Genome Sciences 373
Genome Informatics

Quiz Section #1

March 28, 2017

About me

Email: cnoecker@uw.edu

Office hours: Mondays, 4:30-5:30 PM

Foege S-040

Or by appointment!

My research focuses on modeling to integrate different kinds of data from microbial communities

Quiz section goals

- solidify in-class material
- develop understanding of programming concepts
- learn basic Python to write bioinformatics programs

attendance is not required, but the material covered in section is required

Homework policy

No late homework accepted without **prior** arrangements

Group work, Internet searching: You can (and should) use them, but don’t copy exactly! We can tell!

The point is **to learn.**

Grading is equally about your **effort** and your **execution**

Homeworks continued

- First assignment will be assigned tomorrow via Catalyst
- Due Wednesday 4/5 before class (1:30PM)
  - Start early!

Questions:

Catalyst discussion board:

https://catalyst.uw.edu/gopost/board/cnoecker/43929/

Email, office hours

Questions about course logistics?

Today’s goals

- Quick review on alignments
- Algorithms and programs: what and why
- Getting started programming in Python

What is an alignment?

Arrangement of nucleotide (or amino acid) sequences, to identify **regions of similarity** that may be a consequence of functional, structural, or evolutionary relationships between the sequences.

```
G – A A T T C A G T T A
|     |   | |   |     |
G G – A – T C – G - - A
```

What are some reasons to align sequences?

One big reason: compare *homologous* sequences

Sequences with shared ancestry

Orthologs

Common Ancestor

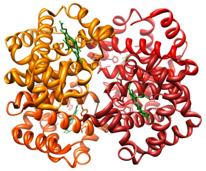
Hemoglobin

Hemoglobin

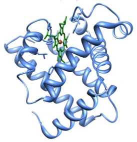
```
G – A A T T C A G T T A
|     |   | |   |     |
G G – A – T C – G - - A
```

Paralogs

Common Ancestor



Hemoglobin



Myoglobin

```
G – A A T T C A G T T A
|     |   | |   |     |
G G – A – T C – G - - A
```

Alignment example

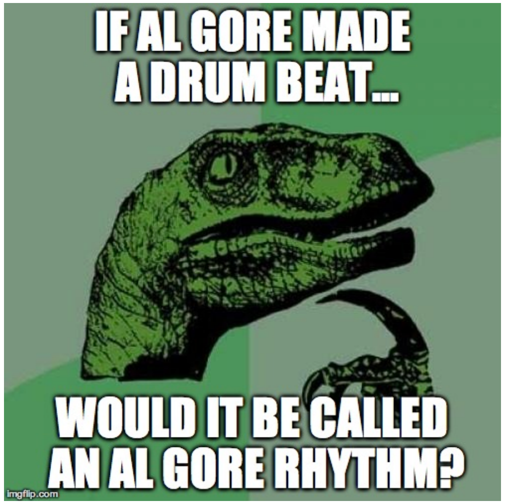
Write down 2 possible alignments of the following two sequences:

ACCTTGT
TCTGTCC

Which one is “better”? Does it depend what you’re trying to do?

Algorithms

What is an algorithm?


IF AL GORE MADE A DRUM BEAT...
WOULD IT BE CALLED AN AL GORE RHYTHM?
imgflip.com

A step by step list of instructions that, if followed exactly, will solve the problem under consideration

The instructions can be carried out or ***implemented*** in different ways:

- Programmed to be run by a computer
- Carried out yourself

Like a recipe!

Properties of algorithms

- Is an unambiguously defined series of steps
- Works for all inputs in a defined set
- Always produces a defined set of outputs, for those inputs
- Is guaranteed to produce a correct result, for those inputs

Often written in “pseudocode”

Example algorithm: Find the smallest number

```
Input: three numbers A, B, and C
Output: the largest number

current_smallest <- A
if B < current_smallest:
   current_smallest <- B
else:
   [do nothing]
if C < current_smallest:
   current_smallest <- C
else:
   [do nothing]
return current_smallest
```

What set of inputs is this algorithm defined for?

Which of these is an algorithm?

- Instructions for how to find the reverse complement of a DNA sequence

- A program that finds the reverse complement for any DNA sequence

Programming with Python

Why are we learning to program?

This class is designed for you to **understand** and **use** bioinformatics algorithms

You won’t learn to **implement** all of them, but understanding them requires *programmatic thinking*

Plus, if you do want to implement an algorithm or otherwise code anything, you will be off to a good start!

What is a program?

A series of instructions that performs a specific task when executed by a computer

Why are programs useful?

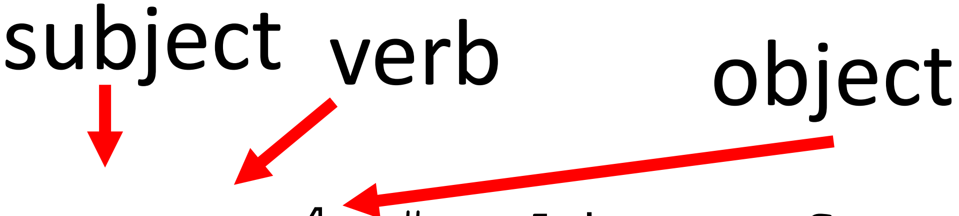
A note for those with programming experience

- Some of this will be review

- It’s fine to use Python tricks and modules beyond what I show in quiz section
    - But please don’t, for ex, use a BioPython function to do an entire homework problem in one command

What is a program?

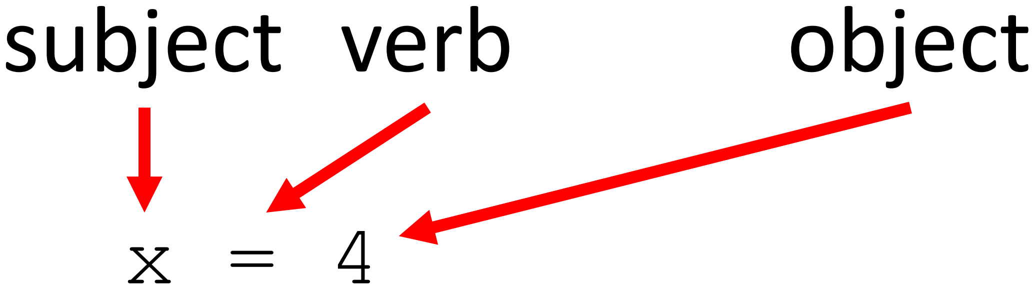
A series of instructions that performs a specific task when executed by a computer



subject verb object

```
x = 4 #A line of code…
y = 8 #is like a sentence
z = x + y
print(z)
```

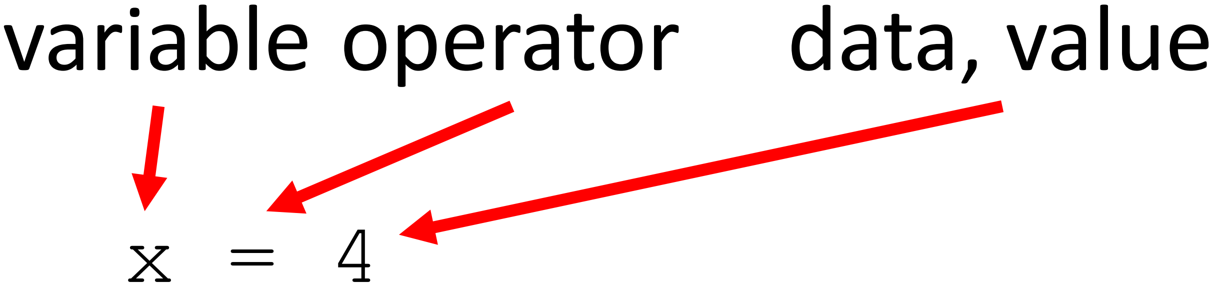
Variables and operators



subject verb object

```
x = 4
```

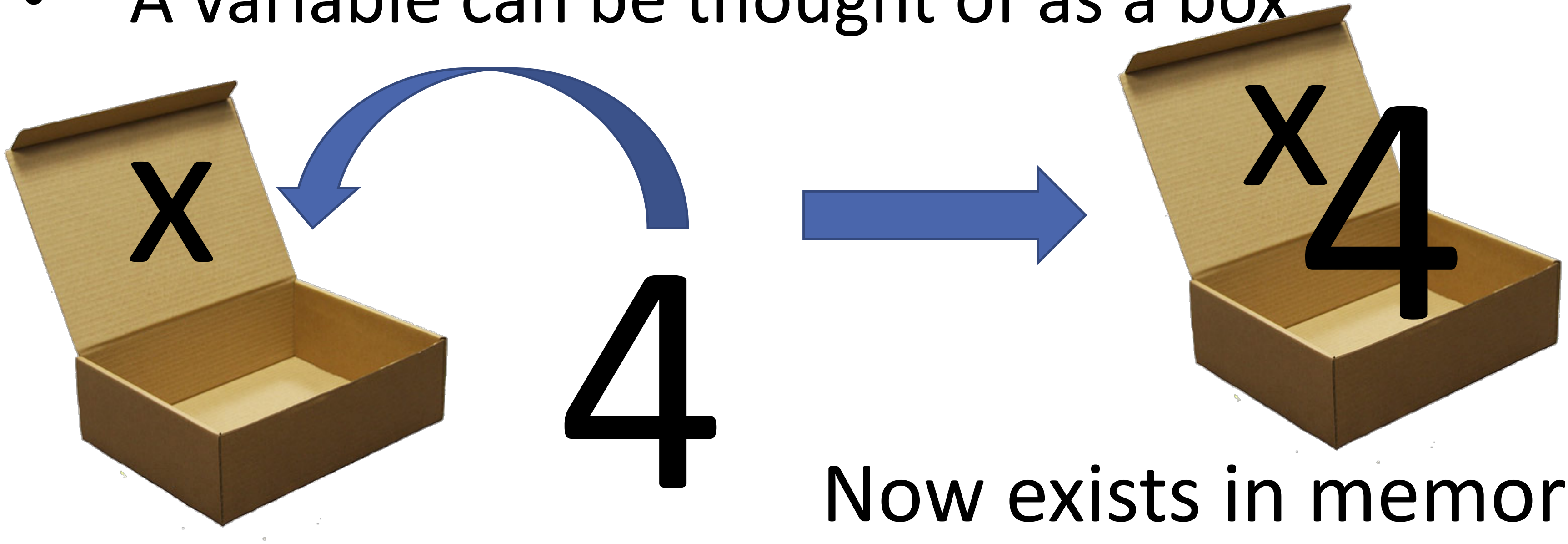
Variables and operators



variable operator data, value

```
x = 4
```

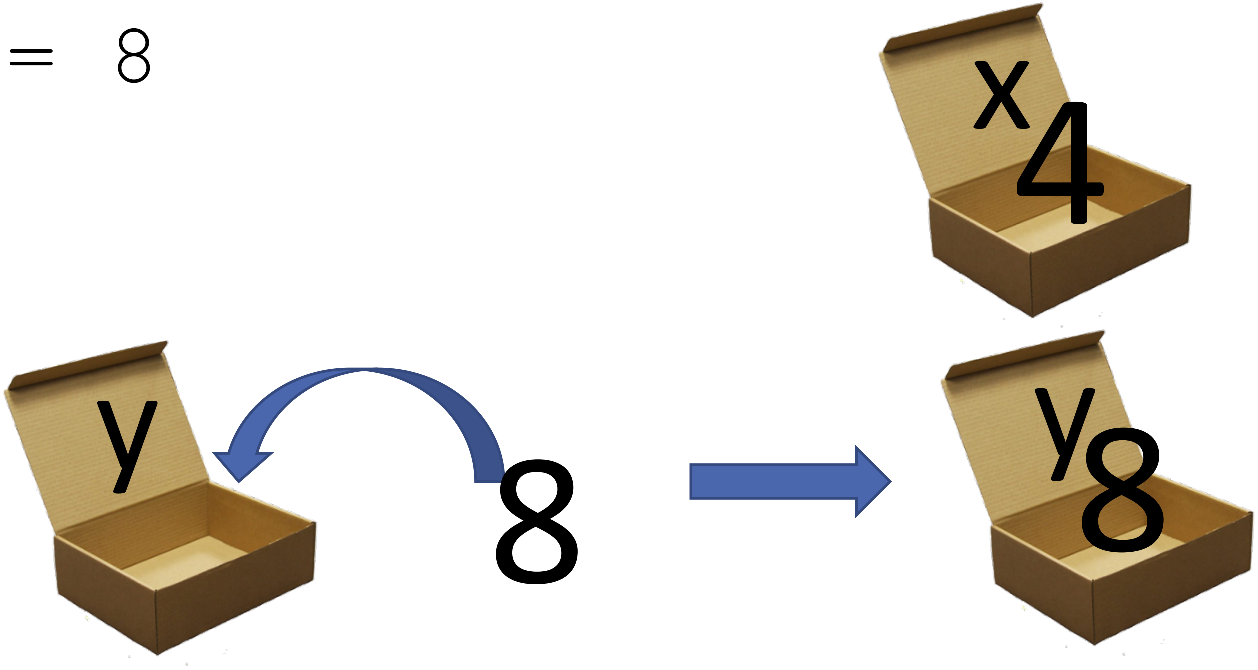
- An operator is the verb
- “=“ assigns values to variables
- A variable can be thought of as a box



Now exists in memory!

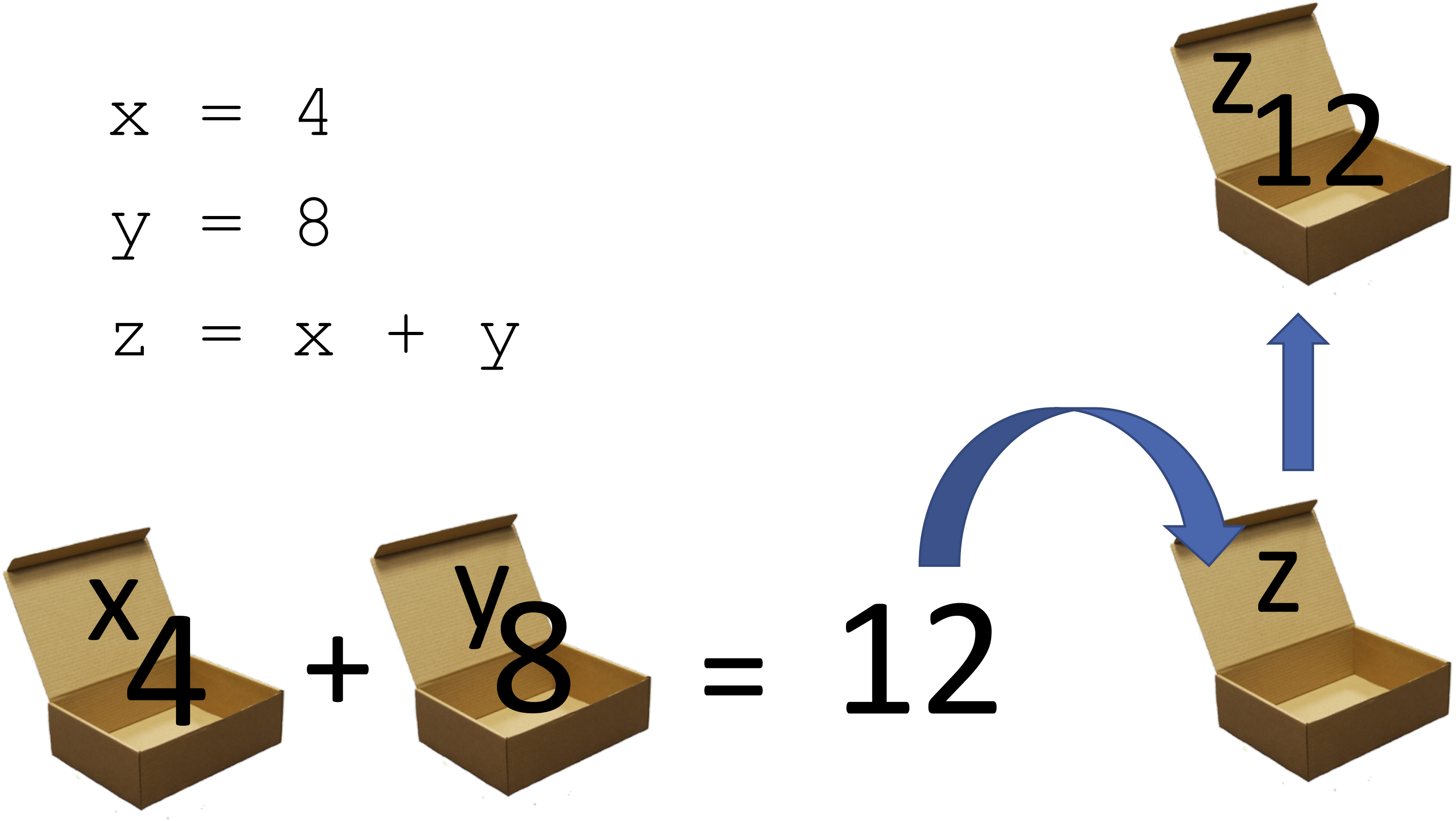
Variables and operators

```
x = 4
y = 8
```



Variables and operators

```
x = 4
y = 8
z = x + y
```



Let’s use Python!

1. Open a new text file and save it as “myfirstprogram.py”
2. Type the text below and save.

```
x = 4
y = 8
z = x + y
print(z)
```

3. Open terminal and type “python myfirstprogram.py”

Comments!

Any text followed by a “#” in the same line is not read by the computer

```
x = 4 # This is a line of code
y = 8 # This is another
z = x + y # z is the sum of x and y
# print(z)
```

Why are comments useful?

- For when you look back later
- If other people are trying to read, use, or understand your code
  - E.g. your grader!
- To help make sure your thinking is clear

You can also use Python interactively

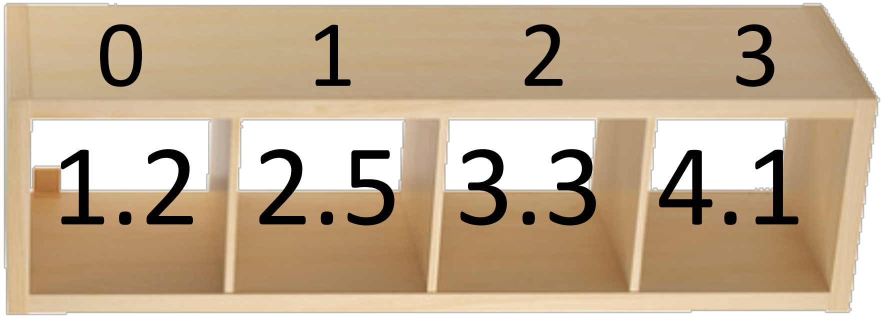
- Open a terminal and type “python”
  - OR: Install Jupyter and open a notebook

- Now you can type lines of code, one at a time, and view the result in real time

```
>>> x = 1
>>> print x
1
>>> x
1
```

A list is like a bookshelf of variables accessible by position in the sequence

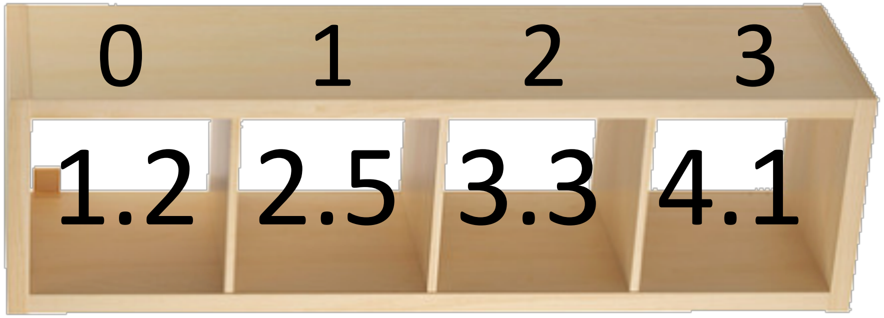
```
x = [ 1.2, 2.5, 3.3, 4.1]
```



```
>>> print x[0]
1.2
>>> print x[2]
3.3
>>>print x[-1]  ?
```

You can “slice” a list into a smaller piece with notation below

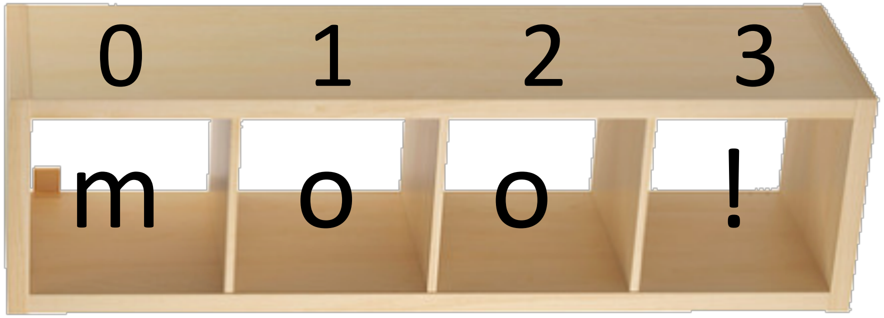
```
x = [ 1.2, 2.5, 3.3, 4.1]
```



```
>>> print x[0:2]
[1.2, 2.5]
>>> print x[1:3]
[2.5, 3.3]
>>>print x[1:]
```

A string is like a list of characters

```
x = ‘moo!’
```



```
>>> print x[0]
>>> print x[2]
>>> print x[-1]
```

Variables have *types*

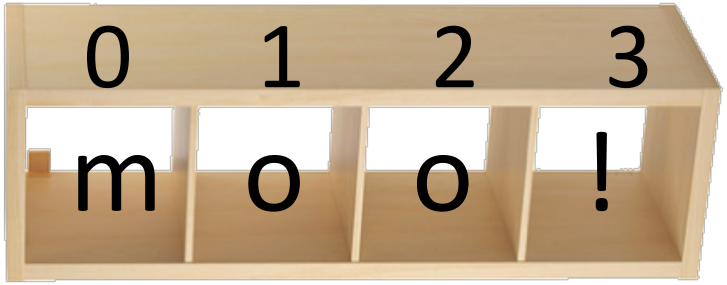
- Boolean
  - True or False
- Int
  - 1, 12, -46, 0
- Float
  - 1.24, 12.0, -0.5

Simple types

Variables have *types*

- List
  - [True, False, 1, 12]
- String
  - ‘hello how are you?’
- Hash/Dictionary
  - [True:12, False:1]

Complex types



Common Boolean operators

```
x = 4 # not boolean! (assignment)
```

```
x == 4
x != 4
x > 4
x <= 3
x > 2 and x < 5
x == 4 or x != 4
```

We can use Boolean operators in If/else statements

```
x = 4
```

Only things that evaluate to a Boolean go here

```
if x == 5:
  print ‘x is 5!’
else:
  print ‘x is not 5!’
```

```
‘x is not 5!’
```

Review and practice problems

http://interactivepython.org/runestone/static/thinkcspy/index.html Sections 1, 2, 4

Homework on Catalyst tomorrow…