CMSC201
Computer Science I for Majors

Lecture 02 – Algorithmic Thinking

Prof. Katherine Gibson

Prof. Jeremy Dixon

Last Class We Covered

- Syllabus
  - Grading scheme, expectations, etc.
  - Academic Integrity Policy
- Computer System Components
- Binary numbers
  - Converting between binary and decimal
- Algorithmic thinking
  - Making sandwiches for aliens

Any Questions from Last Time?

Today's Objectives

- To practice thinking algorithmically
- To understand and be able to implement proper program development
- To start learning about control structures
- To be able to express an algorithm using a flow chart

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

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?

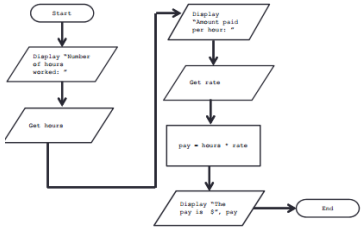
"Weekly Pay" Example

- 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

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

Step 2A: Pseudocode

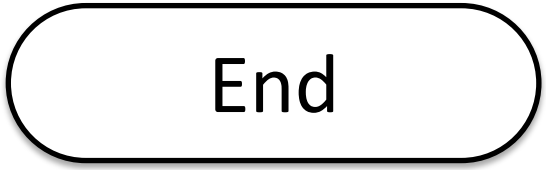
- Start with a plain English description, then…

```
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
```

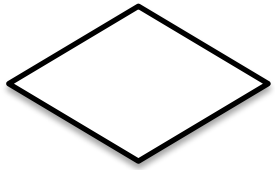
Flowchart Symbols

Start Symbol

Input/Output



End Symbol

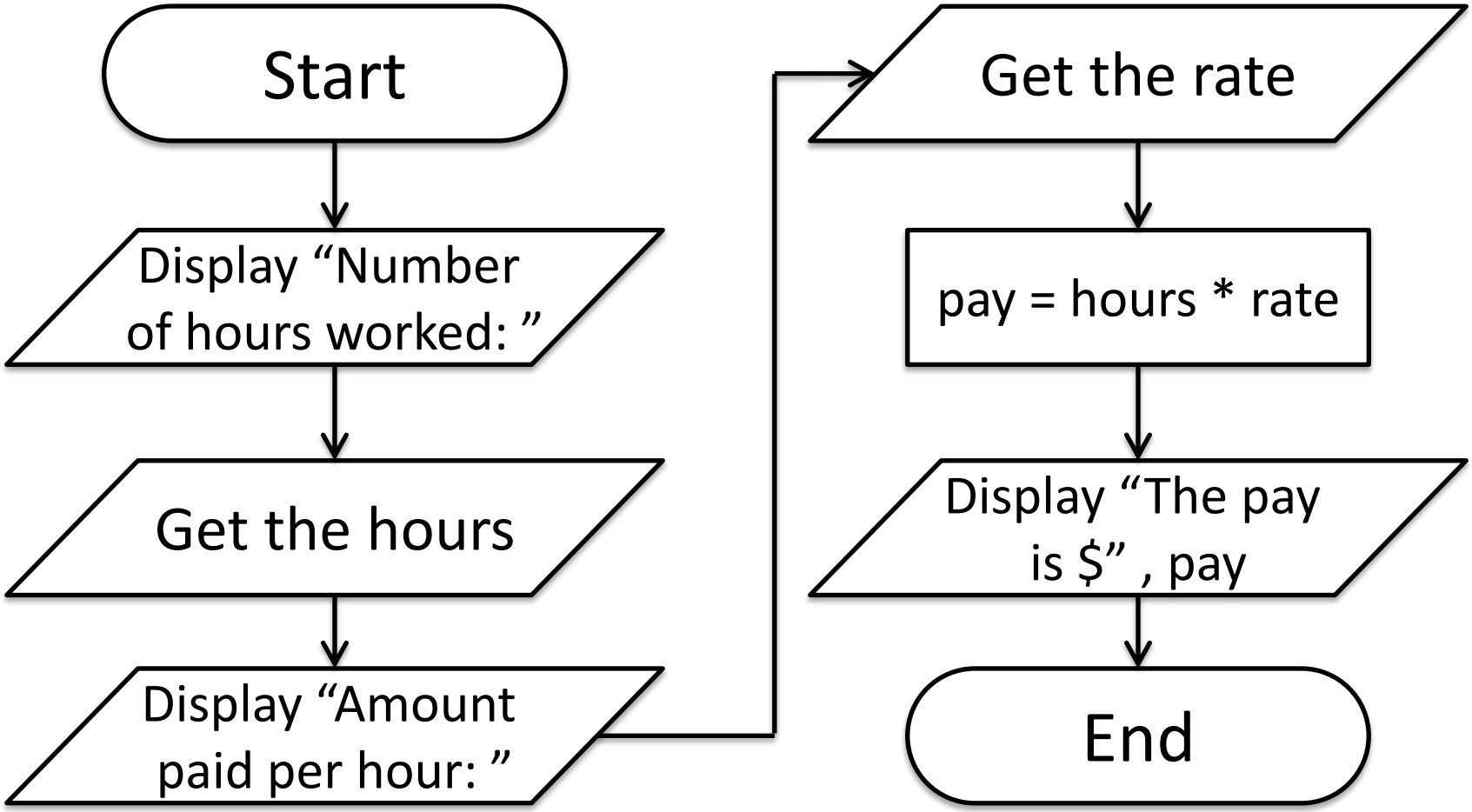


Decision Symbol

Data Processing Symbol

Flow Control Arrows

Step 2B: Flowchart



Steps 3 and 4: Implementation and Testing/Debugging

- We'll cover implementation in detail next class

- Testing and debugging your program involves identifying errors and fixing them
  - We'll talk about this later today

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 in any language
- All languages have 3 important control structures we can use in our algorithms

Control Structures

Control Structures

- Structures that control how the program "flows" or operates, and in what order

- Sequence
- Decision Making
- Looping

Sequence

- One step after another, with no branches
- Already wrote one for “Weekly Pay” problem
- What are some real life examples?
  - Dialing a phone number
  - Purchasing and paying for groceries

Decision Making

- Selecting one choice from many based on a specific reason or condition
  - If something is true, do ***A*** … if it's not, do ***B***

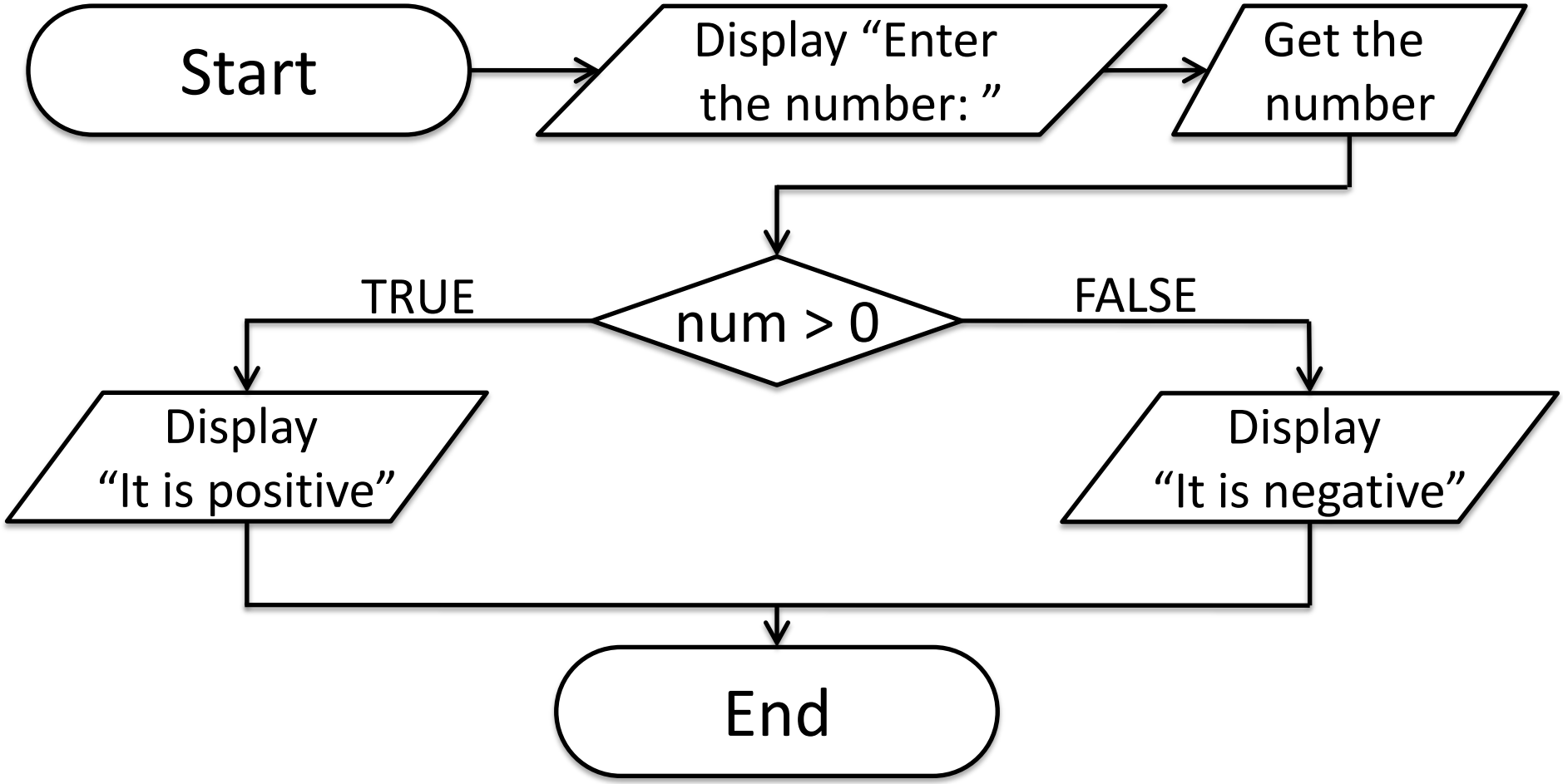
- What are some real life examples?
  - Walking around campus (construction!)
  - Choosing where to eat lunch

Decision Making: Pseudocode

- Answer the question "Is a number positive?"
  - Start with a plain English description

```
1. Display "Enter the number: "
2. Get the number (call it num)
3. If num > 0
4.     Display "It is positive"
5. Else
6.     Display "It is negative"
```

Decision Making: Flowchart



Looping

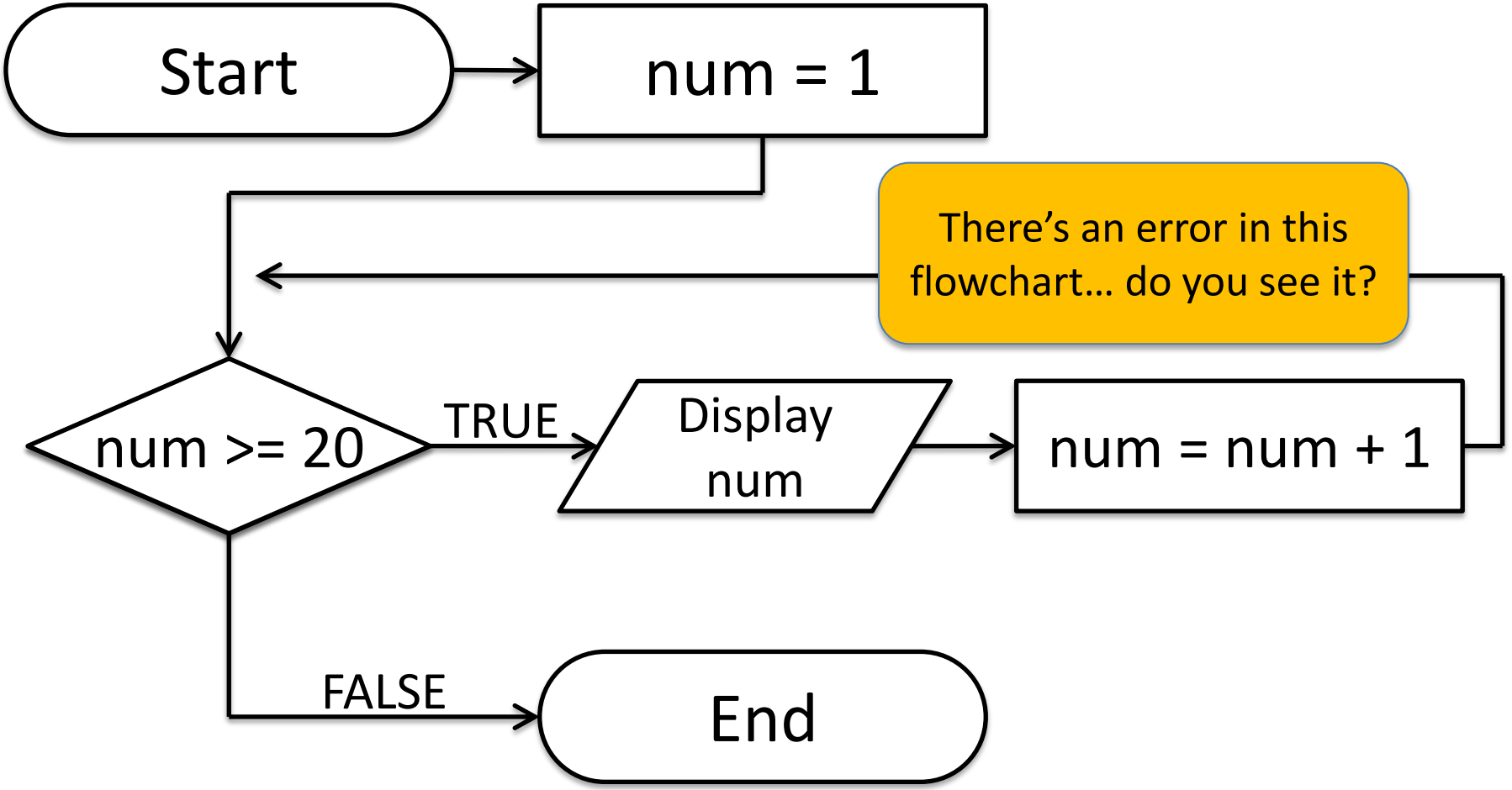
- Doing something over and over again
- Used in combination with decision making
  - Otherwise we loop forever
    - This is called an “infinite loop”
- What are some real life examples?
  - Doing homework problem sets
  - Walking up steps

Looping: Pseudocode

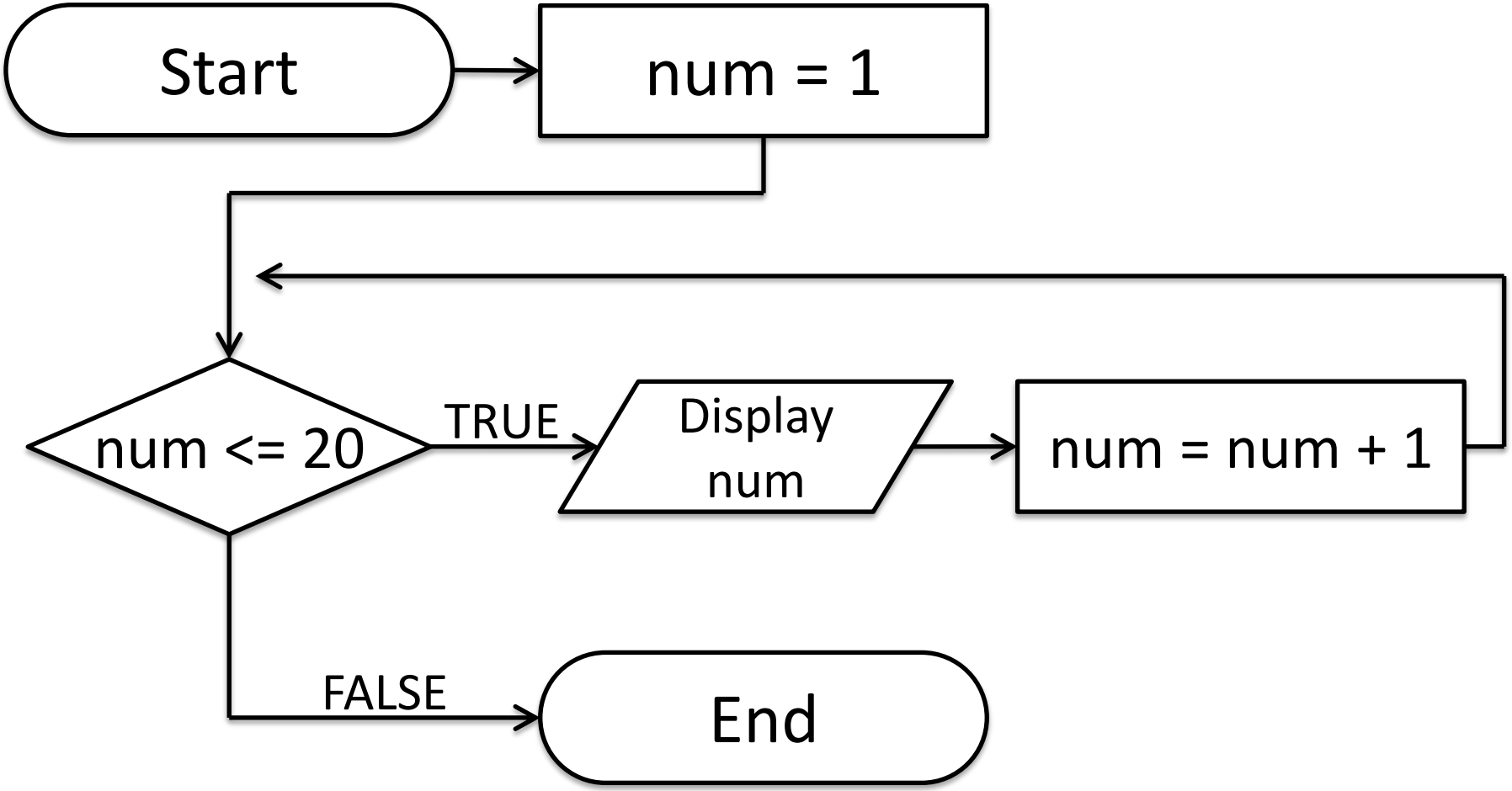
- Write an algorithm that counts from 1-20
  - Start with a plain English description

```
1. Set num = 1
2. While num <= 20
3.     Display num
4.     num = num + 1
5. (End loop)
```

Looping: Flowchart



Looping: Flowchart

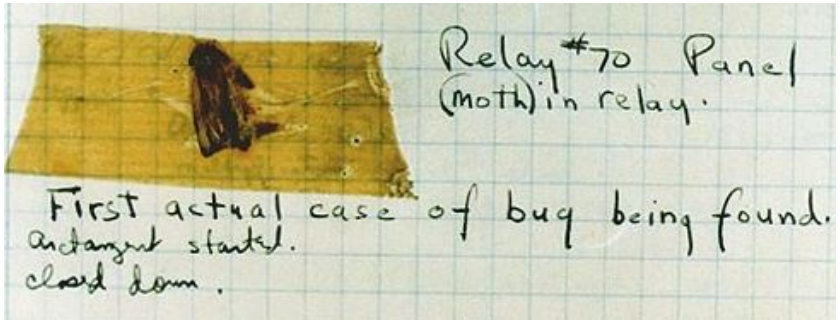


Debugging

A Bit of History on "Bugs"

- US Navy lab – September 9, 1947
- Grace Hopper and her colleagues were working on the Harvard Mark II
  - Or trying to… it wasn't working right

- They found a literal bug inside the machine
  - Taped the bug (a moth) 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

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:

```
("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

- 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")
```

not actually a syntax error

Logical Errors

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

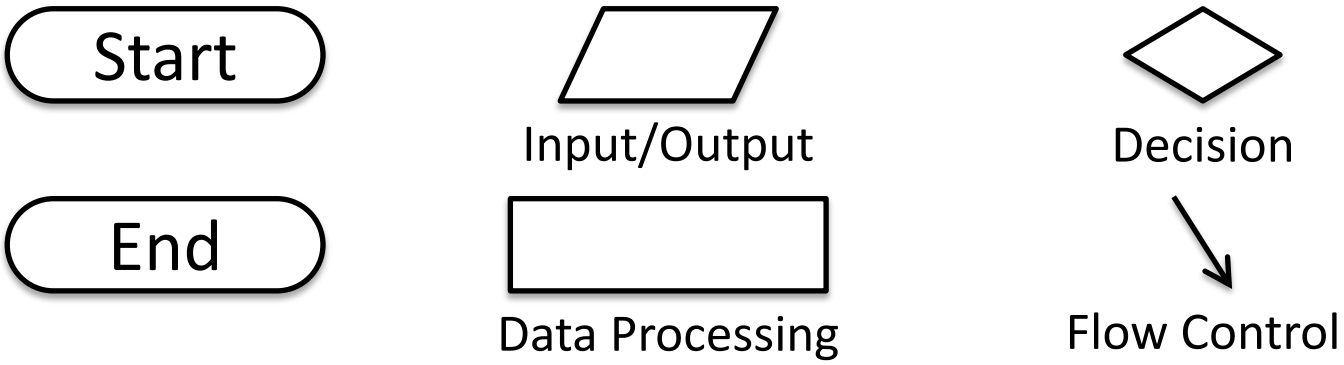
- Examples of logical errors:
  - Using the wrong value for something

```
currentYear = 2013
```

  - Doing steps in the wrong order
    - "Close jelly jar. Put jelly on bread. Open jelly jar."

Exercise

- Write an algorithm that asks a user for their name, then responds with “Hello NAME”
- You can use a flowchart or pseudocode

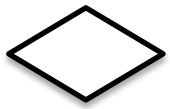


Exercise #2

- Write an algorithm that asks a user for their grade, and tells them their letter grade.

A: 100 - 90
B: <90 - 80
C: <80 - 70
D: <70 - 60
F: <60 - 0

Input/Output



Decision

Data Processing

Flow Control

Announcements

- Your Lab 0 is an in-person lab this week!
  - You need to go to your labs during your assigned lab time
- Homework 1 is out
  - Due by next Monday (Feb 8th) at 8:59:59 PM
- Both of these assignments are on Blackboard

Practice Problems

- Complete the 2 exercises on the previous slides
- Modify our "count to 20" algorithm so that it counts from 0 to 100, in increments of 5
- Design an algorithm that finds the average of three exam scores (pseudocode or flowchart)
- Advanced: Design an algorithm that asks the user for two numbers, and then asks them if they want to multiply, add, or subtract the numbers from each other; perform the operation the user wanted, and show them the result