MY470 Computer Programming

What Is Computation?

Week 1 Lecture

Overview

- Computational thinking and algorithms
- Computers, programming languages, and computer programs
- Objects, expressions, and variables
- Debugging
- Version control with GitHub

Computational Thinking

> Computational Thinking is the thought processes involved in formulating a problem and expressing its solution in a way that a computer — human or machine — can effectively carry out.

Wing, Jeannette M. (2006). [Computational thinking (http://tech-insider.org/academia/research/acrobat/0603.pdf)](http://tech-insider.org/academia/research/acrobat/0603.pdf). *Communications of the ACM*, 49(3), 33-35.

Defining Characteristics of Computational Thinking

Wing, Jeannette M. (2006). [Computational thinking (http://tech-insider.org/academia/research/acrobat/0603.pdf)](http://tech-insider.org/academia/research/acrobat/0603.pdf). *Communications of the ACM*, 49(3), 33-35.

- **Conceptualizing**, not programming — requires thinking at multiple levels of abstraction

- A way that **humans**, not computers, think — requires cleverness and imagination

- Combines **mathematical and engineering** thinking — dictated by the constraints of physical computing devices

- For **everyone**, everywhere — just like reading, writing, and arithmetic

Algorithms

An algorithm is a well-defined computational procedure that takes value(s) as input and produces value(s) as output.

- "Recipe" or "instructions" for solving a well-defined computational problem
- Consists of a sequence of simple steps, control flow, and a stopping rule
- Can be specified in human language or programming language (or even as hardware design)

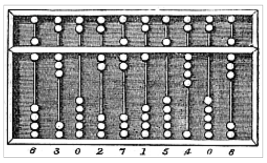
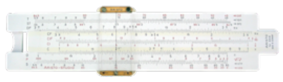
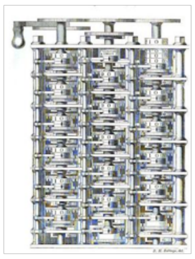
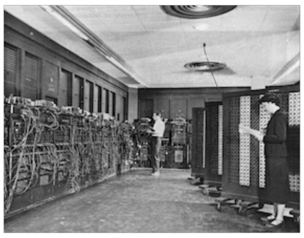
For example, **a sorting algorithm**

- Takes as input a sequence of numbers
- Returns a permutaion (an ordering) of the input sequence such that successive numbers are larger or

equal

Computers

Computers automatically perform calculations, either built-in or user-defined, and store the results.

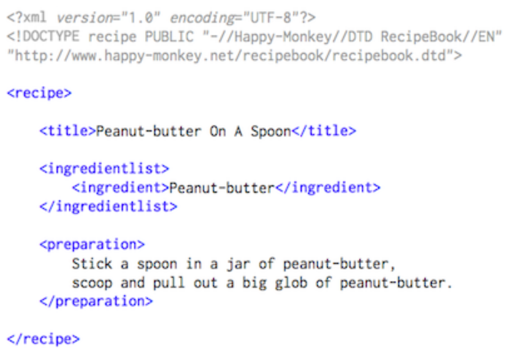
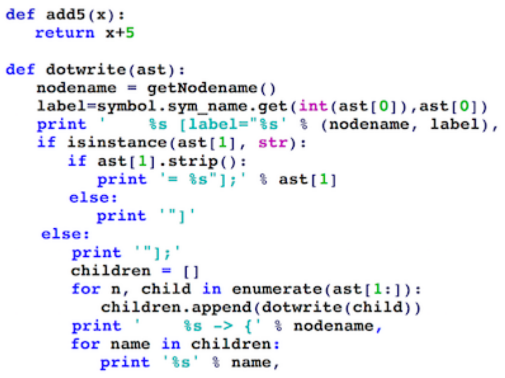
(Image sources: Wikimedia)

Programming Languages

A programming language is a formal language used to specify a set of instructions for a computer to execute.

- Primitive constructs
- Syntax
- Static semantics
- Semantics

Markup vs. Programming Languages

	Markup Languages	Programming Languages
		
Examples	TeX, HTML, XML, **Markdown**	C, Java, JavaScript, **Python**, **R**
Use	Structure and present data	Transform and generate data
Execution	Program (e.g. a browser)	Computer hardware
Structure	Inline tags	Primitive constructs, syntax, static semantics, semantics

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE recipe PUBLIC "-//Happy-Monkey//DTD RecipeBook//EN"
"http://www.happy-monkey.net/recipebook/recipebook.dtd">

<recipe>

    <title>Peanut-butter On A Spoon</title>

    <ingredientlist>
        <ingredient>Peanut-butter</ingredient>
    </ingredientlist>

    <preparation>
        Stick a spoon in a jar of peanut-butter,
        scoop and pull out a big glob of peanut-butter.
    </preparation>

</recipe>
```

```
def add5(x):
    return x+5

def dotwrite(ast):
    nodename = getNodename()
    label=symbol.sym_name.get(int(ast[0]),ast[0])
    print '    %s [label="%s' % (nodename, label),
    if isinstance(ast[1], str):
        if ast[1].strip():
            print '= %s"];' % ast[1]
        else:
            print '"]'
     else:
        print '"];'
        children = []
        for n, child in enumerate(ast[1:]):
            children.append(dotwrite(child))
        print '    %s -> {' % nodename,
        for name in children:
            print '%s' % name,
```

(Image sources: Wikimedia)

Primitive Constructs in Programming Languages

- Literals

```
In [2]: 470
```

```
Out[2]: 470
```

```
In [2]: 'MY'
Out[2]: 'MY'
```

- Infix operators

```
In [3]: 470/3
Out[3]: 156.66666666666666
```

Syntax in Programming Languages

- Rules for forming strings of characters and symbols
- Programming languages have strict syntax

```
In [4]: 470 + 0.5
Out[4]: 470.5
```

```
In [5]: 470 0.5

  File "<ipython-input-5-5a5b76bbe317>", line 1
    470 0.5
          ^
SyntaxError: invalid syntax
```

Static Semantics in Programming Languages

- Rules for forming meaningful syntactically valid strings

```
In [6]: 'MY'/470

---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-6-fb25aaf6edea> in <module>()
----> 1 'MY'/470

TypeError: unsupported operand type(s) for /: 'str' and 'int'
```

Semantics in Programming Languages

- The meaning associated with a syntactically correct string that has no static semantic errors
- Programming languages have simple semantics — statements have only one meaning

- **But this may not be the meaning the programmer had in mind!**

Types of Programming Languages

- Low-level vs. high-level
- General vs. application-targetted
- Interpreted vs. compiled

Computer Program

- A sequence of definitions and commands
    - Commands (or "statements") instruct the computer to do something
- For interpreted languages:
    - Programs are executed by the language interpreter (or "shell")
    - They can be typed directly in the shell
    - Or they can be stored in a file and run from the shell

Objects, Data Types, and Expressions

- Programs manipulate objects
- Objects have types
    - Scalar — indivisible
    - Non-scalar — with internal structure
- Expressions combine objects and operators

In [ ]:
```
# scalar objects
2
0.125
True
```

In [ ]:
```
# non-scalar objects
'This is a string.'
[1, 2, 3, 'a', 'x']
```

In [ ]:
```
# expressions
2/0.125
'MY' + '470'
```

Variables

- Variables associate objects with a name

In [ ]:
```
a = 3.14
b = 11.2
c = a*(b**2)
```

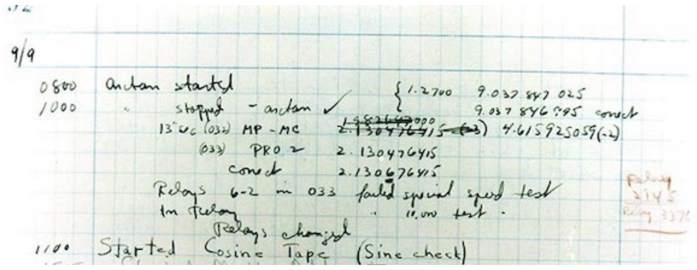
In [ ]:
```
pi = 3.14
diameter = 11.2
area = pi*(diameter**2)
```

- 📖**Variable names help humans read programs!**

- 📖**Comments also improve legibility!**

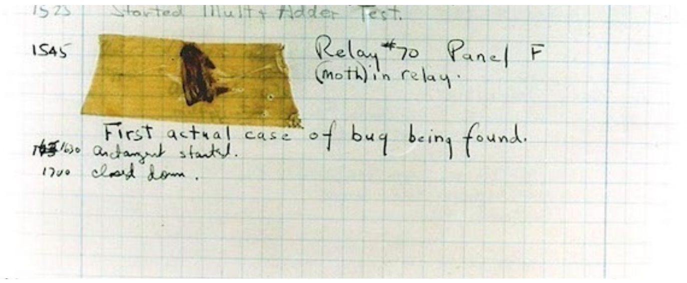
In [ ]:
```
pi = 3.14
diameter = 11.2 # diameter of circle
area = pi*((diameter/2)**2) # estimate area of circle using diameter
```

Computer Bugs



9/9

0800 Anctan started
1000 " stopped - anctan ✓ {1.2700 9.037 847 025
9.037 846 995 correct
13" uc (032) MP - MC ~~1.982147000~~ ~~2.130476415~~ (~~-3~~) 4.615925059(-2)
(033) PRO 2 2.130476415
correct 2.130676415
Relays 6-2 in 033 failed special speed test
In relay " 10,000 test .
Relays changed
1100 Started Cosine Tape (Sine check)


1525 Started Multi Adder Test.
1545 Relay #70 Panel F
(moth) in relay.
First actual case of bug being found.
1630 antangent started.
1700 closed down.

The actual first computer bug. On September 9, 1947, Admiral Grace Hopper found this moth trapped on a relay of the Harvard Mark II computer. (Image source: U.S. Naval Historical Center Online Library)

What Is Computer Programming Really about?

99 little bugs in the code,

99 bugs in the code,

1 bug fixed...run again,

100 little bugs in the code...

How to Debug: Two Options

1. **Google** the error and find an answer on **Stackoverflow**
2. Use **`print()`** systematically

The `print` Function in Python

In [7]:
```python
print('The')
print('The', 'winning', 'number', 'is', 7, '.')
print('The winning number is '+ str(7) + '.')
```

```
The
The winning number is 7 .
The winning number is 7.
```

Debugging Systematically

1. Compare input in successful and failing runs

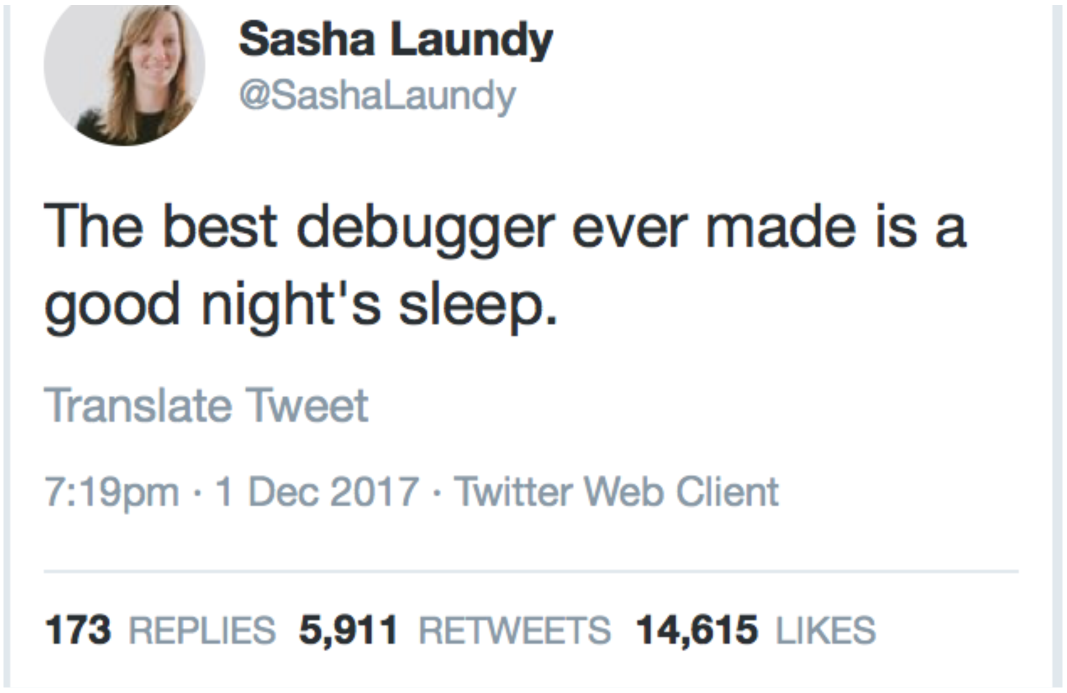
- Formulate a hypothesis
- Design an experiment to test the hypothesis; use `print()`
- Keep record of your experiment
- Repeat

After Debugging for Hours...

- Stop

- Try commenting your code or explaining it to someone else

- Sleep on it


Sasha Laundy
@SashaLaundy

The best debugger ever made is a good night's sleep.

Translate Tweet

7:19pm · 1 Dec 2017 · Twitter Web Client

173 REPLIES 5,911 RETWEETS 14,615 LIKES

(Image source: Reddit)

Version Control with GitHub

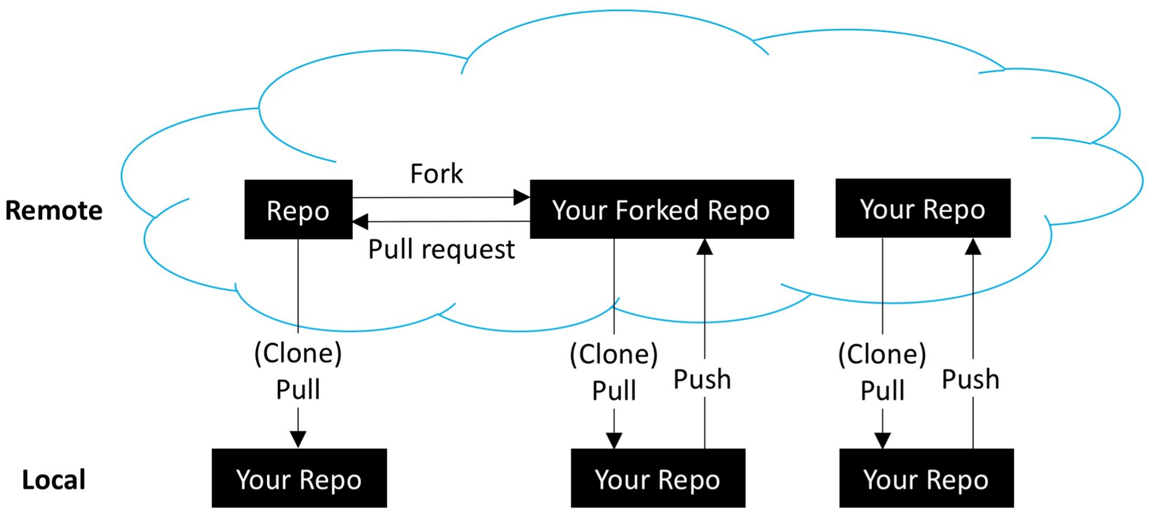
- Code hosting platform for version control and collaboration
- Based on Git
    - Version control system for tracking changes in computer files and coordinating work on those files among multiple people
    - Created in 2005 by Linus Torvalds
- Largest host of source code in the world
- Bought by Microsoft in 2018

GitHub Lingo

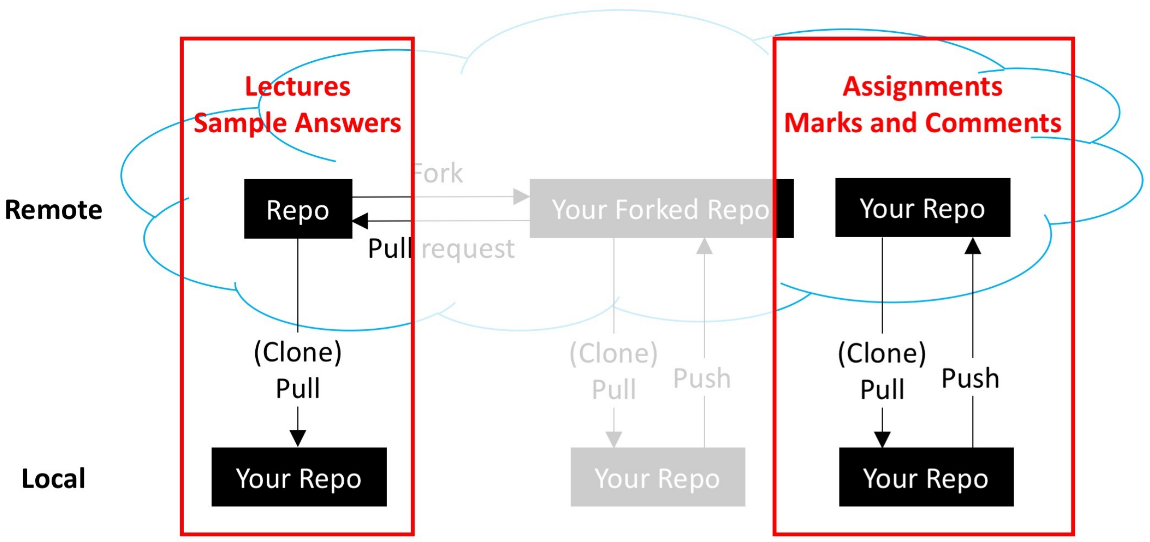
- **Repository** – a space for a project/assignment
- **Clone** – a copy of the repository that lives on your computer
- **Branch** – a paralel version of the repository

- **Commit** – save changes with a short description
- **Pull request** – ask changes to be merged
- **Merge** – incorporate changes (then delete branch)

GitHub Workflow



GitHub Workflow in MY470



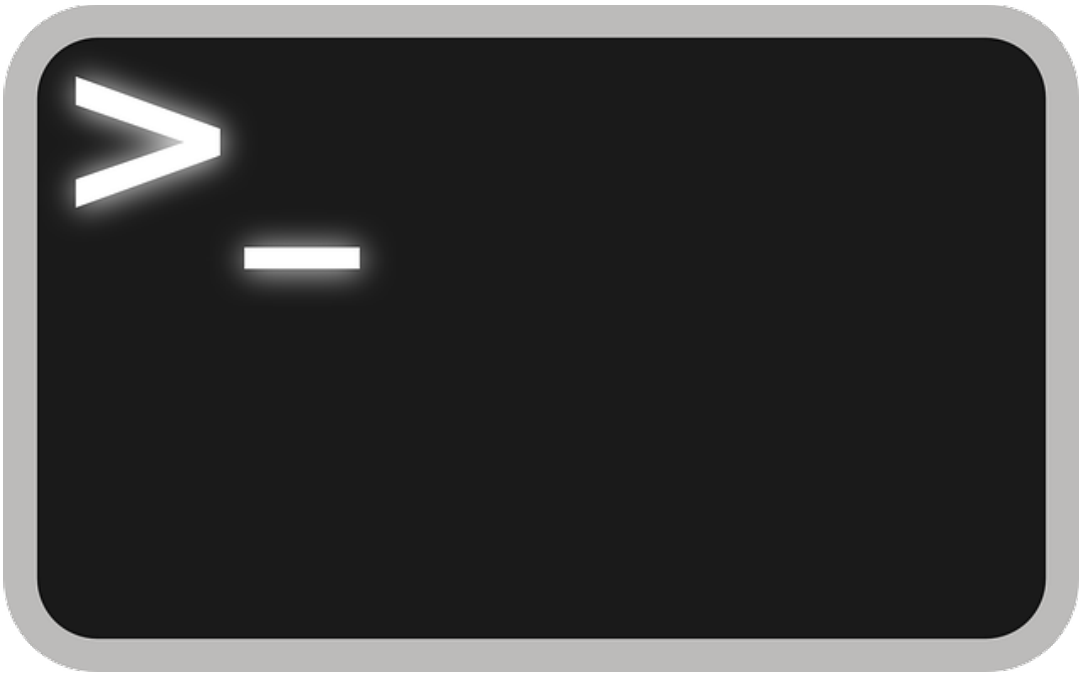
Getting Started with GitHub

- Create personal account on https://github.com/ (https://github.com/)
- Go to https://education.github.com/ (https://education.github.com/) and get the Student Developer Pack for some cool freebies

- Three ways to interact
  1. Browser (covered in lab)
  2. Command line (covered in lab)
  3. GitHub Desktop

Terminal = Console = Shell = Command Line = Command Prompt

(for our purposes here)



- Efficient way to access files, run programs, and execute code
- Allows to schedule and batch-process tasks
- Provides scripts for reproducible workflows across different operating systems

Useful Bash Commands

- Print current working directory

  ```
  pwd
  ```

- Change current working directory

  ```
  cd Path/to/directory
  ```

- Go back to the parent directory of the current one

  ```
  cd ..
  ```

- Go back to your home directory

  ```
  cd ~
  ```

- Create a new directory

  ```
  mkdir dirname
  ```

- Print a list of files and subdirectories

  ```
  ls
  ```

- Launch a Python interpreter (type `exit()` to stop and go back to bash)

  ```
  python
  ```

Change Your Default Text Editor for Git

You can use your favorite editor by customizing the Git default editor.

For example, you can use **Nano** (https://www.nano-editor.org/). It is much easier to use than Vim: `Ctrl+o` to save and `Ctrl+x` to close.

To set Nano as the default editor for your commit messages, run the following:

```
git config --global core.editor "nano"
```

Nano comes pre-installed with Linux and OS. For Windows, download and install **Nano-win** (https://github.com/mcandre/nano-win).

Important Git Commands

- Copy online repository

  ```
  git clone https://github.com/lse-my470/lectures.git
  ```

- Update local repository

  ```
  git pull
  ```

- See the status of local respository

  ```
  git status
  ```

- See the change history of local respository

  ```
  git log
  ```

- Stage all changes

  ```
  git add --all
  ```

- Commit staged changes

  ```
  git commit -m "your commit message here"
  ```

- Upload your changes to online repository

  ```
  git push
  ```

Resources

- Get started: GitHub tutorials (https://guides.github.com/)
- Get it done: Git cheatsheet (https://education.github.com/git-cheat-sheet-education.pdf)

What Is Computation?

We use programming languages to write programs that instruct computers to perform algorithms, which calculate results or process data.

- **Lab**: Installing Anaconda, working with Jupyter, and uploading assignments on GitHub
- **Problem set (FORMATIVE)**: Due at 12:00 on Monday
- **Next week**: Data types in Python