CompSci 101
Turtles, for loop, accumulation, range

Susan Rodger

February 9, 2023

```
create a new empty string ret
for each character ch in the phrase
    if ch is not a vowel
        add ch to the end of ret
ret is the result
```

H is for …

- **HTTP**
  - A Protocol we use every day, and HTTPS
- **Hello World**
  - The quintessential first program: 40 years ago! http://helloworldcollection.de/
- **Hack**
  - Hacker, Hacktivism, Hack Duke
- **Hashing**
  - How Dictionaries work

Brian Fox

- **See Wikipedia: http://bit.ly/brianfox2018**
  - Bash Shell, Stallman, Wells Fargo, more
- **See LifeHacker: http://bit.ly/brianfox-hack**
  - Learned Logo at 8, wrote it at 21 for Apple!
  - Open Voting

There's nothing that I am better at than everyone else, except being me. There's no secret to being me. Follow your interests and work hard at them. Then you will play bass better, program better, cook better, ride motorcycles better, or anything else that you really want to do.

Announcements

- **Assignment 2 out – Quiz due 2/14, program 2/16**
- **APT-2 due tonight!**
- **Lab 4 Friday**
  - Complete prelab before going to lab
- **Reading and Sakai quizzes for next week up today**
- **Exam 1**
  - Do not discuss until it is handed back!

PFTD

- Import a file
- String and List Functions
- Turtles
- For loop/Accumulation

Main: if __name__ == '__main__':

- Main – where Python starts and ends in some file
- Consider file Food.py

```
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Main: if __name__ == '__main__':

- Main – where Python starts and ends in some file
- Consider file Food.py

```
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Execution starts here:

OUTPUT:
Making the sandwich peanut butter and jelly

Main vs. Import

- Import – another file with useful code (functions)
  - Ignores if __name__ == '__main__' in the other file
- Food.py

```
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

- FoodFriend.py

```
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

Main vs. Import

- **Import – another file with useful code (functions)**
  - Ignores `if __name__ == '__main__'` in the other file
- **Food.py**

```python
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

- **FoodFriend.py**

```python
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

Food is file where function makeSandwich is

Food 'dot' tells you which file makeSandwich function is in

Run FoodFriend.py

- **FoodFriend.py**

```python
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

Run FoodFriend.py

- **FoodFriend.py**

Grab functions from Food.py

```python
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

Run FoodFriend.py

- **FoodFriend.py**

```python
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

Here is function makeSandwich

- **Food.py**

```python
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Ignores code in main

Run FoodFriend.py

- **FoodFriend.py**

```
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

Use the makeSandwich function in the file Food.py

- **Food.py**

```
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Run FoodFriend.py

- **FoodFriend.py**

```
import Food

if __name__ == '__main__':
    Food.makeSandwich("bacon, lettuce, and tomato")
```

OUTPUT:
Making the sandwich bacon, lettuce and tomato

- **Food.py**

```
def makeSandwich(food):
    print("Making the sandwich", food)

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Main vs. Import

- **Run main in Food.py**

- **Run main in FoodFriend.py**

Main vs. Import

- **Run main in Food.py**

```
Making the sandwich peanut butter and jelly
```

- **Run main in FoodFriend.py**

```
Making the sandwich bacon, lettuce, and tomato
```

Food2.py – Bad Code!

- **Food2.py – Modification of Food.py**

```
def makeSandwich(food):
    print("Making the sandwich", food)

makeSandwich('hummus and sprouts')

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Food2.py – Bad Code!

- **Food2.py – Modification of Food.py**

```
def makeSandwich(food):
    print("Making the sandwich", food)

makeSandwich('hummus and sprouts')

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Code not indented, this is bad code!!!!

Modify Main

- **Food2.py**

```
def makeSandwich(food):
    print("Making the sandwich", food)

makeSandwich('hummus and sprouts')

if __name__ == '__main__':
    makeSandwich('peanut butter and jelly')
```

Line of code will execute when this file is imported. Then you are executing code more than just the functions in that file.

Code not indented, this is bad code!!!!

Modified Main vs. Import

- **Run main in Food2.py**

```
Making the sandwich hummus and sprouts
Making the sandwich peanut butter and jelly
```

- **Run main in FoodFriend.py with import of Food2.py**

```
Making the sandwich hummus and sprouts
Making the sandwich bacon, lettuce, and tomato
```

Remember, ALWAYS put code in main or in a function, indented!

More String and List Methods

String

`.find(s)`	index of first occurrence of s
`.rfind(s)`	index of last occurrence of s (from Right)
`.upper()/ .lower()`	uppercase/lowercase version of string
`.strip()`	remove leading/trailing whitespace
`.count(s)`	number of times see s in string
`.startswith(s)`	bool of whether the string begins with s
`.endswith(s)`	bool of whether the string ends with s

List

`sum(lst)`	sum of the elements in lst
`max(lst)`	maximum value of lst
`min(lst)`	minimum value of lst
`.append(elm)`	Mutates the list by adding elm to the end of the list
`.count(elm)`	Number of times see elm in the list

Some String Methods

```
str = ‘ghosts’
x = str.find(‘s’)
x = str.rfind(‘s’)
x = str.upper()
x = str.count(‘s’)
x = str.startswith(‘gh’)
x = str.endswith(‘s’)
x = str.endswith(‘t’)
```

Some String Methods

```
str = ‘ghosts’               str   is ‘ghosts’
x = str.find(‘s’)            x  is  3
x = str.rfind(‘s’)           x  is  5
x = str.upper()              x  is  ‘GHOSTS’
x = str.count(‘s’)           x  is  2
x = str.startswith(‘gh’)     x  is  True
x = str.endswith(‘s’)        x  is  True
x = str.endswith(‘t’)        x  is  False
```

Some List Methods

```
lst = [5, 2, 4, 5, 5]        lst   is   [5, 2, 4, 5, 5]
x = max(lst)
x = min(lst)
x = sum(lst)
x = lst.count(5)
lst.append(7)
x = lst.append(3)
```

Some List Methods

```
lst = [5, 2, 4, 5, 5]
x = max(lst)
x = min(lst)
x = sum(lst)
x = lst.count(5)
lst.append(7)
```
~~x =~~ lst.append(3)

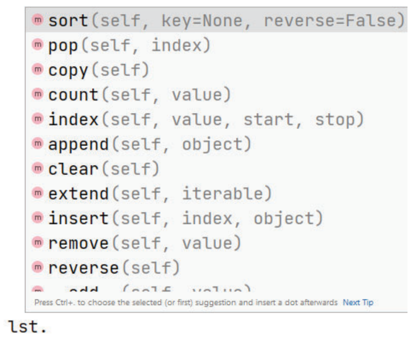
lst is [5, 2, 4, 5, 5]
x is 5
x is 2
x is 21
x is 3
lst is [5, 2, 4, 5, 5, 7]
x is None and lst is [5,2, 4, 5, 5, 7, 3]

Correct way to use append

Don't use append this way, no return value

Three ways to use functions with List

- x = max(lst)
  - lst is parameter to the max function that has a return value
- x = lst.count(5)
  - lst has its own functions that can be applied to a list
- lst.append(7)
  - mutates/changes lst, no return value


```
sort(self, key=None, reverse=False)
pop(self, index)
copy(self)
count(self, value)
index(self, value, start, stop)
append(self, object)
clear(self)
extend(self, iterable)
insert(self, index, object)
remove(self, value)
reverse(self)
__add__(self, value)
Press Ctrl+. to choose the selected (or first) suggestion and insert a dot afterwards Next Tip
lst.
```

Three ways to use functions with List

- x = max(lst)
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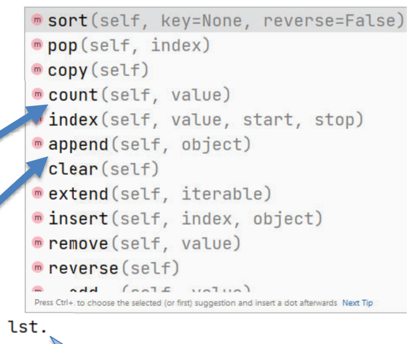
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Press Ctrl+. to choose the selected (or first) suggestion and insert a dot afterwards Next Tip
lst.
```

When you type the name of a list followed by '.' then PyCharm shows you all the list functions

Three ways to use functions with List

- x = max(lst)
  - lst is parameter to the max function that has a return value
- x = lst.count(5)
  - lst has its own functions that can be applied to a list
- lst.append(7)
  - mutates/changes lst, no return value

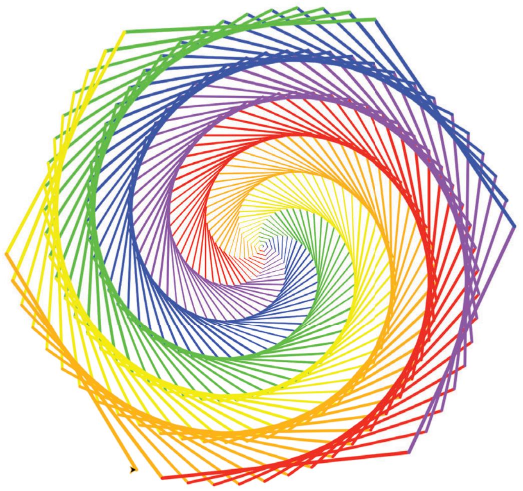
Use list as parameter

Use list function with a return value

Use list function that mutates, no return value

WOTO-1 – Import, Strings and Lists
http://bit.ly/10123s-0209-1

Run Turtle, Run



Turtle Programming

- **Must:**
  - Import turtle module
  - Create window/Screen
  - Last thing - exit on click
  - Create turtles to use, name/type/value
- **Review Turtle commands and concepts**
  - http://bit.ly/turtle_tutorial for more, and book
- **See ColorMyWorld.py, and Spiro.py for some ideas**
  - Color, Position, Leaving Turtle where started
  - Many more commands than this

Put yourself in the turtle t…

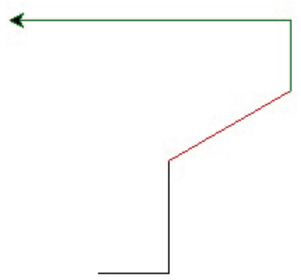
```
t.forward(50)          # turtle moves forward
                        #  drawing  a line
t.left(90)             # turtle turns to its left
t.pencolor("blue")      # change pen color
t.forward(100)         # turtle moves forward
                        # drawing  line, new color
```

Example: simple.py

```python
import turtle

def drawPicture(turt):
    t.forward(50)
    t.left(90)
    t.forward(80)
    t.pencolor('red')
    t.right(60)
    t.forward(100)
    t.pencolor('green')
    t.left(60)
    t.forward(50)
    t.left(90)
    t.forward(200)


if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    drawPicture(t)
    win.exitonclick()
```



Example: Simple.py parts

```python
import turtle


if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    drawPicture(t)
    win.exitonclick()
```

- **Import at the top**

Example: Simple.py parts

```python
import turtle


if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    drawPicture(t)
    win.exitonclick()
```

- **Create window**

Example: Simple.py parts

```python
import turtle


if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    drawPicture(t)
    win.exitonclick()
```

- **Create turtle with name t**

Example: Simple.py parts

```python
import turtle



if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    drawPicture(t)
    win.exitonclick()
```

- **Call function to draw and pass the turtle t as an argument**

Example: Simple.py parts

```python
import turtle



if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    drawPicture(t)
    win.exitonclick()
```

- **Close canvas when click on it**

Example: Simple.py DrawPicture

```python
def drawPicture(turt):
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    turt.left(90)
    turt.forward(80)
    turt.pencolor('red')
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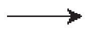
    turt.forward(100)
    turt.pencolor('green')
    turt.left(60)
    turt.forward(50)
    turt.left(90)
    turt.forward(200)
```



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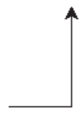
    turt.forward(200)
```



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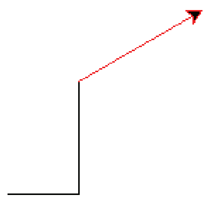

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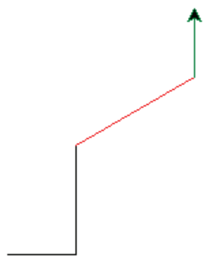

Example: Simple.py DrawPicture

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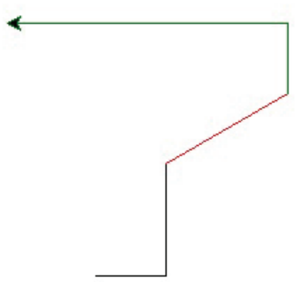
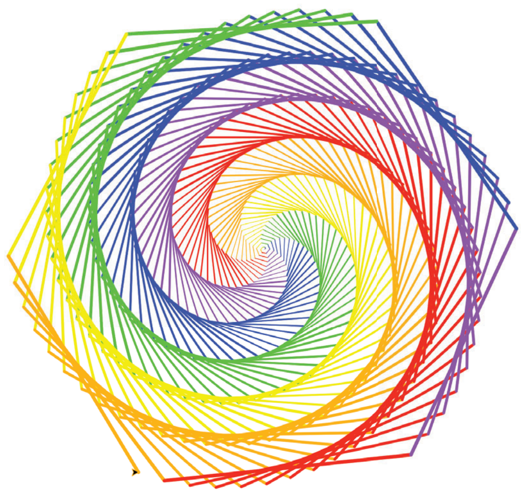
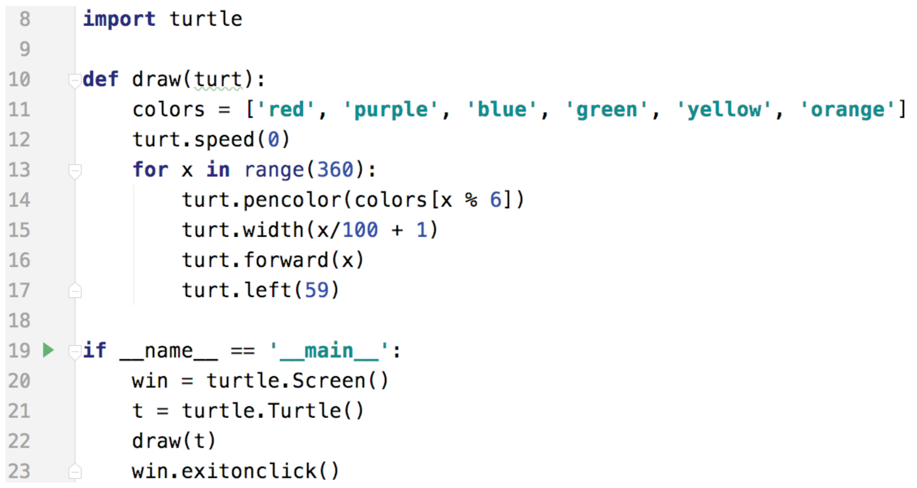


Run Turtle, Run



What are key concepts in Spiro.py?

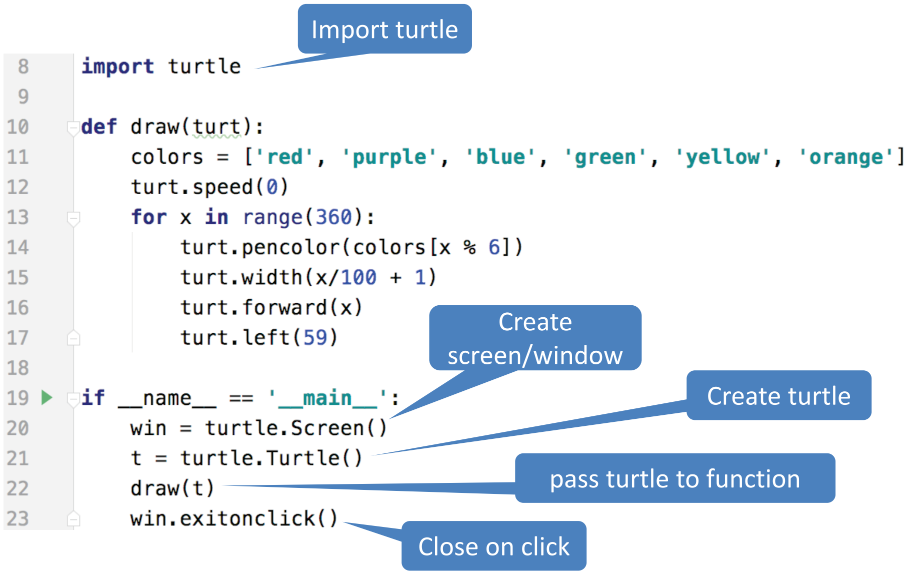


```python
import turtle

def draw(turt):
    colors = ['red', 'purple', 'blue', 'green', 'yellow', 'orange']
    turt.speed(0)
    for x in range(360):
        turt.pencolor(colors[x % 6])
        turt.width(x/100 + 1)
        turt.forward(x)
        turt.left(59)

if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    draw(t)
    win.exitonclick()
```

What are key concepts in Spiro.py?



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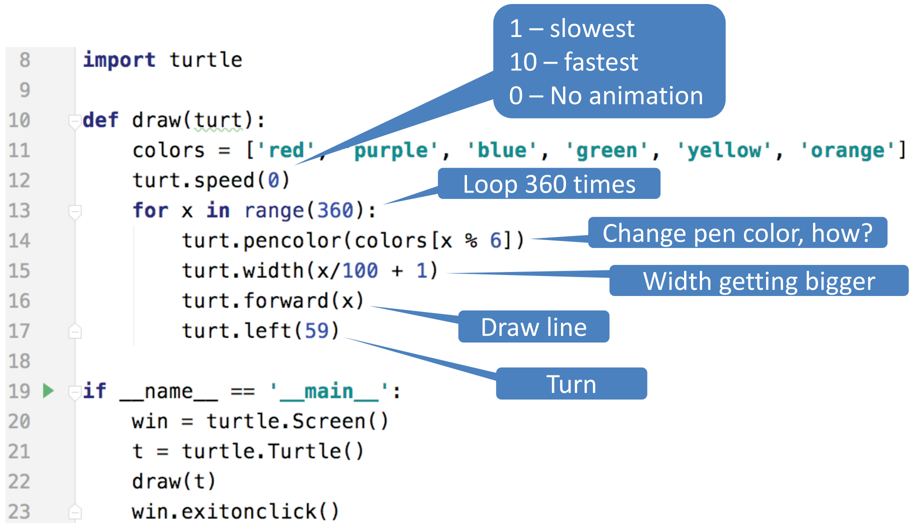

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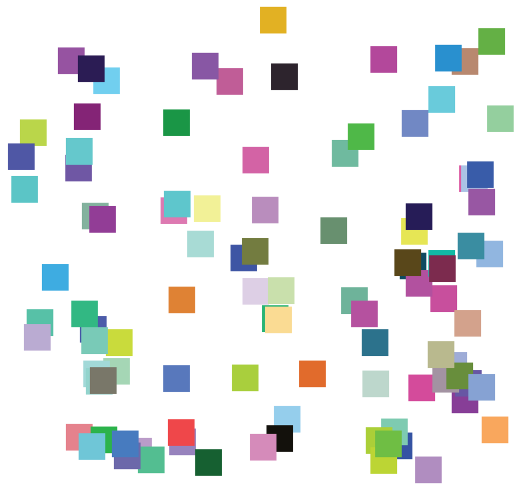
        turt.width(x/100 + 1)
        turt.forward(x)
        turt.left(59)

if __name__ == '__main__':
    win = turtle.Screen()
    t = turtle.Turtle()
    draw(t)
    win.exitonclick()
```

Useful turtle functions

- **`forward(n)/backward(n)` – move turtle n pixels**
- **`left(n)/right(n)` – turn turtle n degrees**
- **`pendown()/pendup()` – whether actually drawing**
- **`setposition(x, y)` – puts turtle in this (x,y) coordinate (a.k.a. `goto`, `setpos`)**
- **`sethead(n)` – points turtle in this direction (n=0 is east)**
- **Many more in documentation!**
  - https://docs.python.org/3/library/turtle.html

ColorMyWorld.py

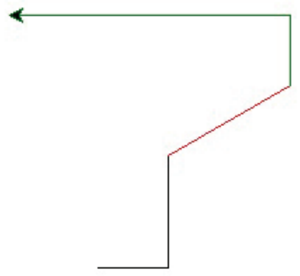


Turtle Concepts

- **Create a screen so you can ..**
  - Exit On Click
  - Some other Screen Functions
- **Create a turtle so you can …**
  - Move and draw using the turtle
- **Drawing Concepts**
  - Pen [up and down]
  - Fill
  - Color
  - Position

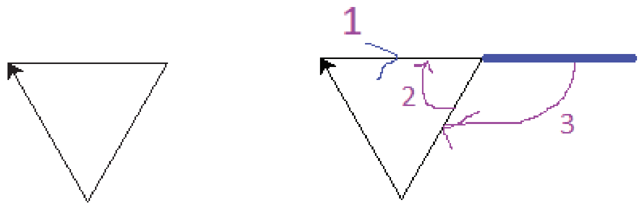
WOTO-2 - Turtles

http://bit.ly/10123s-0209-2



WOTO-2: Explanation of degrees to turn turtle to draw a triangle

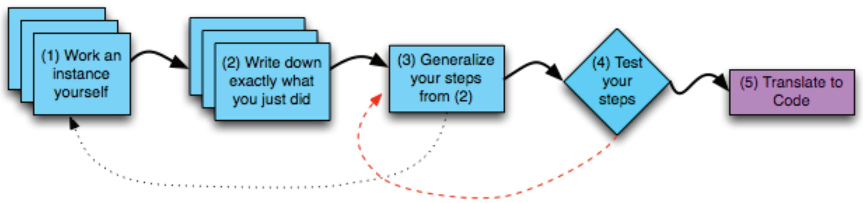
- **1) direction turtle is moving in first line**
- **2) is the angle inside the triangle which must be 60 degrees**
- **3) is the angle the turtle must turn right, which is 120 degrees**
- **4) note 60 + 120 is 180, which is half of a circle.**



Looping over Sequences

- **Let's explore this:**
  - Given a sentence:
    - "Duke Computer Science is so much fun!"
  - How do we create this sentence?
    - "Dk Cmptr Scnc s s mch fn!"
  - Input is sentence. Output has vowels removed

Designing Solution


(1) Work an instance yourself
(2) Write down exactly what you just did
(3) Generalize your steps from (2)
(4) Test your steps
(5) Translate to Code

1. **Work an instance: Go Duke -> G Dk**
2. **What did we do?**
   a. Paper and pencil, write it down!
3. **Generalize**
4. **Test: "Computer" -> "Cmptr"?**

What did we do?

- **"Went through character sequence and removed the vowels."**
  - Not precise enough, what does "removed the vowels" mean? In Python?

What did we do?

- **"Went through character sequence and removed the vowels."**
  - Not precise enough, what does "removed the vowels" mean? In Python?
- **"For each character, if it's not a vowel add it to the output string"**
  - "For each" -> loop
  - "if it's not" -> if statement
  - "a vowel" -> new function?

What did we do?

- **"Went through character sequence and removed the vowels."**
  - Not precise enough, what does "removed the vowels" mean? In Python?
- **"For each character, if it's not a vowel add it to the output string"**
  - "For each" -> loop
  - "if it's not" -> if statement
  - "a vowel" -> new function?
  - "add it…" -> string concatenation

Yes because functions should only do one thing. Makes testing easier

Step 3 and 4: Algorithm

input is string **phrase**

```
create a new empty string ret
for each character ch in the phrase
    if ch is not a vowel
        add ch to the end of ret
ret is the result
```

Step 4: Test this algorithm on "Computer"

Step 5: Now ready to translate this to code!

Step 3 and 4: Algorithm

```
create a new empty string ret
for each character ch in the phrase
    if ch is not a vowel          <------------ How?
        add ch to the end of ret
ret is the result
```

Step 4: Test this algorithm on "Computer"

Step 5: Now ready to translate this to code!

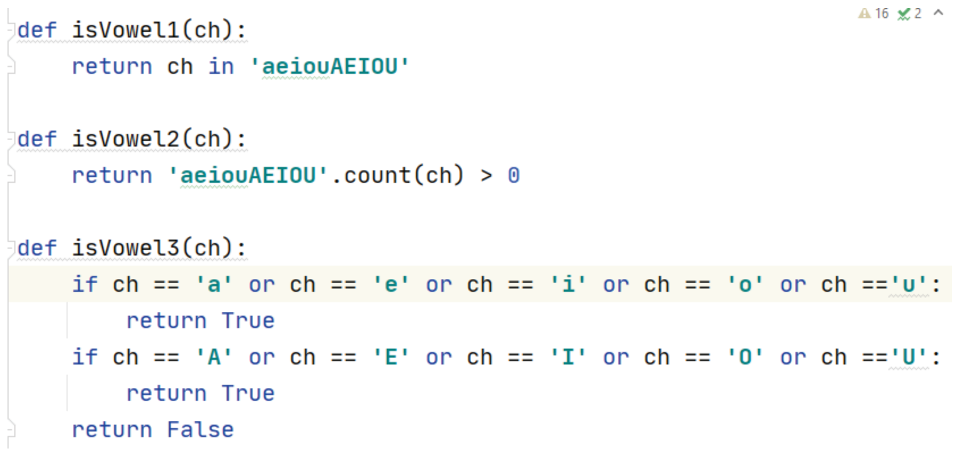
Step 5: Translate to Code

- **Which function do we implement first?**
  - Translate sentence?
  - Is a vowel?
  - Reasons to prefer one to the other?
- **How do we verify that our function is correct?**
  - Reproducible testing not detailed here
  - Testing is really, really important

WOTO-3
http://bit.ly/10123s-0209-3

- **Is it a vowel?**

IsVowel Functions

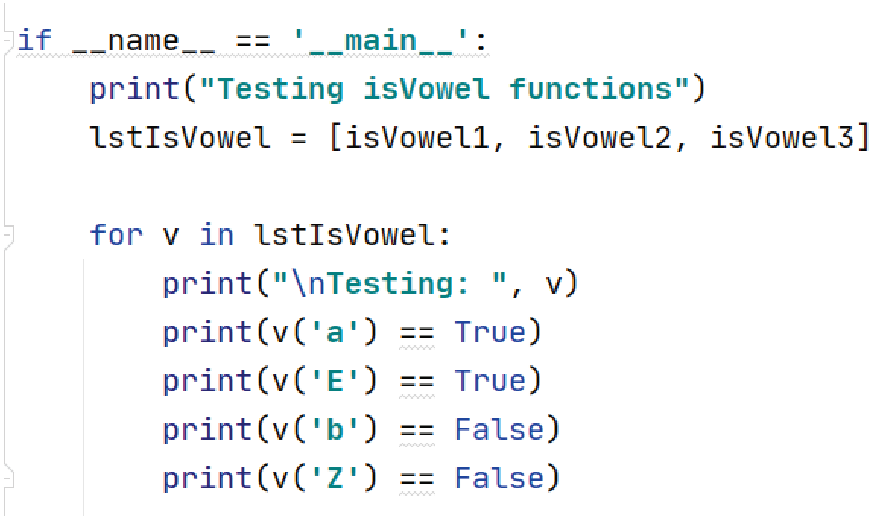


```
def isVowel1(ch):
    return ch in 'aeiouAEIOU'

def isVowel2(ch):
    return 'aeiouAEIOU'.count(ch) > 0

def isVowel3(ch):
    if ch == 'a' or ch == 'e' or ch == 'i' or ch == 'o' or ch =='u':
        return True
    if ch == 'A' or ch == 'E' or ch == 'I' or ch == 'O' or ch =='U':
        return True
    return False
```

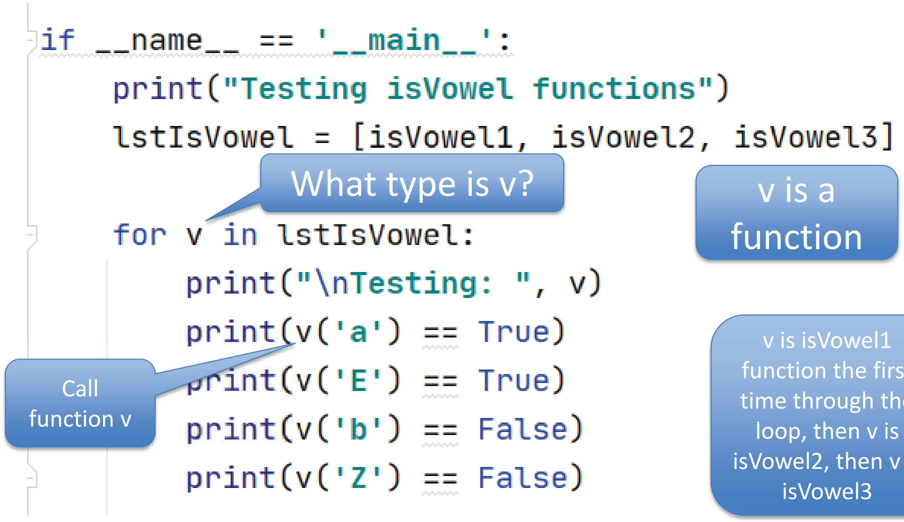
Testing IsVowelFunctions



```
if __name__ == '__main__':
    print("Testing isVowel functions")
    lstIsVowel = [isVowel1, isVowel2, isVowel3]

    for v in lstIsVowel:
        print("\nTesting: ", v)
        print(v('a') == True)
        print(v('E') == True)
        print(v('b') == False)
        print(v('Z') == False)
```

Testing IsVowelFunctions



```
if __name__ == '__main__':
    print("Testing isVowel functions")
    lstIsVowel = [isVowel1, isVowel2, isVowel3]

    for v in lstIsVowel:
        print("\nTesting: ", v)
        print(v('a') == True)
        print(v('E') == True)
        print(v('b') == False)
        print(v('Z') == False)
```

What type is v?

v is a function

Call function v

v is isVowel1 function the first time through the loop, then v is isVowel2, then v is isVowel3

Accumulator Pattern: NoVowels

- **"For each character, if it's not a vowel add it to the output string"**
- **Accumulator pattern: change a variable in a loop**
  - Accumulate a value while iterating through loop

Accumulator Pattern: NoVowels

```
create a new empty string **ret**
for each character **ch** in the **phrase**
    if **ch** is not a vowel
        add **ch** to the end of **ret**
**ret** is the result
```

```
def noVowels(phrase):
    ret = ""
    for ch in phrase:
        if not isVowel1(ch):
            ret = ret + ch
    return ret
```

Accumulator Pattern: NoVowels Build new string: ret

```
def noVowels(phrase):
    ret = ""
    for ch in phrase:
        if not isVowel1(ch):
            ret = ret + ch
    return ret
```

Initialize before loop

Update inside loop

Do something with value after loop