MY470_wk1_lecture

September 30, 2024

0.0.1 MY470 Computer Programming

1 What Is Computation?

1.0.1 Week 1 Lecture

1.1 Overview

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

1.2 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. *Communications of the ACM*, 49(3), 33-35.

1.2.1 Defining Characteristics of Computational Thinking

Wing, Jeannette M. (2006). Computational thinking. *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

1.3 Algorithms

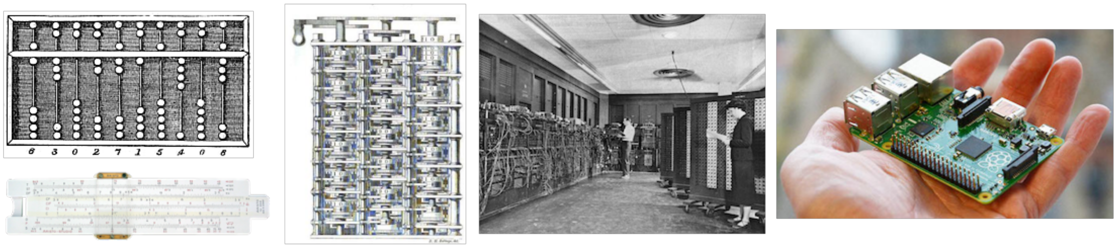
An algorithm is a well-defined computational procedure that takes value(s) as input and produces value(s) as output.

- "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 permutation (an ordering) of the input sequence such that successive numbers are larger or equal

1.4 Computers

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



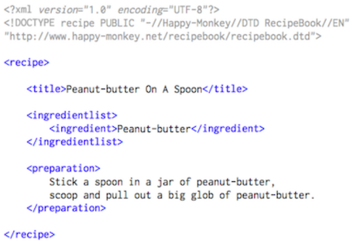
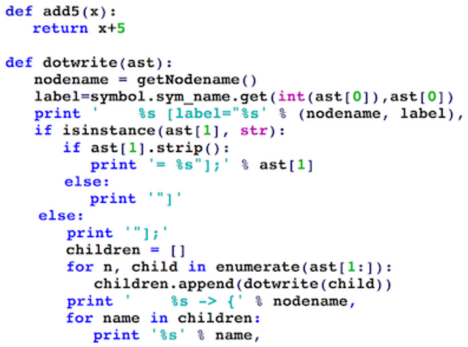
(Image sources: Wikimedia)

1.5 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

1.6 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)

1.6.1 Primitive Constructs in Programming Languages

- Literals

```
[2]: 470
```

```
[2]: 470
```

```
[2]: 'MY'
```

```
[2]: 'MY'
```

- Infix operators

```
[3]: 470/3
```

```
[3]: 156.66666666666666
```

1.6.2 Syntax in Programming Languages

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

```
[4]: 470 + 0.5
```

```
[4]: 470.5
```

```
[5]: 470 0.5
```

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

1.6.3 Static Semantics in Programming Languages

- Rules for forming meaningful syntactically valid strings

```
[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'
```

1.6.4 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!**

1.7 Types of Programming Languages

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

1.8 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

1.9 Objects, Data Types, and Expressions

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

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

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

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

1.10 Variables

- Variables associate objects with a name

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

[ ]:

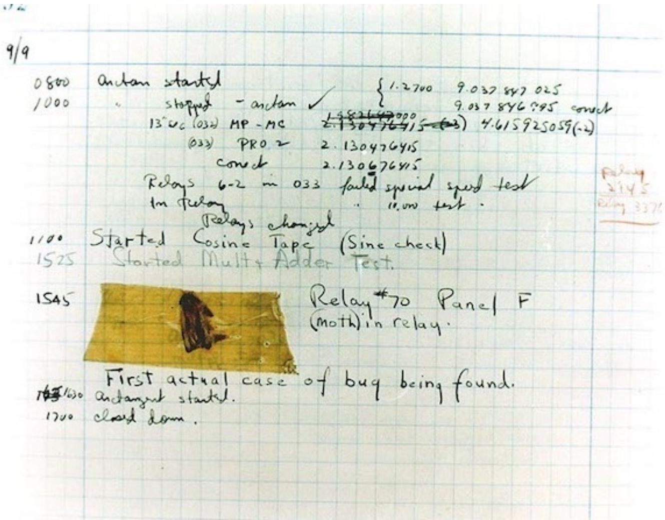
```
pi = 3.14
diameter = 11.2
area = pi*(diameter**2)
```

- **Variable names help humans read programs!**
- **Comments also improve legibility!**

[ ]:

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

1.11 Computer Bugs



9/9

0800 Arctan started

1000 " stopped - arctan ✓ {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 " 11,000 test .

Relays changed

1100 Started Cosine Tape (Sine check)

1525 Started Mult + Adder Test.

1545 Relay #70 Panel F

(moth) in relay.

First actual case of bug being found.

~~1525~~ 1630 Arctangent started.

1700 closed down.

Relay 2145

Relay 3370

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)

1.12 How Does Debugging Typically Go?

99 little bugs in the code,

99 bugs in the code,

1 bug fixed…run again,

100 little bugs in the code…

1.13 How to Debug: Two Options

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

1.14 The `print` Function in Python

[7]:

```python
print('The')
print('The', 'winning', 'number', 'is', 7, '.')
print('The winning number is '+ str(7) + '.')
```

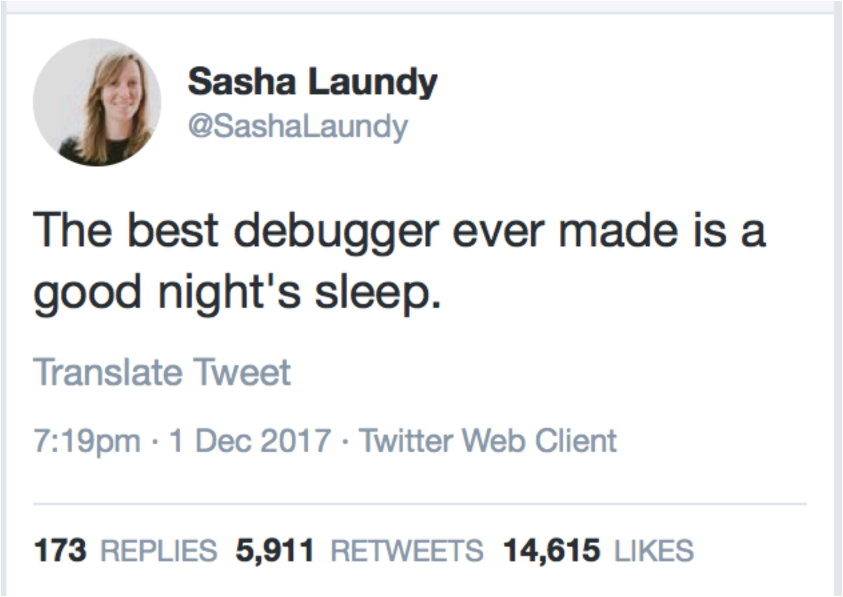
```
The
The winning number is 7 .
The winning number is 7.
```

1.15 Debugging Systematically

1. Compare input in successful and failing runs
2. Formulate a hypothesis
3. Design an experiment to test the hypothesis; use `print()`
4. Keep record of your experiment
5. Repeat

1.16 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.

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

173 REPLIES **5,911** RETWEETS **14,615** LIKES

(Image source: Reddit)

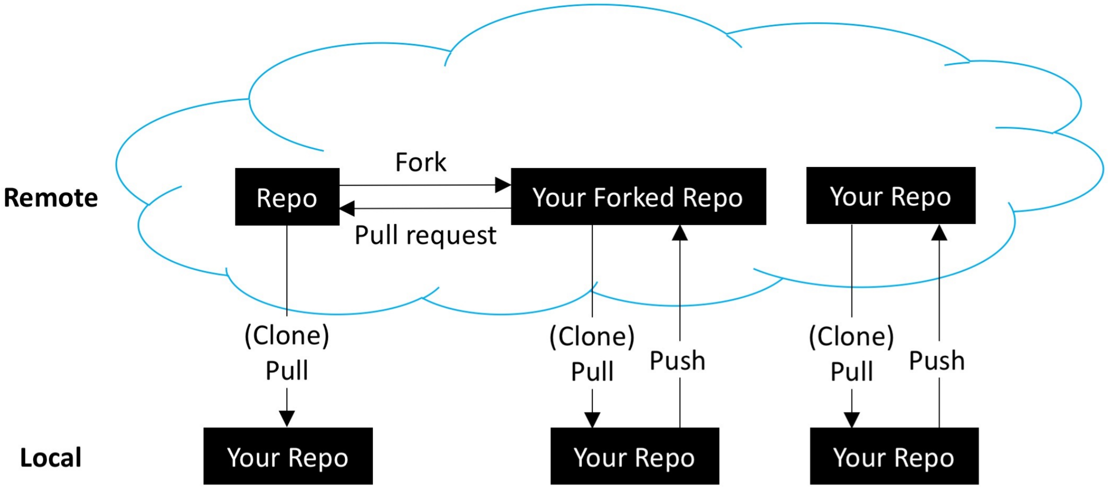
1.17 Version Control with GitHub

- 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

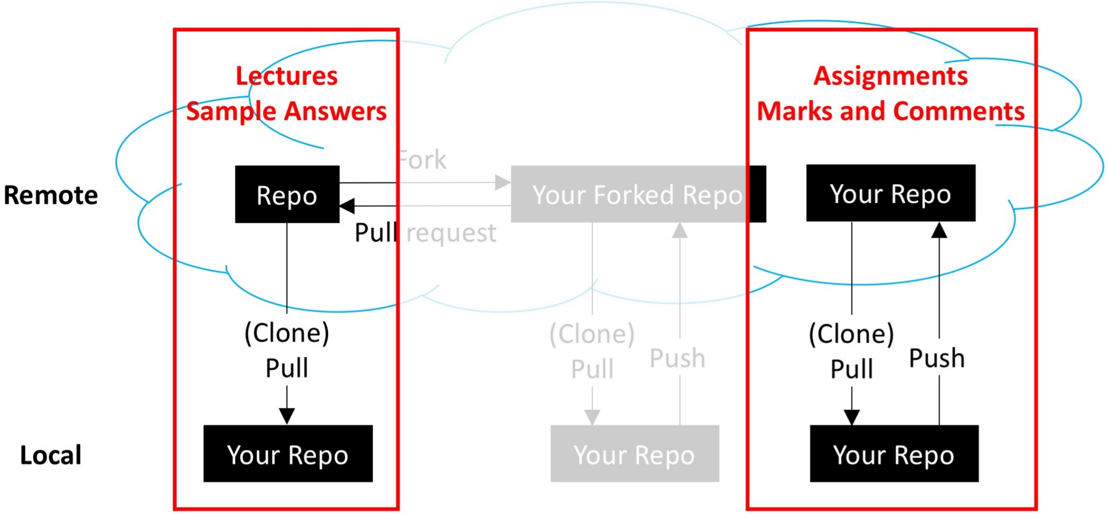
1.18 GitHub Lingo

- **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)

1.19 GitHub Workflow



1.20 GitHub Workflow in MY470

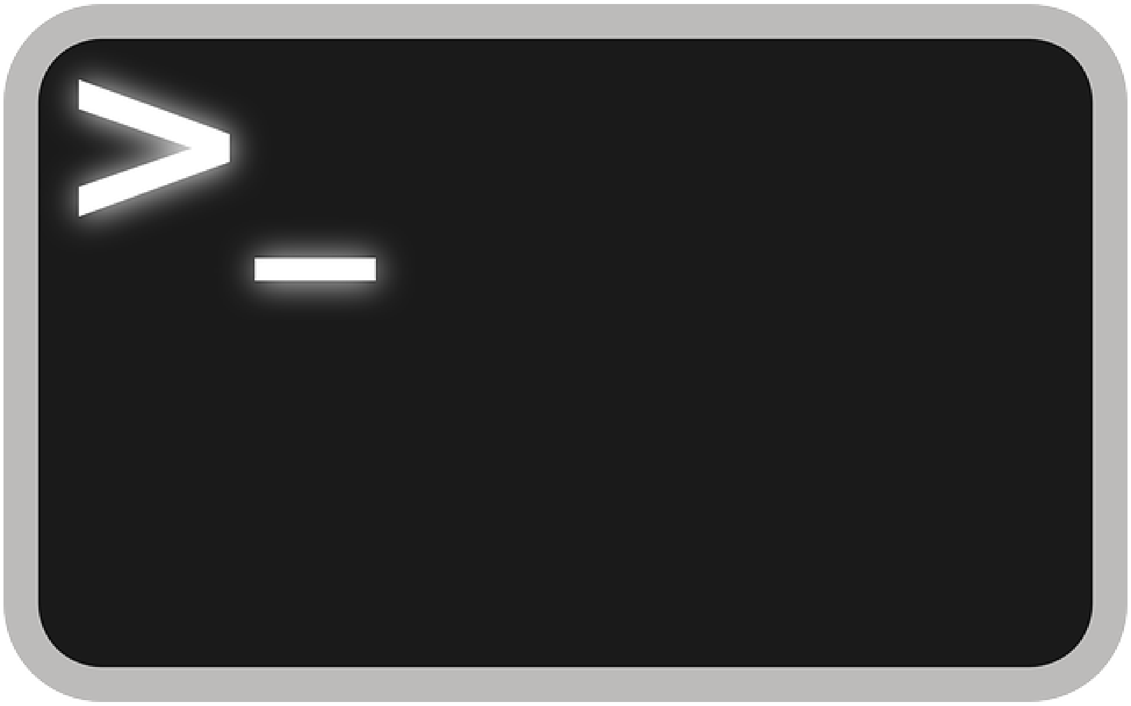


1.21 Getting Started with GitHub

- Create personal account on https://github.com/
- Go to https://education.github.com/ and get the Student Developer Pack for some cool freebies
- Three ways to interact (covered in lab)
  1. Browser
  2. Command line
  3. VS Code (or alternative IDE/app)

1.22 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

1.23 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
```

1.24 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**. 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**.

1.25 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
```

1.26 Resources

- Get started: GitHub tutorials
- Get it done: Git cheatsheet

1.27 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 VS Code and Jupyter notebooks, uploading assignments on GitHub
- **Next week**: Data types in Python