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

Lecture 07 – While Loops (Part 2)

Last Class We Covered

- Using **`while`** loops
  - Syntax of a **`while`** loop
  - Interactive loops
  - Infinite loops and other problems

Any Questions from Last Time?

Today's Objectives

- To learn about constants and their importance
- To explore more and different **`while`** loops
  - Sentinel loops
  - Boolean flags

Constants (and Magic)

Literal Values

- Remember, ***literal values*** are any integer, float, or string that is *literally* in the code
- Literals sometimes have a specific meaning
  - The strings “no” or “yes” as valid user choices
  - Having 7 days of the week, or 12 months in a year
- The meaning of these literals can be difficult to figure out as the program gets longer, or as you work with code you didn’t write

Literal Value Confusion

- What do the pieces of code below do/mean?

```
num = int(input("Enter a number (1 - 52): "))
```

```
if choice == 4:
    print("Thanks for playing!")
```

```
while year < 1900 or year > 2017:
    print("Invalid choice")
```

Literal Value Confusion

- What do the pieces of code below do/mean?

```
num = int(input("Enter a number (1 - 52): "))
```

Weeks in a year? Cards in a deck?

```
if choice == 4:
    print("
```

A menu option? To quit the program?

```
while year < 1900 or year > 2017:
    print("Invalid cho
```

Inputting a valid year? For what?

Literals are Magic!

- These literal values are “magic”, because their meaning is often unknown
  - Called magic numbers, magic strings, etc.

- Other problems include:
  - Reason for choosing the value isn’t always clear
  - Increases the opportunity for errors
  - Makes the program difficult to change later
    - Which 52 is weeks, and which is size of a card deck?

Constants

- Instead of using “magic” literal values, replace them in your code with named ***constants***

- Constants should be ALL CAPS with a **“_”** (underscore) to separate the words

- Having a variable name also means that typos will be caught more easily

Literal Value Clarification

- After using constants, the code might look like:

```
MENU_QUIT   = 4     # more options listed above
MIN_YEAR    = 1900
MAX_YEAR    = 2017

if choice == MENU_QUIT:
    print("Thanks for playing!")

while birthYear < MIN_YEAR or birthYear > MAX_YEAR:
    print("Invalid choice")
```

"Magic" Numbers Example

- You're looking at the code for a virtual casino
  - You see the number 21
  - What does it mean?

```
if value < 21:
```

✗

- Blackjack? Drinking age? VIP room numbers?

```
if customerAge < DRINKING_AGE:
```

✓

- Constants make it easy to update values – why?
  - Don't have to figure out which "21"s to change

Another “Magic” Example

- Can also have “magic” characters or strings
  - Use constants to prevent <u>any</u> “magic” values
- For example, a blackjack program that uses the strings “**H**” for hit, and “**S**” for stay

```
if userChoice == "H":
```
✗

```
if userChoice == HIT:
```
✓

  - Which of these options is easier to understand?
  - Which is easier to update if it’s needed?

Using Constants

- Calculating the total for a shopping order

```
MD_TAX   = 0.06
subtotal = input("Enter subtotal: ")
subtotal = float(subtotal)
tax   = subtotal * MD_TAX
total = tax + subtotal
print("Your total is:", total)
```

easy to update if tax rate changes

we know exactly what this number is

Acceptable “Magic” Literals

- Not everything needs to be made a constant!
  - 0 and 1 as initial or incremental values
  - 100 when calculating percentages
  - 2 when checking if a number is even or odd
  - Numbers in mathematical formulas
    - **`0.5*base*height`** or **`2*pi*(radius**2)`**
- Most strings don’t need to be constants
  - Only if the value has a meaning or specific usage

Constant Practice

- Which of these are fine as just literal values?

```
count  = 0
count += 1
while count < 100:
if choice == 1:
if age < 0:
percent = num / 100
perimSquare = 4 * sideLen
print("Hello!")
while ans != "yes":
```

Constant Practice

- Which of these are fine as just literal values?

```
✓ count  = 0
✓ count += 1
✗ while count < 100:
✗ if choice == 1:
✓ if age < 0:
✓ percent = num / 100
✓ perimSquare = 4 * sideLen
✓ print("Hello!")
✗ while ans != "yes":
```

Could argue that this should be MIN_AGE

If “yes” is used as an option through the whole program, this should be a constant

Where Do Constants Go?

- Constants go before **main()**, after your header comment
- All variables that aren't constants must still be inside of **main()**

```
# File:     hw2_part6.py
# Author:   Dr. Gibson
# etc...

MAX_DAYS    = 30
WEEK_LEN    = 7

def main():
    date = int(input("Please enter day: "))

    if date >= 1 and date <= MAX_DAYS:
        # etc...
main()
```

Are Constants Really Constant?

- In some languages (like C, C++, and Java), you can have a variable that CANNOT be changed

- This is <u>not possible</u> with Python variables
  - Part of why coding standards are so important
  - If code changes the value of **`MAX_ENROLL`**, you know that's a constant, and that it should <u>not</u> be changed

Sentinel Values and **`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
  - Want to keep getting input until some "end"
    - User inputs a value that means they're finished

what we're covering now

Sentinel Values

- ***Sentinel values*** "guard" the end of your input
- They are used:
  - When you don't know the number of entries
  - In **`while`** loops to control data entry
  - To let the user indicate an "end" to the data

- Common sentinel values include:
  - **`STOP`**, **`-1`**, **`0`**, **`QUIT`**, and **`EXIT`**

Sentinel Loop Example

- Here’s an example, where we ask the user to enter student names:

```
END = "QUIT"

def main():

    name = input("Please enter a student, or 'QUIT' to stop: ")

    while name != END:
        print("Hello", name)
        name = input("Please enter a student, or 'QUIT' to stop: ")
main()
```

Sentinel Loop Example

- Here’s an example, where we ask the user to enter student names:

```
END = "QUIT"

def main():
    name = input("Please enter a student, or 'QUIT' to stop: ")
    while name != END:
        print("Hello", name)
        name = input("Please enter a student, or 'QUIT' to stop: ")

main()
```

sentinel values should be saved as a constant

initialize the loop variable with user input

check for the termination condition

get a new value for the loop variable

Sentinel Loop Example

- Here’s an example, where we ask the user to enter student names:

```
END = "QUIT"

d

    name = input("Please enter a student, or 'QUIT' to stop: ")

    while name != END:
        print("Hello", name)
        name = input("Please enter a student, or 'QUIT' to stop: ")
main()
```

make sure to tell the user how to stop entering data

we’ll cover how to actually use constants in an input string later

make sure to use the value before asking for the next one

Priming Reads

- This loop example uses a ***priming read***
  - We "prime" the loop by reading in information before the loop runs the first time
- We duplicate the line of code asking for input
  - Once <u>before</u> the loop
  - And then <u>inside</u> the loop
- This is the preferred way to use sentinel loops

Boolean Flags

Complex Conditionals

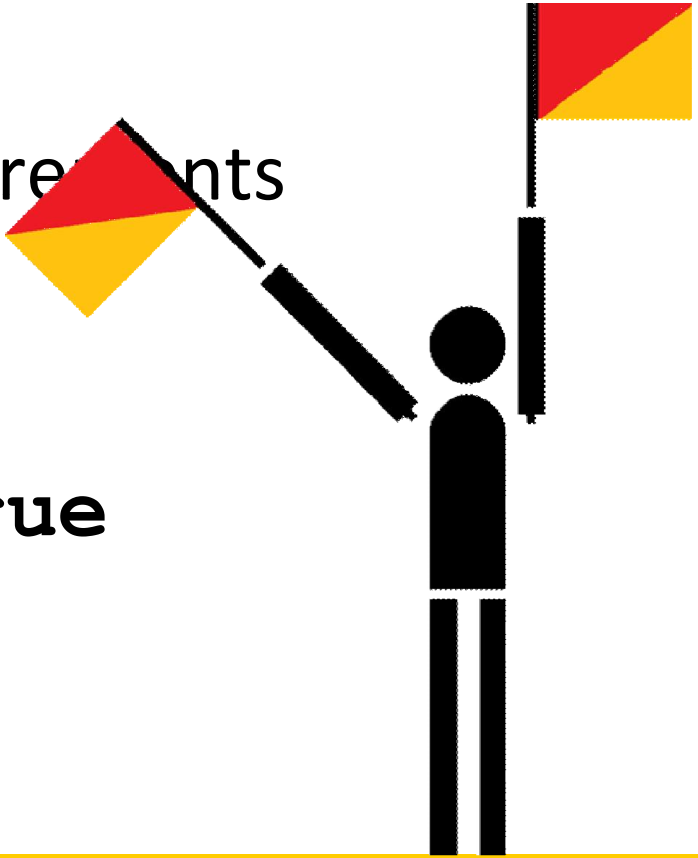
- Sometimes, a **`while`** loop has many restrictions or requirements
  - Expressing them in one giant conditional is difficult, or maybe even impossible

- Instead, break the problem down into the separate parts, and use a single Boolean "flag" value as the loop variable

Boolean Flags

- A Boolean value used to control the while loop
  - Communicates if the requirements have been satisfied yet

- Value should evaluate to **`True`** while the requirements have not been met



General Layout – Multiple Requirements

- Start the **`while`** loop by
  - Getting the user's input
  - Assuming that all requirements are satisfied
    - (Set the Boolean flag so that the loop would exit)

- Check each requirement individually
  - For each requirement, if it isn't satisfied, change the Boolean flag so the loop repeats
    - (Optionally, print out what the failure was)

General Layout – Multiple Ways

- Start the `while` loop by
  - Getting the user’s input
  - Don’t assume the requirements have been met
    - (Do not change the Boolean flag at the start of the loop)
- Check each way of satisfying the requirements
  - If one of the ways satisfies the requirements, change the Boolean flag so the loop doesn’t repeat

Boolean Flag Usage Examples

- Multiple requirements to satisfy
  - Password must be at least 8 characters long, no longer than 20 characters, and have no spaces or underscores
- Multiple ways to satisfy the requirements
  - Grade must be between 0 and 100,
    unless extra credit is allowed, in which
    case it can be over 100 (but still must be >= 0)

Image Sources

- Magic wand (adapted from):
  - https://commons.wikimedia.org/wiki/File:Magic_wand.svg
- Sentry guard (adapted from):
  - www.publicdomainpictures.net/view-image.php?image=160669
- Flag waver (adapted from):
  - https://pixabay.com/p-34873