Lecture 2

Variables & Assignment

Announcements for Today

If Not Done Already

- Install Python
  - Make sure right version
  - Make sure Kivy works
- Enroll in Ed Discussions
- Sign into CMS
  - Fill out the Survey
  - Complete AI Quiz

Labs 0, 1

- Labs are due at next class
  - So labs 0, 1 due **now**
  - By *end* of the lab section
  - Try to finish them *before*
- Makes T/W a little tight
  - Only 2 days (not 5)
  - Will keep them small
- Getting behind is bad!

Helping You Succeed in this Class

- **Consultants.** Phillips 318 (after hours)
  - Daily office hours (see website) with consultants
  - Very useful when working on assignments
- **AEW Workshops**. Additional discussion course
  - Runs parallel to this class – completely optional
  - See website; talk to advisors in Olin 167.
- **Ed Discussions.** Forum to ask and answer questions
  - Go here first **before** sending question in e-mail
- **Office Hours.** Talk to the professor!
  - Available in Bailey lower lobby between lectures

Labs vs. Assignments

Labs

- Held twice a week
- Graded on **completeness**
  - Always S/U
  - Try again if not finished
- Indirect affect on grade
  - Can miss up to 3 labs
  - After that, grade reduced
- Similar to language drills
  - Simple, but take time

Assignments

- Every two weeks
  - First one due Sep. 22
- Graded on **correctness**
  - Assign points out of 100
- But **first** one is for *mastery*
  - Resubmit until perfect grade
- 40% of your final grade
- Can work with a partner!
  - Mixer coming soon

Academic Integrity

- Every semester we have cases of *plagiarism*
  - Claiming the work of others as your own
  - This is an **Academic Integrity violation**
- This course has a very specific policy
  - Do not listen to (non-staff) upperclassmen
  - Look at the course website for the new details
- Complete Academic Integrity Quiz on CMS
  - Must complete successfully to stay in class

Polling Today

- Have you registered with Poll Everywhere?
- If not, do it right now!
  - https://polleverwhere.com
  - Log in with netid@cornell.edu
  - Log in a second time after than
- If so, go to https://pollev.com/cucs1110
  - Will have today's polls ready

Warm-Up: Using Python

- How do you plan to use Python?

A. I want to work mainly in the Phillips lab
B. I want to use my own Windows computer
C. I want to use my own Macintosh computer
D. I want to use my own Linux computer
E. I will use whatever I can get my hands on

Warm-Up: Using Python

- How do you plan to use P

A. I want to work mainly

B. I want to use my own

C. I want to use my own Macintosh computer

D. I want to use my own Linux computer

E. I will use whatever I can get my hands on

Can text if having issues:

- Text **CUCS1110** to **22333**
- Then text A-E to same

Type: Set of values and the operations on them

- 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 a few weeks

Example: `str`

- **Values:** text, or *sequence of characters*
  - String literals must be in quotes
  - Double quotes: `"Hello World!"`, `" abcex3$g<&"`
  - Single quotes: `'Hello World!'`, `' abcex3$g<&’`
- **Operation:** + (catenation, or concatenation)
  - `'ab' + 'cd'` evaluates to `'abcd’`
  - concatenation can only apply to strings
  - `'ab' + 2` produces an **error**

Converting Values Between Types

- Basic form: *type*(*expression*)
  - This is an expression
  - Evaluates to value, converted to new type
  - This is sometimes called **casting**
- **Examples:**
  - `float(2)` evaluates to `2.0` (a **float**)
  - `int(2.6)` evaluates to `2` (an **int**)
  - Note information loss in 2nd example

Converting Values Between Types

- Conversion is measured *narrow* to *wide*

bool ⇒ int ⇒ float

- **Widening:** Convert to a wider type
  - Python does automatically
  - **Example:** 1/2.0 evaluates to 0.5
- **Narrowing:** Convert to a narrower type
  - Python never does automatically
  - **Example:** float(int(2.6)) evaluates to 2.0

Operator Precedence

- What is the difference between these two?
  - 2*(1+3)
  - 2*1 + 3

Operator Precedence

- What is the difference between these two?
  - 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 no parentheses?

Operator Precedence

- What is the difference between these two?
  - 2*(1+3) **add, then multiply**
  - 2*1 + 3 **multiply, then add**
- O

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

- There is a video about this
- See website for more info
- Was 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

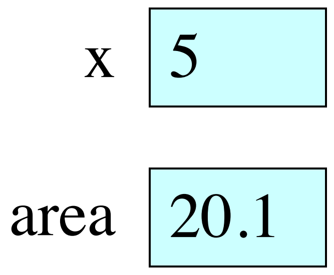
Statement

- **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

- A **variable**
  - is a **box** (memory location)
  - with a **name**
  - and a **value** in the box
- Examples:



Variable **x**, with value 5 (of type **int**)

Variable **area**, w/ value 20.1 (of type **float**)

Using Variables

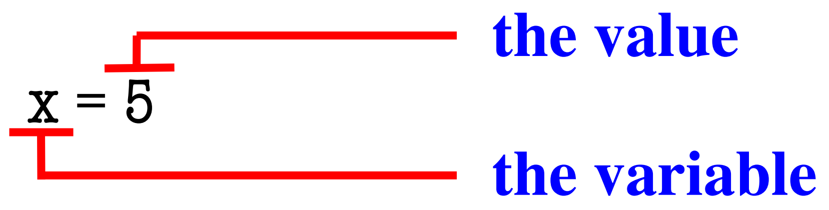
- Variables can be used in expressions
  - Evaluate to the value that is in the box
  - **Example**: `x` $\boxed{5}$ `1 + x` evaluates to `6`
- Variables can change values
  - **Example**: `x` $\boxed{\cancel{5}\ 1.5}$ `1 + x` evaluates to `2.5`
  - Can even change the **type** of their value
  - Different from other languages (e.g. Java)

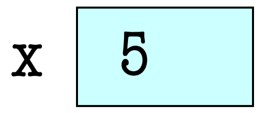
Naming Variables

- Python has strict rules of how to assign names
  - Names must only contain letters, numbers, _
  - They cannot start with a number
- **Examples**
  - `e1` is a **valid** name
  - `1e2` is **not valid** (it is a **float**)
  - `a_b` is a **valid** name
  - `a+b` is **not valid** (it is + on two variables)

Variables and Assignment Statements

- Variables are created by **assignment statements**





- This is a **statement**, not an **expression**
  - **Expression**: Something Python turns into a value
  - **Statement**: Command for Python to do something
  - Difference is that has no value itself
- **Example**:

```
>>> x = 5
(NOTHING)
```

But can now use `x` as an expression

Variables Do Not Exist Until Made

- Example:

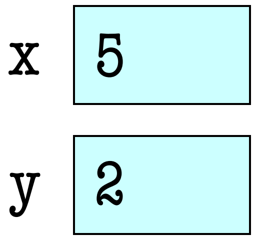
```
>>> y
Error!
>>> y = 3
>>> y
3
```

- Changes our model of Python
  - Before we just typed in one line at a time
  - Now program is a **sequence** of lines

Assignments May Contain Expressions

- **Example**: `x = 1 + 2`
  - Left of equals must always be variable: ~~`1 + 2 = x`~~
  - Read assignment statements right-to-left!
  - Evaluate the expression on the right
  - Store the result in the variable on the left
- We can include variables in this expression
  - **Example**: `x = y+2`
  - **Example**: `x = x+2`

This is not circular! Read right-to-left.



Execute the Statement: `x = x + 2`

- Draw variable x on piece of paper:

x $\boxed{5}$

Execute the Statement: `x = x + 2`

- Draw variable x on piece of paper:

  x $\boxed{5}$

- Step 1: evaluate the expression `x + 2`
  - For x, use the value in variable x
  - Write the expression somewhere on your paper

Execute the Statement: `x = x + 2`

- Draw variable x on piece of paper:

  x $\boxed{5\quad\quad}$

- Step 1: evaluate the expression `x + 2`
  - For x, use the value in variable x
  - Write the expression somewhere on your paper
- Step 2: Store the value of the expression in `x`
  - Cross off the old value in the box
  - Write the new value in the box for x

Execute the Statement: `x = x + 2`

- Draw variable x on piece of paper:

  x $\boxed{5}$

- Step 1: evaluate the expression `x + 2`
  - For x, use the value in variable x
  - Write the expression somewhere on your paper
- Step 2: Store the value of the expression in `x`
  - Cross off the old value in the box
  - Write the new value in the box for x
- Check to see whether you did the same thing as your neighbor, discuss it if you did something different.

Which One is Closest to Your Answer?

A:

x ~~5~~ 7

B:

x 5

x 7

C:

x ~~5~~

x 7

D:

¯_(ツ)_/¯

Which One is Closest to Your Answer?

A:

x ~~5~~ 7

✓

B:

x 5

x 7

C:

x ~~5~~

x 7

```
x = x + 2
```

Execute the Statement: `x = 3.0 * x + 1.0`

- You have this:

x $\boxed{\cancel{5}\quad 7\qquad\qquad}$

Execute the Statement: `x = 3.0 * x + 1.0`

- You have this:

  x $\boxed{\cancel{5}\ 7}$

- Execute this command:
  - Step 1: **Evaluate** the expression `3.0 * x + 1.0`
  - Step 2: **Store** its value in x

Execute the Statement: `x = 3.0 * x + 1.0`

- You have this:

  x ~~5~~ 7

- Execute this command:
  - Step 1: **Evaluate** the expression `3.0 * x + 1.0`
  - Step 2: **Store** its value in x
- Check to see whether you did the same thing as your neighbor, discuss it if you did something different.

Which One is Closest to Your Answer?

A:

x ~~5~~ ~~7~~ 22.0

B:

x ~~5~~ 7

x 22.0

C:

x ~~5~~ ~~7~~

x 22.0

D:

¯_(ツ)_/¯

Which One is Closest to Your Answer?

A:

x ~~5~~ ~~7~~ 22.0

✓

B:

x ~~5~~ 7

x 22.0

C:

x ~~5~~ ~~7~~

x 22.0

```
x = 3.0 * x + 1.0
```

Execute the Statement: `x = 3.0 * x + 1.0`

- You now have this:

  x $\boxed{\cancel{5}\ \cancel{7}\ 22.0}$

- The command:
  - Step 1: **Evaluate** the expression `3.0 * x + 1.0`
  - Step 2: **Store** its value in x
- This is how you execute an assignment statement
  - Performing it is called **executing the command**
  - Command requires both **evaluate** AND **store** to be correct
  - Important *mental model* for understanding Python

Exercise: Understanding Assignment

- Add another variable, interestRate, to get this:

x ~~5~~ ~~7~~ 22.0 interestRate 4

- Execute this assignment:

```
interestRate =  x / interestRate
```

- Check to see whether you did the same thing as your neighbor, discuss it if you did something different.

Which One is Closest to Your Answer?

A:

x ~~5~~ ~~7~~ ~~22.0~~ 5.5

interestRate ~~4~~ 5.5

B:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~

interestRate 5.5

C:

x ~~5~~ ~~7~~ 22.0

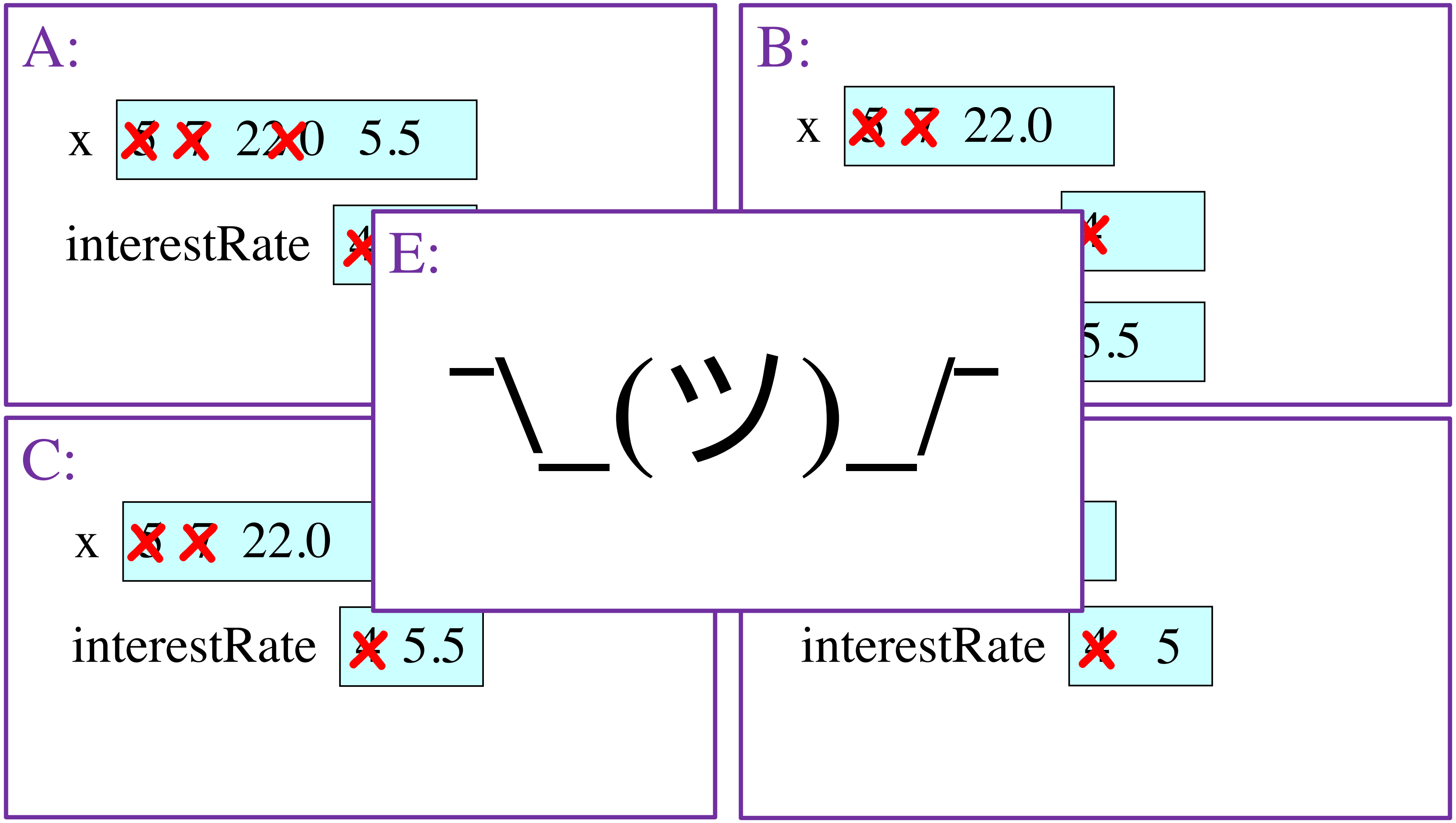
interestRate ~~4~~ 5.5

D:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ 5

Which One is Closest to Your Answer?


A:
x $\cancel{5}$ $\cancel{7}$ $\cancel{22.0}$ 5.5
interestRate $\cancel{4}$
B:
x $\cancel{5}$ $\cancel{7}$ 22.0
$\cancel{4}$
5.5
C:
x $\cancel{5}$ $\cancel{7}$ 22.0
interestRate $\cancel{4}$ 5.5
interestRate $\cancel{4}$ 5
E:
¯_(ツ)_/¯

Which One is Closest to Your Answer?

```
interestRate =  x/interestRate
```

B:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~

interestRate 5.5

C:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ 5.5

✓

D:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ 5

Exercise: Understanding Assignment

- You now have this:

  x $\boxed{\cancel{5}\ \cancel{7}\ 22.0}$ interestRate $\boxed{\cancel{4}\,5.5}$

- Execute this assignment:

```
intrestRate =  x + interestRate
```

- Check to see whether you did the same thing as your neighbor, discuss it if you did something different.

Which One is Closest to Your Answer?

A:

x: ~~5~~ ~~7~~ 22.0

interestRate: ~~4~~ ~~5.5~~ 27.5

B:

x: ~~5~~ ~~7~~ 22.0

interestRate: ~~4~~ 5.5

intrestRate: 27.5

C:

x: ~~5~~ ~~7~~ ~~22.0~~ 27.5

interestRate: ~~4~~ 5.5

D:

x: ~~5~~ ~~7~~ 22.0

interestRate: ~~4~~ ~~5.5~~

intrestRate: 27.5

Which One is Closest to Your Answer?

A:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~

B:

x ~~5~~ ~~7~~ 22.0

estRate ~~4~~ 5.5

27.5

C:

x ~~5~~ ~~7~~ 22~~.~~0 2

interestRate ~~4~~ 5.5

E:

¯_(ツ)_/¯

interestRate ~~4~~ 5~~.~~5

intrestRate 27.5

Which One is Closest to Your Answer?

A:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ ~~5.5~~ 27.5

B: ✓

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ 5.5

intrestRate 27.5

```
intrestRate =  x + interestRate
   ^
   e
```

Which One is Closest to Your Answer?

A:

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ ~~5.5~~ 27.5

B: ✓

x ~~5~~ ~~7~~ 22.0

interestRate ~~4~~ 5.5

intrestRate 27.5

```
intrestRate =  x + interestRate
   ^
   e
```

Spelling mistakes in Python are bad!!

Dynamic Typing

- Python is a **dynamically typed language**
  - Variables can hold values of any type
  - Variables can hold different types at different times
- 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**
  - Each variable restricted to values of just one type
  - This is true in Java , C, C++, etc.

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**