Using Objects and Images in Python

Look at little UTA Tiffany using objects! Learn from her!

based in part on notes from the CS-for-All curriculum developed at Harvey Mudd College

What Is An Object?

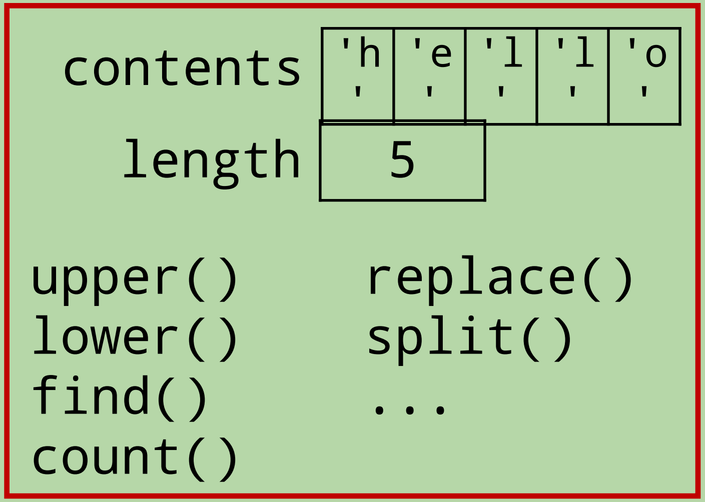
- An object is a construct that groups together:
  - one or more data values (the object's *attributes*)
  - one or more functions that operate on those data values (known as the object's *methods*)

- Objects are typically nouns
  - Attributes correspond to adjectives (i.e., properties of the noun)
  - Methods correspond to verbs that act on the noun

Strings Are Objects

- In Python, a string is an object.
  - ***attributes:***
    - the characters in the string
    - the length of the string
  - ***methods:*** functions inside the string that we can use to operate on the string

string object for 'hello'

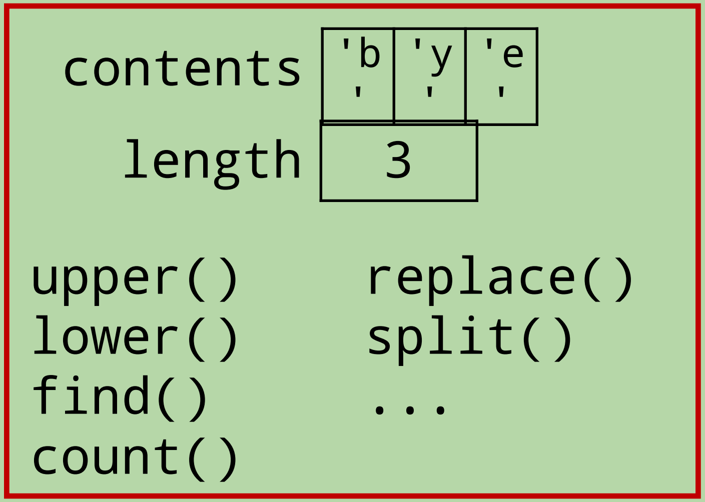


contents 'h' 'e' 'l' 'l' 'o'

length 5

```
upper()     replace()
lower()     split()
find()      ...
count()
```

string object for 'bye'



contents 'b' 'y' 'e'

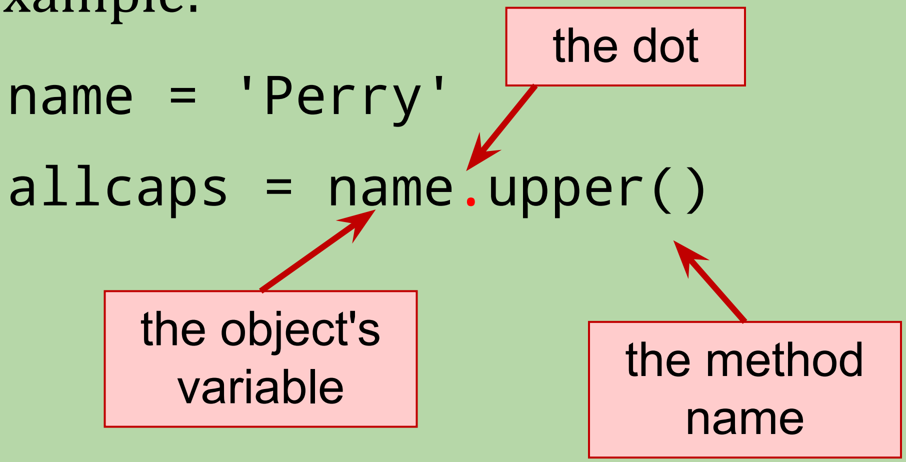
length 3

```
upper()     replace()
lower()     split()
find()      ...
count()
```

Calling a Method

- An object's methods are inside the object,
  so we use *dot notation* to call them.

- Example:

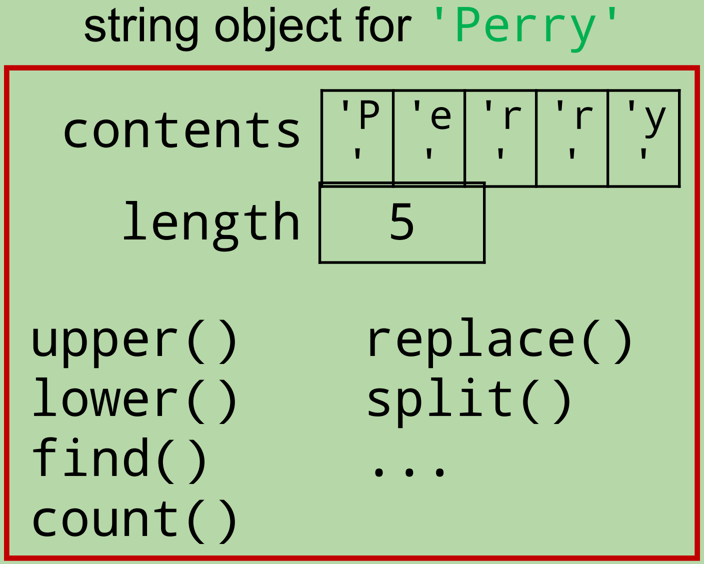


```
name = 'Perry'
allcaps = name.upper()
```

the dot

the object's variable

the method name



string object for 'Perry'

```
 contents  'P' 'e' 'r' 'r' 'y'
   length  5

upper()       replace()
lower()       split()
find()        ...
count()
```

- Because a method is inside the object,
  it is able to access the object's attributes.

String Methods (partial list)

- `s.lower()` return a copy of `s` with all lowercase characters
- `s.upper()` return a copy of `s` with all uppercase characters
- `s.find(sub)` return the index of the first occurrence of the substring `sub` in the string `s` (-1 if not found)
- `s.count(sub)` return the number of occurrences of the substring `sub` in the string `s` (0 if not found)
- `s.replace(target, repl)` replace all occurrences of the substring `target` in `s` with the substring `repl`

Examples of Using String Methods

```
>>> weather = 'A snowy start to Spring!'

>>> weather.upper()
'A SNOWY START TO SPRING!'

>>> weather.lower()
'a snowy start to spring!'

>>> weather.replace('s', 'f')
'A fnowy ftart to Spring!'

>>> weather
'A snowy start to Spring!'
```

Splitting a String

- The split() method breaks a string into a list of substrings.

```
>>> name = 'Martin Luther King'
>>> name.split()
['Martin', 'Luther', 'King']
>>> components = name.split()
>>> components[0]
'Martin'
```

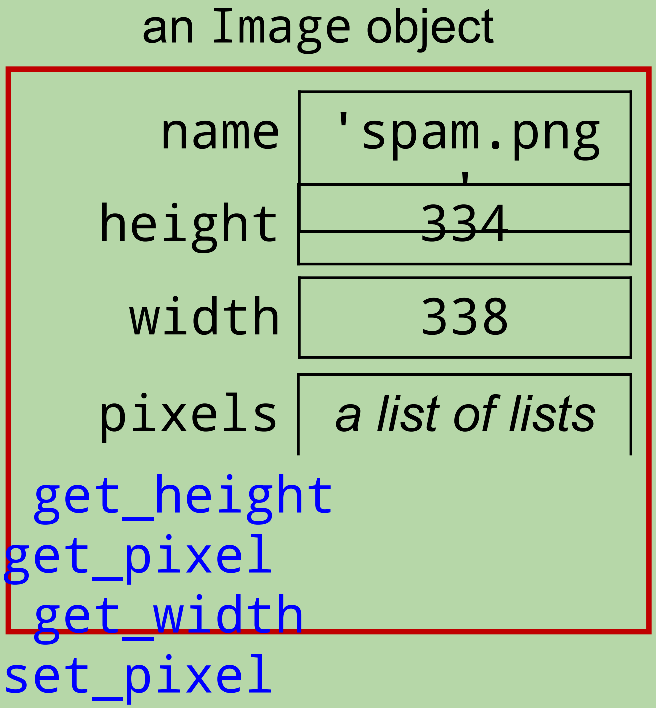
- By default, it uses *whitespace characters* (spaces, tabs, and newlines) to determine where the splits should occur.

- You can specify a different separator:

```
>>> date = '11/10/2014'
>>> date.split('/')
['11', '10', '2014']
```

hw02: Image Objects

- Each `Image` object has:
  - attributes:
    - the name of the image
    - the height of the image
    - the width of the image
    - the pixels in the image



an Image object

name 'spam.png'

height 334

width 338

pixels *a list of lists*

get_height

get_pixel

get_width

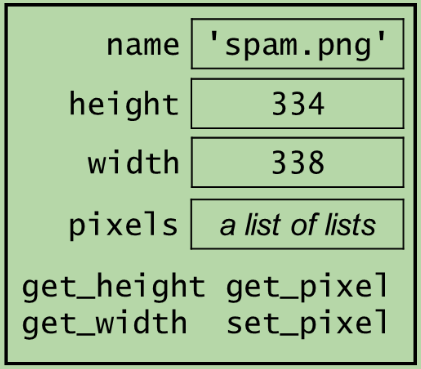
set_pixel

- methods:
  - `img.get_height()` – returns the height of the image `img`
  - `img.get_width()` – returns the width of the image `img`
  - `img.get_pixel(r, c)` – returns the list of RGB values for the pixel at position `(r, c)` in the image `img`
  - `img.set_pixel(r, c, rgb)` – changes the RGB values for the pixel at position `(r, c)` in `img` to the list `rgb`

Different Image Objects for Different Images

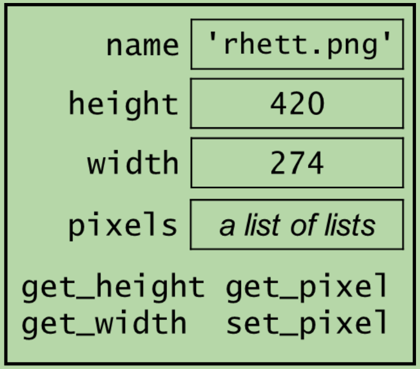
image

`Image` object



name	'spam.png'
height	334
width	338
pixels	*a list of lists*

get_height get_pixel
get_width set_pixel



name	'rhett.png'
height	420
width	274
pixels	*a list of lists*

get_height get_pixel
get_width set_pixel

Pixels in hw02

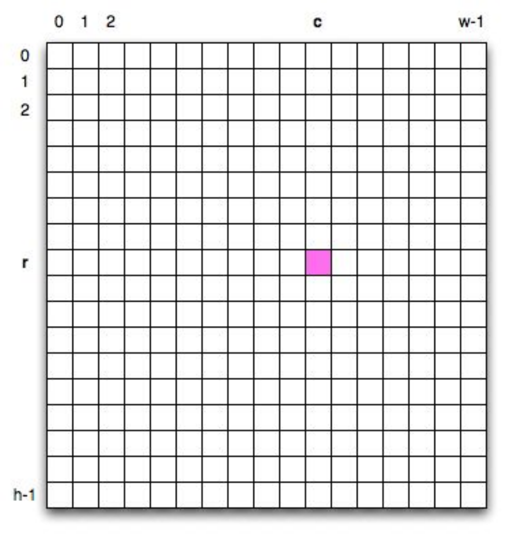
- The color of each pixel is represented by a list of 3 integers:

  `[red, green, blue]`

  - example: the pink pixel at right has color

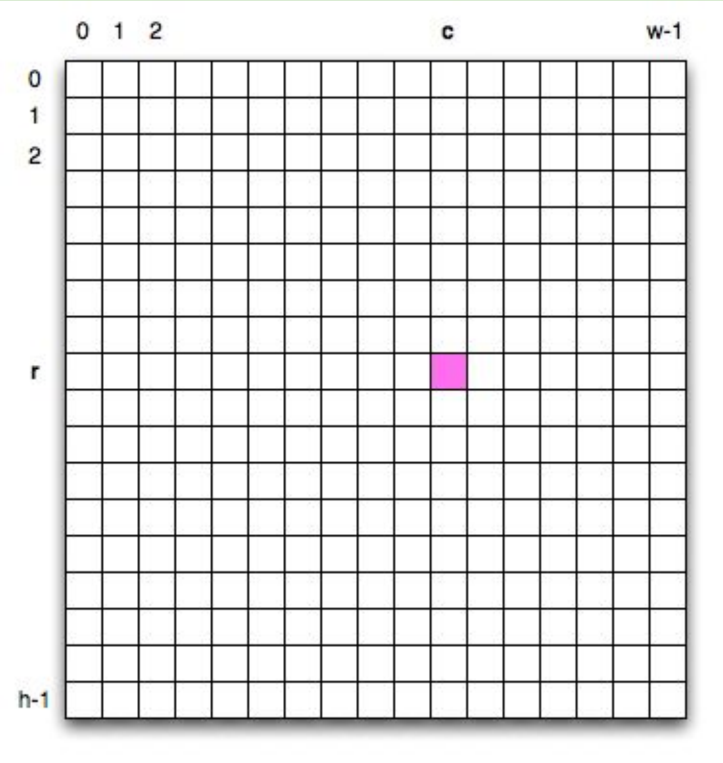
    `[240, 60, 225]`

  - known as RGB values
  - each value is between 0-255



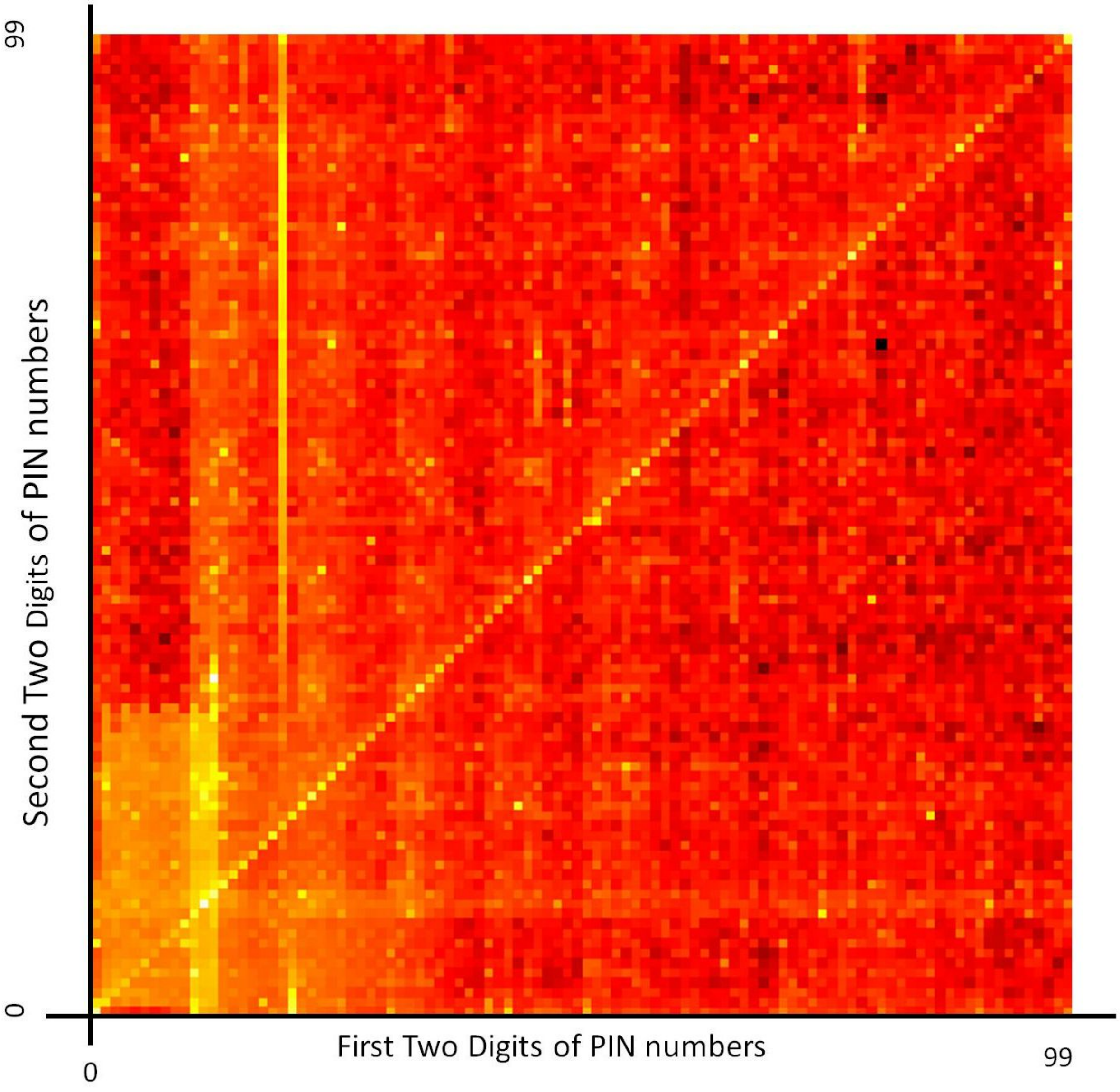
- Other examples:
  - pure red: `[255, 0, 0]`
  - pure green: `[0, 255, 0]`
  - pure blue: `[0, 0, 255]`
  - white: `[255, 255, 255]`
  - black: `[0, 0, 0]`

Nested loops and ***2D structure***



```
for r in range(h):
    for c in range(w):
        # process the pixel at (r, c)
```

The frequency of (leaked) 4-digit PIN codes. Brighter color reflects higher frequency. The brightness in the lower left corner reflects people choosing their birth month (1 – 12) and day (1 – 31); the vertical line suggests birth years (i.e., the first two digits are 19); the diagonal line reflects a preference for repeated couplets of numbers (e.g., 1212 or 3636).



Nested loops and *2D structure*

```
for x in range(100):
  for y in range(100):
    f = pin_freq(x, y)
    c = freq_color(f)
    img.set_pixel(x,y,c)
```

hw02: T.T. Securities (TTS)

Analyzes a sequence of stock prices

```
          day day day day day day day day
           0   1   2   3   4   5   6   7
prices = [45, 80, 10, 30, 27, 50, 5, 15]
```

The menu to implement:

```
(0) Input a new list of prices
(1) Print the current list
(2) Find the latest price
(3) Find the average price
(4) Find the standard deviation
(5) Find the min and its day
(6) Find the max and its day
(7) Test a threshold
(8) Your TTS investment plan
(9) Quit
Enter your choice:
```

Our starter code

```
def display_menu():
    """ prints a menu of options
    """
    print()
    print('(0) Input a new list of prices')
    print('(1) Print the current prices')
    print('(2) Find the latest price')
   ...
    print('(9) Quit')
    print()

...
```

Our starter code

```
def tts():
    prices = []
    while True:
        display_menu()
        choice = int(input('Enter your choice: '))
        print()
        if choice == 0:
            prices = get_new_prices()
        elif choice == 9:
            break
        elif choice == 1:
            print_prices(prices)
        elif choice == 2:
            latest = latest_price(prices)
            print('The latest price is', latest)
        ## add code to process the other choices here
        ...
    print('See you yesterday!')
```

User Input

- Getting a *string value* from the user:

  ```
  variable = input(prompt)
  ```

  where *prompt* is a string

- Getting an *integer value*:

  ```
  variable = int(input(prompt))
  ```

- Getting a *floating-point value*:

  ```
  variable = float(input(prompt))
  ```

- Getting an arbitrary non-string value (e.g., a list):

  ```
  variable = eval(input(prompt))
  ```

  - eval treats a string as an expression to be evaluated

- Examples:

  ```
  name = input('name of assignment: ')
  count = int(input('possible points: '))
  scores = eval(input('list of scores: '))
  ```

User Input

- Getting a *string value* from the user:

  variable = input(*prompt*)   where *prompt* is a string

- Getting an *integer value*:

  variable = int(input(*prompt*))

- Getting a *floating-point value*:

  variable = float(input(*prompt*))

- Examples:

```
name = input('name of assignment: ‘)
count = int(input('possible points: '))
price = float(input('enter a price: '))
```

Our starter code

```
def get_new_prices():
   new_list = eval(input('Enter new prices: '))
   return new_list

def print_prices(prices):
    """ prints the current list of prices
        input: prices is a list of 1 or more numbers.
    """
    ## IMPORTANT: You will need to change this...
    print('current prices:', prices)

def latest_price(prices):
    return prices[-1]
```

Our starter code

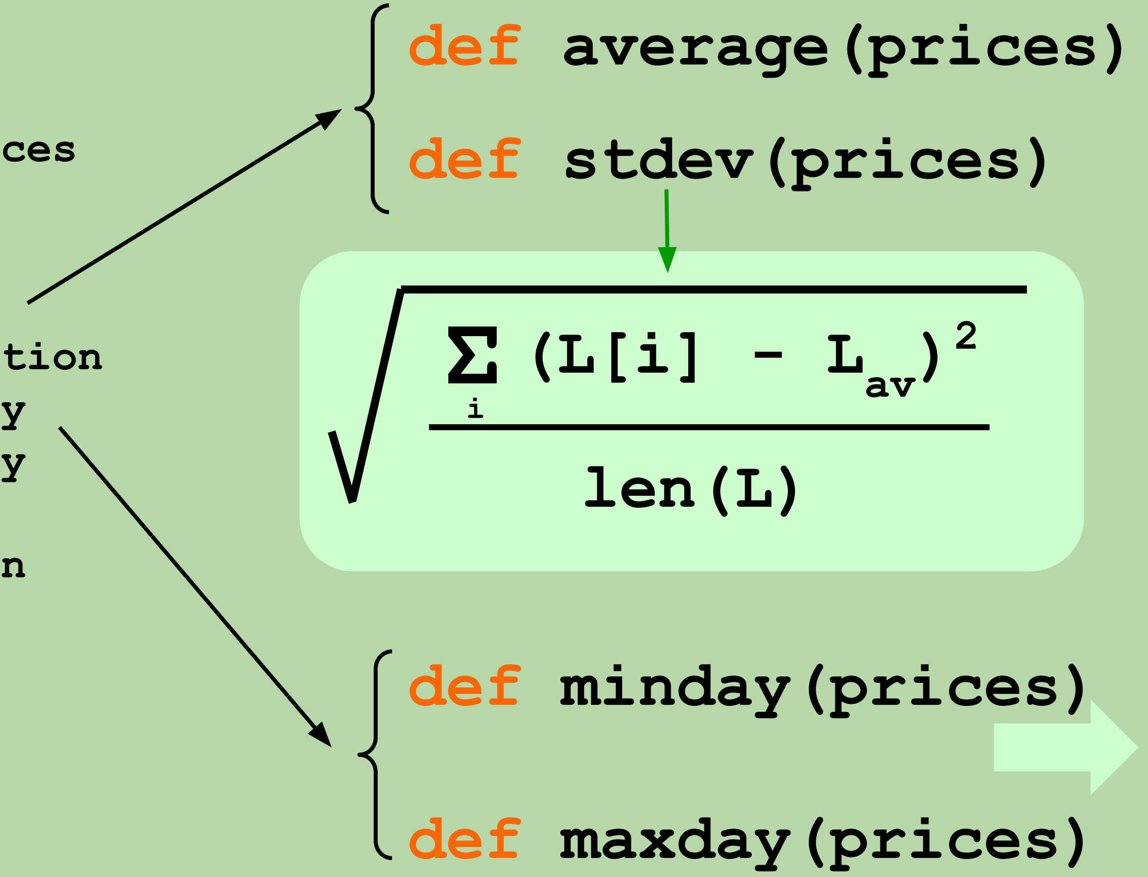
```
def get_new_prices():
    """ gets a new list of prices from the user and returns it
    """
    try:
        new_price_list = input("Enter a new list of prices: ")
        new_price_list = [float(x) for x in \
       new_price_list.split(' ')]
        return new_price_list
    except:
        print('\nInvalid input. System exiting...\n')
        exit()

def print_prices(prices):
    """ prints the current list of prices
        input: prices is a list of 1 or more numbers.
    """
    ## IMPORTANT: You will need to change this...
    print('current prices:', prices)

def latest_price(prices):
    return prices[-1]
```

Functions you'll write

All use loops…

Menu

```
(0) Input a new list of prices
(1) Print the current list
(2) Find the latest price
(3) Find the average price
(4) Find the standard deviation
(5) Find the min and its day
(6) Find the max and its day
(7) Test a threshold
(8) Your TTS investment plan
(9) Quit
Enter your choice:
```



```
def average(prices)

def stdev(prices)
```

$$\sqrt{\frac{\sum_{i} (L[i] - L_{av})^2}{len(L)}}$$

```
def minday(prices)

def maxday(prices)
```

plus others!

Min price

What's the ***idea*** for finding the smallest (minimum) price?

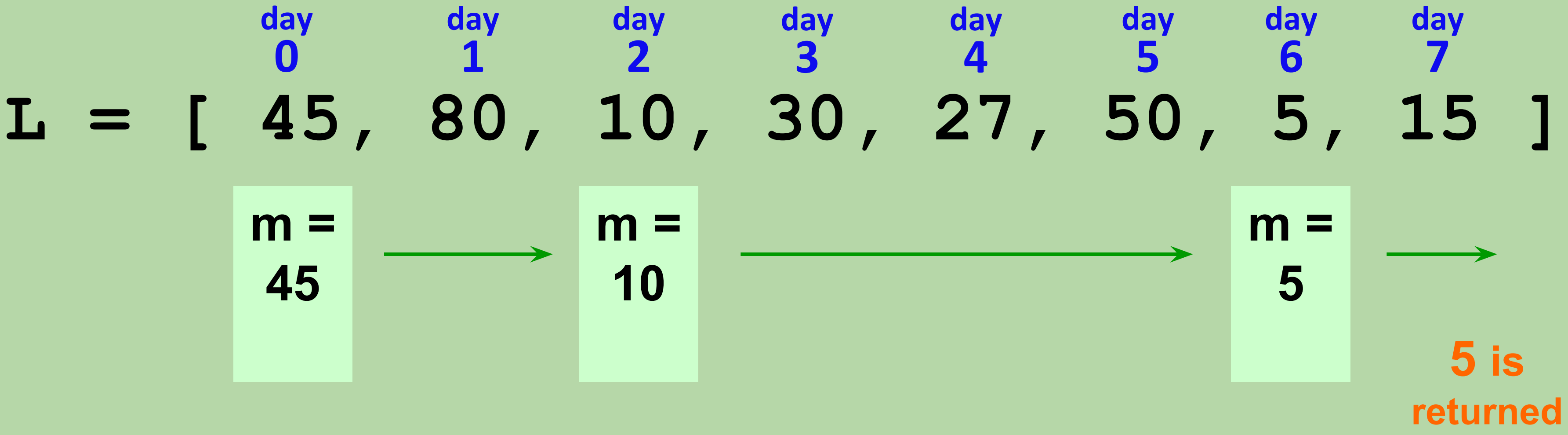
```
      day  day  day  day  day  day  day day
       0    1    2    3    4    5    6   7
L = [ 45, 80, 10, 30, 27, 50, 5, 15 ]
```

m =

m is the "min so far"

track the value of the ***minimum so far*** as you loop over list

Min price



day 0 day 1 day 2 day 3 day 4 day 5 day 6 day 7

```
L = [ 45, 80, 10, 30, 27, 50, 5, 15 ]
```

m = 45

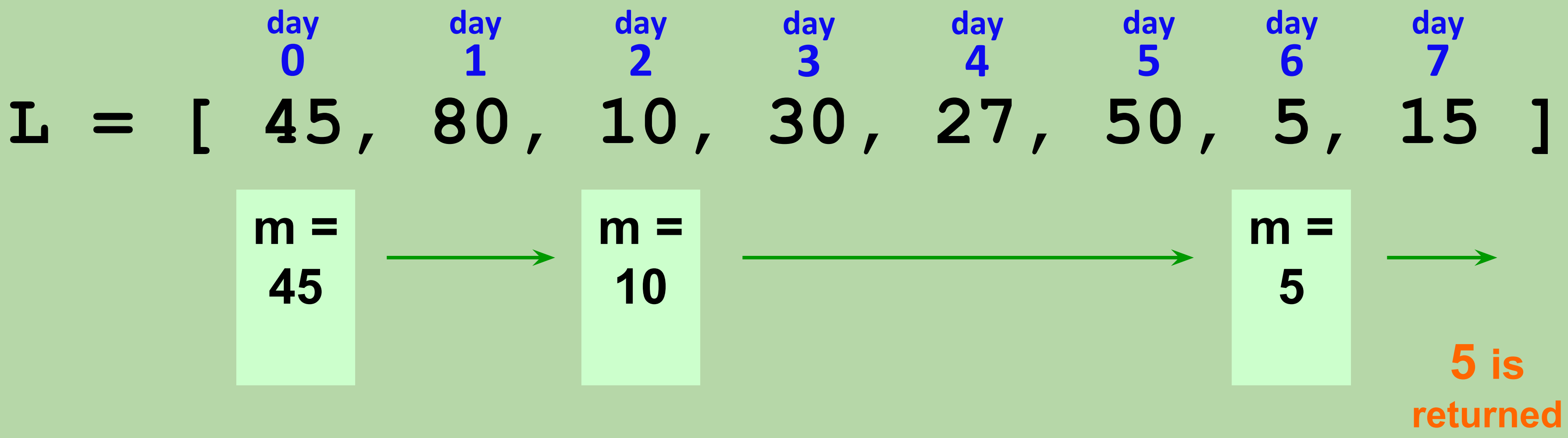
m = 10

m = 5

5 is returned

```
def minprice(prices):
    m = prices[0]
    for x in prices:
        if x < m:
            m = x
    return m
```

Min price vs. min ***day***



day 0 day 1 day 2 day 3 day 4 day 5 day 6 day 7

```
L = [ 45, 80, 10, 30, 27, 50, 5, 15 ]
```

m = 45 → m = 10 → m = 5 →

5 is returned

```
def minprice(prices):
    m = prices[0]
    for x in prices:
        if x < m:
            m = x
    return m
```

What about the ***day*** of the minimum price?

T.T. Securities
==
Time Travel
Securities!

```
(0) Input a new list of prices
(1) Print the current list
(2) Find the latest price
(3) Find the average price
(4) Find the standard deviation
(5) Find the min and its day
(6) Find the max and its day
(7) Test a threshold
(8) Your TTS investment plan
(9) Quit
Enter your choice:
```

Min price vs. min ***day***

```
      day  day  day  day  day  day  day  day
       0    1    2    3    4    5    6    7
L = [ 45,  80,  10,  30,  27,  50,  5,   15 ]
```

6 should be returned!

```
def minday(prices):
    ???
    for i in range(len(prices)): # index-based!
        if __________:



    return mi
```

The TTS Advantage!

Your stock's prices: L = [45, 80, 10, 30, 27, 50, 5, 15]

Day	Price
0	45.00
1	80.00
2	10.00
3	30.00
4	27.00
5	50.00
6	5.00
7	15.00

What is the best TTS investment strategy here?

You may only sell ***after*** you buy.

The TTS Advantage!

Your stock's prices: L = [45, 80, 10, 30, 27, 50, 5, 15]

Day	Price
0	45.00
1	80.00
2	10.00
3	30.00
4	27.00
5	50.00
6	5.00
7	15.00

What is the best TTS investment strategy here?

You may only sell ***after*** you buy.

Finding a minimum difference

`diff` should return the **smallest** absolute diff. between any value from `l1` and any value from `l2`.

```
            l1        l2
>>> diff([12,3,7], [6,0,5])
1              ↑    ↑
```

```
def diff(l1, l2):
```

Hint! Use nested loops!

Hint! Track the *min diff so far* as you loop over `l1` and `l2`…

Which of these works?

A.

```
def diff(l1, l2):
    mindiff = abs(l1[0]-l2[0])
    for x in l1:
        for y in l2:
            d = abs(x - y)
            if d < mindiff:
                mindiff = d
    return mindiff
```

B.

```
def diff(l1, l2):
    mindiff = 0
    for x in l1:
        for y in l2:
            d = abs(x - y)
            if d < mindiff:
                mindiff = d
    return mindiff
```

C.

```
def diff(l1, l2):
    mindiff = abs(l1[0]-l2[0])
    for x in l1:
        for y in l2:
            d = abs(x - y)
            if d < mindiff:
                return d
            else:
                return mindiff
```

D. more than one of them

Which of these works?

A.

```
def diff(l1, l2):
   mindiff = abs(l1[0]-l2[0])
   for x in l1:
      for y in l2:
         d = abs(x - y)
         if d < mindiff:
            mindiff = d
   return mindiff
```

B.

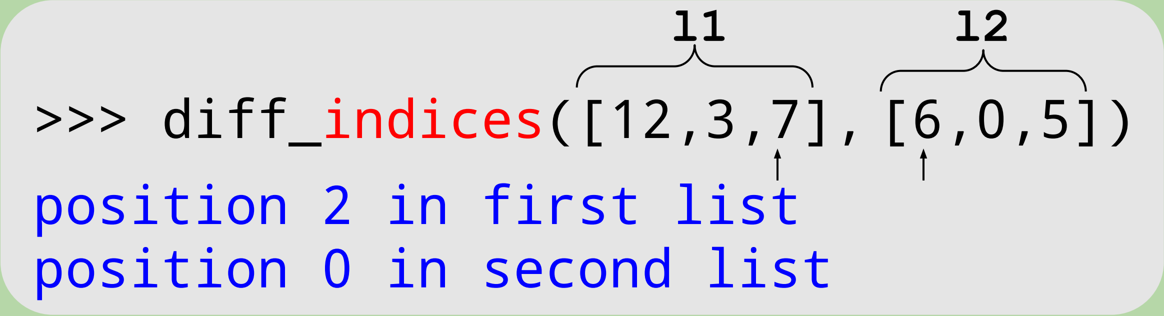
```
def diff(l1, l2):
   mindiff = 0
   for x in l1:
      for y in l2:
         d = abs(x - y)
         if d < mindiff:
            mindiff = d
   return mindiff
```

C.

```
def diff(l1, l2):
   mindiff = abs(l1[0]-l2[0])
   for x in l1:
      for y in l2:
         d = abs(x - y)
         if d < mindiff:
            return d
         else:
            return mindiff
```

D. more than one of them

What if we want the indices of the min-diff values?



```
>>> diff_indices([12,3,7], [6,0,5])
position 2 in first list
position 0 in second list
```

should *print*
instead of returning

```
def diff_indices(l1, l2):    # what needs to change?
    mindiff = abs(l1[0] - l2[0])
    for x in l1:
        for y in l2:
            d = abs(x - y)
            if d < mindiff:
                mindiff = d

    return mindiff
```

What if we want the indices of the min-diff values?

```
                    l1         l2
>>> diff_indices([12,3,7], [6,0,5])
                        ↑    ↑
position 2 in first list
position 0 in second list
```

should *print*
instead of returning

```
def diff_indices(l1, l2):
    mindiff = abs(l1[0] - l2[0])
    pos1 = 0
    pos2 = 0

    for i in range(len(l1)):
        for j in range(len(l2)):
            d = abs(l1[i] - l2[j])
            if d < mindiff:
                mindiff = d
                pos1 = i
                pos2 = j

    print('position', pos1, 'in first list')
    print('position', pos2, 'in second list')
```