

THE CS106A
SAGA CONTINUES



Control Flow Revisited

Chris Gregg

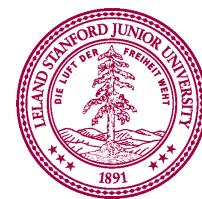
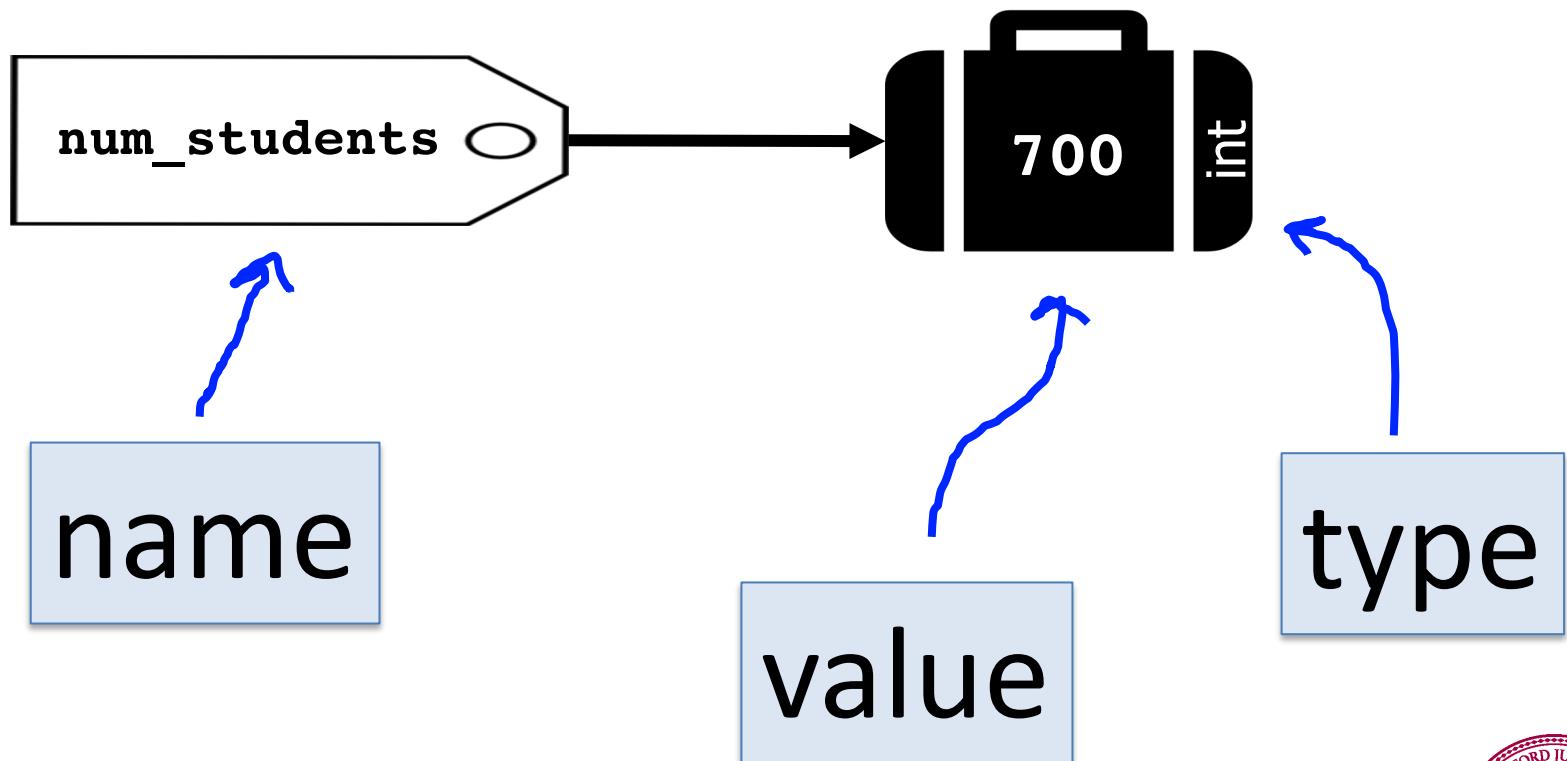
Based on slides by Chris Piech
CS106A, Stanford University

Starring
MARK HAMILL · HARRISON FORD · CARRIE FISHER
BILLY DEE WILLIAMS · ANTHONY DANIELS
DAVID PROWSE · KENNY BAKER · PETER MAYHEW · FRANCOIS DIAZ
as Darth Vader as R2-D2 as Chewbacca as Yoda
Directed by IRVIN KERSHNER Produced by GARY KURTZ
LEIGH BRACKETT · LAWRENCE KASDAN GEORGE LUCAS
Executive Producer JOHN WILLIAMS
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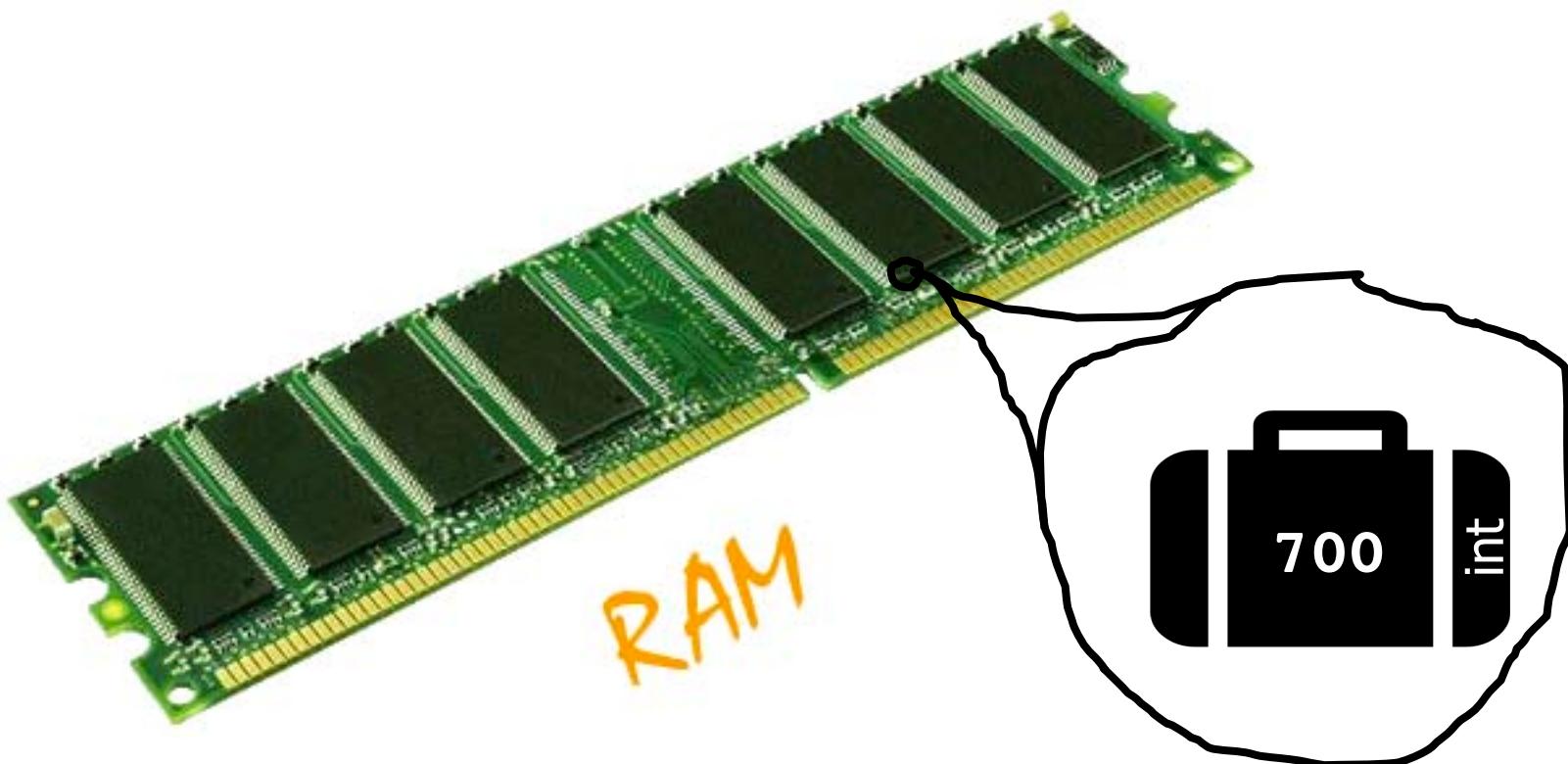
Review

Suitcase Analogy

`num_students = 700`



Teeny Tiny Suitcases



My computer has space for about 2 billion boxes

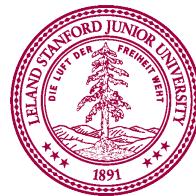


Create, Modify, Use

```
# Create a variable, of type int  
# called age with the value 30.  
age = 30
```

```
# Modify age to be one greater.  
age += 1
```

```
# Use the value in age (output it)  
print(f"age is: {age}")
```



Binary Operators

+	Addition	*	Multiplication
-	Subtraction	/	Division
%	Remainder	//	Int Division
		**	Exponentiation

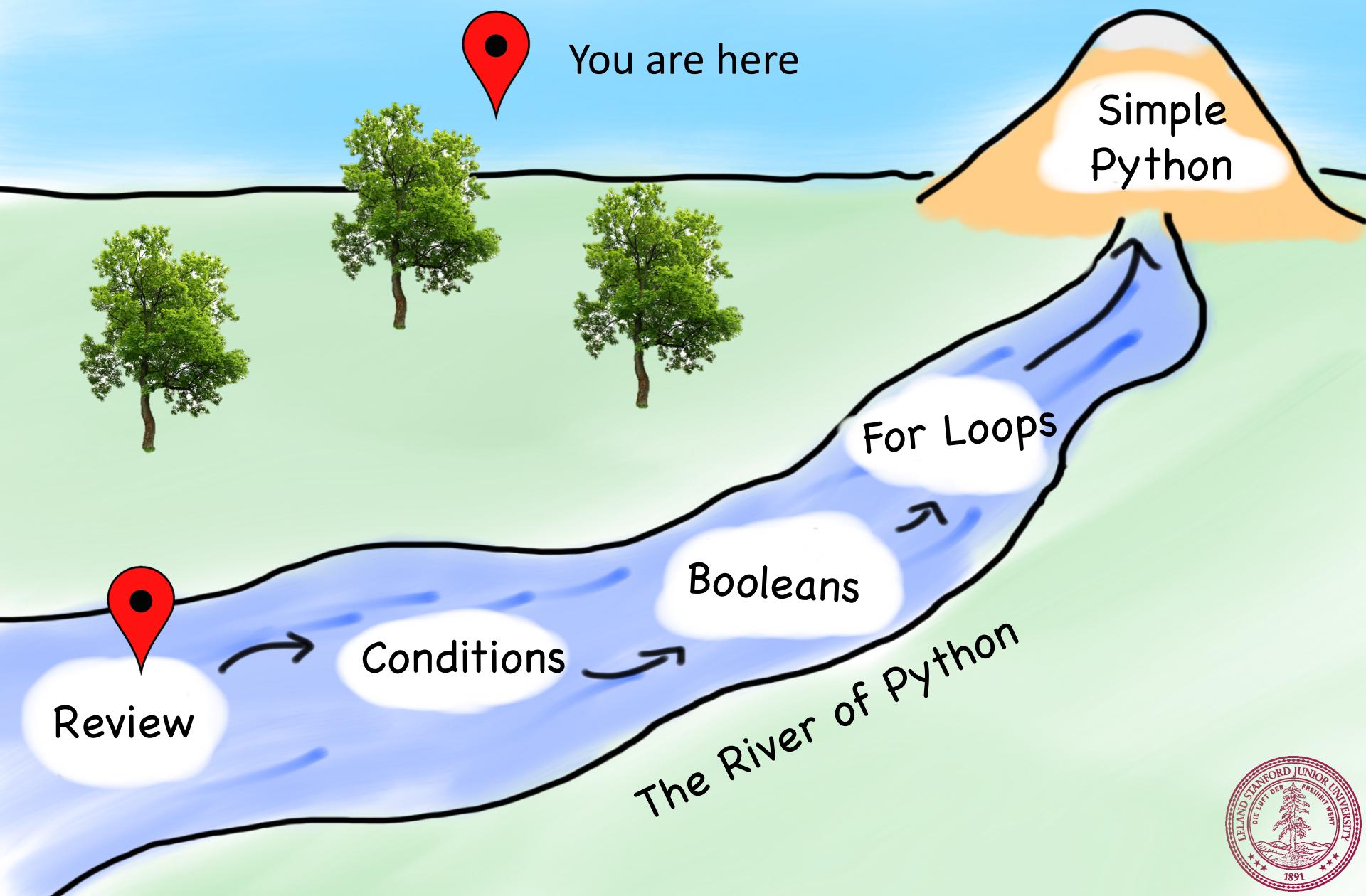


Today's Goal

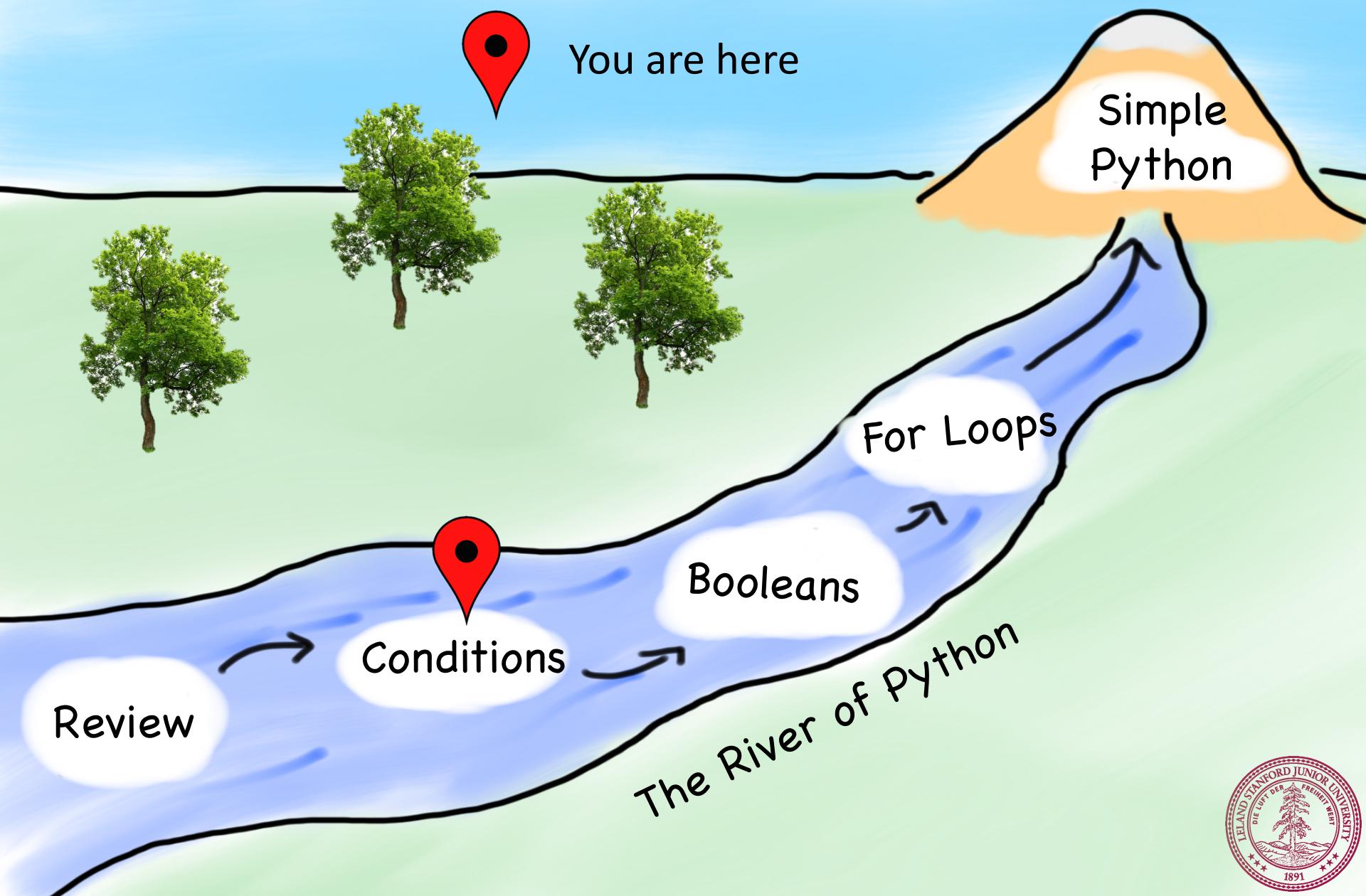
1. Be able to use For / While / If in Python



Today's Route



Today's Route



While Loop in Karel

```
while front_is_clear() :  
    body
```

```
if beepers_present() :  
    body
```

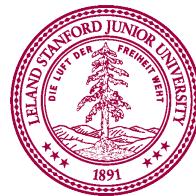


While Loop Redux

while *condition* :
body

if *condition* :
body

The condition should be a “boolean” which
is either **True** or **False**



Cool Example: Carbon Dating



C₁₄ = 1.2 dpm



C₁₄ = 13.6 dpm

$$\text{age} = K \cdot \log\left(\frac{\% \text{ C}14}{100}\right)$$



Cool Example: Carbon Dating

```
def main():
    calculate_age_single_sample()

def calculate_age_single_sample():
    # use the half life formula to calculate the age
    # https://en.wikipedia.org/wiki/Radiocarbon\_dating
    pct_left = float(input("% of natural c14 in your sample:"))
    age = math.log(pct_left / 100) * HALF_LIFE_CONSTANT
    print(f"Your sample is {age} years old.")
```

* It calculates the age of a C14 sample



Cool Example: Carbon Dating

Before repeating the body,
check if this statement
evaluates to True

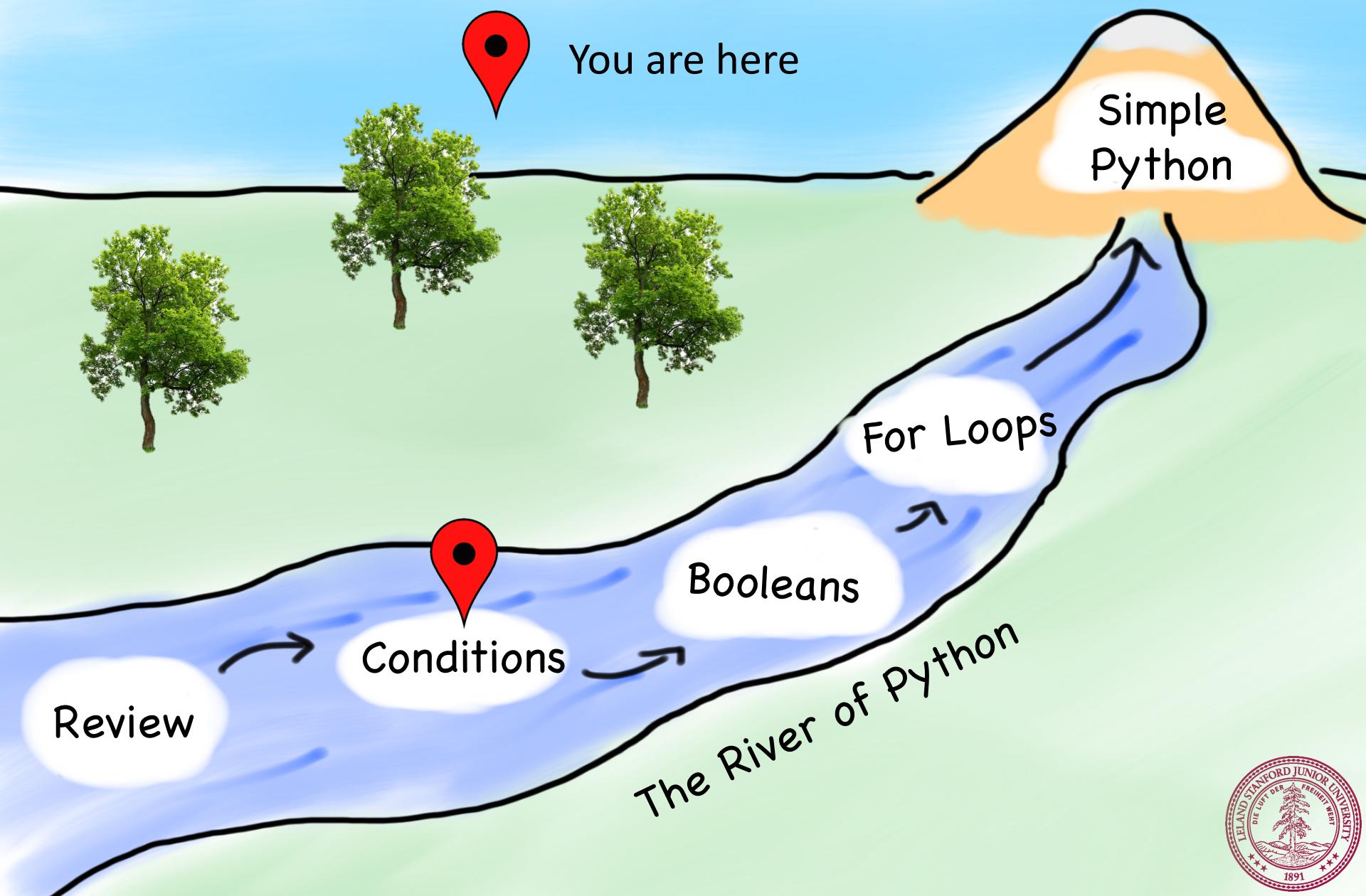
```
def main():
    while True:
        calculate_age_single_sample()

def calculate_age_single_sample():
    # use the half life formula to calculate the age
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    print(f"Your sample is {age} years old.")
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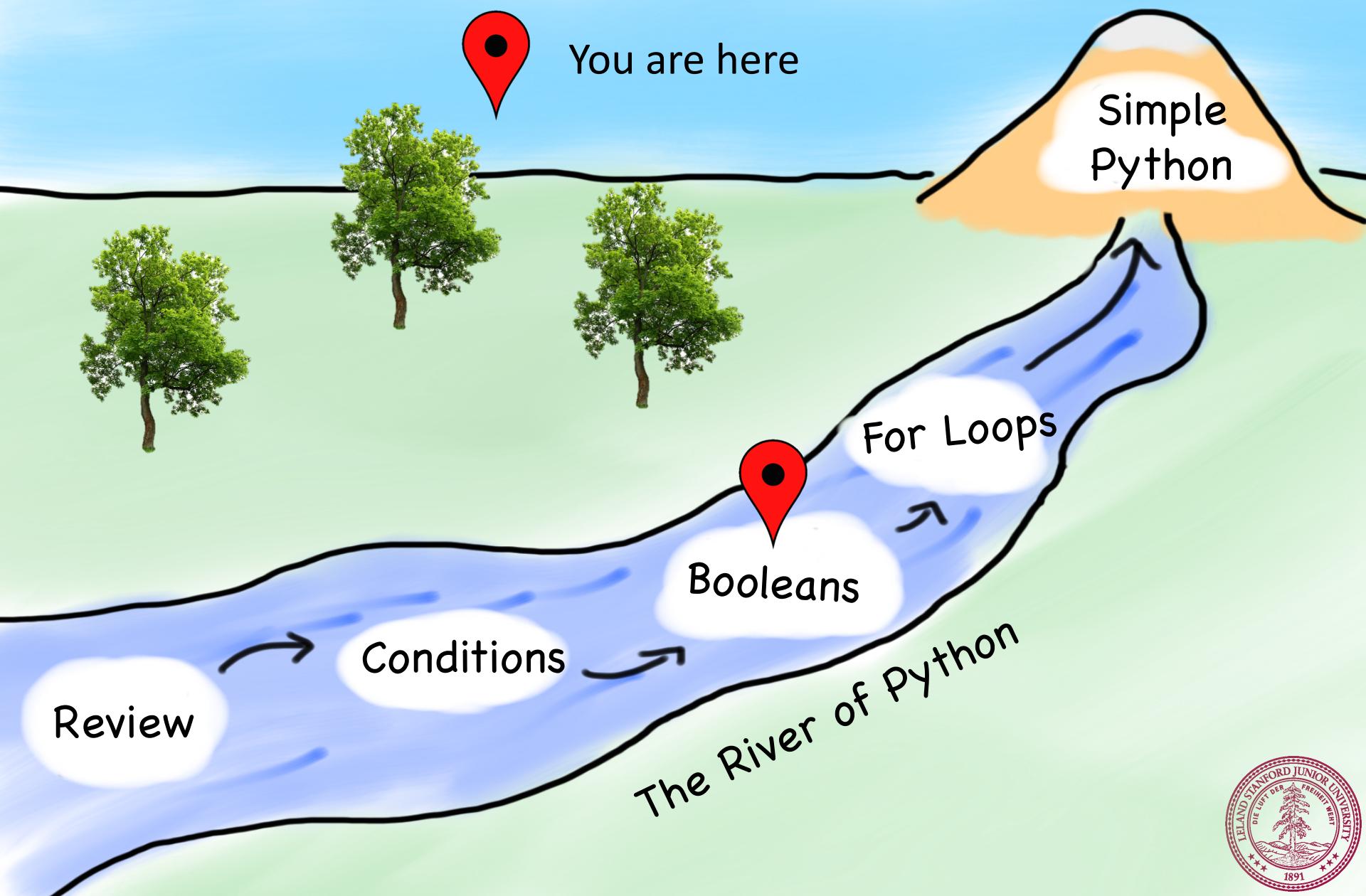
* It calculates the age of a C14 sample



Today's Route



Today's Route



Booleans

1 < 2



Booleans

1 < 2

True



Comparison Operators

Operator	Meaning	Example	Value
<code>==</code>	equals	<code>1 + 1 == 2</code>	True
<code>!=</code>	does not equal	<code>3.2 != 2.5</code>	True
<code><</code>	less than	<code>10 < 5</code>	False
<code>></code>	greater than	<code>10 > 5</code>	True
<code><=</code>	less than or equal to	<code>126 <= 100</code>	False
<code>>=</code>	greater than or equal to	<code>5.0 >= 5.0</code>	True

* All have equal precedence



Comparison Operators

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<code>>=</code>	greater than or equal to	<code>5.0 >= 5.0</code>	True

* All have equal precedence



Comparison Operators

```
if 1 < 2 :  
    print("1 is less than 2")
```

```
num = int(input("Enter a number: "))  
  
if num == 0:  
    print("That number is 0")  
  
else :  
    print("That number is not 0.")
```



If Else Revisited

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

if num == 0:
    print("Your number is 0")

else:
    if num > 0:
        print("Your number is positive")

    else:
        print("Your number is negative")
```



If Else Revisited

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

if num == 0:
    print("Your number is 0")

elif num > 0:
    print("Your number is positive")

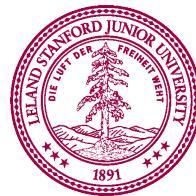
else:
    print("Your number is negative")
```



If Else Revisited

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

if num == 0:
    print("Your number is 0")
elif num > 0:
    print("Your number is positive")
else:
    print("Your number is negative")
```



If Else Revisited

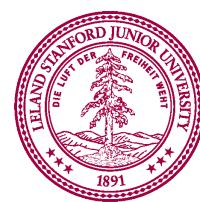
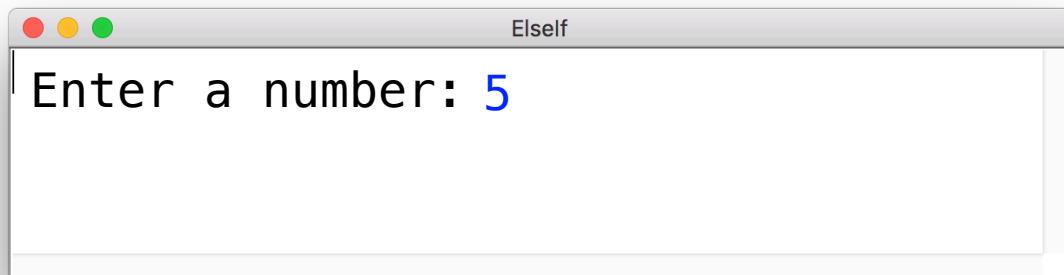
```
num = int(input("Enter a number: "))

if num == 0:
    print("Your number is 0")

elif num > 0:
    print("Your number is positive")

else:
    print("Your number is negative")
```

“5”



If Else Revisited

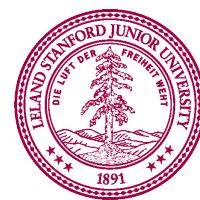
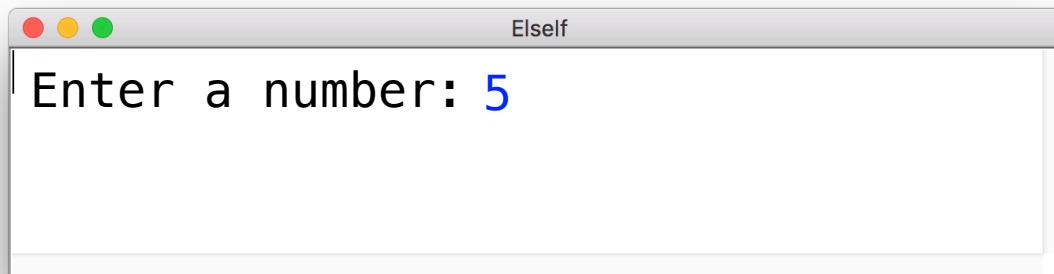
5

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

if num == 0:
    print("Your number is 0")

elif num > 0:
    print("Your number is positive")

else:
    print("Your number is negative")
```

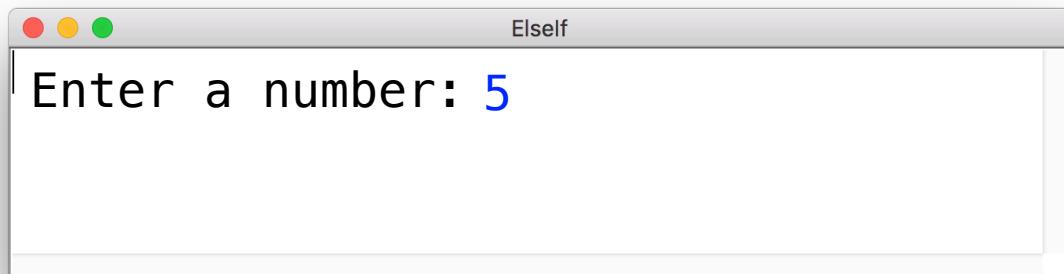


If Else Revisited

5

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

if num == 0:
    print("Your number is 0")
elif num > 0:
    print("Your number is positive")
else:
    print("Your number is negative")
```



5

num



If Else Revisited

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

if num == 0:

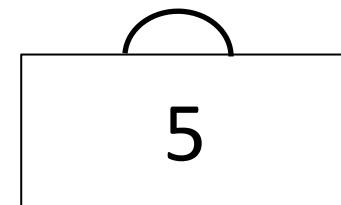
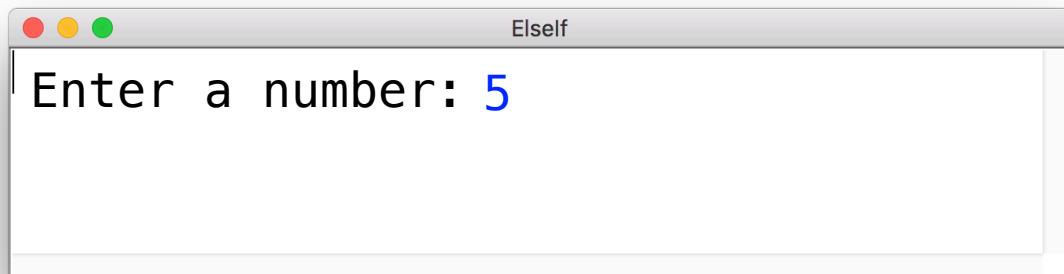
    print("Your number is 0 ")

elif num > 0:

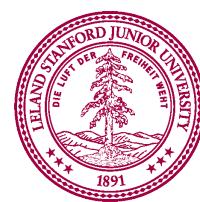
    print("Your number is positive")

else:

    print("Your number is negative")
```



num



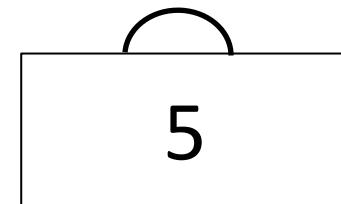
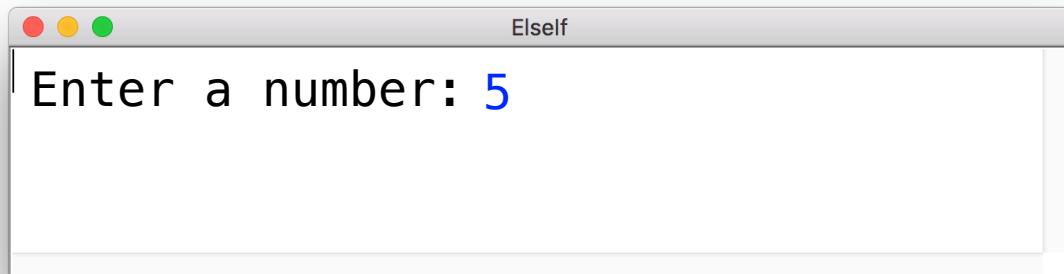
If Else Revisited

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num = int(input("Enter a number: "))

if num == 0:
    print("Your number is 0 ")

elif num > 0:
    print("Your number is positive")

else:
    print("Your number is negative")
```



If Else Revisited

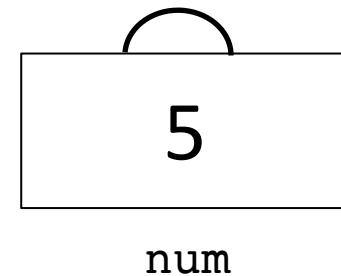
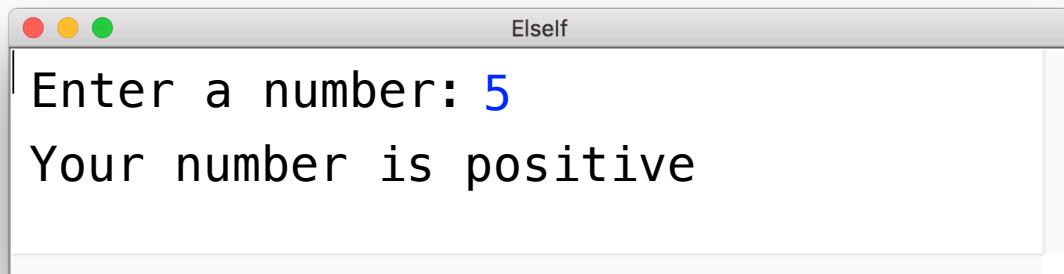
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if num == 0:
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elif num > 0:
    print("Your number is positive")
```

else:

```
    print("Your number is negative")
```



num



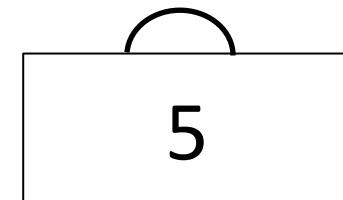
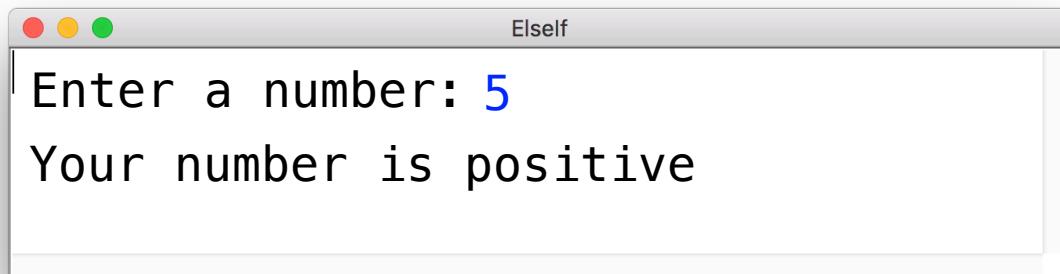
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else:
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```



num



Conditions in Python



Use **while** and **if** statements
in Python.

They are the same as in Karel,
except that the **test** can be any
expression that evaluates to
True or **False**



Amazing

Guess My Number

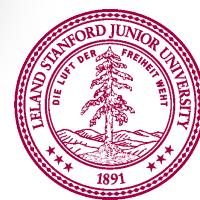
```
GuessMyNumber
I am thinking of a number between 0 and 99...
Enter a guess: 50
Your guess is too high

Enter a new number: 25
Your guess is too low

Enter a new number: 40
Your guess is too low

Enter a new number: 45
Your guess is too low

Enter a new number: 48
Congrats! The number was: 48
```

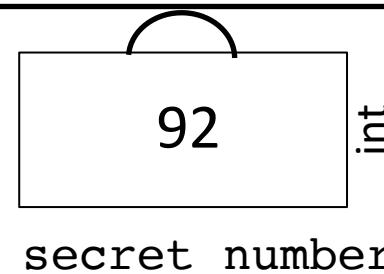


Guess My Number

```
secret_number = random.randint(1, 99)
print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
while guess != secret_number:
    # True if guess is less than secret number
    if guess < secret_number:
        print("Your guess is too low")
    else:
        print("Your guess is too high")

print() # an empty line
guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

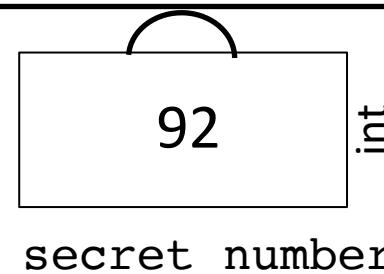


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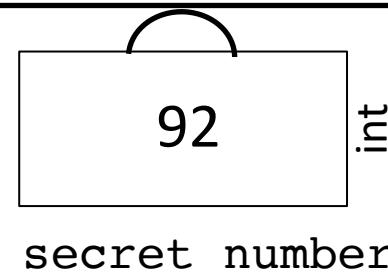
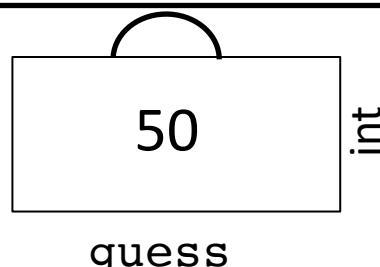


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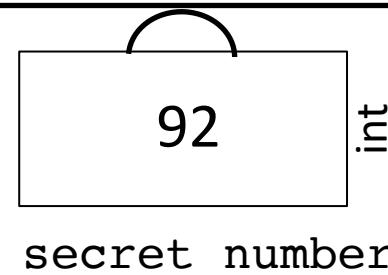
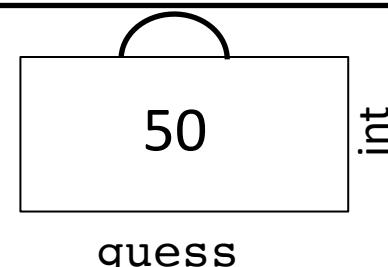


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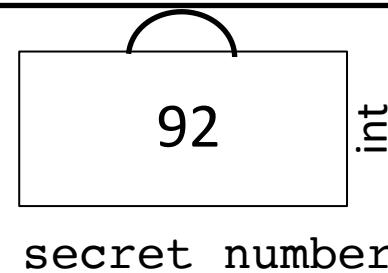
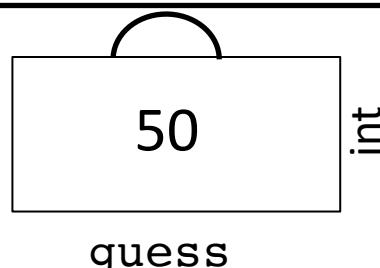


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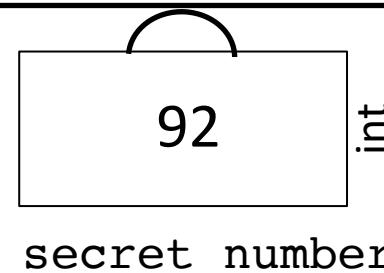
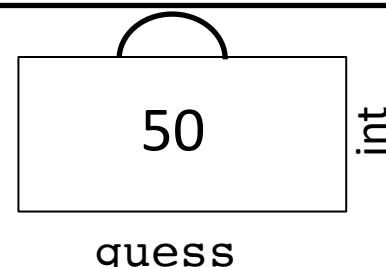


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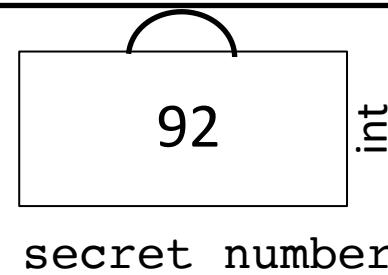
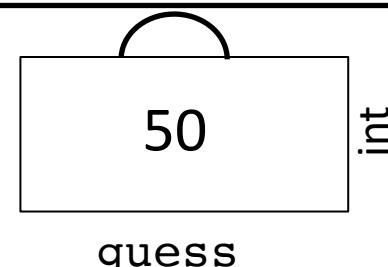


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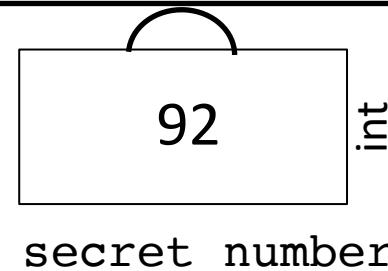
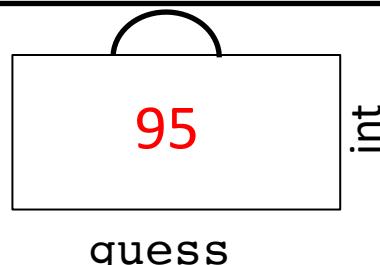


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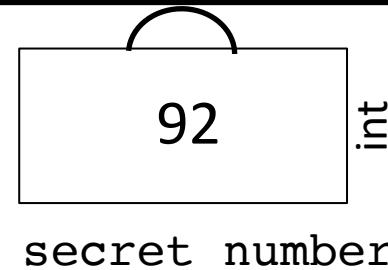
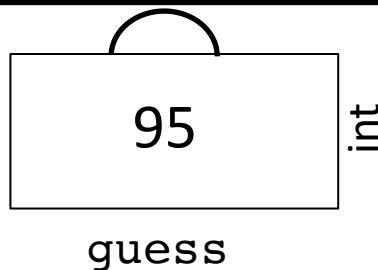


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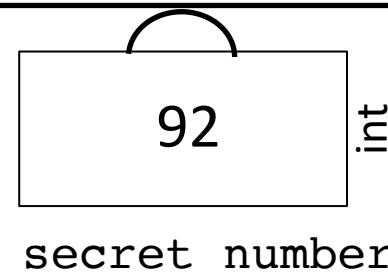
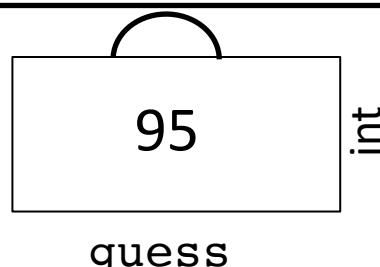


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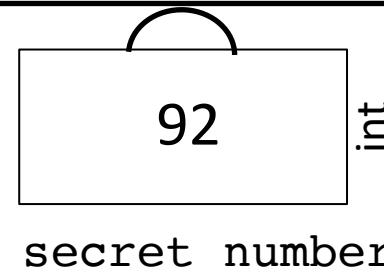
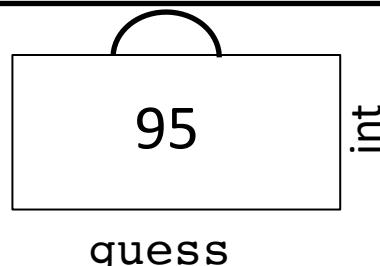


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    print() # an empty line
    guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

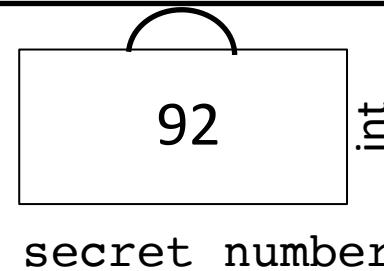
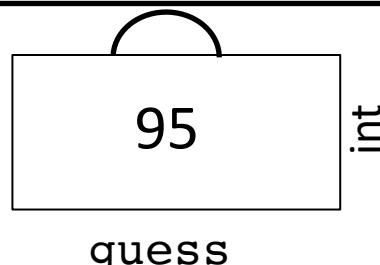


Guess My Number

```
secret_number = random.randint(1, 99)
print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
while guess != secret_number:
    # True if guess is less than secret number
    if guess < secret_number:
        print("Your guess is too low")
    else:
        print("Your guess is too high")

print() # an empty line
guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

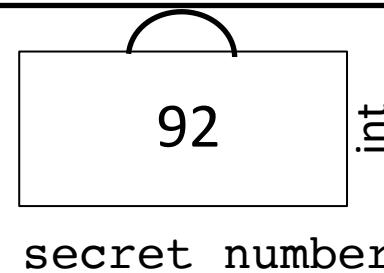
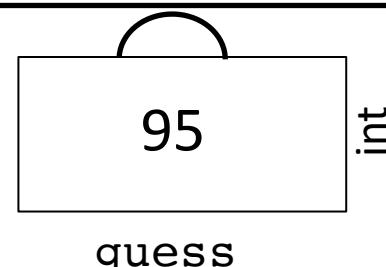


Guess My Number

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guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
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print() # an empty line
guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

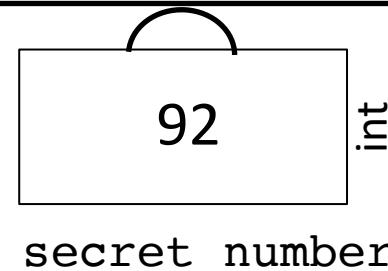
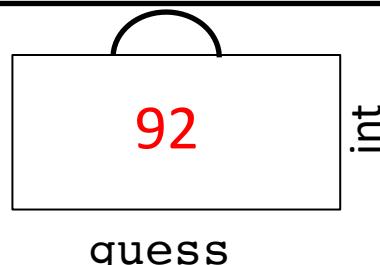


Guess My Number

```
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print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
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    else:
        print("Your guess is too high")

print() # an empty line
guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

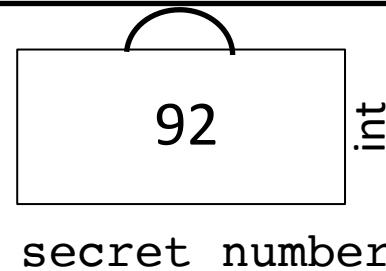
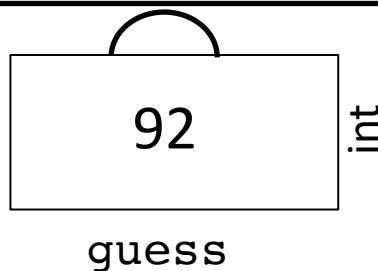


Guess My Number

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print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
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        print("Your guess is too low")
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    print() # an empty line
    guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

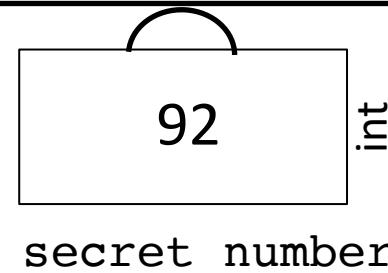
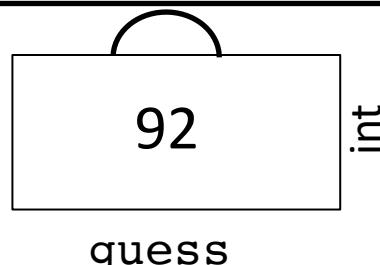


Guess My Number

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print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
while guess != secret_number:
    # True if guess is less than secret number
    if guess < secret_number:
        print("Your guess is too low")
    else:
        print("Your guess is too high")

    print() # an empty line
    guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```

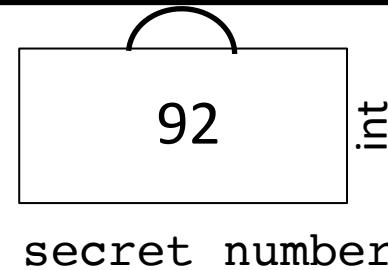
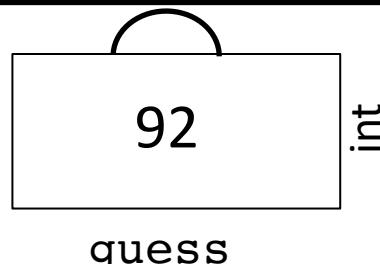


Guess My Number

```
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print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
# True if guess is not equal to secret number
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    if guess < secret_number:
        print("Your guess is too low")
    else:
        print("Your guess is too high")

    print() # an empty line
    guess = int(input("Enter a new guess: "))

print(f"Congrats! The number was: {secret_number}")
```



Challenge: Sentinel Loops

- **sentinel**: A value that signals the end of user input.
 - **sentinel loop**: Repeats until a sentinel value is seen.
- Example: Write a program that prompts the user for numbers until the user types -1, then output the total of the numbers.
 - In this case, -1 is the sentinel value.

Type a number: **10**

Type a number: **20**

Type a number: **30**

Type a number: **-1**

total is **60**





Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0
while num != -1:
    num = int(input("Enter a number: "))
    total += num

print(f"total is {total}")
```

NameError:
name 'num' is not defined



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0
num = int(input("Enter a number: "))
while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```



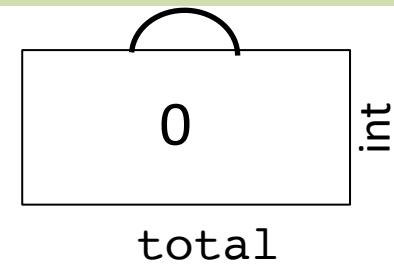
Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence
```

```
total = 0
```

```
num = int(input("Enter a number: " ))
while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence
```

```
total = 0
```

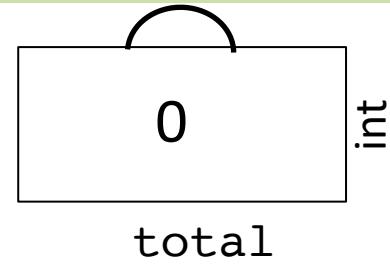
```
num = int(input("Enter a number: " ))
```

```
while num != -1:
```

```
    total += num
```

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

```
print(f"total is {total}")
```



Example: Sentinel Loops

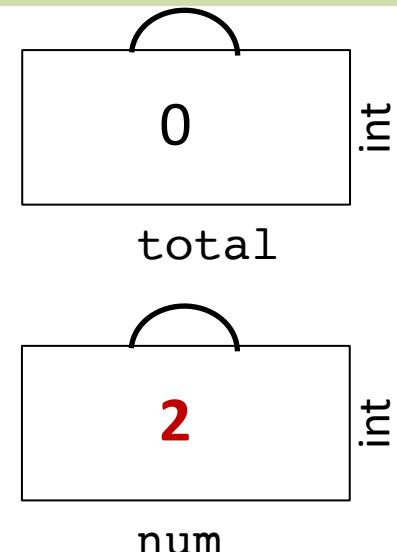
```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```

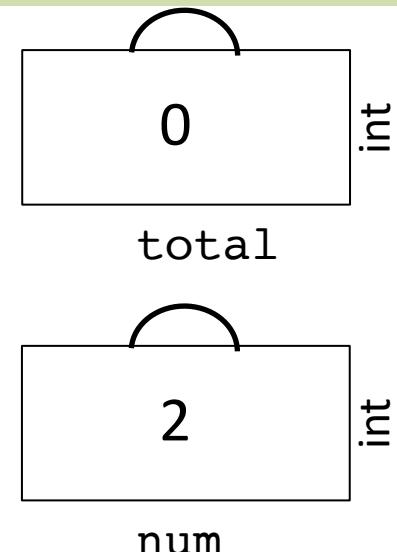


Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0
num = int(input("Enter a number: "))
while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

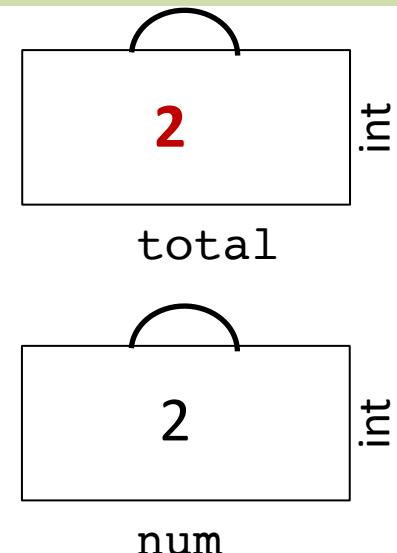
total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num

    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence
```

```
total = 0
```

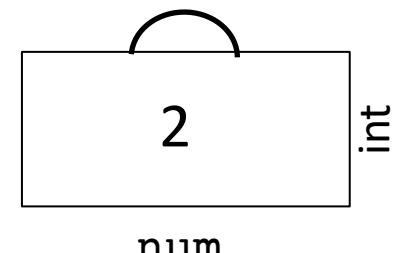
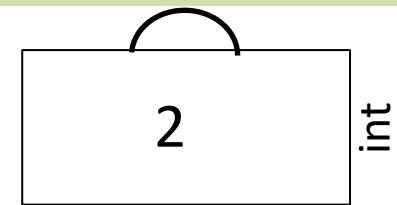
```
num = int(input("Enter a number: " ))
```

```
while num != -1:
```

```
    total += num
```

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

```
print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence
```

```
total = 0
```

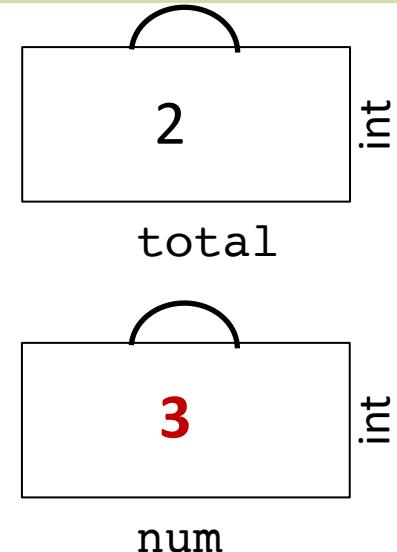
```
num = int(input("Enter a number: " ))
```

```
while num != -1:
```

```
    total += num
```

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

```
print(f"total is {total}")
```



Example: Sentinel Loops

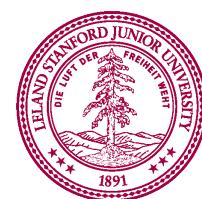
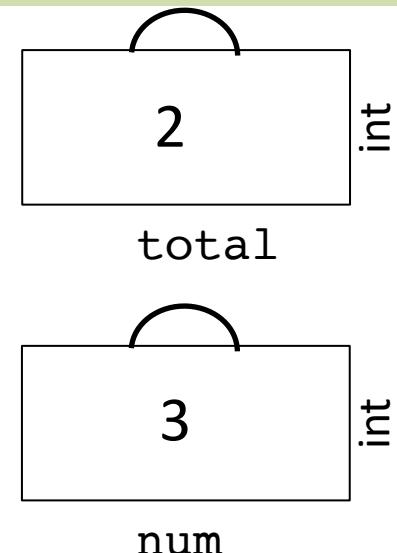
```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```

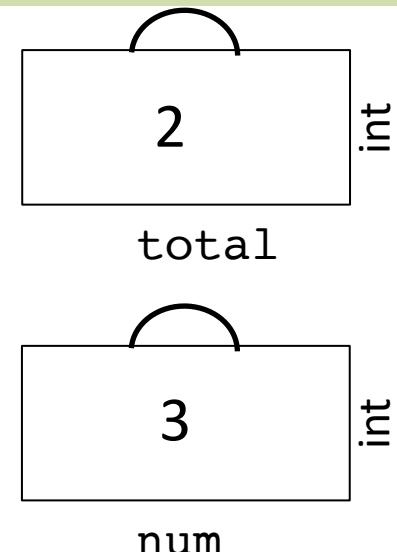


Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0
num = int(input("Enter a number: "))
while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

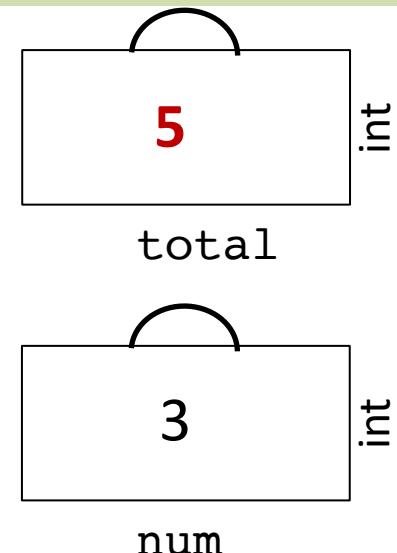
total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num

    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence
```

```
total = 0
```

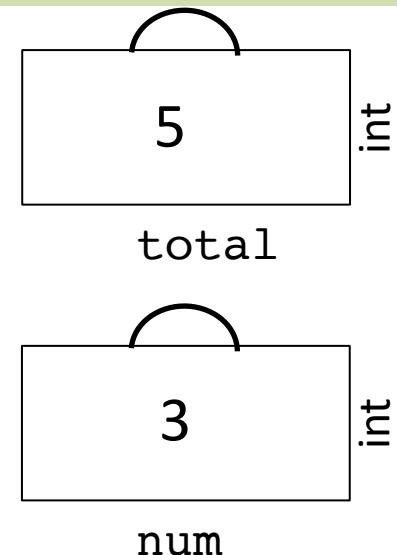
```
num = int(input("Enter a number: " ))
```

```
while num != -1:
```

```
    total += num
```

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

```
print(f"total is {total}")
```



Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence
```

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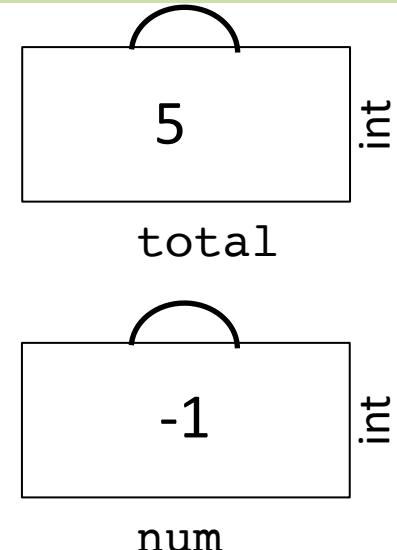
```
num = int(input("Enter a number: " ))
```

```
while num != -1:
```

```
    total += num
```

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

```
print(f"total is {total}")
```



Example: Sentinel Loops

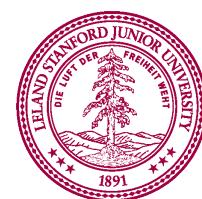
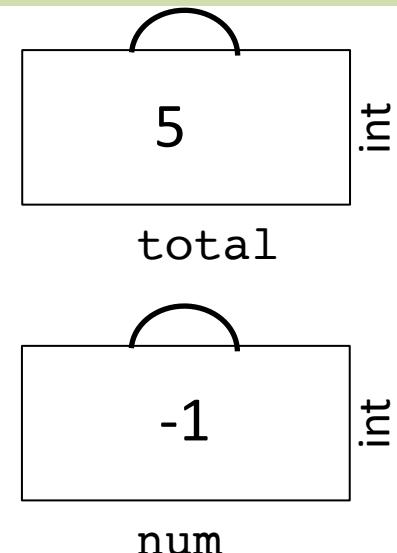
```
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# ask for number - post
# add number to total - fence

total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

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# fencepost problem!
# ask for number - post
# add number to total - fence

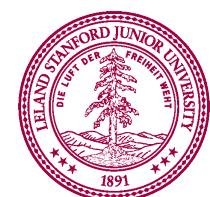
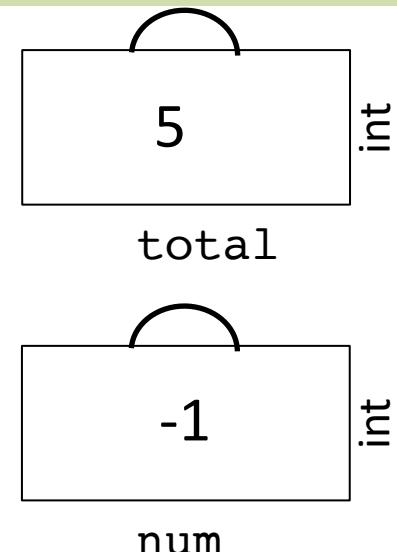
total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num

    num = int(input("Enter a number: "))

print(f"total is {total}")
```



Example: Sentinel Loops

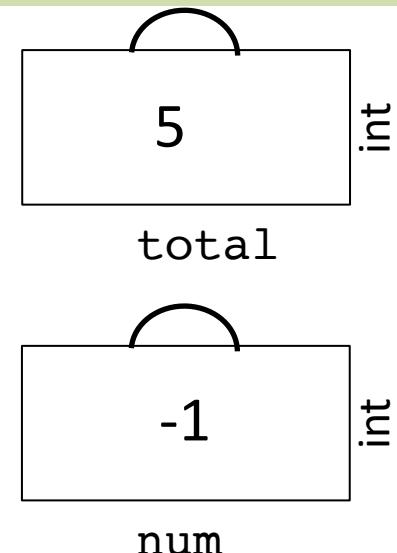
```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0

num = int(input("Enter a number: "))

while num != -1:
    total += num
    num = int(input("Enter a number: "))

print(f"total is {total}")
```

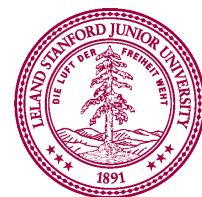


Example: Sentinel Loops

```
# fencepost problem!
# ask for number - post
# add number to total - fence

total = 0

while True:
    num = int(input("Enter a number: "))
    if num == -1:
        break # immediately exits loop
    total += num
print(f"total is {total}")
```



Logical Operators

In order of precedence:

Operator	Example	Result
not	not (2 == 3)	True
and	(2 == 3) and (-1 < 5)	False
or	(2 == 3) or (-1 < 5)	True

Can "chain" tests as in algebra

```
# assume x is 15  
2 <= x <= 10
```

```
# identical version  
2 <= x and x <= 10
```



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

<https://docs.python.org/3/reference/expressions.html#operator-precedence>



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

`5 * 7 >= 3 + 5 * 6 and not False`



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

`35 >= 3 + 5 * 6 and not False`

<https://docs.python.org/3/reference/expressions.html#operator-precedence>



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

`35 >= 3 + 5 * 6 and not False`

`35 >= 3 + 30 and not False`

<https://docs.python.org/3/reference/expressions.html#operator-precedence>



Precedence Madness

Precedence:

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`5 * 7 >= 3 + 5 * (7 - 1) and not False`

`35 >= 3 + 5 * 6 and not False`

`35 >= 3 + 30 and not False`

`35 >= 33 and not False`



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

`35 >= 3 + 5 * 6 and not False`

`35 >= 3 + 30 and not False`

`35 >= 33 and not False`

`True and not False`



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

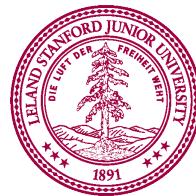
`35 >= 3 + 5 * 6 and not False`

`35 >= 3 + 30 and not False`

`35 >= 33 and not False`

`True and not False`

`True and True`



Precedence Madness

Precedence:

arithmetic > comparison > not > and/or

`5 * 7 >= 3 + 5 * (7 - 1) and not False`

`35 >= 3 + 5 * 6 and not False`

`35 >= 3 + 30 and not False`

`35 >= 33 and not False`

`True and not False`

`True and True`

`True`

<https://docs.python.org/3/reference/expressions.html#operator-precedence>



George Boole

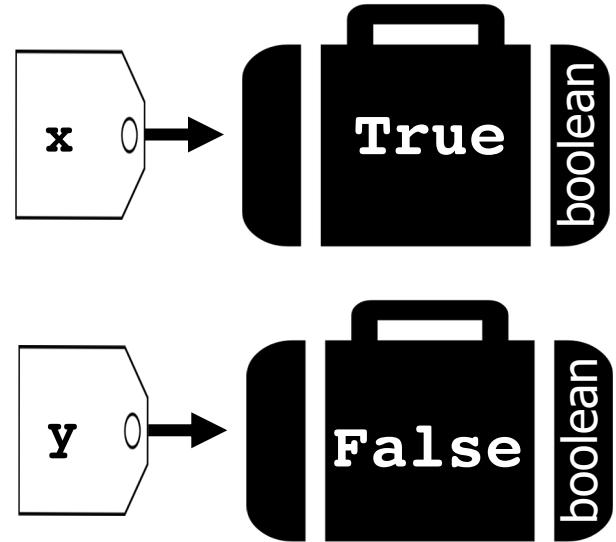


English Mathematician teaching in Ireland 1815 – 1864
Boole died of being too cool



Boolean Variables

```
# Store expressions that evaluate to True/False  
x = 1 < 2      # True  
y = 5.0 == 4.0  # False
```



Boolean Variables

```
# Store expressions that evaluate to True/False
x = 1 < 2      # True
y = 5.0 == 4.0  # False

# Directly set to True/False
is_sheltering = True
is_raining = False
```



Boolean Variables

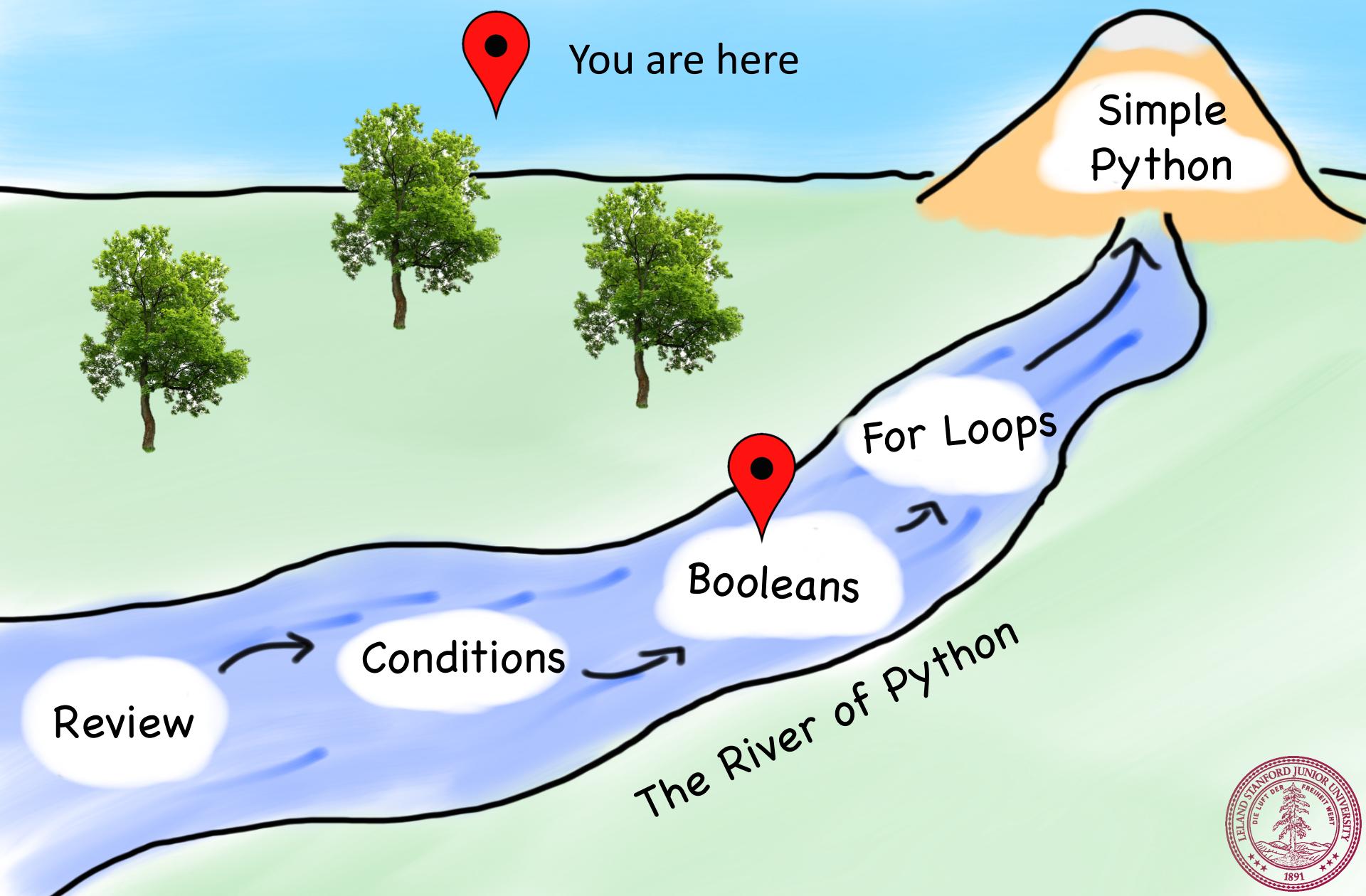
```
# Store expressions that evaluate to True/False
x = 1 < 2      # True
y = 5.0 == 4.0  # False

# Directly set to True/False
is_sheltering = True
is_raining = False

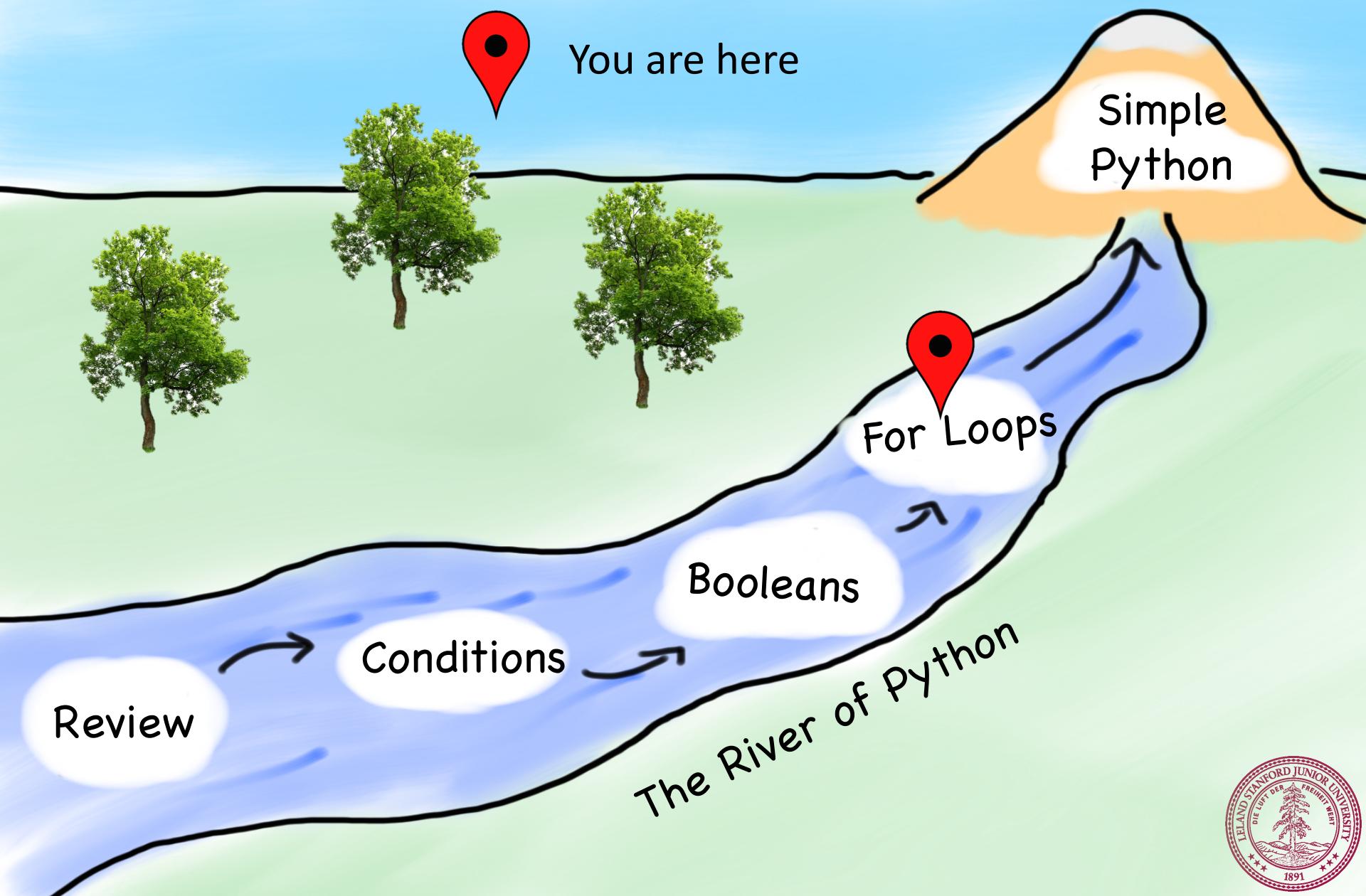
play_again = input('Play again? "y" or "n"') == 'y'
if play_again:
    ...
    ...
```



Today's Route



Today's Route



How would you print “Python rocks socks”
100 times

For Loop Redux

```
def main():
    for i in range(100):
        print("Python rocks socks!")
```



For Loop Redux

```
for i in range(100):  
    print("Python rocks socks!")
```

```
i = 0  
while i < 100:  
    print("Python rocks socks!")  
    i += 1
```



For Loop Redux

Create a counting
variable i

```
for i in range(100):  
    print("Python rocks socks!")
```

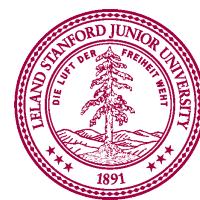
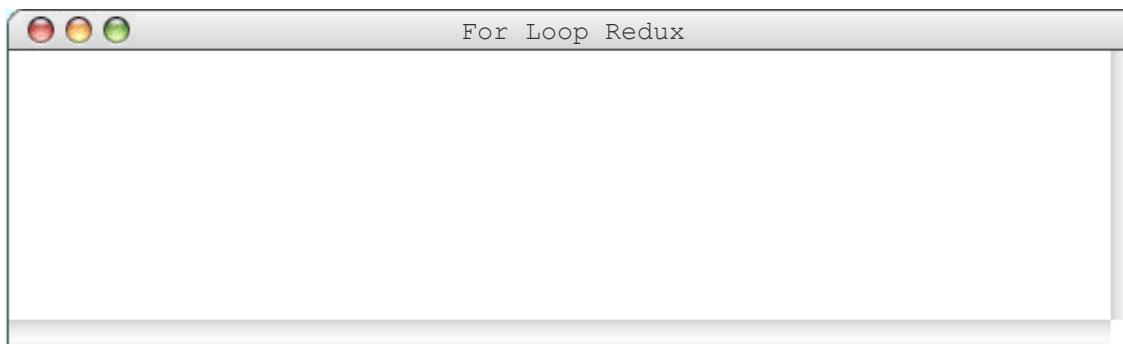
Which takes on
the values 0 to 99
one at a time



For Loop Redux

range(3) → 0, 1, 2

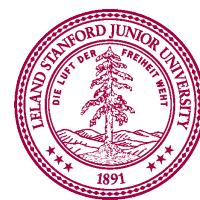
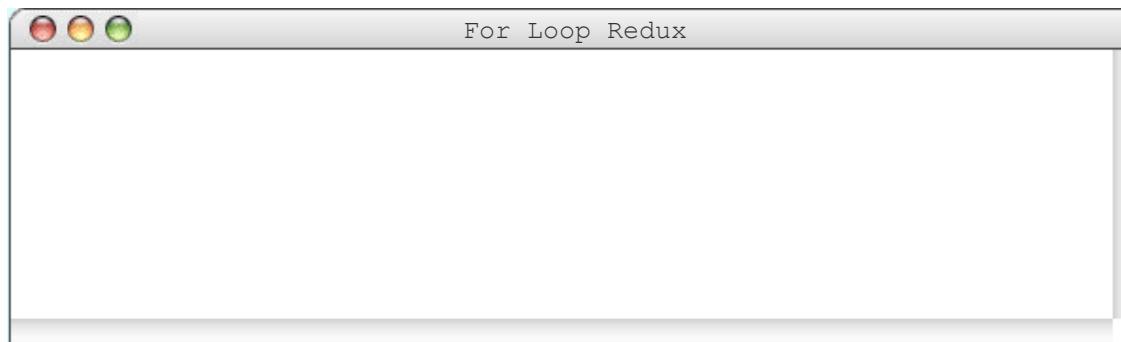
```
for i in range(3):  
    print("Python rocks socks!")
```



For Loop Redux

range(3) → 0, 1, 2

```
for i in range(3):  
    print("Python rocks socks!")
```

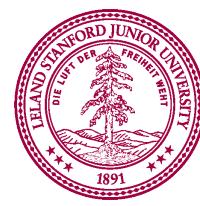
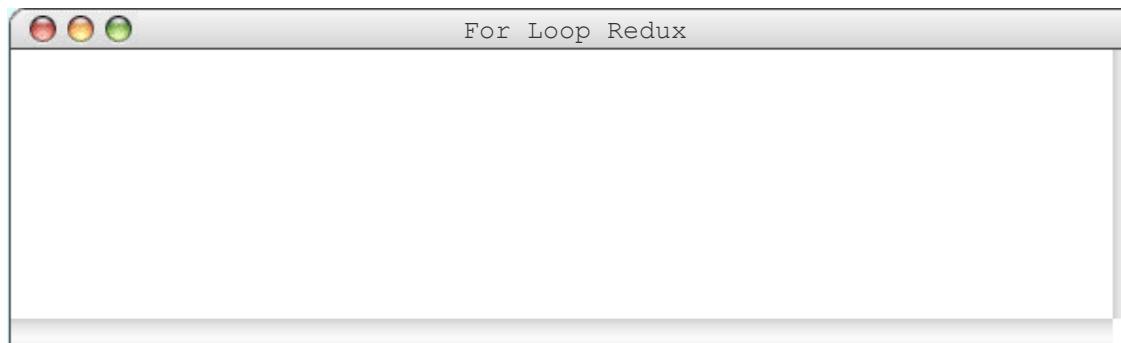


For Loop Redux

i 0

range(3) → 0, 1, 2

```
for i in range(3):  
    print("Python rocks socks!")
```

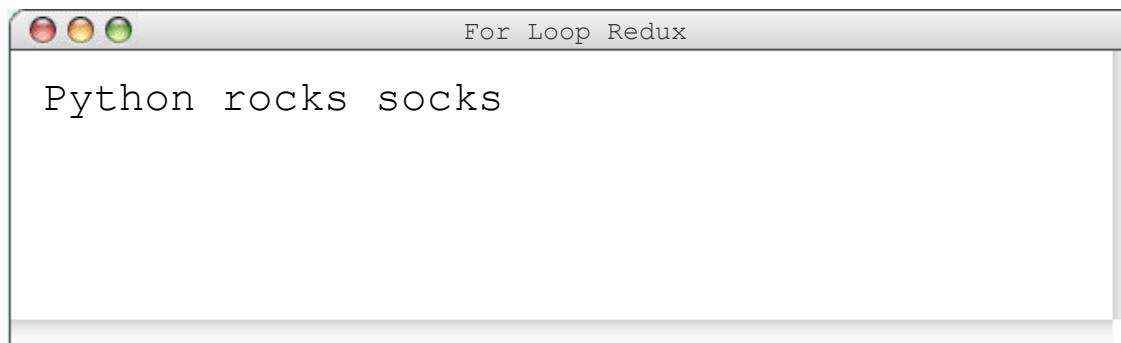


For Loop Redux

i 0

range(3) → 0, 1, 2

```
for i in range(3):  
    print("Python rocks socks!")
```

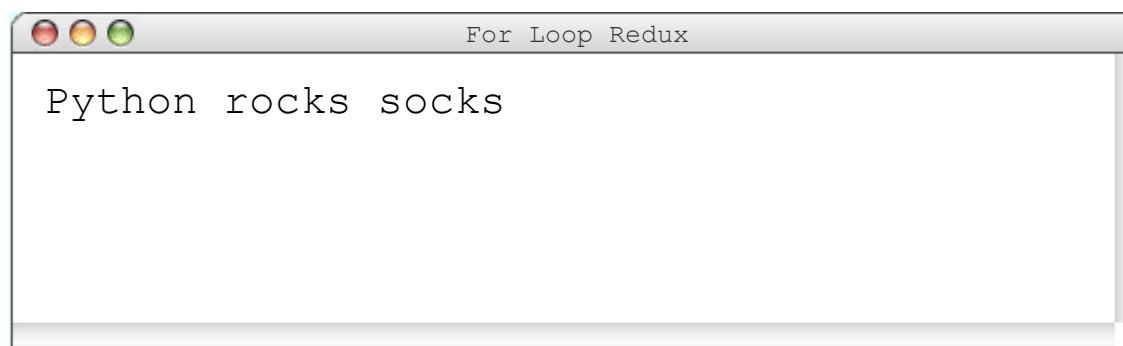


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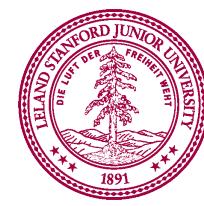
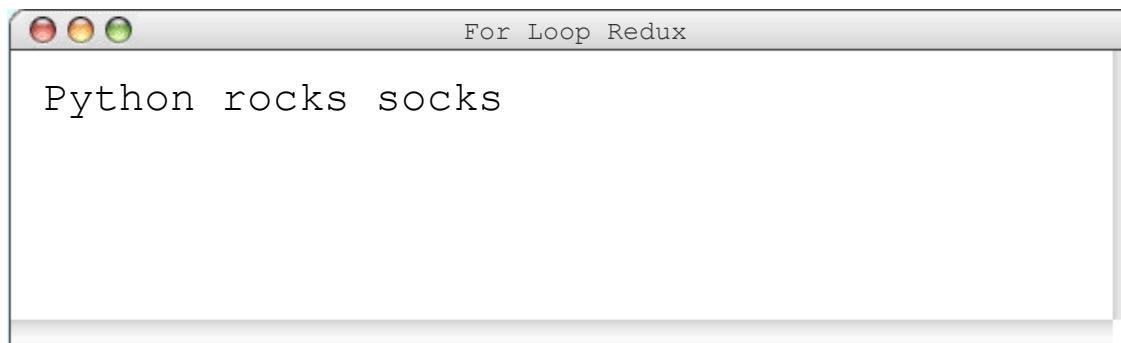


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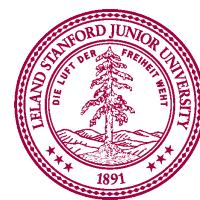
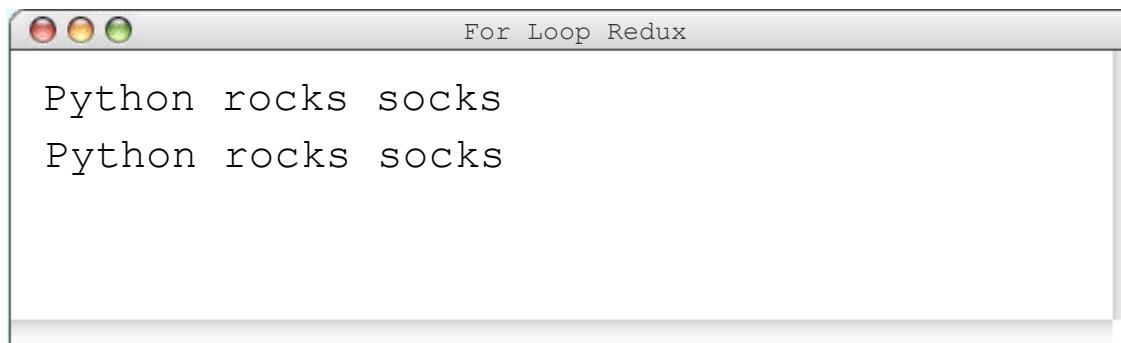


For Loop Redux

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```
for i in range(3):  
    print("Python rocks socks!")
```

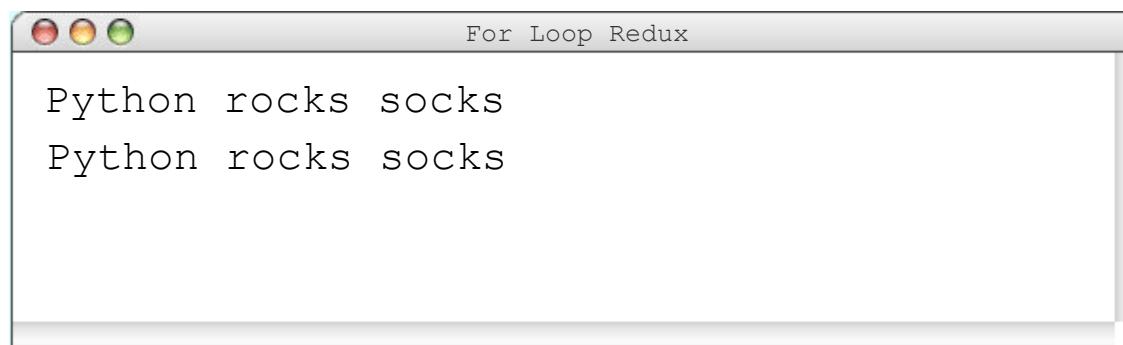


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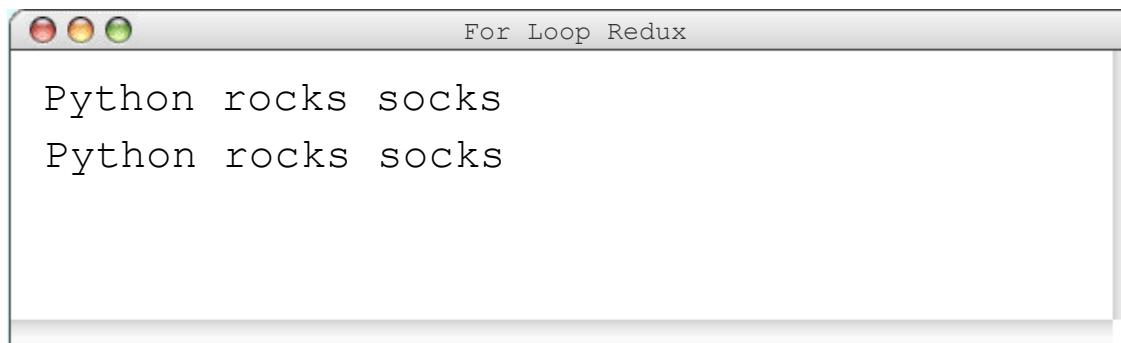


For Loop Redux

i 2

range(3) → 0, 1, 2

```
for i in range(3):  
    print("Python rocks socks!")
```

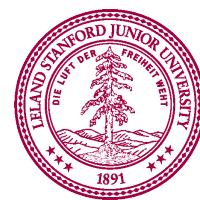
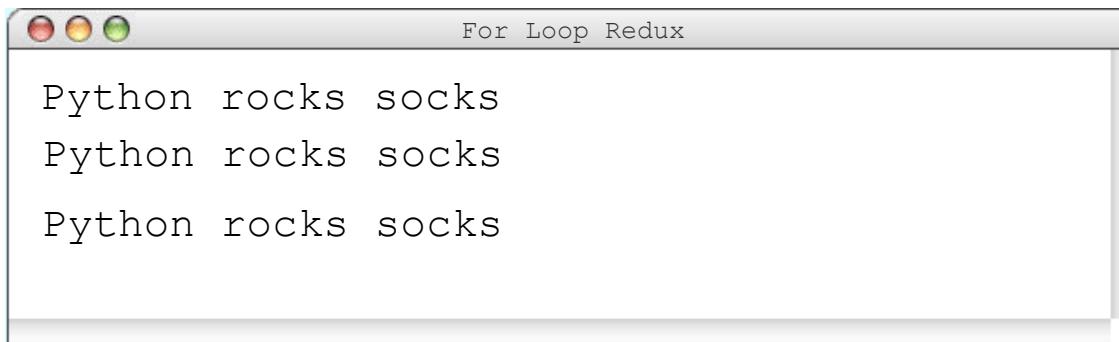


For Loop Redux

i 2

range(3) → 0, 1, 2

```
for i in range(3):  
    print("Python rocks socks!")
```

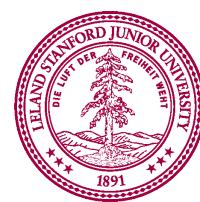
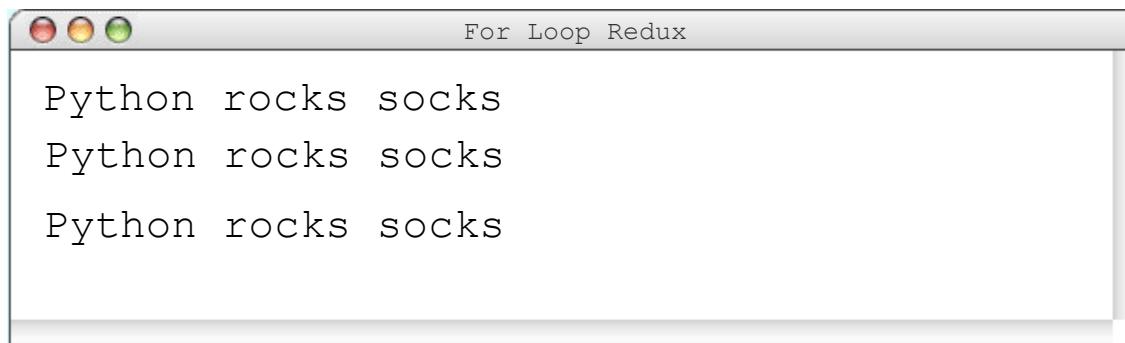


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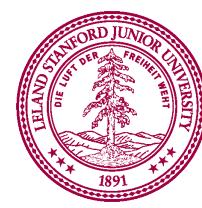
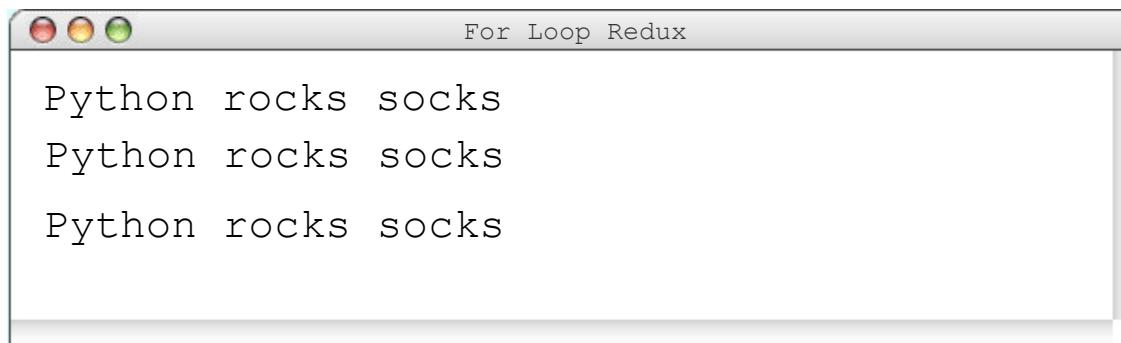


For Loop Redux

i 3

range(3) → 0, 1, 2

```
for i in range(3):  
    print("Python rocks socks!")
```



You can use the for loop variable



How would you print the first 100 even numbers?

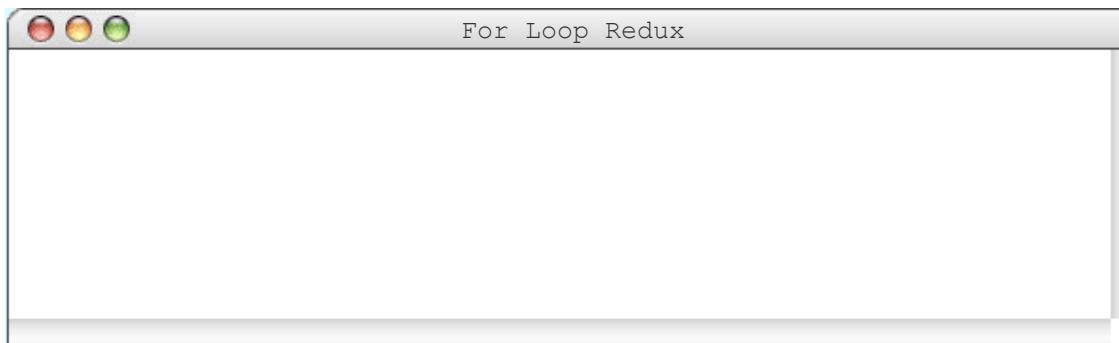
Printing Even Numbers

```
PrintEven...  
0  
2  
4  
6  
8  
10  
12  
14  
16  
18  
20  
22  
24  
26  
28  
30  
32  
34  
36  
38
```



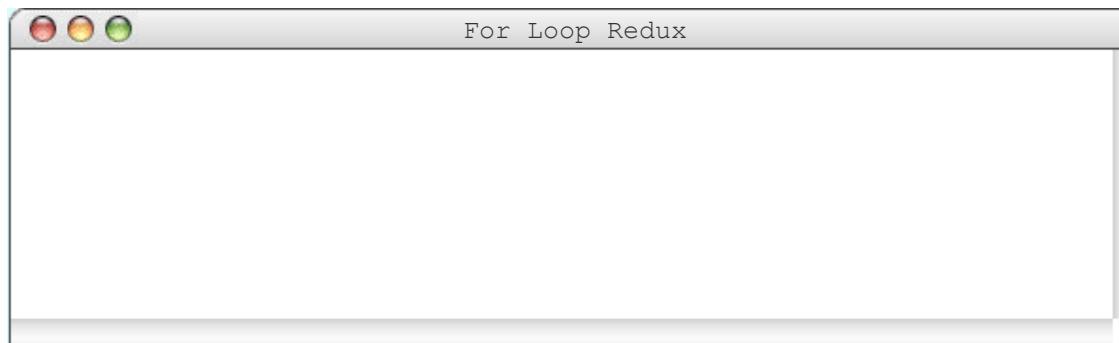
Printing Even Numbers

```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

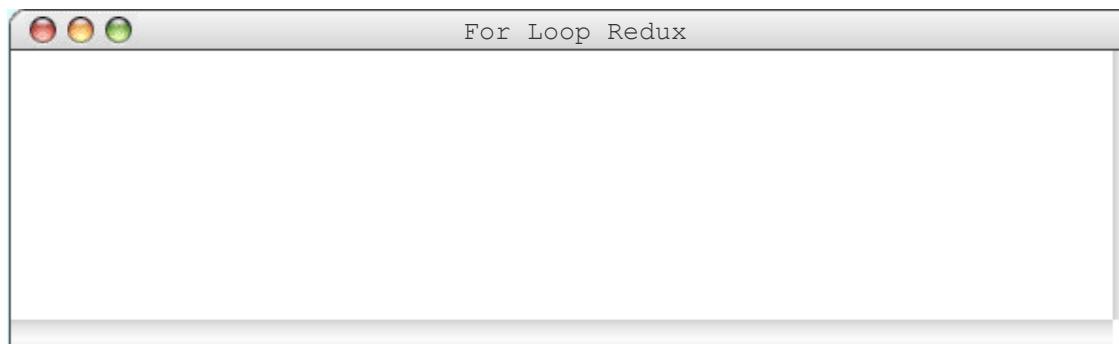
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

i 0

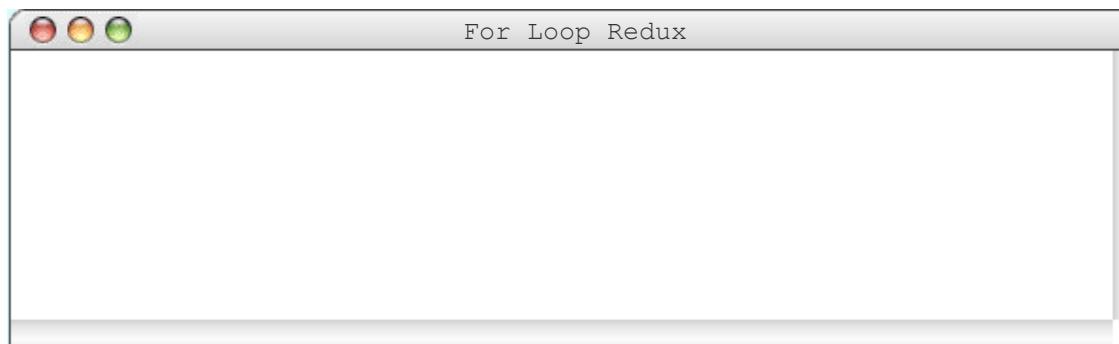
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

i 0

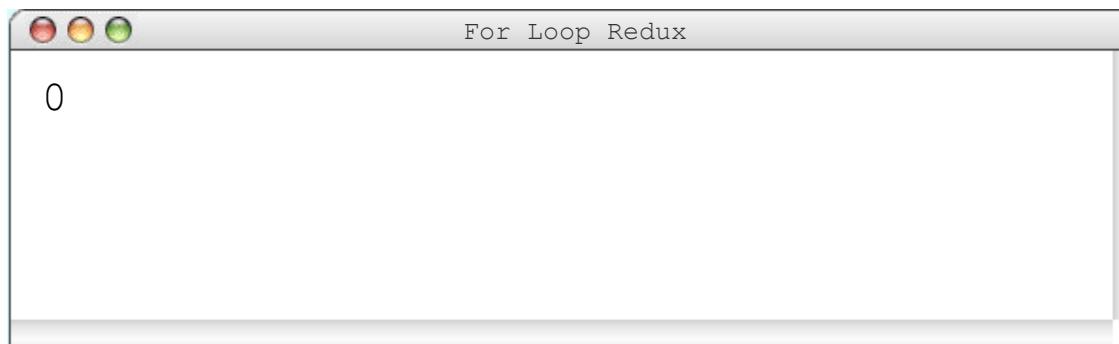
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

i 0

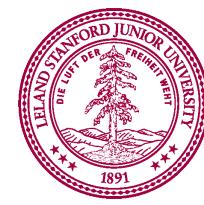
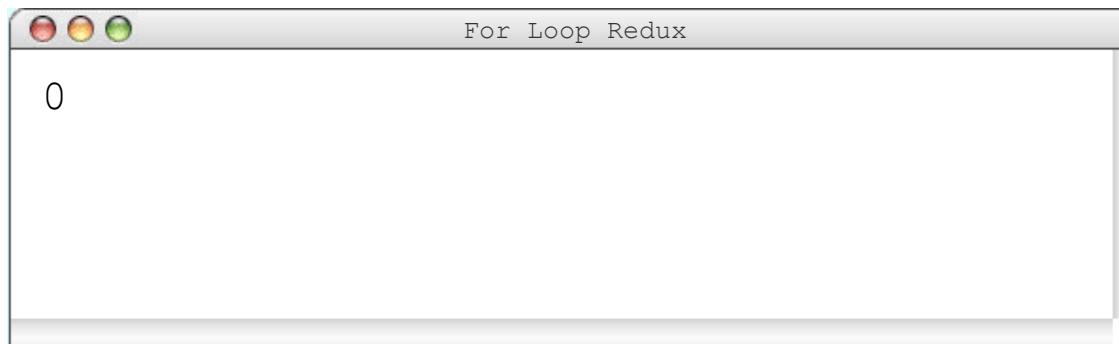
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

i 1

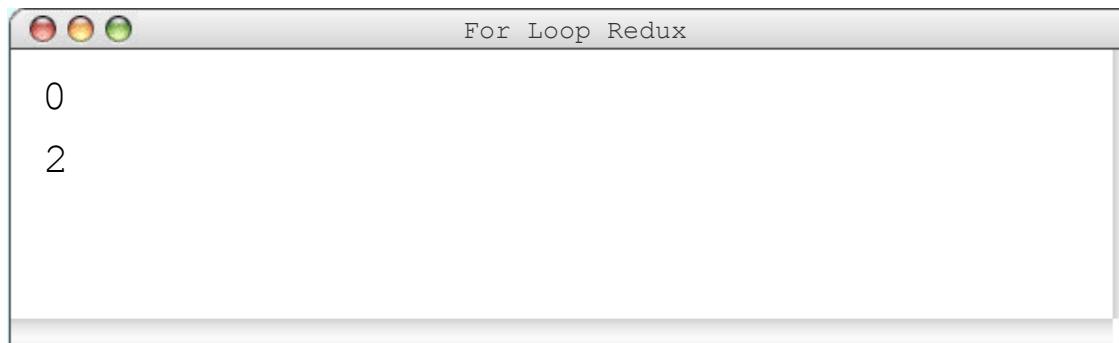
```
for i in range(3):  
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```



Printing Even Numbers

i 1

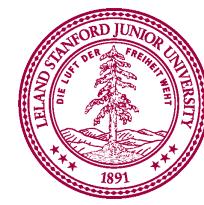
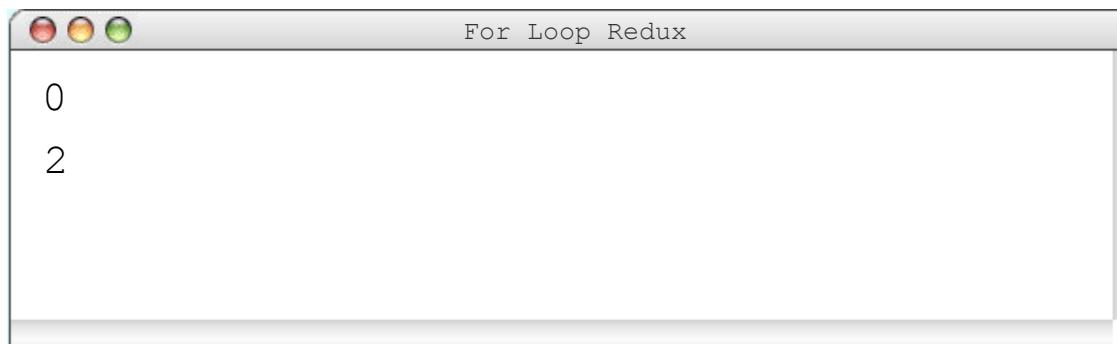
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

i 2

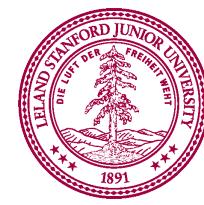
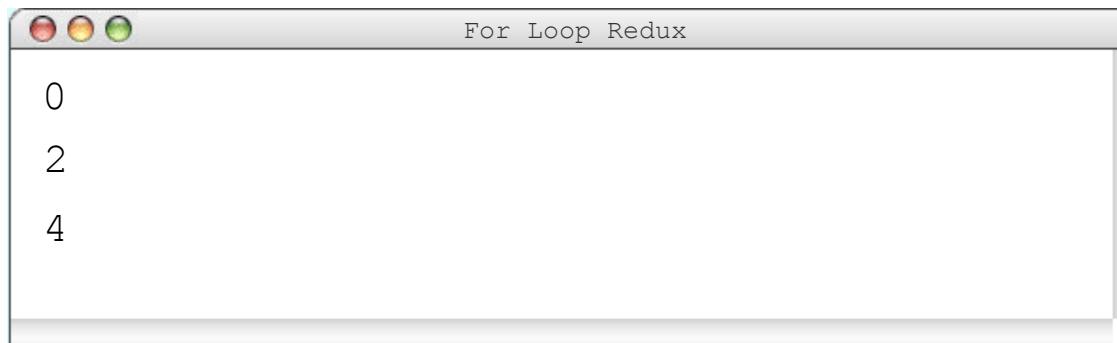
```
for i in range(3):  
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```



Printing Even Numbers

i 2

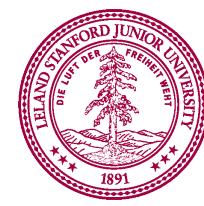
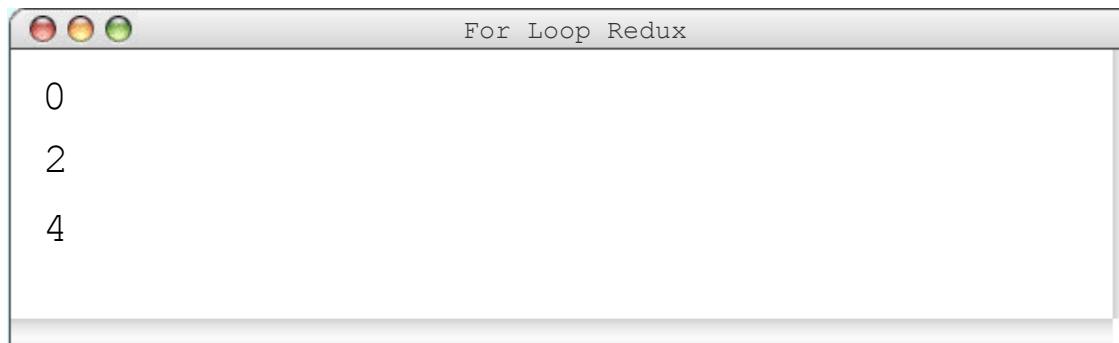
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

i 3

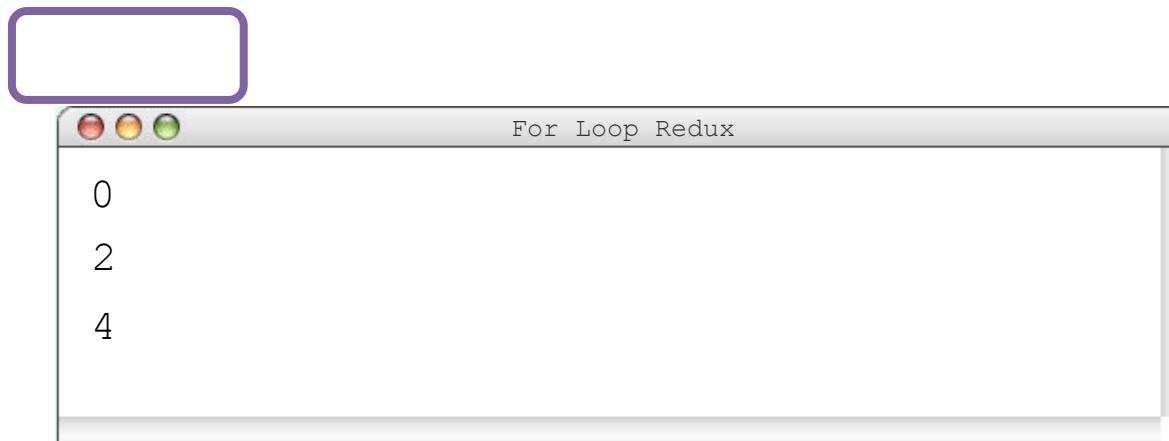
```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

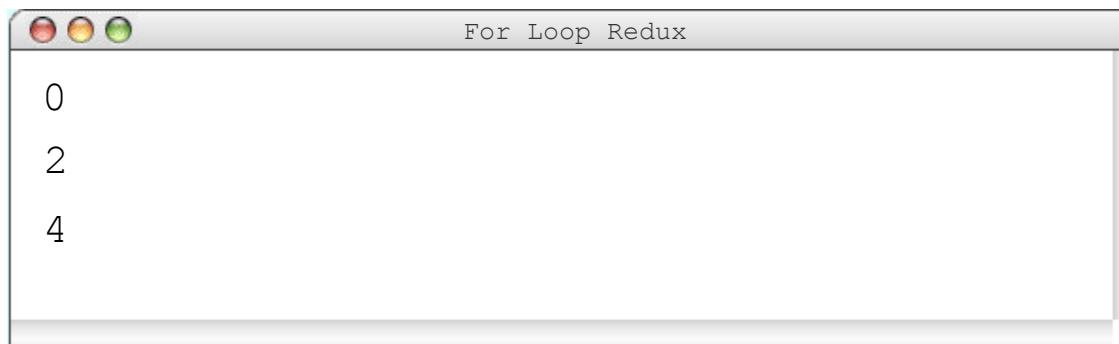
i 3

```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

```
for i in range(3):  
    print(i * 2)
```



Printing Even Numbers

```
# our solution    0, 1, 2
```

```
for i in range(3):
```

```
    print(i * 2)
```

```
# equivalently
```

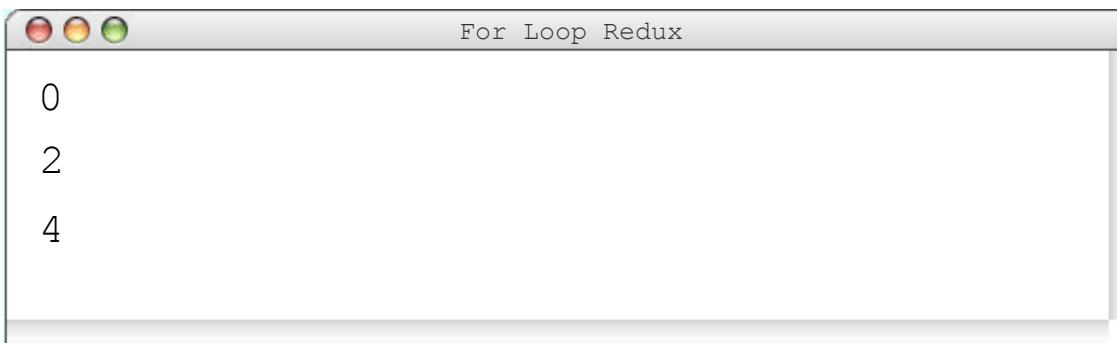
```
for i in range(0, 6, 2):
```

```
    print(i)
```

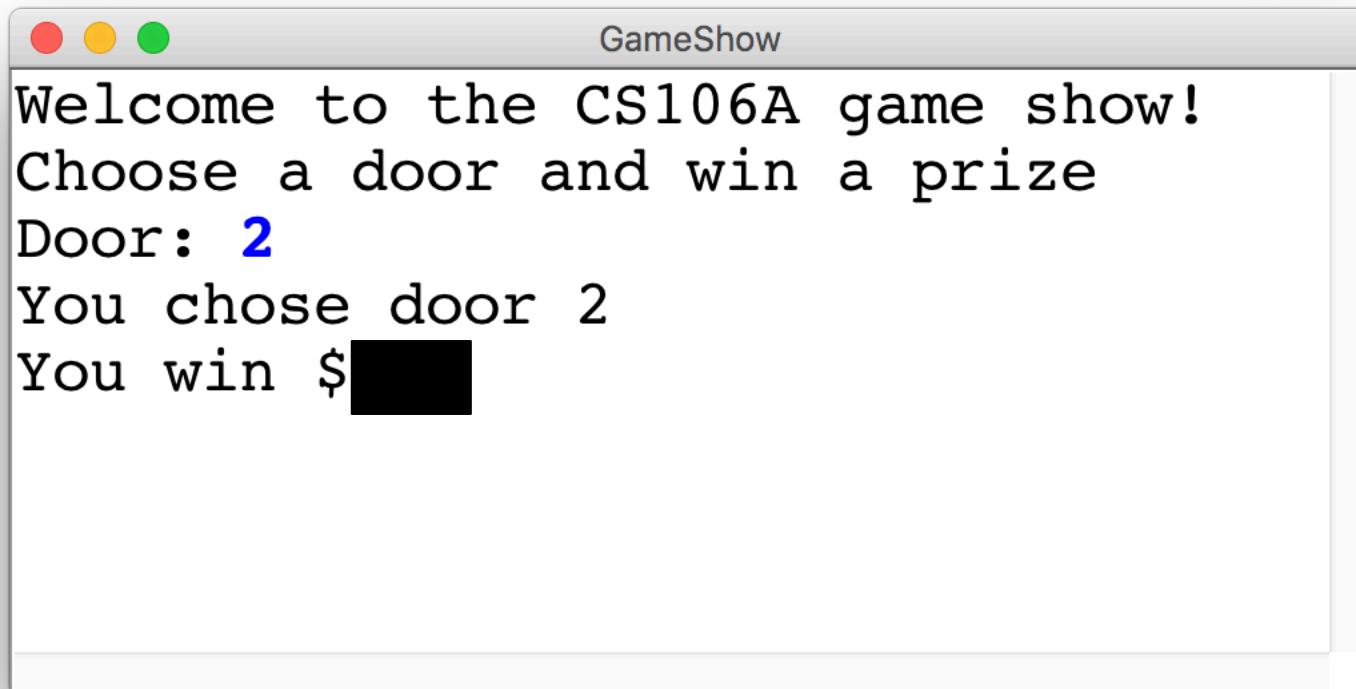
Start at 0

Stop before 6

skip by 2 each time



Game Show



* To be delivered via amazon
gift cards



Choose a Door

```
door = int(input("Door: "))
# while the input is invalid
while door < 1 or door > 3:
    # tell the user the input was invalid
    print("Invalid door!")
    # ask for a new input
    door = int(input("Door: "))
```

or
and



The Door Logic

```
prize = 4

if door == 1:
    prize = 2 + 9 // 10 * 100

elif door == 2:
    locked = prize % 2 != 0
    if not locked:
        prize += 6

elif door == 3 :
    for i in range(door):
        prize += i
```

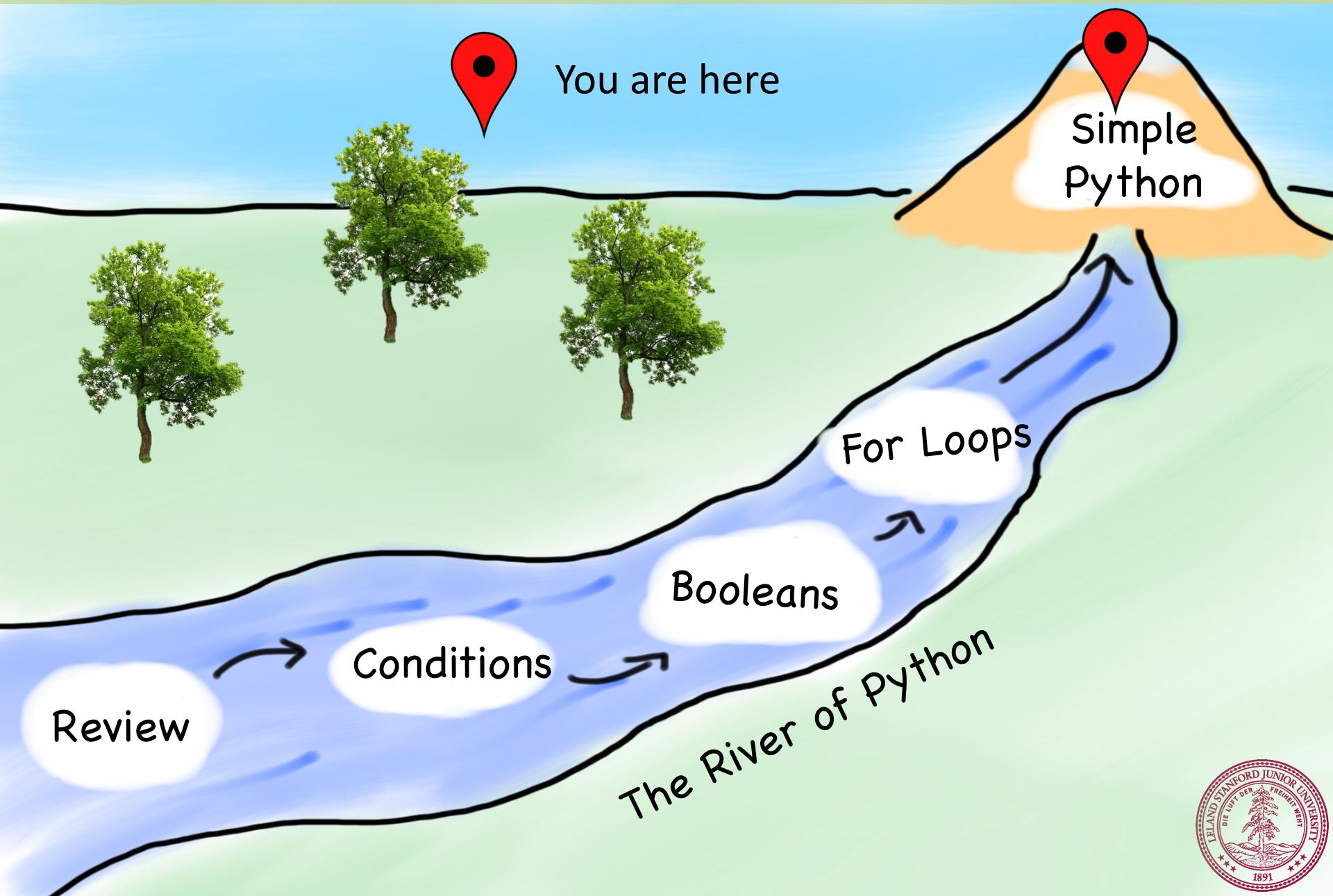


That's all

```
def main() :  
    for i in range(999999):  
        print("You rock!")  
        print("See you on Monday")
```



Today's Route



Today's Goal

1. Be able to use For / While / If in Python

