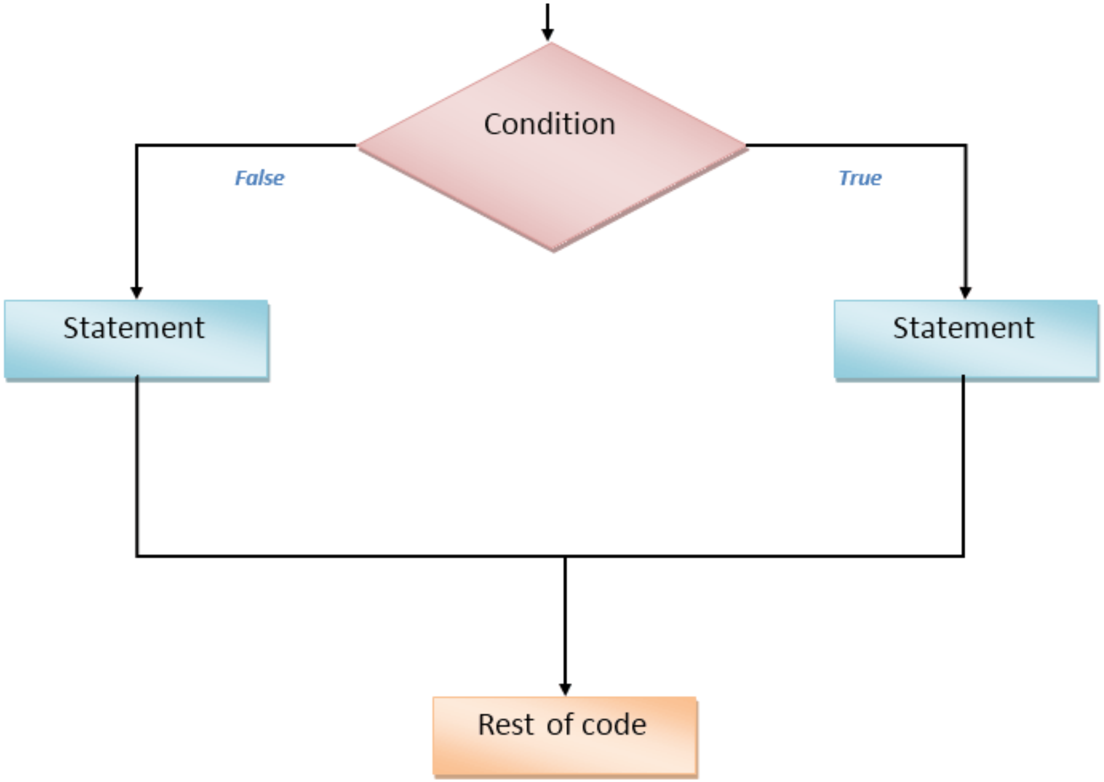
15-112
Fundamentals of Programming

Lecture 2:
Basic Building Blocks of Programming Continued



May 17, 2016

Basic Building Blocks

Statements

Tells the computer to do something. An instruction.

Data Types

Data is divided into different types.

Variables

Allows you to store data and access stored data.

Operators

Allows you to manipulate data.

Functions

Programs are structured using functions.

Conditional Statements

Executes statements if a condition is satisfied.

Loops

Execute a block of code multiple times.

One the menu today:

More on operators

More on functions

Conditional statements

Practice problem(s)

More on operators

More on operators

Arithmetic operators: `+` `-` `*` `/` `//` `**` `%`

Assignment operators: `+=` `-=` `*=` `/=` `//=` `%=`

Comparison operators: `==` `!=` `<` `<=` `>` `>=`

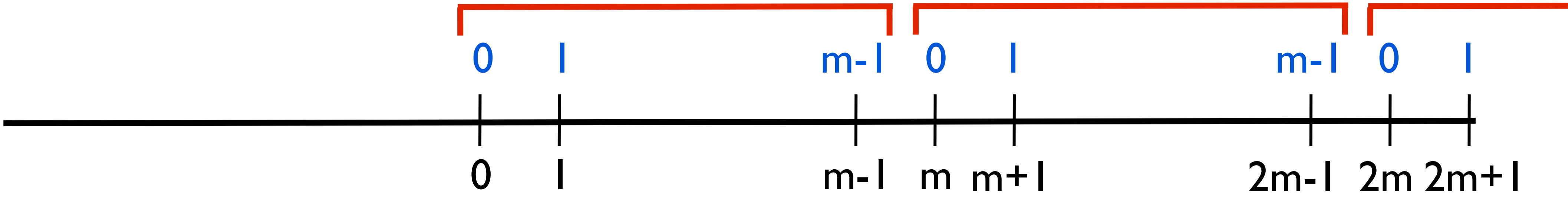
(takes two numerical values and produces bool value)

Boolean operators: `not` `or` `and`

More on operators

%   Modulo operator

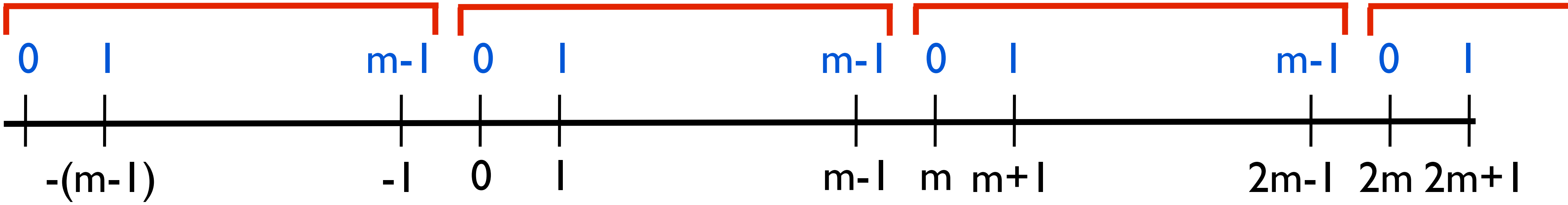
n % m   means   n mod m



More on operators

`%` Modulo operator

n % m means n mod m



When n is positive: n%m is the remainder when n is divided by m

When n is negative: add multiples of m to n until you are between 0 and m-1

More on operators

`%` Modulo operator

n % m means n mod m

A couple of useful things you can do:

n % 1	the fractional part of n
n % 2	parity of n

More on operators

Boolean operators: `not` `or` `and`

```
not boolean-expression
```

Flips the value of the expression.

not (“123” == 123)   **not** (3 == 3.0)

```
boolean-exp1 and boolean-exp2
```

Evaluates to True only if both expressions are True.

((“a” < “b”) **and** (“b” < “z”))

```
boolean-exp1 or boolean-exp2
```

Evaluates to True only if at least one of the expressions is True.

((False < True) **or** False)

The rules correspond to how we use “and” and “or” in our daily lives.

I have an apple OR I have an orange.

I have an apple AND I have an orange.

More on operators

Operator Precedence

Summary: what you would expect!

`or`

`and`

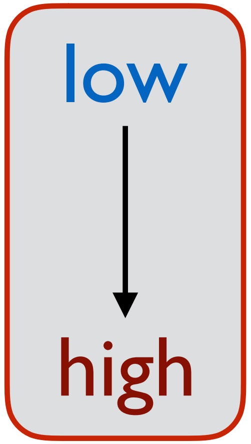
`not`

comparison operators: ==, !=, <, >, ...

+, -

*, /, //, %

**



low

high

put parentheses to change order or improve readability.

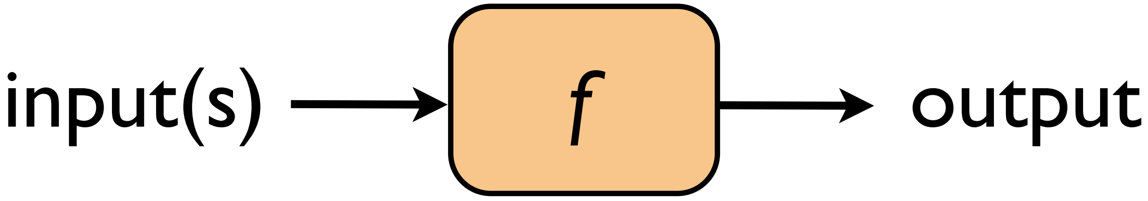
```
print(1 < 2 and 5 < 2 + 1 * 2)
```

yuck!

More on functions

More on functions

A function in Python:



In fact,

Python program = a function + other "helper" functions

More on functions

Example problem:

Write a function that takes 2 integers as input and returns the maximum of the ones digit of the numbers.

```
def max(x, y):
    # some code here
```

helper functions

```
def onesDigit(x):
    # some code here


def largerOnesDigit(x, y):
    return max(onesDigit(x), onesDigit(y))
```

More on functions

Write a function that takes an integer and returns its tens digit.

tensDigit(5)	should return 0
tensDigit(95)	should return 9
tensDigit(4321)	should return 2

Hint: If n is the input, think about the values

n %10 and n // 10

```
def tensDigit(n):
    return (n // 10) % 10
```

Always test your function before you move on!

More on functions

Test function

```
def testTensDigit():
    assert(tensDigit(5) == 0)
    assert(tensDigit(95) == 9)
    assert(tensDigit(4321) == 2)
    assert(tensDigit(-1234) == 3)          Fail
    print(“Passed all tests!”)
```

Make sure you select your test cases carefully!

Retry:

```
def tensDigit():
    return (abs(n) // 10) % 10
```

More on functions

Built-in Functions

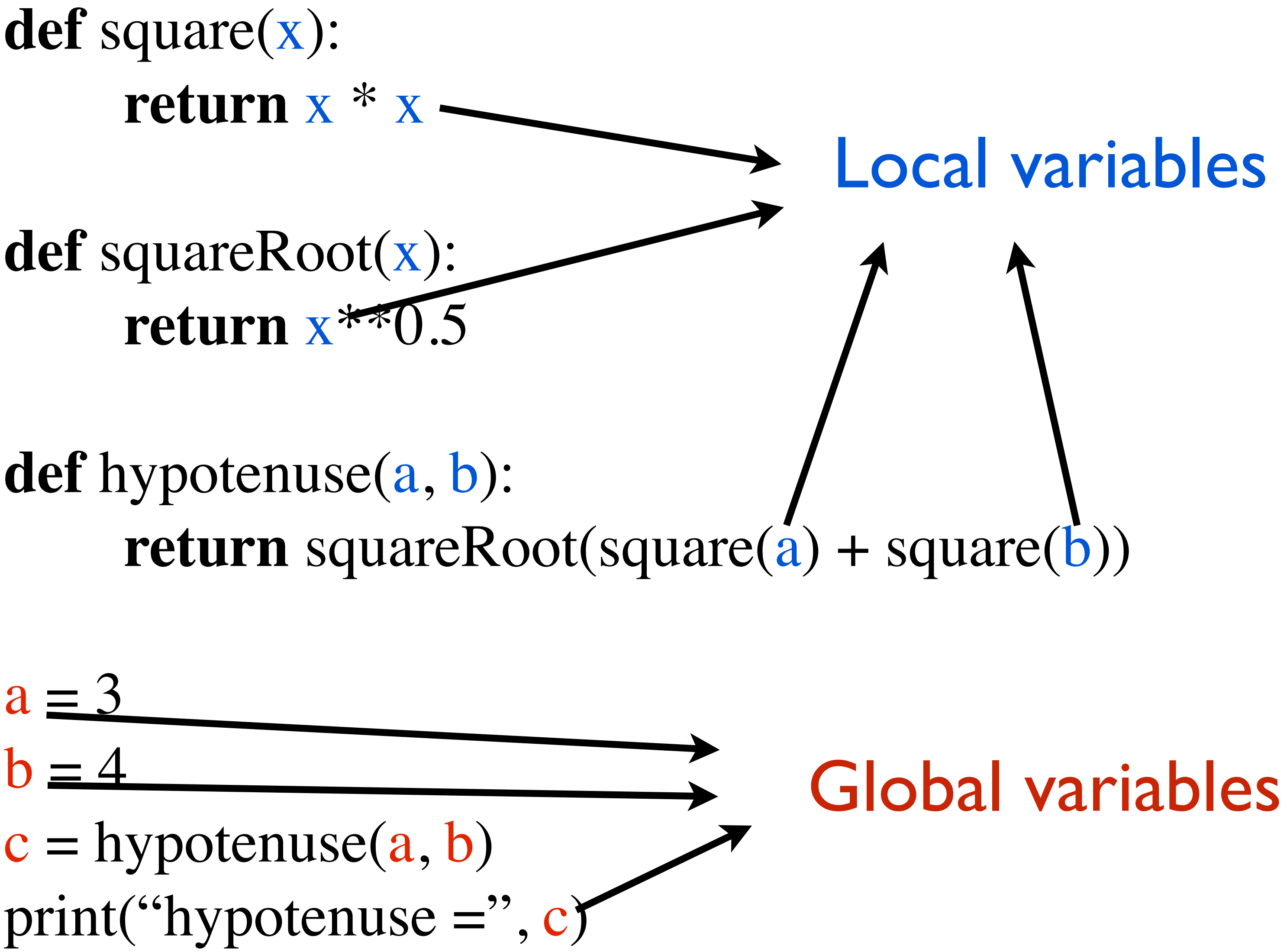
```
print(abs(-5))
print(max(2, 3))
print(min(2, 3))
print(pow(2, 3))
print(round(3.14))
print(round(3.14, 1))     # round with the given number of digits

print(type(5), end=“ ”)        <class 'int'>    <class 'str'>    <class 'bool'>
print(type(“hello”), end=“ ”)
print(type(True))
```

What other built-in functions are there?

See the official Python documentation.

More on functions

Variable scope



```
def square(x):
        return x * x

def squareRoot(x):
        return x**0.5

def hypotenuse(a, b):
        return squareRoot(square(a) + square(b))

a = 3
b = 4
c = hypotenuse(a, b)
print(“hypotenuse =”, c)
```

Local variables

Global variables

More on functions

Variable scope

```
def square(x):
        return x * x

def squareRoot(x):
        return x**0.5

def hypotenuse():
        return squareRoot(square(a) + square(b))

a = 3
b = 4
c = hypotenuse()
print(“hypotenuse =”, c)
```

Don’t do this!

In fact, never use globals!

More on functions

Variable scope

```
def square(x):
    return x * x

def squareRoot(x):
    return x**0.5

def hypotenuse():
    a = 1
    return squareRoot(square(a) + square(b))

a = 3
b = 4
c = hypotenuse()
print(“hypotenuse =”, c)
```

creates a local a,
does not refer to the global a

More on functions

Variable scope

```
def square(x):
    return x * x

def squareRoot(x):
    return x**0.5

def hypotenuse():
    global a
    a = 1
    return squareRoot(square(a) + square(b))

a = 3
b = 4
c = hypotenuse()
print(“hypotenuse =”, c)
```

specifies that a will refer to the global variable

Conditional Statements

Conditional Statements

3 Types:

if statement

if-else statement

if-elif-...-elif-else statement

if Statement

```
instruction1
instruction2

if (expression):
    instruction3
    instruction4


instruction5
```

Ideally, should evaluate to **True** or **False**.

If the expression evaluates to **True**:

```
instruction1
instruction2
instruction3
instruction4
instruction5
```

if Statement

```
instruction1
instruction2

if (expression):
    instruction3
    instruction4


instruction5
```

Ideally, should evaluate to True or False.

If the expression evaluates to False:

```
instruction1
instruction2
instruction5
```

if Statement

```
def abs(n):
    if(n < 0):
        n = -n
    return n
```

```
def abs(n):
    if(n < 0): n = -n
    return n
```

```
def abs(n):
    if(n < 0):
        return -n
    return n
```

if Statement

```
instruction1
instruction2

if(expression1):
     instruction3
     instruction4

if(expression2):
     instruction5
     instruction6

instruction7
```

If both expressions evaluate to **true**:

```
instruction1
instruction2
instruction3
instruction4
instruction5
instruction6
instruction7
```

If the first expression is true, we don’t skip checking the second one.

if Statement

```
def message(age)
    if (age < 16):
        print(“You can’t drive.”)
    if (age < 18):
        print(“You can’t vote.”)
    if (age < 21):
        print(“You can’t drink alcohol.”)
    if (age >= 21):
        print(“You can do anything that’s legal.”)
    print(“Bye!”)
```

if - else

```
instruction1
instruction2

if(expression):
    instruction3
    instruction4
else:
    instruction5
    instruction6

instruction7
```

If the expression evaluates to True.

```
instruction1
instruction2
instruction3
instruction4
instruction7
```

Exactly one of the two blocks will get executed!

if - else

```
instruction1
instruction2

if(expression):
    instruction3
    instruction4
else:
    instruction5
    instruction6

instruction7
```

If the expression evaluates to **False**.

```
instruction1
instruction2
instruction5
instruction6
instruction7
```

Exactly one of the two blocks will get executed!

if - else

```
def f(x, y, z):
    if((x <= y and y <= z) or (x >= y and y >= z)):
        return True
    else:
        return False
```

if - else

```
def inOrder(x, y, z):
    if((x <= y and y <= z) or (x >= y and y >= z)):
        return True
    else:
        return False
```

if - else

```
def inOrder(x, y, z):
    if((x <= y and y <= z) or (x >= y and y >= z)):
        return True
    return False
```

if - else

What if you want to check 2 or more conditions ?

```
if(expression1):
    instruction1
else:
    if(expression2):
        instruction2
    else:
        instruction3
```

Only one of `instruction1`, `instruction2`, `instruction3` will be executed.

if - elif - else

```
if(expression1):
    instruction1
else:
    if(expression2):
        instruction2
    else:
        instruction3
```

```
if(expression1):
    instruction1
elif(expression2):
    instruction2
else:
    instruction3
```

if - elif - else

```
def numberOfQuadraticRoots(a, b, c):
    # Returns number of roots (zeros) of y = a*x**2 + b*x + c
    d = b**2 - 4*a*c
    if (d > 0):
        return 2
    elif (d == 0):
        return 1
    else:
        return 0
```

if - elif - … - elif - else

```
def getGrade(score):
    if (score >= 90):
        grade = "A"
    elif (score >= 80):
        grade = "B"
    elif (score >= 70):
        grade = "C"
    elif (score >= 60):
        grade = "D"
    else:
        grade = "R"
    return grade
```

Some guidelines on correct usage of conditional statements

see notes

Practice Problem

Exercise: round(n)

Write a function that takes a float (or int) as input and returns the integer nearest to it.

Exercise: round(n)

Steps to follow

- Find a mental picture of the solution

- Write an algorithm

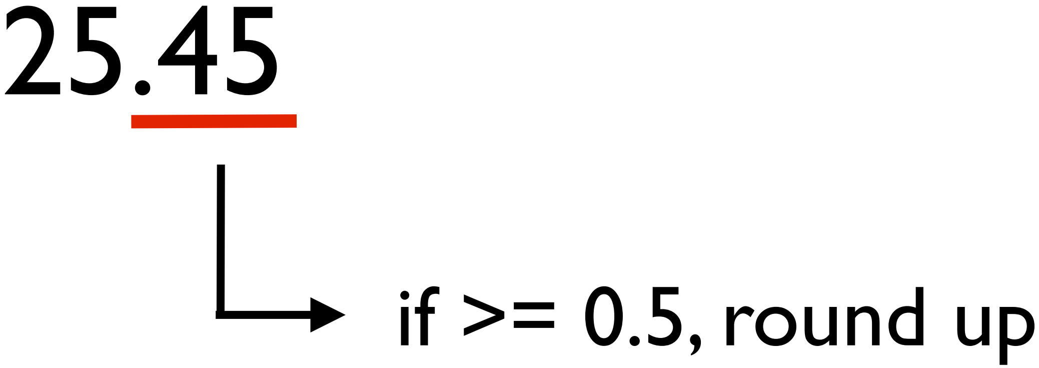
- Write the code

- TEST!

- Fix the bugs (if any)

Exercise: round(n)

- Find a mental picture of the solution

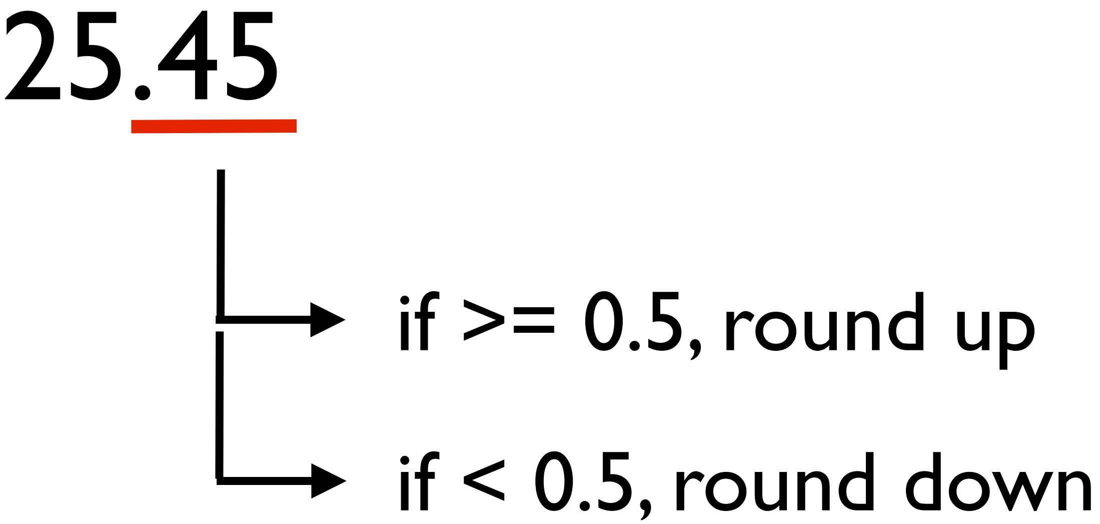


25.45

if >= 0.5, round up

Exercise: round(n)

- Find a mental picture of the solution



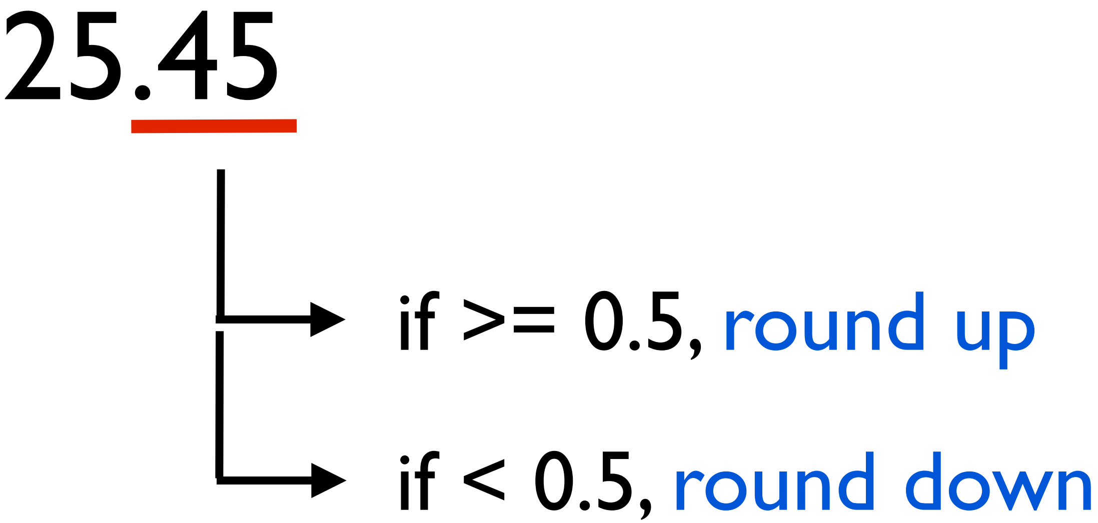
25.45

if >= 0.5, round up

if < 0.5, round down

Exercise: round(n)

- Find a mental picture of the solution



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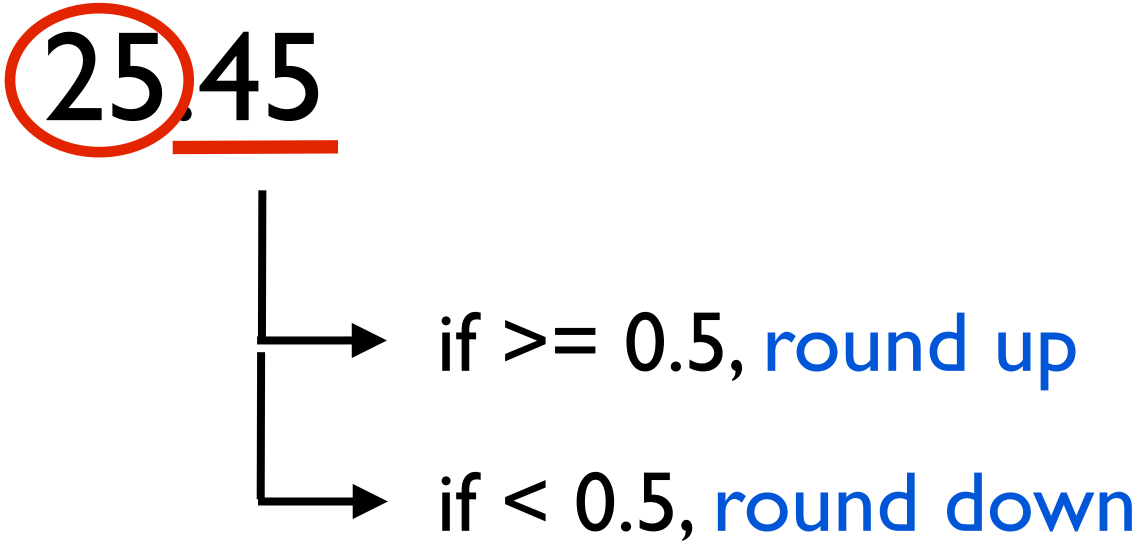
if >= 0.5, round up

if < 0.5, round down

Exercise: round(n)

- Find a mental picture of the solution



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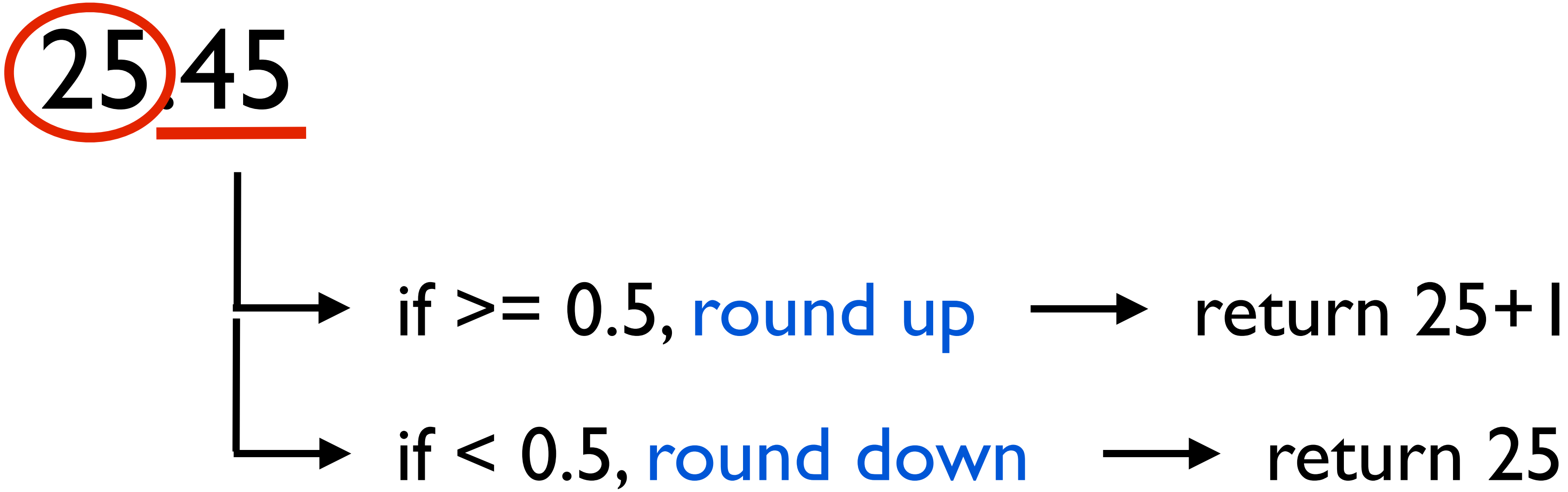
if >= 0.5, round up

if < 0.5, round down

Exercise: round(n)

- Find a mental picture of the solution



25.45

if >= 0.5, round up → return 25+1

if < 0.5, round down → return 25

Exercise: round(n)

Steps to follow

- Find a mental picture of the solution

- Write an algorithm

- Write the code

- TEST!

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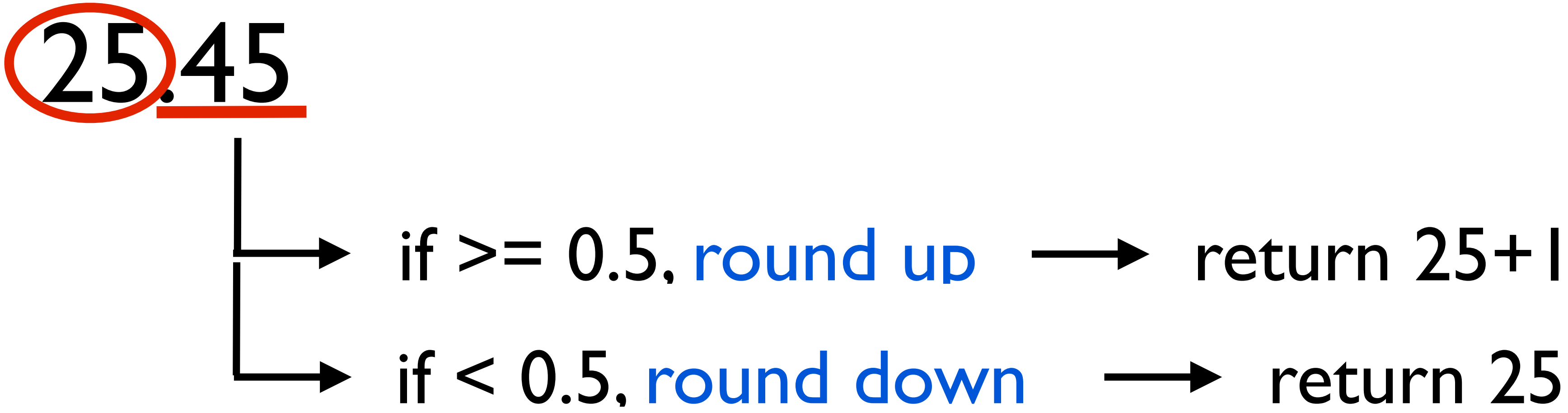
Exercise: round(n)

- Write an algorithm



25.45

if >= 0.5, round up → return 25+1

if < 0.5, round down → return 25

- Let n be the input number.
- Let intPart be the integer part of n.
  Let decPart be the decimal part of n.
- if decPart >= 0.5, return intPart + 1
- if decPart < 0.5, return intPart

Exercise: round(n)

Steps to follow

- Find a mental picture of the solution

- Write an algorithm

- Write the code

- TEST!

- Fix the bugs (if any)

Exercise: round(n)

- Write the code

algorithm:

- Let n be the input number.
- Let intPart be the integer part of n.
  Let decPart be the decimal part of n.
- if decPart >= 0.5, return intPart + 1
- if decPart < 0.5, return intPart

```
def round(n):
    intPart = int(n)
    decPart = n % 1
    if(decPart >= 0.5): return intPart + 1
    else: return intPart
```

Exercise: round(n)

- Find a mental picture of the solution

- Write an algorithm

- Write the code

- TEST!

- Fix the bugs (if any)

Exercise: round(n)

- TEST!

```
def testRound():
    assert(round(0) == 0)
    assert(round(0.5) == 1)
    assert(round(0.49999) == 0)
    assert(round(1238123.00001) == 1238123)
    assert(round(-0.5) == 0)    Error
    assert(round(-0.49999) == 0)
    assert(round(-0.51) == -1)
    assert(round(-1238123.00001) == -1238123)
    print(“Passed all tests!”)
```

Exercise: round(n)

Steps to follow

- Find a mental picture of the solution

- Write an algorithm

- Write the code

- TEST!

- Fix the bugs (if any)

Exercise: round(n)

- Fix the bugs (if any)

Exercise for you.