Interactive programs!

Letting the user choose…

(and more loopiness!)

Plus, if you've got a time machine…

Possible hardware

User input...

```
meters = input('How many m? ')
cm = meters * 100
print("That's", cm, 'cm.')
```

What will Python think?

I think I like these units better than light years per year!

User input...

```
meters = input('How many m?  ')

cm = meters * 100

print("That's", cm, 'cm.')
```

`input` **ALWAYS** returns a **string** –
no matter what's typed!

What will Python think?

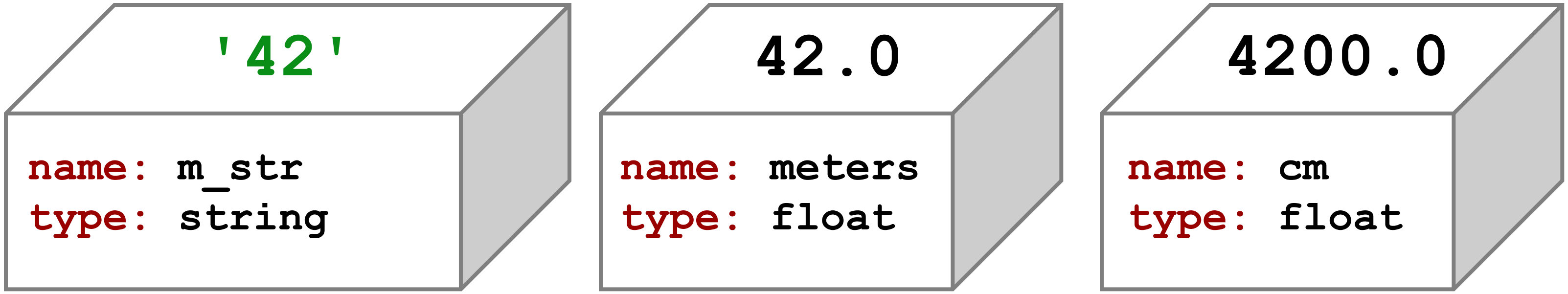
I think I like these units better
than light years per year!

Fix #1: **convert** to the right type

```
m_str = input('How many m?  ')

meters = float( m_str )

cm = meters * 100
print("That's", cm, 'cm.')
```



'42'
name: m_str
type: string

42.0
name: meters
type: float

4200.0
name: cm
type: float

... but **crash**-able

Fix #2: **convert** and **check**

```
m_str = input('How many m? ')

try:
  meters = float( m_str )
except:
  print("What? Didn't compute!")
  print("Setting meters = 42")
  meters = 42.0

cm = meters * 100
print('That\'s', cm, 'cm.')
```

crash-able

try-except lets you try code and – if it crashes – *catch* an error and handle it

Fix #2

User-errors are called ***exceptions.***

This is ***exception handling***.

```
try:
   meters = float( m_str )
except:
   print("What? Didn't compute!")
   print("Setting meters = 42")
   meters = 42.0

cm = meters * 100
print('That\'s', cm, 'cm.')
```

crash-able

try-except lets you try code and – if it crashes – *catch* an error and handle it

Fix #3: **eval** executes Python code!

```
m_str = input('How many m?  ')

meters = eval( m_str )

cm = meters * 100
print('That is', cm, 'cm.')
```

What could go wrong here?

Fix #3: **eval** executes Python code!

```
m_str = input('How many m?  ')

try:
   meters = eval( m_str )
except:
   print("What? Didn't compute!")
   print("Setting meters = 42")
   meters = 42.0

cm = meters * 100
print('That is', cm, 'cm.')
```

What could **REALLY** go wrong here?

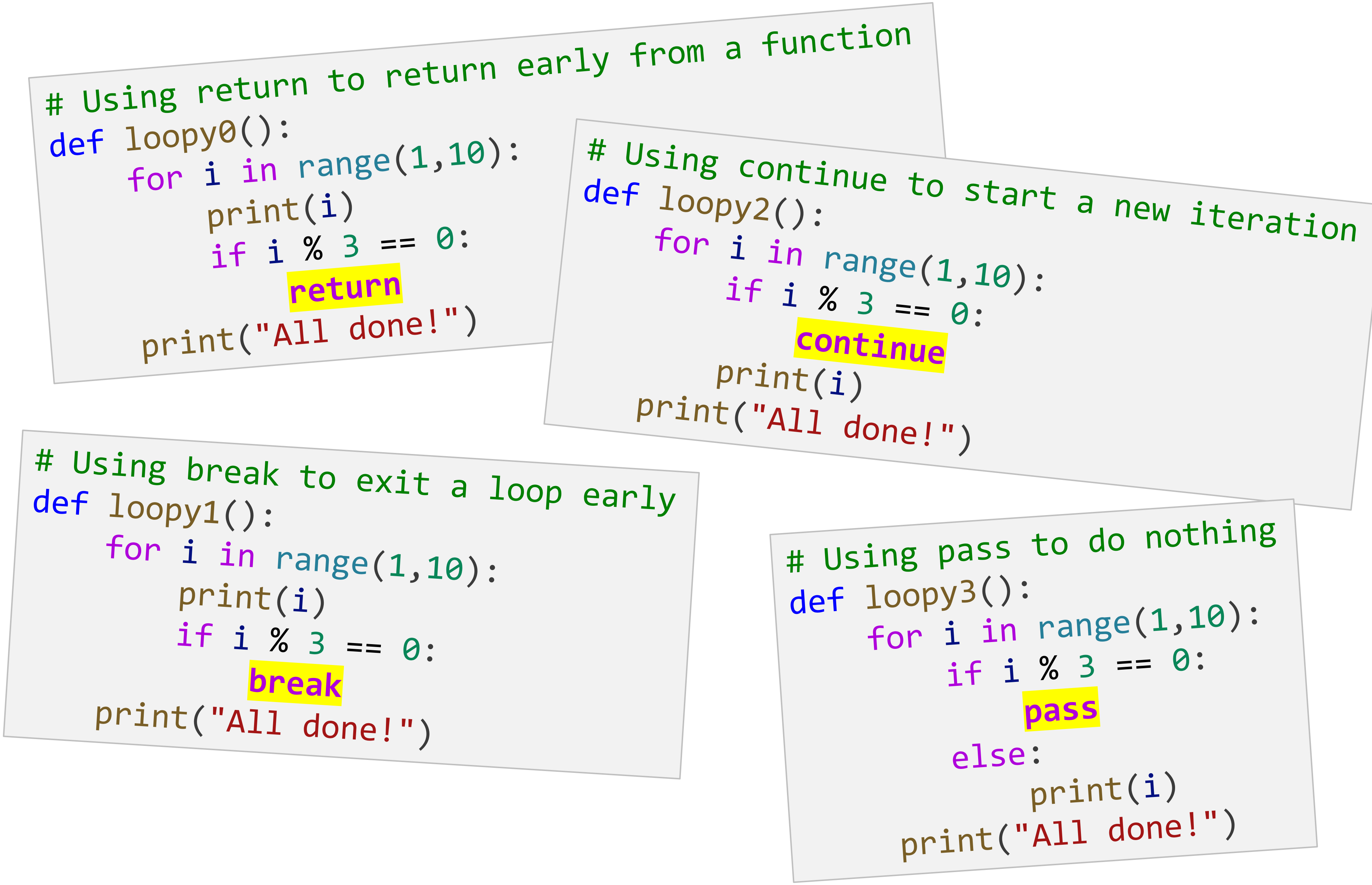
Eval? More like Evil !!

More loop control...

```
# Using return to return early from a function
def loopy0():
    for i in range(1,10):
        print(i)
        if i % 3 == 0:
            return
    print("All done!")
```

```
# Using break to exit a loop early
def loopy1():
    for i in range(1,10):
        print(i)
        if i % 3 == 0:
            break
    print("All done!")
```

More loop control...



```python
# Using return to return early from a function
def loopy0():
    for i in range(1,10):
        print(i)
        if i % 3 == 0:
            return
    print("All done!")
```

```python
# Using continue to start a new iteration
def loopy2():
    for i in range(1,10):
        if i % 3 == 0:
            continue
        print(i)
    print("All done!")
```

```python
# Using break to exit a loop early
def loopy1():
    for i in range(1,10):
        print(i)
        if i % 3 == 0:
            break
    print("All done!")
```

```python
# Using pass to do nothing
def loopy3():
    for i in range(1,10):
        if i % 3 == 0:
            pass
        else:
            print(i)
    print("All done!")
```

Mystery sequences...

[-35, -24, -13, -2, 9, 20, 31, ?]

[26250, 5250, 1050, 210, ?]

[90123241791111, 93551622, 121074, 3111, ?]

[1, 11, 21, 1211, 111221, ?]

What's next?

I'm glad you asked!

A larger application ...

```
def menu():
    """ prints our menu of options """
    print("(0) Continue")
    print("(1) Enter a new list")
    print("(2) Analyze")
    print("(9) Break (quit)")


def main():
    """ handles user input for our menu """

    while True:
        menu()
        uc = input('Which option? ')

        try:
            uc = int(uc)     # was it an int?
        except:
            continue         # back to the top!
```

Calls a helper function

Perhaps `uc` the reason for this?

```
def main():
    """ handles user input for our menu """
    L = [30,10,20]   # a starting list


    while True:
        menu()   # print menu
        uc = input('Which option? ')

        if uc == 9:
            break
```

(9) Quit

```
        elif uc == 0:
            continue
```

(0) Continue

```
        elif uc == 1:
            ... input ... eval ...
```

(1) Get new list

```
        elif uc == 2:
```

(2) Analyze !

... and so on ...

```
def main():
    """ handles user input for our menu """
    L = [30,10,20]   # a starting list


    while True:
        menu()   # print menu
        uc = input('Which option? ')

        if uc == 9:
```

(9) Quit

```
            break
```

break breaks *out of the loop...*

```
        elif uc == 0:
```

(0) Continue

```
            continue
```

continue jumps *back to the top...*

```
        elif uc == 1:
```

(1) Get new list

```
            ... input ... eval ...
```

uses **eval** (+check) for a new L

```
        elif uc == 2:
```

(2) Analyze !

other functions as needed...

... and so on ...

Big-picture view!

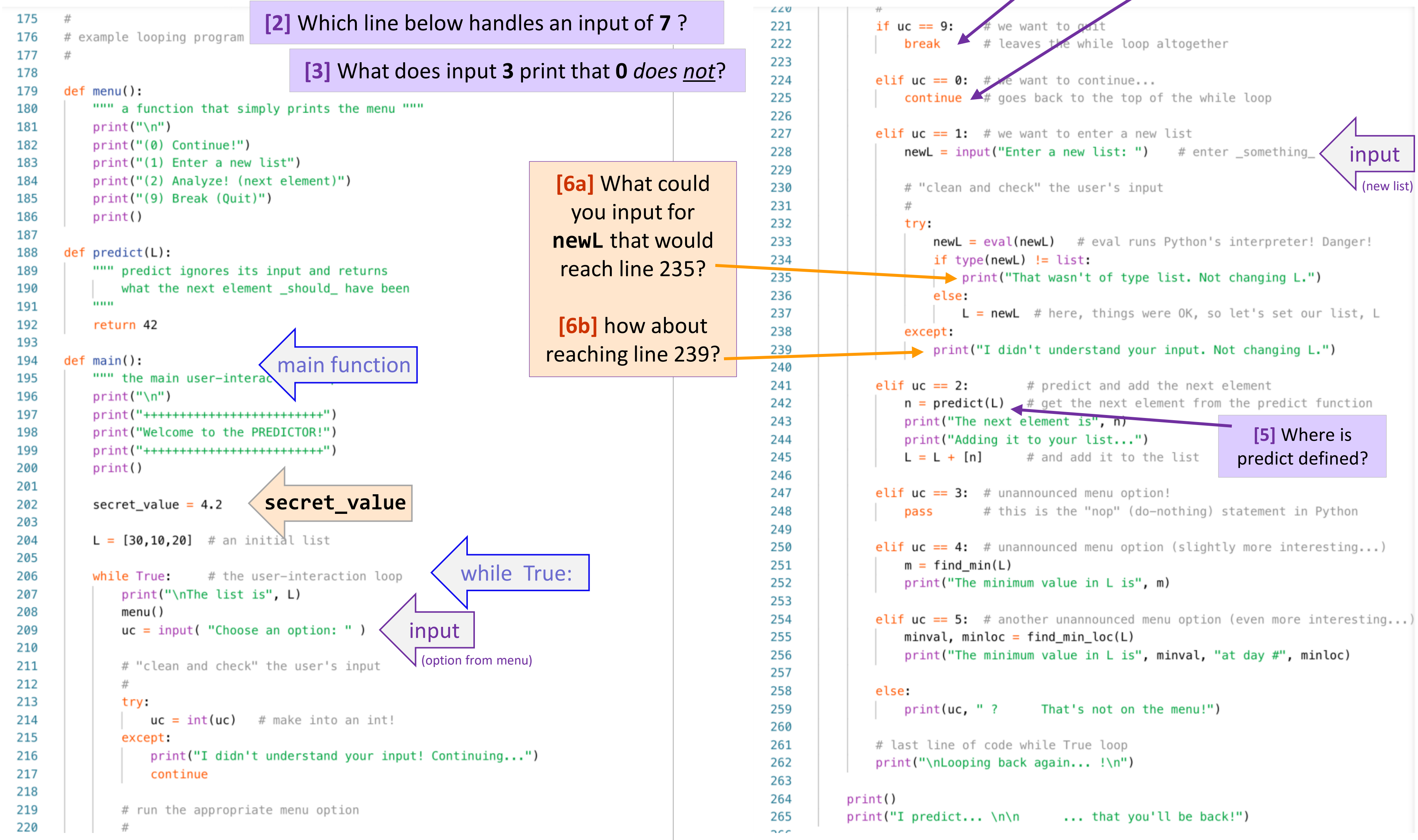
[0] Which line of code handles an input of **1** ?

[1] Which line of code handles an input of **5** ?

[2] Which line below handles an input of **7** ?

[3] What does input **3** print that **0** *does* *not*?

[4] What line of code runs after this **break** ? and **continue** ?



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191      """
192      return 42
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196      print("\n")
197      print("+++++++++++++++++++++++++")
198      print("Welcome to the PREDICTOR!")
199      print("+++++++++++++++++++++++++")
200      print()
201
202      secret_value = 4.2
203
204      L = [30,10,20]  # an initial list
205
206      while True:     # the user-interaction loop
207          print("\nThe list is", L)
208          menu()
209          uc = input( "Choose an option: " )
210
211          # "clean and check" the user's input
212          #
213          try:
214              uc = int(uc)   # make into an int!
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217              continue
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221          if uc == 9:     # we want to quit
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225              continue    # goes back to the top of the while loop
226
227          elif uc == 1:   # we want to enter a new list
228              newL = input("Enter a new list: ")    # enter _something_
229
230              # "clean and check" the user's input
231              #
232              try:
233                  newL = eval(newL)   # eval runs Python's interpreter! Danger!
234                  if type(newL) != list:
235                      print("That wasn't of type list. Not changing L.")
236                  else:
237                      L = newL  # here, things were OK, so let's set our list, L
238              except:
239                  print("I didn't understand your input. Not changing L.")
240
241          elif uc == 2:         # predict and add the next element
242              n = predict(L)    # get the next element from the predict function
243              print("The next element is", n)
244              print("Adding it to your list...")
245              L = L + [n]       # and add it to the list
246
247          elif uc == 3:   # unannounced menu option!
248              pass        # this is the "nop" (do-nothing) statement in Python
249
250          elif uc == 4:   # unannounced menu option (slightly more interesting...)
251              m = find_min(L)
252              print("The minimum value in L is", m)
253
254          elif uc == 5:   # another unannounced menu option (even more interesting...)
255              minval, minloc = find_min_loc(L)
256              print("The minimum value in L is", minval, "at day #", minloc)
257
258          else:
259              print(uc, " ?      That's not on the menu!")
260
261          # last line of code while True loop
262          print("\nLooping back again... !\n")
263
264      print()
265      print("I predict... \n\n      ... that you'll be back!")
```

[6a] What could you input for **newL** that would reach line 235?

[6b] how about reaching line 239?

[5] Where is predict defined?

Full-program menu-interaction example

Try it!

[EC] How could a user learn the value of **secret_value** if they guessed that variable name *and* could run the program -- but *didn't have this source code*?

Big-picture view!

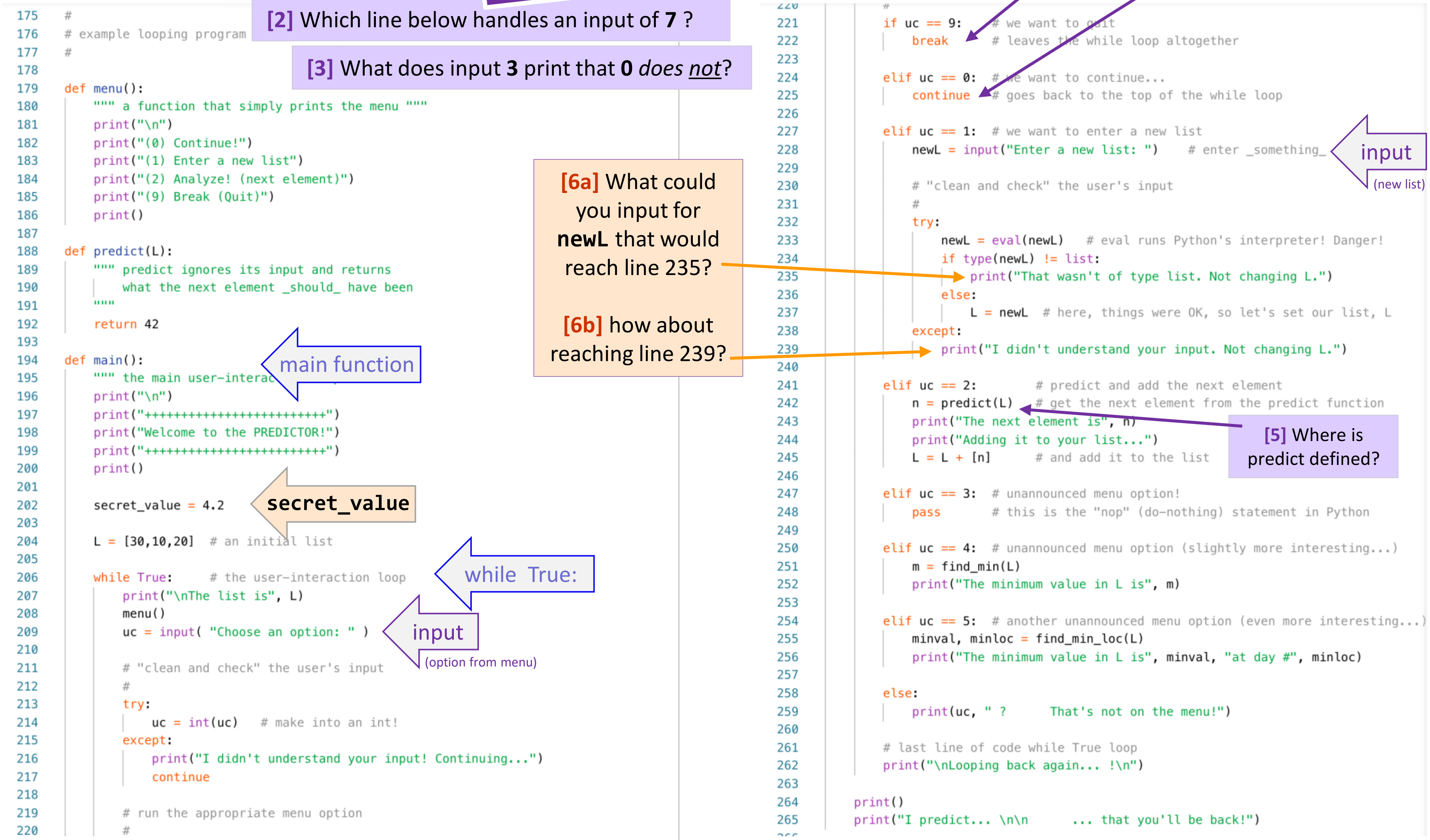
[0] Which line of code handles an input of **1** ? **227**

[1] Which line of code handles an input of **5** ? **254**

[2] Which line below handles an input of **7** ?

[3] What does input **3** print that **0** *does not*?

[4] What line of code runs after this **break** ? and **continue** ?



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```

main function

secret_value

while True:

input

(option from menu)

input

(new list)

[6a] What could you input for **newL** that would reach line 235?

[6b] how about reaching line 239?

[5] Where is predict defined?

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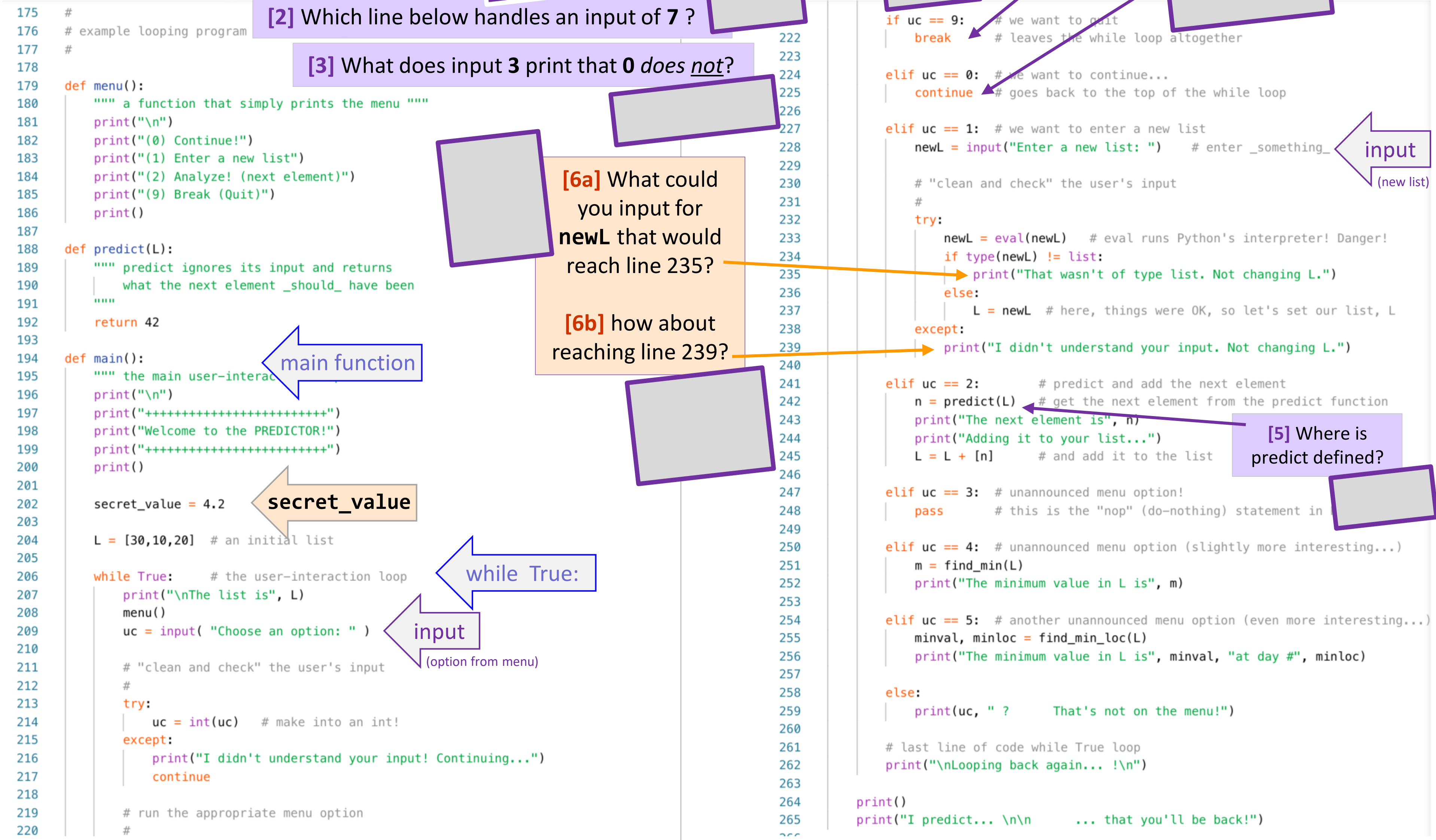

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Full-program menu-interaction example

Try it!

[EC] How could a user learn the value of **`secret_value`** if they guessed that variable name *and* could run the program -- but *didn't have this source code*?

Big-picture view!

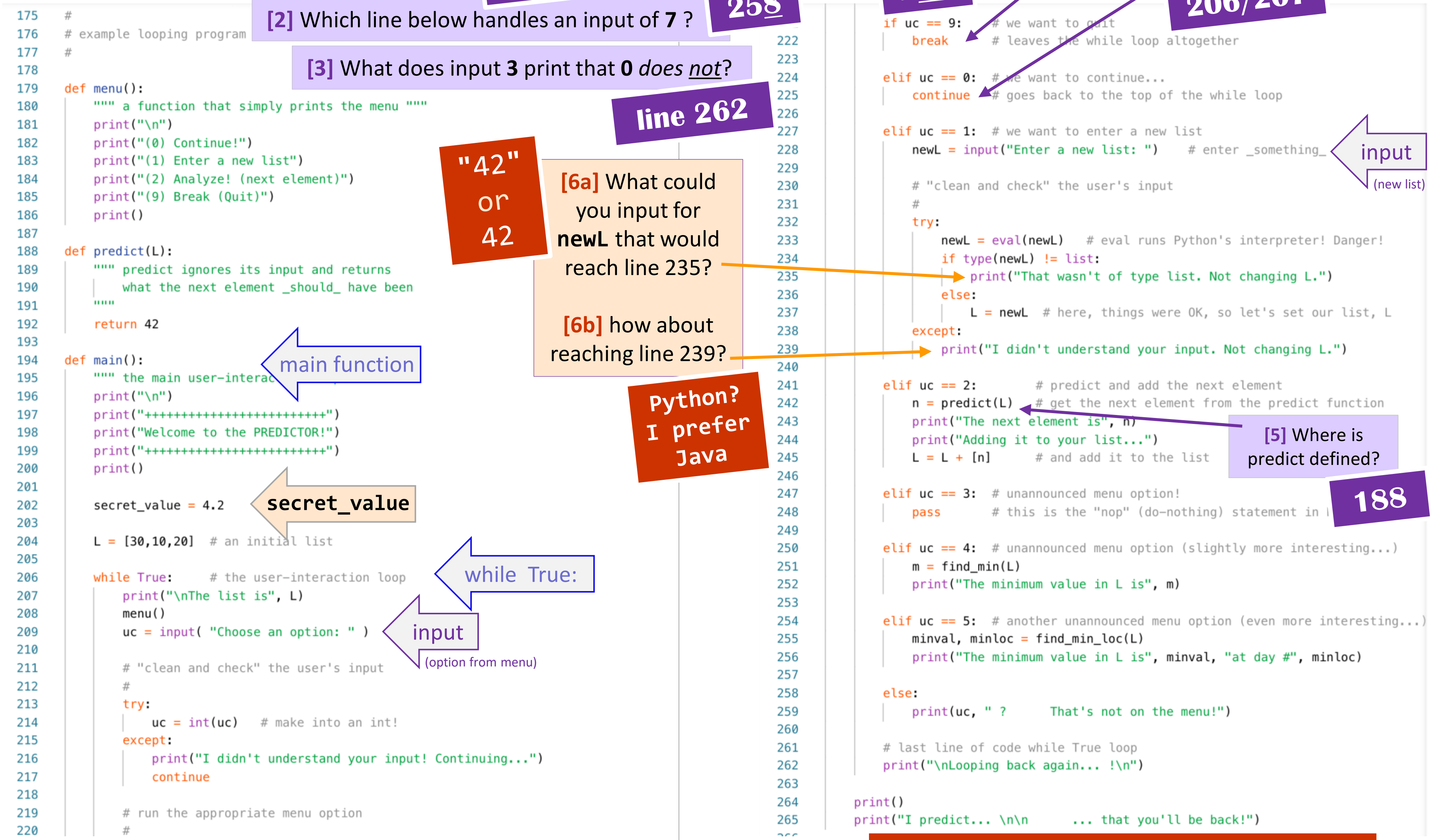
[0] Which line of code handles an input of **1** ? **227**

[1] Which line of code handles an input of **5** ? **254**

[2] Which line below handles an input of **7** ? **258**

[3] What does input **3** print that **0** *does not*? **line 262**

[4] What line of code runs after this **break** ? and **continue** ? **264** **206/207**



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[5] Where is predict defined? **188**

[6a] What could you input for **newL** that would reach line 235?

"42" or 42

[6b] how about reaching line 239?

Python? I prefer Java

[redacted]

[EC] How could a user learn the value of **secret_value** if they guessed that variable name *and* could run the program -- but *didn't have this source code*?

Full-program menu-interaction example

Sols...

Big-picture view!

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line 262

[4] What line of code runs after this **break** ? and **continue** ?

264

206/207

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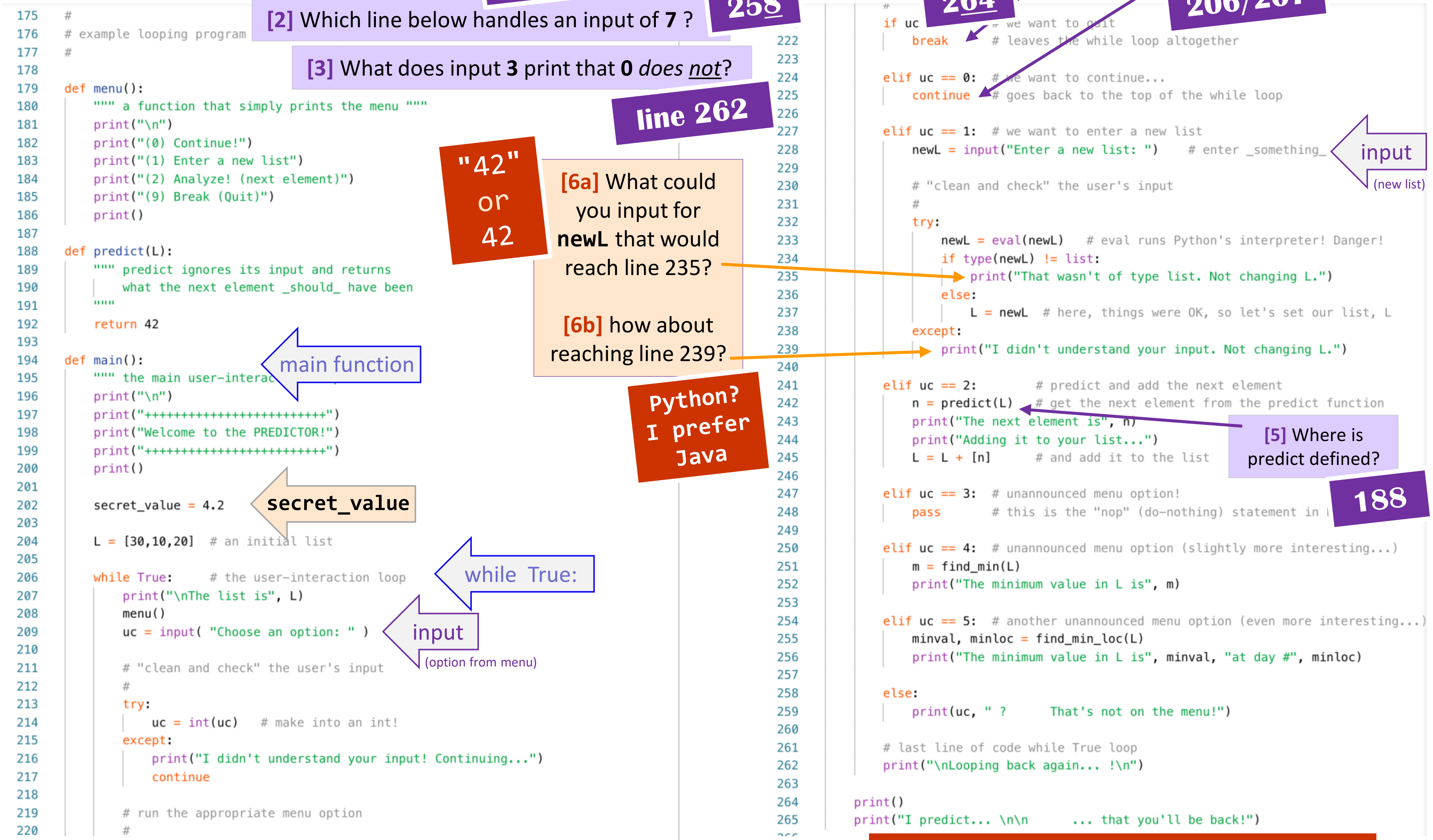

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234                     if type(newL) != list:
235                         print("That wasn't of type list. Not changing L.")
236                     else:
237                         L = newL  # here, things were OK, so let's set our list, L
238                 except:
239                     print("I didn't understand your input. Not changing L.")
240
241             elif uc == 2:        # predict and add the next element
242                 n = predict(L)   # get the next element from the predict function
243                 print("The next element is", n)
244                 print("Adding it to your list...")
245                 L = L + [n]      # and add it to the list
246
247             elif uc == 3:  # unannounced menu option!
248                 pass       # this is the "nop" (do-nothing) statement in
249
250             elif uc == 4:  # unannounced menu option (slightly more interesting...)
251                 m = find_min(L)
252                 print("The minimum value in L is", m)
253
254             elif uc == 5:  # another unannounced menu option (even more interesting...)
255                 minval, minloc = find_min_loc(L)
256                 print("The minimum value in L is", minval, "at day #", minloc)
257
258             else:
259                 print(uc, " ?      That's not on the menu!")
260
261             # last line of code while True loop
262             print("\nLooping back again... !\n")
263
264         print()
265         print("I predict... \n\n      ... that you'll be back!")
```

input [0, 1, 2, secret_value]

[EC] How could a user learn the value of **secret_value** if they guessed that variable name *and* could run the program -- but *didn't have this source code*?

Full-program menu-interaction example

Sols...

Loops

```
def fac( N ):
    result = 1
    for x i

    re
```

sequences!

Basic design strategies

Is one more *reasonable* than the other?

Recursion

```
def fac( N ):
    if N == 1:
        re
```

self-similarity

Loops

```
def fac( N ):
    result = 1
    for x in range(1,N+1):
        result *= x
    return result
```

Strategy: look for **repetition** + use it… .

Basic design strategies

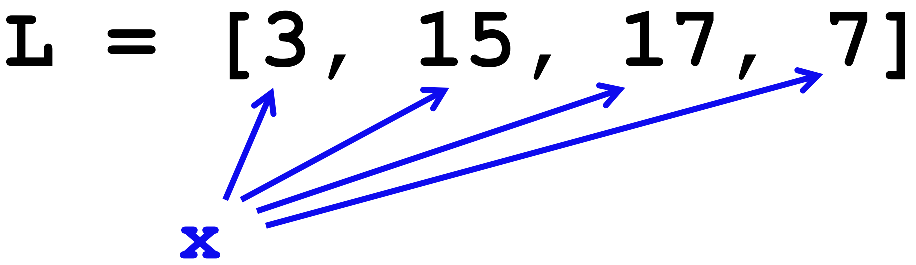
Strategy: Look for **self-similarity** + use it… .

Is one more *reasonable* than the other?

Recursion

```
def fac( N ):
    if N == 1:
        return 1
    else:
        return N*fac(N-1)
```

`for`: *two "loop patterns"*



```
L = [3, 15, 17, 7]
```

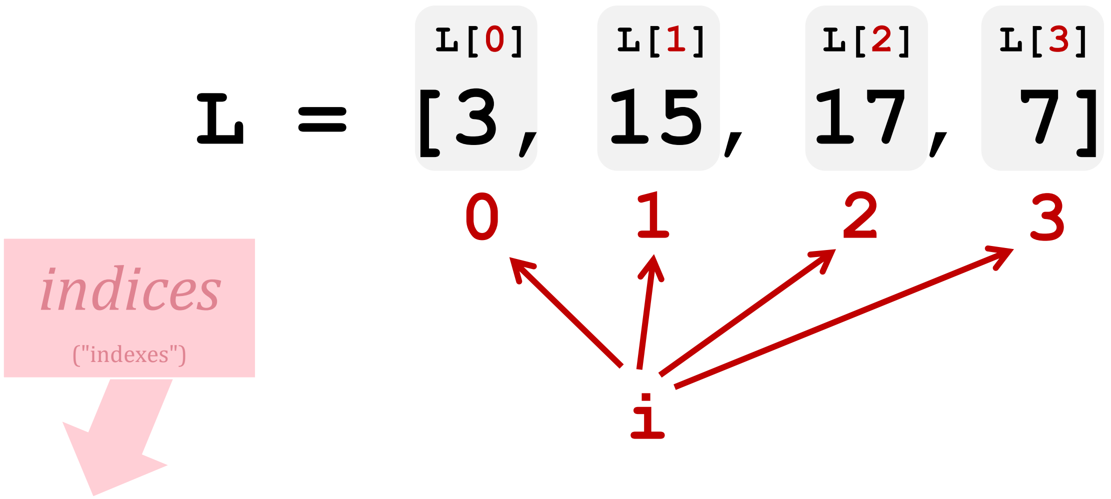
"deceptively easy"

elements

```
for x in L:
    total += x
```

element-based loops

`for`: *two "loop patterns"*



```
for i in range(len(L))
   total += L[i]
```

***index*-based loops**

— access data indirectly,
(by its *index*)

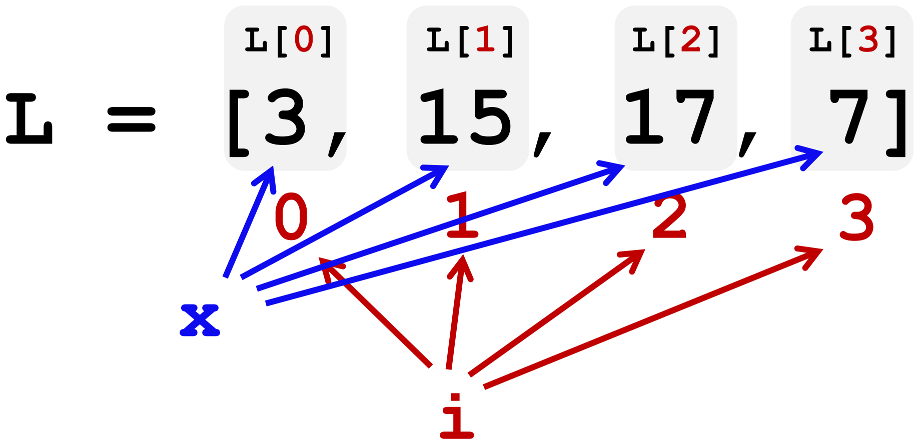
elements

```
for x in L:
   total += x
```

***element*-based loops**

— access data directly

for: *two "loop patterns"*



```
for i in range(len(L))
   total += L[i]
```

index-based loops
— access data i

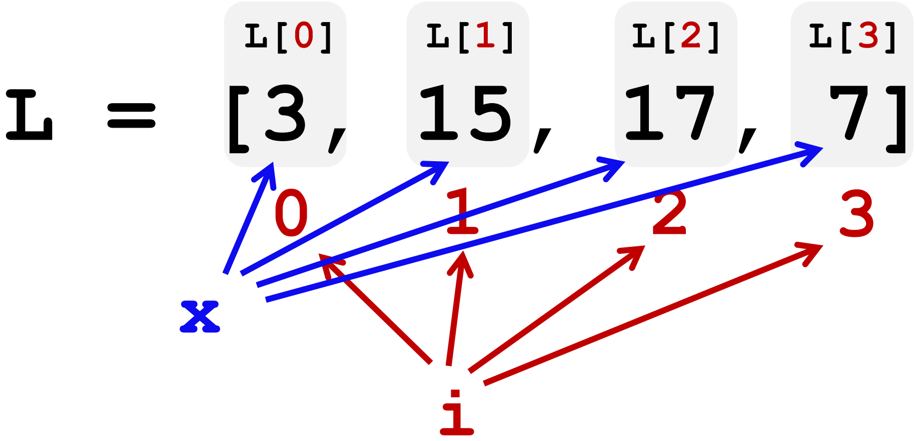
Elements vs Indexes

Indices

```
for x in L:
   total += x
```

element-based loops
— access data directly

`for`: *two variables*



```
for i in range(len(L))
   total += L[i]
```

index-ba

i

Elements vs Indexes

Indices

```
for x in
   total  =
```

x

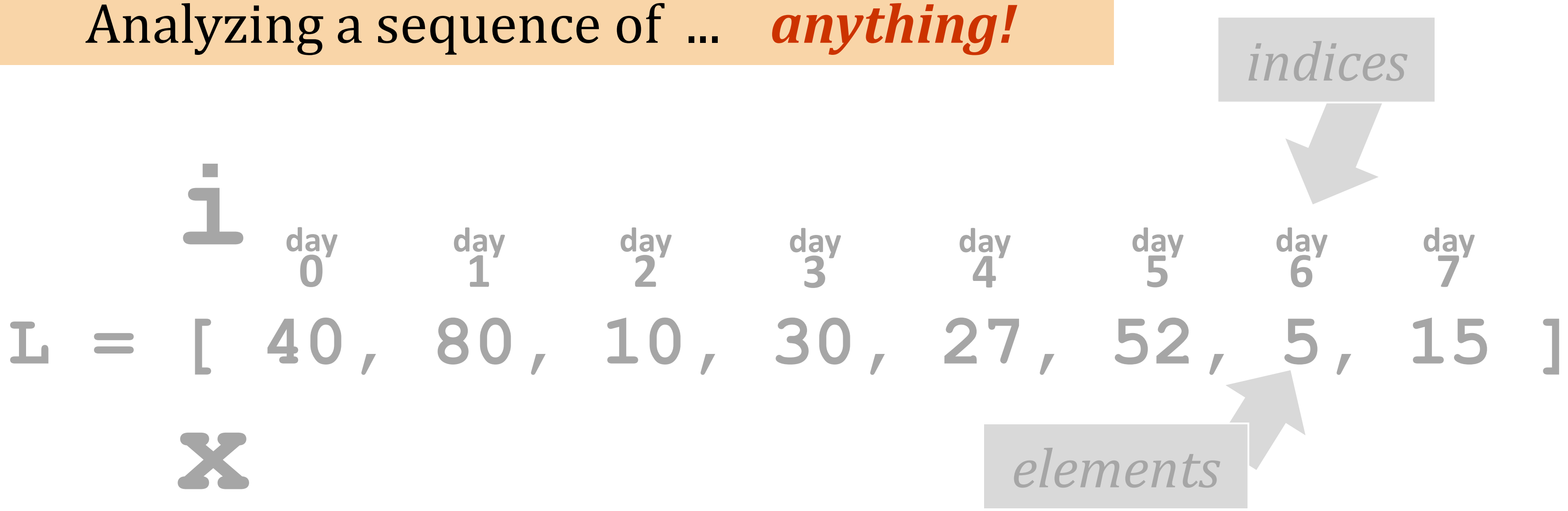
element-based loops

"Get into a rut...
and stay there!"

hw8pr4: T. T. Securities (TTS)

hw8pr4: T. T. Securities (TTS)

Analyzing a sequence of ... ***anything!***

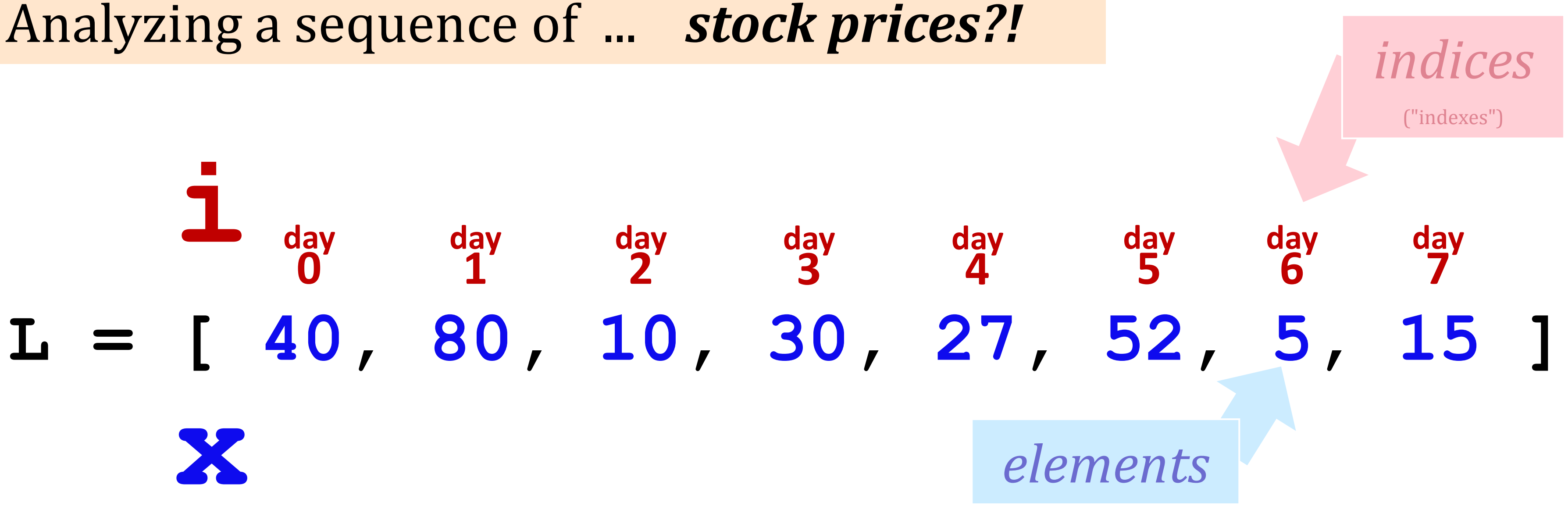


```
L = [ 40, 80, 10, 30, 27, 52, 5, 15 ]
```

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

hw8pr4: T. T. Securities (TTS)

Analyzing a sequence of ... ***stock prices?!***



tasks

```
(0)  Input a new list
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(4)  Find the min and its day
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Enter your choice:
```

hw8pr4: T. T. Securities (TTS)

Analyzing a sequence of ... ***stock prices?!***

*indices ~ **days***

i

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

```
L = [ 40, 80, 10, 30, 27, 52, 5, 15 ]
```

x

*elements ~ **prices***

Implement a (text) menu:

```
(0)  Input a new list
(1)  Print the current list
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(4)  Find the min and its day
(5)  Find the max and its day
(6)  Your TTS investment plan
(9)  Quit
Enter your choice:
```

```
webbrowser.open_new_tab(url)
```

let's see...

T. T. Securities

"Taking the broke out of brokerage."

Software side ...

```
(0)  Input a new list
(1)  Print the current list
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(3)  Find the standard deviation
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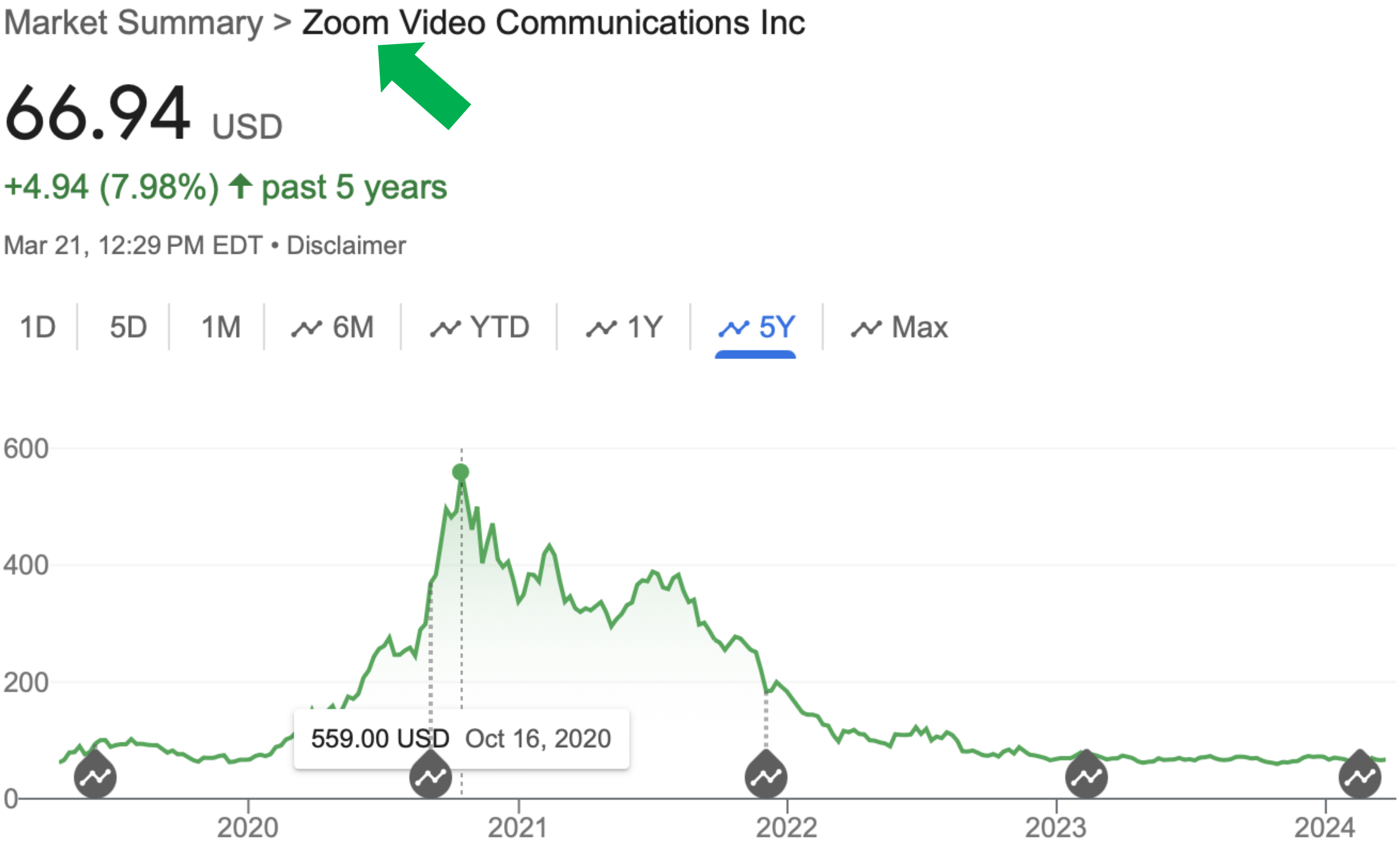
(9)  Quit
Enter your choice:
```

Hardware side...

Investment analysis for the 21st century ... *and beyond*

One motivation for TT securities…



Market Summary > Zoom Video Communications Inc

66.94 USD

+4.94 (7.98%) ↑ past 5 years

Mar 21, 12:29 PM EDT • Disclaimer

Name(s) ______________________________

The TTS-strategy:

[0] T.T. Securities's customer pledge:
"We select the day to buy and day to sell that ***will maximize your price-difference****..."**

Your stock's prices: L = [40, 80, 10, 30, 27, 52, 5, 15]

index	*element*
Day	**Price**
0	40.0
1	80.0
2	10.0
3	30.0
4	27.0
5	52.0
6	5.0
7	15.0

[1] What is the best TTS investment strategy for ***this list***, L?

It's **NOT** 75!

[1b] Which day would you _buy_ (and at what price) ?

[1c] Which day would you _sell_ (and at what price) ?

[1d] What is the per-share profit in this best case? (!!!)

```
for each buy-day, b:
    for each sell-day, s:
```

[2] How could ***nested loops*** help us find the *best* TTS strategy? *(a "code sketch...")*

Important fine print:

*To make our business plan **realistic**, however, we only allow selling ***after*** buying.

this *all* seems sketch...

Name(s) ______________________________

The TTS-strategy:

[0] T.T. Securities's customer pledge:
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Your stock's prices: L = [40, 80, 10, 30, 27, 52, 5, 15]

index **Day**	*element* **Price**
0	40.0
1	80.0
2	10.0
3	30.0
4	27.0
5	52.0
6	5.0
7	15.0

maximum price-difference: **42**

buy on **day 2**

sell on ***day 5***

[1] What is the best TTS investment strategy for ***this list***, L?

It's **NOT** 75!

[1b] Which day would you _buy_ (and at what price) ?

[1c] Which day would you _sell_ (and at what price) ?

[1d] What is the per-share profit in this best case? (!!!)

It's **42** :-)

```
set max-so-far = 0

for each buy-day, b:

    for each sell-day, s:

        compute the profit

        if profit is > max-so-far:

            remember it in a variable!

return profit, its b-day, and s-day
```

[2] How could ***nested loops*** help us find the *best* TTS strategy? *(a "code sketch...")*

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index	*element*
Day	**Price**
0	40.0
1	80.0
2	10.0
3	30.0
4	27.0
5	52.0
6	[illegible]
7	15.0

[1] What is the best TTS investment strategy for ***this list***, L?

It's **NOT** 75!

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[1c] Which day would you _sell_ (and at what price) ?

[1d] What is the per-share profit in this best case? (!!!)

It's **42** :-)

maximum price-difference: **42**

buy on **day 2**

Pass these into their own future!

```
set max-so-far = 0

for each buy-day, b:

    for each sell-...

        if profit is > max-so-far:

            remember it in a variable!

return profit, its b-day, and s-day
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[2] How could ***nested loops*** help us find the *best* TTS strategy? *(a "code sketch...")*

Important fine print:

this *all* seems sketch...

*To make our business plan **realistic**, however, we only allow selling ***after*** buying.

hw8pr4: T. T. Securities (TTS)

Analyzes a sequence of *"stock prices"*

```
      i  day  day  day  day  day  day  day  day
          0    1    2    3    4    5    6    7
L = [ 40, 80, 10, 30, 27, 52, 5, 15 ]
      x
```

Implement a text ***menu***:

```
(0) Input a new list
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(9) Quit
Enter your choice:
```

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Analyzes a sequence of *"stock prices"*

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    i  day   day   day   day   day   day   day  day
        0     1     2     3     4     5     6    7
L = [ 40,   80,   10,   30,   27,   52,   5,   15 ]
    x
```

Implement a (text) menu:

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 (0)  Input a new list
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Enter your choice:
```

Functions you'll write

All use loops…

Menu

```
(0) Input a new list
(1) Print the current list
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(5) Find the max and its day
(6) Your TTS investment plan
(9) Quit
Enter your choice:
```

```
def average( L )

def stdev( L )
```

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

```
def minprice( L )

def maxday( L )
```

also, max…

```
webbrowser.open_new_tab(url)
```

Min price

Just call **min** ?

```
      day   day   day   day   day   day   day   day
       0     1     2     3     4     5     6     7
L = [ 40,   80,   10,   30,   27,   52,   5,    15 ]
```

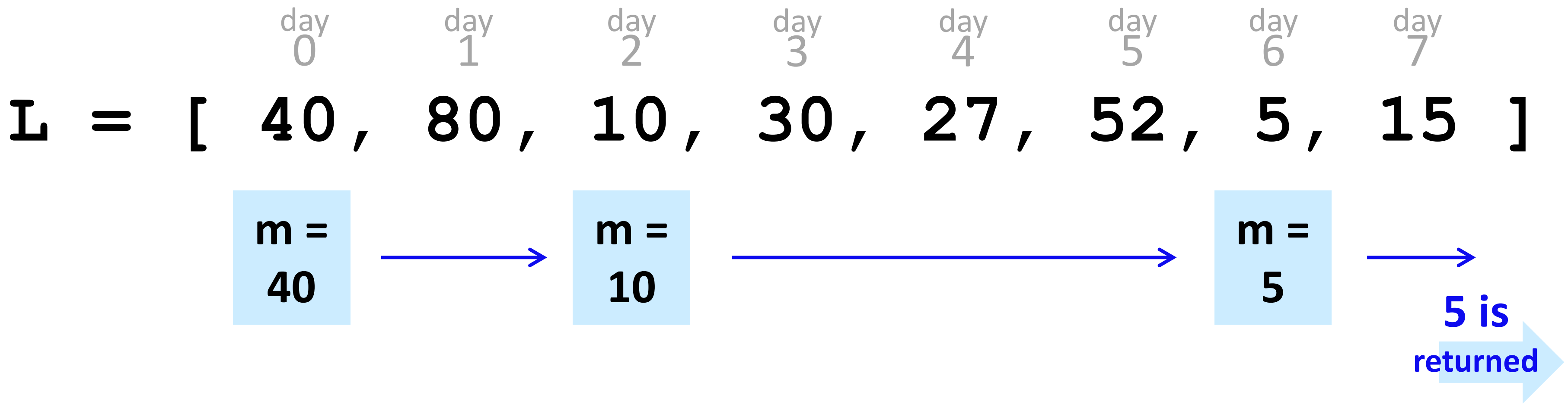
m =

m is the
"min so far"

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

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

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



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

```
L = [ 40, 80, 10, 30, 27, 52, 5, 15 ]
```

m = 40

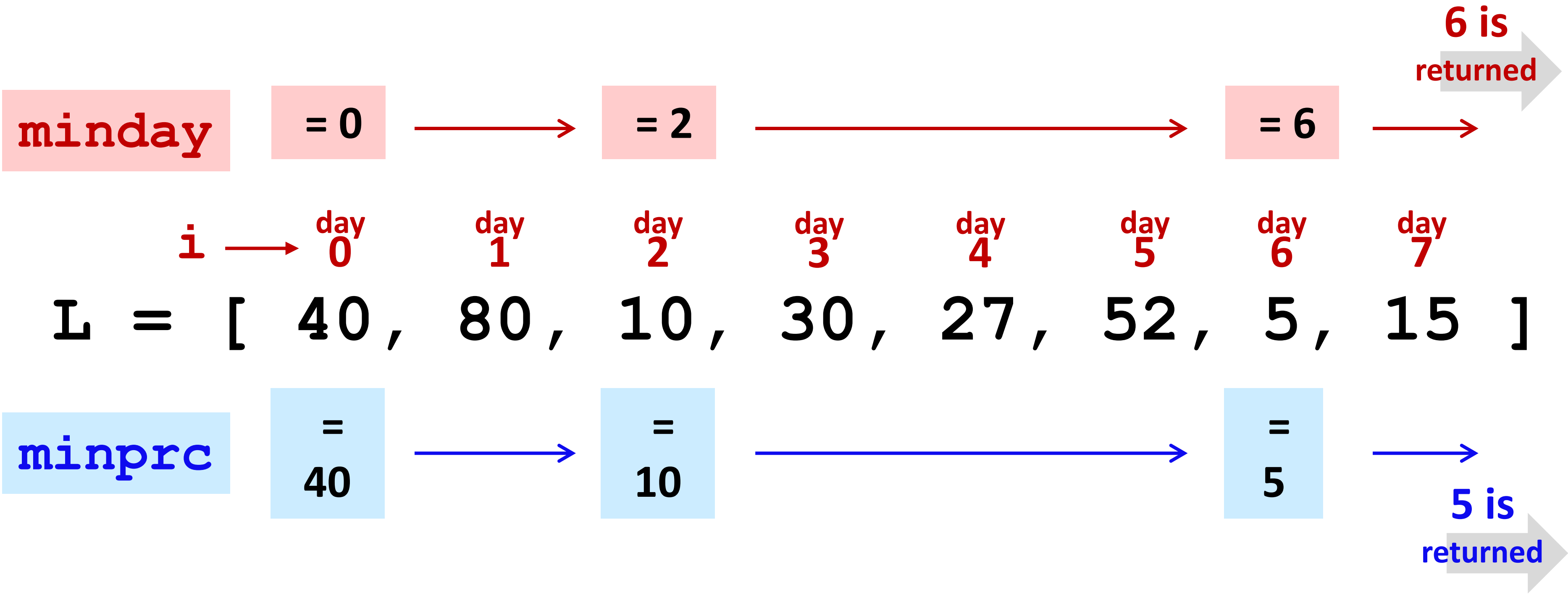
m = 10

m = 5

5 is returned

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

What about tracking BOTH the *day* of the minimum price ***and*** that min **price**?



6 is returned

minday = 0 = 2 = 6

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

L = [40, 80, 10, 30, 27, 52, 5, 15]

minprc = 40 = 10 = 5

5 is returned

```
def min_prc_day( L ):
   minprc = L[0]
   minday = 0
   for i in range(len(L)):
      if

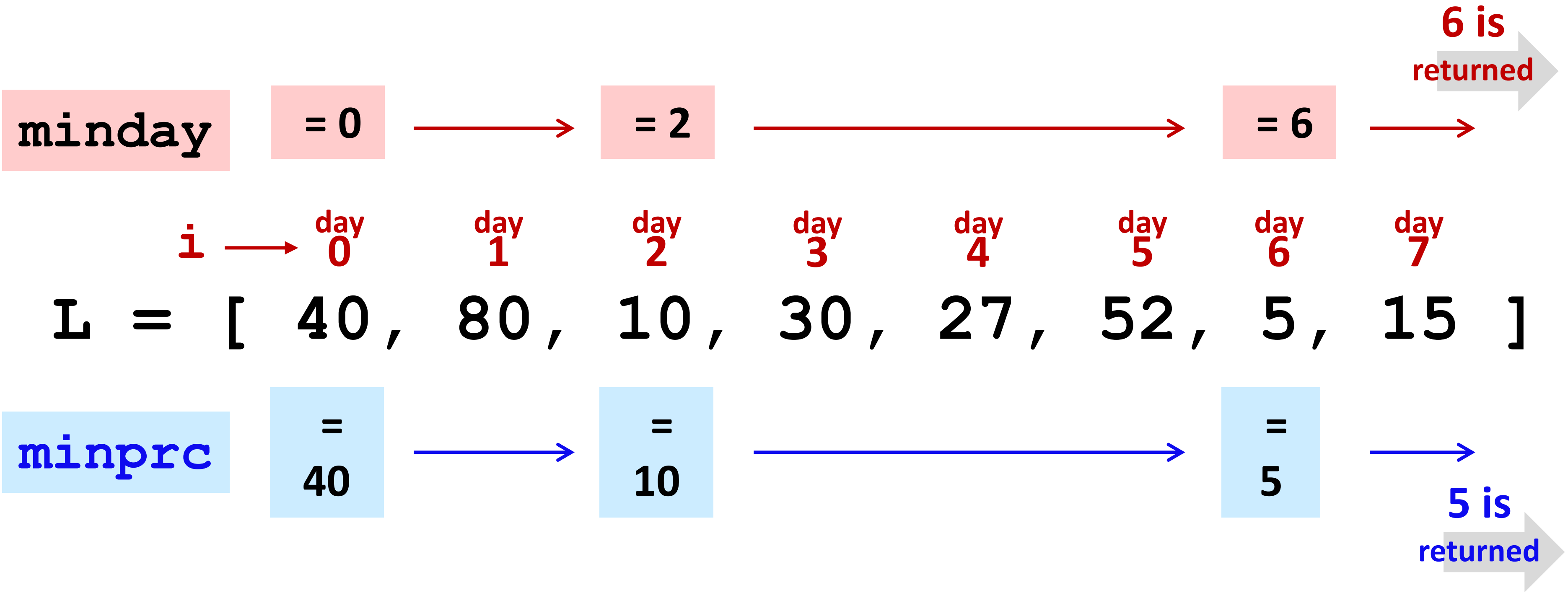

   return minprc, minday
```

track price *and* day

loop over **locs** (i)

check one and update both (as needed)

return *both*!



minday

= 0

= 2

= 6

6 is returned

i

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

L = [40, 80, 10, 30, 27, 52, 5, 15]

minprc

= 40

= 10

= 5

5 is returned

```
def min_prc_day( L ):
   minprc = L[0]
   minday = 0
   for i in range(len(L)):
      if L[i] < minprc:
         minprc = L[i]
         minday = i
   return minprc, minday
```

track price *and* day

loop over locs (i)

check one and update both

(as needed)

return *both*!

The TTS advantage!

What is the best TTS investment strategy here?

Your stock's prices: L = [40, 80, 10, 30, 27, 52, 5, 15]

```
Day   Price
 0     40.0
 1     80.0
 2     10.0
 3     30.0
 4     27.0
 5     52.0
 6      5.0
 7     15.0
```

```
(0)  Input a new list
(1)  Print the current list
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```
set max-so-far = 0

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        compute the profit

        if profit is > max-so-far:

            remember it in a variable!

return profit, its b-day, and s-day
```

Important fine print:

To make our business plan **realistic**, however, we only allow selling ***after*** buying.

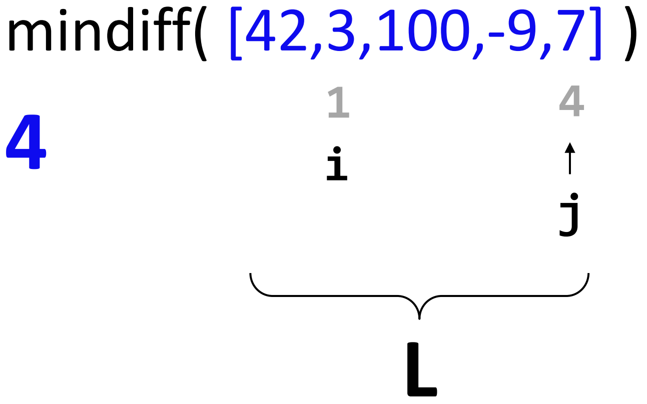
mindiff([42,3,100,-9,7])

Write **mindiff** to return the **smallest** abs. diff. between any two elements from **L.**

mindiff([42,3,100,-9,7])

Hint: This uses nested loops!

Write **mindiff** to return the **smallest** abs. diff. between any two elements from **L.**



mindiff([42,3,100,-9,7])

4

mindiff([42,3,100,-9,7])

4

Hint: This uses nested loops!

```
for i in range(4):
  for j in range(4):
```

Track the value of the *minimum so far* as you loop over **L twice**...

Write **mindiff** to return the **smallest** abs. diff. between any two elements from **L.**

```
def mindiff( L ):

    mdiff = abs(L[1]-L[0])

    for i in range(len(L)):
        for j in range(    ,len(L)):

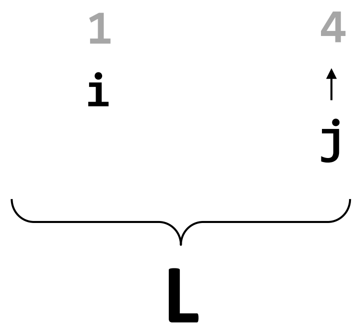
            if 



    return mdiff
```

mindiff([42,3,100,-9,7])

4



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for i in range(4):
   for j in range(4):
```

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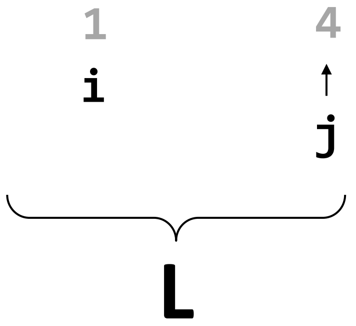
Write **mindiff** to return the **smallest** abs. diff. between any two elements from **L.**

mindiff([42,3,100,-9,7])

4



```
def mindiff( L ):

   mdiff = abs(L[1]-L[0])

   for i in range(len(L)):
      for j in range(i+1,len(L)):

         if abs(L[j]-L[i]) < mdiff:
            mdiff = abs(L[j]-L[i])

   return mdiff
```

Hint: This uses nested loops!

```
for i in range(4):
   for j in range(4):
```

Track the value of the *minimum so far* as you loop over **L twice**...

The TTS advantage!

What is the best TTS investment strategy here?

very similar to mindiff

You

, 10, 30, 27, 52, 5, 15]

Day	Price
0	40.0
1	80.0
2	10.0
3	30.0
4	27.0
5	52.0
6	5.0
7	15.0

```
set max-so-far = 0

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    for each sell-day, s:

        compute the profit

        if profit is > max-so-far:

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return profit, its b-day, and s-day
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Important fine print:

To make our business plan **realistic**, however, we only allow selling ***after*** buying.

The TTS advantage!

What is the best TTS investment strategy here?

Your stock's prices: L = [40, 80, 10, 30, 27, 52, 5, 15]

Day	Price
0	40.0
	30.0
4	27.0
5	52.0
6	5.0
7	15.0

```
set max-so-far = 0

    each sell-day, s:
        compute the profit
        if profit is > max-so-far:
            remember it in a variable!
return profit, its b-day, and s-day
```

See "future you" next week!

... hw8 is ready to help!

Important fine print:

To make our business plan **realistic**, however, we only allow selling ***after*** buying.