http://www.cs.cornell.edu/courses/cs1110/2018sp

Lecture 2: Variables & Assignments

(Sections 2.1-2.3,2.5)

CS 1110
Introduction to Computing Using Python

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CS 1110, Lecture 2 Announcements

Sections

- **Start this week! Yay!**
- Please go only to the Section you are enrolled in
- Need to Change your Section *or your Lecture?*
  See our Section Swapping Station on Piazza:
  https://piazza.com/class/jckqwmqflaz6i?cid=10

Enrollment

- Lots of turnover in the first week. Don't give up!
- Perhaps another class meets your needs?

http://www.cs.cornell.edu/courses/cs1110/2018sp/resources/alternatives.php

Things to do this week

Read textbook

- Chapter 2.1-2.3, 2.5
- Chapter 3.1-3.3

Lab 1:

- Go to your registered section
- Complete lab handout
- You have **one week** to show your work:
  - to TA by end of lab, or:
  - in consulting hours up to 1 day before your lab, or:
  - in TA (not professor) office hours
    (but student questions take precedence over this)
  - to TA **within first 10 minutes** of next week's lab

Helping you succeed in this class

Consultants. ACCEL Lab Green Room

- Daily office hours (see website) with consultants
- Very useful when working on assignments

ENGRG 1010: AEW Workshops. Additional discussion course open to **ALL** students

- Runs parallel to this class – optional
- See website

Piazza. Online forum to ask/answer questions

- Go here first before e-mailing questions

Office Hours. Talk to the professors!

- Olin 128 between lectures

iClickers

- Fun! Interactive!
- Not for a grade; no need to register.

iClicker Warm Up: Using Python

How do you Plan to use Python?

A. I want to work mainly in the computer labs
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

From last time: **Types**

Type: set of values & operations on them

Type **float:**

- Values: real numbers
- Ops: +, -, *, /, **

Type **int:**

- Values: integers
- Ops: +, -, *, //, %, **

Type **bool:**

- Values: integers
- Ops: not, and, or

Type **str:**

- Values: string literals
  - Double quotes: **“abc”**
  - Single quotes: **‘abc’**
- Ops: + (concatenation)

Converting from one type to another

Command: *<type>*(*<value>*)

```
>>> float(2)
2.0
```

converts value 2 to type **float**

```
>>> int(2.6)
2
```

converts value 2.6 to type **int**

This kind of conversion is also called "casting"

Different from type(*<value>*)

type(*<value>*) **tells** you the type

<type>(*<value>*) **converts** the type

Implicit (Automatic) Conversions

Python sometimes converts types automatically

Example: `1/2.0`

- evaluates to a **float**: `0.5`
- internally:
  - Step 1: Python casts 1 (an **int**) to 1.0 (a **float**)
  - Step 2: Python evaluates `1.0/2.0`

Behavior depends on whether the conversion is narrowing or widening

Variable "width"

Types differ in how much information held

Convert without losing information?

- **float→int** (*e.g.*, 4.7 to 4) ← info lost
- **int→float** (*e.g.*, 4 to 4.0) ← seems ok

"Wide" = more information capacity

From narrow to wide: **bool** ⇒ **int** ⇒ **float**

Widening Conversion

From a **narrower** type to a **wider** type

Python does automatically if needed:

- Example: `1/2.0` evaluates to a `float`: `0.5`
- Example: `True + 1` evaluates to an `int`: `2`
  - `True` converts to `1`
  - `False` converts to `0`

Note: does not work for **str**

- Example: 2 + “ab” produces an error

Narrowing Conversion

From a **wider** type to a **narrower** type

- Example: `int(2.6)`

- causes information to be lost
- Python **never** does this automatically

Note: you can just always cast

- Instead of `1/2.0`, can write `float(1)/2.0`

Types matter!

You Decide:

- What is the right type for my data?
- When is the right time for conversion (if any)

- Zip Code as an **`int`**?
- Grades as an **`int`**?
- Lab Grades as a **`bool`**?

What are your goals:

Accuracy? Clarity? Fairness?

Operator Precedence

What is the difference between:

2*(1+3)	2*1 + 3
add, then multiply	***multiply, then add***

Operations performed in a set order

- Parentheses make the order explicit

What if there are no parentheses?

→ **Operator Precedence:** fixed order to processes operators when no 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 (except for **)
  - Example: 1/2*3 is (1/2)*3

- Section 2.5 in your text
- See website for more info
- Major portion of Lab 1

Operators and Type Conversions

Operator Precedence

Exponentiation: **

Unary operators: + –

Binary arithmetic: * / %

Binary arithmetic: + –

Comparisons: < > <= >=

Equality relations: == !=

Logical not

Logical and

Logical or

Evaluate this expression:

False + 1 + 3.0 / 3

A. 3

B. 3.0

C. 1.3333

D. 2

E. 2.0

Operators and Type Conversions

Operator Precedence

Exponentiation: **

Unary operators: + –

Binary arithmetic: * / %

Binary arithmetic: + –

Comparisons: < > <= >=

Equality relations: == !=

Logical not

Logical and

Logical or

Evaluate this expression:

False + 1 + 3.0 / 3

False + 1 + 1.0

1 + 1.0

2.0

New Tool: Variable Assignment

An *assignment statement:*

- takes an *expression*
- evaluates it, and
- stores the *value* in a *variable*

Example: (read right to left)

```
>>> x = 5
```

expression evaluates to 5

equals sign (just one!)

variable

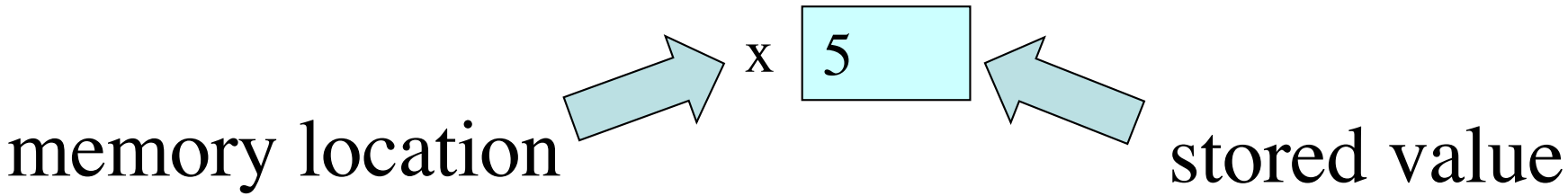
Executing Assignment Statements

```
>>> x = 5
>>>
```

Press ENTER and…

Hmm, looks like nothing happened…

- But something did happen!
- Python *assigned* the *value* 5 to the *variable* x
- Internally (and invisible to you):



Retrieving Variables

```
>>> x = 5
>>> x
5
>>>
```

Press ENTER and…

Python tells me the stored value

In More Detail: Variables (Section 2.1)

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

- Examples:

Variable names must start with a letter (or _).

The type belongs to the *value*, not to the *variable*.

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

1e2 is a **float**, but e2 is a variable name

In More Detail: Statements

```
>>> x = 5
>>>
```

Press ENTER and…

Hm, looks like nothing happened…

- 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)

Expressions vs. Statements

Expression

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

Statement

- **Does** something
  - Python *executes it*
  - Need not result in a value
- Examples:
  - `x = 2 + 1`
  - `x = 5`

Look so similar
but they are not!

You can assign more than literals

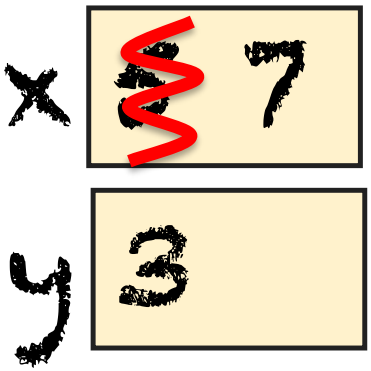
```
>>> x = 5
>>> x = 3.0 ** 2 + 4 – 1
>>> x = 2 + x
```

"x gets 5"

"x gets the value of this expression"

"x gets 2 plus the current value of x"

Keeping Track of Variables



- Draw boxes on paper:

```
>>> x = 5
```

- New variable declared?

```
>>> y = 3
```

Write a new box.

- Variable updated?

```
>>> x = 7
```

Cross out old value. Insert new value.

Execute the Statement: `x = x + 2`

Draw variable x on piece of paper:

1. Evaluate the expression `x + 2`
   - For `x`, use the value in variable `x`
   - Write the expression somewhere on your paper
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`

Did you do the same thing as your neighbor ?
If not, *discuss*.

Which one is closest to your answer?

A.

x [~~5~~ 7]

B.

x [5]

x [7]

C.

x [~~5~~]

x [7]

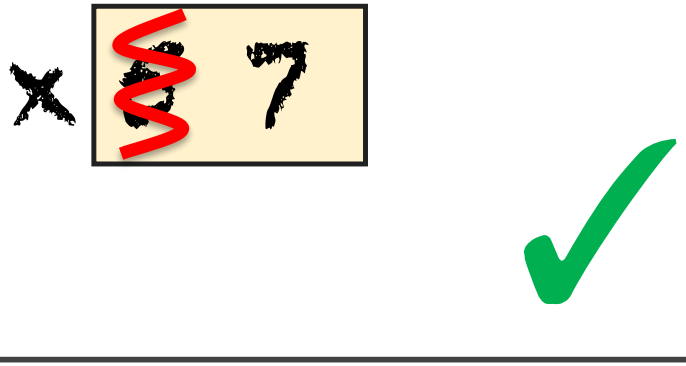
D.

¯_(ツ)_/¯

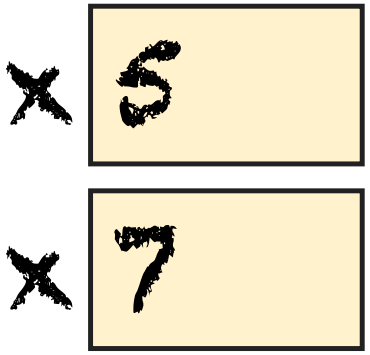
$x = x + 2$

And The Correct Answer Is…

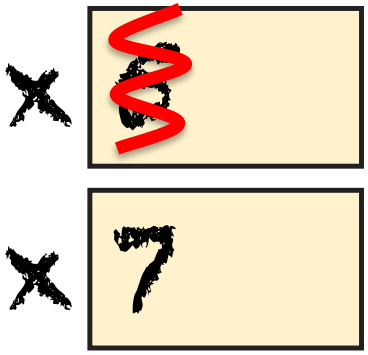
A.



B.



C.



D.

¯_(ツ)_/¯

$x = x + 2$

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

Begin with this:

1. **Evaluate** the expression `3.0*x+1.0`
2. **Store** its value in `x`

Did you do the same thing as your neighbor ? If not, *discuss*.

Which one is closest to your answer?

A.

x [illegible] 22.0

B.

x [illegible] 7

x 22.0

C.

x [illegible]

x 22.0

D.

¯_(ツ)_/¯

x = 3.0 * x+1.0

And The Correct Answer Is…

A.

x [§ § 22.0] ✓

B.

x [§ 7]

x [22.0]

C.

x [§ §]

x [22.0]

D.

¯_(ツ)_/¯

x = 3.0 * x+1.0

Executing an Assignment Statement

The command: `x = 3.0*x+1.0`

"Executing the command":

1. **Evaluate** right hand side `3.0*x+1.0`
2. **Store** the value in the variable `x`'s box

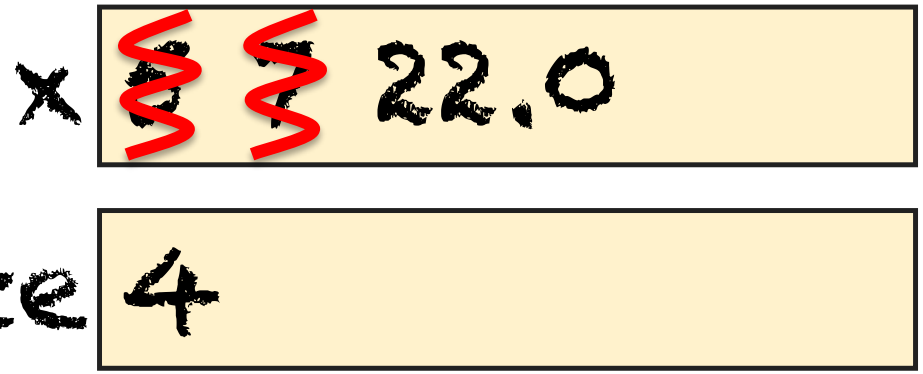
- Requires both evaluate AND store steps
- Critical mental model for learning Python

Exercise 1: Understanding Assignment

Begin with:

Declare a new variable:

```
>>> rate = 4
```



Execute this assignment:

```
>>> rate = x / rate
```

Did you do the same thing as your neighbor ? If not, *discuss*.

Which one is closest to your answer?

A.

x ~~22.0~~ 5.5

rate ~~4~~ 5.5

B.

x ~~22.0~~

rate ~~4~~

rate 5.5

C.

x ~~22.0~~

rate ~~4~~ 5.5

D.

x ~~22.0~~

rate ~~4~~ 5

E. ¯_(ツ)_/¯

rate = x / rate

And The Correct Answer Is…

A.

x ~~22.0~~ 5.5

rate ~~s~~ 5.5

B.

x ~~s~~ 22.0

rate ~~s~~

rate 5.5

C.

✓ x ~~s~~ 22.0

rate ~~s~~ 5.5

D.

x ~~s~~ 22.0

rate ~~s~~ 5

rate = x / rate

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 = x / 2.0
```

← x contains an **int** value

← x now contains a **float** value

Alternative: a **statically typed** language

- Examples: Java, C
- Each variable restricted to values of just one type

More Detail: Testing Types

Command: type(<value>)

Can test a variable:

```
>>> x = 5
>>> type(x)
<class 'int‘>
```

Can test a type with a Boolean expression:

```
>>> type(2) == int
True
```

Exercise 2: Understanding Assignment

Begin with:

Execute this assignment:

```
>>> rat = x + rate
```

Did you do the same thing as your neighbor ? If not, *discuss*.

Which one is closest to your answer?

A.

x	27.5
rate	5.5

B.

x	22.0
rate	5.5
rat	27.5

C.

x	22.0
rate	27.5

D.

x	22.0
rate	
rat	27.5

E. ¯_(ツ)_/¯

rat = x + rate

And The Correct Answer Is…

A.

x | 27.5

rate | 5.5

B.

x | 22.0

rate | 5.5

rat | 27.5 ✓

C.

x | 22.0

rate | 27.5

D.

x | 22.0

rate

rat | 27.5

Spelling Matters!

rat = x + rate