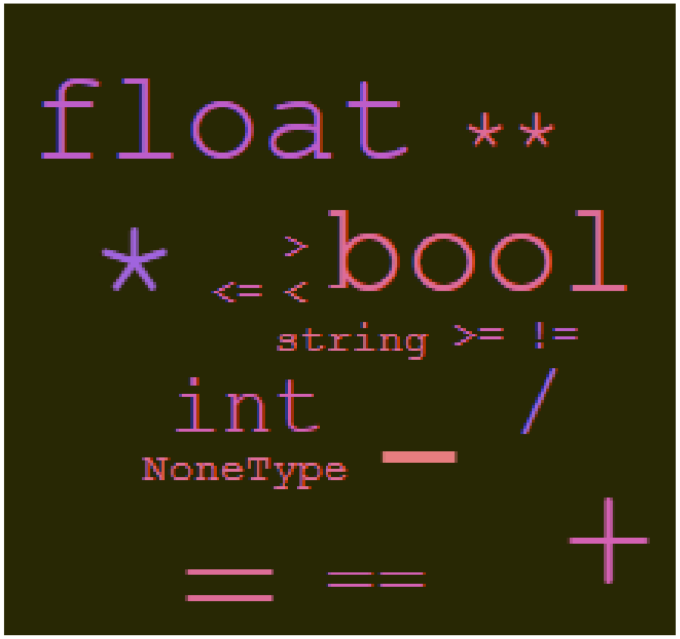
# Aspects of Languages

- **Primitive constructs**
  - English:
    - words, punctuation
  - Programming languages:
    - numbers, strings, simple operators



# Aspects of Languages

- **Syntax**
  - English:
    - "boy dog cat" (incorrect), "boy hugs cat" (correct)
    - "Let's eat grandma!" (probably incorrect), "Let's eat, grandma!" (correct)
  - Programming language:
    - "hi"5 (incorrect), 4*5 (correct)



# Aspects of Languages

- **Semantics** is the meaning associated with a syntactically correct string of symbols
  - **English:**
    - Can have many meanings (ambiguous), e.g.
    - “Flying planes can be dangerous”
    - Other examples?
  - **Programming languages:**
    - Must be *un*ambiguous
    - Can only have one meaning
    - Actual behavior is not always the intended behavior!

# Python3

- Programming language used in this course
- Great introductory language
    - Better human readability and user friendly syntax
- For this class, we need `Python 3.9.1` or above
- Checking version of Python on machine
    - (Mac,  Linux, or Windows Subsystem for Linux)
    - Type `python3 ––version` in Terminal (Ubuntu Shell)
- **Preinstalled on all lab machines**
- Installing Python3 on your machine:  see setup guide on webpage

# Python Primitive Types

- Every **value** has a data **type**. For example:
    - 10 is an integer (type: **int**)
    - 3.145 is a decimal number (type: **float**)
    - 'Williams' or "Williams" is a sequence of characters (type: **string**)
    - 0 (False) and 1 (True) (type: **boolean or bool**)
        - Represent answers to decision questions (yes/no)
    - "Empty" value (type: **None**)
- We will revisit booleans and None types soon!

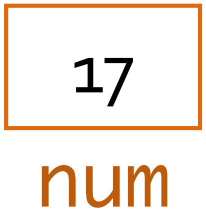
Knowing the **type** of a **value** allows us to choose the right ***operator*** for expressions.

# Python Operators

- **Arithmetic operators:**
  - **+** (addition), **-** (subtraction), ***** (multiplication)
  - **/** (floating point division, returns a value with a decimal point)
  - **//** (integer division, returns an integer)
  - **%** (modulo, or remainder)
  - ****** (power, or exponent)
- (We will try these out with examples later and see how they behave)
- **Assignment operator:**
  - **=** ("is assigned", not "equals")
  - Not to be confused with mathematical equality, which is written as == in programming languages
  - = is used to "assign" values to **variables**

# Variables and Assignments

- A **variable** names a value that we want to use later in a program
  - If we define **`num = 17`** then the value **`17`** essentially gets stored in a box in memory with the label **`num`**
  - We are **assigning** **`num`** (a variable) the value **`17`**



17

num

- Once defined, we can reuse variable names again, and later assignments can change the value in a variable box
  - **`num = num - 5`**
  - What is stored in **`num`** after this evaluates?

**Math vs Programming.** An assignment: expression on the right evaluated first and the value is stored in the variable name on the left

# Variables and Assignments

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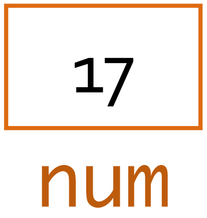
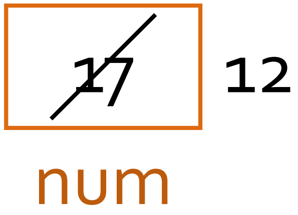


17

num

- Once defined, we can reuse variable names again, and later assignments can change the value in a variable box
  - `num = num - 5`
  - What is stored in `num` after this evaluates?
  - var = <expression> (result of expression gets stored in the variable box var)



~~17~~ 12

num

- **Question**. Why would we want to name values or expressions?

# Abstracting Expressions

- Why give names to data values or the results of expressions?
    - To reuse names instead of values
    - Easier to change code later
- For example:

```
pi = 3.1415926  # useful to name
radius = 2.2
area = pi * (radius**2)
# suppose now we want to change radius
radius = 2.2 + 1
area = pi * (radius**2) # new area
```

# An Aside:  Python Interfaces

- Now we know a little bit about
  - Python primitive data types (ints, floats, strings, etc)
  - Operators (mathematical, assignment)
  - Variables
- Before we move on to more concepts, let's experiment a bit to see what we can do with these
- This semester, we will run Python code in two ways:
  - As a **script** (save code in a file, run from Terminal)
  - **Interactively** (from Terminal) in an interactive python session

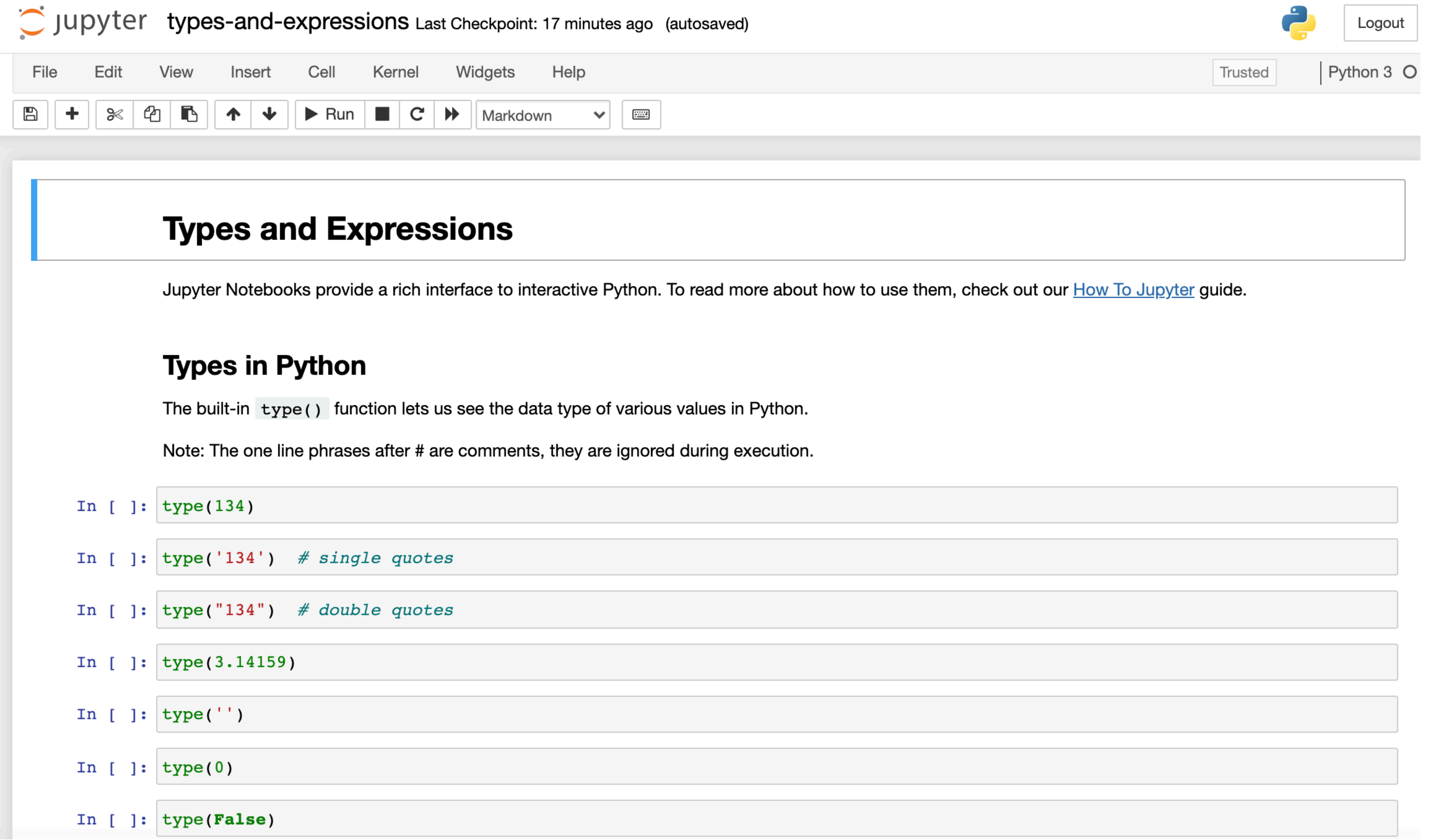
# Python: Program as a Script

- A **program** is a sequence of definitions and commands
  - Definitions are evaluated
  - Commands are executed and instruct the interpreter to do something
- Type instructions in a **file** that is read and evaluated sequentially
  - For example, this week in lab you will write `helloworld.py` in a file and then execute it from the Terminal with  
    `python3 helloworld.py`
  - Common method: good for longer pieces of code or programs
  - We will use this method in our labs
  - Called "running the Python program as a *script*"

# Python: Interactive

- Running Python **interactively** is great for introductory programming
- Launch the Python interpreter by typing **`python3`** in the Terminal
  - Opens up Interactive Python
  - Almost like a "calculator" for Python commands
  - Takes a Python expression as input and spits out the results of the expression as output
  - Great for trying out short pieces of code
  - Great for teaching Python in Lectures
- Today we will use a "fancy" version of Interactive Python called **Jupyter Notebooks**

# Lecture 2: Jupyter Notebook



## Types and Expressions

Jupyter Notebooks provide a rich interface to interactive Python. To read more about how to use them, check out our How To Jupyter guide.

### Types in Python

The built-in `type()` function lets us see the data type of various values in Python.

Note: The one line phrases after # are comments, they are ignored during execution.

```
In [ ]: type(134)
```

```
In [ ]: type('134')  # single quotes
```

```
In [ ]: type("134")  # double quotes
```

```
In [ ]: type(3.14159)
```

```
In [ ]: type('')
```

```
In [ ]: type(0)
```

```
In [ ]: type(False)
```

# Python Built-In Functions

# Built-In Functions

- Python comes with a ton of built-in capabilities in the form of **functions**
- We'll formally discuss functions soon, but for now, let's look at a few examples

# Built-in functions: input()

- `input()` displays its single argument as a prompt on the screen and waits for the user to input text, followed by **Enter/Return**
- It returns the entered value as a **string**

```
In[1] input('Enter your name: ')
Enter your name: Harry Potter
Out[1] 'Harry Potter'
In[2] age = input('Enter your age : ')
Enter your age: 17
In[3] age
Out[3] ’17'
```

Prompts in Maroon. User input in blue.
Inputted values are by default a **string**

# Built-in functions: print()

- `print()` displays a character-based representation of its argument(s) on the screen and returns a special **`None`** value (not displayed).

```
In[1] name = 'Harry Potter'
In[2] print('Your name is', name)
Your name is Harry Potter
In[3] age = input('Enter your age : ')
Enter your age: 17
In[4] print('The age of ' + name + ' is ' + age)
The age of Harry Potter is 17
```

Comma as a separator adds a space

Can also add spaces through string *concatenation*

# Built-in functions: int()

- When given a string that's a sequence of digits, optionally preceded by `+/-, int()` returns the corresponding integer
- On any other string it raises a `ValueError`
- When given a float, `int()` returns the integer that results after truncating it towards zero
- When given an integer, `int()` returns that same integer

```
In [1] int('42')
Out [1] 42
In [2] int('-5')
Out [2] -5
In [3] int('3.141')
ValueError
```

# Built-in functions: float()

- When given a string that's a sequence of digits, optionally preceded by `+/–,` and optionally including one decimal point, `float()` returns the corresponding floating point number.
- On any other string it raises a `ValueError`
- When given an integer, `float()` converts it to a floating point number.
- When given a floating point number, float returns that number

```
In[1] float('3.141')
Out[1] 3.141
In[2] float('–273.15')
Out[2] –273.15
In[3] float('3.1.4')
ValueError
```

# Built-in functions: str()

- Converts a given type to a `string` and returns it
- Returns a syntax error when given invalid input

```
In[1] str(3.141)
Out[1] '3.141'
In[2] str(None)
Out[2] 'None'
In[3] str(134)
Out[3] '134'
In[4] str($)
SyntaxError: invalid syntax
```

# An Aside: Submitting Labs via Git

- Git is a version control system that lets you manage and keep track of your source code history
- **GitHub** is a cloud-based git repository management & hosting service
    - **Collaboration**: Lets you share your code with others, giving them power to make revisions or edits
- **GitLabs** is similar to GitHub but we maintain it internally at Williams and will use to handle submissions and grading

# An Aside: Directories in Unix

- 'Folders' on your computers are called 'directories' in Unix-based operating systems
- Your 'current directory' is important when executing commands on the Terminal
  - For example, programs that run as a script, such as **`helloworld.py`**, must be in the *same* directory as where you execute the command **`python3 helloworld.py`**
  - Otherwise your computer doesn't know which program to run
- Similarly, when you **`git pull`**, you need to be in the correct directory
- Useful to learn how to navigate between directories with the Terminal

# Useful Unix Commands

- `pwd` print working directory
- `mkdir <dir name>` make new directory (or folder)
- `cd <dir name>` change directory
- Special directory names
  - `.` (single dot, current directory)
  - `..` (two dots, parent directory)
  - `~` (tilde, home directory)
- `cd ..` takes you to the parent directory
- `cd` takes you "home"
- `ls` shows contents of current directory