CE 311K: Introduction to Computer Methods

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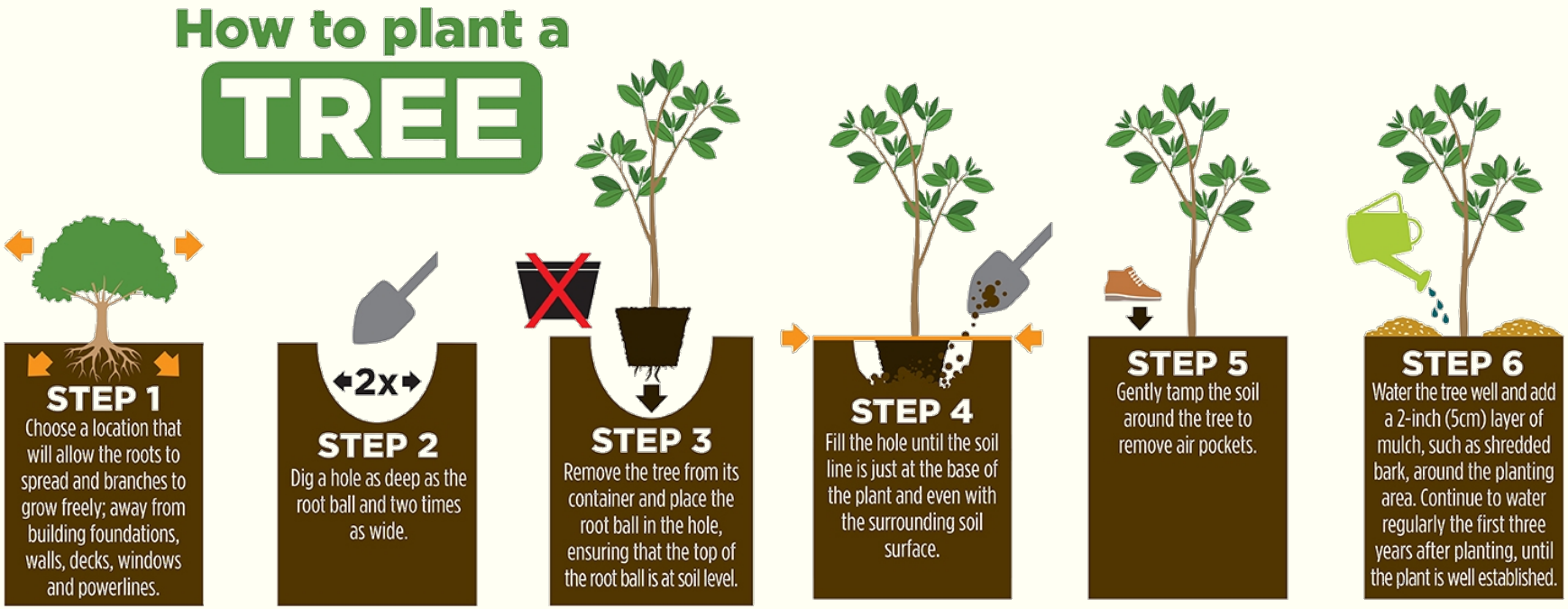
Overview

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

? How are you feeling this morning?

What is an algorithm?



? 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).

? Could you guess the storage size requirements?

To infinity and beyond...

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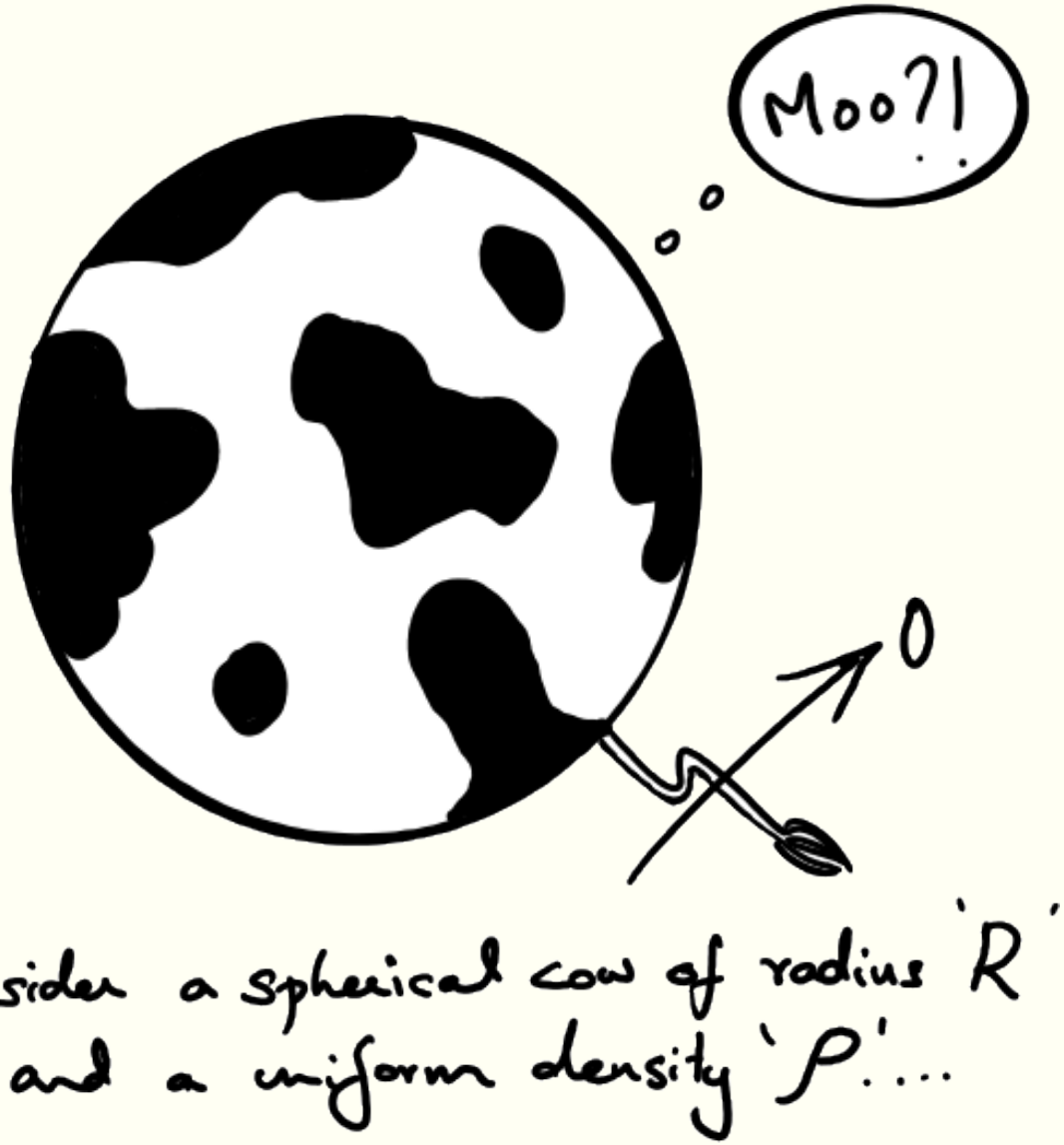
Disney's Frozen: Modeling snow

⍰How to bury Anna under the snow?

Modeling the real world: Spherical Cow

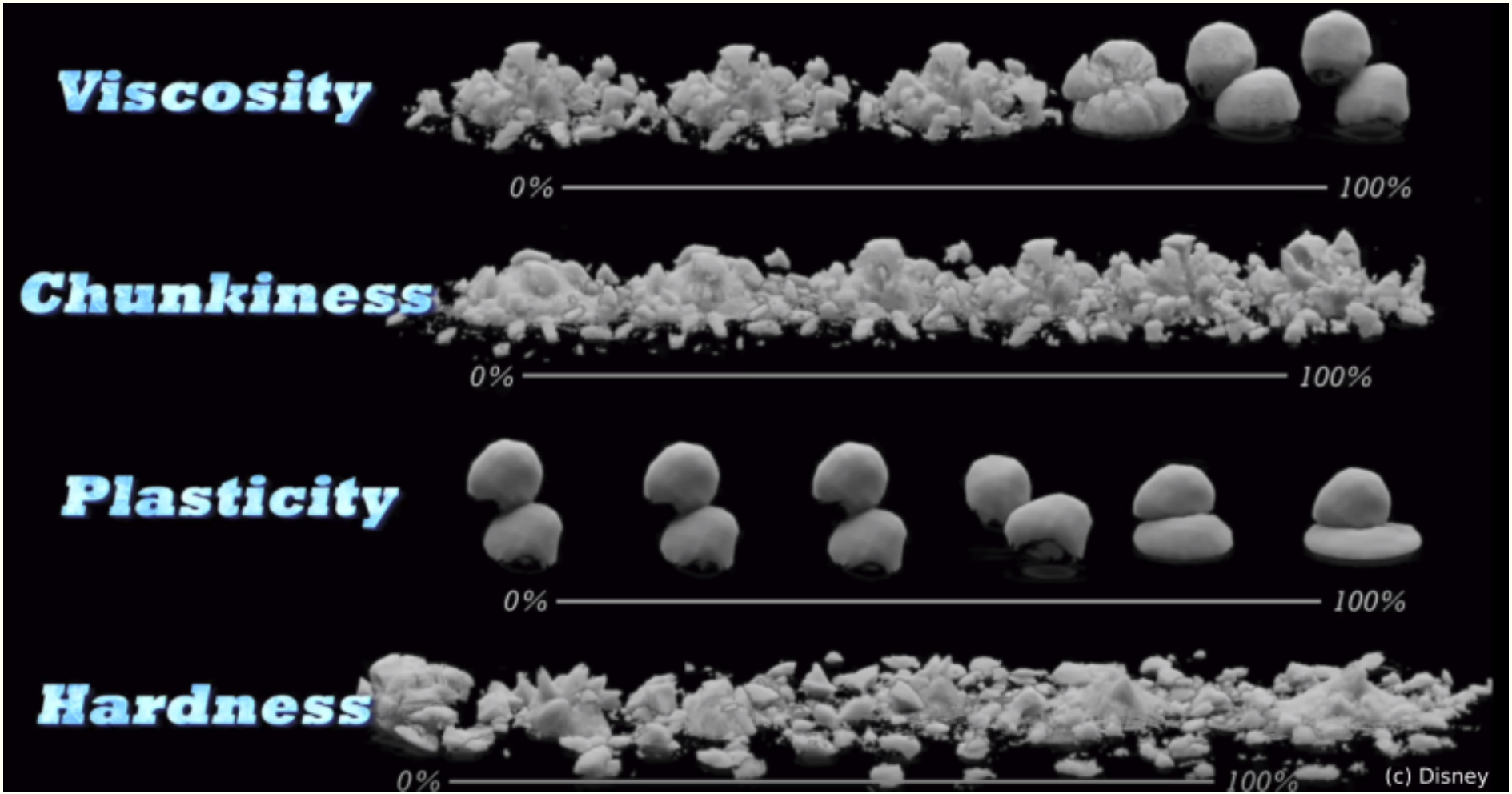


Modeling snow

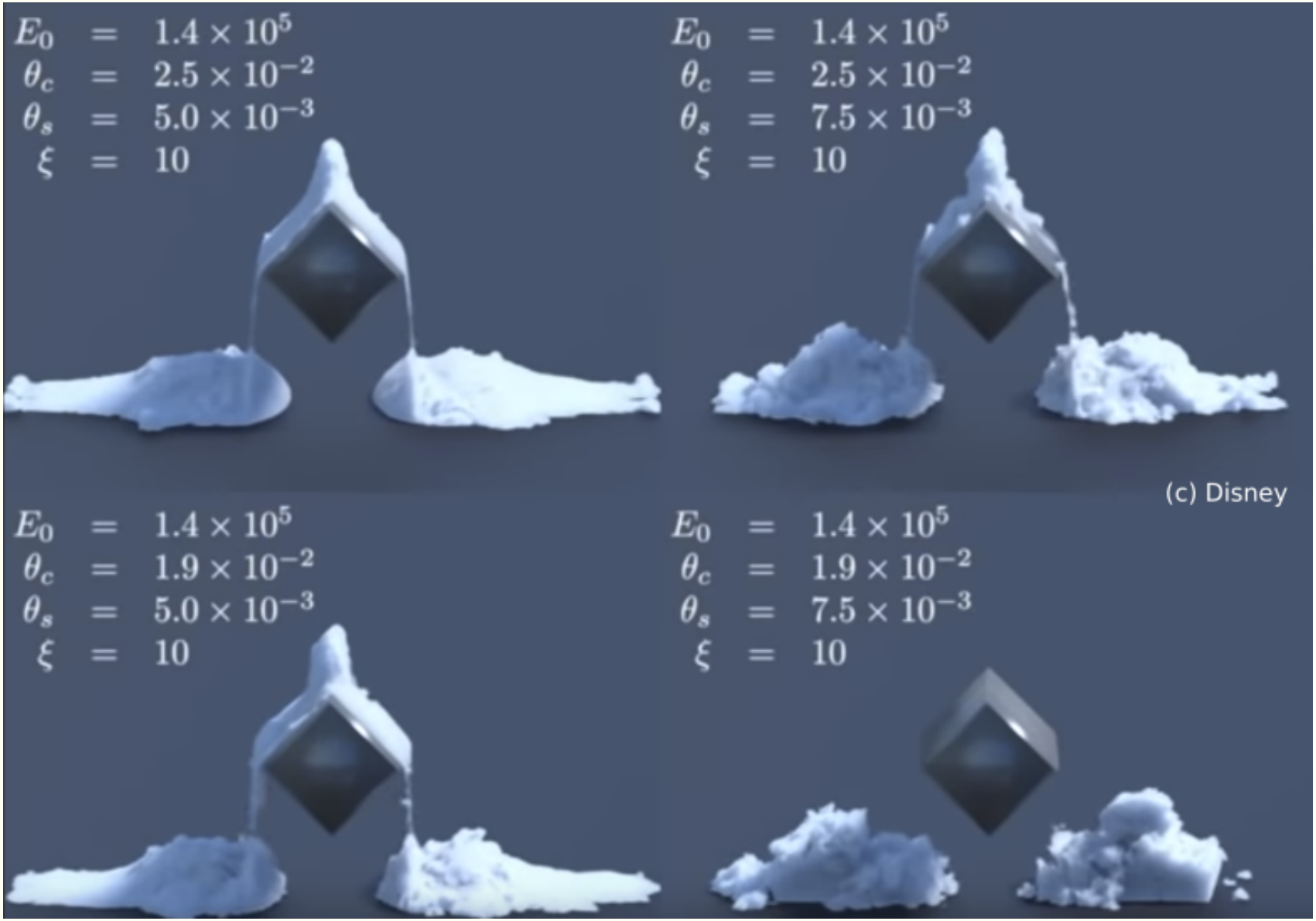
How to animate like Disney: Effect of snow quantity

What type of snow?

Snow properties



Snow material parameters



How to model snow?

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What does a computer do?

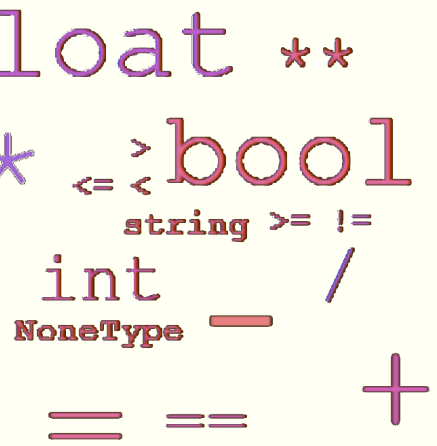
IBM Bluegene/P supercomputer (credit: unknown)

Companies using python

What are the primary aspects of a language?

Aspects of languages: Primitive constructs

English word cloud (credit: Michael Twardos)



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

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: 3.1415926535897 93

e: 2.7182818284590452

Engineers:

Naming matters

? 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)
```