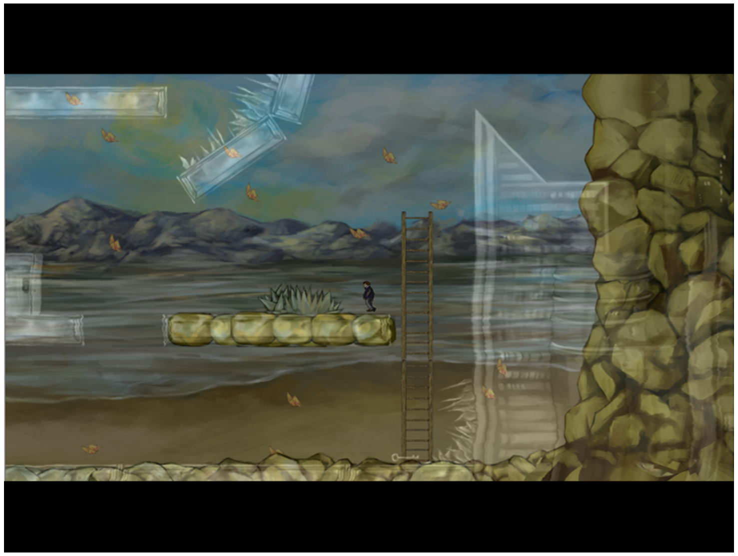
Lecture 1

Course Overview, Python Basics

CS 1133 Fall 2017: Walker White

- **Outcomes:**
  - **Competency** with basic Python programming
    - Ability to create Python modules and programs
    - Ability to use the most common built-in data types
  - **Knowledge** of object-oriented programming
    - Ability to recognize and use objects in Python.
    - Ability to understand classes written by others.
- **Website:**
  - www.cs.cornell.edu/courses/cs1133/2017fa/

About Your Instructor



- **Director**: GDIAC
  - **G**ame **D**esign **I**nitiative **a**t **C**ornell
  - Teach game design
- (and CS 1110 in fall)

Class Structure

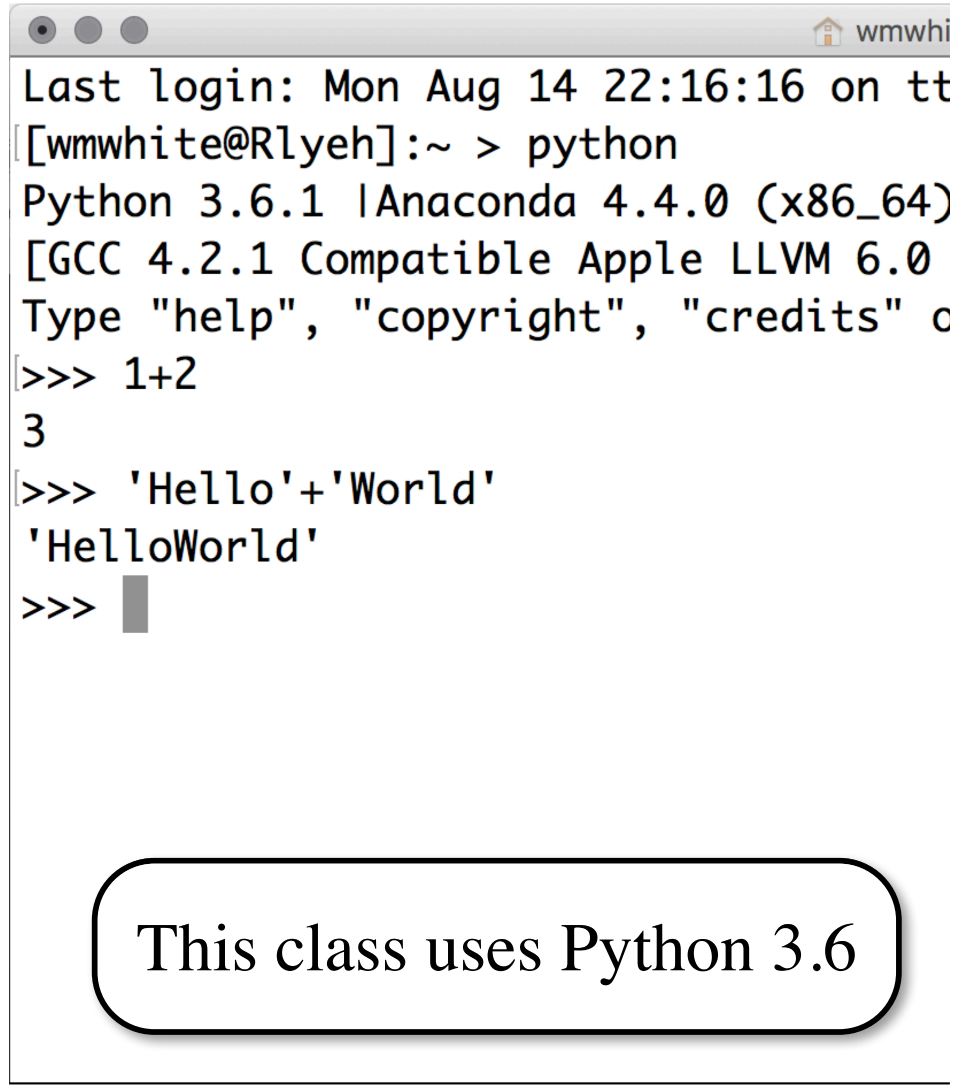
- **Lectures.** Every Monday/Friday
  - Similar to lectures in CS 1110
  - Some interactive demos; bring laptops
- **Labs.** Every Wednesday
  - Self-guided activities to give practice
  - Several instructors on hand to help out
- **Consulting Hours**: 4:30-9:30, Sunday-Thursday
  - Open office hours with (CS 1110) staff
  - Open to CS 1133 students as well
  - Held in ACCEL Labs, Carpenter Hall

Grading Policy

- There will be two assignments
  - Course is not long enough to do much more
  - But both will involve programming
- Must earn 85% to pass an assignment
  - Get two more attempts if you fail
  - But you must meet the posted deadlines!
- Must pass both assignments
- No exams; labs are not graded

Getting Started with Python

- Designed to be used from the “command line”
  - OS X/Linux: **Terminal**
  - Windows: **Command Prompt**
  - Purpose of the first lab
- Once installed type “python”
  - Starts an *interactive shell*
  - Type commands at >>>
  - Shell responds to commands
- Can use it like a calculator
  - Use to evaluate *expressions*



The Basics

Values

- 42
- 12.345
- "Hello!"

Types

- **int**eger
- **float** (real number)
- **str**ing (of characters)

Expressions

- 34 * (23 + 14)
- 1.0 / 3.0
- "Hel" + "lo!"

Python and Expressions

- An expression **represents** something
  - Python *evaluates it* (turns it into a value)
  - Similar to what a calculator does
- Examples:
  - 2.3
    Literal (evaluates to self)
  - (3 * 7 + 2) * 0.1
    An expression with four literals and some operators

Representing Values

- **Everything** on a computer reduces to numbers
  - Letters represented by numbers (ASCII codes)
  - Pixel colors are three numbers (red, blue, green)
  - So how can Python tell all these numbers apart?
- **Type:**
  A set of values and the operations on them.
  - Examples of operations: +, -, /, *
  - The meaning of these depends on the type

Example: Type **int**

- Type **int** represents integers
  - values: …, –3, –2, –1, 0, 1, 2, 3, 4, 5, …
    - Integer literals look like this: `1`, `45`, `43028030` (no commas or periods)
  - operations: `+`, `–`, `*`, `//`, `**`, unary `–`

multiply (`*`) — to power of (`**`)

- **Principle**: operations on **int** values must yield an **int**
  - **Example:** `1 // 2` rounds result down to 0
    - Companion operation: `%` (remainder)
    - `7 % 3` evaluates to 1, remainder when dividing 7 by 3
  - Operator / is not an **int** operation in Python 3

Example: Type float

- Type **float** (floating point) represents real numbers
  - values: distinguished from integers by decimal points
    - In Python a number with a "." is a **float** literal (e.g. `2.0`)
    - Without a decimal a number is an **int** literal (e.g. `2`)
  - operations: `+`, `–`, `*`, `/`, `**`, unary `–`
    - Notice that float has a different division operator
    - **Example**: `1.0/2.0` evaluates to 0.5
- **Exponent notation** is useful for large (or small) values
  - `–22.51e6` is $–22.51 * 10^{6}$ or –22510000
  - `22.51e–6` is $22.51 * 10^{–6}$ or 0.00002251

A second kind of **float** literal

Representation Error

- Python stores floats as **binary fractions**
  - Integer mantissa times a power of 2
  - Example: 12.5 is $100 * 2^{-3}$

    mantissa (100) **exponent** (-3)
- Impossible to write every number this way exactly
  - Similar to problem of writing 1/3 with decimals
  - Python chooses the closest binary fraction it can
- This approximation results in **representation error**
  - When combined in expressions, the error can get worse
  - **Example**: type 0.1 + 0.2 at the prompt >>>

Example: Type bool

- Type boolean or **bool** represents logical statements
  - values: **True**, **False**
    - Boolean literals are just `True` and `False` (have to be capitalized)
  - operations: not, and, or
    - not b: **True** if b is false and **False** if b is true
    - b and c: **True** if both b and c are true; **False** otherwise
    - b or c: **True** if b is true or c is true; **False** otherwise
- Often come from comparing **int** or **float** values
  - Order comparison: i < j i <= j i >= j i > j
  - Equality, inequality: i == j i != j

"=" means something else!

Example: Type `str`

- Type String or **str** represents text
  - values: any sequence of characters
  - operation(s): + (catenation, or concatenation)
- **String literal**: sequence of characters in quotes
  - Double quotes: `" abcex3$g<&"` or `"Hello World!"`
  - Single quotes: `'Hello World!'`
- Concatenation can only apply to strings.
  - `'ab' + 'cd'` evaluates to `'abcd'`
  - `'ab' + 2` produces an **error**

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The meaning of + depends on the **type**

Summary of Basic Types

- Type **int**:
  - **Values**: integers
  - **Ops**: +, –, *, //, %, **
- Type **float**:
  - **Values**: real numbers
  - **Ops**: +, –, *, /, **
- Type **bool**:
  - **Values**: **True** and **False**
  - **Ops**: not, and, or
- Type **str**:
  - **Values**: string literals
    - Double quotes: `"abc"`
    - Single quotes: `'abc'`
  - **Ops**: + (concatenation)

Will see more types in the next week

Converting Values Between Types

- Basic form: *type*(*value*)
  - `float(2)` converts value 2 to type **float** (value now 2.0)
  - `int(2.6)` converts value 2.6 to type **int** (value now 2)
  - Explicit conversion is also called "casting"
- Narrow to wide: **bool** ⇒ **int** ⇒ **float**
  - *Widening*. Python does automatically if needed
    - **Example**: `1/2.0` evaluates to 0.5 (casts 1 to **float**)
  - *Narrowing*. Python *never* does this automatically
    - Narrowing conversions cause information to be lost
    - **Example**: `float(int(2.6))` evaluates to 2.0

Operator Precedence

- What is the difference between the following?
  - 2*(1+3) **add, then multiply**
  - 2*1 + 3 **multiply, then add**
- Operations are performed in a set order
  - Parentheses make the order explicit
  - What happens when there are no parentheses?
- **Operator Precedence**: The *fixed* order Python processes operators in *absence* of parentheses

Precedence of Python Operators

- **Exponentiation**: **
- **Unary operators**: + –
- **Binary arithmetic**: * / %
- **Binary arithmetic**: + –
- **Comparisons**: < > <= >=
- **Equality relations**: == !=
- **Logical not**
- **Logical and**
- **Logical or**

- Precedence goes downwards
  - Parentheses highest
  - Logical ops lowest
- Same line = same precedence
  - Read “ties” left to right
  - Example: 1/2*3 is (1/2)*3

- Section 2.7 in your text
- See website for more info
- Major portion of Lab 1

Expressions vs Statements

Expression

- **Represents** something
  - Python *evaluates it*
  - End result is a value
- Examples:
  - `2.3` — Literal
  - `(3+5)/4` — Complex Expression

Statement

- **Does** something
  - Python *executes it*
  - Need not result in a value
- Examples:
  - `print('Hello')`
  - `import sys`

Will see later this is not a clear cut separation

Variables (Section 2.1)

- A **variable** is
  - a **named** memory location (**box**),
  - a **value** (in the box)
- Examples

x	5	Variable **x**, with value 5 (of type **int**)
area	20.1	Variable **area**, w/ value 20.1 (of type **float**)

- Variable names must start with a letter
  - So 1e2 is a **float**, but e2 is a variable name

Variables and Assignment Statements

- Variables are created by **assignment statements**
  - Create a new variable name and give it a value

```
x = 3
```

the value (3)

the variable (x)

- This is a **statement**, not an **expression**
  - Tells the computer to DO something (not give a value)
  - Typing it into >>> gets no response (but it is working)
- Assignment statements can have expressions in them
  - These expressions can even have variables in them

```
x = x + 2
```

the expression (x + 2)

the variable (x)

Dynamic Typing

- Python is a **dynamically typed language**
  - Variables can hold values of any type
  - Variables can hold different types at different times
  - Use `type(x)` to find out the type of the value in x
  - Use names of types for conversion, comparison

```
type(x) == int
x = float(x)
type(x) == float
```

- The following is acceptable in Python:

```
>>> x = 1
```
← x contains an **int** value

```
>>> x = x / 2.0
```
← x now contains a **float** value

- Alternative is a **statically typed language** (e.g. Java)
  - Each variable restricted to values of just one type

Dynamic Typing

- Often want to track the type in a variable
  - What is the result of evaluating x / y?
  - Depends on whether x, y are **int** or **float** values
- Use expression `type(<expression>)` to get type
  - `type(2)` evaluates to `<type 'int'>`
  - `type(x)` evaluates to type of contents of x
- Can use in a boolean expression to test type
  - `type('abc') == str` evaluates to **True**