Functions

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Boolean Variable

```
karel_is_awesome = True

my_bool = 1 < 2
```


Boolean Operations

```
a = True

b = False


both_true = a and b

either_true = a or b

opposite = not a
```

There is an *i* in for loop

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

terminal

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


There is an *i* in for loop

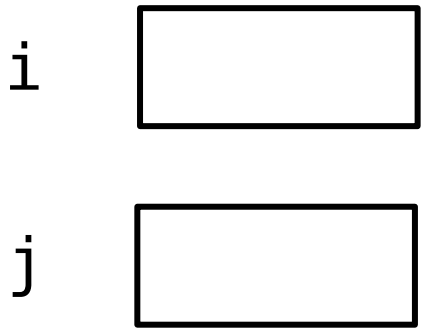
```
print('i', 'j')
for i in range(2):
    for j in range(3):
        print(i,j)
```

terminal

```
i j
0 0
0 1
0 2
1 0
1 1
1 2
```

There is an *i* in for loop

```
print('i', 'j')
for i in range(2):
    for j in range(3):
        print(i,j)
```



terminal

```
i j
```

There is an *i* in for loop

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print('i', 'j')
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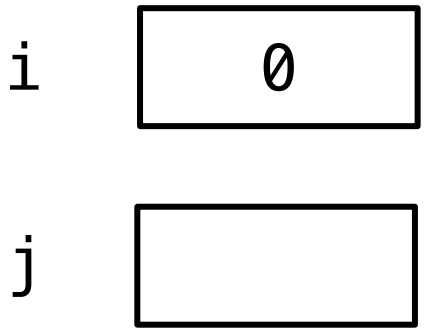
        print(i,j)
```



terminal

```
i j
```

There is an *i* in for loop

```
print('i', 'j')
for i in range(2):
    for j in range(3):
        print(i,j)
```

i 0

j 0

terminal

```
i j
```

There is an *i* in for loop

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for i in range(2):
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        print(i,j)
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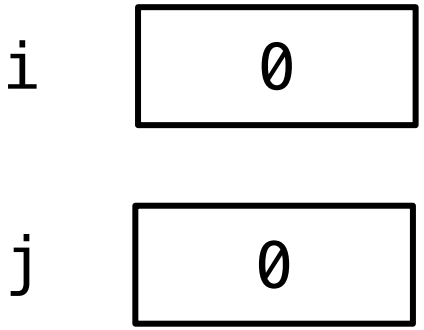

terminal

```
i j
0 0
```

There is an *i* in for loop

```
print('i', 'j')
for i in range(2):
    for j in range(3):
        print(i,j)
```

i 0

j 1

terminal

```
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0 0
```

There is an *i* in for loop

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print('i', 'j')
for i in range(2):
    for j in range(3):
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```

i 0

j 1

terminal

```
i j
0 0
0 1
```

There is an *i* in for loop

```
print('i', 'j')
for i in range(2):
    for j in range(3):
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```

i 0

j 2

terminal

```
i j
0 0
0 1
```

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        print(i,j)
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i 0

j 2

terminal

```
i j
0 0
0 1
0 2
```

There is an *i* in for loop

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print('i', 'j')
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i 0

j 2

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0 0
0 1
0 2
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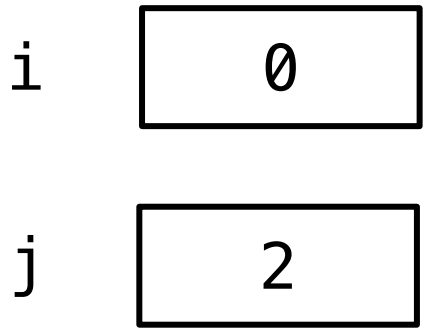

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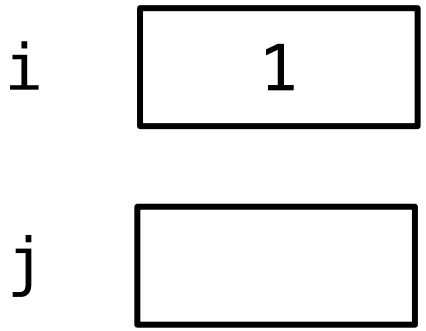

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0 1
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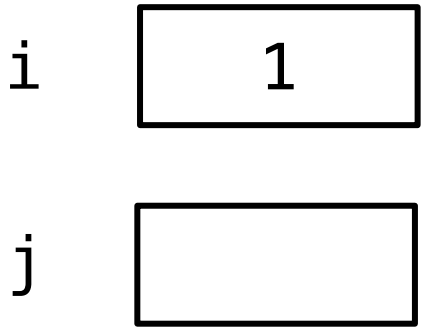
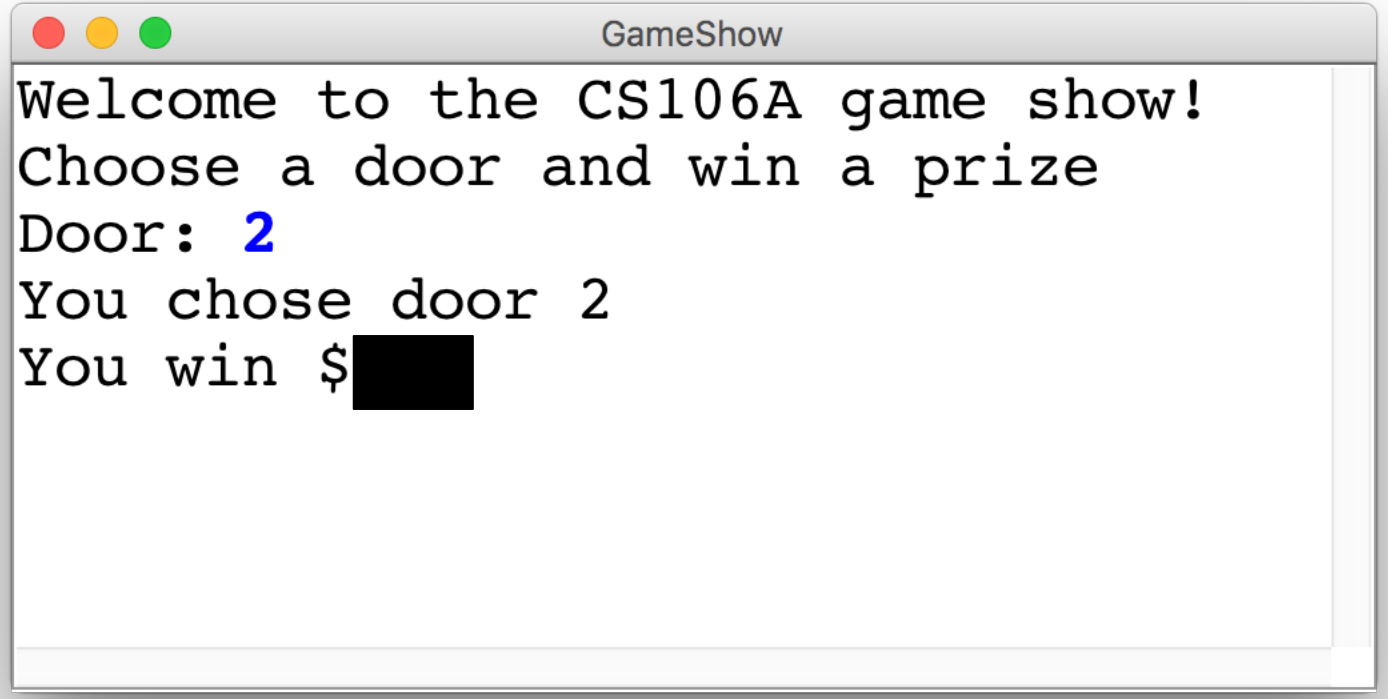


terminal

```
i j
0 0
0 1
0 2
1 0
1 1
1 2
```

Game Show


GameShow
Welcome to the CS106A game show!
Choose a door and win a prize
Door: 2
You chose door 2
You win $

Choose a Door

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

or

and

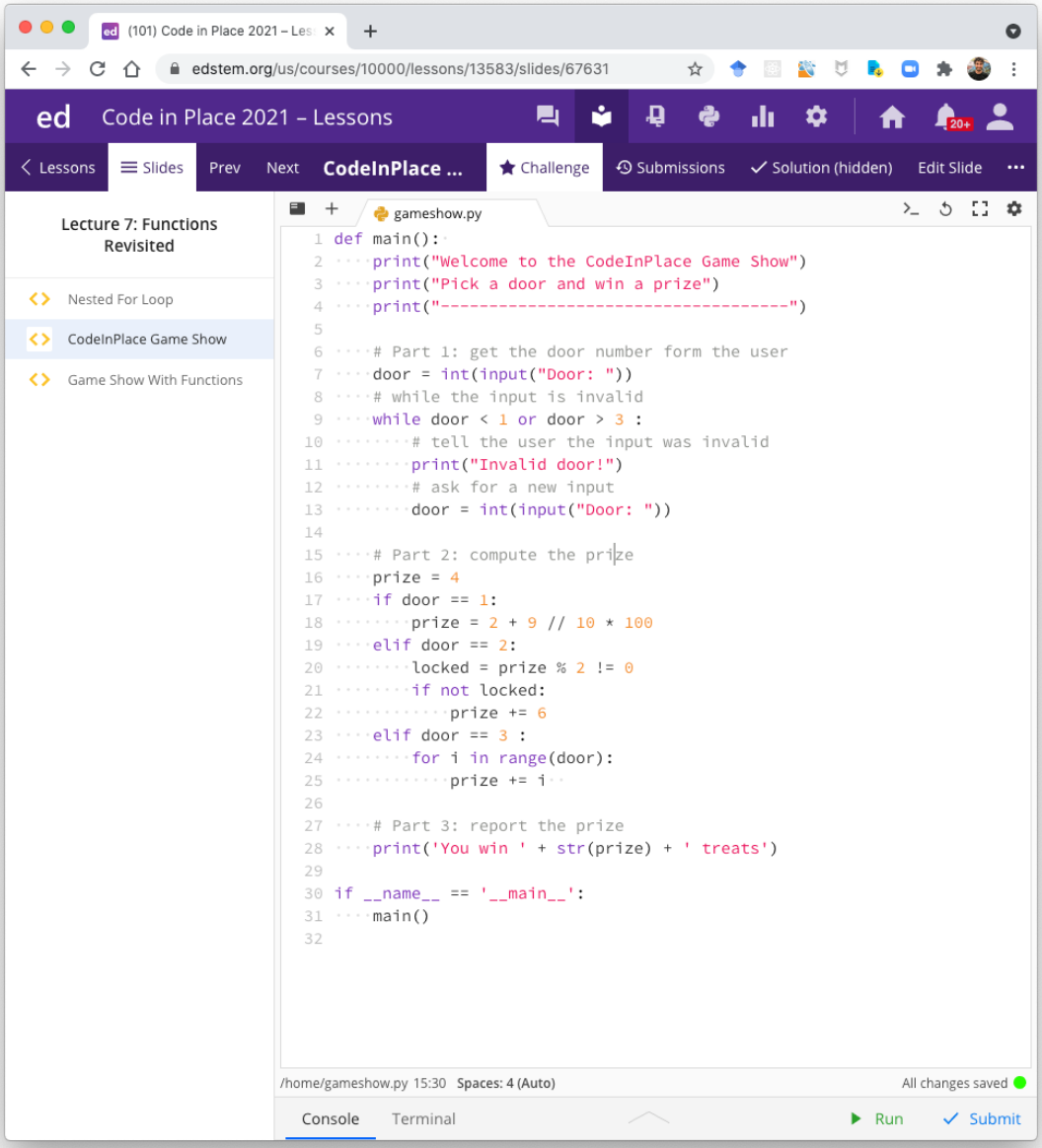
The Door Logic

```
prize = 4

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

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

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

Learn How To:

1. Write a function that takes in information
2. Write a function that gives back information

Why can't we just add functions?



Calling functions

```
turn_right()
```

```
move()
```

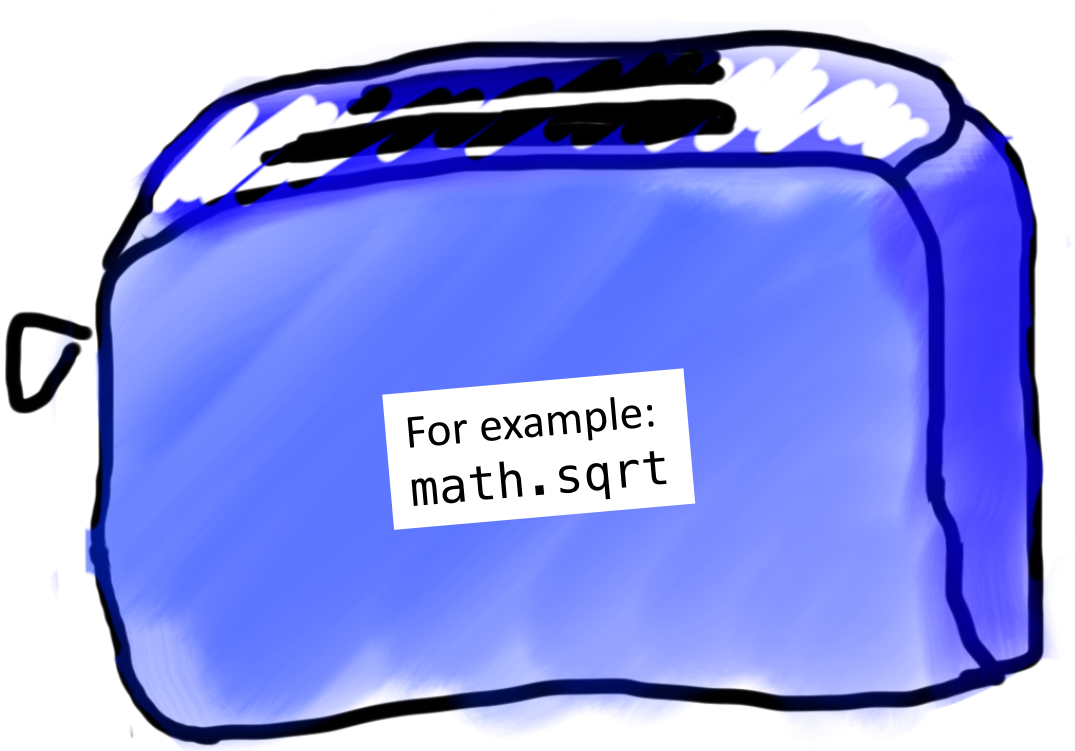
```
# gives back the text the user entered
input("string please! ")
```

```
print("hello world")
```

```
# gives back a float version
float("0.42")
```

```
# gives back the square root
math.sqrt(25)
```

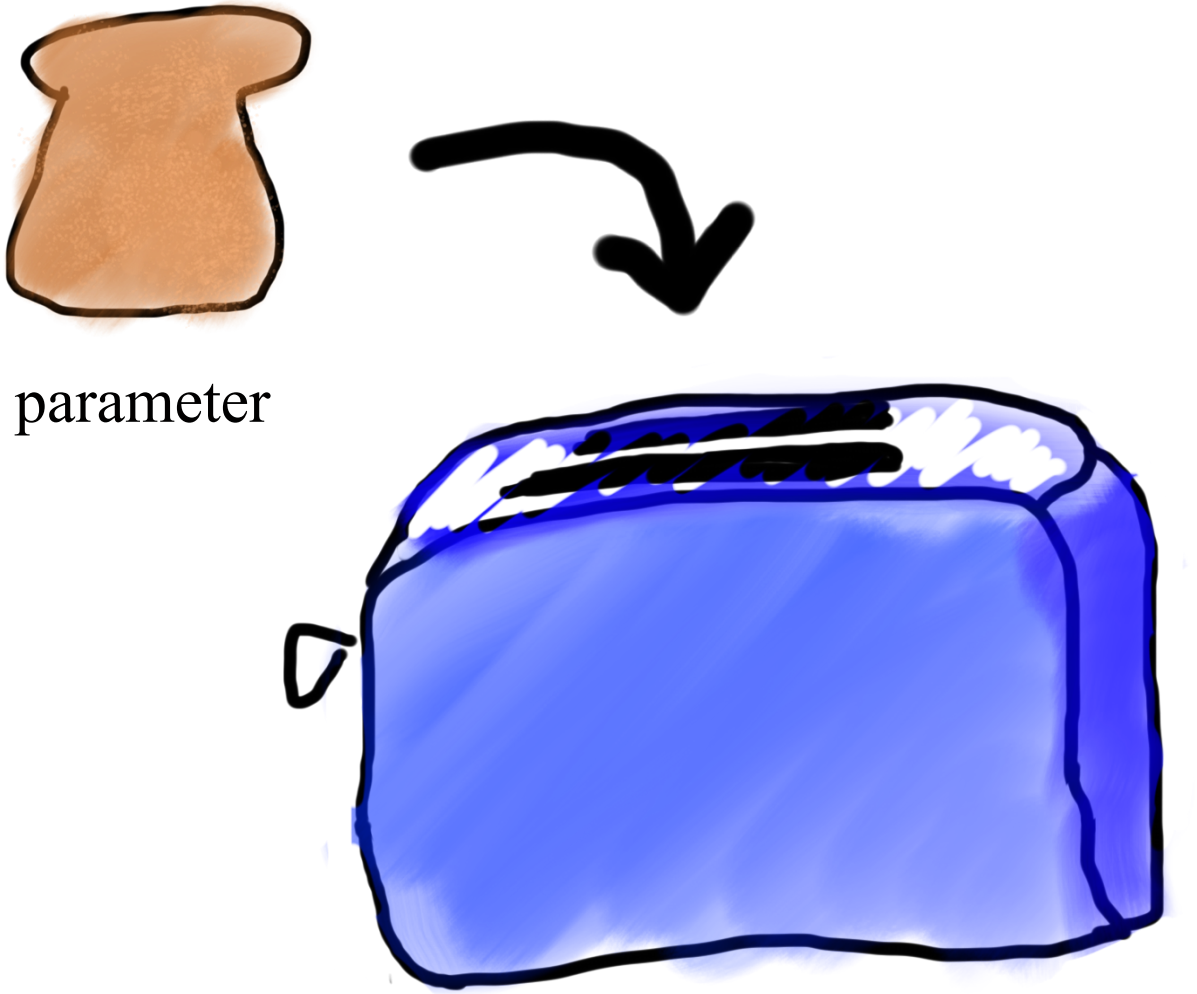

Toasters are functions



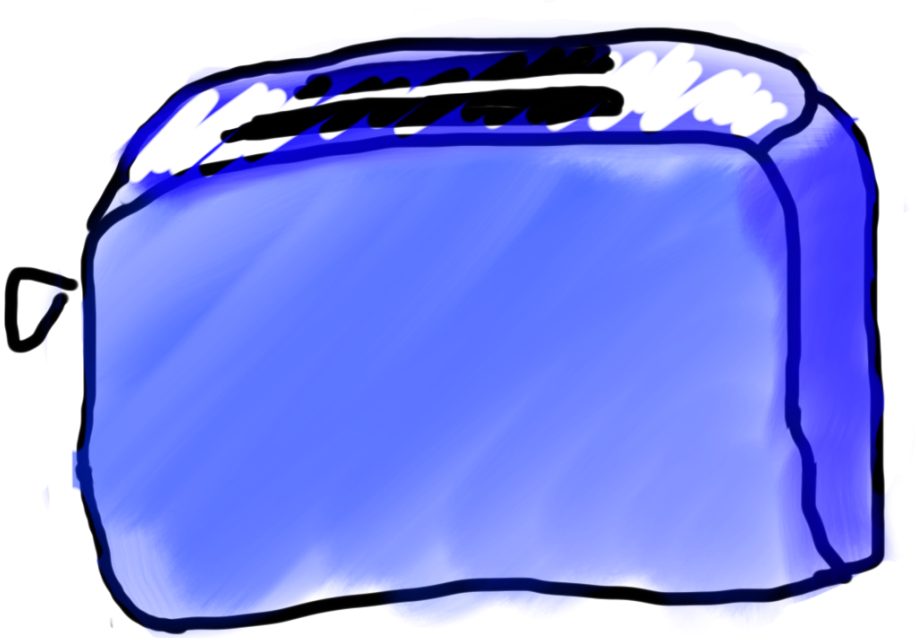
Toasters are functions

parameter

Toasters are functions



Toasters are functions



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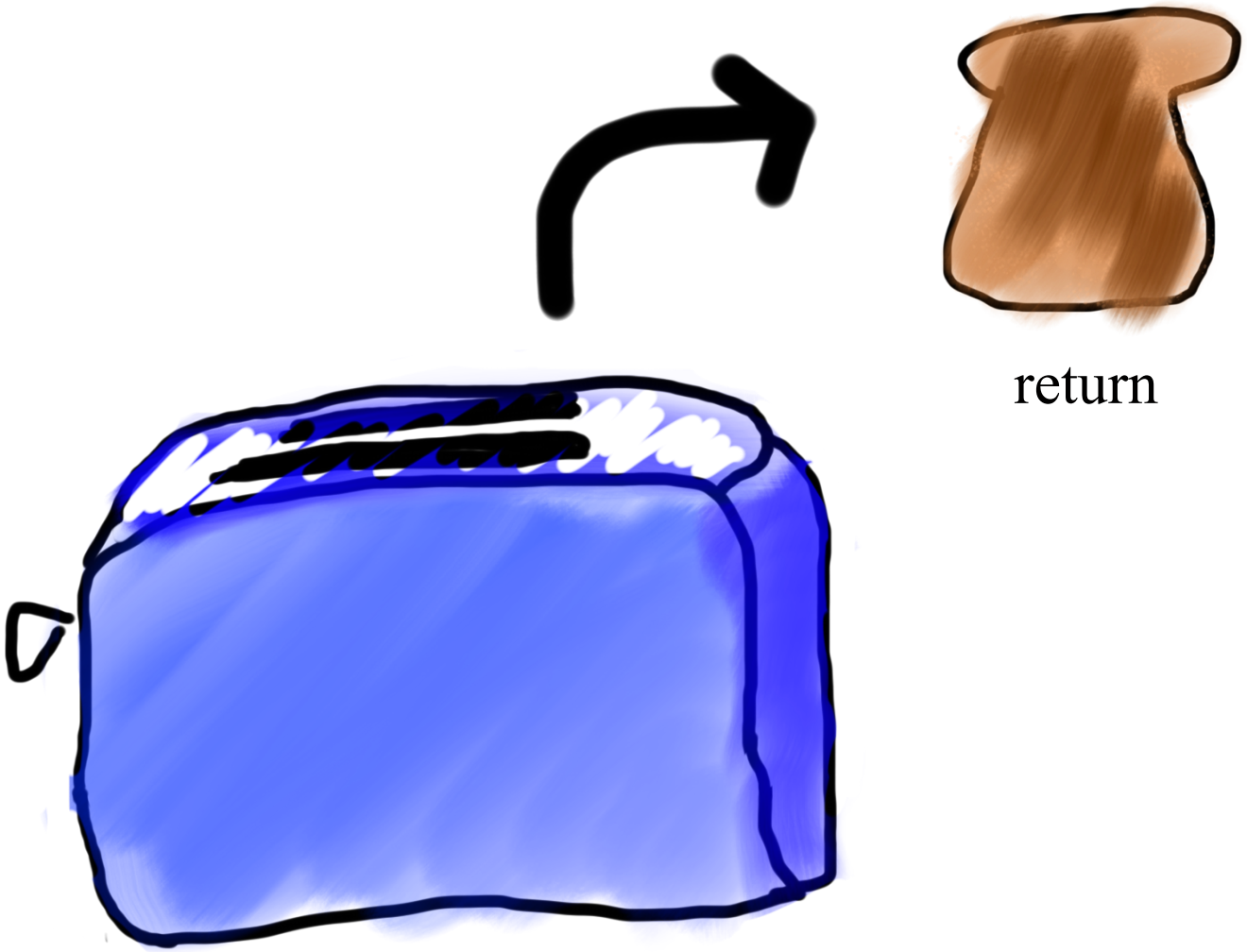
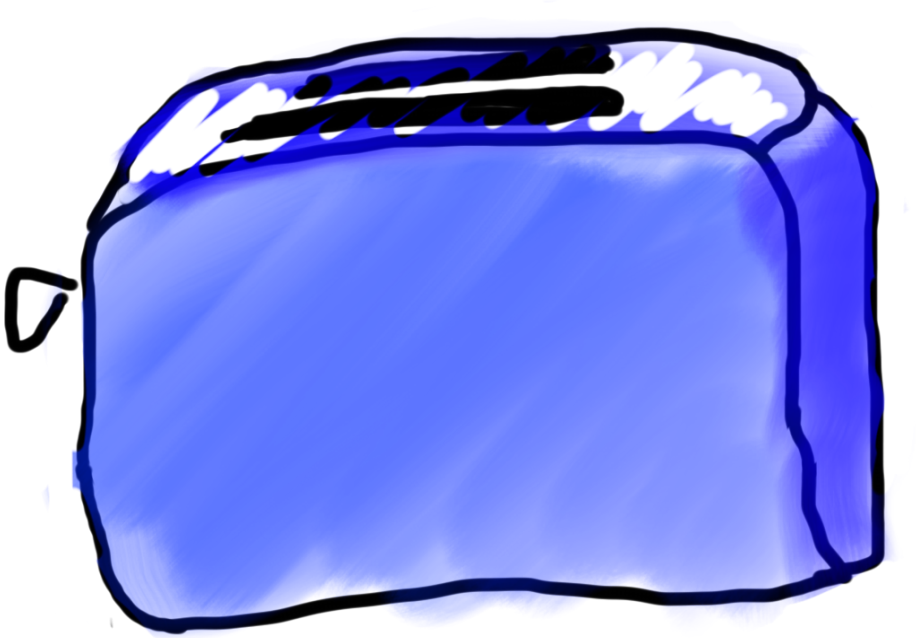
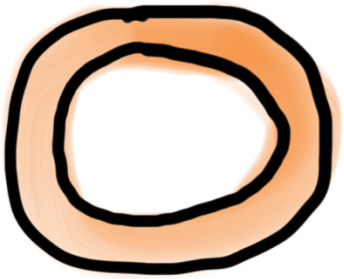


Toasters are functions

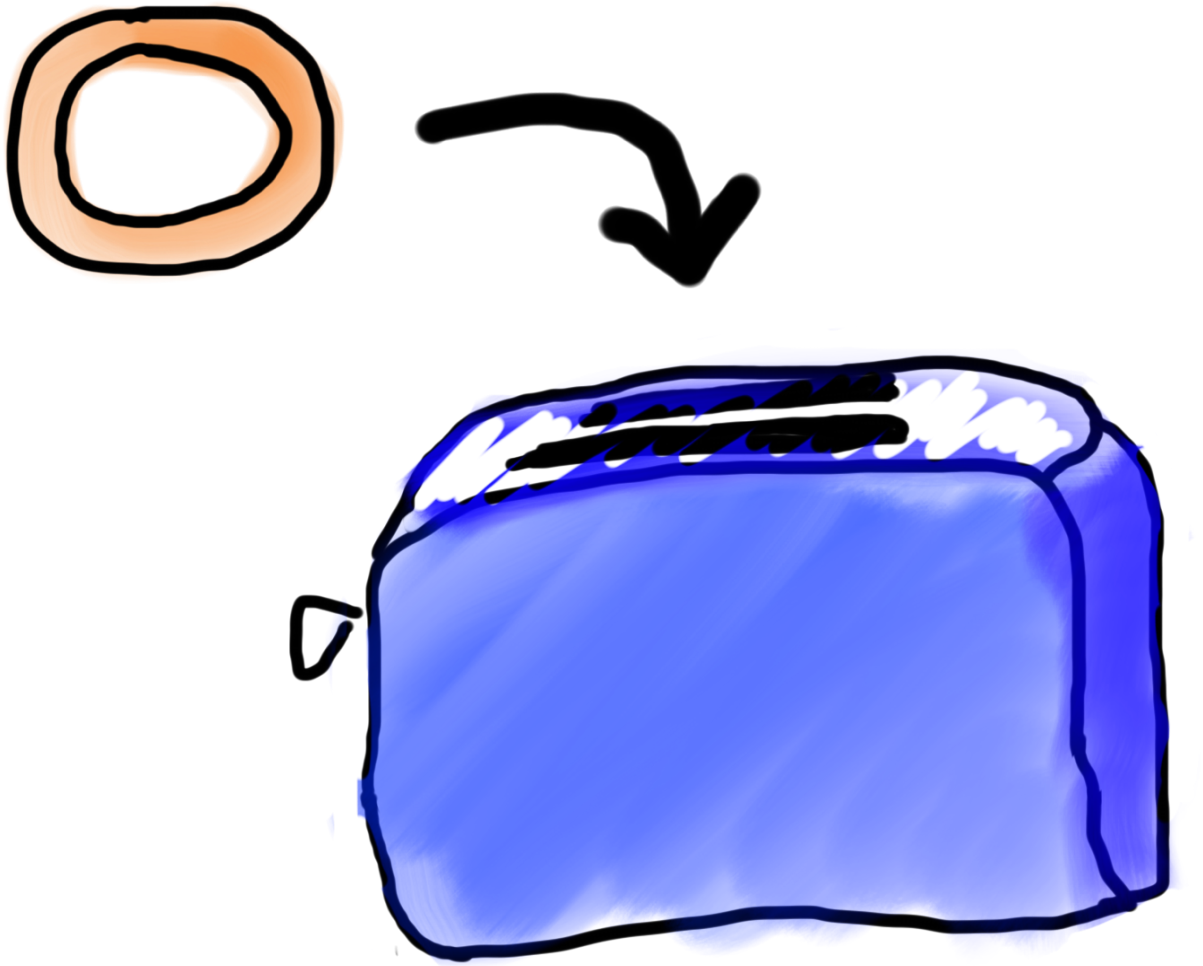


Toasters are functions

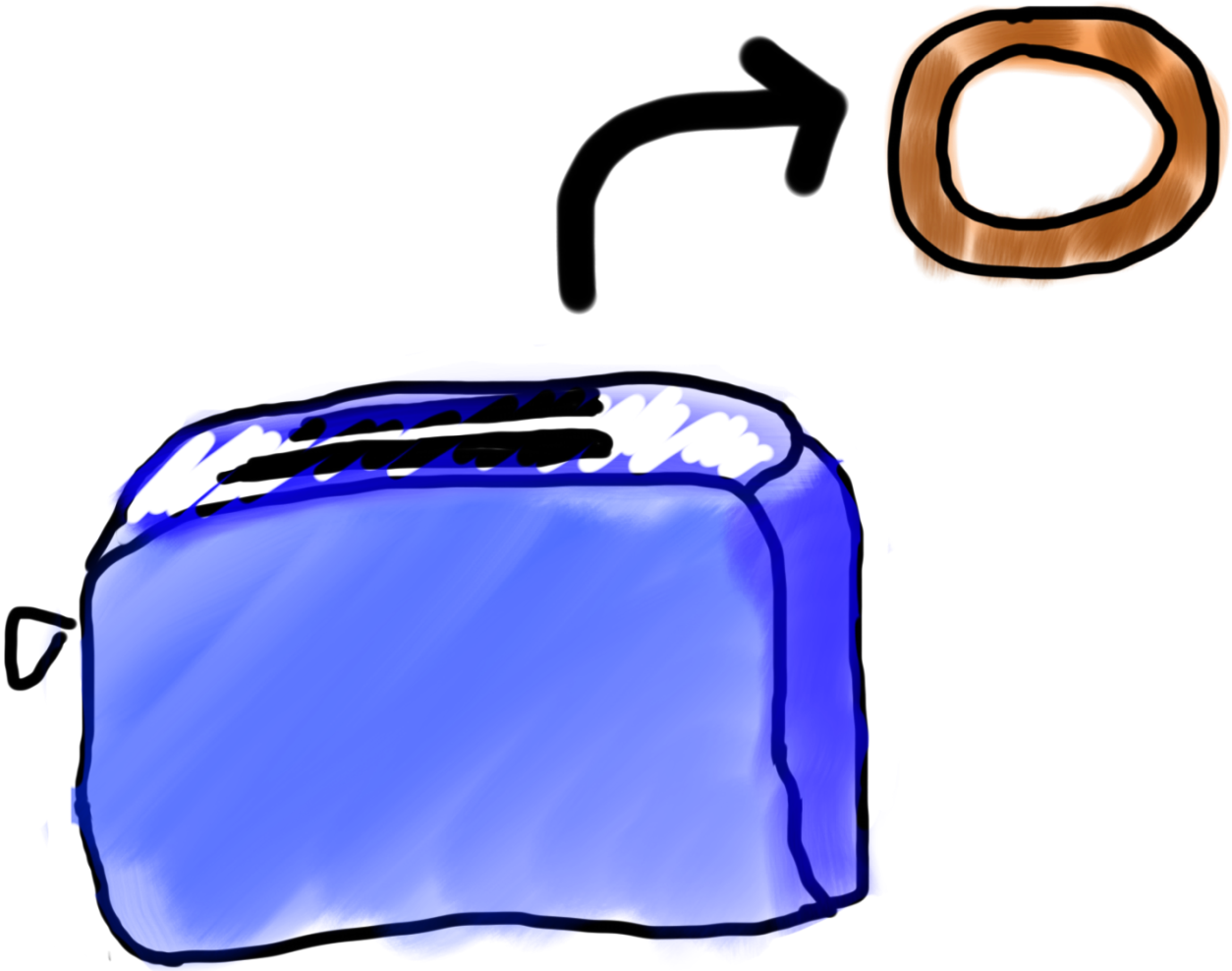


* You don’t need a second toaster if you want to toast bagels. Use the same one.

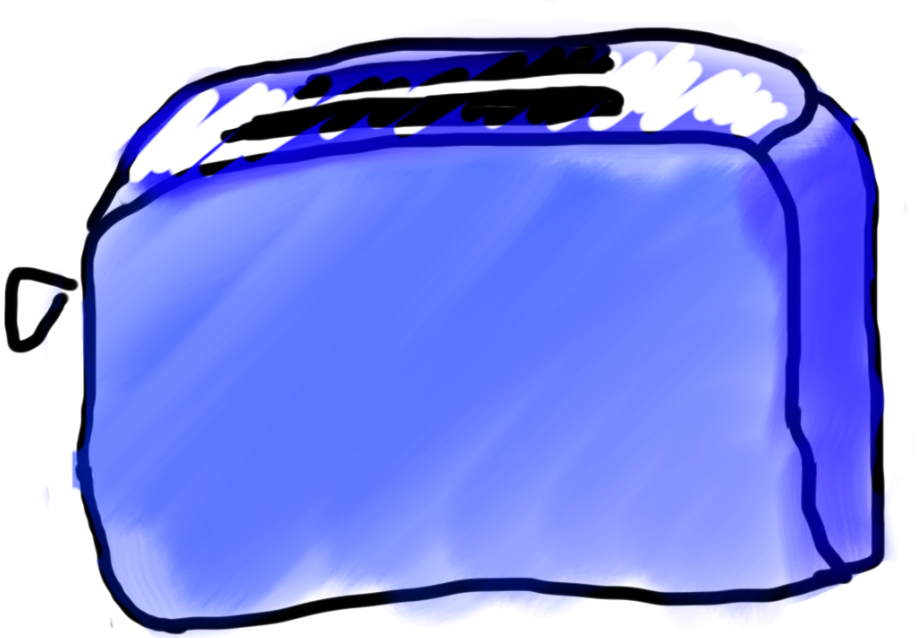
Toasters are functions



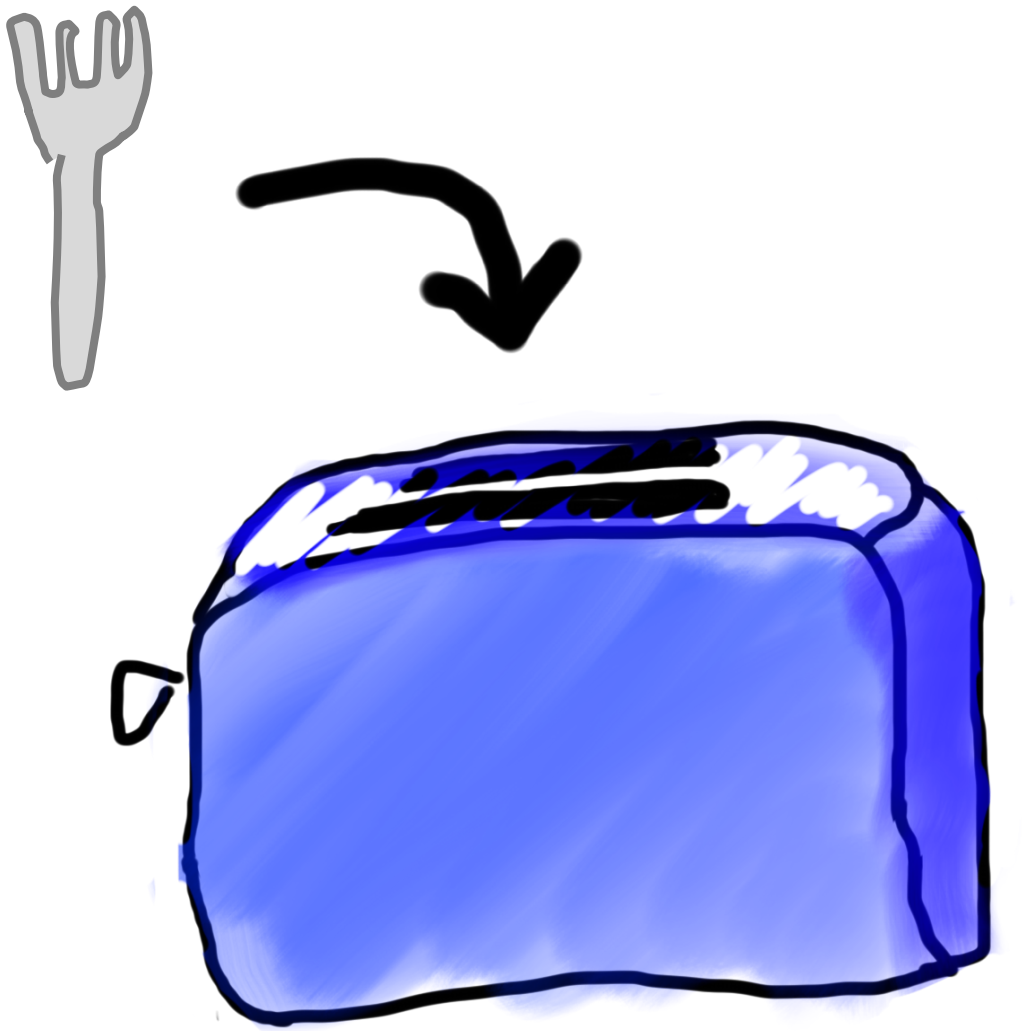
Toasters are functions



Toasters are functions



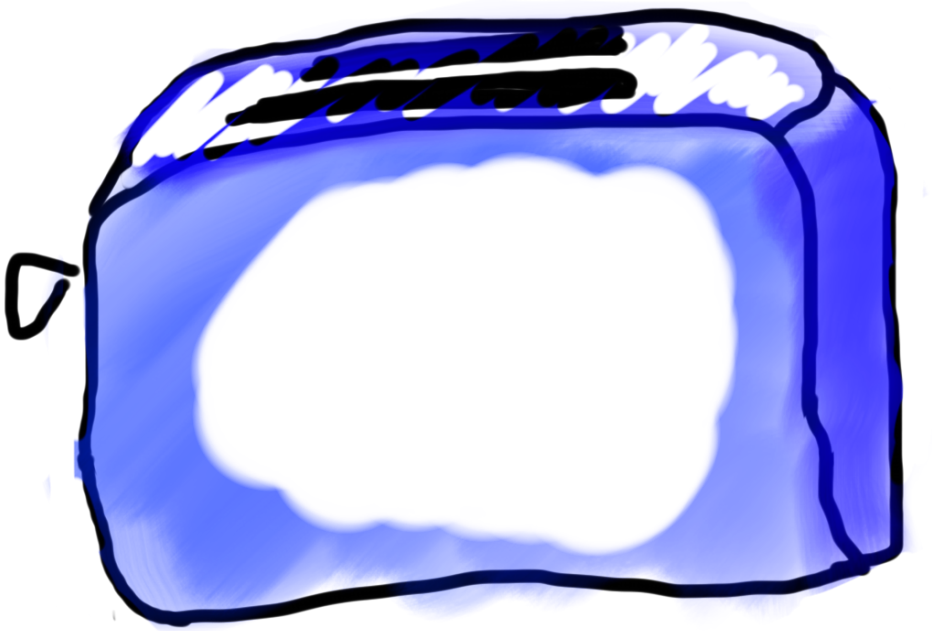
Toasters are functions



Toasters are functions

functions are Like Toasters

functions are Like Toasters



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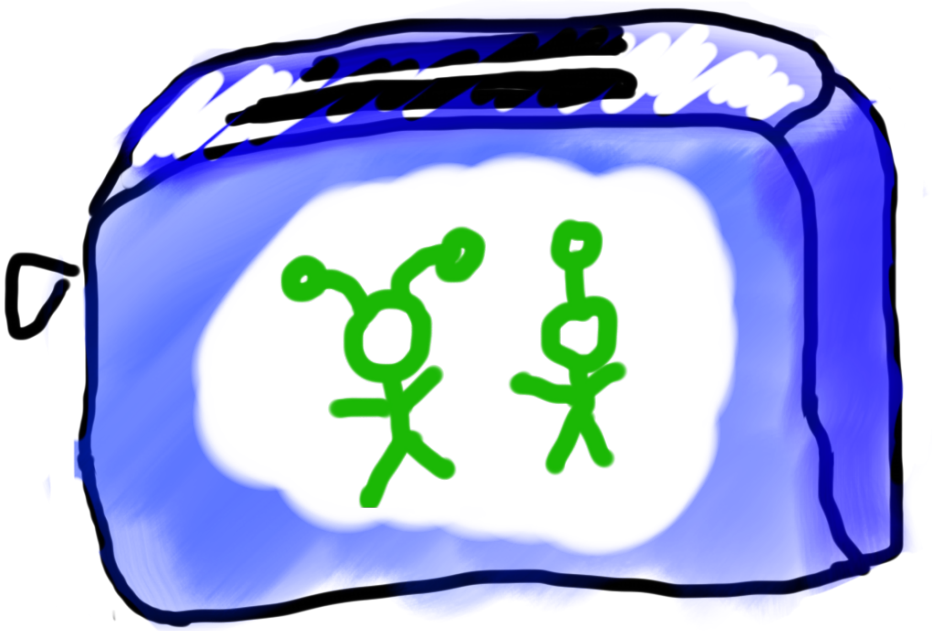

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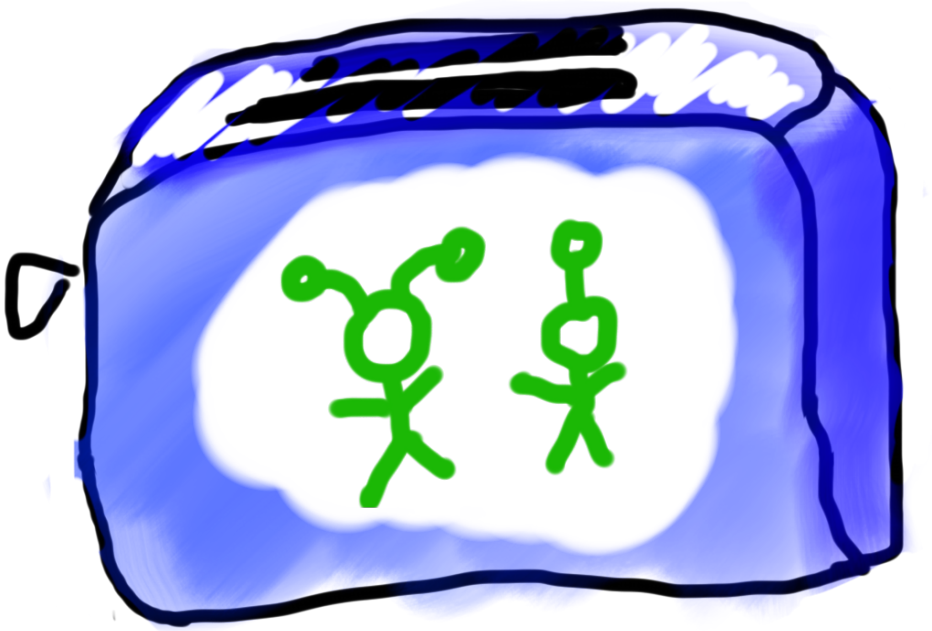

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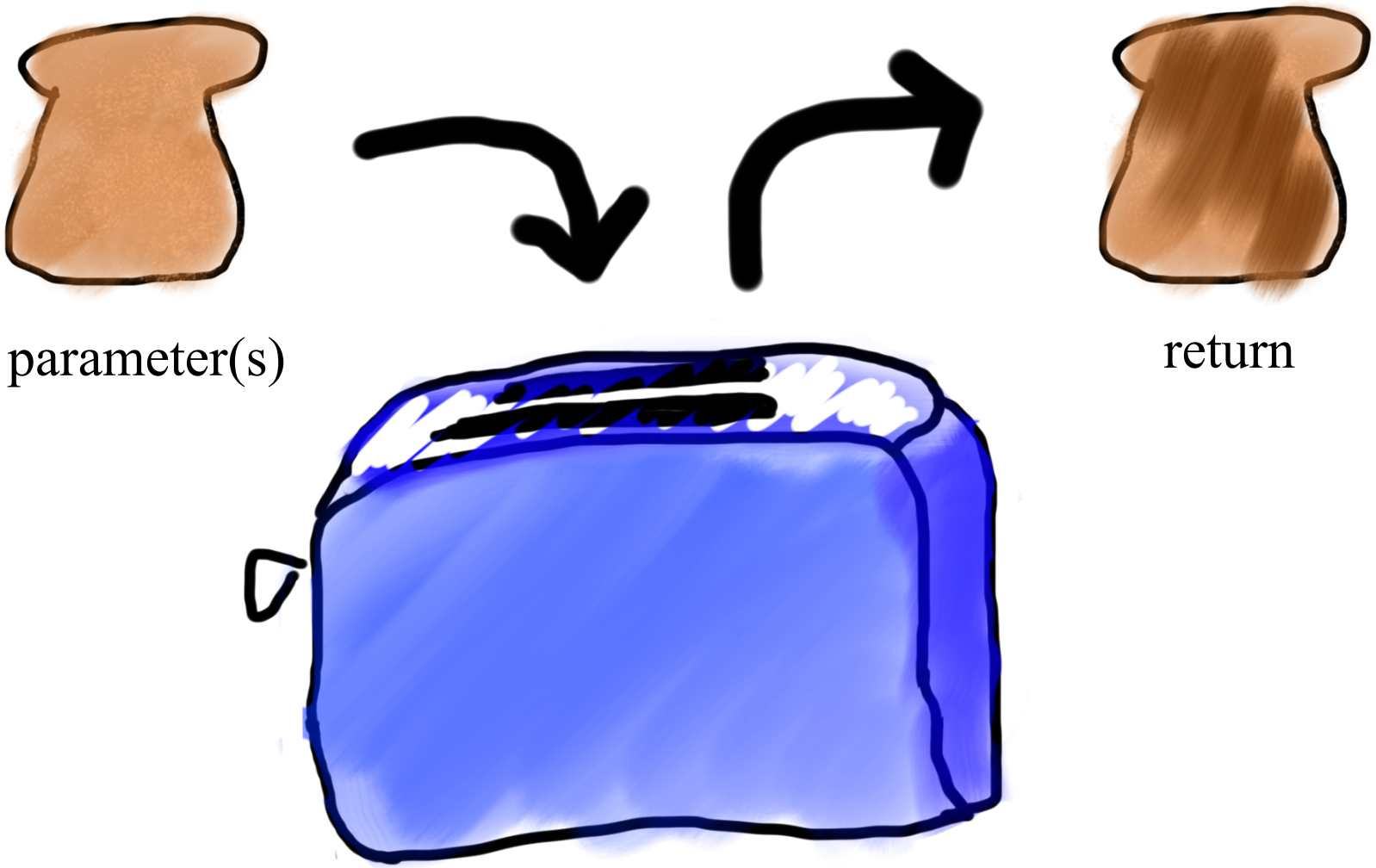
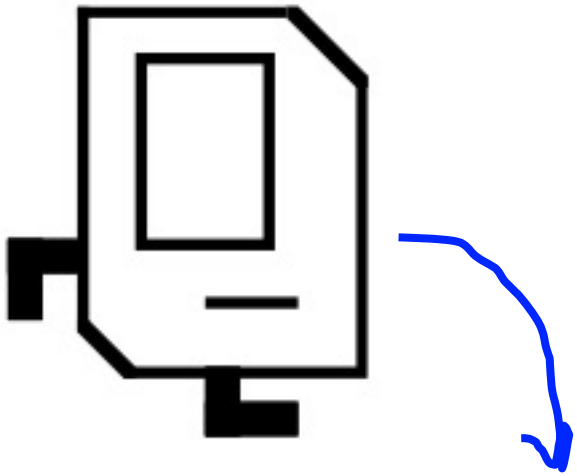


Classic Challenge for CS106A

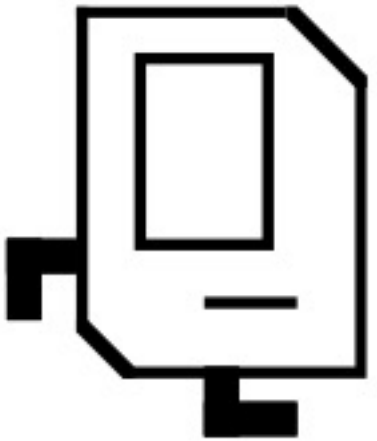
Perhaps the most underrated concept by students

Historical Aside



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**!

Intuition

Example 1

```
def woot():
    for i in range(3):
        print('woot')


def main():
    woot()
```

Example 2

```
def woot(num):
    for i in range(num):
        print('woot')


def main():
    woot(10)
```

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

Anatomy of a function

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

function caller

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

function author

Anatomy of a function

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

function "call"

function caller

function "definition"

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

function author

Anatomy of a function

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

function caller

name

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

function author

Anatomy of a function

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

information given

function caller

information expected

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

function author

Anatomy of a function

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

Arguments

function caller

Parameters

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

function author

Anatomy of a function

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

function caller

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

body

function author

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):
    sum = a + b
    return sum / 2
```

Anatomy of a function

No parameters (expects no information)

```
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)
```

When a function ends it "returns"

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

Formally

```
def name_of_function(parameters):
    statements
    # optionally at any point
    return value
```

- ***name:*** how you refer to the function
- ***parameters:*** information passed into function
- ***return***: information given back from the function

Parameters

Parameters let you provide a function some information when you are calling it.

Is returning
the same as printing?

Is returning
the same as printing?

NO

Anatomy of a function

Function caller

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

Function author

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

Function author's contract - average:

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

User

Uses the terminal (later UI)

Function Caller (Coder)

Uses helper functions

Function Author (Coder)

Writes helper functions others can use

User

Uses the terminal (later UI)

Function Caller (Coder)

Uses helper functions

Function Author (Coder)

Writes helper functions others can use

Learn by Example

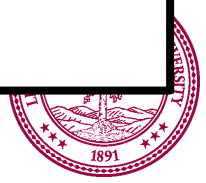
No Parameter, No Return

```
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

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```

user

terminal

```
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```
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caller

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> python intro.py
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```

user

terminal

```
> python intro.py
Welcome to class
It’s the best part of my day
```

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

caller

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

```
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

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

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

Parameter Example

main memory

No variables

terminal

> python opinion.py

```
def print_opinion(num):
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    else :
        print("Whattever")


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

Parameter Example

main memory

No variables

print_opinion memory

terminal

```
> python opinion.py
```

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

Parameter Example

main memory

No variables

print_opinion memory

num

terminal

> python opinion.py

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


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


Parameter Example

main memory

No variables

print_opinion memory

num **5**

terminal

> python opinion.py

```
def print_opinion(num):
    if(num == 5):
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Parameter Example

main memory

No variables

print_opinion memory

num 5

terminal

> python opinion.py

```
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    if(num == 5):
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def main():
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Parameter Example

main memory

No variables

print_opinion memory

num | 5

terminal

```
> python opinion.py
I love 5!
```

```
def print_opinion(num):
    if(num == 5):
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def main():
    print_opinion(5)
```


Parameter Example

main memory

No variables

print_opinion memory

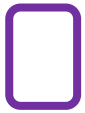
num 5

terminal

```
> python opinion.py
I love 5!
```

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

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



Parameter Example

main memory

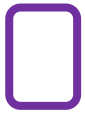
No variables

terminal

```
> python opinion.py
I love 5!
```

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


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



Parameter Example

main memory

No variables

terminal

```
> python opinion.py
I love 5!
```

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


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

Parameter Example

main memory

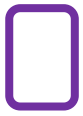
No variables

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


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

terminal

```
> python opinion.py
I love 5!
```



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

No variables

terminal

```
> python m2cm.py
```

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


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

Parameter and Return Example

main memory

No variables

```
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

No variables

meteresToCm memory

terminal

```
> python m2cm.py
```

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


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

Parameter and Return Example

main memory

No variables

meteresToCm memory

meters 5.2

terminal

```
> python m2cm.py
```

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


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

Parameter and Return Example

main memory

No variables

meteresToCm memory

meters | 5.2

terminal

> python m2cm.py

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

520.0

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


Parameter and Return Example

main memory

No variables

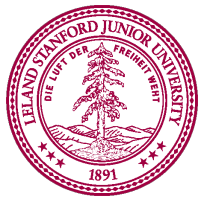
terminal

```
> python m2cm.py
```

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


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

520.0



Parameter and Return Example

main memory

terminal

```
> python m2cm.py
```

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



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

520.0

Parameter and Return Example

main memory

result | 520.0

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 * meters


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

This is our favorite paradigm (fn author returns, fn caller print).
It's the most flexible, modular. Its elegance is unparalleled.

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))
    print(meters_to_cm(9.1))
```

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
```

```
# 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 receives value on the console

Is returning
the same as printing?

Is returning
the same as printing?

NO

Is “input”
the same as parameters?

Is “input”
the same as parameters?

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

main memory

No variables

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

    return num2


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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

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

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> python maxmax.py
```

Multiple Return Statements

main memory

No variables

```
def max(num1, num2):
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def main():
    larger = max(5, 1)
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terminal

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> python maxmax.py
```


Multiple Return Statements

main memory

No variables

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

    return num2



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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

max memory

num1 num2

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

    return num2


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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

max memory

num1 **5**

num2

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

    return num2



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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

max memory

num1 **5**

num2 **1**

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

    return num2



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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

max memory

num1 | 5 | num2 | 1

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

    return num2


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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

max memory

num1 | 5

num2 | 1

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

    return num2



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

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory

No variables

max memory

num1 | 5 | num2 | 1

```
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

No variables

max memory

num1 | 5 | num2 | 1

```
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

No variables

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

    return num2


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

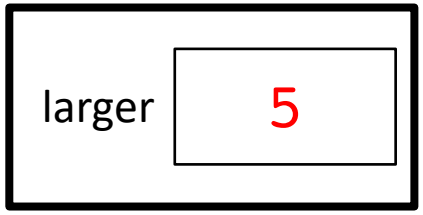
5

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory




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

    return num2


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

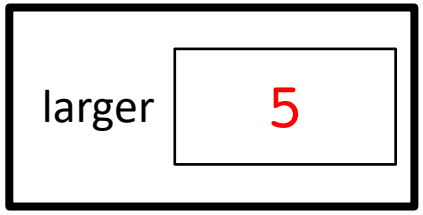
5

terminal

```
> python maxmax.py
```

Multiple Return Statements

main memory




```
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    return num2



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

terminal

```
> python maxmax.py
```

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)
```


Multiple Return Statements

main memory

No variables

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

    return num2
```

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


Multiple Return Statements

main memory

No variables

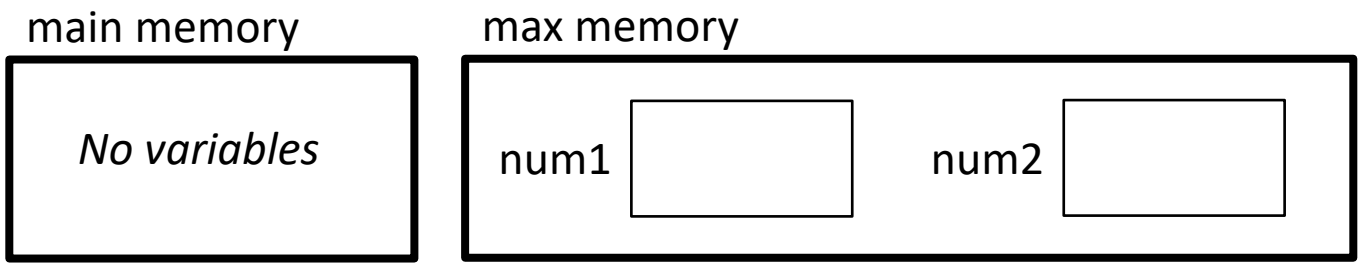
```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2



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


Multiple Return Statements



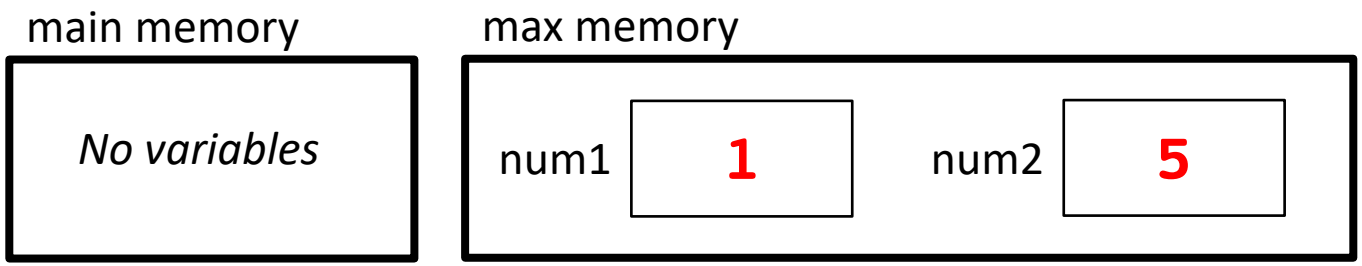

```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2



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

Multiple Return Statements




```
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    return num2



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```
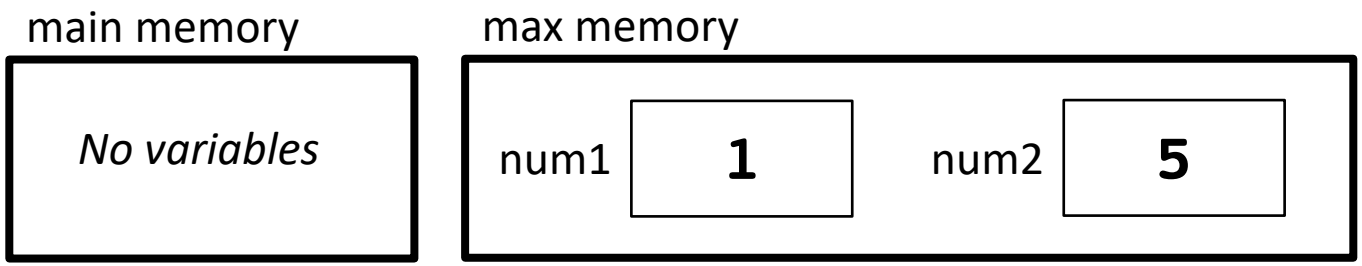

Multiple Return Statements




```
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    return num2


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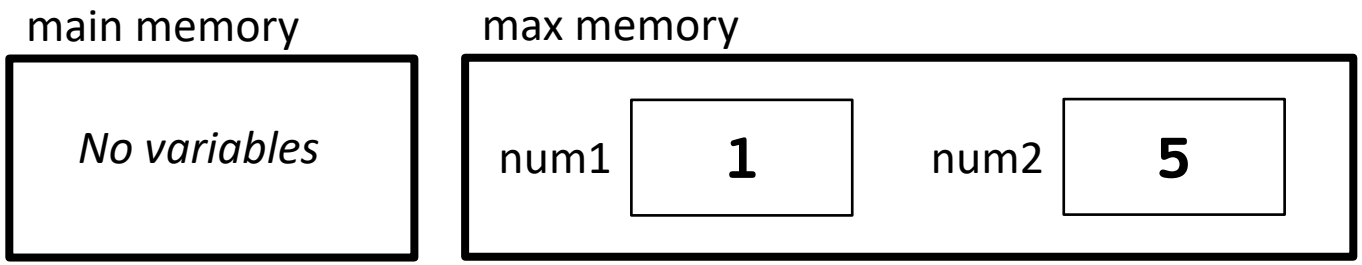

Multiple Return Statements




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

    return num2
```

5

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

Multiple Return Statements

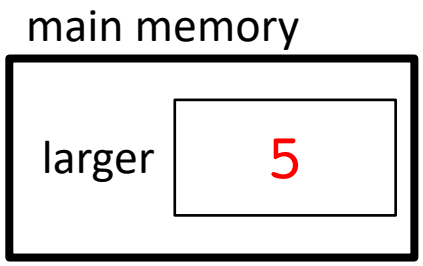
main memory

No variables

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

    return num2



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

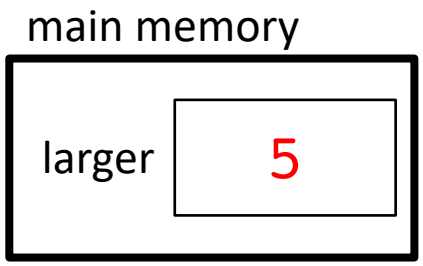
5

Multiple Return Statements



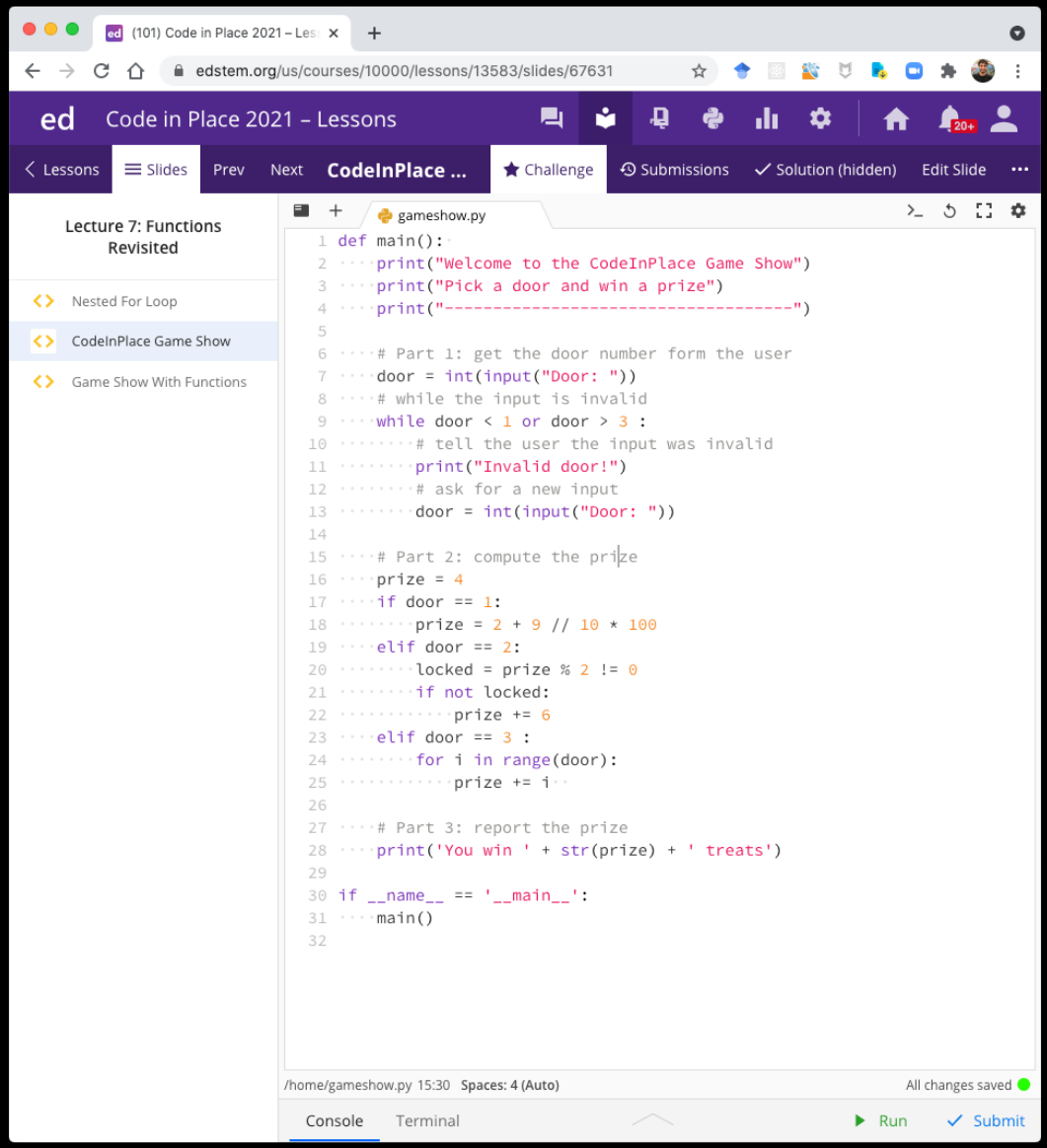

```
def max(num1, num2):
    if num1 >= num2:
        return num1

    return num2



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

Multiple Return Statements




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

    return num2



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

Fix this program



Piech + Sahami, CS106A, Stanford University