Programming Foundations in Python
Adapted From: CMSC 201 Computer Science I for Majors

Lecture 05 – Algorithmic Thinking

Last Class We Covered

- Decision structures

- One-way (using **`if`**)
- Two-way (using **`if`** and **`else`**)
- Multi-way (using **`if`**, **`elif`**, and **`else`**)

- Nested decision structures

Any Questions from Last Time?

Today's Objectives

- To practice thinking algorithmically
- To understand and be able to implement proper program development
  - To learn more about "bugs"
- To get practice with decision structures

What is an Algorithm?

- Steps used to solve a problem

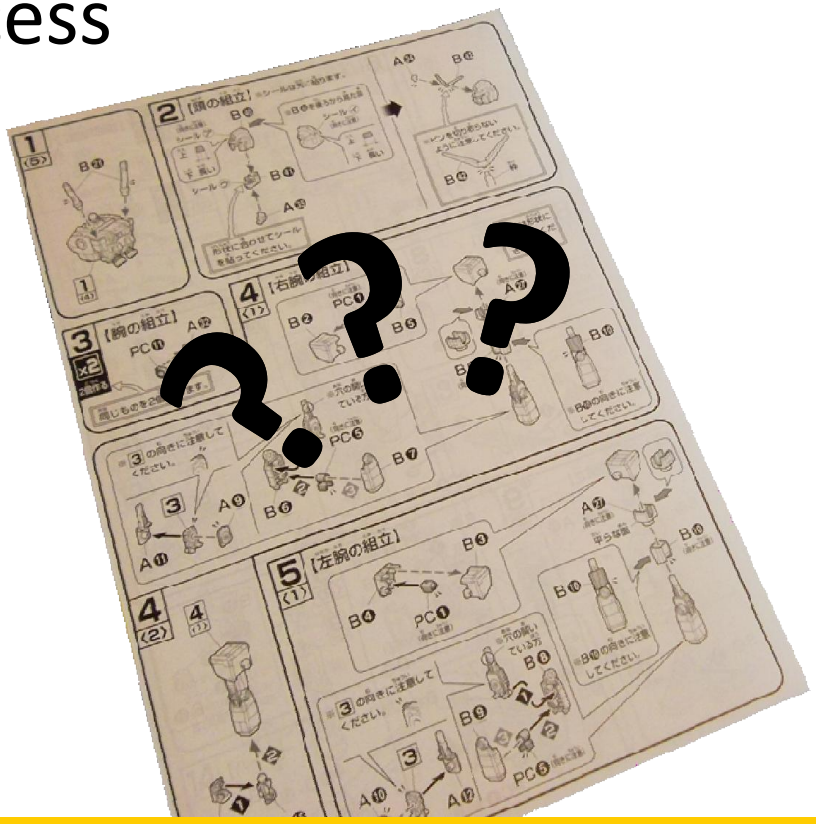
- Problem must be
  - Well defined
  - Fully understood by the programmer

- Steps must be
  - Ordered
  - Unambiguous
  - Complete

Algorithmic Thinking

- Algorithms are an ordered set of clear steps that fully describes a process

- Examples from real life?
  - Recipes
  - Driving directions
  - Instruction manual



Developing an Algorithm

Program Development

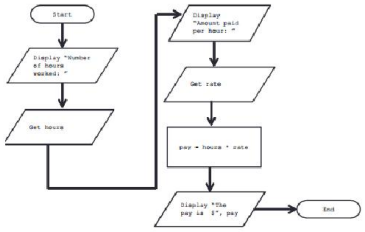
1. Understand the problem
2. Represent your solution (your algorithm)
   - Pseudocode
   - Flowchart
3. Implement the algorithm in a program
4. Test and debug your program

Step 1: Understanding the Problem

- Input
  - What information or data are you given?
- Process
  - What must you do with the information/data?
  - **This is your algorithm!**
- Output
  - What are your deliverables?

Step 2: Represent the Algorithm

- Can be done with flowchart or ***pseudocode***
- Flowchart



  - Symbols convey different types of actions
- Pseudocode
  - A cross between code and plain English
- One may be easier for you – use that one

Steps 3 and 4: Implementation and Testing/Debugging

- Implementing and testing/debugging your program are two steps that go hand in hand

- After implementing, you must test it
- After discovering errors, you must find them
  - Once found, you must fix them
  - Once found and fixed, you must test again

Development Example: Weekly Pay

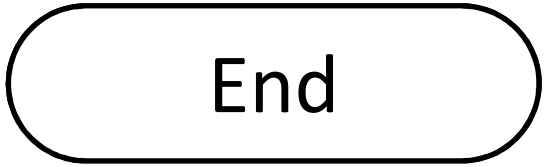
- Create a program to calculate the weekly pay of an hourly employee
  - What is the input, process, and output?

- Input: pay rate and number of hours
- Process: multiply pay rate by number of hours
- Output: weekly pay

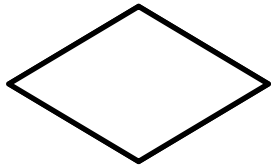
Flowchart Symbols

Start Symbol

Input/Output



End Symbol

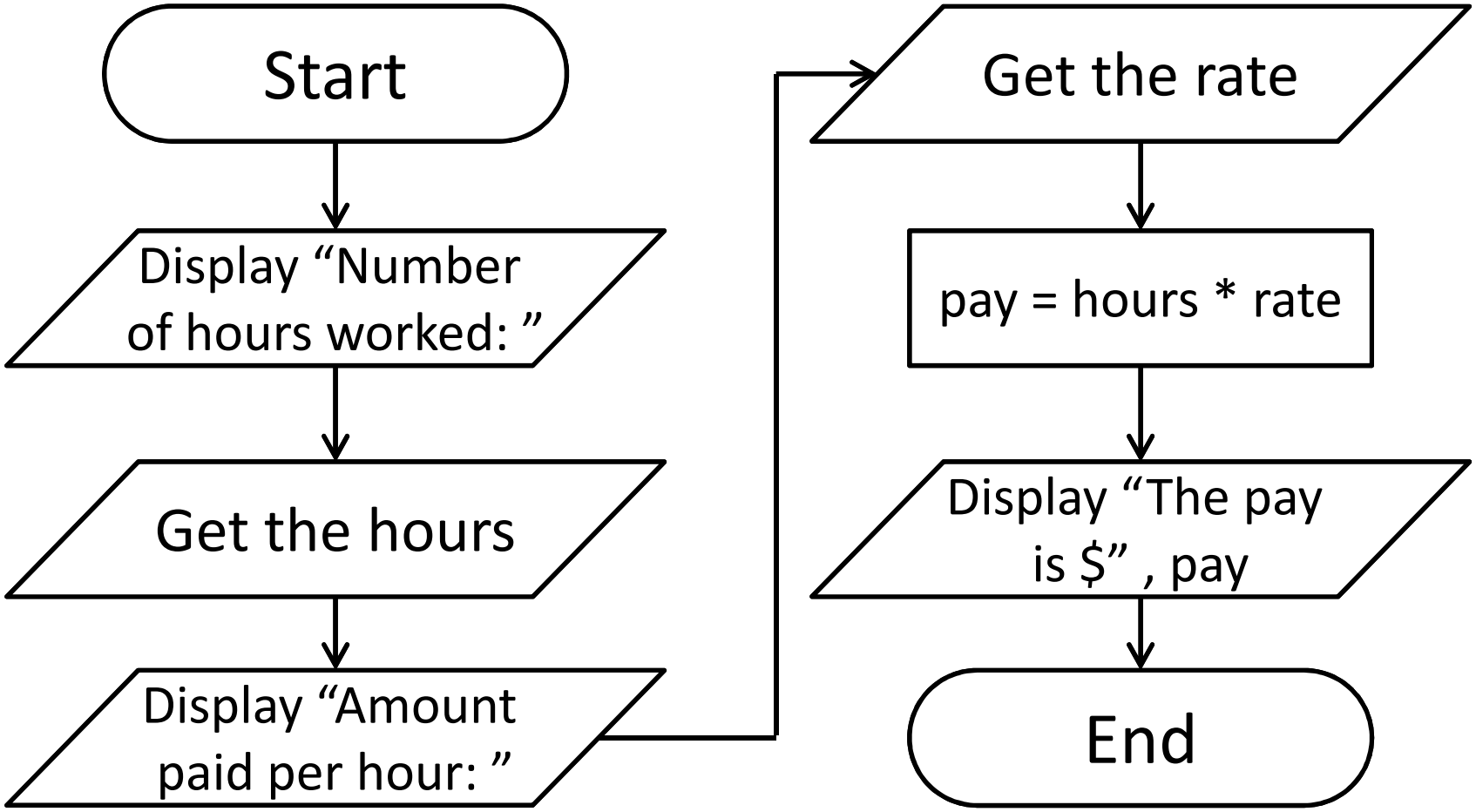


Decision Symbol

Data Processing Symbol

Flow Control Arrows

Step 2A: Flowchart



Step 2B: Pseudocode

- Start with a plain English description, then…

```
1. Display "Number of hours worked: "
2. Get the hours
3. Display "Amount paid per hour: "
4. Get the rate
5. Compute pay = hours * rate
6. Display "The pay is $" , pay
```

Algorithms and Language

- Notice that developing the algorithm didn't involve any Python at all
  - Only pseudocode or a flowchart was needed
  - An algorithm can be coded up in any language
- All languages share certain tools that can be used in your algorithms
  - For example, ***control structures*** and ***expressions***

Debugging

Where did the name ‘bug’ originate from?

A Bit of History on "Bugs"

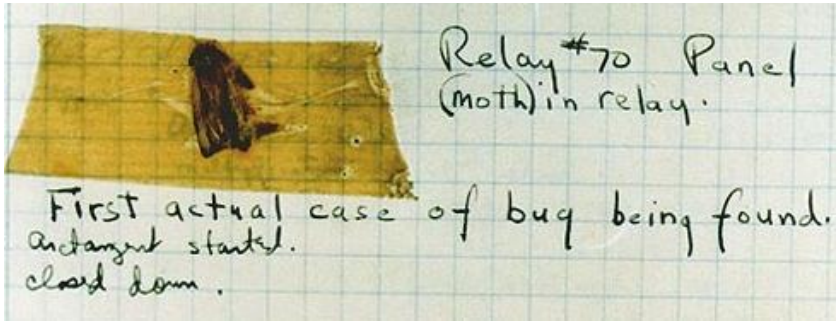
Rear Admiral Grace Hopper

- US Navy lab (Sep 1947)
- Grace Hopper and her colleagues were working on the Harvard Mark II
  - Instructions read one at a time from a tape
- Or trying to… it wasn't working right

A Bit of History on "Bugs"

Mark II, general view of calculator frontpiece, 1948.

- Mark II was a LARGE machine that took up an entire room
  - You could open each panel and look inside
- They found a moth inside the machine
  - Taped the bug into their log book



Errors ("Bugs")

- Two main classifications of errors

- Syntax errors
  - Prevent Python from understanding what to do
- Logical errors
  - Cause the program to run incorrectly, or to not do what you want

PB&J Using Exact Instructions

- "You're not even making any sense! He's already ruined it on purpose, he knows how to make one."
- Watch the video here
  - (Image from Josh Darnit's Exact Instructions Challenge)

https://www.youtube.com/watch?v=cDA3_5982h8&feature=youtu.be&t=12s

Syntax Errors

- "Syntax" is the set of rules followed by a computer programming language
  - Similar to grammar and spelling in English
- Examples of Python's syntax rules:
  - Keywords must be spelled correctly

    `True` and **`False`**, not **`Ture`** or **`Flase`** or **`Truu`**
  - Quotes and parentheses must be closed in order:

```
("open and close")
```

Syntax Error Examples

- Find the syntax errors in each line of code below:

```
1    prnit("Hello")
2    print("What"s up?")
3    print("Aloha!)
4    print("Good Monring")
```

Syntax Error Examples

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```

not actually a syntax error

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```

The syntax highlighting in your code editor can often help you see where the errors are

Logical Errors

- Logical errors don't bother Python at all… they only bother you!

- Examples of logical errors:
  - Using the wrong value for something

```
currentYear = 2013
```

  - Doing steps in the wrong order
    - "Place pan in the oven. Preheat oven to 350. Pour batter into pan, spreading evenly."

Comments in Debugging

- Comments are often used to convey what your program is doing
  - If there is a bug, however, your code may not actually be accomplishing that task
- Comments are very useful when debugging, because they separate intent from actuality
  - "Is your code working?" and "Is your code doing what it's supposed to do?" are very different questions

Practicing Decision Structures

Exercise: Moving on to CMSC 202

- Ask the user their major and the grade they earned in CMSC 201
  - Print out whether they can move on to CMSC 202 next semester
- If they're a CMSC or CMPE major
  - They need an A or a B
- Otherwise
  - They need an A, B, or a C

Image Sources

- IKEA instructions (adapted from):
  - https://www.flickr.com/photos/girlinblack/6697086037
- Rear Admiral Grace Hopper:
  - https://commons.wikimedia.org/wiki/File:Grace_Hopper.jpg
- Mark II:
  - http://amhistory.si.edu/archives/images/d8324-1.jpg
- Notebook bug (adapted from):
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