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
elif
elif
else
else
```

```
if
elif
if
elif
```

```
if
if
elif
else
```

```
if
    if
    if
else
    if
```

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

```
if
elif
```

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

```
if         ✘
else
elif
```

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

```
if         ✔
elif
if
elif
```

```
if         ✔
if
elif
else
```

```
if           ✔
    if
    if
else
    if
```

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

```
if         ✔
elif
```

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

```
if        ✗
else
elif
```

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

```
if        ✓
elif
if
elif
```

```
if        ✓
if
elif
else
```

```
if            ✓
    if
    if
else
    if
```

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

```
if        ✓
elif
```

Looping

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Control Structures

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

- Sequence ✓

 we've already seen these

- Decision Making ✓

- Looping

  what we're covering today

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Looping

- Doing something over and over (and over) again

- Used in combination with decision making
  - If no decision is being made, we just 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…
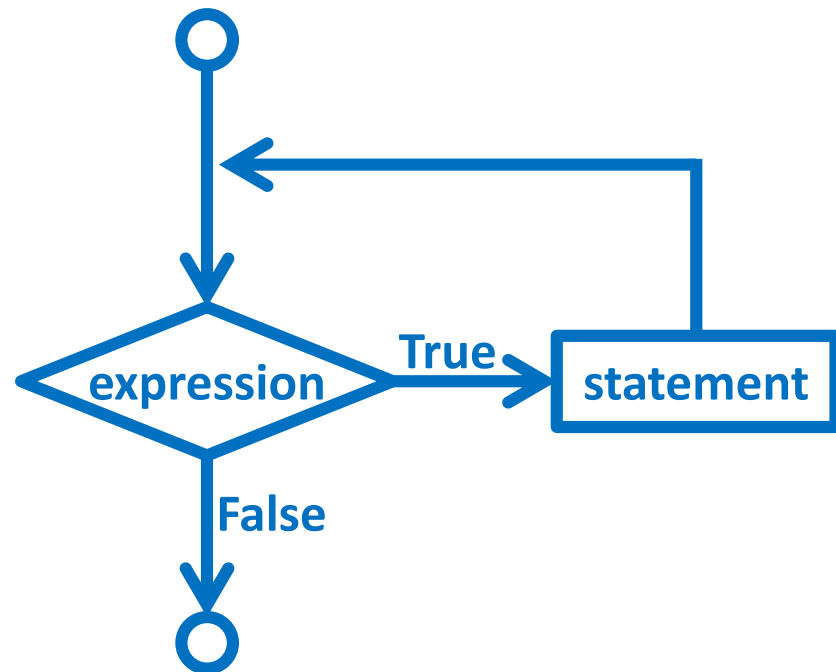
Looping

- Python has two kinds of loops, and they are used for two different purposes

- The **while** loop

  what we're covering today

  – Works for basically everything

- 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 uses a Boolean condition
  - That evaluates to either `True` or `False`

- If the condition is `True`:
  - Body of `while` loop is executed
    - Once that's over, 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

```python
date = 0

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

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

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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",
```

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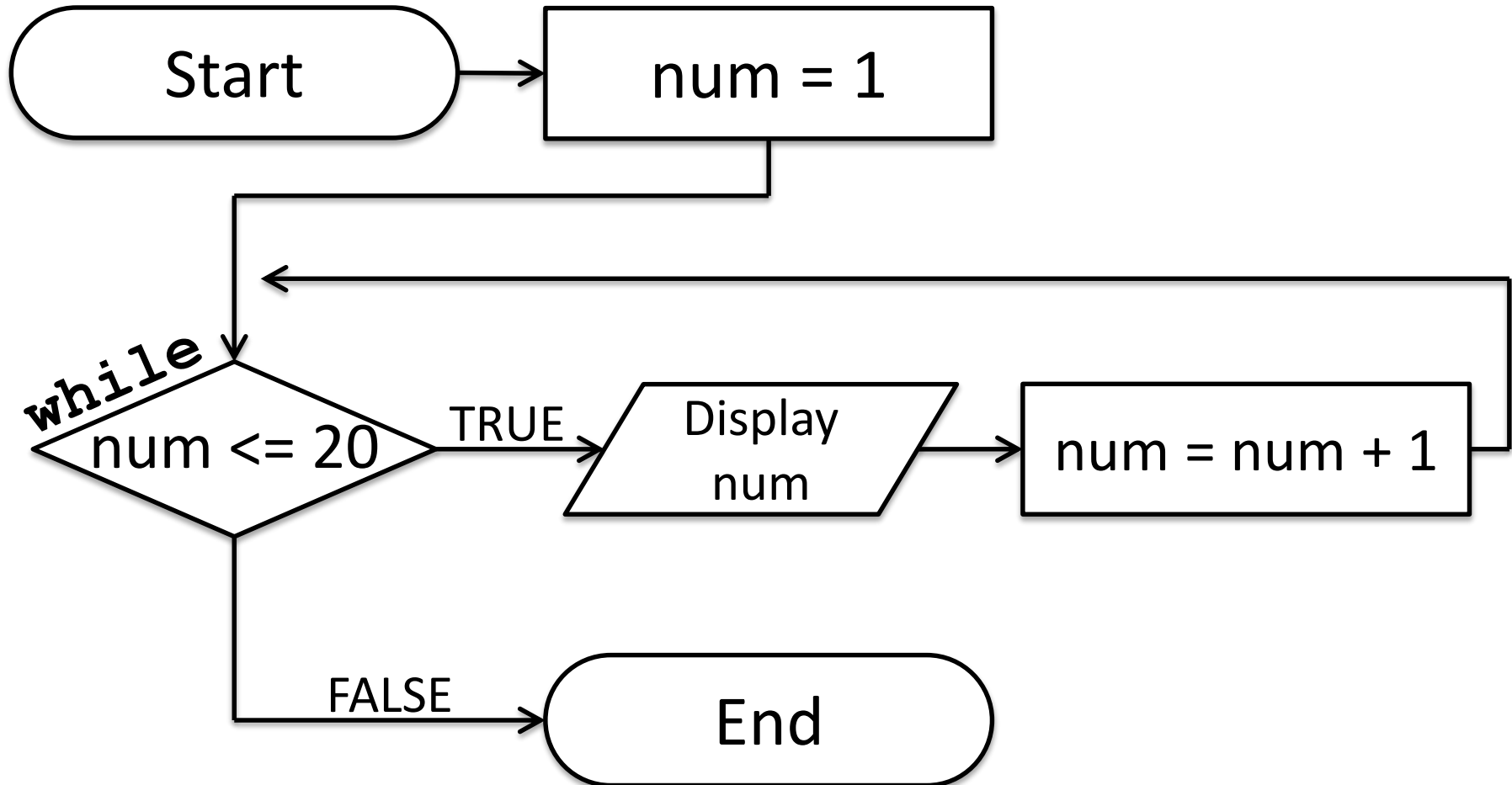
Example `while` Loop

- 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

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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 10 down to 0?

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Calculating `while` Loops

- For a `while` loop that needs to calculate something, you must initialize the relevant variable <u>outside</u> 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

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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

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Loop Body Not Being Reached

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

```python
militaryTime = 1300

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

When is the Conditional Checked?

```python
savings = 0
while savings < 1000:
    # full-time job pays out
    savings += 500
    # freelancing job pays out
    savings += 150
print("savings is", savings)
```

- What is the value of savings at the end?

When is the Conditional Checked?

```python
savings = 0
while savings < 1000:
    # full-time job pays out
    savings += 500
    # freelancing job pays out
    savings += 150
print("
```

> The value of savings is 1300

> Even though the condition was "reached" when we added 500 the second time, the entire loop must run before the conditional is checked again

- What is the value of savings at the end?

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?

```python
age = int(input("How old are you? "))
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 = int(input("How
while age < 18:    # can't vote until 18
    print("You can't vote at age", age)


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

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Infinite Loop Example #2

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

```python
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(...name? ")

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

Don't ever do this! It's sloppy programming, and it's not allowed in 201.

Infinite Loop Example #3

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

```python
cookiesLeft = 50

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

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

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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?

```python
countdown = 10

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


print("Blastoff!")
```

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Infinite Loop Example #4

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

```python
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?

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

print("You passed!")
```

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Infinite Loop Example #5

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

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

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


print("You passed!")
```

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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

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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!")
```

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Loop Example #5 – Truth Table

- Let's evaluate this expression

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

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

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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)

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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"			

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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 have to think carefully about conditionals!

Loop Example #5 – Completed

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

```python
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

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Example `while` Loop

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

```python
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)
```

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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 may auto-complete to "**emacs hw1_part**"

- **up arrow**

  – Brings back your previous command in the terminal

  – Hit again to go further back

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Announcements

- HW 1 is out on Blackboard now
  - Must complete the Syllabus and Course Website Quiz to see it
  - Due by Friday (February 15th) at 8:59:59 PM

- HW 2 will be out on Blackboard Saturday
  - Complete the Academic Integrity Quiz to see it
  - Due by Friday (February 22rd) at 8:59:59 PM

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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/

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