Week 3a: for, list processing, range, project

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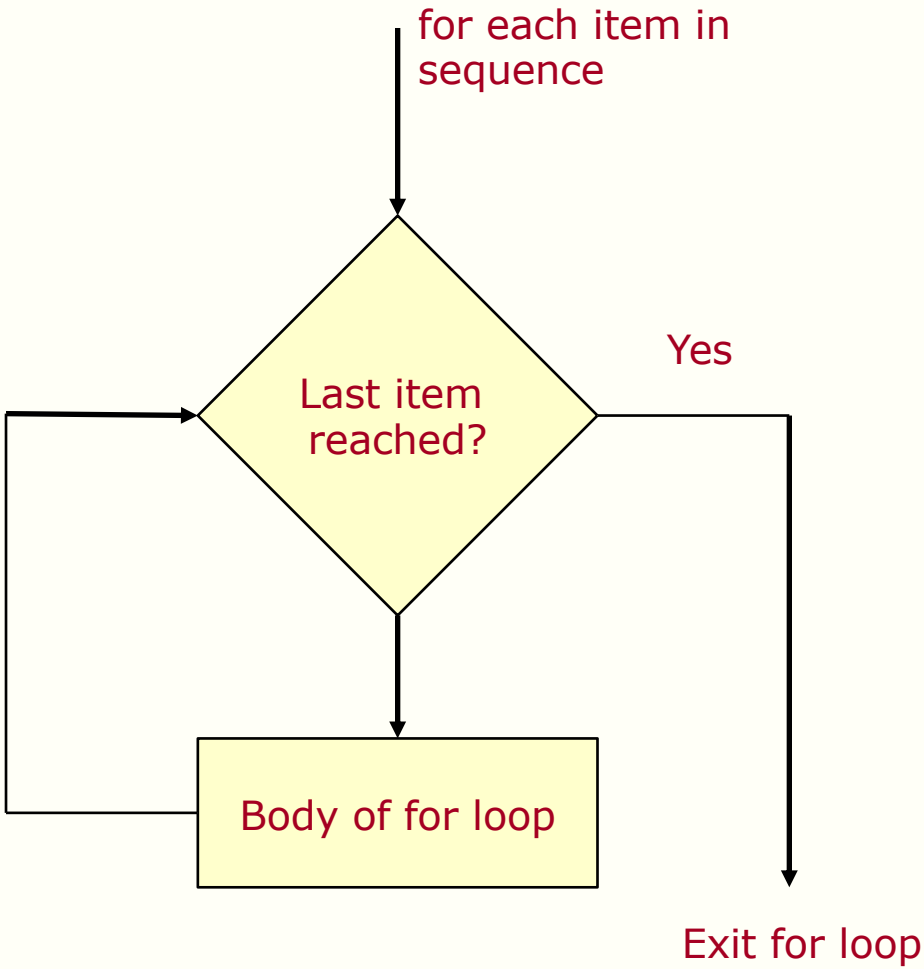
Thanks to Chun Tung Chou

and Ashesh Mahidadia

Lecture 3A

- The key topic today is the for-loop
- We will also do an in-class project which makes use of a few topics that you have learnt so far. These topics are:
  - List, for-loop, function, plotting

Why using loops in programming?



*The power of this is that the **for** loop continues until we reach the last item in the sequence*

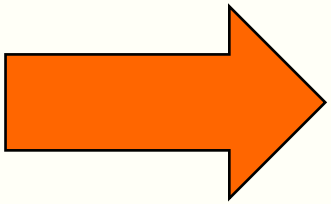
Iteration (Repetition)

- Often need to execute statements repeatedly
- Loops are statements that can do this
- Process is called iteration
- Kinds of loop:
  - For (iterate a fixed number of times)
  - While (iterate as long as something is True)
- We will spend a part of the lecture in the next few weeks to learn about loops

G’day, mate!

- I wish to say G’day to the student in an ENGG1811 class.
- I’ve created a list of names. There are 379 names.

```
Sanjula
Badi
Labeeb
Alex
Ahmed
Kais
Ethan
Lucy
Esmaeel
Rabie-Bin
Michelle
Patricia
Samaita
Charbel
Chelsea
Mana
```



```
G'day, Sanjula
G'day, Badi
G'day, Labeeb
G'day, Alex
G'day, Ahmed
G'day, Kais
G'day, Ethan
G'day, Lucy
G'day, Esmaeel
G'day, Rabie-Bin
G'day, Michelle
G'day, Patricia
G'day, Samaita
G'day, Charbel
G'day, Chelsea
G'day, Mana
```

We can use the following code:

```
1 print("G'day,Sanjula")
2 print("G'day,Badi")
3 print("G'day,Labeeb")
4 print("G'day,Alex")
5 print("G'day,Ahmed")
6 print("G'day,Kais")
7 print("G'day,Ethan")
8 print("G'day,Lucy")
9 print("G'day,Esmaeel")
10 print("G'day,Rabie-Bin")
11 print("G'day,Michelle")
12 print("G'day,Patricia")
13 print("G'day,Samaita")
14 print("G'day,Charbel")
15 print("G'day,Chelsea")
16 print("G'day,Mana")
```

There are still 363 lines ☹

The enlightened way

- The code is in gday.py

```
 7 # The names of the students are stored in a file
 8 # called first_names.txt
 9 # The following lines of code read the file and
10 # store the names in a list
11 with open('first_names.txt') as f:
12     student_name_list = f.read().splitlines()
13
14 # The variable student_name_list is a Python list
15 # containing the names
16
17 # Say G'day to everyone
18 for name in student_name_list:
19     print("G'day,",name)
20
```

These two lines of code print out the 379 G'day

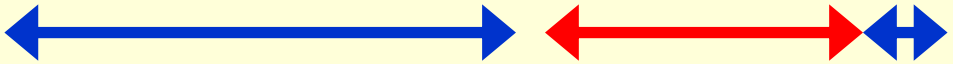
Writing for-loop

- End result wanted

```
G'day, Charlie
G'day, Hannah
G'day, Olivia
G'day, Usman
```

- Long code

```
print("G'day,", "Charlie" )
print("G'day,", "Hannah"  )
print("G'day,", "Olivia"  )
print("G'day,", "Usman"   )
```



The same for each line

Vary for each line

- For loop

A list containing what is to be varied for each line

```
for name in ["Charlie", "Hannah", "Olivia", "Usman"]:
    print("G'day, ", name )
```

For loop

```
for name in ["Charlie", "Hannah", "Olivia", "Usman"]:
    print("G'day, ",name)
```

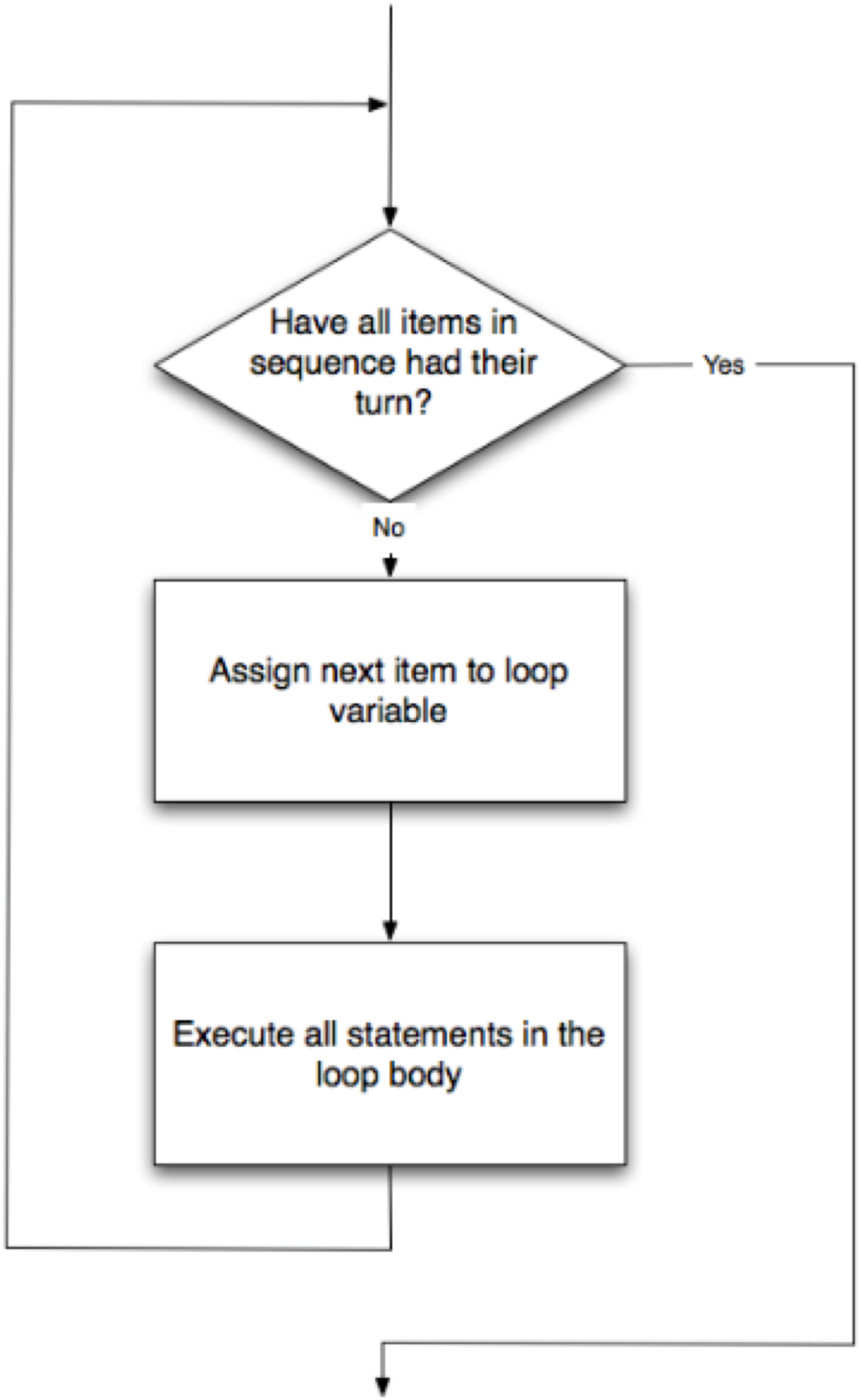
- The code is in gday_explained.py
- Let us copy the code to Python Tutor and see how it is executed
- http://pythontutor.com/

The for-loop explained

```
for name in ["Charlie", "Hannah", "Olivia", "Usman"]:
    print("G'day, ",name)
```

- The variable **name** is called the loop variable
- Code under for-loop is indented
- The loop variable is assigned to the first item in the list
- **name** is now the string "Charlie". The code in the for-loop is executed assuming this value of **name**
- After executing the code under the for-loop, execution return to the for-line. The computer checks whether there is a next item in the list. Yes, there is so the computer assigned "Hannah" to the variable **name.** The code in the for-loop is executed assuming this value of **name**
- This is repeated until all items in the list have been used

Flowchart



http://interactivepython.org/runestone/static/thinkcspy/PythonTurtle/FlowofExecutionoftheforLoop.html

Exercise

- The file is for_exercise_prelim.py
- Use a for loop to replace the following five statements:

```
print('The square of',1,'is',1**2)
print('The square of',2,'is',2**2)
print('The square of',3,'is',3**2)
print('The square of',5,'is',5**2)
print('The square of',7,'is',7**2)
```

- To get started:

```
for num in        :
    print('The square of',    ,    ,    )
```

Using for-loops to create a list from another list

- Very often you may need to create a list from another list
- For example, you are given the list

  [2, -3, 4, -5]

  and you want to compute the cube of each number and store the results in a new list, which is:

  [8, -27, 64, -125]

- There are two methods you can do this. We will use .append() today.

- Let us first understand what .append() does first

Appending an element to a list

```
In [7]: a_list = [3,-5,9]

In [8]: a_list.append(-1)

In [9]: a_list
Out[9]: [3, -5, 9, -1]

In [10]: a_list.append(-7)

In [11]: a_list
Out[11]: [3, -5, 9, -1, -7]
```

```
In [27]: b_list = [] # An empty list

In [28]: b_list.append(-1)

In [29]: b_list
Out[29]: [-1]
```

Example: Create a list from another list (1)

- Use the list [2, -3, 4, -5] to create the new list [8, -27, 64, -125] using .append()

```
num_list = [2,-3,4,-5]

new_list_1 = []  # An empty list

for num in num_list:
    new_num = num**3
    new_list_1.append(new_num)
```

- Code in the first cell in create_list_ex.py
- Visualize with Python tutor http://pythontutor.com/

Example: Create a list from another list (2)

```
for num in num_list:
    new_num = num**3
    new_list_1.append(new_num)
```

- The operation performed on each element of the list.
- We can make it more complicated.
  - Example: If num > 0, compute its cube; otherwise, square it

```
for num in num_list:
    if num > 0:
        new_num = num**3
    else:
        new_num = num**2
    new_list_2.append(new_num)
```

- Code in the second cell in create_list_ex.py

Example: Create a list from another list (3)

```
for num in num_list:
    if num > 0:
        new_num = num**3
    else:
        new_num = num**2
    new_list_2.append(new_num)
```

- We can move these lines of code into a function and call the function within the loop

- Code in the third cell in create_list_ex.py

Cells in Spyder

- Spyder allows us to divide the code into cells and we can run the code in each cell independently
  - Good for testing and debugging code
  - To run a cell, make sure your mouse cursor is in that cell and click 

Operations on list

- You know how to append an element to a list
- There are other operations that you can do on a list
  - Finding the maximum or minimum element in a list
  - Sum the elements in a list
  - Determining the number of elements in a list
    - Terminology: length of a list = number of elements in a list
  - See list_processing.py
  - There are many other operations:
    - E.g. sort, count the occurrence of a value etc.
    - See https://www.programiz.com/python-programming/methods/list

range()

- range() is a Python function that generates a sequence of integers
- The function can take 1 to 3 inputs and its behaviour depends on the number of inputs
- Examples in range_ex.py

range() expression	sequence	explanation
range(5)	0,1,2,3,4	One input. Starting from 0. Keep increasing by 1. Does not including the number specified by the input.
range(2,8)	2,3,4,5,6,7	Two inputs. 1st number in list = 1st input

- With 2 inputs, the function has the form range(start,stop)
  - range(0,stop) is the same as range(stop)
- #elements in the list = stop - start

range()

range() expression	sequence	explanation
range(2,20,4)	2,6,10,14,18, ~~22~~  (Error: 22 should not be included)	The first input (=2 in this example) is the starting value of the sequence. The last input (= 4 in this example) is the increment. The next element of the sequence is obtained by adding the increment to the element before: 2, 2 + 4, 2 + 4 + 4 Keep incrementing until a number >= the last input (= 20 in this case) is reached. Stop but don't include the last number generated.

- The general form is range(start,stop,inc)
- #elements in the list = ceil ((stop-start)/inc)
  - ceil(x) = smallest integer greater than or equal to x

Project: goal

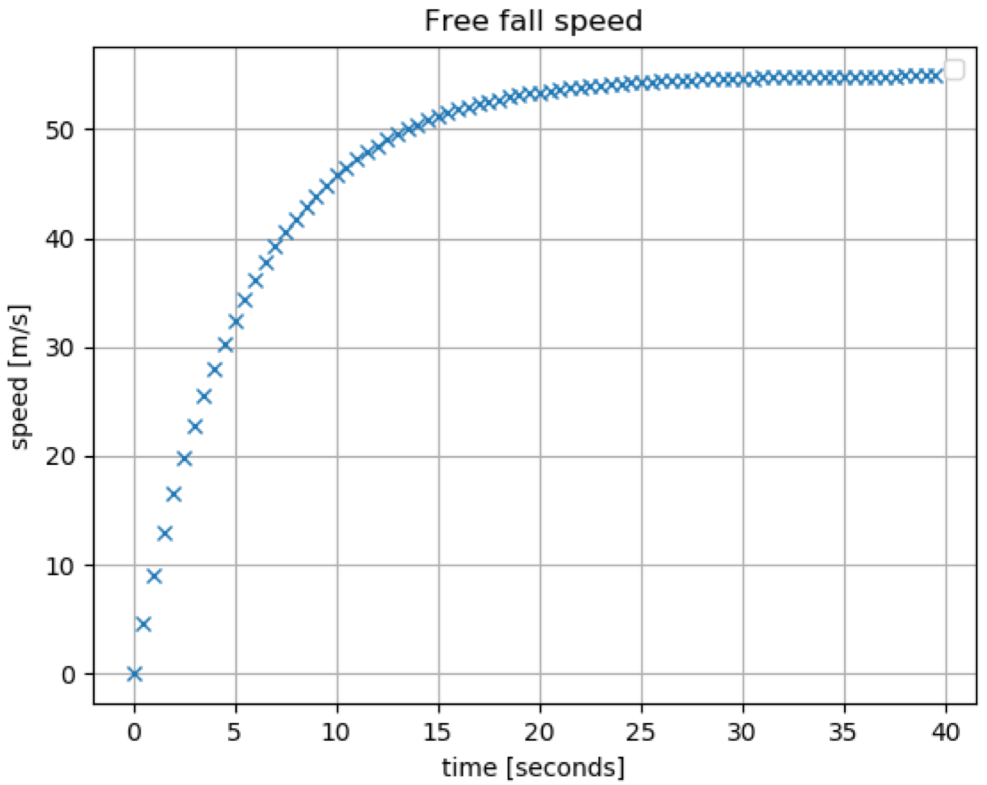
- If you drop an object of mass *m* in a medium with drag coefficient *d* and acceleration due to gravity *g*, then the object's speed *v(t)* at time *t* is given by:

$$v(t) = \frac{gm}{d}\left(1 - e^{-\frac{d}{m}t}\right)$$

- Given the numerical value of *m*, *g* and *d*, the goal of the project is to plot *v(t)* against *t*
  - for t = 0, 0.5, 1, 1.5, …., 39.5, 40
- You certainly know how to do this by using pen, paper and calculator. You may also need a bit of perseverance because it does get a bit repetitive

Project: end product

- You will do it in Python
- The end product



Part 1: Write a function

- mass *m*, drag coefficient *d*, acceleration due to gravity *g*
- speed *v(t)* at time *t* is:

$$v(t) = \frac{gm}{d}\left(1 - e^{-\frac{d}{m}t}\right)$$

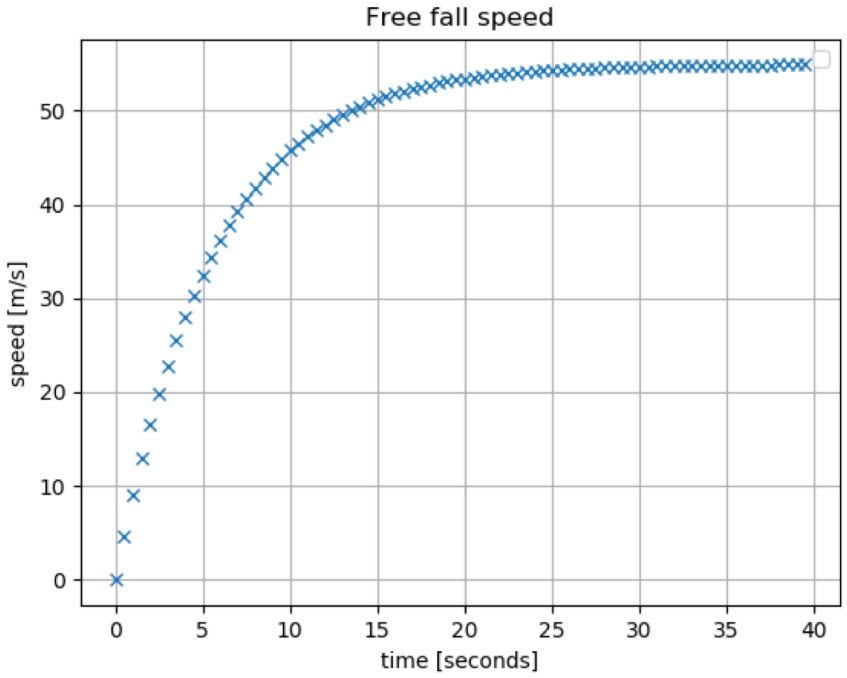
- Exercise:
  - Open the file project_prelim.py
  - Write a function called free_fall() to compute *v(t)*
    - The def line of the function is given in Line 16:

```
def free_fall(t,mass,drag):
```

    - The calculation requires:
      - Constant g – defined in Line 13
      - The math library (imported in Line 9) and math.exp() to calculate exponential. E.g math.exp(-2.1) gives $e^{-2.1}$
    - The function should return the computed speed
    - Testing: Lines 28 & 29 have the expected values

Part 2: Producing the graph

- You want to plot a graph of the free fall speed against time
- In order to produce the graph, you need to create two lists



List of time instants

- The first list is a list of time instants (in seconds). We ask you to use:

```
[0  0.5  1  1.5  2  2.5                              39.5  40]
```

- There are 81 numbers in the list and of course you are not going to type these 81 numbers in
- The function range() will be useful here but you need to know range() can only generate a sequence of integers, it cannot generate numbers with decimal points
- The hints are:
  - You can generate this list by using range() together with a for-loop
  - The numbers are all multiples of a constant

List of speeds

- The second list is a list of speeds
- If you do this *manually*, you will do:
  - Time is 0. Use the speed formula. Speed = 0.
  - Time is 0.5. Use the speed formula. Speed = 4.692400935
  - Time is 1. Use the speed formula. Speed = 8.98399681455

  - Time is 40. Use the speed formula. Speed = 54.8885179036
- Of course, you aren't going to do the manual way since you have seen the trick
- You should use the list of times and the function you wrote
  - File project_prelim.py

Summary

- For-loop
  - To repeatedly do some actions
- List processing
- Range

End

Week 3a: for, list processing, range, project