

CE 311K: Introduction to Computer Methods

Krishna Kumar

University of Texas at Austin

krishnak@utexas.edu

Fall 2020

Overview

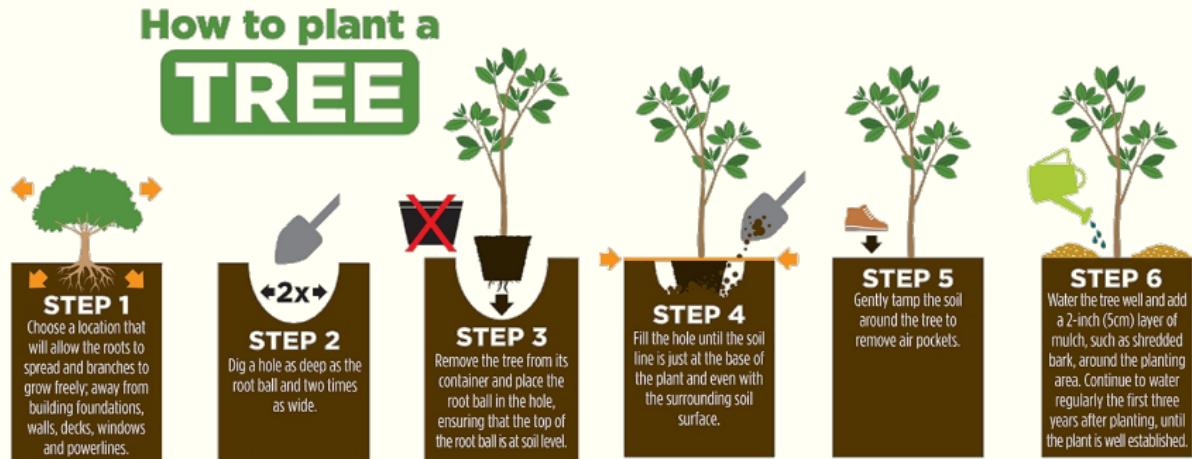
1 Simulations

2 Aspects of languages

3 Python variables and bindings

② How are you feeling this morning?

What is an algorithm?



② Could you identify examples of algorithms in real-world?

The Prophet and the Pioneer Computer Scientists



Ada Lovelace, circa 1838 (credit:
Science Museum, California)



Grace Hopper (credit: unknown)

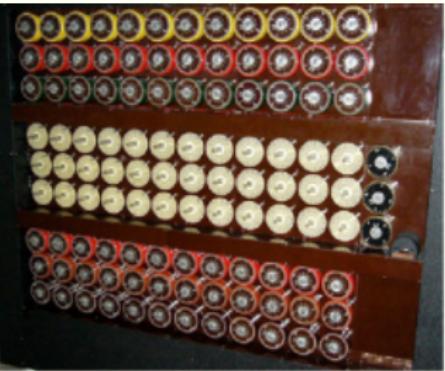
On computable numbers



Alan Turing



3-Rotor Enigma



The Bombe

Enigma has 150,738,274,937,250 possible states. (credit: Rutherford journal)

Decipher this text from an Engima machine:

KLDP AXKR MIMS VNUK M

To infinity and beyond...



Margaret Hamilton next to a stack of the Apollo Guidance Computer source code (1969, credit: MIT Museum) and Katie Bouman who developed the algorithm for creating the first-ever image of black hole (2019, credits: PBS).

② Could you guess the storage size requirements?

To infinity and beyond...



M87 galaxy black hole (JPL)



Gargantua black hole, Interstellar (Warner Bros)

1 Simulations

2 Aspects of languages

3 Python variables and bindings

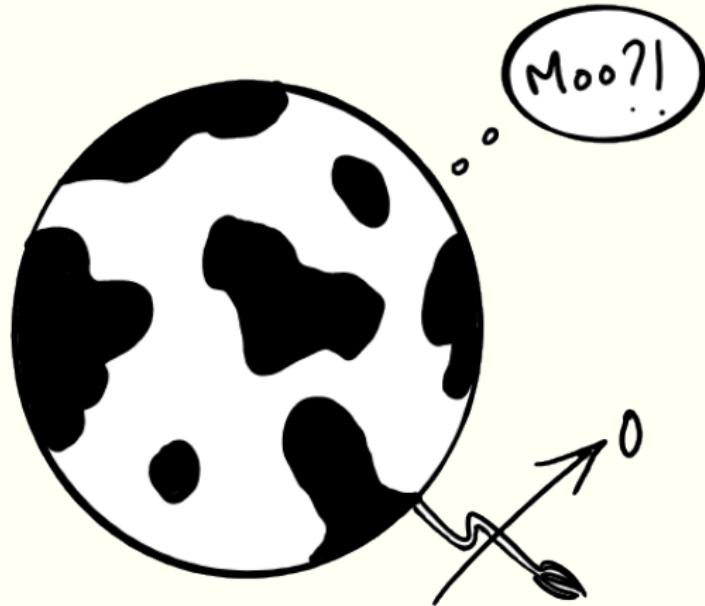
Disney's Frozen: Modeling snow



② How to bury Anna under the snow?



Modeling the real world: Spherical Cow



Consider a spherical cow of radius ' R '
and a uniform density ' ρ '....

Modeling snow



How to animate like Disney: Effect of snow quantity



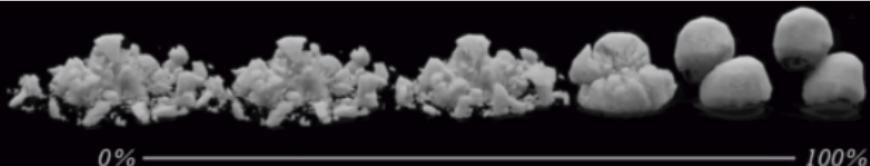
(c) Disney

What type of snow?

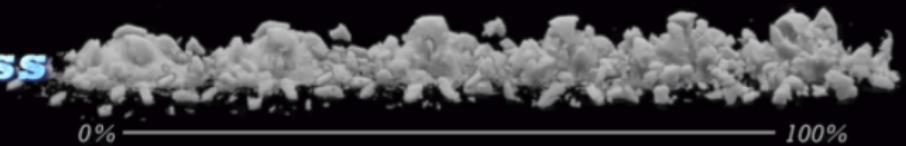


Snow properties

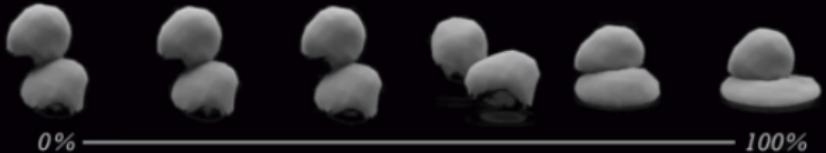
Viscosity



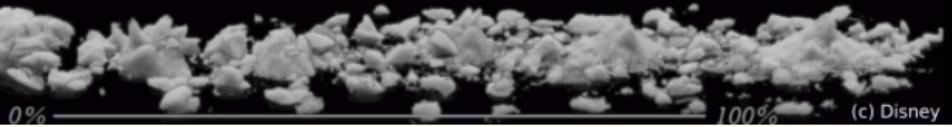
Chunkiness



Plasticity



Hardness



Snow material parameters

$$\begin{aligned}E_0 &= 1.4 \times 10^5 \\ \theta_c &= 2.5 \times 10^{-2} \\ \theta_s &= 5.0 \times 10^{-3} \\ \xi &= 10\end{aligned}$$



$$\begin{aligned}E_0 &= 1.4 \times 10^5 \\ \theta_c &= 2.5 \times 10^{-2} \\ \theta_s &= 7.5 \times 10^{-3} \\ \xi &= 10\end{aligned}$$



(c) Disney

$$\begin{aligned}E_0 &= 1.4 \times 10^5 \\ \theta_c &= 1.9 \times 10^{-2} \\ \theta_s &= 5.0 \times 10^{-3} \\ \xi &= 10\end{aligned}$$



$$\begin{aligned}E_0 &= 1.4 \times 10^5 \\ \theta_c &= 1.9 \times 10^{-2} \\ \theta_s &= 7.5 \times 10^{-3} \\ \xi &= 10\end{aligned}$$



How to model snow?



1 Simulations

2 Aspects of languages

3 Python variables and bindings

Q What does a computer do?



IBM Bluegene/P supercomputer (credit: unknown)

Companies using python

The popular YouTube video sharing system is largely written in Python

Google makes extensive use of Python in its web search system

Dropbox storage service codes both its server and client software primarily in Python

The Raspberry Pi single-board computer promotes Python as its educational language



RaspberryPi

COMPANIES USING PYTHON



BitTorrent[®]



BitTorrent peer-to-peer file sharing system began its life as a Python Program

NASA uses Python for specific Programming Task

The NSA uses Python for cryptography and intelligence analysis

Netflix and Yelp have both documented the role of Python in their software infrastructures

⌚ What are the primary aspects of a language?

Aspects of languages: Primitive constructs



English word cloud (credit: Michael Twardos)

```
float **  
* <= > bool  
string >= !=  
int /  
NoneType -  
- == +
```

Python word cloud (credit: unknown)

Python program

- We'll be using Python 3.x
 - a program is a sequence of definitions and commands
-
- programs manipulate **data objects**
 - objects are

Scalar objects

```
In [1]: type(5)
Out[1]: int
In [2]: type(3.0)
Out[2]: float
```

Printing to console

To show the output from code to a user print command:

```
In [1]: 3+2
```

```
Out[1]: 5    "out": interactive shell
```

```
In [2]: print(3+2)
```

```
5    "No out": Shown to user
```

Aspects of languages: Syntax and Static semantics

Syntax

Static semantics is when syntactically valid strings have meaning:

Aspects of languages: Semantics

Semantics is the meaning associated with a syntactically correct string of symbols with no static semantic errors:

- *English*: can have many meanings “Flying planes can be dangerous”.
- *programming languages*: have only one meaning but may not be what programmer intended

Expressions and operations

- Operations on ‘ints’ and ‘floats’:
 - $i + j$: *sum* (int or float)
 - $i - j$: *difference* (int or float)
 - $i * j$: *product* (int or float)
 - i / j : *division* (float)
 - $i \% j$: *remainder* of i divided by j
 - $i ** j$: i to the *power* of j

Operator precedence

()	Parantheses (grouping)
**	Exponential
+x, -x	Positive, negative
* , / , %	Multiplication, division, remainder
+ , -	Addition, subtraction

If at equal level terms are evaluated from left to right.

Where things can go wrong

- 1 Simulations
- 2 Aspects of languages
- 3 Python variables and bindings

Binding variables and values

Equal sign is an **assignment** of a value to a variable name.

```
pi = 3.14159  
pi_approx = 22/7
```

Changing bindings

- can *re-bind* variable names using new assignment statements
- previous value may still stored in memory but lost the handle for it
- value for area does not change until you tell the computer to do the calculation again

```
pi = 3
radius = 11
area = 363
radius = 14
```

Engineering approximations

π : 3.141592653589793

e: 2.7182818284590452

Engineers:



Three. Take it or leave it.

Naming matters

② What's wrong with the following code segment?

```
a = 3.14159  
b = 11.2  
c = a*(b**2)  
print(c)
```

```
pi = 3.14159  
diameter = 11.2  
area = pi*(diameter**2)  
print(area)
```