Iteration I

A loop allows you to execute the same statements multiple times. Python has two kinds of loop structures: `for` loops, which iterate over the items of a sequence, and `while` loops, which continue to execute as long as a condition is true. This week we will study `for` loops.

Warm-up

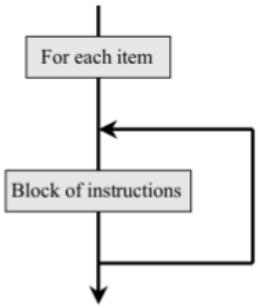
1. Complete the following code that reads in scores separated by a comma and prints the minimum, maximum and average score.

```
def ____________________________________________________________:
    
    
    
    
    
    
    
    
    
    
def main() -> None:
    scores = input("Scores: ") // user inputs: "90.5,99.0,94.5,97.0"
    ____________________________________________________________
    print(__________________) // expected output: [90.5,99.0,95.25]

main()
```

Model 1 `for` Statements

A `for` loop executes the same block of code "for each item in a sequence". The instructor will trace `loops.py`, that contains the following code:

```
def main() -> None:
    print("hello")
    for x in [2, 7, 1]:
        print("the number is", x)
    print("goodbye")

main()
```



2. How many times does the indented line of code execute under the `for` loop? 3 times

3. How many times does the line of code NOT indented execute after the `for` loop? 1 time

4. Identify the value of `x` each time the indented line of code is executed.

   a) 1st time: x = 2

   b) 2nd time: x = 7

   c) 3rd time: x = 1

5. Indicate how many times the `for` loop executes.

   a) non-consecutive numbers: `[5, -7, 0]` 3 times

   b) numbers decreasing in value: `[3, 2, 1, 0]` 4 times

   c) all have the same value: `[4, 4]` 2 times

   d) single value in a list: `[8]` 1 time

6. In general, what determines the number of times that the loop repeats?

The length of the list.

7. What determines the value of the variable `x`? Explain your answer in terms of what is assigned (`x = ...`) each time the loop runs.

The value `x` is selected from the list. Each time the loop runs, the next value from the list is assigned to `x`.

8. ***Loop tables*** are very useful when tracing the changes to the state inside of the loop. Draw the loop table corresponding to the code used in the demo:

x	Output
2	the number is 2
7	the number is 7
1	the number is 1
outside the loop	goodbye

9. Consider the following modifications to the program:

   a) Write a statement that assigns `[0, 1, 2, 3, 4]` to the variable `numbers`.

```
numbers = [0, 1, 2, 3, 4]
```

   b) Rewrite the `for x ...` statement to use the variable `numbers` instead.

```
for x in numbers:
```

c) Does the assignment need to come before or after the `for` statement?

Before

10. Consider the following code snippet:

```
for c in "Hi!":
    print(c)
```

a) What is the output of this `for` statement?

```
H
i
!
```

b) What determined how many times `print(c)` was called?

The length of the string

c) Explain what a `for` statement does with strings.

It iterates over each character

11. What data types can and can't a `for` loop handle?

Sequences like lists and strings; Numbers don't work; you can loop over integers and floats.

Model 2 The `range` Function

The Python `range` function will generate a list of numbers. The `range` function can take up to three numbers as arguments. Fill in the table below:

Python code	Output
`range(5)`	range(0, 5)
`list(range(5))`	[0, 1, 2, 3, 4]
`x = range(3)`	
`print(x)`	range(0, 3)
`print(list(x))`	[0, 1, 2]
`list(range(5, 10))`	[5, 6, 7, 8, 9]
`list(range(-3, 4))`	[-3, -2, -1, 0, 1, 2, 3]
`list(range(4, 10, 2))`	[4, 6, 8]
`for i in range(5):` `  print(i)`	prints 0, 1, 2, 3, 4 (separate lines)

12. Explain the difference in output between the first two lines of code (with and without the `list` function).

The first line of output describes the range as a function. The second line shows the actual range of values as a list.

13. If the argument of the `range` function specifies a single number (x):

a) What will be the first number listed? 0

b) What will be the last number listed? x - 1

c) How many numbers will be in the list? x

d) Use the range function to generate the sequence 0, 1, 2, 3. range(4)

14. If the argument of the `range` function specifies two numbers (x, y):

a) What will be the first number listed? x

b) What will be the last number listed? y - 1

c) How many numbers will be in the list? y - x

d) Use the range function to generate the sequence 1, 2, 3, 4. range(1, 5)

15. If the argument of the `range` function specifies three numbers (x, y, z):

a) What will be the first number listed? x

b) What does the third argument represent? how much to add each time

c) How many numbers will be in the list? $\lceil (y - x)/z \rceil$

d) Use the range function to generate the sequence 1, 3, 5, 7. range(1, 8, 2) or range(1, 9, 2)

16. Modify the `for` statement in Model 1 so that the number of times the loop executes is determined by a variable named `times`.

a) How did you change the `for` statement?

```
for i in range(times):  # no need for list() conversion
```

b) How would you cause the loop to print the values 0 to 5?

Add this line before the loop: `times = 6`

17. Consider the two different types of `for` statements used in Model 1 and 2.

a) If you wanted to execute a loop 100 times, which type of `for` statement would you choose and why?

for i in range(number), so that you don't have to specify the list.

b) If you wanted to use each item of an existing list inside the loop, which type of `for` statement would you choose and why?

for i in list, since the list exists already and might not be a range.

18. Does the `range` function work with strings? If so, show an example. If not, show how to print the letters A to Z in a loop.

The arguments to range must be integers. You can use the built-in function `chr` to convert integers to their corresponding Unicode characters:

```
for i in range(65, 91):
    print(chr(i))
```

Model 3 The Accumulator Pattern

The pattern of iterating the updating of a variable is commonly referred to as the ***accumulator pattern***. We refer to the variable as the ***accumulator***. The anatomy of the accumulation pattern includes:

- ***initializing an accumulator variable*** to an initial value (such as 0 if accumulating a sum).
- ***iterating*** (e.g., traversing the items in a sequence).
- ***updating the accumulator variable*** on each iteration (i.e., when processing each item in the sequence).

Consider the following code snippet:

```
1 mystery = "@4b!"
2 count = 0
3 for w in mystery:
4     count = count + 1
5 print(count)
```

19. Which line of code initializes the accumulator variable? 2

20. Which line of code is iterating? 3

21. Which line of code updates the accumulator variable? 4

22. What is the purpose of this code snippet?

It counts how many characters are in the string `mystery`.

23. Draw the loop table corresponding to this code snippet:

w	count
'@'	1
'4'	2
'b'	3
'!'	4

24. Write a for loop that makes a copy of `mystery` by copying each character one-by-one and then prints the result:

```
mystery = "@4b!"
copy = ""
for c in mystery:
    copy = copy + c
print(copy)
```

25. Draw the loop table corresponding to the previous code snippet:

c	copy
'@'	'@'
'4'	'@4'
'b'	'@4b'
'!'	'@4b!'

26. Write a for loop that reverses the characters in `mystery` and then prints the result:

```
mystery = "@4b!"
reversed = ""
for c in mystery:
    reversed = c + reversed
print(reversed)
```

27. Draw the loop table corresponding to the previous code snippet:

c	reversed
'@'	'@'
'4'	'4@'
'b'	'b4@'
'!'	'!b4@'