Functions

CS106A, Stanford University

Review!

Boolean variables

```
karel_is_awesome = True

my_bool = 1 < 2
```

Boolean operations

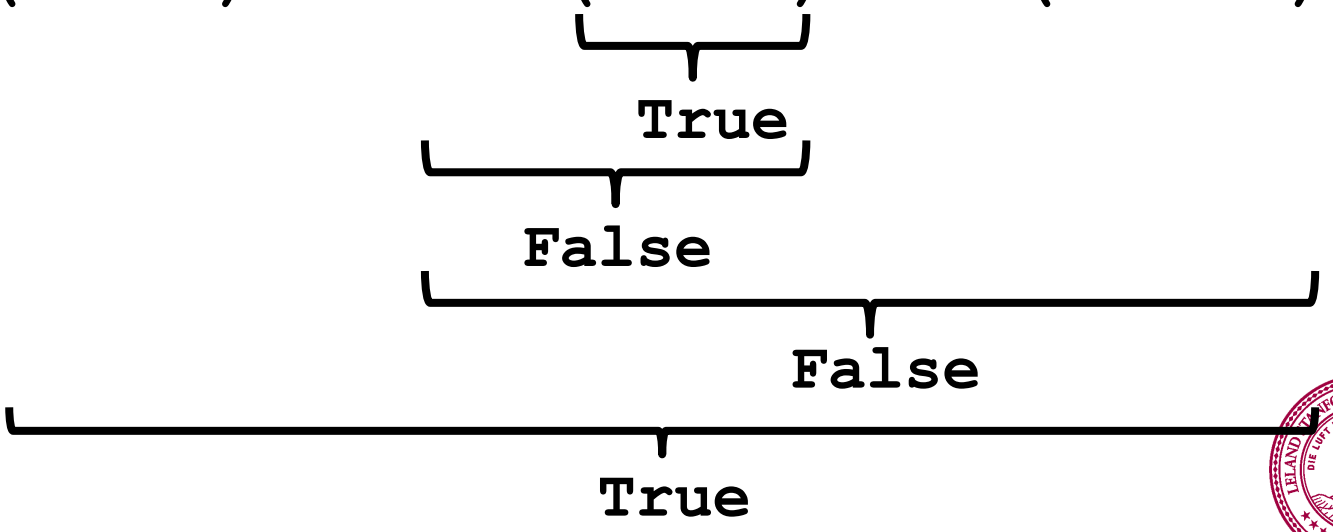
```
p = True
q = False

opposite = not p          # False

both_true = p and q       # False

either_true = p or q      # True

funky = (5 > 3) or not (1 < 2) and (6 == 6)
```



Count starting From 0

```
for i in range(10):
    print(i)
```

```
0
1
2
3
4
5
6
7
8
9
```

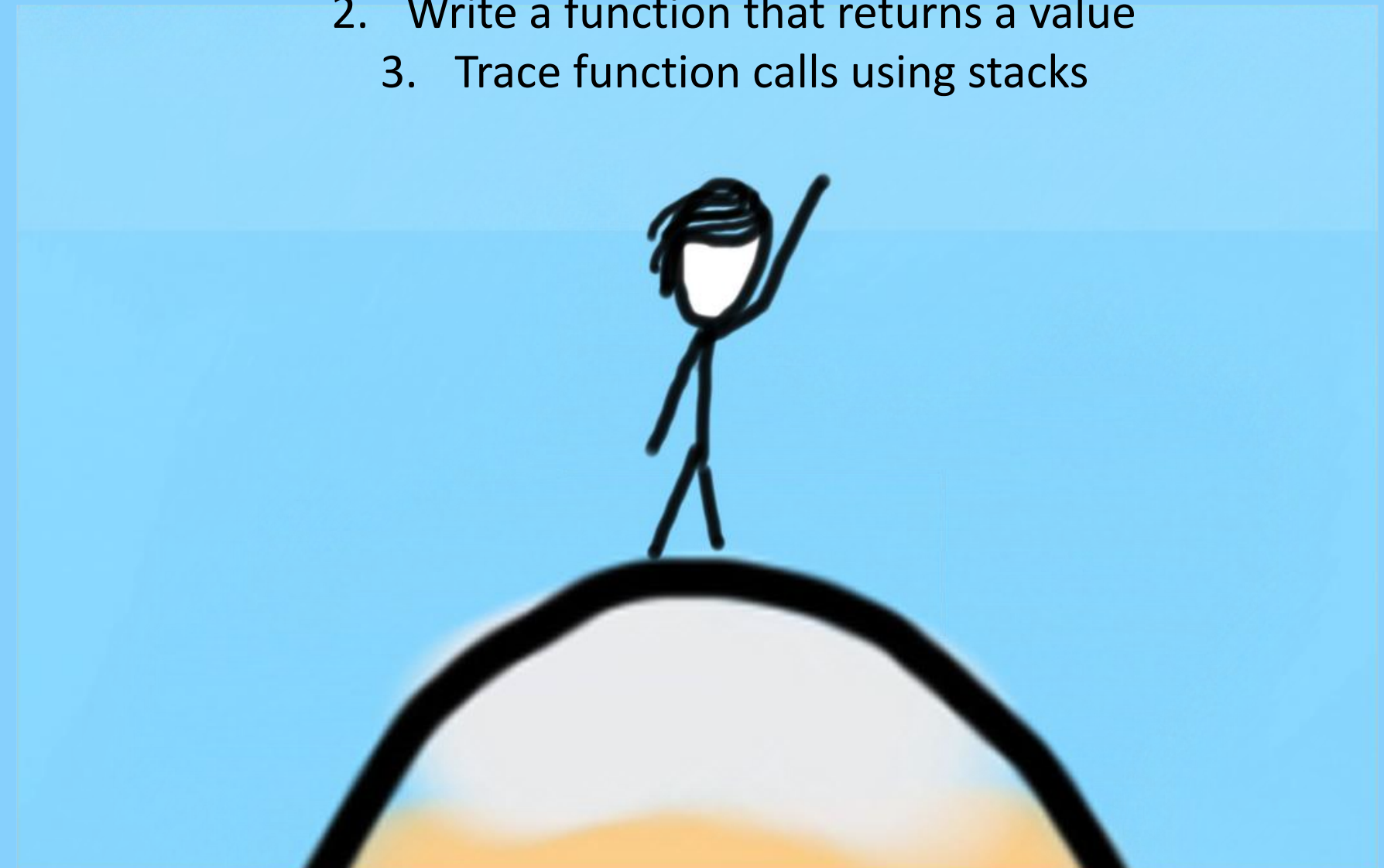
Index starts counting from 0

Counts up to, but not including the number in `range`

Review: guessnumber.py

Learn How To:

1. Write a function that takes in values
2. Write a function that returns a value
3. Trace function calls using stacks



Recall, calling functions

```
print("hello world")

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

secret_number = random.randint(1, 100)

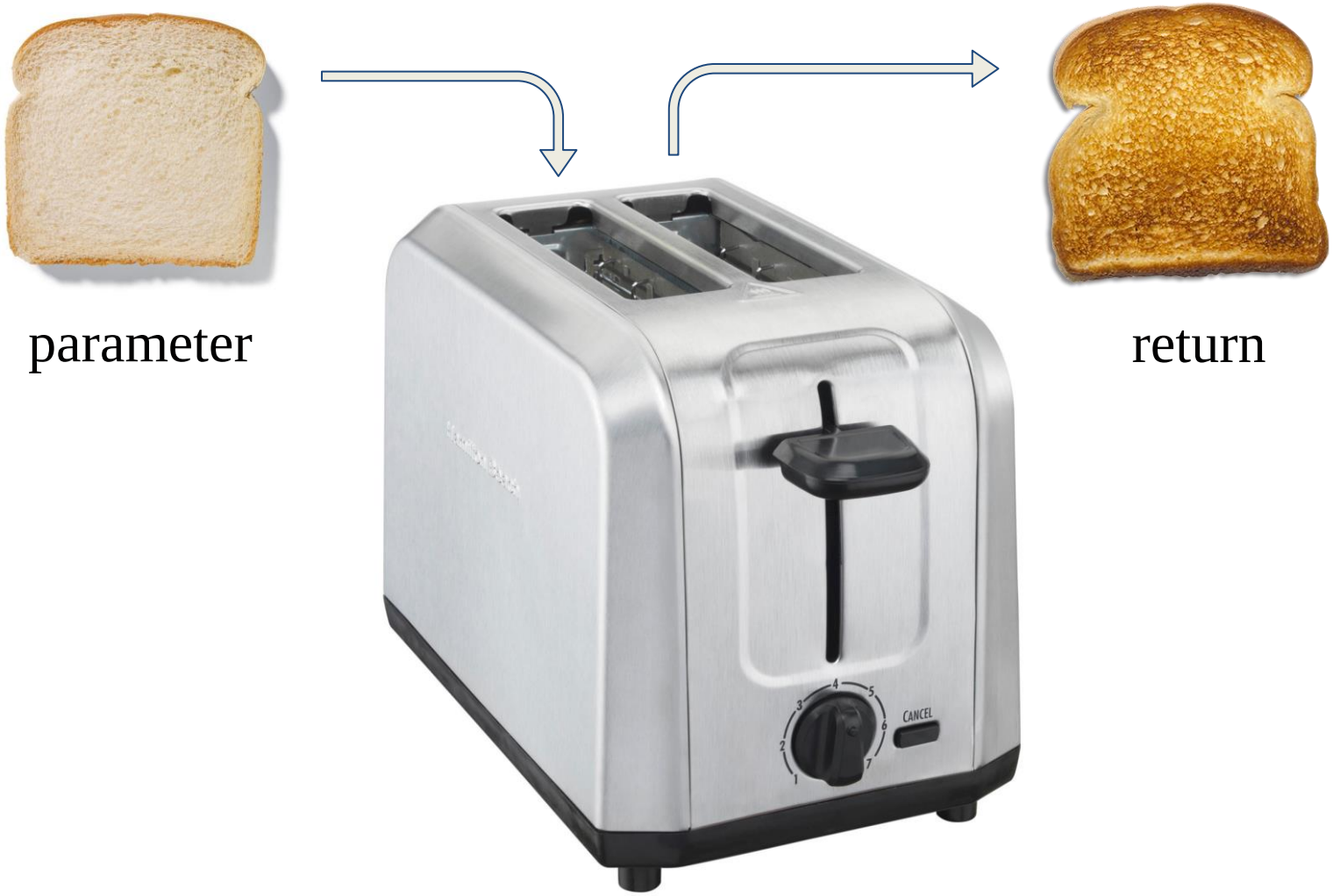
root = math.sqrt(num)
```

Defining a function

```
def turn_right():
    turn_left()
    turn_left()
    turn_left()
```

Big difference with python functions:
Python functions can **take in data**, and can **return data**!

A toaster is a function?!

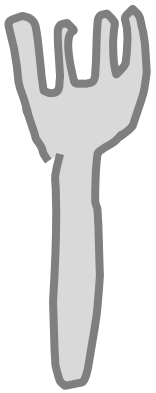


A toaster is a function?!

parameter

return

A toaster is a function?!



parameter

A toaster is a function?!

implementation

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A toaster is a function?!

implementation

Abstraction

Civilization advances by extending the number of operations we can perform without thinking about them.

--Alfred North Whitehead

Abstraction is one of the most critical concept in computing

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

```
def average(a, b):
    sum = a + b
    return sum / 2
```

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

function "call"

function "definition"

```
def average(a, b):
    sum = a + b
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```

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

function name

```
def average(a, b):
    sum = a + b
    return sum / 2
```

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

input given

```
def average(a, b):
    sum = a + b
    return sum / 2
```

input expected

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

arguments

parameters

```
def average(a, b):
    sum = a + b
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```

Anatomy of a function

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def main():
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    print(mid)
```

```
def average(a, b):
    sum = a + b
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```

function body

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

This call "evaluates" to the value returned

```
def average(a, b):
    sum = a + b
    return sum / 2
```

Ends the function and gives back a value

Anatomy of a function

Also a function call

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

```
def average(a, b):
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```

Anatomy of a function

No parameters (expects no input)

```
def main():
    mid = average(5.0, 10.2)
    print(mid)
```

```
def average(a, b):
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```

Anatomy of a function

```
def main():
    mid = average(5.0, 10.2)
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When a function ends it “returns”

```
def average(a, b):
    sum = a + b
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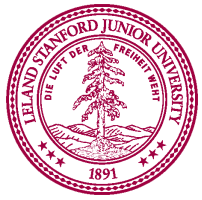
```



Formally

```
def name(parameters):
    statements
    return value        # optionally
```

- ***name:*** name of function (in `snake_case`)
- ***parameters:*** information passed into function
- ***return*:** information given back from the function

Parameters

Parameters let you provide a function with some information when you call it.

Parameters allow a function to be reused with different input information.

Program user

Uses the terminal (or user interface)

Coder: function caller

Uses helper functions

Coder: function author

Writes helper functions other coders can use

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Anatomy of a function

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def main():
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    print(mid)
```

Function caller

```
def average(a, b):
    sum = a + b
    return sum / 2
```

Function author

Function author's contract - `average`:

If you call this function you must provide two **parameters**. The function will give back a **return** value.

Learn by Example

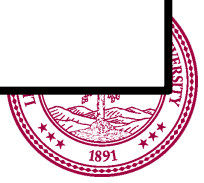
No Parameter, No Return

```
def print_intro():
    print("Welcome to class")
    print("It's the best part of my day.")


def main():
    print_intro()
```

terminal

```
> python intro.py
```



No Parameter, No Return

function author

```
def print_intro():
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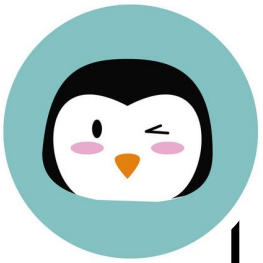
```

user

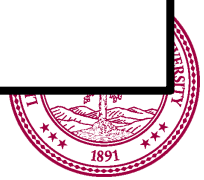


terminal

```
> python intro.py
```

```
def main():
    print_intro()
```

caller



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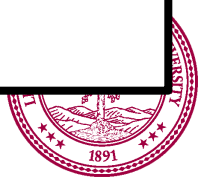

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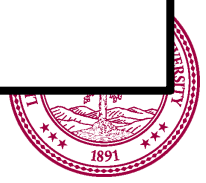

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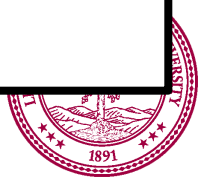

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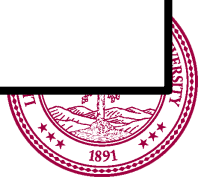

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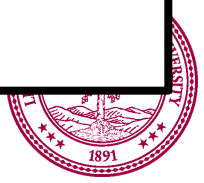

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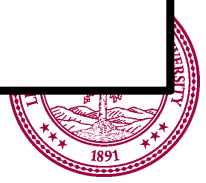

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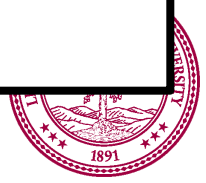

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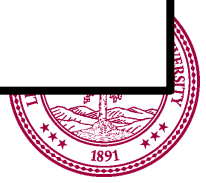

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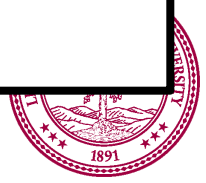

OMG! Let's do another one!

Parameter Example

```
def print_opinion(num):
    if (num == 5):
        print("I love 5!")
    else :
        print("Whattever")


def main():
    print_opinion(5)
```

terminal

```
> python opinion.py
```

Parameter Example

main memory

No variables

terminal

> python opinion.py

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print_opinion memory

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Parameter Example

main memory

No variables

print_opinion memory

num

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main memory

No variables

print_opinion memory

num 5

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Parameter Example

main memory

No variables

print_opinion memory

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print_opinion memory

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Parameter Example

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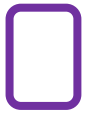

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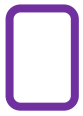

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terminal

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I love 5!
```

One more! Pleeeeze!

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters

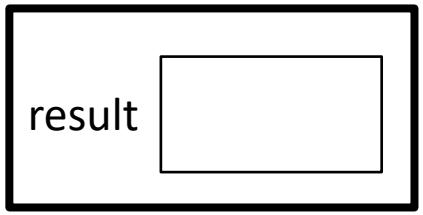

def main():
    result = meters_to_cm(5.2)
    print(result)
```

terminal

```
> python m2cm.py
```

Parameter and Return Example

main memory

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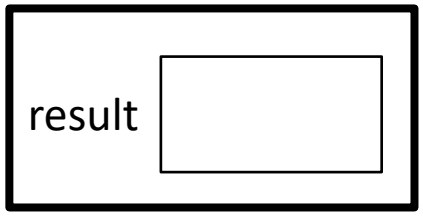


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Parameter and Return Example

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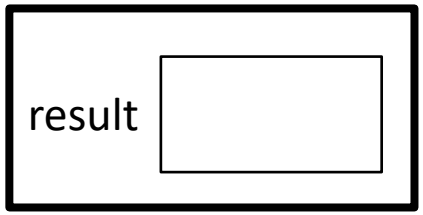
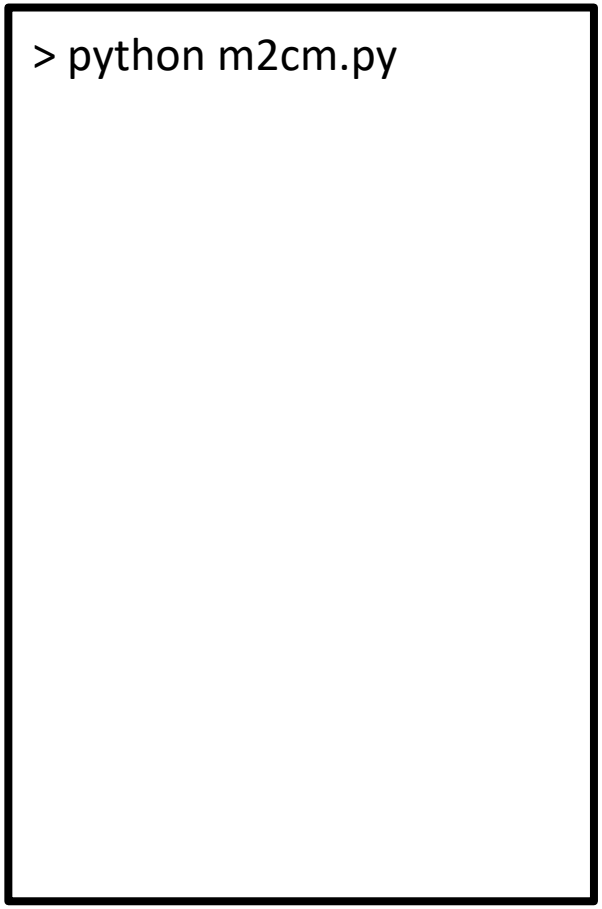


meteresToCm memory

terminal

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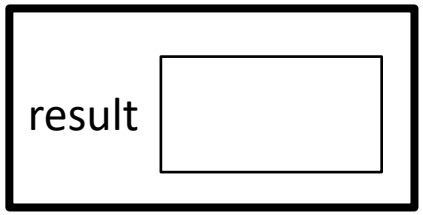

meteresToCm memory

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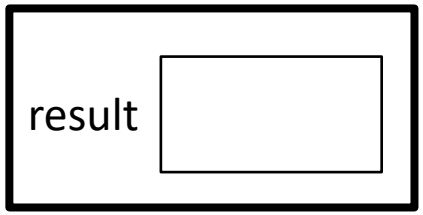
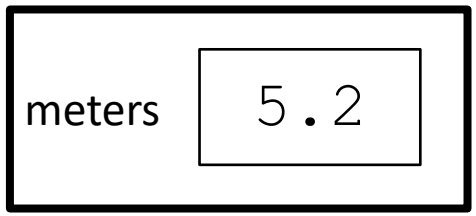


meteresToCm memory



terminal

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520.0

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Parameter and Return Example

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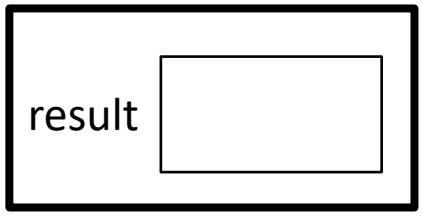


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520.0

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Parameter and Return Example

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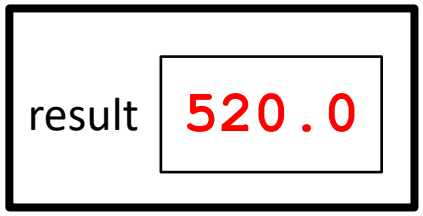


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520.0

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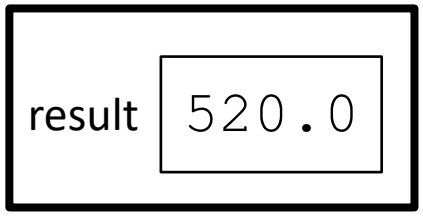

terminal

```
> python m2cm.py
520.0
```

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    result = meters_to_cm(5.2)
    print(result)
```

Parameter and Return Example

main memory

result | 520.0

terminal

```
> python m2cm.py
520.0
```

```
def meters_to_cm(meters):
    return 100 * m

    result = meters_to_cm(5.2)
    print(result)
```

This is our favorite paradigm: function author returns value, function caller prints it. It's the most flexible, modular. Its elegance is unparalleled.

More!

More!

More!

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

terminal

```
> python m2cm.py
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

terminal

```
> python m2cm.py
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

terminal

```
> python m2cm.py
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
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```

520.0

terminal

```
> python m2cm.py
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

520.0

terminal

```
> python m2cm.py
520.0
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

terminal

```
> python m2cm.py
520.0
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

910.0

terminal

```
> python m2cm.py
520.0
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

910.0

terminal

```
> python m2cm.py
520.0
910.0
```

Parameter and Return Example

```
def meters_to_cm(meters):
    return 100 * meters


def main():
    print(meters_to_cm(5.2))
    print(meters_to_cm(9.1))
```

terminal

```
> python m2cm.py
520.0
910.0
```

Is returning
the same as printing?

```
# How is this function
def meters_to_cm_case1(meters):
    return 100 * meters

# Different than this function?
def meters_to_cm_case2(meters):
    print(100 * meters)
```

```
# How is this function
def meters_to_cm_case1(meters):
    return 100 * meters

# Different than this function?
def meters_to_cm_case2(meters):
    print(100 * meters)
```

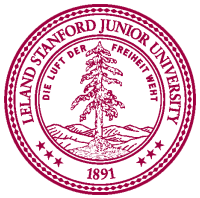
When a function **produces** a value does it *print* or *return*?

`return`

`print`

Caller receives value.
Can store it and/or print it.

User sees value on the terminal.



Is returning
the same as printing?

NO

Multiple Return Statements

```
def max(num1, num2):
    if num1 >= num2:
        return num1

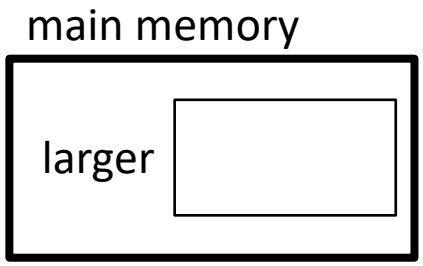
    return num2


def main():
    larger = max(5, 1)
```

terminal

```
> python maxmax.py
```

Multiple Return Statements

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        return num1

    return num2
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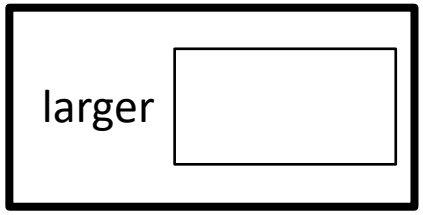
terminal

```
> python maxmax.py
```

```
def main():
    larger = max(5, 1)
```

Multiple Return Statements

main memory

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def main():
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terminal

```
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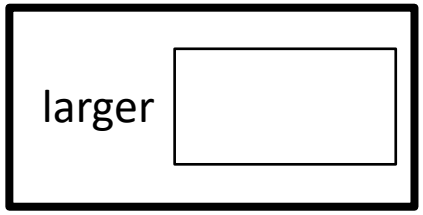
```

Multiple Return Statements

main memory

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def main():
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terminal

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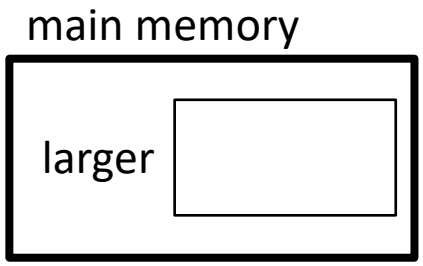
> python maxmax.py
```

Multiple Return Statements

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def main():
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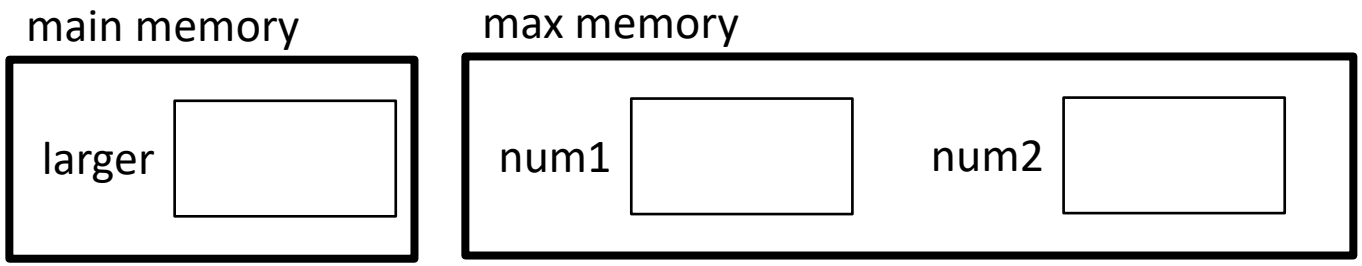
Multiple Return Statements

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terminal

```
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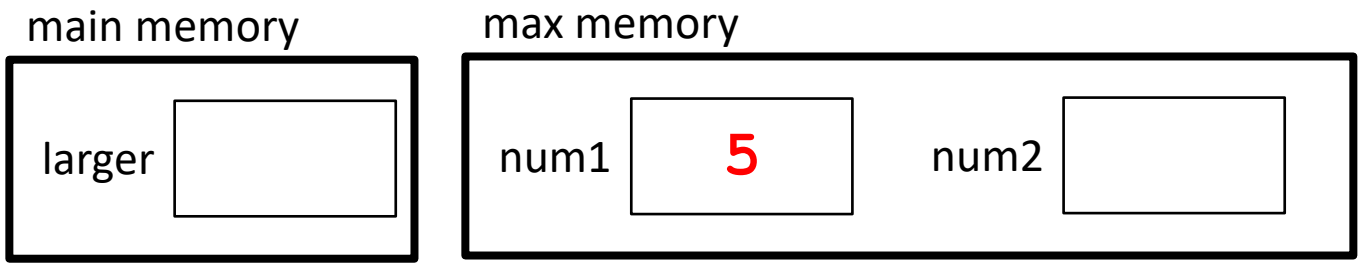
```

Multiple Return Statements

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terminal

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> python maxmax.py
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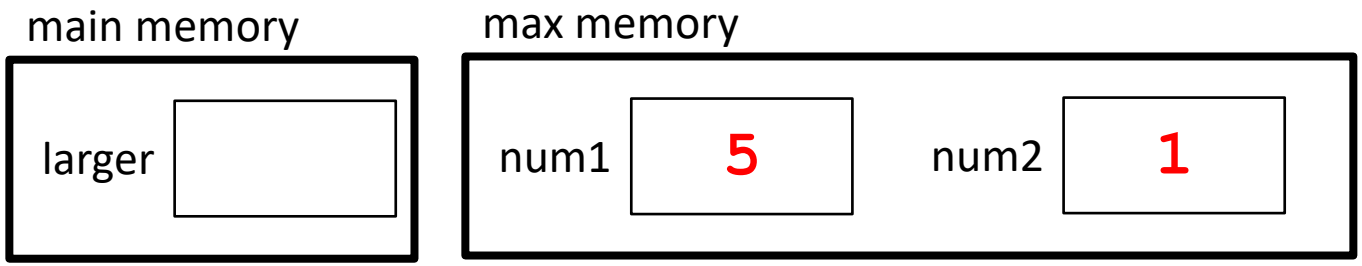
Multiple Return Statements

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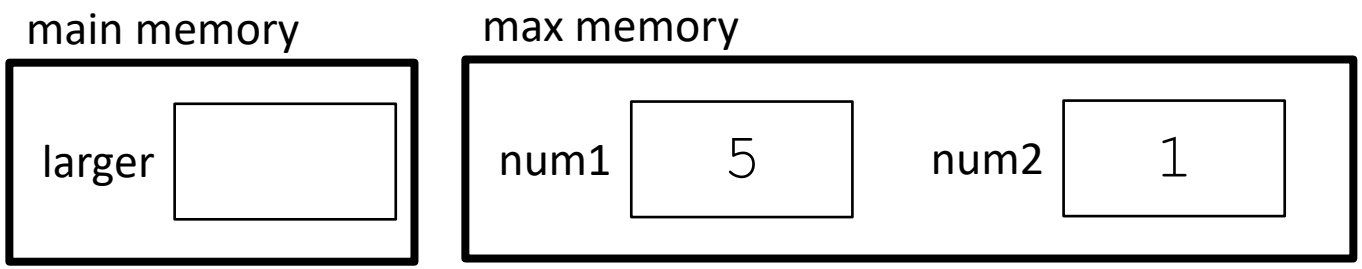
```

terminal

```
> python maxmax.py
```

Multiple Return Statements

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terminal

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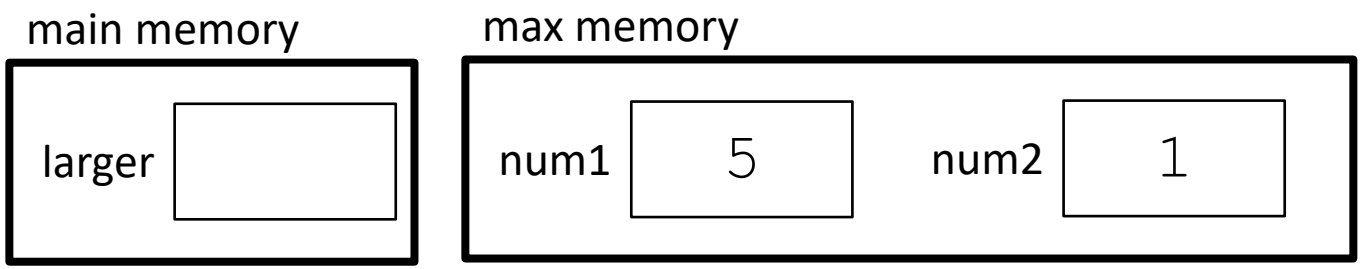
```

Multiple Return Statements

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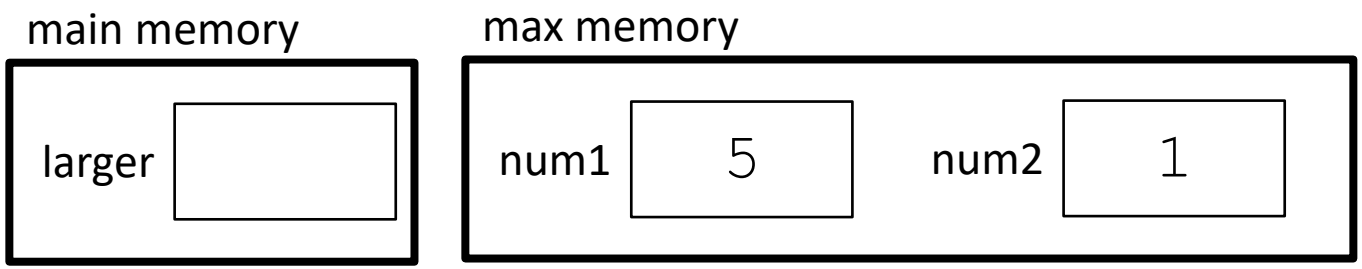
```

terminal

```
> python maxmax.py
```

Multiple Return Statements




```
def max(num1, num2):
    if num1 >= num2:
        return num1
    return num2

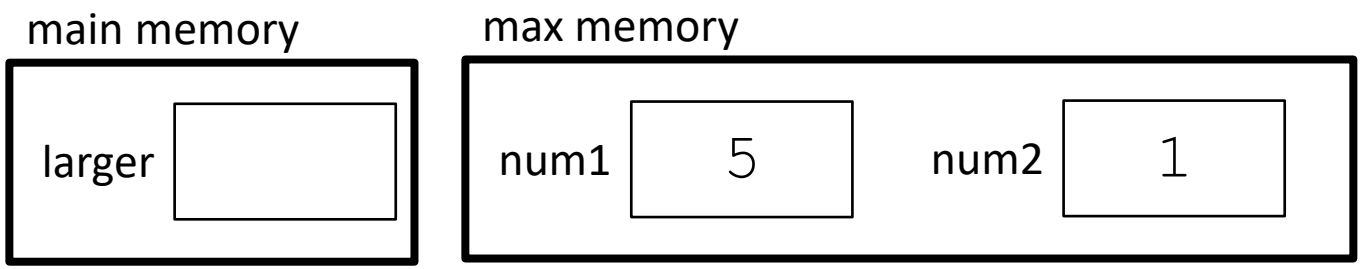
def main():
    larger = max(5, 1)
```

5

terminal

```
> python maxmax.py
```

Multiple Return Statements




```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2



def main():
    larger = max(5, 1)
```

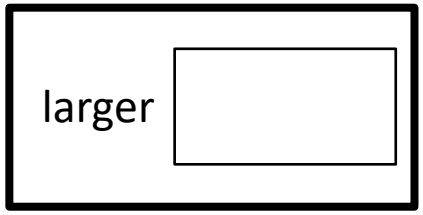
5

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory




```
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    return num2



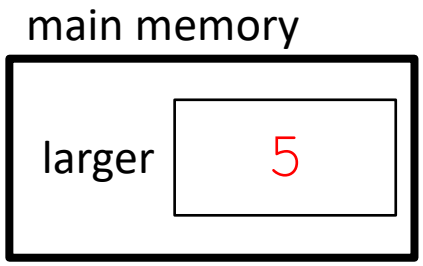
def main():
    larger = max(5, 1)
```

5

terminal

```
> python maxmax.py
```

Multiple Return Statements




```
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    return num2


def main():
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```

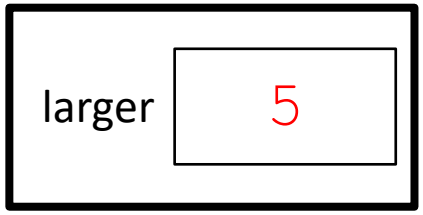
5

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory




```
def max(num1, num2):
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    return num2



def main():
    larger = max(5, 1)
```

terminal

```
> python maxmax.py
```

What if we change the order of arguments?

Multiple Return Statements

```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2


def main():
    larger = max(5, 1)
```

Multiple Return Statements

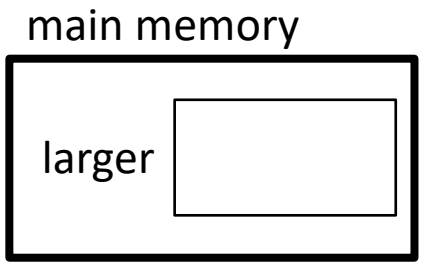
```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2


def main():
    larger = max(1, 5)
```

Changed the order of arguments

Multiple Return Statements

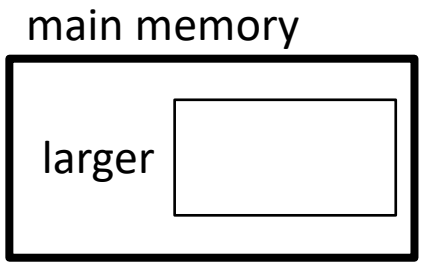



```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2
```

```
def main():
    larger = max(1, 5)
```

Multiple Return Statements




```
def max(num1, num2):
    if num1 >= num2:
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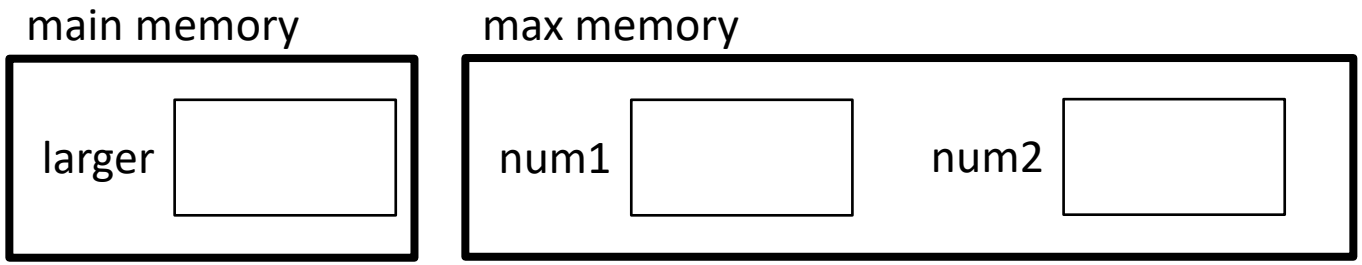
    return num2



def main():
    larger = max(1, 5)
```

Multiple Return Statements

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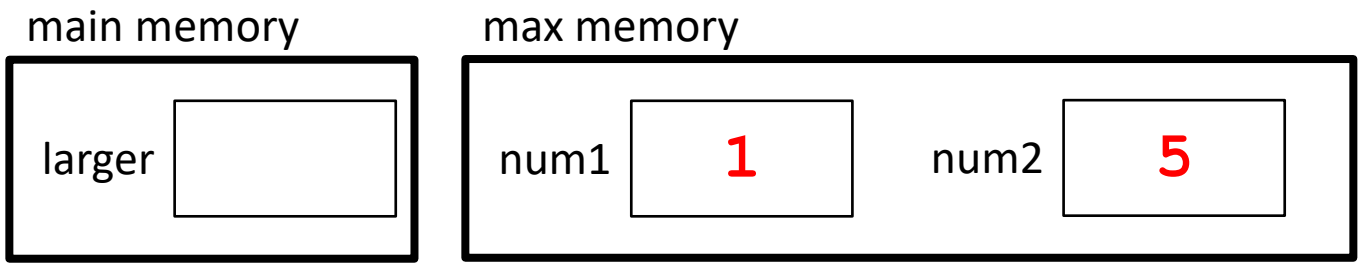
        return num1

    return num2



def main():
    larger = max(1, 5)
```

Multiple Return Statements




```
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    return num2



def main():
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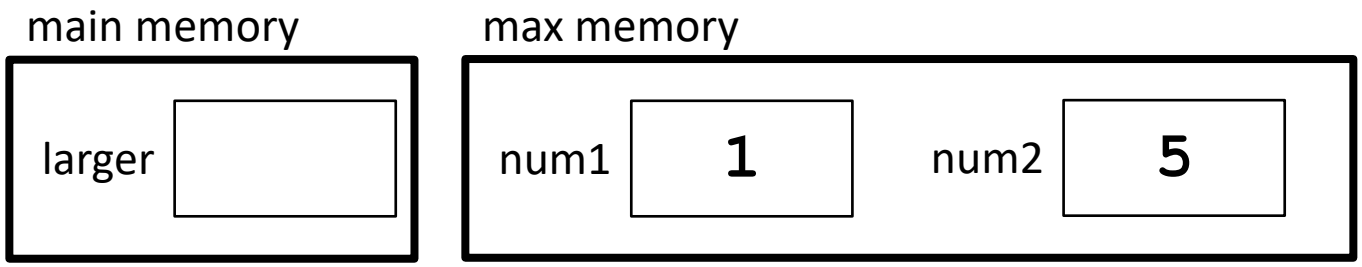
```

Multiple Return Statements

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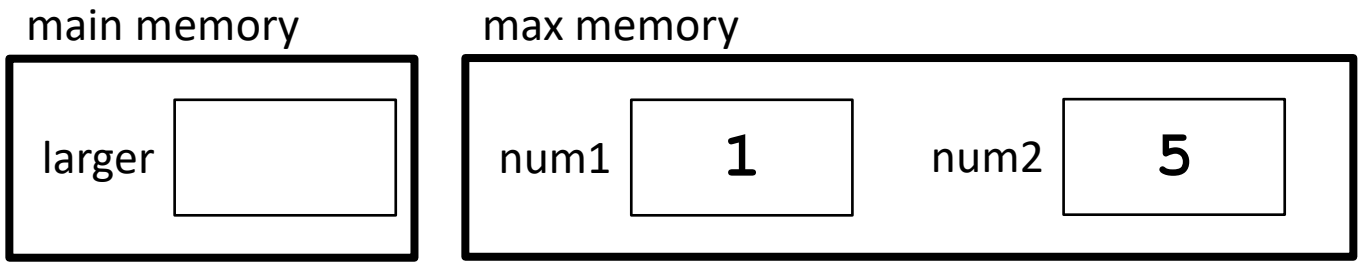
Multiple Return Statements



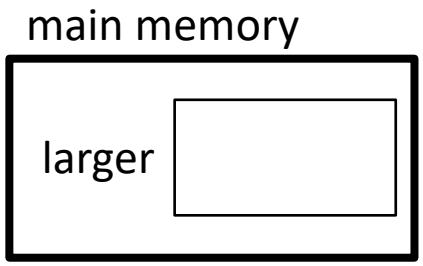

```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2
```

5

```
def main():
    larger = max(1, 5)
```

Multiple Return Statements




```
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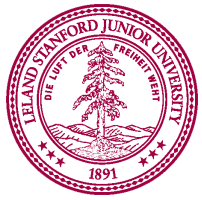
    if num1 >= num2:
        return num1

    return num2

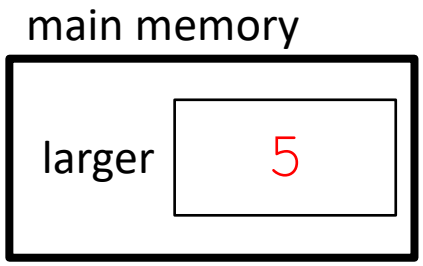


def main():
    larger = max(1, 5)
```

5



Multiple Return Statements

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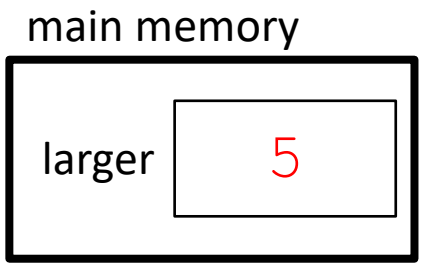
5

Multiple Return Statements

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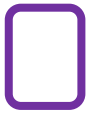
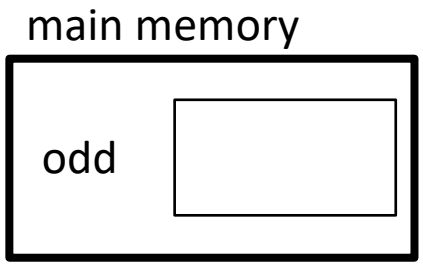


Hey, can I return a bool?

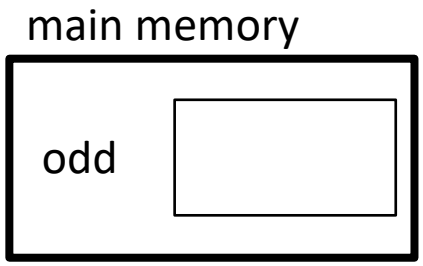
Predicate functions




```
def is_odd(num):
    return (num % 2) == 1
```

```
def main():
    odd = is_odd(3)
```

Predicate functions

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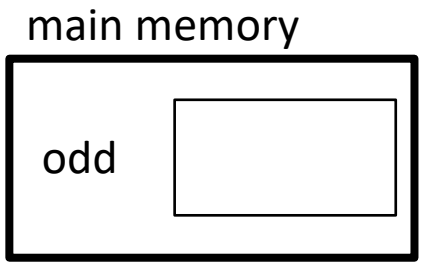


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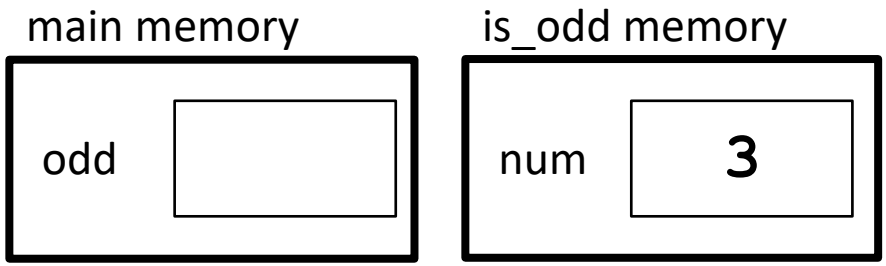


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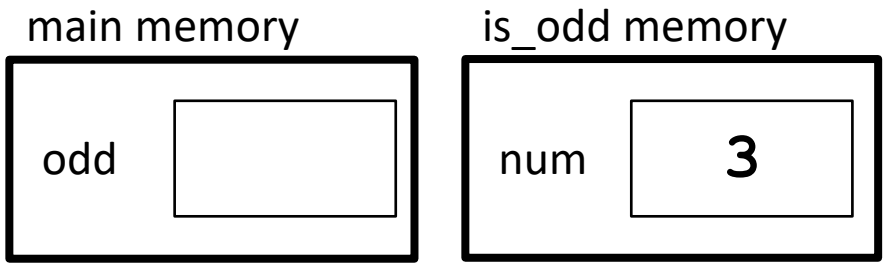
Predicate functions

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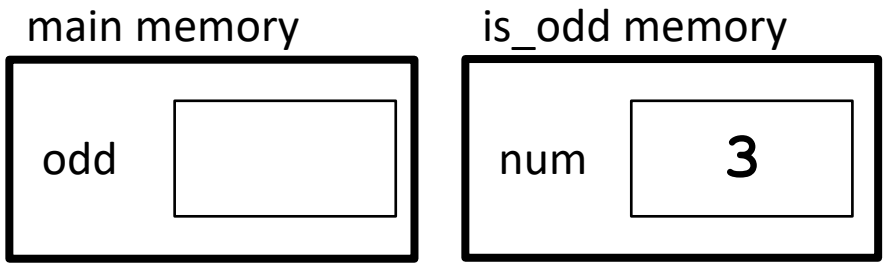
Predicate functions

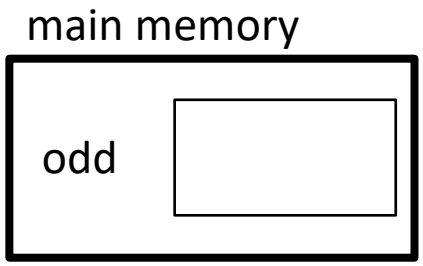



```
def is_odd(num):
    return (num % 2) == 1
```

True

```
def main():
    odd = is_odd(3)
```

Predicate functions

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```
def main():
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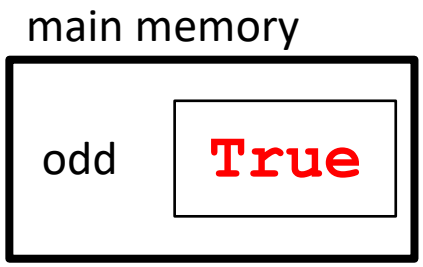
```

True

Predicate functions

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```
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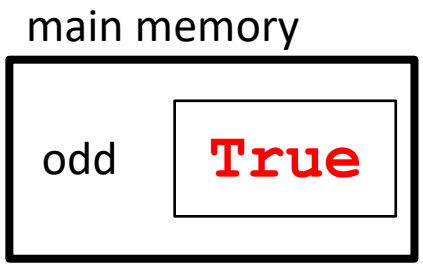
Predicate functions

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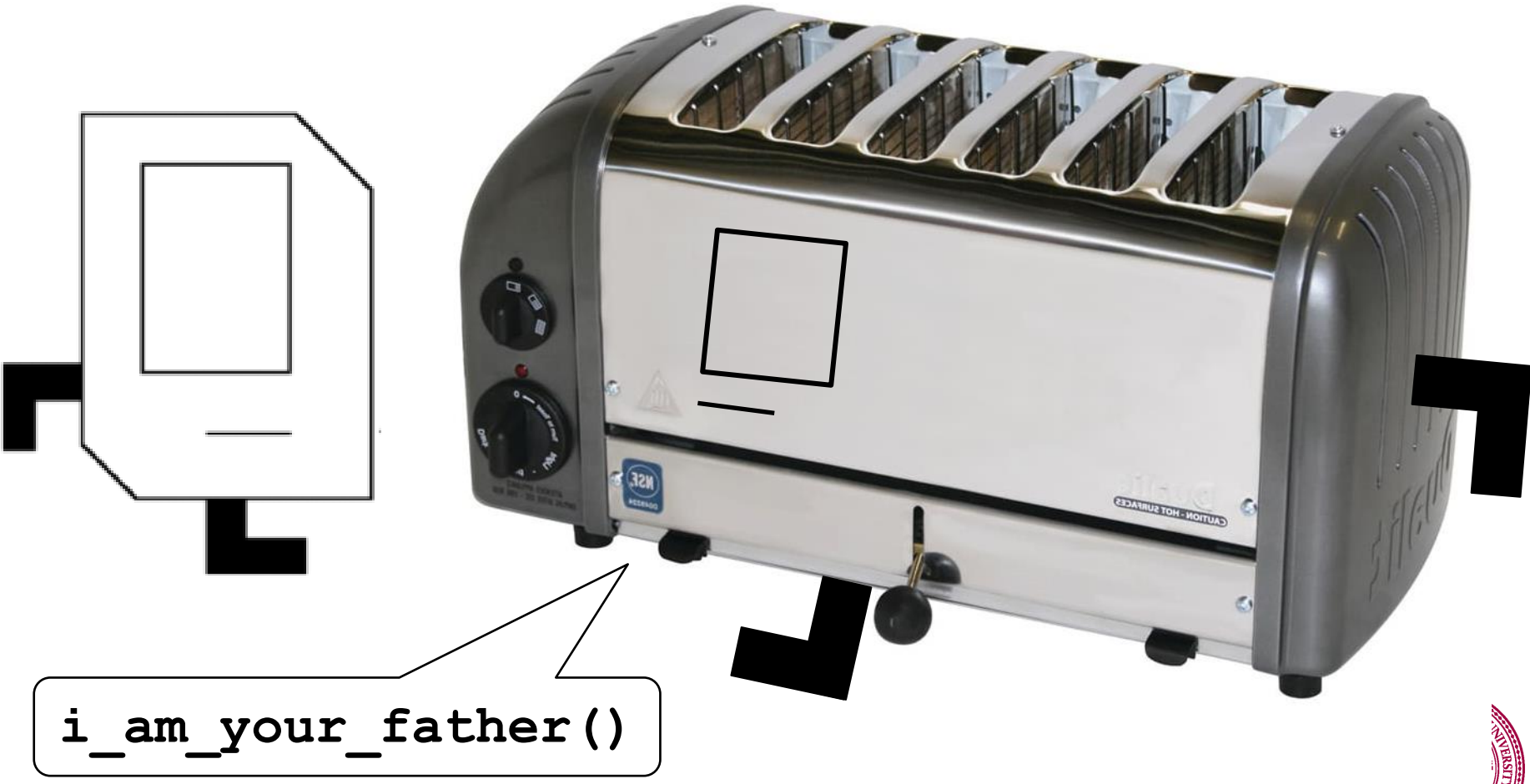
    return (num % 2) == 1
```

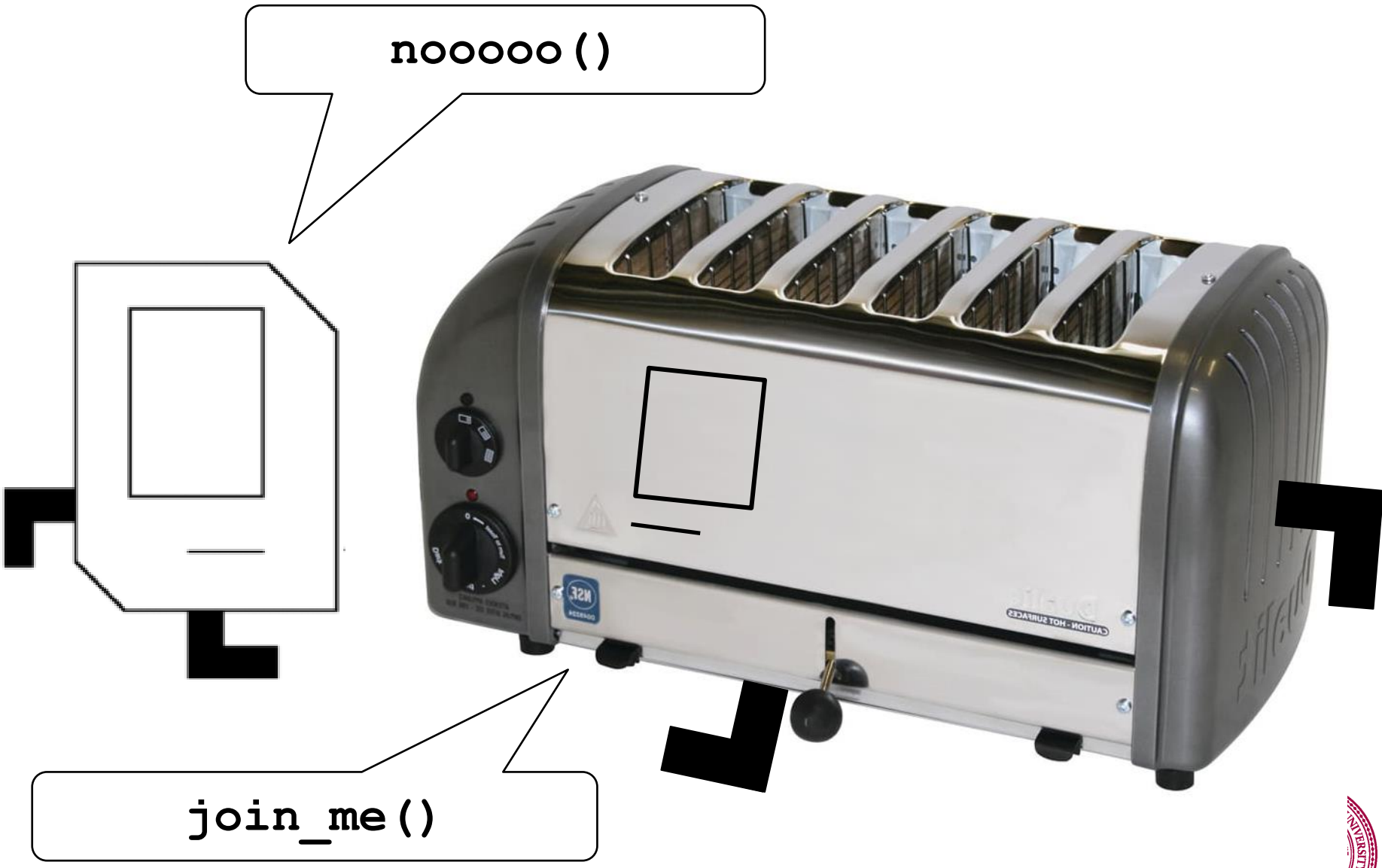
```
def main():
    odd = is_odd(3)
```

You're ready!

You're ready!



You're ready!



You're ready!

```
together_we_can_rule_the_galaxy()
```

You're ready!

You're ready!

```
if time_available():
    superguessnumber.py
```