http://www.cs.cornell.edu/courses/cs1110/2020sp

Lecture 8: Conditionals & Control Flow

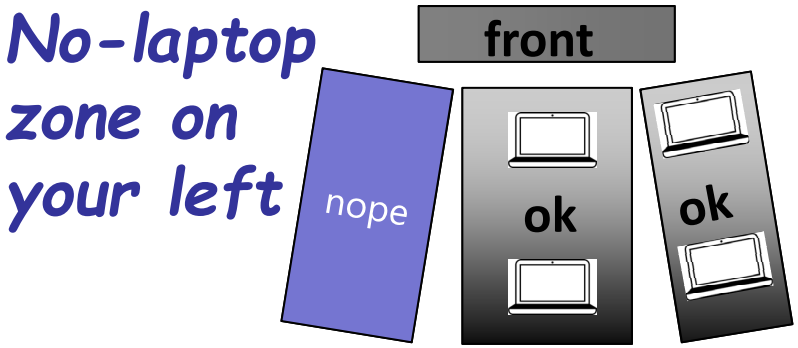
(Sections 5.1-5.7)

CS 1110

Introduction to Computing Using Python

[E. Andersen, A. Bracy, D. Fan, D. Gries, L. Lee,
S. Marschner, C. Van Loan, W. White]

Announcements



- **Optional 1-on-1** with a staff member to help *just you* with course material. Sign up for a slot on CMS under "SPECIAL: one-on-ones".
- A1 first submission due Feb 19 Wedn at 11:59pm

Review: Objects are *referenced*

- Must ***call constructor*** function to ***create*** object
- Object variable stores ***ID of*** object
- Multiple variables can reference same object

Swap (Question)

```
import shapes
p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

def swap_x(p, q):
1    t = p.x
2    p.x = q.x
3    q.x = t

swap_x(p, q)
```

What is in p.x at the end of this code?

A: 1
B: 2
C: 3
D: I don't know

Global Space

p	**id1**
q	**id2**

Heap Space

id1 Point3

x	1
y	2
z	3

id2 Point3

x	3
y	4
z	5

Swap (Solution)

```
import shapes
p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

def swap_x(p, q):
1    t = p.x
2    p.x = q.x
3    q.x = t

swap_x(p, q)
```

What is in p.x at the end of this code?

A: 1
B: 2
C: 3 **CORRECT**
D: I don't know

Global Space

p	**id1**
q	**id2**

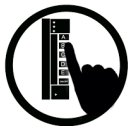
Heap Space

id1 Point3

x	1
y	2
z	3

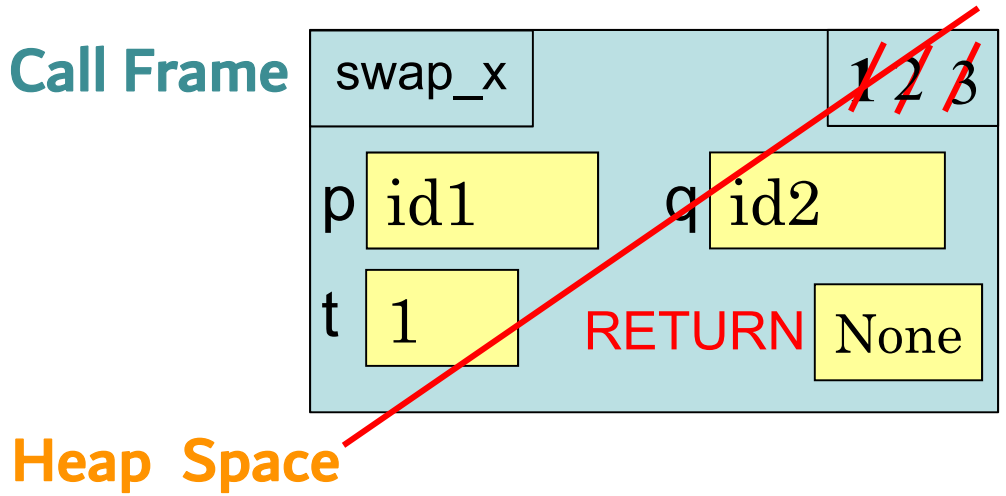
id2 Point3

x	3
y	4
z	5

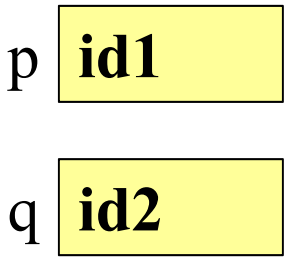


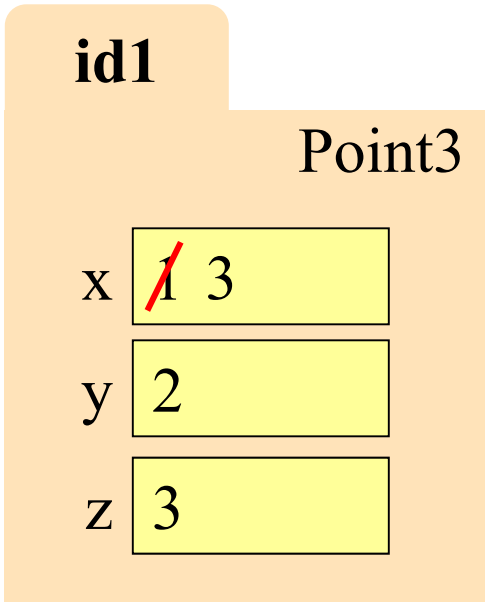
Swap (Explanation)

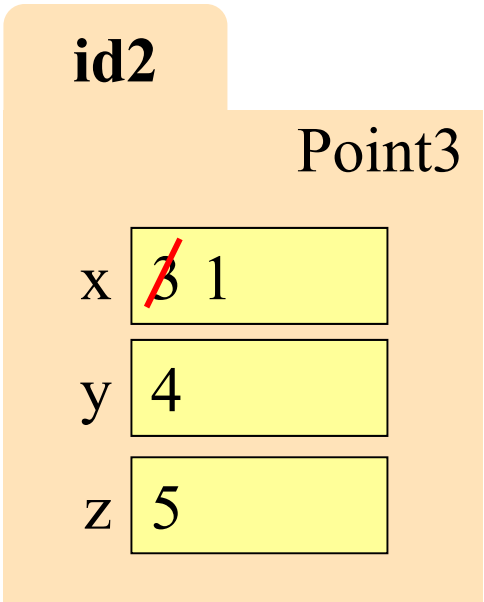
```
import shapes
p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

def swap_x(p, q):
1    t = p.x
2    p.x = q.x
3    q.x = t

swap_x(p, q)
```



Global Space







Global p (Question)

```
import shapes
p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

def swap(p, q):
1   t = p
2   p = q
3   q = t

swap(p, q)
```

What is in global p after calling swap?

A: **id1**
B: **id2**
C: I don't know

Global Space

p **id1**

q **id2**

Heap Space

id1 Point3

x 1
y 2
z 3

id2 Point3

x 3
y 4
z 5

Global p (Solution)

```
import shapes
p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

def swap(p, q):
1   t = p
2   p = q
3   q = t

swap(p, q)
```

What is in global p after calling swap?

A: **id1** **CORRECT**
B: **id2**
C: I don't know

Global Space

p **id1**

q **id2**

Heap Space

id1 Point3

x 1

y 2

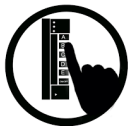
z 3

id2 Point3

x 3

y 4

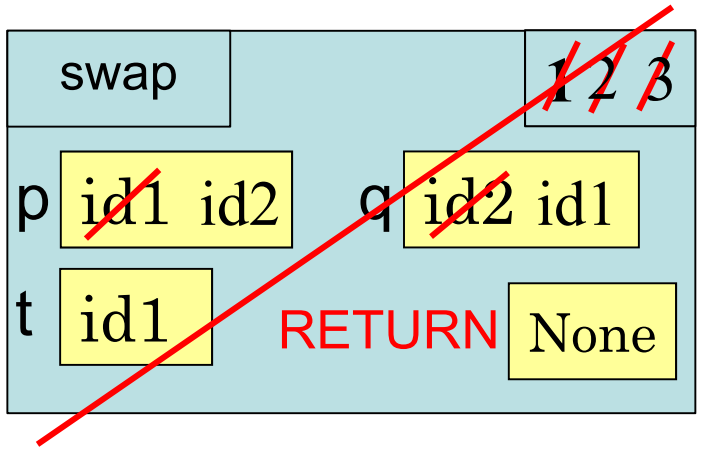
z 5



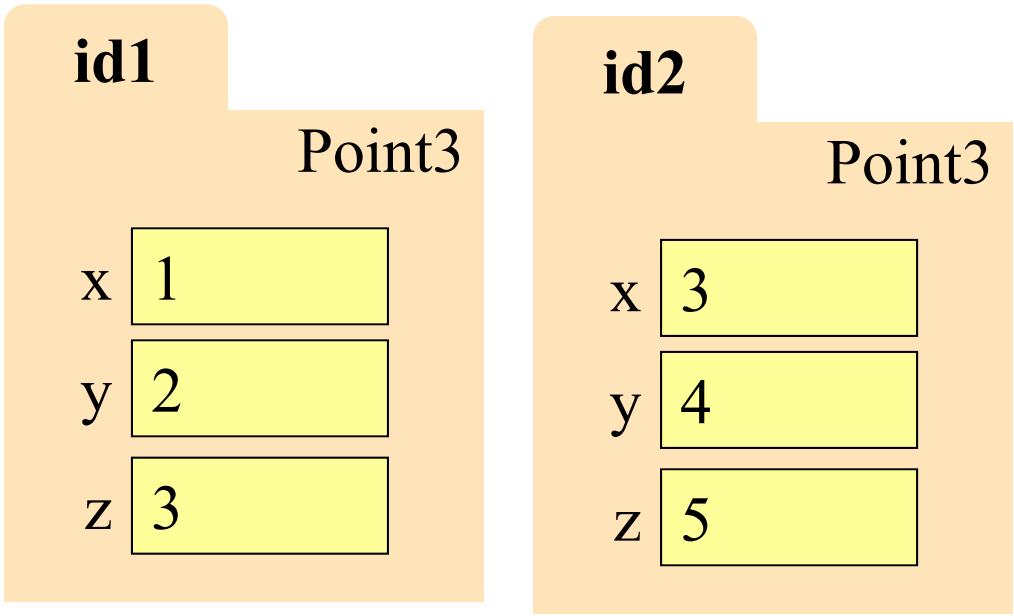
Global p (Explanation)

```
import shapes
p = shapes.Point3(1,2,3)
q = shapes.Point3(3,4,5)

def swap(p, q):
1   t = p
2   p = q
3   q = t

swap(p, q)
```

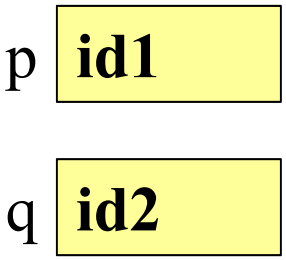
Call Frame

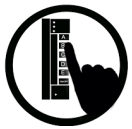


Heap Space



Global Space

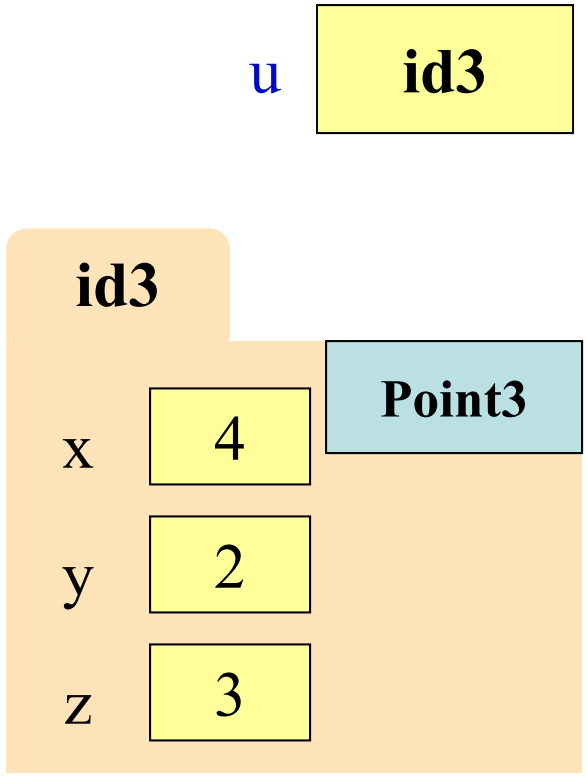




Methods: Functions Tied to Classes

- **Method**: function tied to object
  - Method call looks like a function call preceded by a variable name:

    ⟨*variable*⟩.⟨*method*⟩(⟨*arguments*⟩)



Example:

```
import shapes
u = shapes.Point3(4,2,3)
u.greet()
```

"Hi! I am a 3-dimensional point located at (4,2,3)"

Where else have you seen this??

Example: String Methods

- s_1.upper()
  - Returns returns an upper case version of s_1
- s.strip()
  - Returns a copy of s with white-space removed at ends
- s_1.index(s_2)
  - Returns position of the first instance of s_2 in s_1
  - error if s_2 is not in s_1
- s_1.count(s_2)
  - Returns number of times s_2 appears inside of s_1

Built-in Types vs. Classes

Built-in types

- Built-into Python
- Refer to instances as *values*
- Instantiate with *literals*
- Can ignore the folders

Classes

- Provided by modules
- Refer to instances as *objects*
- Instantiate w/ *constructors*
- Must represent with folders

So far only about understanding ***objects***;
later will create your own ***classes***

Big Picture

Statements either affect **data** or **control**

- **DATA:** change the value of a variable, create a variable, *etc.*

  Examples:

  ```
  x = x + 1
  name = "Alex"
  ```

- **CONTROL:** tell python what line to execute next

  Examples:

  ```
  greet(name)
  if name == "Alex":
  ```

  ← **today's Lecture**

Conditionals: If-Statements

Format

```
if <boolean-expression>:
    <statement>
    …
    <statement>
```

Example

```
# is there a new high score?
if curr_score > high_score:
    high_score  = curr_score
    print("New high score!")
```

Execution:

if ⟨*boolean-expression*⟩ is true, then execute all of the statements indented directly underneath (until first non-indented statement)

What are Boolean expressions?

Expressions that evaluate to a Boolean value.

```
is_student = True
is_senior = False
num_credits  = 25
```

Boolean operations:

```
if is_student and is_senior:
   print("Hi senior student!")
```

Boolean variables:

```
if is_student:
   print("Hi student!")
```

Comparison operations:

```
if num_credits > 24:
   print("Are you serious?")
```

What gets printed, Round 1

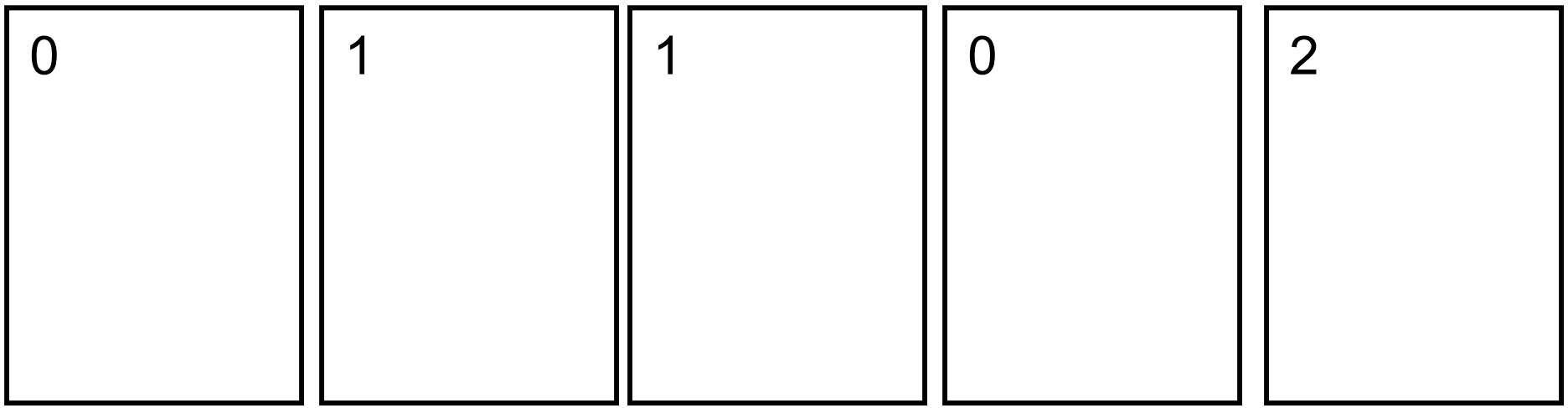
```
a = 0
print(a)
```

```
a = 0
a = a + 1
print(a)
```

```
a = 0
if a == 0:
    a = a + 1
print(a)
```

```
a = 0
if a == 1:
    a = a + 1
print(a)
```

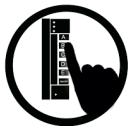
```
a = 0
if a == 0:
    a = a + 1
a = a + 1
print(a)
```



What gets printed? (Question)

```
a = 0
if a == 0:
    a = a + 1
if a == 0:
    a = a + 2
a = a + 1

print(a)
```

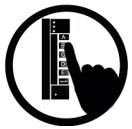
A: 0
B: 1
C: 2
D: 3
E: I do not know



What gets printed? (Solution)

```
a = 0                    Executed
if a == 0:               Executed
    a = a + 1            Executed
if a == 0:               Executed
    a = a + 2            Skipped
a = a + 1                Executed

print(a)
```

A: 0
B: 1
C: 2 **CORRECT**
D: 3
E: I do not know



Conditionals: If-Else-Statements

Format

```
if <boolean-expression>:
    <statement>
    …
else:
    <statement>
    …
```

Example

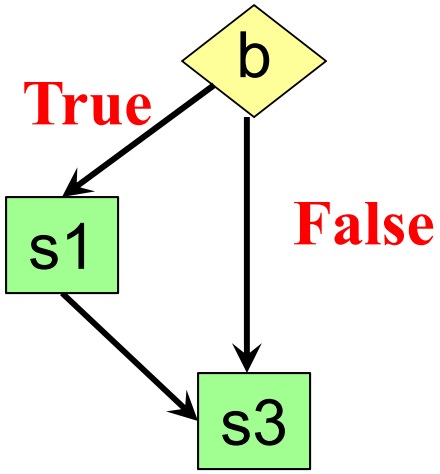
```
# new record?
if curr_score > high_score:
    print("New record!")
else:
    print("Try again next time")
```

Execution:

if ⟨*boolean-expression*⟩ is true, then execute statements indented under **if**; otherwise execute the statements indented under **else**

Conditionals: "Control Flow" Statements

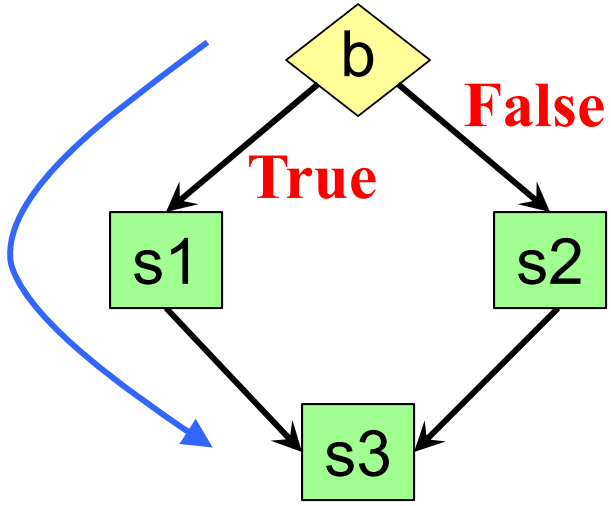
```
if b :
    s1    # statement
s3        # statement
```



Branch Point: Evaluate & Choose

Statements: Execute

```
if b :
    s1
else:
    s2
s3
```

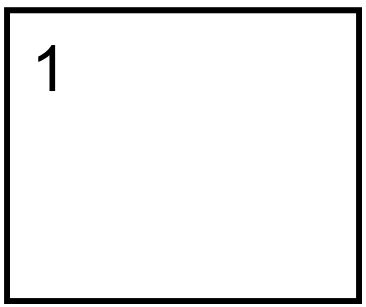


Flow

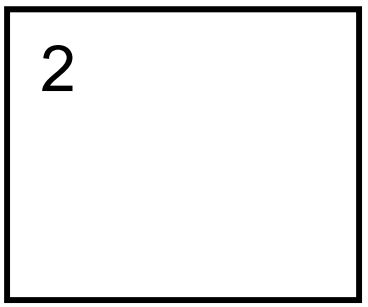
Program only takes one path during an execution (something will **not** be executed!)

What gets printed, Round 2

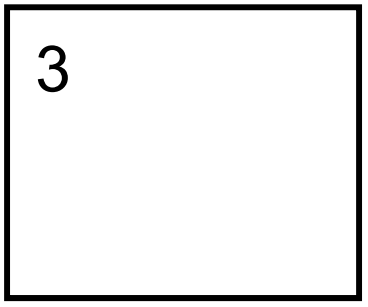
```
a = 0
if a == 0:
    a = a + 1
else:
    a = a + 2

print(a)
```



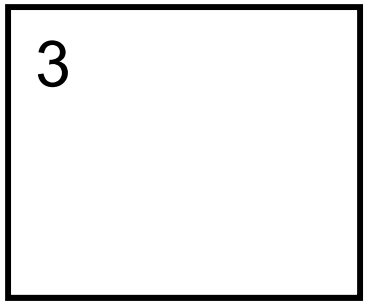

```
a = 0
if a == 1:
    a = a + 1
else:
    a = a + 2

print(a)
```




```
a = 0
if a == 1:
    a = a + 1
else:
    a = a + 2
a = a + 1
print(a)
```




```
a = 0
if a == 1:
    a = a + 1
else:
    a = a + 1
    a = a + 1
a = a + 1
print(a)
```

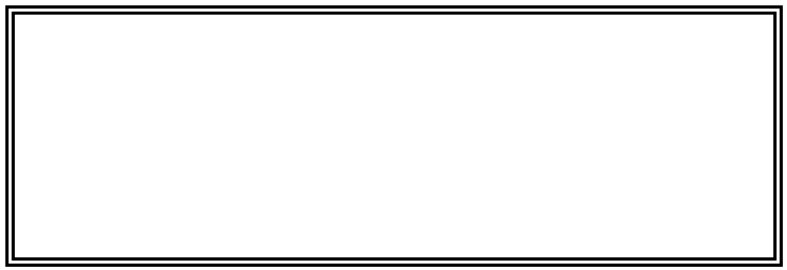


Program Flow (car locked, 0)

if determines which statement is executed next

Global Space

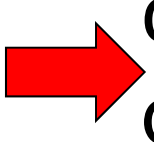
```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = True
   get_in_car(car_locked)
```



Program Flow (car locked, 1)

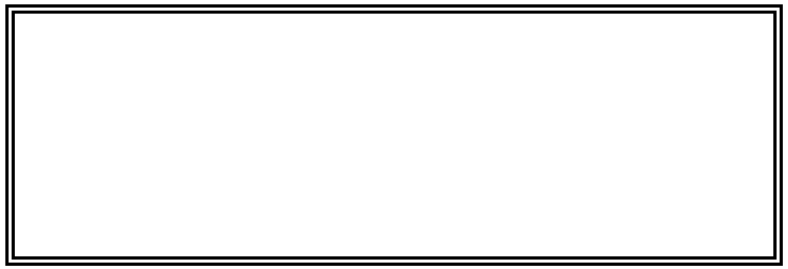
if determines which statement is executed next

```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = True
   get_in_car(car_locked)
```



Global Space

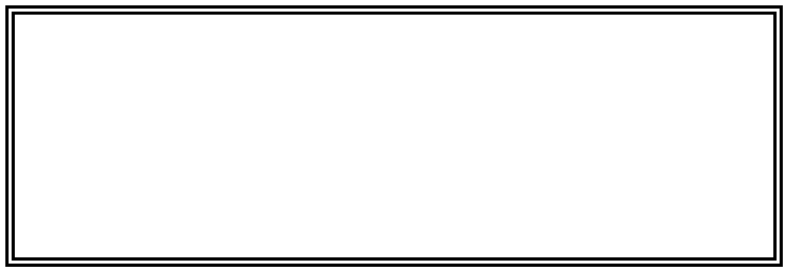
car_locked	True



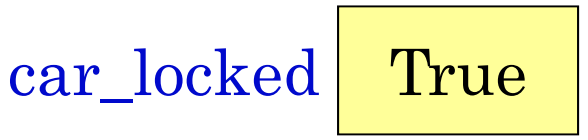
Program Flow (car locked, 2)

if determines which statement is executed next

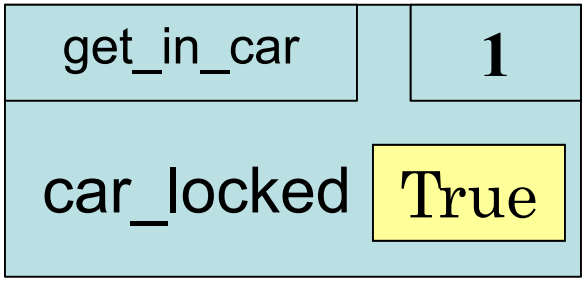
```
def get_in_car(car_locked):
1     if car_locked:
2         print("Unlock car!")
3     print("Open the door.")

car_locked = True
get_in_car(car_locked)
```



Global Space



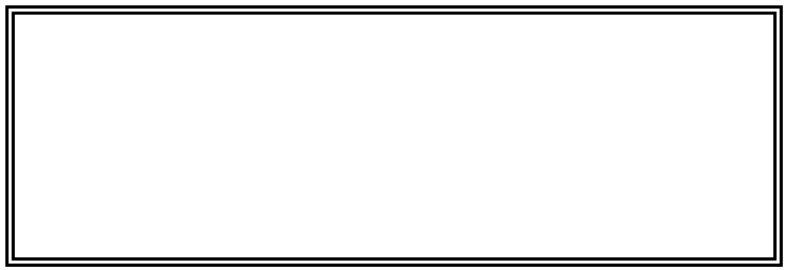
Call Frame



Program Flow (car locked, 3)

if determines which statement is executed next

```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = True
   get_in_car(car_locked)
```



Global Space

car_locked	True

Call Frame

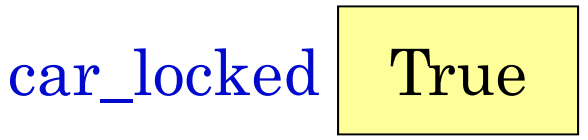
get_in_car	~~1~~ 2
car_locked	True

Program Flow (car locked, 4)

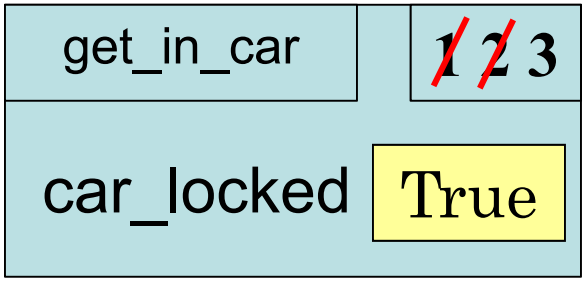
if determines which statement is executed next

```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = True
   get_in_car(car_locked)
```

Global Space



Call Frame

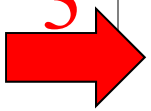


Unlock car!

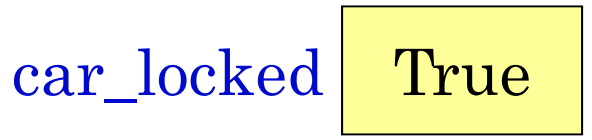
Program Flow (car locked, 5)

if determines which statement is executed next

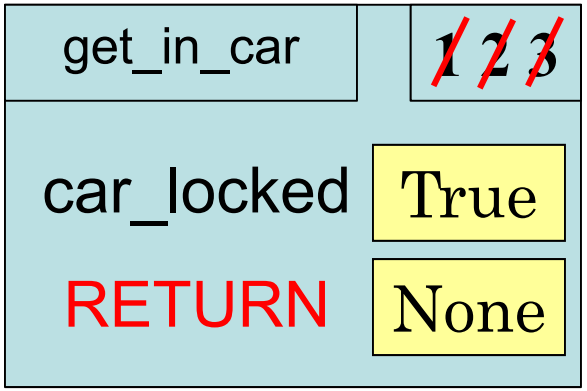
```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = True
   get_in_car(car_locked)
```



Global Space



Call Frame



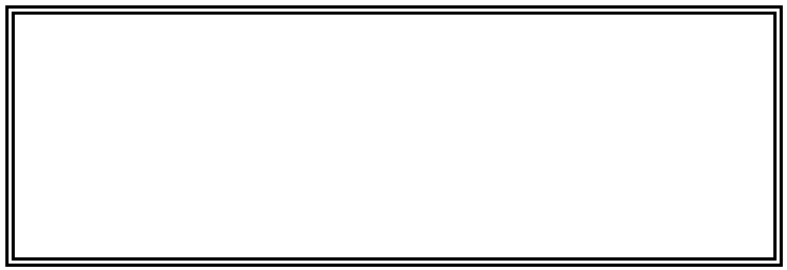

```
Unlock car!
Open the door.
```

Program Flow (car not locked, 0)

if determines which statement is executed next

Global Space

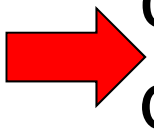
```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = False
   get_in_car(car_locked)
```



Program Flow (car not locked, 1)

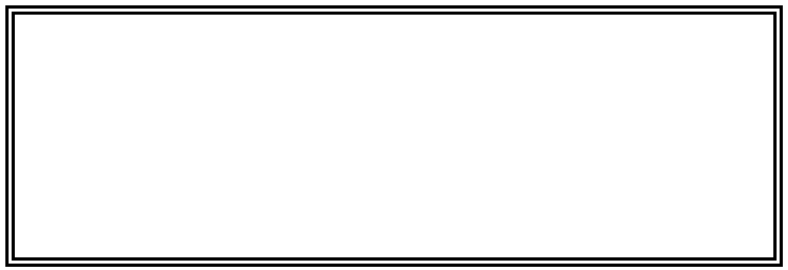
if determines which statement is executed next

```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = False
   get_in_car(car_locked)
```



Global Space

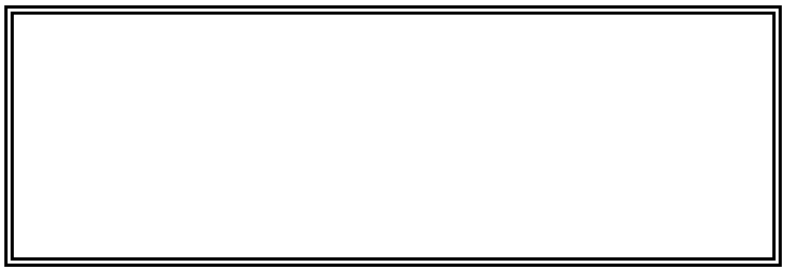
car_locked	False



Program Flow (car not locked, 2)

if determines which statement is executed next

```
def get_in_car(car_locked):
1     if car_locked:
2         print("Unlock car!")
3     print("Open the door.")

car_locked = False
get_in_car(car_locked)
```



Global Space

car_locked	False

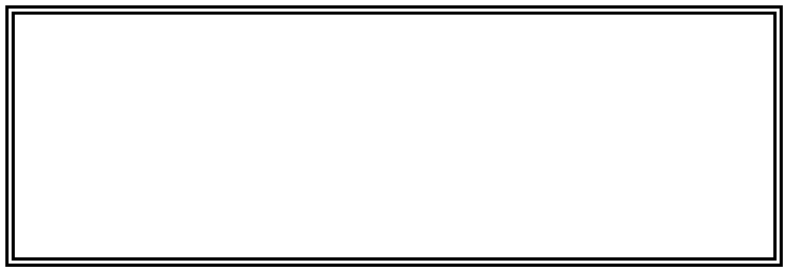
Call Frame

get_in_car	1
car_locked	False

Program Flow (car not locked, 3)

if determines which statement is executed next

```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = False
   get_in_car(car_locked)
```



Global Space

car_locked	False

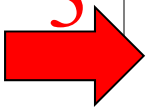
Call Frame

get_in_car	~~1~~ 3
car_locked	False

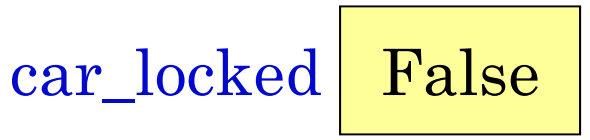
Program Flow (car not locked, 4)

if determines which statement is executed next

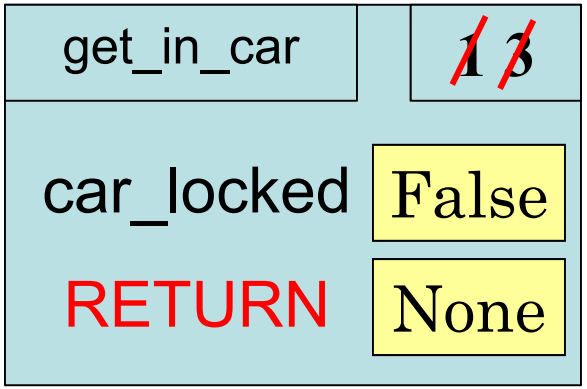
```
   def get_in_car(car_locked):
1      if car_locked:
2          print("Unlock car!")
3      print("Open the door.")

   car_locked = False
   get_in_car(car_locked)
```



Global Space



Call Frame



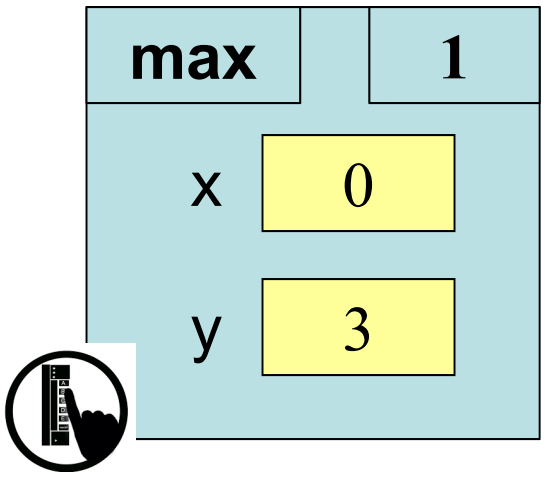
Open the door.

What does the call frame look like next? (Q)

```
def max(x,y):
    if x > y:
1       return x
2   return y
3
```

max(0,3)

Current call frame:

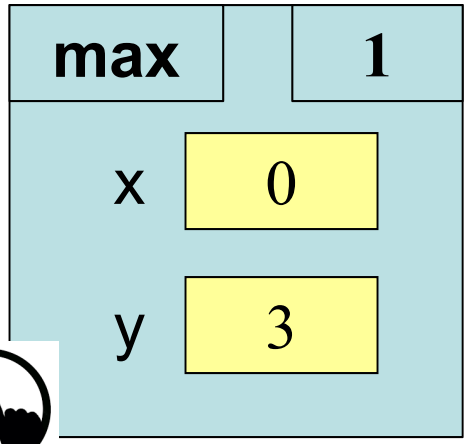


What does the call frame look like next? (Q)

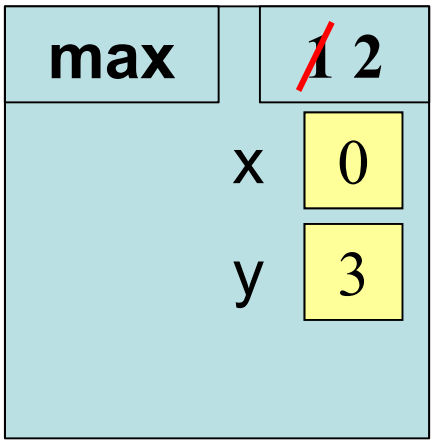
```
def max(x,y):
1   if x > y:
2       return x
3   return y
```

max(0,3)

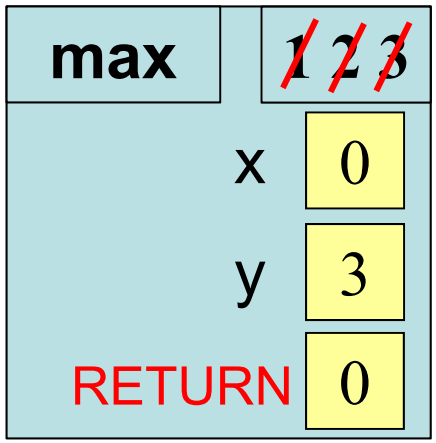
Current call frame:



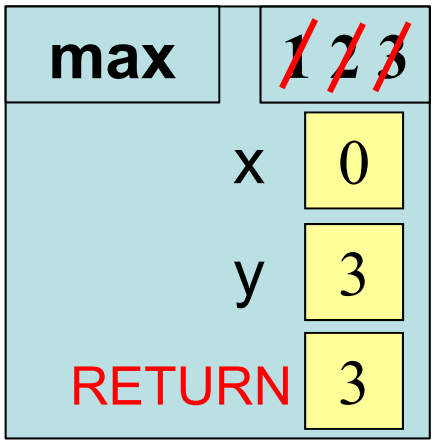
A:



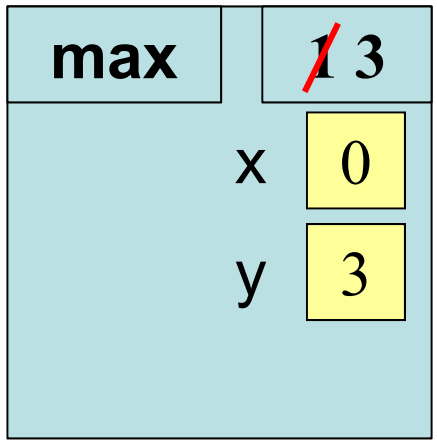
B:



C:



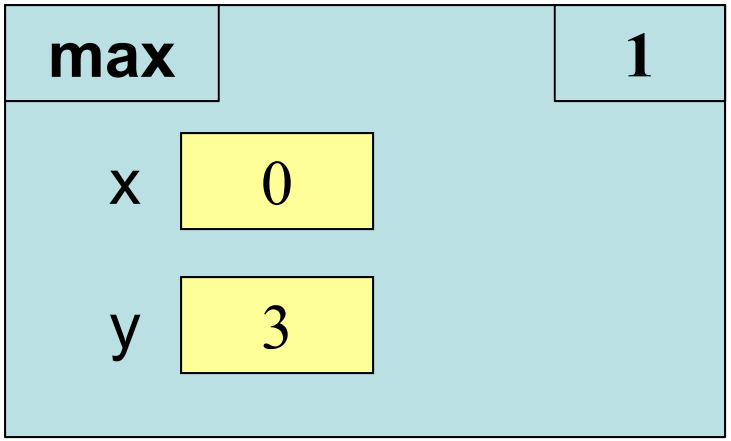
D:



Call Frame Explanation (1)

```
  def max(x,y):
1     if x > y:
2         return x
3     return y
```

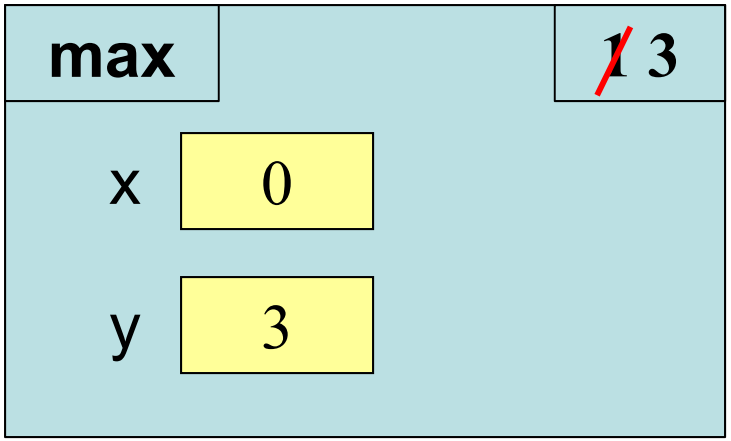
max(0,3):



Call Frame Explanation (2)

```
  def max(x,y):
1 |  if x > y:
2 |  |   return x
3 |  return y
```

max(0,3):

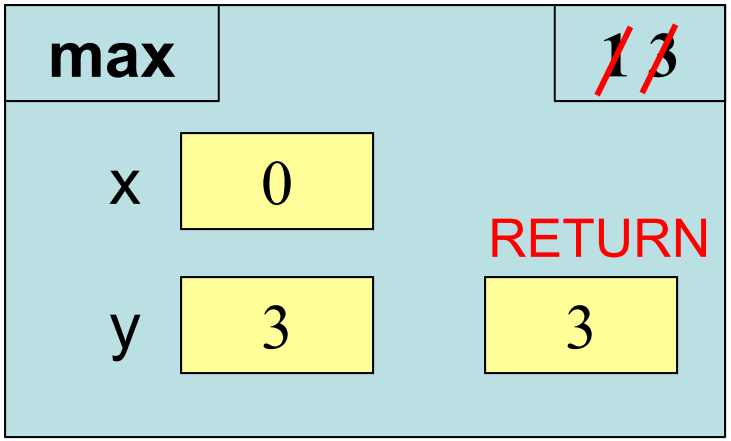


Skips line 2

Call Frame Explanation (3)

```
  def max(x,y):
1 |  if x > y:
2 |  |    return x
3 |  return y
```

max(0,3):



Program Flow and Variables

Variables created inside if continue to exist past if:

```
a = 0
if a == 0:
    b = a + 1
print(b)
```

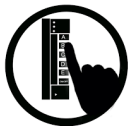
...but are only created if the program actually executes that line of code

Control Flow and Variables (Q1)

```
def max(x,y):
    """Returns: max of x, y"""
    # note: code has a bug!
    # check if x is larger
    if x > y:
        bigger = x
    return bigger

maximum = max(3,0)
```

Value of maximum?

A: 3
B: 0
C: **Error!**
D: I do not know



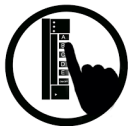
Control Flow and Variables (A1)

```
def max(x,y):
    """Returns: max of x, y"""
    # note: code has a bug!
    # check if x is larger
    if x > y:
        bigger = x
    return bigger

maximum = max(3,0)
```

Value of maximum?

A: 3 **CORRECT**
B: 0
C: **Error!**
D: I do not know

- Local variables last until
  - They are deleted or
  - End of the function
- Even if defined inside **if**

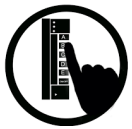


Control Flow and Variables (Q2)

```
def max(x,y):
    """Returns: max of x, y"""
    # note: code has a bug!
    # check if x is larger
    if x > y:
        bigger = x
    return bigger

maximum = max(0,3)
```

Value of maximum?

A: 3
B: 0
C: **Error!**
D: I do not know



Control Flow and Variables (A2)

```
def max(x,y):
    """Returns: max of x, y"""
    # note: code has a bug!
    # check if x is larger
    if x > y:
        bigger = x
    return bigger

maximum = max(0,3)
```

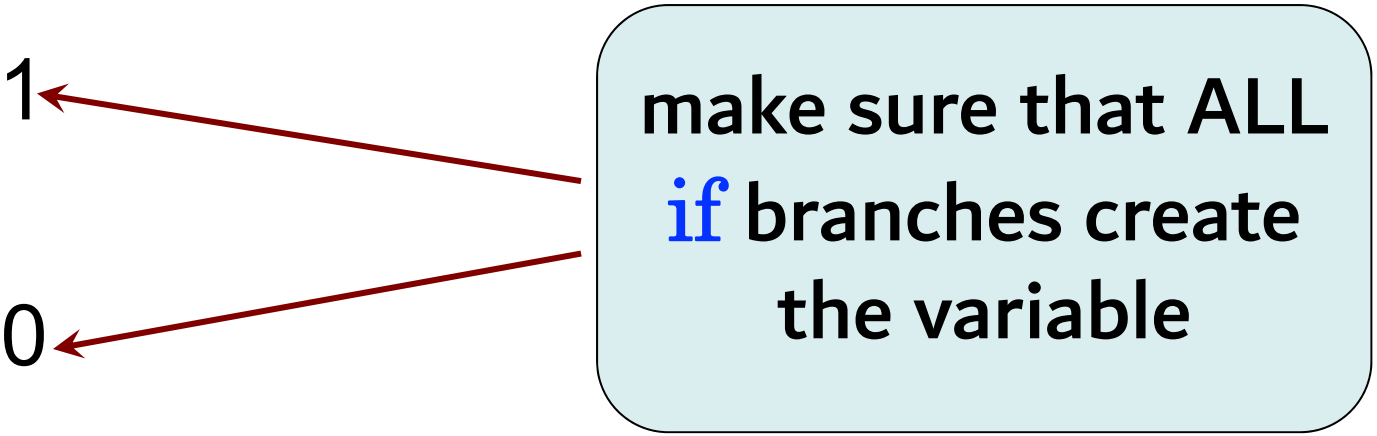
Value of maximum?

A: 3
B: 0
C: **Error!** **CORRECT**
D: I do not know

- Variable existence depends on flow
- Generally terrible idea to refer to variables defined inside an **if** clause

Program Flow and Variables

```
def zero_or_one(a):
    if a == 1:
        b = 1
    else:
        b = 0
    print(b)
```



Conditionals: If-Elif-Else-Statements

Format

```
if <Boolean expression>:
    <statement>
    …
elif <Boolean expression>:
    <statement>
    …
…
else:
    <statement>
    …
```

Example

```
# Find the winner
if score1 > score2:
    winner  = “Player 1”
elif score2 > score1:
    winner  = “Player 2”
else:
    winner = “Players 1 and 2"
```

Conditionals: If-Elif-Else-Statements

Format

if *<Boolean expression>*:
    <statement>
    …
elif *<Boolean expression>*:
    <statement>
    …
…
else:
    <statement>
    …

Notes on Use

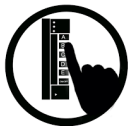
- No limit on number of **elif**
  - Must be between **if**, **else**
- **else** is optional
  - if-elif by itself is fine
- Booleans checked in order
  - Once Python finds a true *<Boolean-expression>*, skips over all the others
  - **else** means **all** *<Boolean-expression>* are false

If-Elif-Else (Question)

```
a = 2

if a == 2:
    a = 3
elif a == 3:
    a = 4
print(a)
```

What gets printed?

A: 2
B: 3
C: 4
D: I do not know

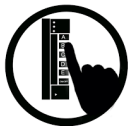


If-Elif-Else (Answer)

```
a = 2

if a == 2:
    a = 3
elif a == 3:
    a = 4
print(a)
```

What gets printed?

A: 2
B: 3 **CORRECT**
C: 4
D: I do not know



What gets printed, Round 3

```
a = 2
if a == 2:
    a = 3
elif a == 3:
    a = 4
print(a)
```

```
a = 2
if a == 2:
    a = 3
if a == 3:
    a = 4
print(a)
```

3

4

Nested Conditionals

```
def what_to_wear(raining, freezing):
    if raining:
        if freezing:
            print(”Wear a waterproof coat.”)
        else:
            print(”Bring an umbrella.")
    else:
        if freezing:
            print(”Wear a warm coat!")
        else:
            print(”A sweater will suffice.")
```

Program Flow and Testing

Can use print statements to examine program flow

```
'before if'
'inside if x>y'
'after if'
```

x must have been greater than y

```
# Put max of x, y in z
print('before if')
if x > y:
    print('inside if x>y')
    z = x
else:
    print('inside else (x<=y)')
    z = y
print('after if')
```

"traces" or "breadcrumbs"