CMSC201
Computer Science I for Majors

Lecture 06 – While Loops

Last Class We Covered

- Algorithms
- Program design
  - Input, process, output
  - Flowcharts and pseudocode
- Syntax and Logic Errors
- Decision structure practice

Any Questions from Last Time?

Today’s Objectives

- To learn about and use a **`while`** loop
  - To understand the syntax of a **`while`** loop
  - To use a **`while`** loop for interactive loops
  - To learn about infinite loops
    - (And how to avoid them)

- To practice conditionals

Practice: **if**, **elif**, and **else**

```
if
else
elif
```

```
if
if
elif
else
```

```
if
elif
```

```
if
elif
elif
else
else
```

```
if
    if
    if
else
    if
```

```
if
elif
if
elif
```

```
if
else
    if
    elif
    elif
else
```

Practice: `if`, `elif`, and `else`

```
if
else
elif
```

✗

```
if
if
elif
else
```

✓

```
if
elif
```

✓

```
if
elif
elif
else
else
```

✗

```
if
   if
   if
else
   if
```

✓

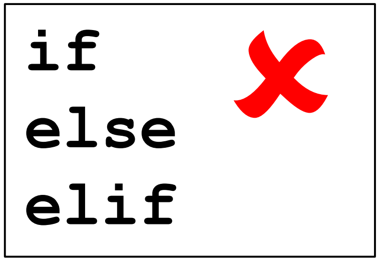
```
if
elif
if
elif
```

✓

```
if
else
   if
   elif
   elif
else
```

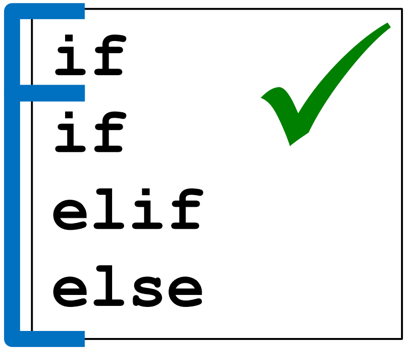
✗

Practice: `if`, `elif`, and `else`



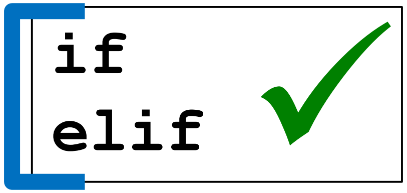
```
if
else
elif
```

✗



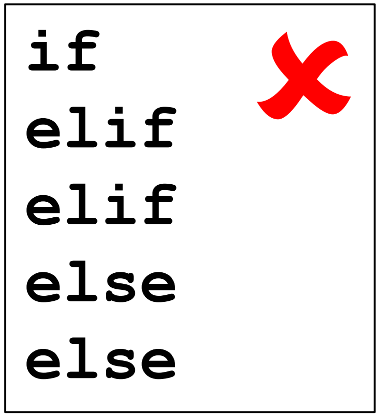
```
if
if
elif
else
```

✓



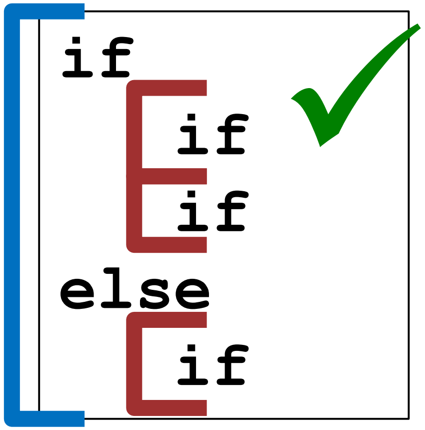
```
if
elif
```

✓



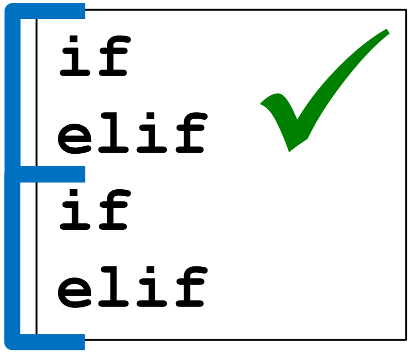
```
if
elif
elif
else
else
```

✗



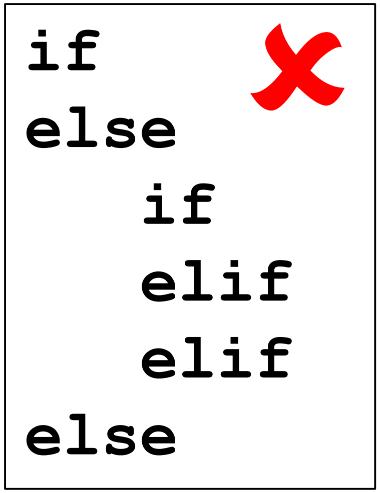
```
if
    if
    if
else
    if
```

✓



```
if
elif
if
elif
```

✓



```
if
else
    if
    elif
    elif
else
```

✗

Looping

Control Structures

- Structures that control how the program "flows" or operates, and in what order
- Sequence ✓
- Decision Making ✓
- Looping

we've already seen these

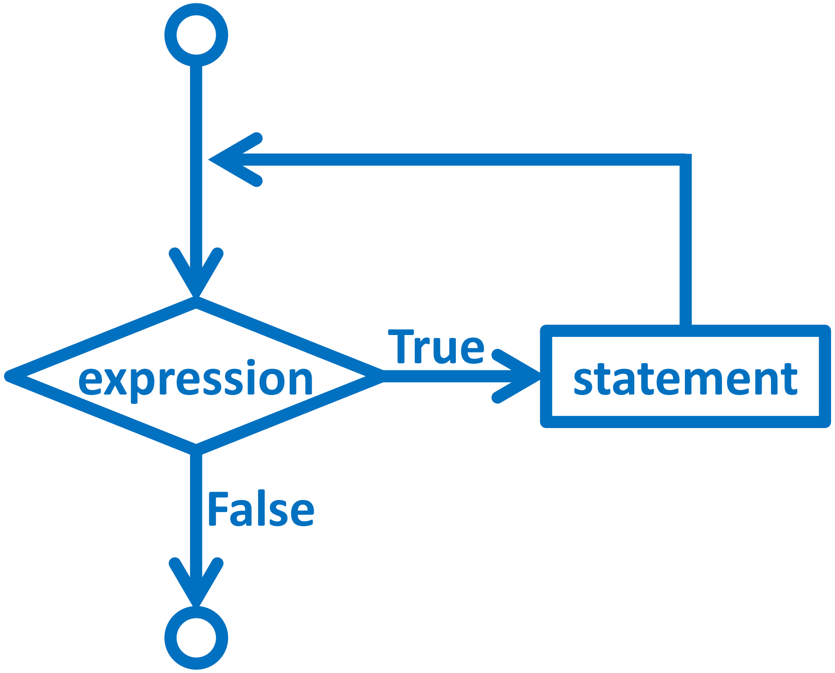
what we're covering today

Looping

- Doing something over and 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?
  - Jumping rope
  - Walking up steps

Looping

- We’ll cover this in detail today
- It looks something like this…



Looping

- Python has two kinds of loops, and they are used for two different purposes
- The **`while`** loop
  - Works for basically everything

what we're covering today

- The **`for`** loop:
  - Best at ***iterating*** over something
  - Best at counted iterations

The **while** Loop

“**`while`**” Loops

-
  ```
  while <condition>:
        <body>
  ```

- The **body** is a sequence of one or more statements <u>indented</u> under the heading
  - As long as the **condition** is **`True`**, the **body** will run (repeatedly if needed)

How a **`while`** Loop Works

- The **`while`** loop requires a Boolean condition
  - That evaluates to either **`True`** or **`False`**

- If the condition is **`True`**:
  - Body of **`while`** loop is executed
  - Condition is checked again
- If the condition is **`False`**:
  - Body of **`while`** loop is skipped

Parts of a `while` Loop

- Here’s some example code… let’s break it down

```
date = 0

while date < 1 or date > 30:
    date = int(input("Enter the day: "))

print("Today is September", date)
```

Parts of a `while` Loop

- Here’s some example code... let’s break it down

initialize the variable the **`while`** loop will use for its decision

```
date = 0
```

the loop’s Boolean condition (loop runs until this is **`False`**)

```
while date < 1 or date > 30:
    date = int(input("Enter the day: "))
```

the body of the loop (must change the value of the loop variable)

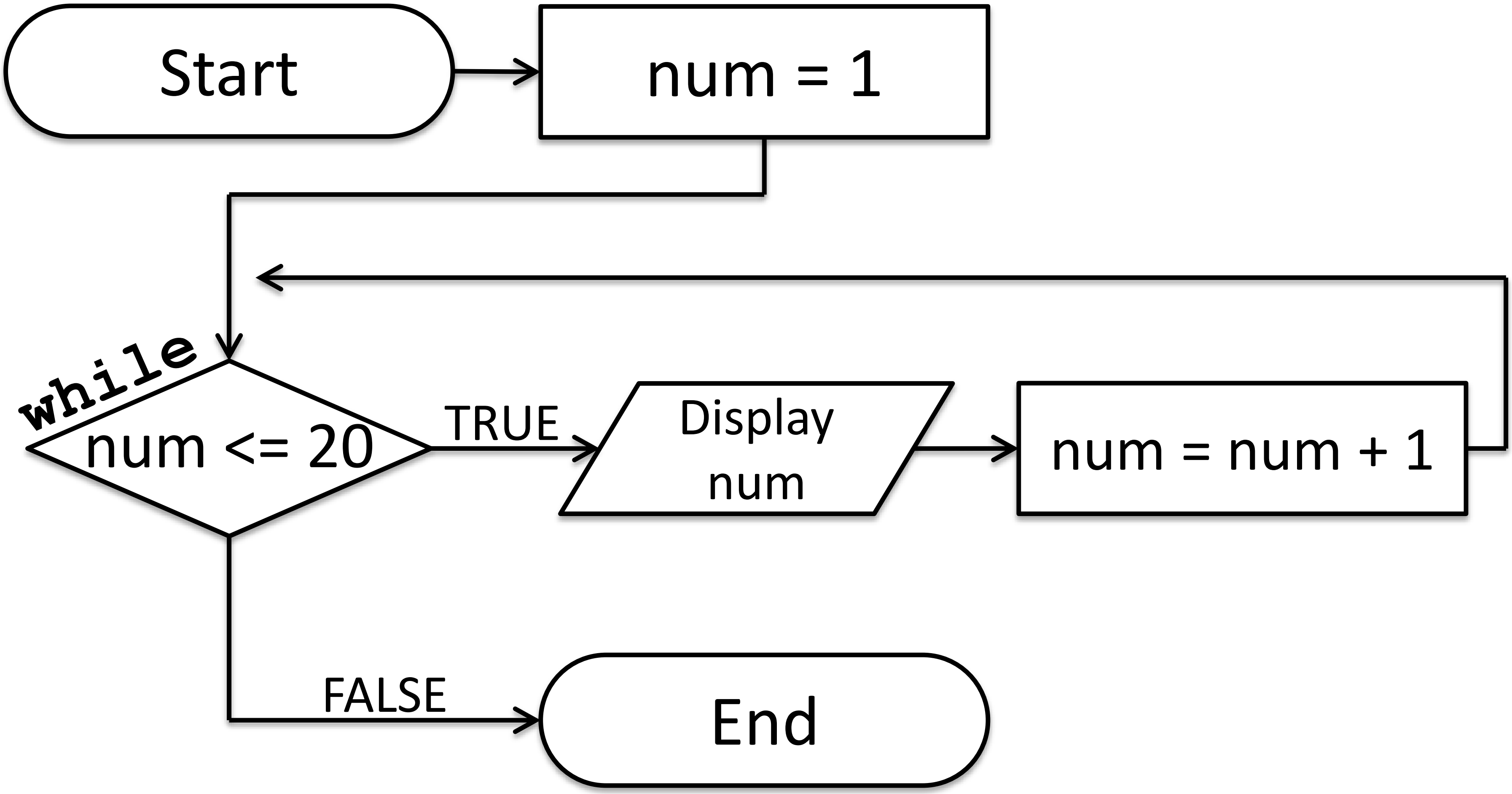
```
print("Today is September",
```

Example **while** Loop

- We can use a **while** loop to count
  - Count from 1 up to and including 20

```
num = 1                 # we have to initialize num

while num <= 20:        # so that we can use it here
    print(num)
    num = num + 1       # don't forget to update
                        # the loop variable
```

Example `while` Loop



Example Counting `while` Loops

- By changing a number of factors, you can change how a counting loop behaves

```
num = 1                  # this controls the start
while num <= 20:         # this controls the stop
    print(num)
    num = num + 1        # this controls the update
```

- How would you count 2, 4, 6, ... 96, 98, 100?
- What about from 0 down to -10?

Calculating **`while`** Loops

- For a **`while`** loop that needs to calculate something, you must initialize the relevant variable outside of the loop, before it starts

- For example, if calculating the total of 10 user-provided numbers, initialize a “total” variable before the while loop

Totaling `while` Loop

- Here is a completed example:

```
count = 0
total = 0

while count < 10:
    num = int(input("Please enter a number: "))
    total += num
    count += 1
print("The total is", total)
```

Infinite Loops and Other Problems

Loop Body Not Being Reached

- A **`while`** loop's body may be skipped over entirely
  - If the Boolean condition is initially **`False`**

```
militaryTime = 1300

while (militaryTime < 1200):
    print("Good morning!")
    militaryTime = militaryTime + 100
```

Infinite Loops

- An ***infinite loop*** is a loop that will run forever
  - The conditional the loop is based on always evaluates to **`True`**, and never to **`False`**

- Why might this happen?
  - The loop variable is not updated
  - The loop variable is updated wrong
  - The loop conditional uses the wrong variable
  - The loop conditional checks the wrong thing

Infinite Loop Example #1

- Why doesn’t this loop end? What will fix it?

```
age = 0
while age < 18:    # can't vote until 18
    print("You can't vote at age", age)

print("Now you can vote! Yay!")
```

Infinite Loop Example #1

- Why doesn’t this loop end? What will fix it?

the loop variable (**age**) never changes, so the condition will never evaluate to **False**

```
age = 0
while age < 18:    # can't vote until 18
    print("You can't vote at age", age)

print("Now you can vote! Yay!")
```

Infinite Loop Example #2

- Why doesn’t this loop end? What will fix it?

```
while True:
    # ask user for name
    name = input("What is your name? ")

print("Hello", name + "!")
```

Infinite Loop Example #2

- Why doesn't this loop end? What will fix it?

True will never evaluate to **False**, so the loop will never exit

```
while True:
    # ask user for name
    name = input("What is your name? ")

print("Hello", name + "!")
```

Infinite Loop Example #3

- Why doesn’t this loop end? What will fix it?

```
cookiesLeft = 50

while cookiesLeft > 0:
    # eat a cookie
    cookiesLeft = cookiesLeft + 1

print("No more cookies!")
```

Infinite Loop Example #3

- Why doesn’t this loop end? What will fix it?

```
cookiesLeft = 50

while cookiesLeft > 0:
    # eat a cookie
    cookiesLeft = cookiesLeft + 1

print("No more cookies!")
```

the loop body is INCREASING the number of cookies, so we’ll never reach zero!

Infinite Loop Example #4

- Why doesn't this loop end? What will fix it?

```
countdown = 10

print("Countdown begin...")
while countdown > 0:
    print(countdown, "...")

print("Blastoff!")
```

Infinite Loop Example #4

- Why doesn’t this loop end? What will fix it?

```
countdown = 10

print("Countdown begin
while countdown > 0:
    print(countdown, "...")

print("Blastoff!")
```

the countdown variable is not being decremented, so it will never go below zero

Infinite Loop Example #5

- Why doesn’t this loop end? What will fix it?

```
grade = ""
name  = ""
while name != "Hrabowski":
    # get the user's grade
    grade = input("What is your grade? ")

print("You passed!")
```

Infinite Loop Example #5

- Why doesn’t this loop end? What will fix it?

the loop conditional is checking the wrong thing! we also never change the name, so this will never end

```
grade = ""
name  = ""
while name != "Hrabowski":
    # get the user's grade
    grade = input("What is your grade? ")

print("You passed!")
```

Ending an Infinite Loop

- If you run a Python program that contains an infinite loop, it may seem like you've lost control of the terminal!

- To regain control, simply type **`CTRL+C`** to interrupt the infinite loop
  - **`KeyboardInterrupt`** will be displayed, and you'll regain control

Practice with Decisions

Loop Example #5 – Fixing It

- Let’s update this to ask for the user’s grade
  - An “A” or a “B” means that they passed

```
grade = ""
while    ...what goes here?
    # get the user's grade
    grade = input("What is your grade? ")

print("You passed!")
```

Loop Example #5 – Truth Table

- Let’s evaluate this expression

```
grade != "A" or grade != "B"
```

`grade`	`grade != "A"`	`grade != "B"`	`or`
`"A"`			
`"B"`			
`"C"`			

Loop Example #5 – Truth Table

- Let’s evaluate this expression

```
grade != "A" or grade != "B"
```

grade	grade != "A"	grade != "B"	or
"A"	False	True	True
"B"	True	False	True
"C"	True	True	True

- This does not give us the answer we want
  - This just loops forever and ever (infinitely)

Loop Example #5 – Truth Table

- Let’s try it with an **`and`** instead of an **`or`**

`grade != "A" and grade != "B"`

`grade`	`grade != "A"`	`grade != "B"`	`and`
`"A"`			
`"B"`			
`"C"`			

Loop Example #5 – Truth Table

- Let’s try it with an **`and`** instead of an **`or`**

```
grade != "A" and grade != "B"
```

grade	grade != "A"	grade != "B"	and
"A"	False	True	False
"B"	True	False	False
"C"	True	True	True

- Now our program will behave how we want
  - You sometimes have to pause and think carefully!

Loop Example #5 – Completed

- Let’s update this to ask for the user’s grade
  - An “A” or a “B” means that they passed

```
grade = ""
while grade != "A" and grade != "B":
    # get the user's grade
    grade = input("What is your grade? ")

print("You passed!")
```

Interactive **`while`** Loops

When to Use **`while`** Loops

- **`while`** loops are very helpful when you want to get input from the user that meets certain specific conditions
  - Positive number
  - A non-empty string
  - A number within a certain range

Example while Loop

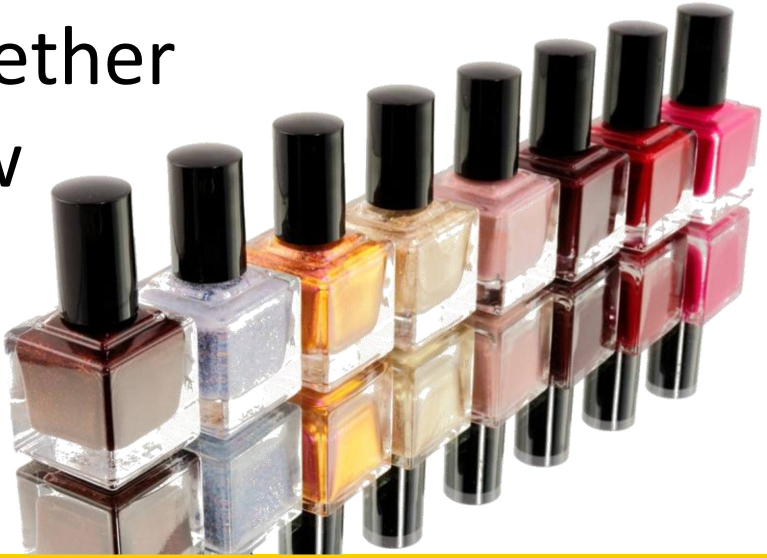
- We can use a **while** loop to get correct input from the user by re-prompting them

```
num  = 0

# so that we can use it here
while num <= 0:
    num = int(input("Enter a positive number: "))

# while loop exits because num is positive
print("Thank you.  The number you chose is:", num)
```

Updated Exercise: Nail Polish

- Update your nail polish “guessing game” to keep re-prompting the user until they guess the right number of bottles

- At each step, tell them whether their guess was high or low
- Exit the loop when they guess correctly



Daily Command Line Shortcut

- **`TAB`**
  - In the command line, hitting TAB will auto-complete up to the point of uniqueness
  - For example, typing "**`emacs h`**" and hitting TAB will auto-complete to "**`emacs hw2_part`**"

- **`up arrow`**
  - Brings back your previous command in the terminal
  - Hit again to go further back

Announcements

- HW 2 is out on Blackboard now
  - Complete the Academic Integrity Quiz to see it
  - Due by Friday (Sep 22nd) at 8:59:59 PM
- Make sure to spell the dog breeds correctly!
  - Will make it much easier for your TA to grade
- Pre Lab 4 Quiz will come out Friday @ 10 AM
  - Must be <u>completed</u> by 10 AM Monday morning

Image Sources

- Infinity symbol:
  - https://commons.wikimedia.org/wiki/File:Flat_UI_-_infinity.png
- Chocolate chip cookie (adapted from):
  - https://en.wikipedia.org/wiki/File:Choco_chip_cookie.png
- Nail polish (adapted from):
  - https://pixabay.com/p-870857/