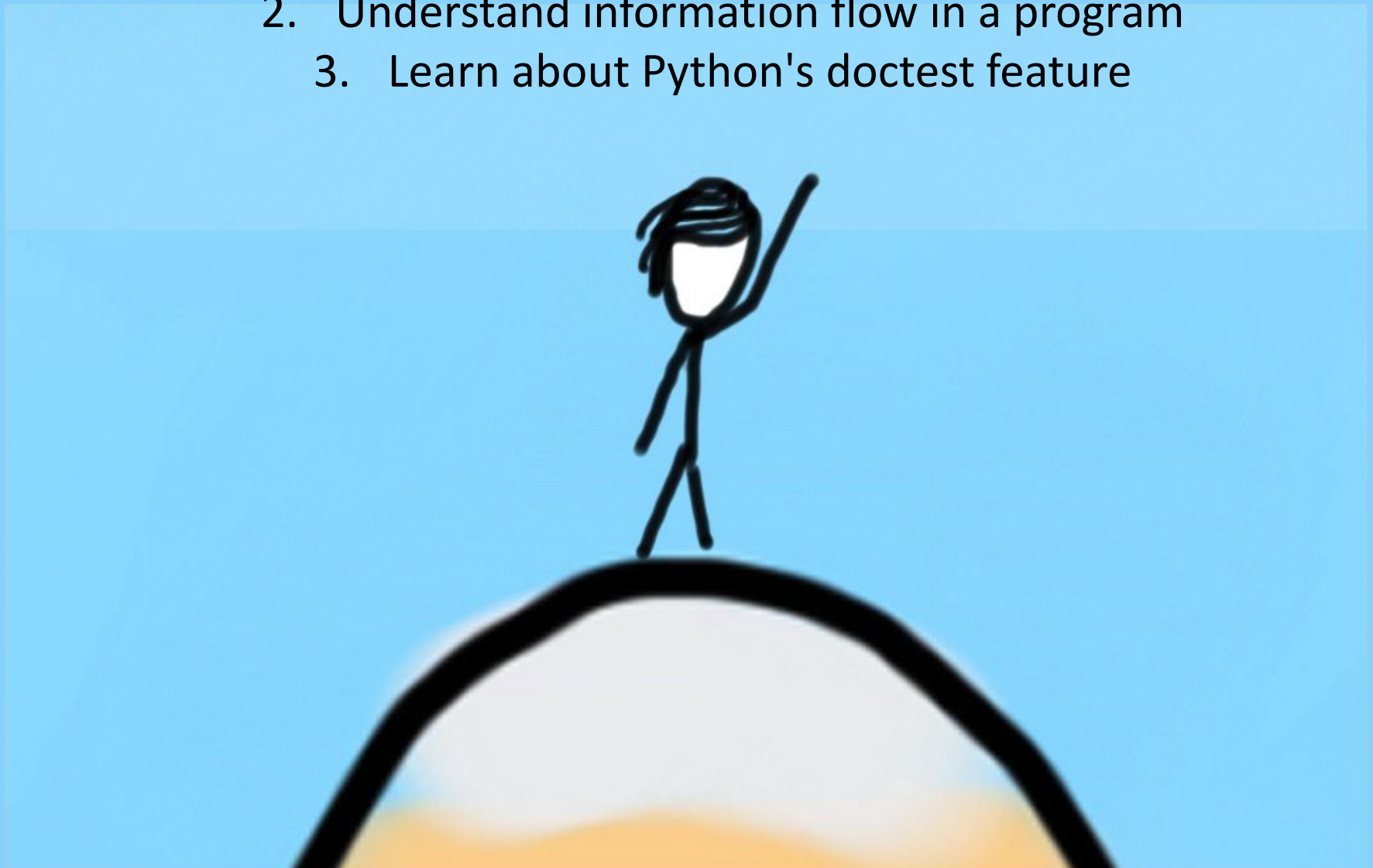
Learning Goals

1. Get more practice with function parameters
2. Understand information flow in a program
3. Learn about Python's doctest feature



Recall, Our Friend the Function

function "call"

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

function "definition"

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

Recall, Our Friend the Function

arguments

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

parameters

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

Parameters

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

A Full Program

```
# Constant - visible to all functions
MAX_NUM = 4


def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))



def factorial(n):
    result = 1
    for i in range(1, n + 1):
        result *= i

    return result
```

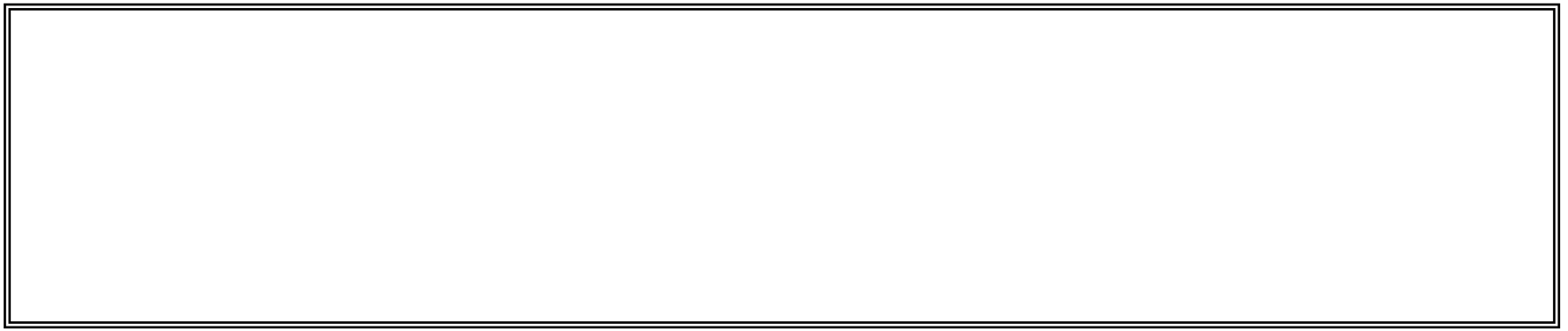
A Full Program

```
# Constant - visible to all functions
MAX_NUM = 4


def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))



def factorial(n):
    result = 1
    for i in range(1, n + 1):
        result *= i

    return result
```

Understand the mechanism

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i 



```
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```

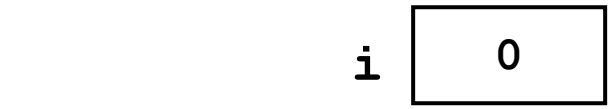

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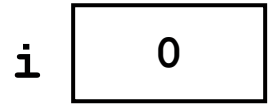

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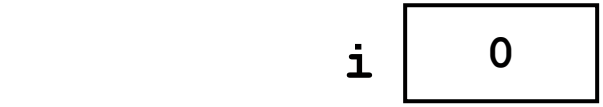

```
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```
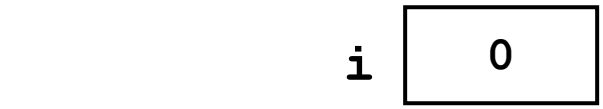
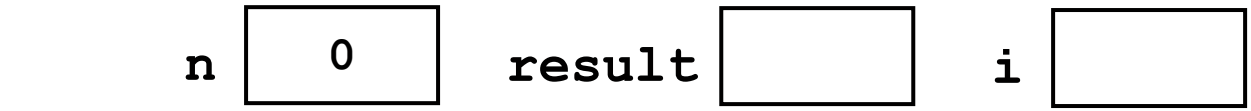



```
def factorial(n):
    result = 1
    for i in range(1, n + 1):
        result *= i

    return result
```



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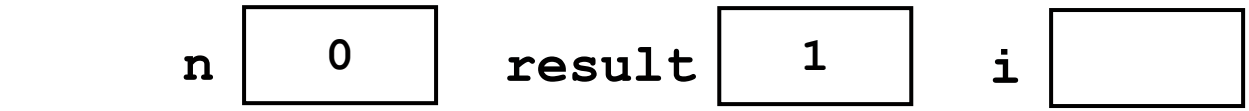

```
def factorial(n):
    result = 1
    for i in range(1, n + 1):
        result *= i

    return result
```

n	0	result	1	i	1

```
def factorial(n):
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    return result
```

n | 0 | result | 1 | i | 1

```
def factorial(n):
    result = 1
    for i in range(1, n + 1):
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    return result
```

n	0	result	1	i	1

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

1

i 0

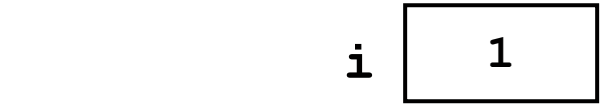
```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

1

i | 0

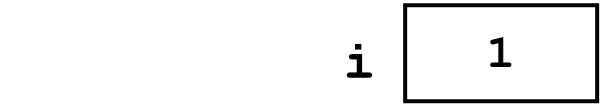
```
0   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```




```
0  1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```




```
0   1
```

```
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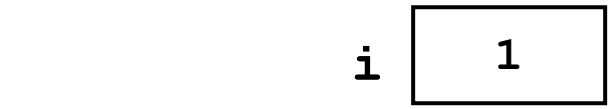
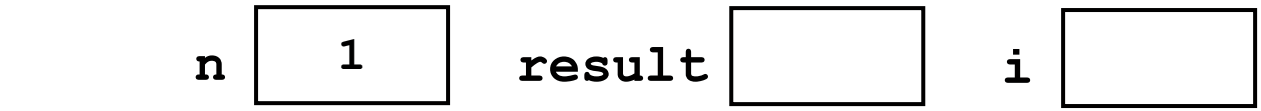



```
0   1
```

```
def factorial(n):
    result = 1
    for i in range(1, n + 1):
        result *= i

    return result
```




```
0  1
```

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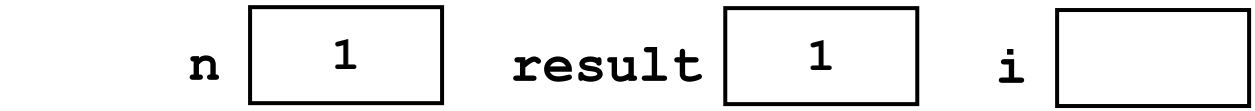


```
0   1
```

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```

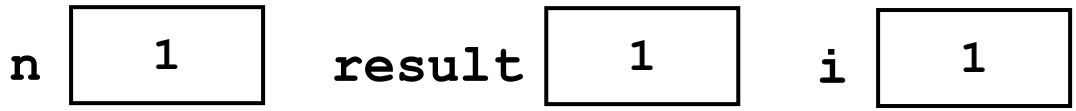


```
0   1
```

```
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```

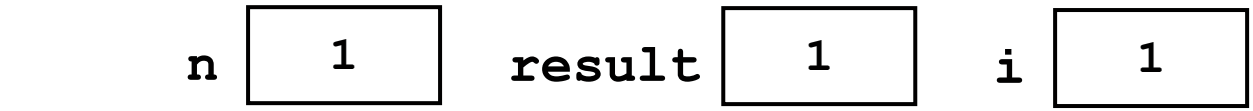


```
0   1
```

```
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    for i in range(1, n + 1):
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    return result
```

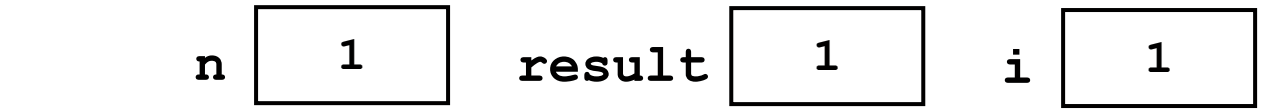


```
0  1
```

```
def factorial(n):
    result = 1
    for i in range(1, n + 1):
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    return result
```
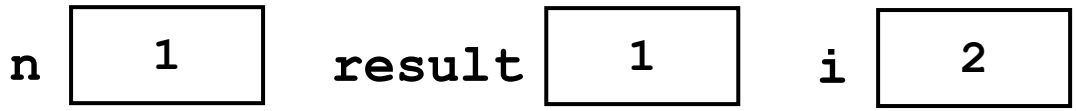
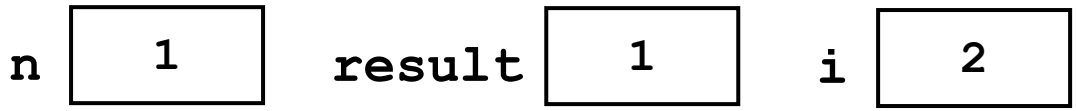




```
0   1
```

```
def factorial(n):
    result = 1
    for i in range(1, n + 1):
        result *= i

    return result
```




```
0   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

1

i 1

```
0  1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

1

i 1

```
0   1
1   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 2

```
0   1
1   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 2

```
0   1
1   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 2

```
0   1
1   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 2

```
0   1
1   1
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

2

i 2

```
0   1
1   1
```

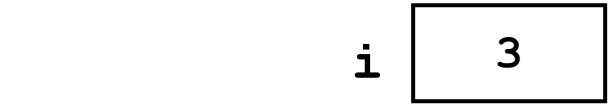
```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

2

i 2

```
0   1
1   1
2   2
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```




```
0   1
1   1
2   2
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i 3

```
0  1
1  1
2  2
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 3

```
0   1
1   1
2   2
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i 3

```
0   1
1   1
2   2
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

6

i 3

```
0   1
1   1
2   2
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

6

i 3

```
0   1
1   1
2   2
3   6
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 4

```
0   1
1   1
2   2
3   6
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 4

```
0   1
1   1
2   2
3   6
```

```
def main():
    for i in range(MAX_NUM):
        print(i, factorial(i))
```

i | 4

Done!

```
0   1
1   1
2   2
3   6
```

Parameters

Every time a function is called, new memory is created for that call.

Parameter values are passed in.

All *local* variables start fresh (no old values)

An interlude: doctest

Doctest

```
def factorial(n):
    """
    This function returns the factorial of n
    Input: n (number to compute the factorial of)
    Returns: value of n factorial
    Doctests:
    >>> factorial(3)
    6
    >>> factorial(1)
    1
    >>> factorial(0)
    1
    """
    result = 1
    for i in range(1, n + 1):
        result *= i
    return result
```

Doctest

```
def factorial(n):
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    This function returns the factorial of n
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    >>> factorial(3)
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    >>> factorial(1)
    1
    >>> factorial(0)
    1
    """
    result = 1
    for i in range(1, n + 1):
        result *= i
    return result
```

Say this was in file "fact.py"
To run doctests (on PC):

```
> py -m doctest fact.py -v
```

Testing: *Why* doesn't your program work?

Let's try it!!

Bad Times With functions

```
# NOTE: This program is buggy!!

def add_five(x):
    x += 5



def main():
    x = 3
    add_five(x)
    print("x = " + str(x))
```

Let's "trace" this program

Bad Times With functions

```
# NOTE: This program is buggy!!

def add_five(x):
    x += 5



def main():
    x = 3
    add_five(x)
    print("x = " + str(x))
```

Good Times With functions

```
# NOTE: This program is feeling just fine...

def add_five(x):
    x += 5
    return x


def main():
    x = 3
    x = add_five(x)
    print("x = " + str(x))
```

Good Times With functions

```
# NOTE: This program is feeling just fine...

def add_five(x):
    x += 5
    return x


def main():
    x = 3
    x = add_five(x)
    print("x = " + str(x))
```

When we want to "reassign" x inside a helper function, employ the `x = change(x)` pattern!

Parameter passing mechanism

When a parameter is passed during a function call, a **new variable** is created for the lifetime of the function call.

That new variable may or may not have the **same name** as the value that was passed in!

No inherent connection between these two

```
# NOTE: This program is buggy!!

def add_five(x):
    x += 5

def main():
    x = 3
    add_five(x)
    print("x = " + str(x))
```

These are two separate variables. They are not linked!

Only relationship: value of main's x is used when creating add_five's x

Later on in class… we will see cases where changes to variables in helper functions seem to persist! It will be great. We will let you know when we get there and exactly when that happens!

Careful!

No Functions in Functions

```
def main():
    print("hello world")
    def say_goodbye():
        print("goodbye!")
```

Technically legal, but often a sign at the start that you are confusing function *definition* and function *call*

No functions in functions

```
def main():
    print("hello world")
    say_goodbye()


def say_goodbye():
    print("goodbye!")
```

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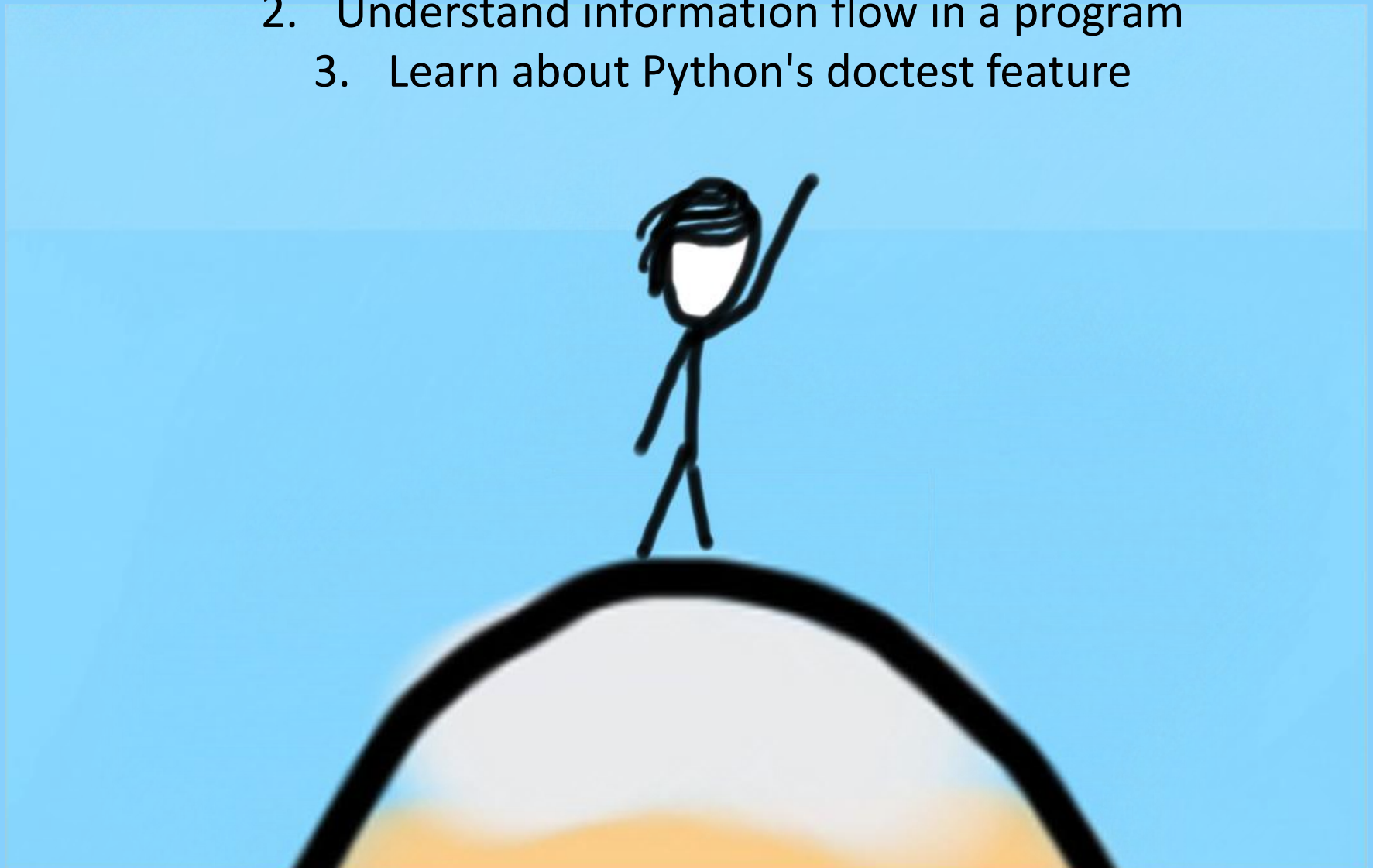

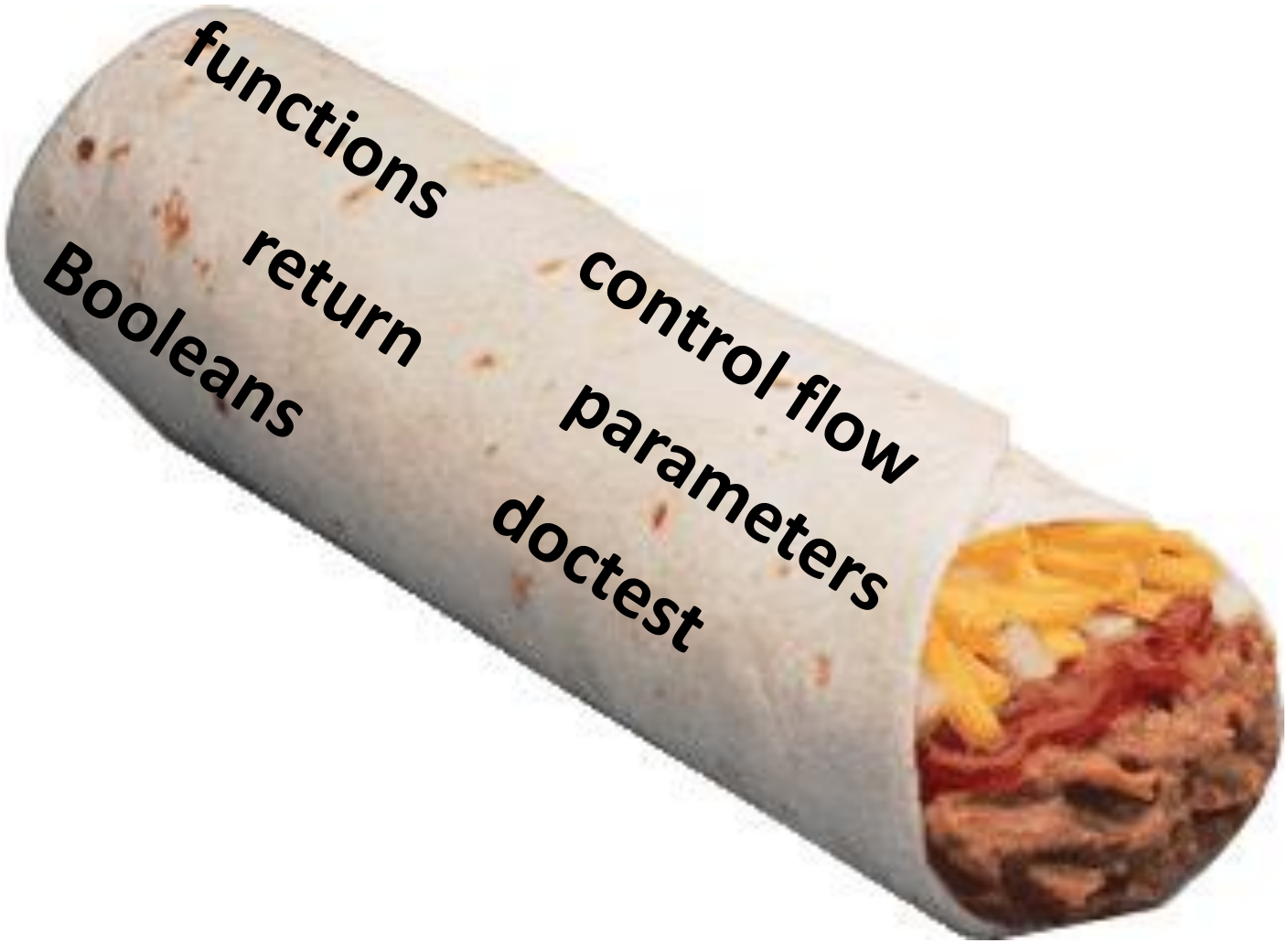
functions
return
Booleans
control flow
parameters
doctest

The Whole Burrito: calendar.py