

THE CSBridge  
SAGA CONTINUES



# Control Flow Revisited

Chris Piech  
CS Bridge 2020

Starring  
MARK HAMILL · HARRISON FORD · CARRIE FISHER  
BILLY DEE WILLIAMS · ANTHONY DANIELS  
Co-starring DAVID PROWSE · KENNY BAKER · PETER MAYHEW · FRANCOIS OZ  
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  
Music by JOHN WILLIAMS

Filmed in Panavision® Colour by Rank Film Laboratories

A Lucasfilm Ltd Production A Twentieth Century Fox Release



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DOLBY STEREO™

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# Chris Piech

## Teaching at Stanford

CS106A

Programming  
Methodologies

CURRENT

CS106B

Programming  
Abstractions

LAST: FALL 2016

CS109

Probability for Computer  
Scientists

LAST: FALL 2018

CS221

Intro to Artificial  
Intelligence

LAST: SUM 2013



I am a professor in the **AI Lab** at  
Stanford. My focus is on  
education and healthcare!



@chrispiech

Piech and Sahami, CS106A, Stanford University



# Chris Piech





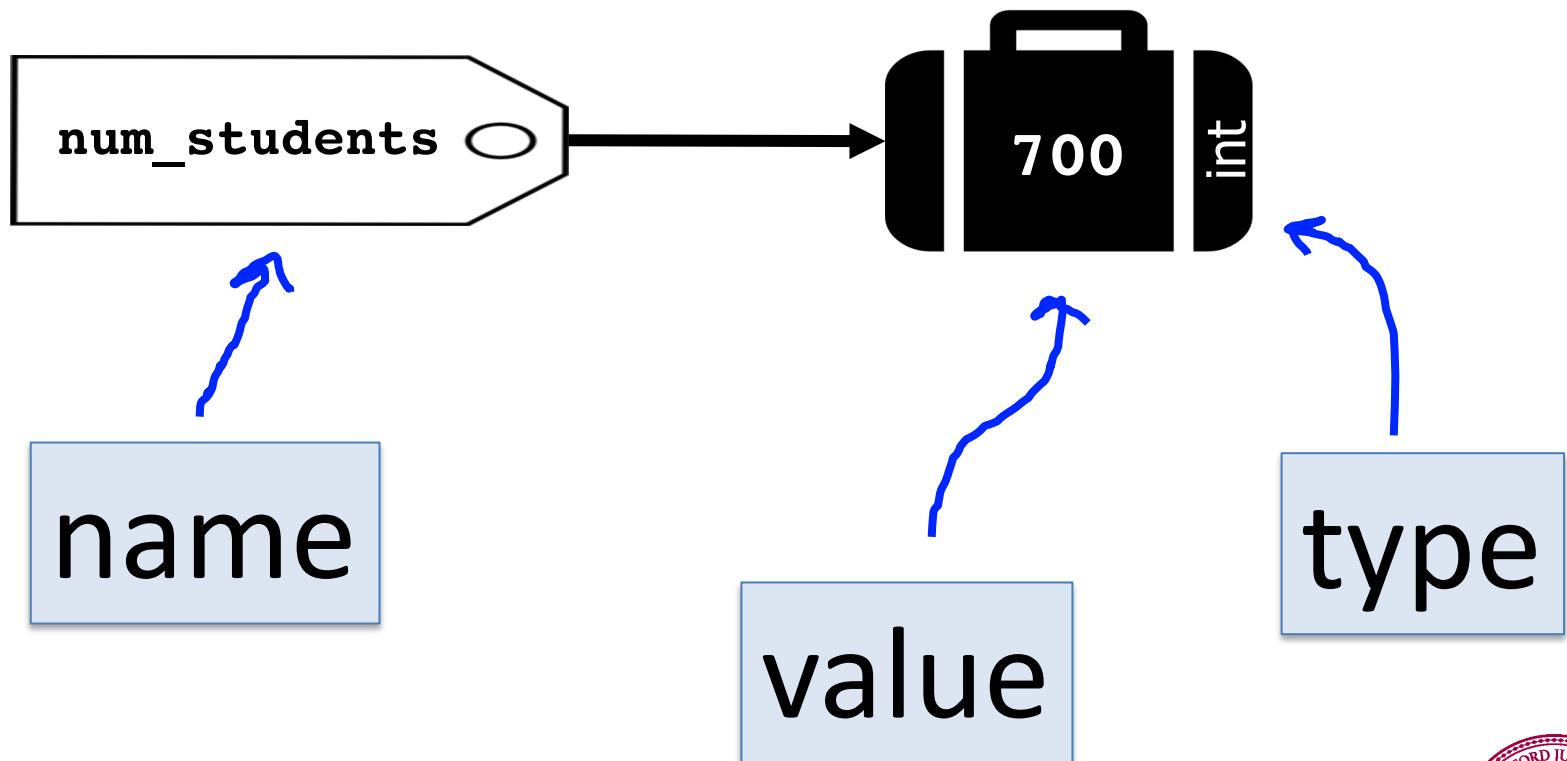
Let's play a game

Truly important concepts

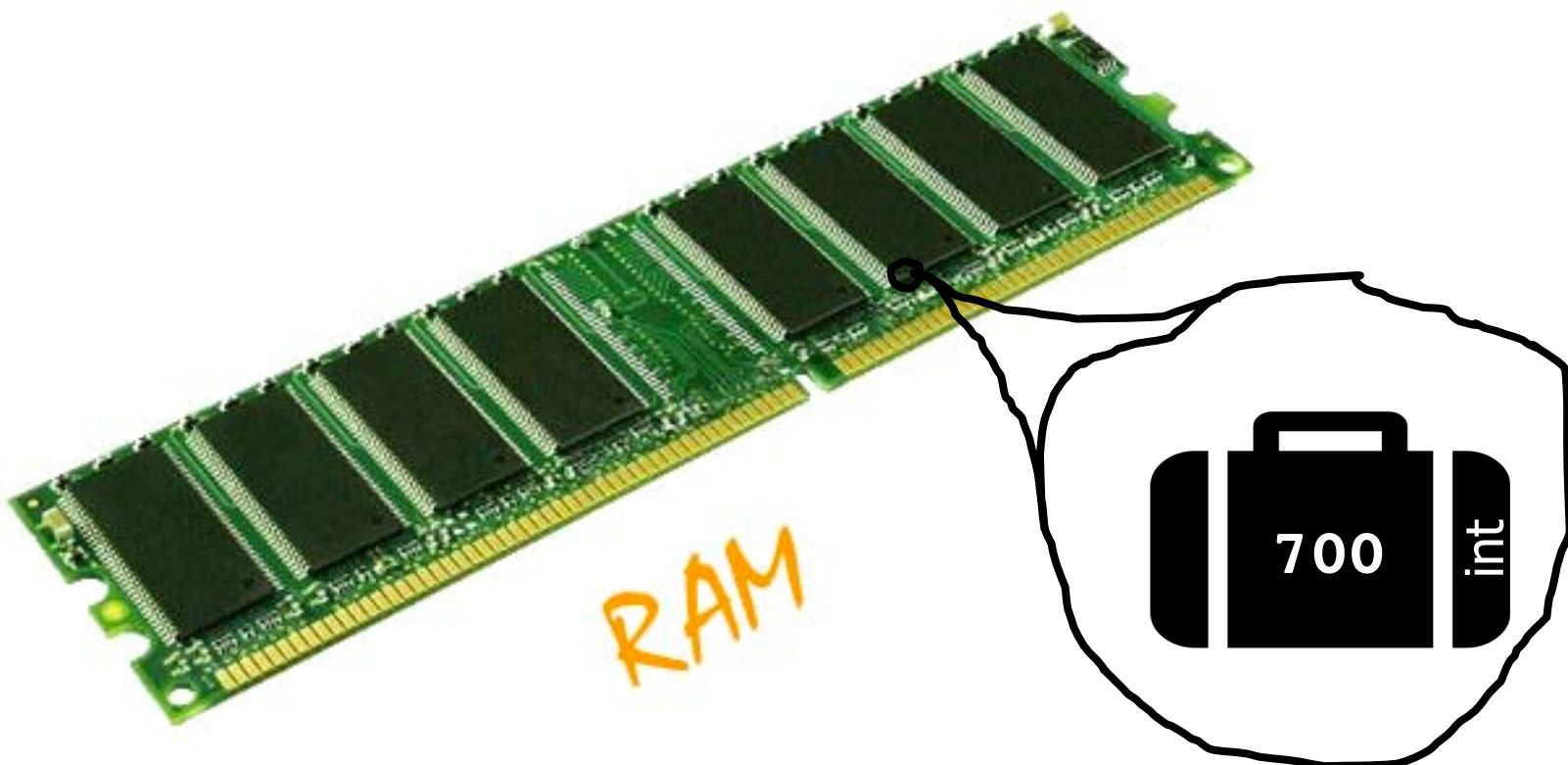
# Review

# Variable 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 = 31
```

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

```
# Use the value in age (output it)  
print("age is: " + age)
```



# Create, Modify, Use

```
# Create a variable, of type int  
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```

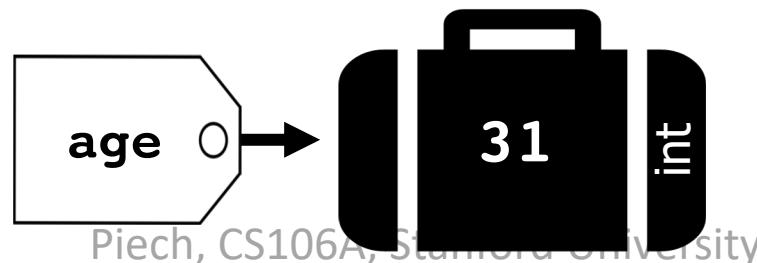
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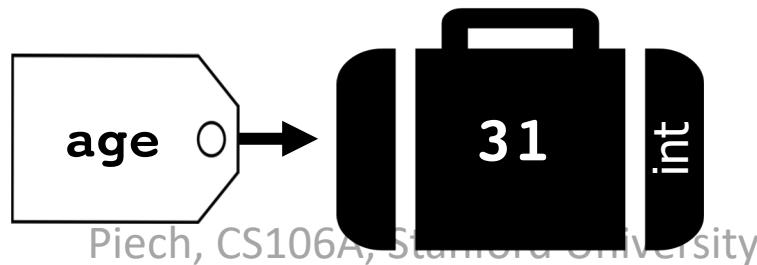


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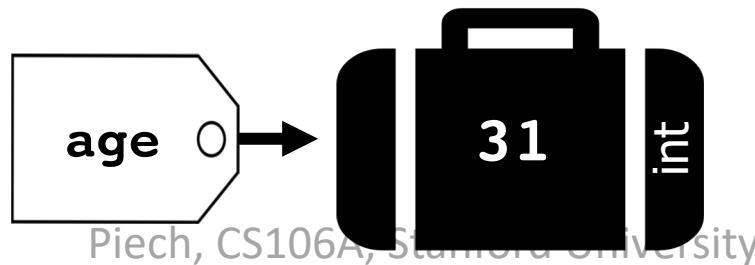


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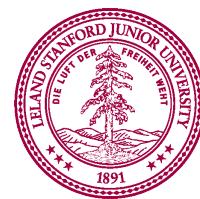
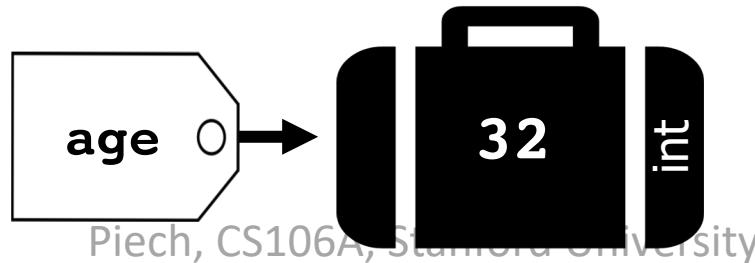


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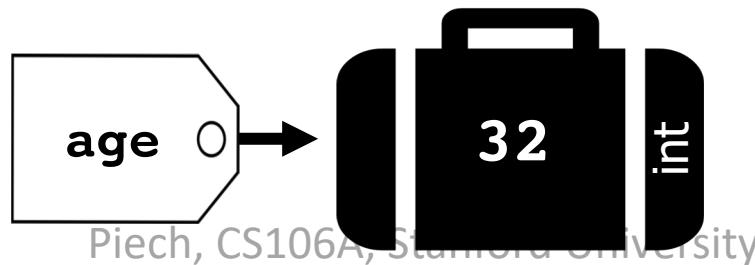


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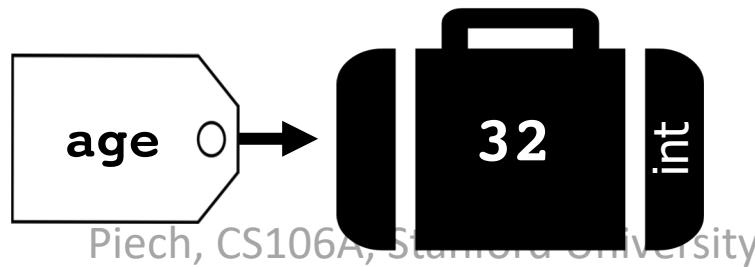


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# Use the value in age (output it)  
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```



# Binary Operators

+	Addition	*	Multiplication
-	Subtraction	/	Division

There are others too!

%	Remainder	//	Int Division
**	Exponentiation		

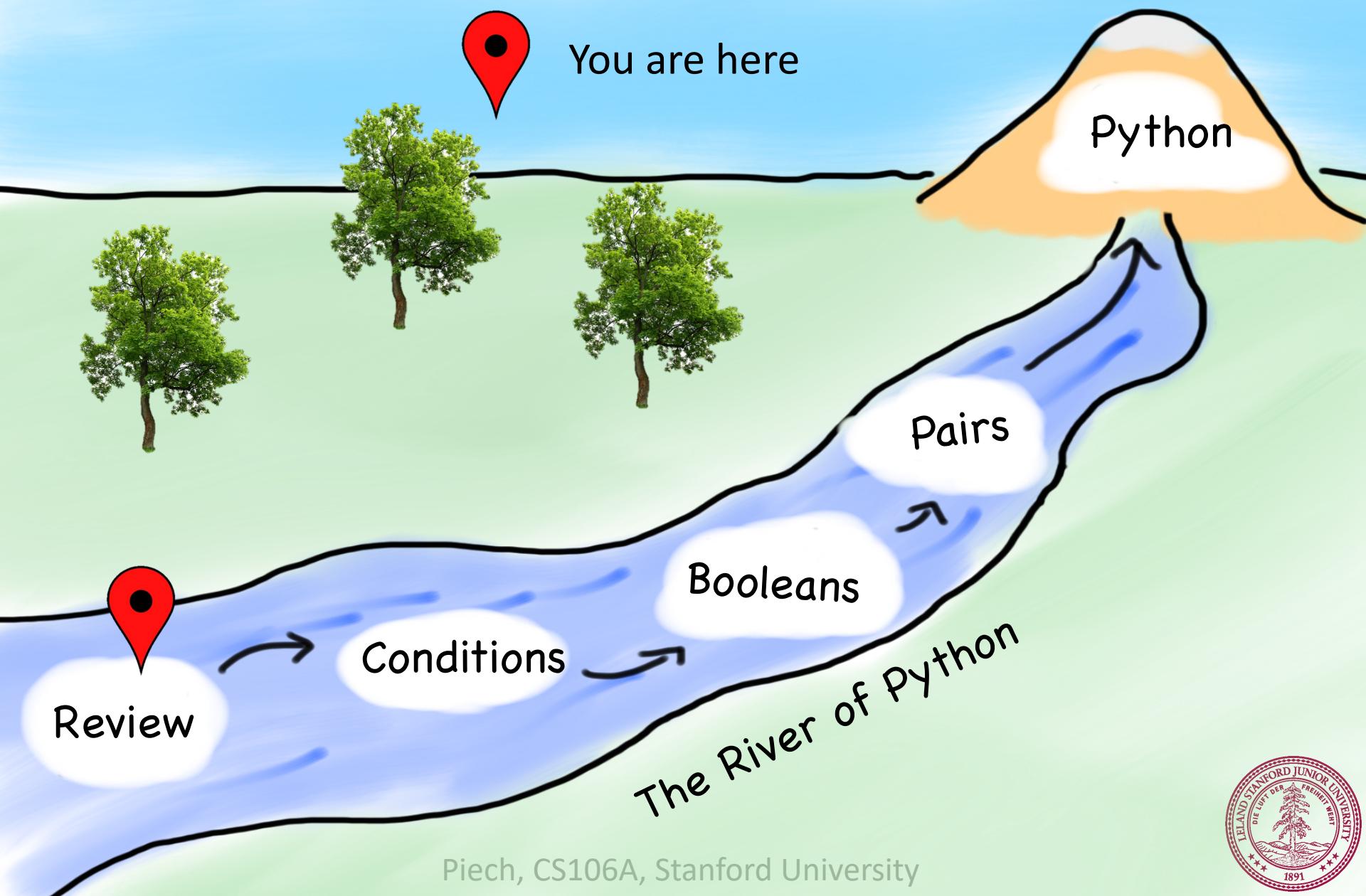


# Today's Goal

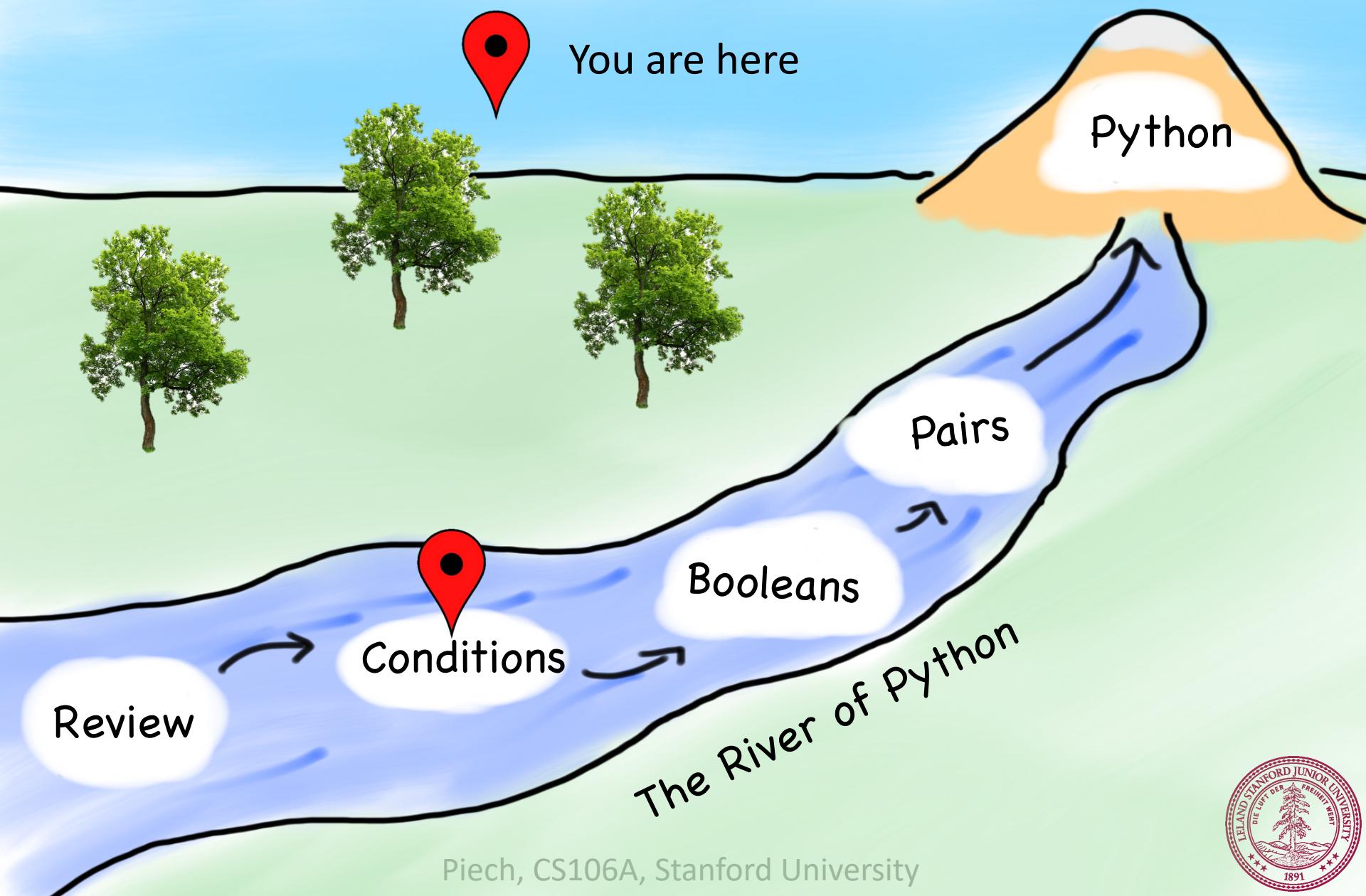
1. Be able to use While and If in Python
2. Combine loops and variables



# 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**



# Loops 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**



# Conditions?

Anything that resolves to a “**True**” or  
“**False**” answer is a condition

$$1 < 2$$



# Conditions

Anything that resolves to a “True” or  
“False” answer is a condition

This is a comparison  
operator

$$1 < 2$$

True



# Conditions

Anything that resolves to a “True” or  
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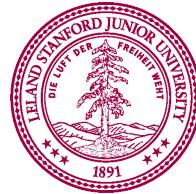
```
my_var < 2
```

True



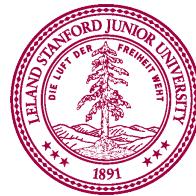
# First Example

```
while 1 < 2 :  
    print("programming is awesome!")  
    print("woot")
```



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    print("programming is awesome!")  
    print("woot")
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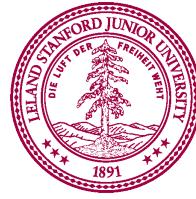
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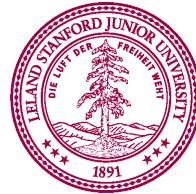
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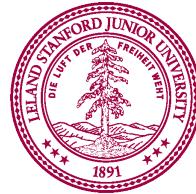
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    print("programming is awesome!")  
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# First Example

```
while 1 < 2 :  
    print("programming is awesome!")  
    print("woot")
```



# 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>&lt;</code>	less than	<code>10 &lt; 5</code>	False
<code>&gt;</code>	greater than	<code>10 &gt; 5</code>	True
<code>&lt;=</code>	less than or equal to	<code>126 &lt;= 100</code>	False
<code>&gt;=</code>	greater than or equal to	<code>5.0 &gt;= 5.0</code>	True

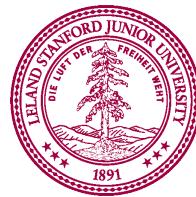
\* All have equal precedence



# Comparison Operators

Operator	Meaning	Example	Value
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<code>&lt;=</code>	less than or equal to	<code>126 &lt;= 100</code>	False
<code>&gt;=</code>	greater than or equal to	<code>5.0 &gt;= 5.0</code>	True

\* All have equal precedence



= vs ==

In python:



==

Is a comparison  
operator

=

Is used for variable  
assignment



# Comparison Operators

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

---

```
num = int(input("Enter a number: "))  
if num == 0: This is a condition  
    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

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

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



# If Else Revisited

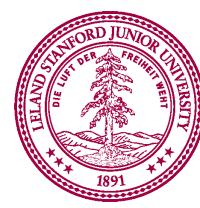
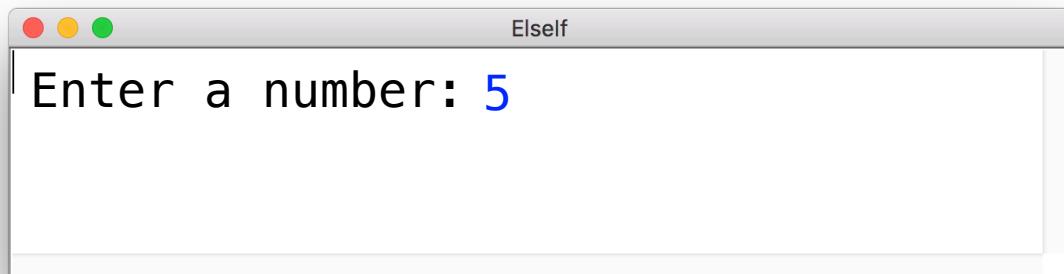
```
num = int(input("Enter a number: "))

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

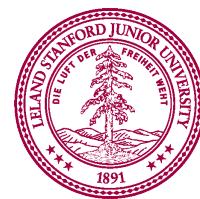
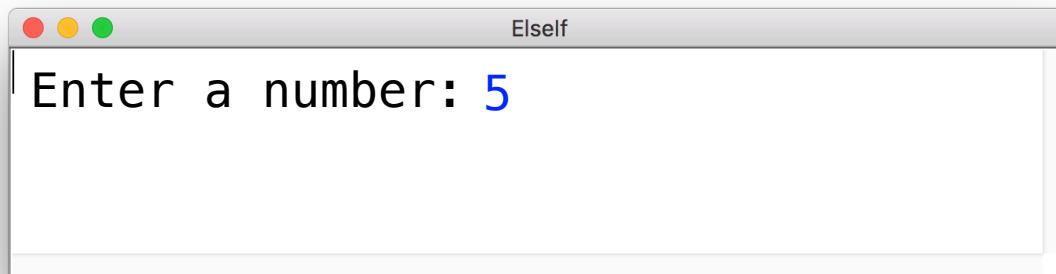
5

```
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")
```

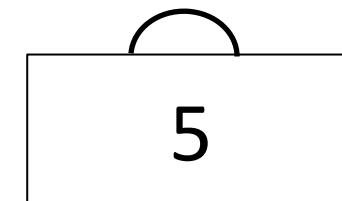
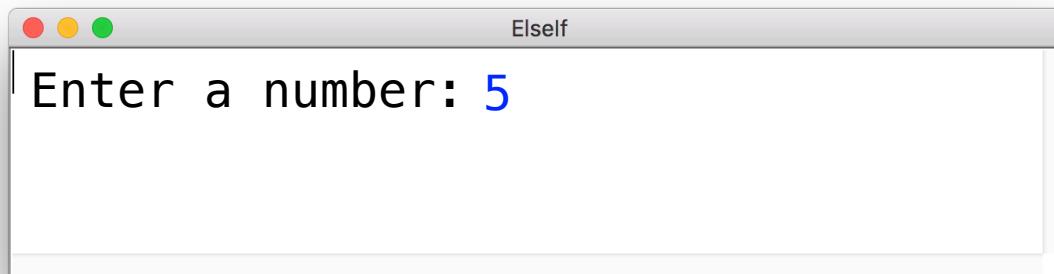


# If Else Revisited

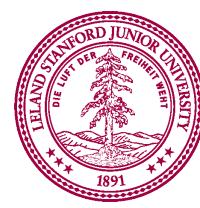
5

```
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")
```



num



# If Else Revisited

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

if num == 0:

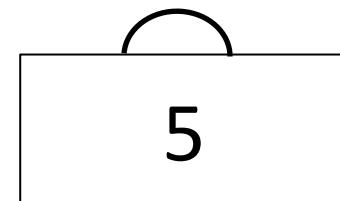
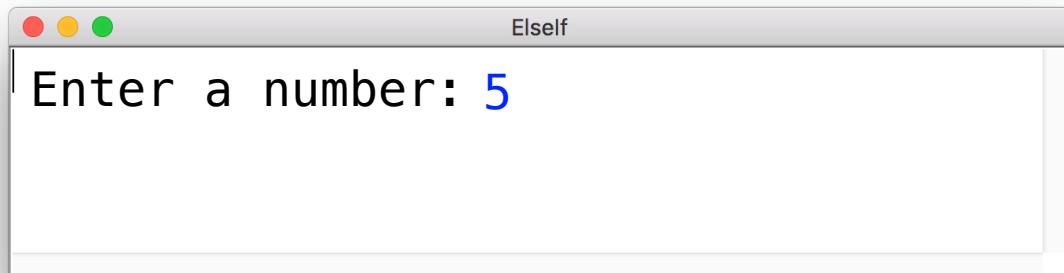
    print("Your number is 0 ")

elif num > 0:

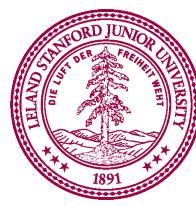
    print("Your number is positive")

else:

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



num



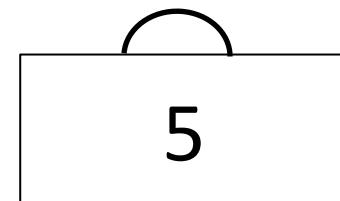
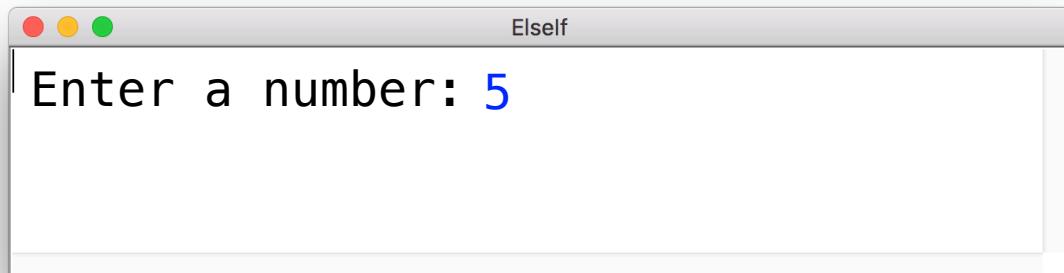
# If Else Revisited

```
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

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

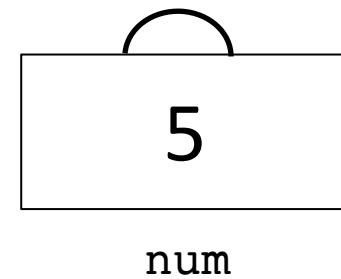
if num == 0:
    print("Your number is 0")

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

**else:**

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

The screenshot shows a terminal window with the title bar 'Elseif'. The window contains the following text:  
Enter a number: 5  
Your number is positive



# If Else Revisited

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

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

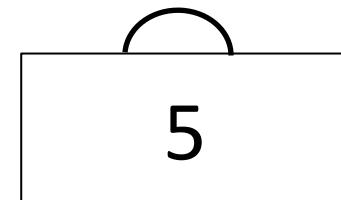
elif num > 0:
    print("Your number is positive")

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



The terminal window shows the following interaction:

```
Elseif
Enter a number: 5
Your number is positive
```



num

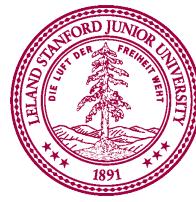


Lets do it again!

# 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

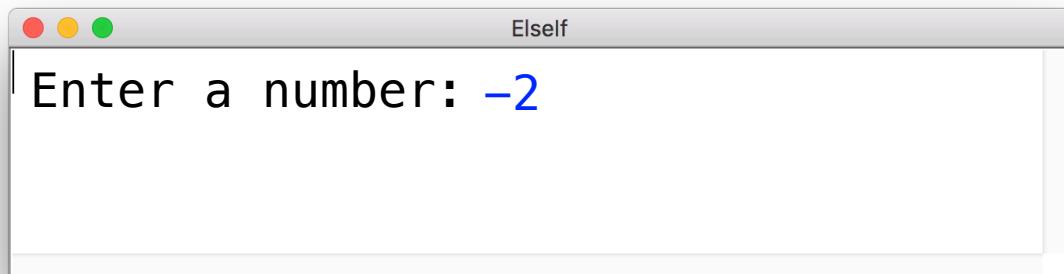
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if num == 0:
    print("Your number is 0")

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

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

“-2”



# If Else Revisited

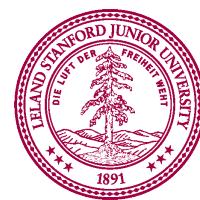
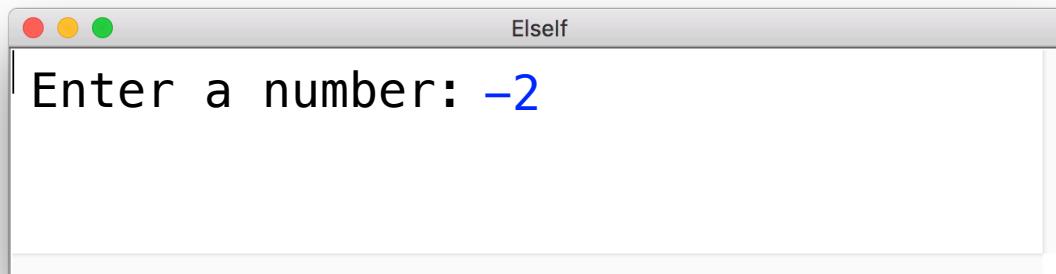
-2

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

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

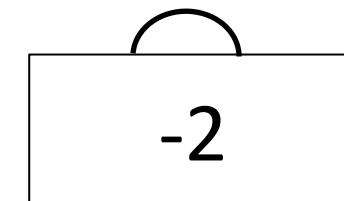
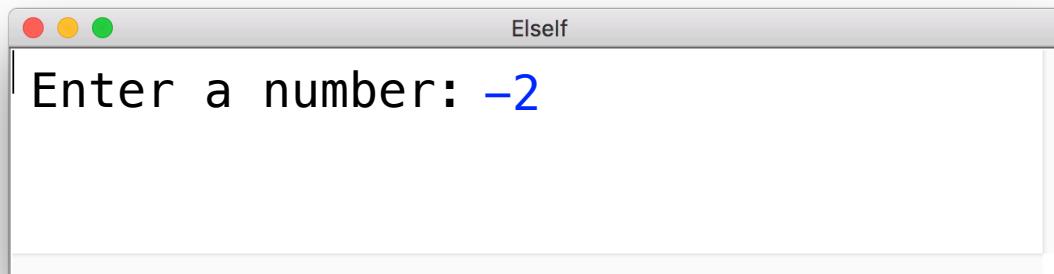


# If Else Revisited

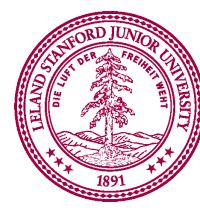
-2

```
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

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

if num == 0:

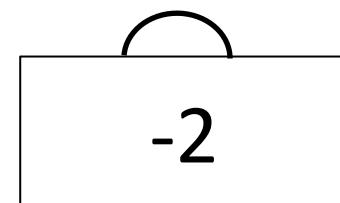
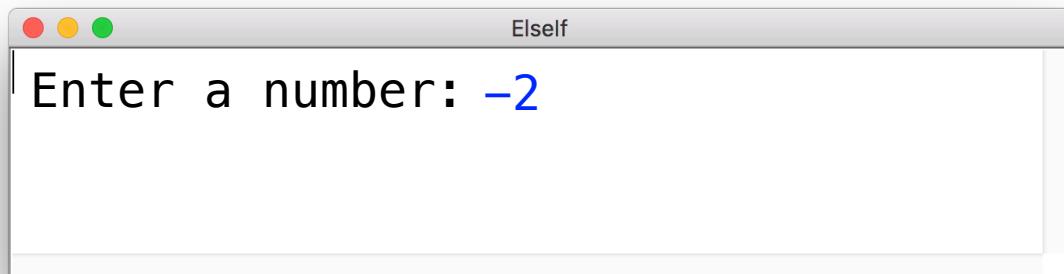
    print("Your number is 0 ")

elif num > 0:

    print("Your number is positive")

else:

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



num



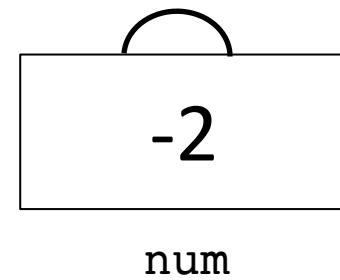
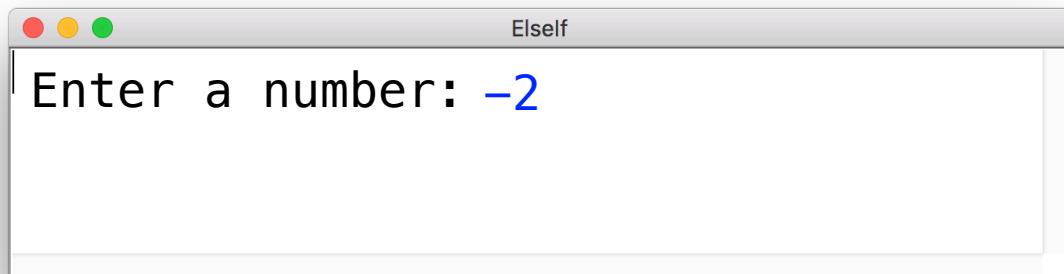
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```



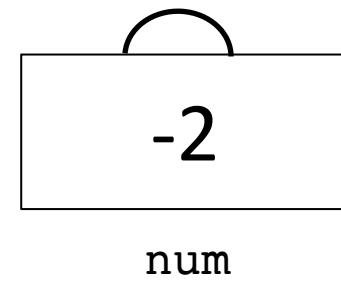
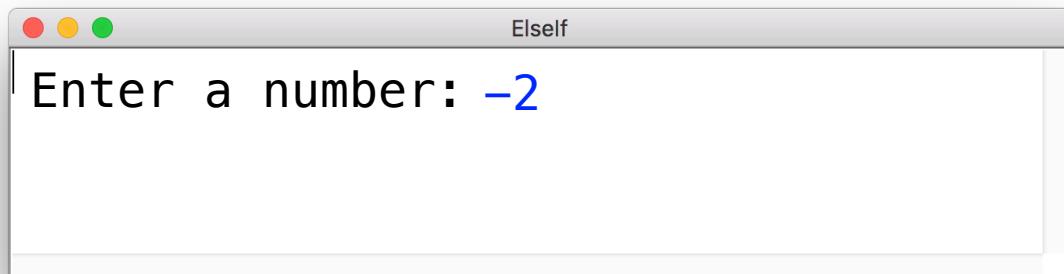
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```



# If Else Revisited

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

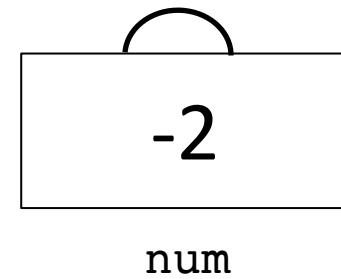
if num == 0:
    print("Your number is 0")

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

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

Elself

```
Enter a number: -2
Your number is negative
```



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
```



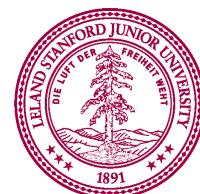
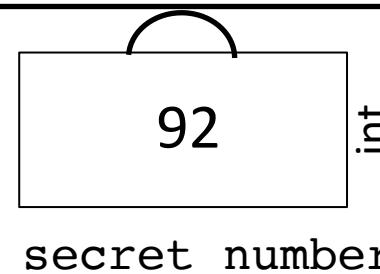
Brace yourself!

# 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("Congrats! The number was: " + str(secret_number))
```

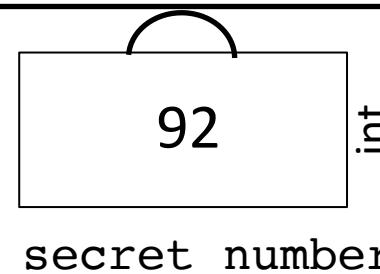


# Guess My Number

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

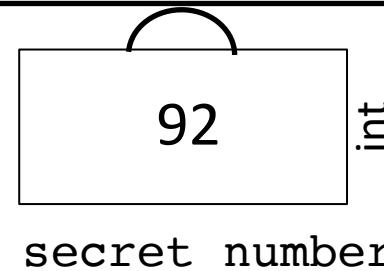
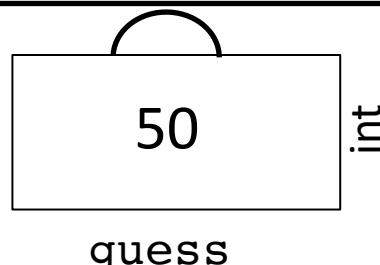


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```

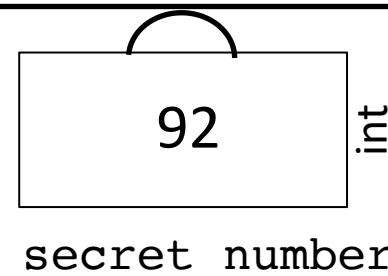
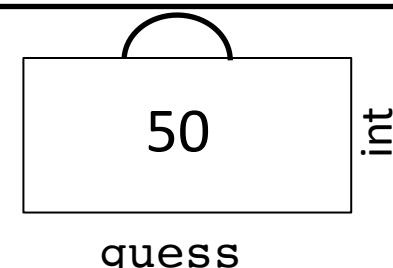


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    print("") # an empty line
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print("Congrats! The number was: " + str(secret_number))
```

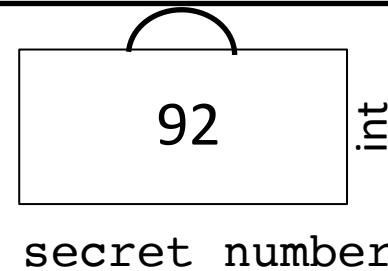
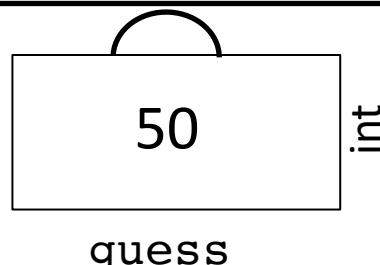


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```

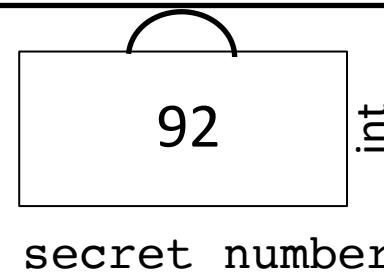
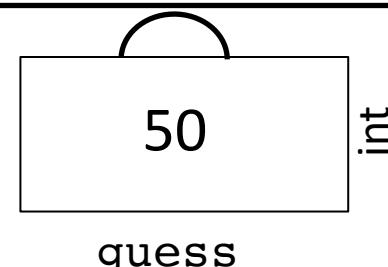


# Guess My Number

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secret_number = random.randint(1, 99)
print("I am thinking of a number between 1 and 99...")
guess = int(input("Enter a guess: "))
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    print("") # an empty line
    guess = int(input("Enter a new guess: "))

print("Congrats! The number was: " + str(secret_number))
```

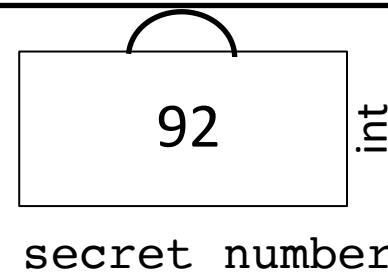
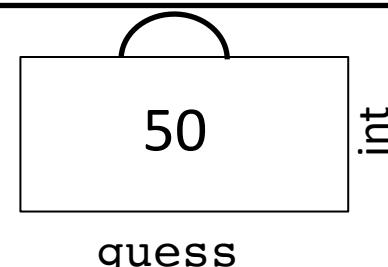


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print("Congrats! The number was: " + str(secret_number))
```

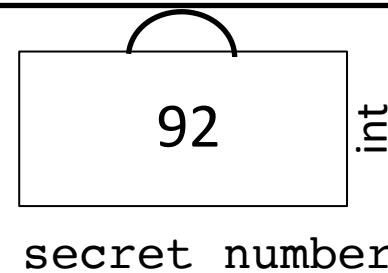
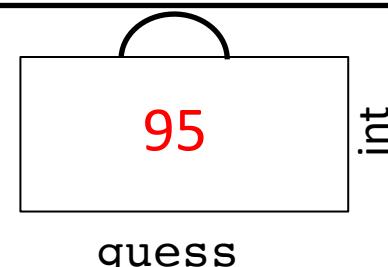


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```

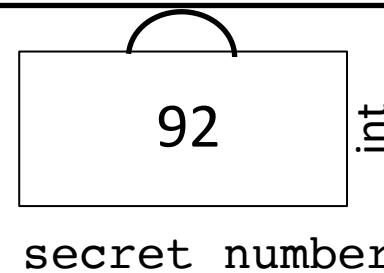
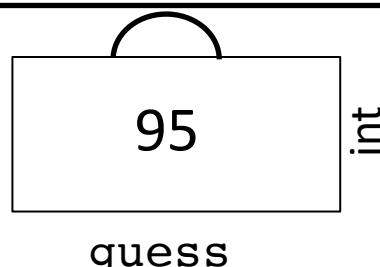


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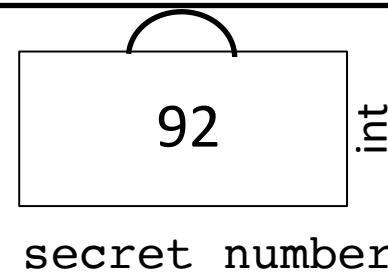
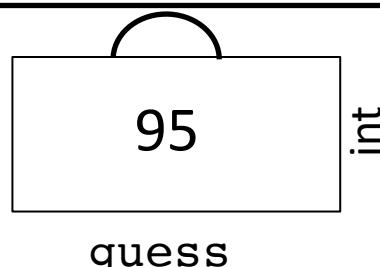


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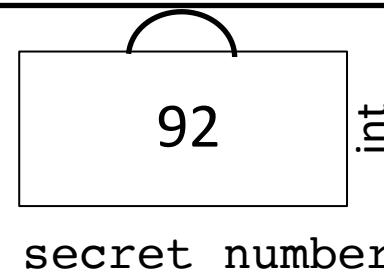
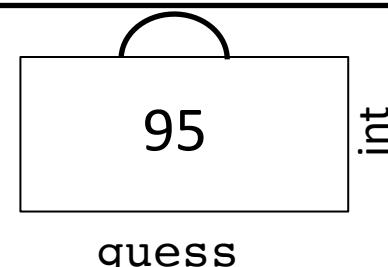


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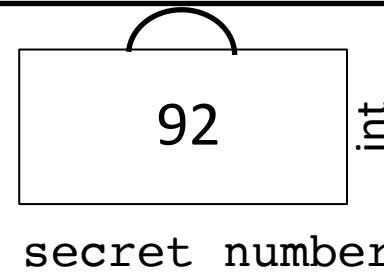
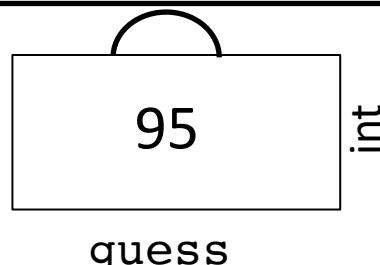


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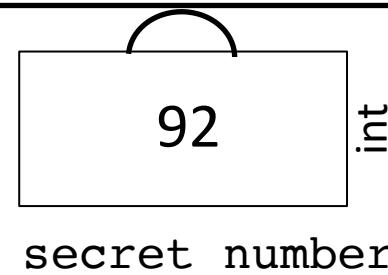
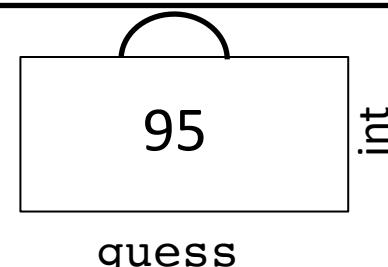


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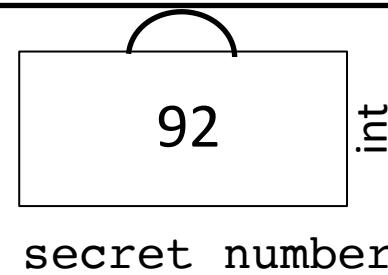
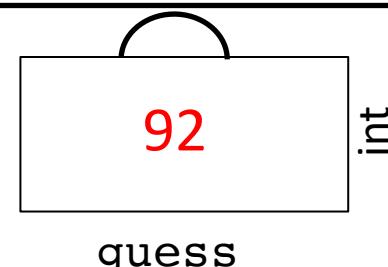


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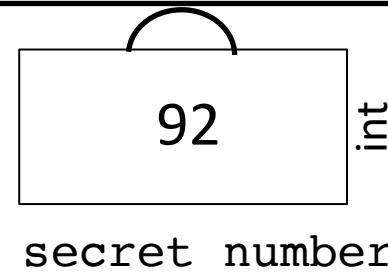
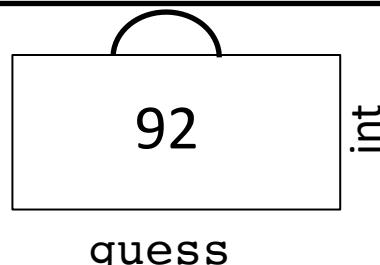


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```

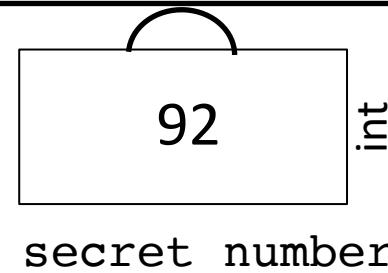
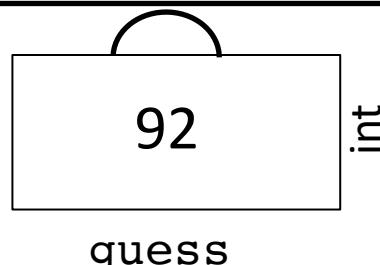


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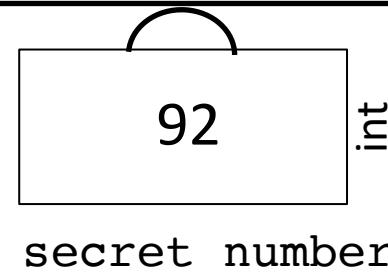
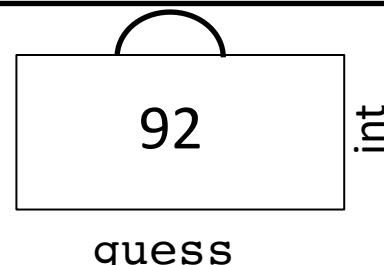


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    print("") # an empty line
    guess = int(input("Enter a new guess: "))

print("Congrats! The number was: " + str(secret_number))
```



# Conditions in Python



Think about what variables you want to declare before the loop starts!

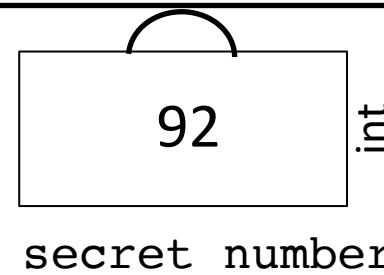
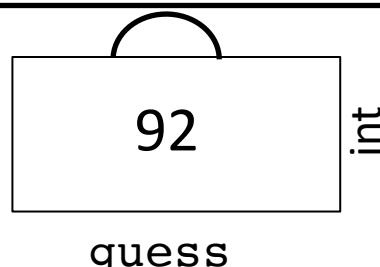


# Guess My Number

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

print("Congrats! The number was: " + str(secret_number))
```

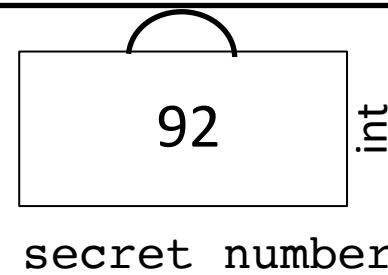
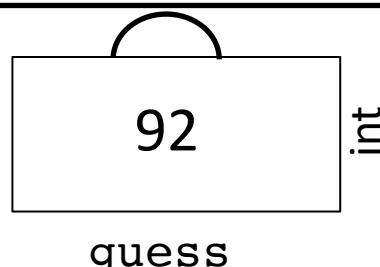


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    print("") # an empty line
    guess = int(input("Enter a new guess: "))

print("Congrats! The number was: " + str(secret_number))
```



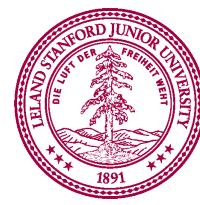
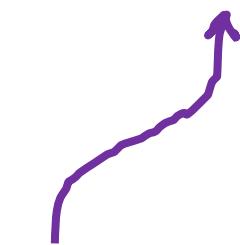
# Random Integers

```
secret_number = random.randint(1, 99)
```

Minimum value

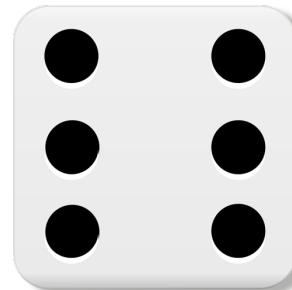


Maximum value



# Challenge: Three Sixes in a row

- Write a program that simulates one **dice roll** at a time. Count how many dice rolls until you get **three sixes in a row!**



You rolled a 6

You rolled a 6

You rolled a 3

You rolled a 2

You rolled a 1

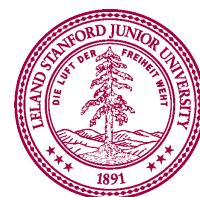
You rolled a 4

You rolled a 6

You rolled a 6

You rolled a 6

Number of times rolled = 152

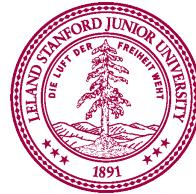




# Example: Sentinel Loops

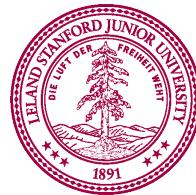
```
def main():
    num_dice_rolls = 0
    # repeat these lines
    dice_value = random.randint(1, 6)
    num_dice_rolls += 1

    print(num_dice_rolls)
```



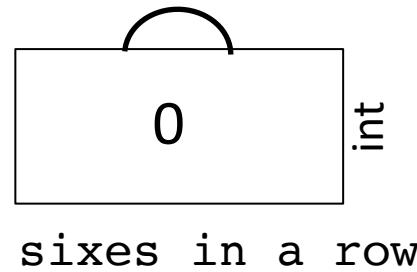
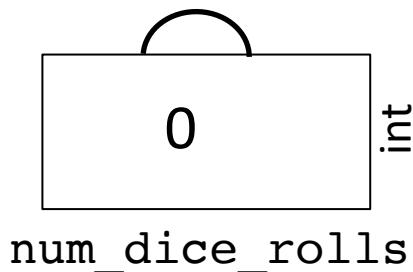
# Example: Sentinel Loops

```
def main():
    num_dice_rolls = 0
    sixes_in_a_row = 0
    while sixes_in_a_row < GOAL_IN_A_ROW:
        dice_value = random.randint(1,6)
        print('You rolled a ' + str(dice_value))
        if dice_value == GOAL_VALUE:
            sixes_in_a_row += 1
        else:
            sixes_in_a_row = 0
        num_dice_rolls += 1
    print(num_dice_rolls)
```



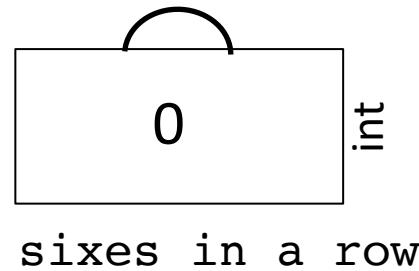
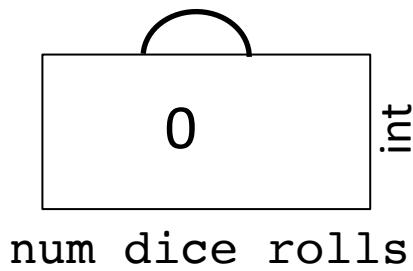
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    while sixes_in_a_row < GOAL_IN_A_ROW:
        dice_value = random.randint(1,6)
        print('You rolled a ' + str(dice_value))
        if dice_value == GOAL_VALUE:
            sixes_in_a_row += 1
        else:
            sixes_in_a_row = 0
        num_dice_rolls += 1
    print(num_dice_rolls)
```



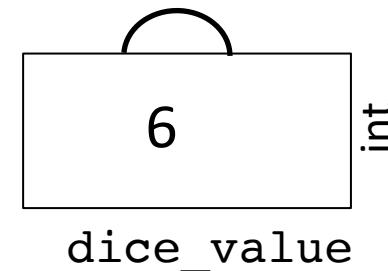
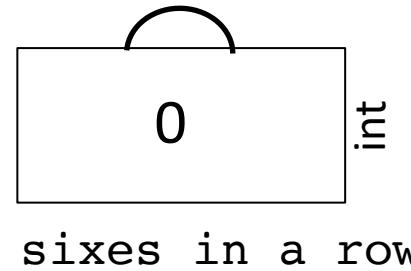
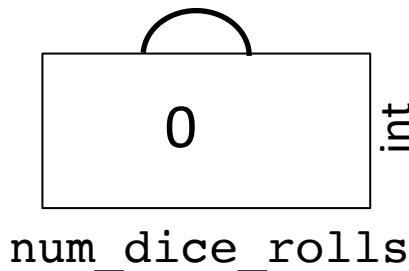
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            sixes_in_a_row += 1
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            sixes_in_a_row = 0
        num_dice_rolls += 1
    print(num_dice_rolls)
```



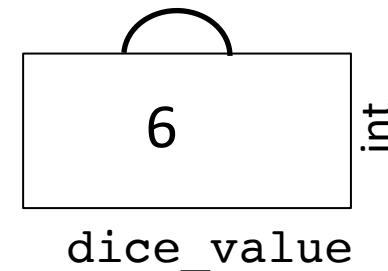
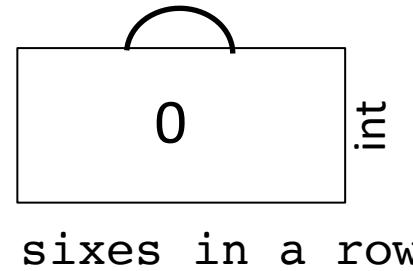
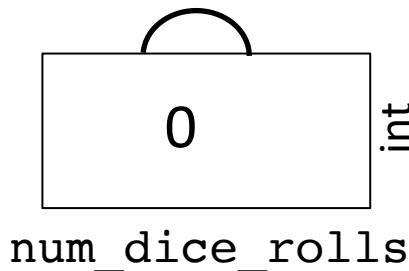
# Example: Sentinel Loops

```
def main():
    num_dice_rolls = 0
    sixes_in_a_row = 0
    while sixes_in_a_row < GOAL_IN_A_ROW:
        dice_value = random.randint(1, 6)
        print('you rolled a ' + str(dice_value))
        if dice_value == GOAL_VALUE:
            sixes_in_a_row += 1
        else:
            sixes_in_a_row = 0
    num_dice_rolls += 1
    print(num_dice_rolls)
```



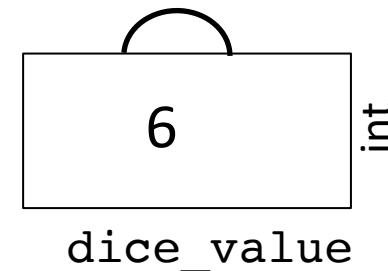
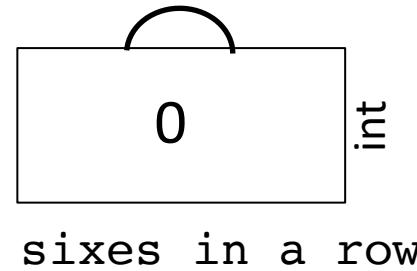
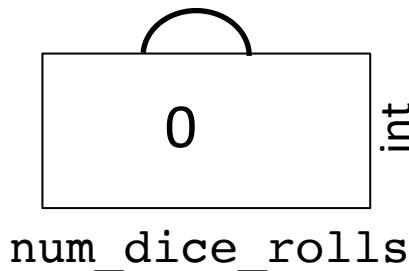
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        num_dice_rolls += 1
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```



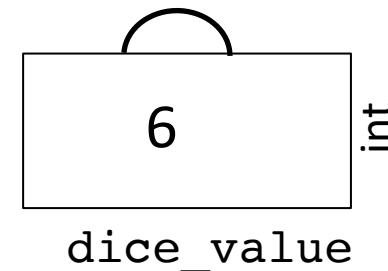
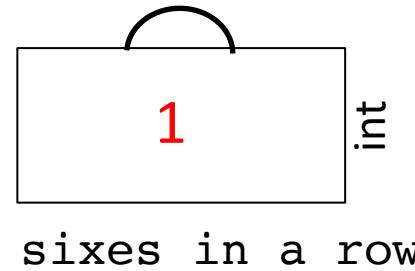
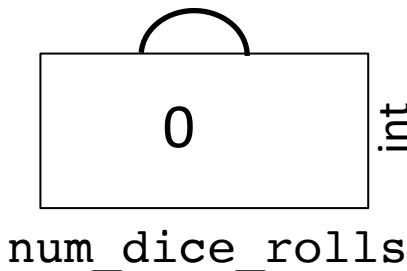
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        num_dice_rolls += 1
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```



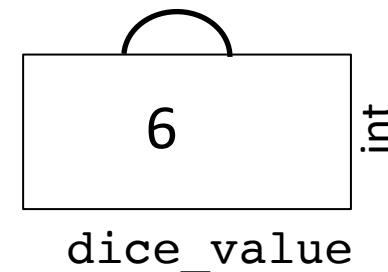
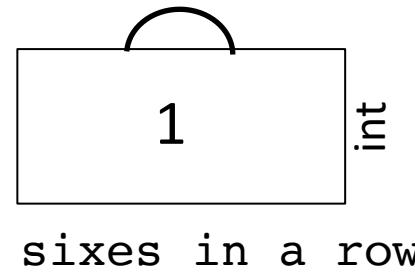
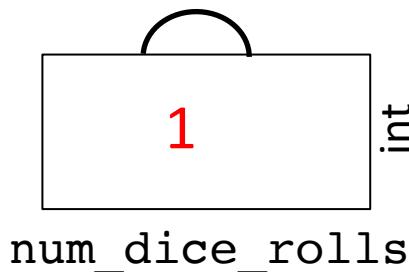
# Example: Sentinel Loops

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        num_dice_rolls += 1
    print(num_dice_rolls)
```



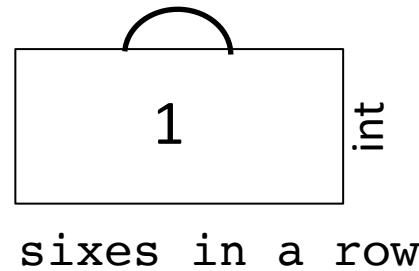
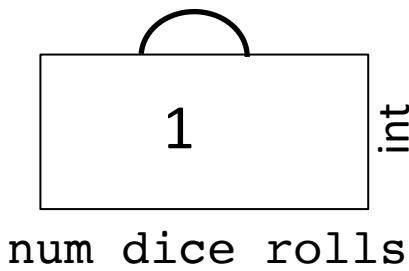
# Example: Sentinel Loops

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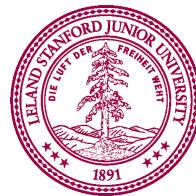
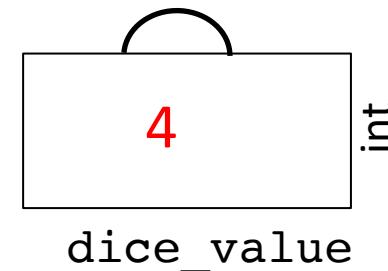
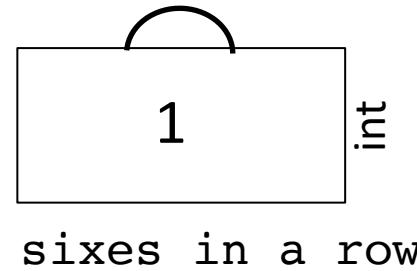
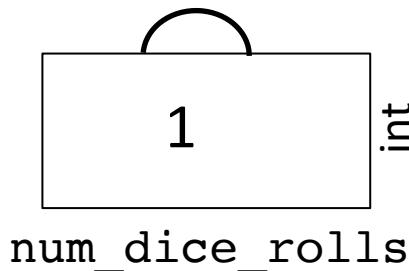
# Example: Sentinel Loops

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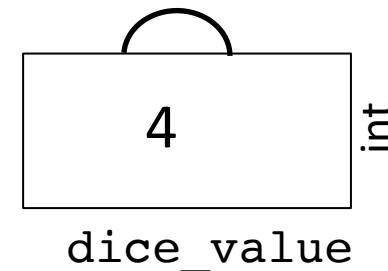
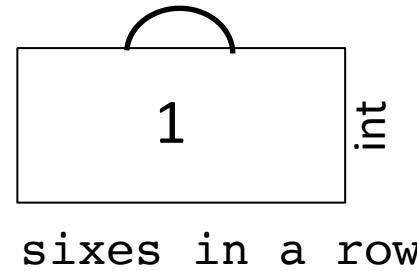
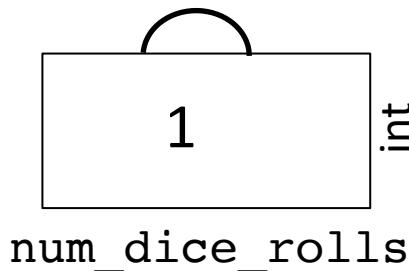
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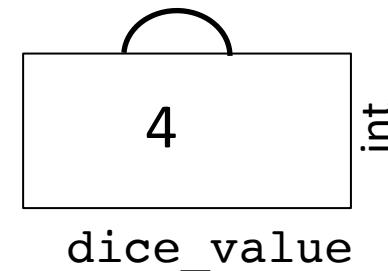
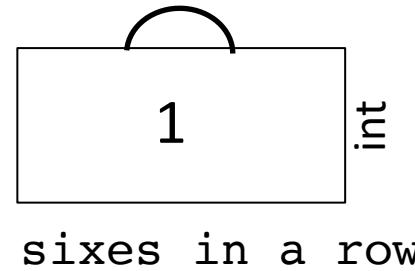
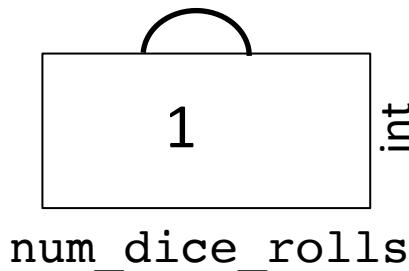
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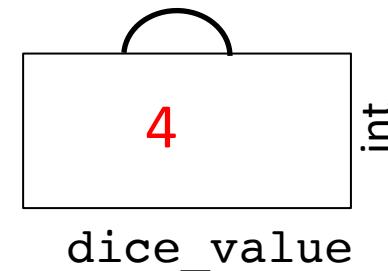
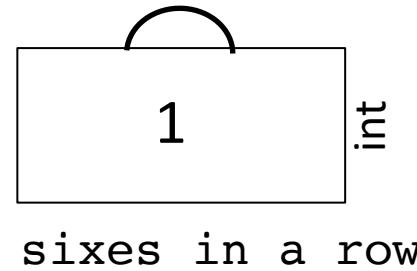
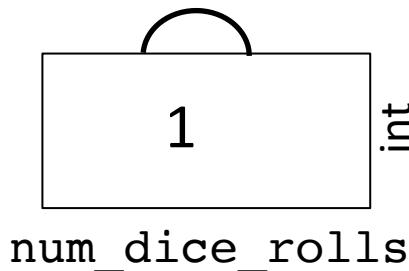
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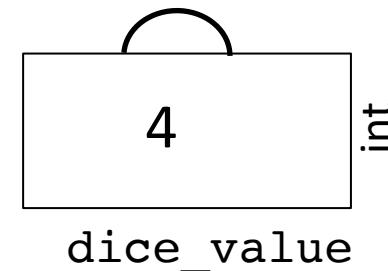
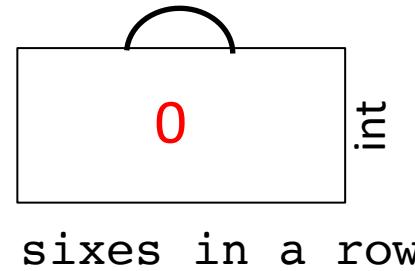
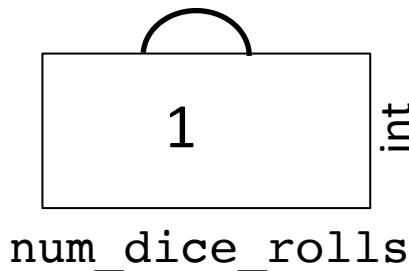
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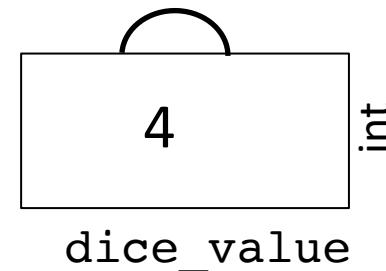
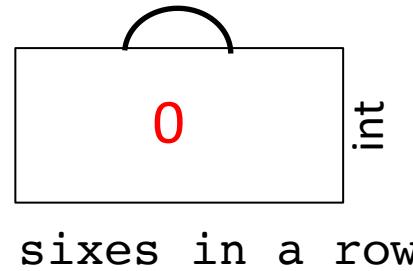
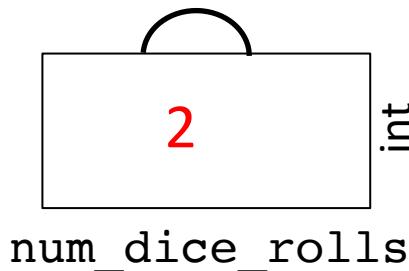
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        else:
            sixes_in_a_row = 0
        num_dice_rolls += 1
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```



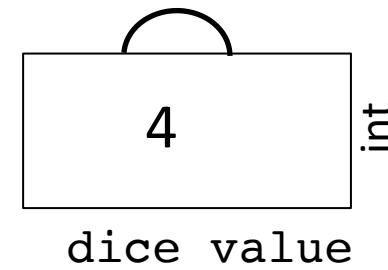
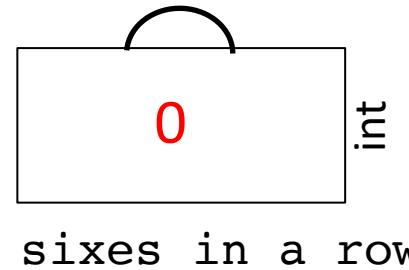
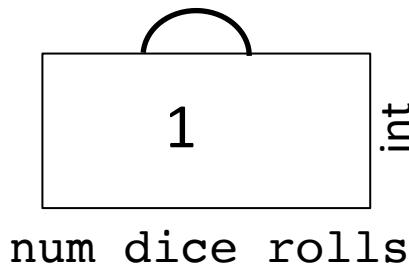
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            sixes_in_a_row += 1
        else:
            sixes_in_a_row = 0
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    print(num_dice_rolls)
```



# Example: Sentinel Loops

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        else:
            sixes_in_a_row = 0
        num_dice_rolls += 1
    print(num_dice_rolls)
```



# When will it get to this line?

```
def main():
    num_dice_rolls = 0
    sixes_in_a_row = 0
    while sixes_in_a_row < GOAL_IN_A_ROW:
        dice_value = random.randint(1,6)
        print('You rolled a ' + str(dice_value))
        if dice_value == GOAL_VALUE:
            sixes_in_a_row += 1
        else:
            sixes_in_a_row = 0
    num_dice_rolls += 1
    print(num_dice_rolls)
```

num\_dice\_rolls

?

int

sixes\_in\_a\_row

?

int

dice\_value

?

int



# Logical Operators

In order of precedence:

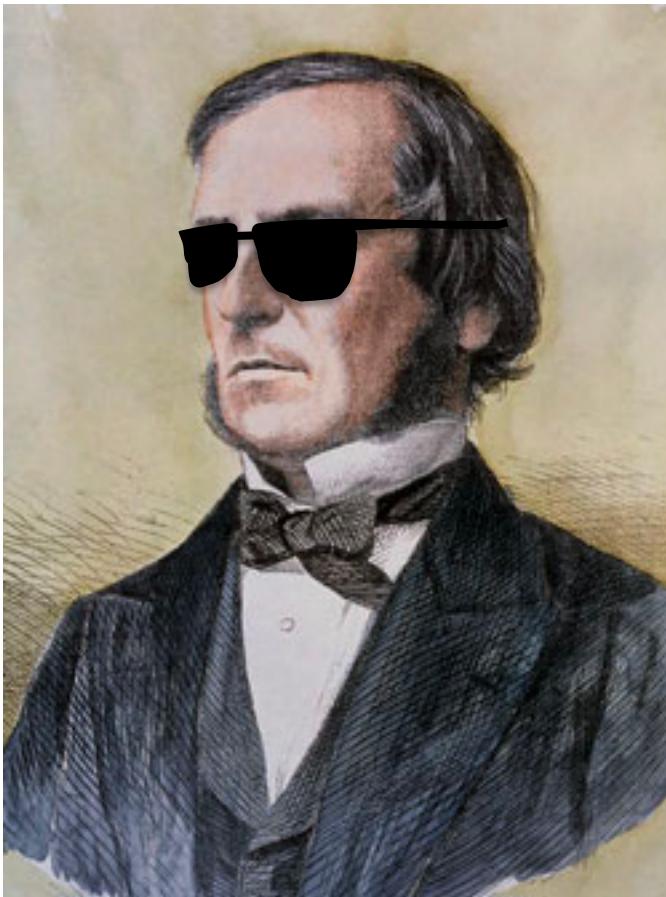
Operator	Example	Result
not	not (2 == 3)	True
and	(2 == 3) and (-1 < 5)	False
or	(2 == 3) or (-1 < 5)	True

```
num1 = int(input("Enter a positive number: "))
num2 = int(input("Enter another number: "))

if num1 < 0 or num2 < 0:
    print("invalid input")
```

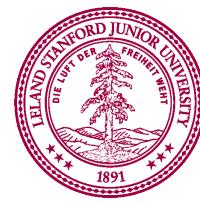


# George Boole



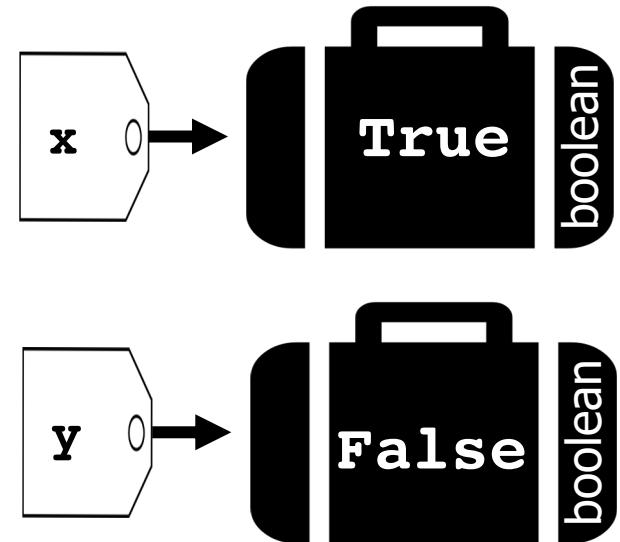
English Mathematician teaching in Ireland 1815 – 1864  
Boole died of being too cool

Piech, CS106A, Stanford University



# 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_teaching = True
is_rock_climbing = 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_teaching = True
is_rock_climbing = False

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



*Please ...*

**NO FOOD OR  
DRINKS**

[FreeSignPrinter.com](#)



Piech, CS106A, Stanford University



\*know your logical precedence



FreeSignPrinter.com

food = **True**

drinks = **True**

is\_allowed = **not food or drinks**



\*know your logical precedence



FreeSignPrinter.com

food = **True**

drinks = **True**

is\_allowed = **not food or drinks**

**False**



\*know your logical precedence



FreeSignPrinter.com

food = **True**

drinks = **True**

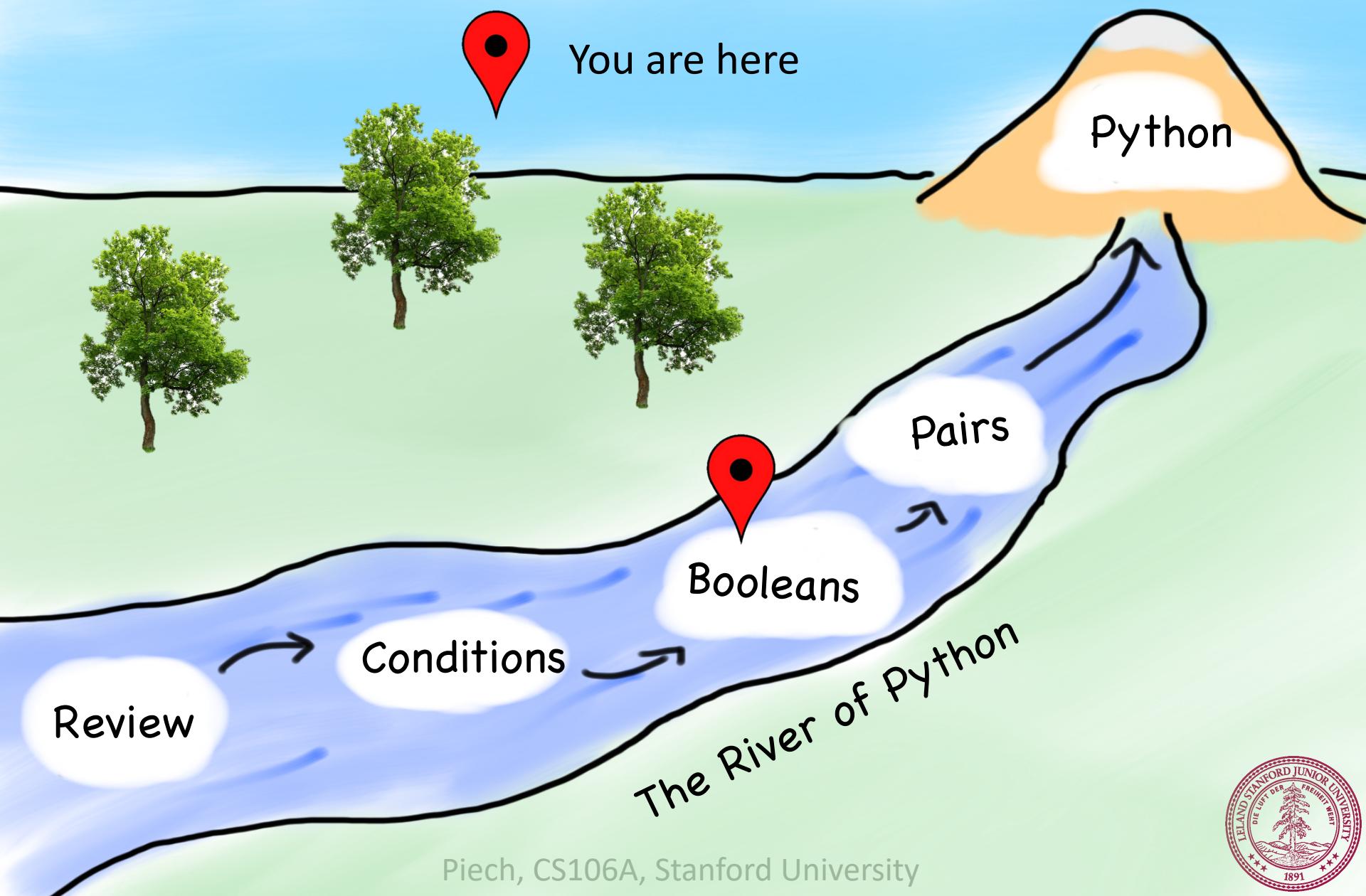
is\_allowed = **not food or drinks**

**False**

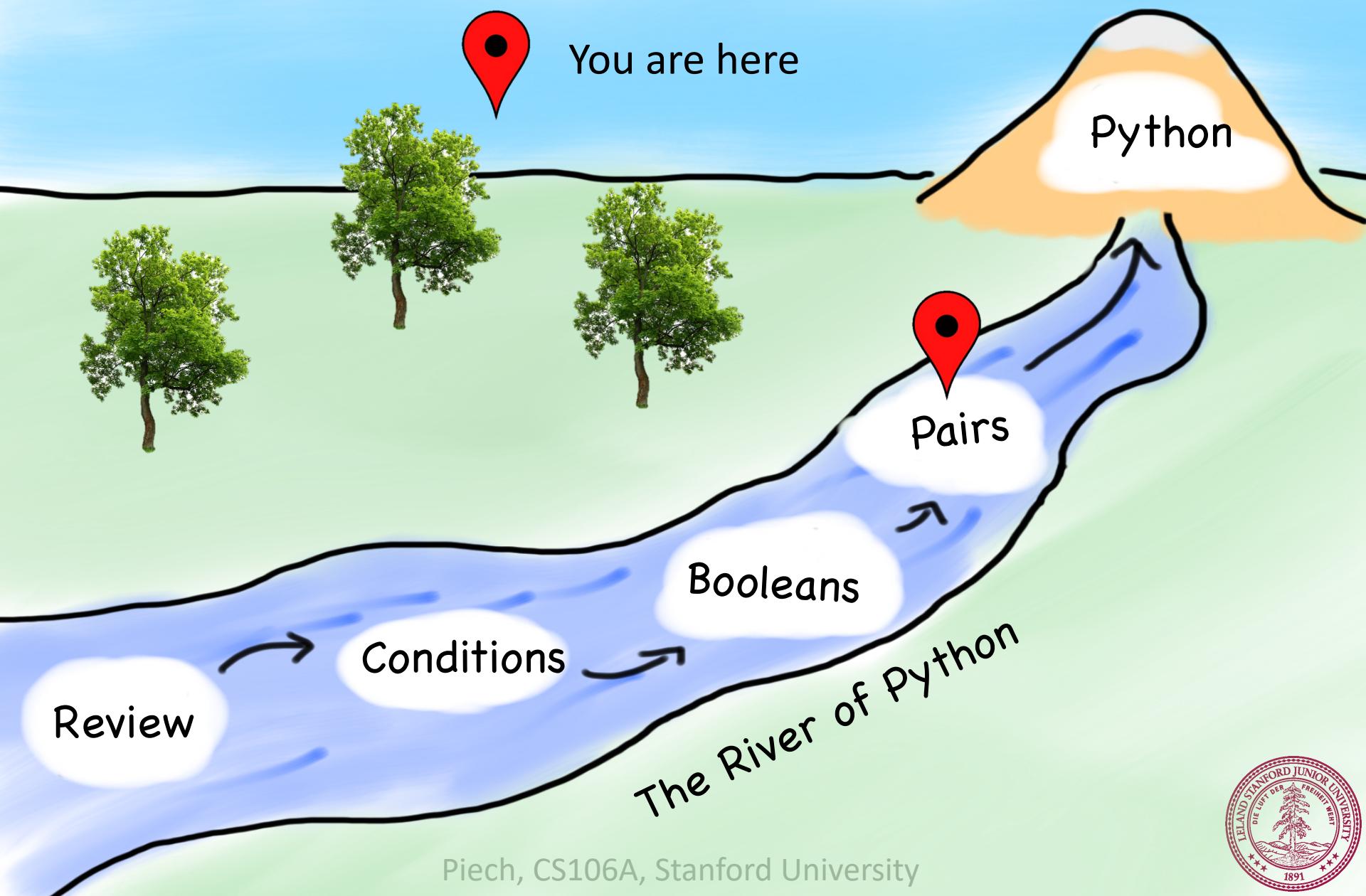
**True**

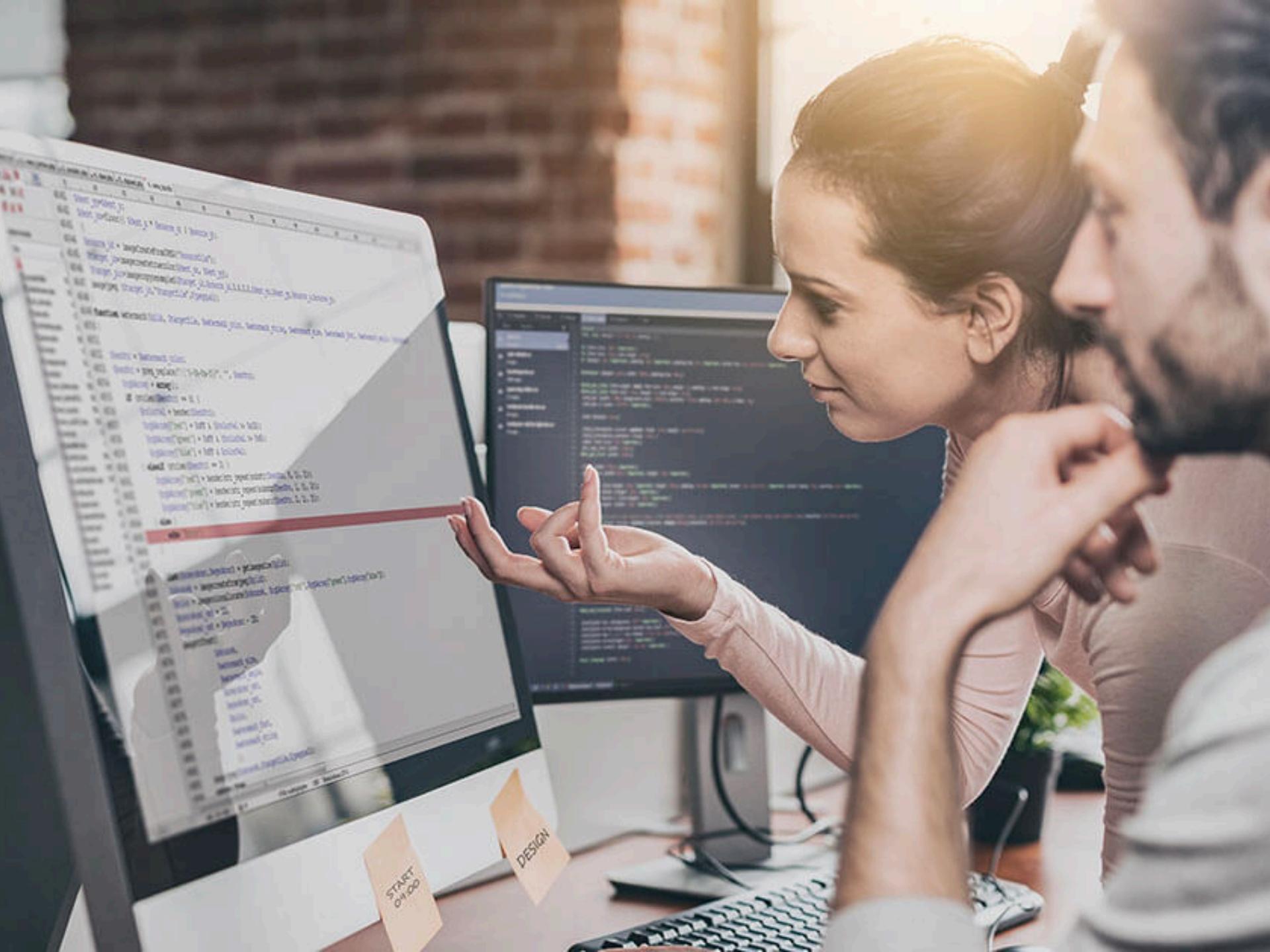


# Today's Route



# Today's Route





```
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 279 280 281 282 283 284 285 286 287 288 289 289 290 291 292 293 294 295 296 297 298 299 299 300 301 302 303 304 305 306 307 308 309 309 310 311 312 313 314 315 316 317 318 319 319 320 321 322 323 324 325 326 327 328 329 329 330 331 332 333 334 335 336 337 338 339 339 340 341 342 343 344 345 346 347 348 349 349 350 351 352 353 354 355 356 357 358 359 359 360 361 362 363 364 365 366 367 368 369 369 370 371 372 373 374 375 376 377 378 379 379 380 381 382 383 384 385 386 387 388 389 389 390 391 392 393 394 395 396 397 398 399 399 400 401 402 403 404 405 406 407 408 409 409 410 411 412 413 414 415 416 417 418 419 419 420 421 422 423 424 425 426 427 428 429 429 430 431 432 433 434 435 436 437 438 439 439 440 441 442 443 444 445 446 447 448 449 449 450 451 452 453 454 455 456 457 458 459 459 460 461 462 463 464 465 466 467 468 469 469 470 471 472 473 474 475 476 477 478 479 479 480 481 482 483 484 485 486 487 488 489 489 490 491 492 493 494 495 496 497 498 499 499 500 501 502 503 504 505 506 507 508 509 509 510 511 512 513 514 515 516 517 518 519 519 520 521 522 523 524 525 526 527 528 529 529 530 531 532 533 534 535 536 537 538 539 539 540 541 542 543 544 545 546 547 548 549 549 550 551 552 553 554 555 556 557 558 559 559 560 561 562 563 564 565 566 567 568 569 569 570 571 572 573 574 575 576 577 578 579 579 580 581 582 583 584 585 586 587 588 589 589 590 591 592 593 594 595 596 597 598 598 599 599 600 601 602 603 604 605 606 607 608 609 609 610 611 612 613 614 615 616 617 618 619 619 620 621 622 623 624 625 626 627 628 629 629 630 631 632 633 634 635 636 637 638 639 639 640 641 642 643 644 645 646 647 648 649 649 650 651 652 653 654 655 656 657 658 659 659 660 661 662 663 664 665 666 667 668 669 669 670 671 672 673 674 675 676 677 678 679 679 680 681 682 683 684
```

# Learning to pair program

The screenshot shows a web-based programming environment. On the left, there is a code editor with the following Python code:

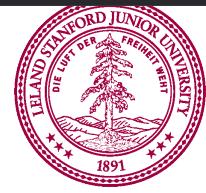
```
1 # happy coding!
2
3 def main():
4     print('hello world')
5
6 if __name__ == '__main__':
7     main()
```

On the right, there is a console area with the following text:

Welcome to PearProgram! This is your console. Click the run button to see your output here.

Below the console, there are three numbered steps with arrows pointing to specific UI elements:

- (1) There are two roles in pair programming: Pilot and Co-Pilot. An arrow points from this text to the "Role: Co-Pilot" button at the top.
- (2) Everyone must understand all the code. Ask a question if you are lost. Feel free to chat as you go! An arrow points from this text to the yellow message icon in the bottom right corner.
- (3) Press this button to run your code. An arrow points from this text to the blue "run" button in the bottom right corner.



Truly important afternoon

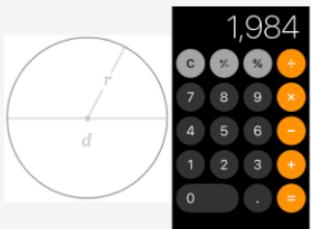
This is hard! Learn a little each day.

# Today's Goal

1. Be able to use While and If in Python
2. Combine loops and variables



## Evening Project [[here](#)]



Area Calculator

[Quickstart](#)

[SL Notes](#)

Variables

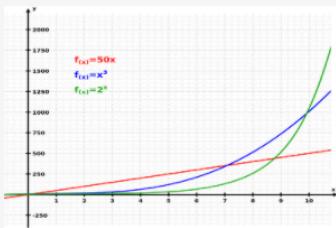


8 Ball

[Section](#)

[SL Notes](#)

Conditionals



Viral Video

[Section](#)

[SL Notes](#)

Conditionals



Khansole Academy

[Project](#)

[SL Notes](#)

Conditionals

