Information, Computation, Communication
Learning Python

Loops – Part II

Agenda

- `enumerate()`
- Nested loops
- Early exit or interrupting loops
    - `break`
    - `continue`
- Nested lists
    - Matrices
    - Nested list comprehension

Next: **Midterm exam**

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Function Enumerate

enumerate()

- …is a built-in Python function that returns not only the **element** of a list but also its corresponding **index** in the list

```
for index, value in enumerate(my_list):  # traverse the list
    # do some computation involving index and/or value
```

Example: enumerate()

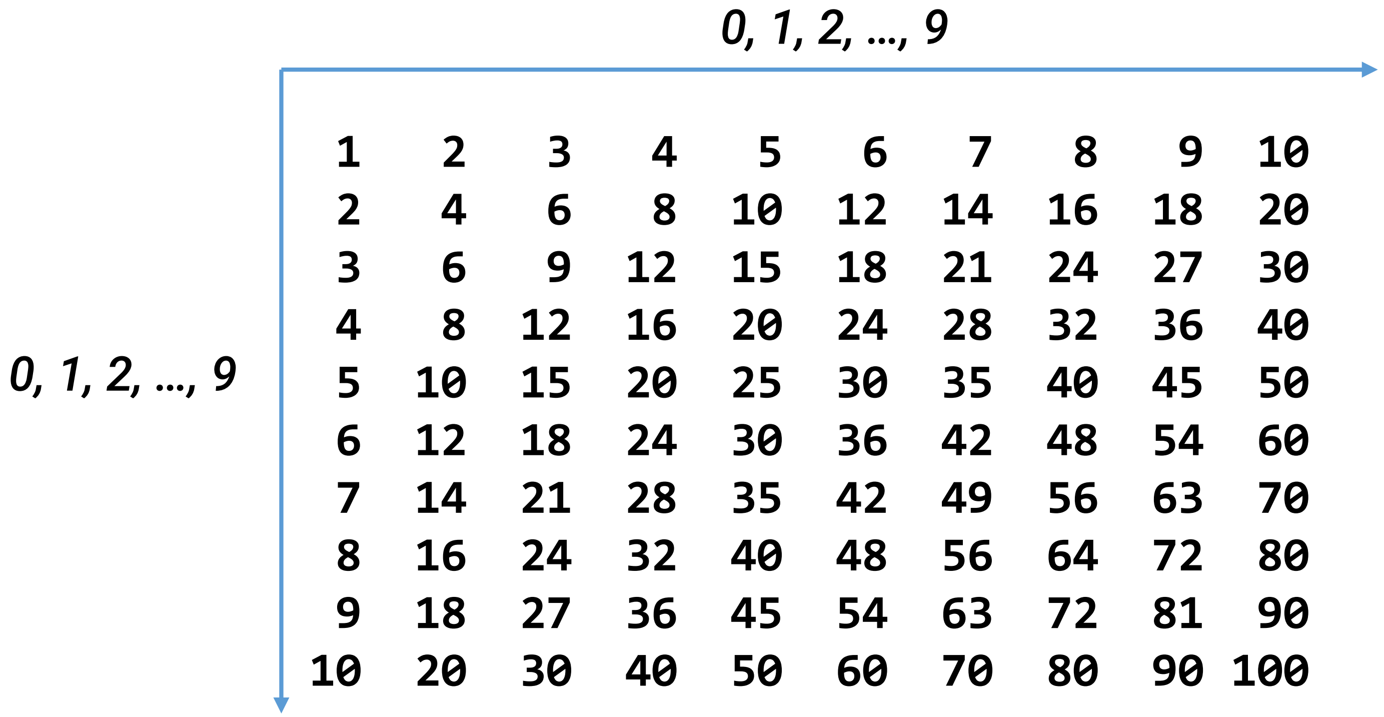
- Write a block of code that reads a list of days in the week and outputs the **index+1** and the **value** (a string) for each of the first five days; you can assume that the list contains all weekdays

```
my_list = ["Mon", "Tue", "Wed", "Thu", "Fri", "Sat", "Sun"]

for index, value in enumerate(my_list):  # traverse the list

    if index < 5:  # focus on the first five elements
        print(index + 1, value, end="; ")  # print

# Output:
# 1 Mon; 2 Tue; 3 Wed; 4 Thu; 5 Fri;
```

Nested Loops

Nested Loops

- …are loops that contain other loops
- Example: **Multiplication table**



```
 1   2   3   4   5   6   7   8   9  10
 2   4   6   8  10  12  14  16  18  20
 3   6   9  12  15  18  21  24  27  30
 4   8  12  16  20  24  28  32  36  40
 5  10  15  20  25  30  35  40  45  50
 6  12  18  24  30  36  42  48  54  60
 7  14  21  28  35  42  49  56  63  70
 8  16  24  32  40  48  56  64  72  80
 9  18  27  36  45  54  63  72  81  90
10  20  30  40  50  60  70  80  90 100
```

Example: Multiplication Table

Outer loop (row) increments row index r:

- **r = 0**
  - Inner loop (column) increments c
  - Inner c = 0, 1, 2, 3, …, 8, 9
  - Output: (r+1) * (c+1)
- **r = 1**
  - Inner c = 0, 1, 2, 3, …, 8, 9
  - Output: (r+1) * (c+1)

…

- **r = 9**
  - Inner c = 0, 1, 2, 3, …, 8, 9
  - Output : (r+1) * (c+1)

c = 0,	1,	2,	3,	4,	5,	6,	7,	8,	9
1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100

Example: Multiplication Table

Outer loop

Inner loop

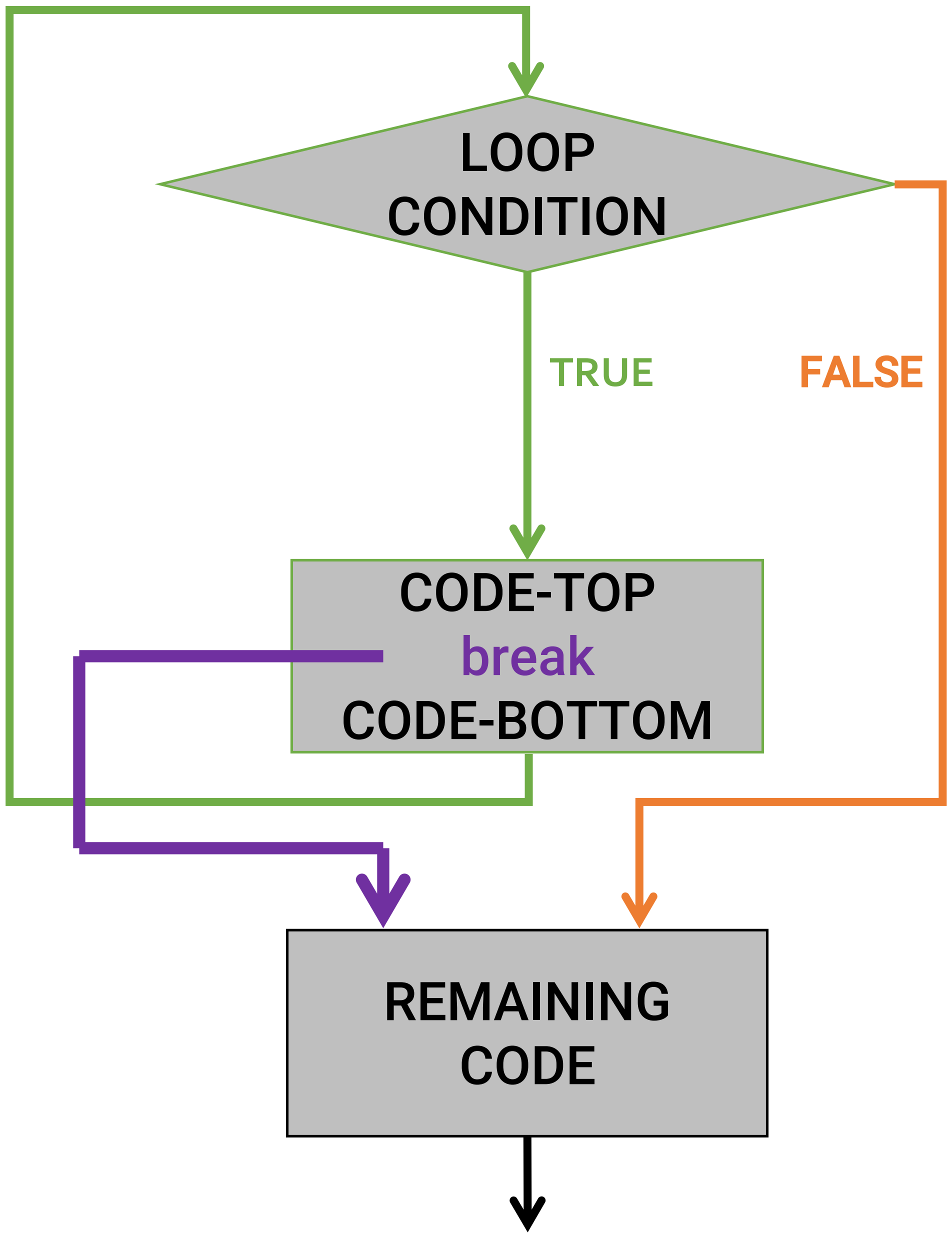
```python
for r in range(10):
    for c in range(10):

        v = (r + 1) * (c + 1)
        # Print the result 'v', formatted to take up to 4 spaces
        # for alignment, and stay on the same line
        print(f"{v:4}", end="")

    # Move to the next line after completing a row of the table
    print()
```

Early Exit from Loops

- `break`

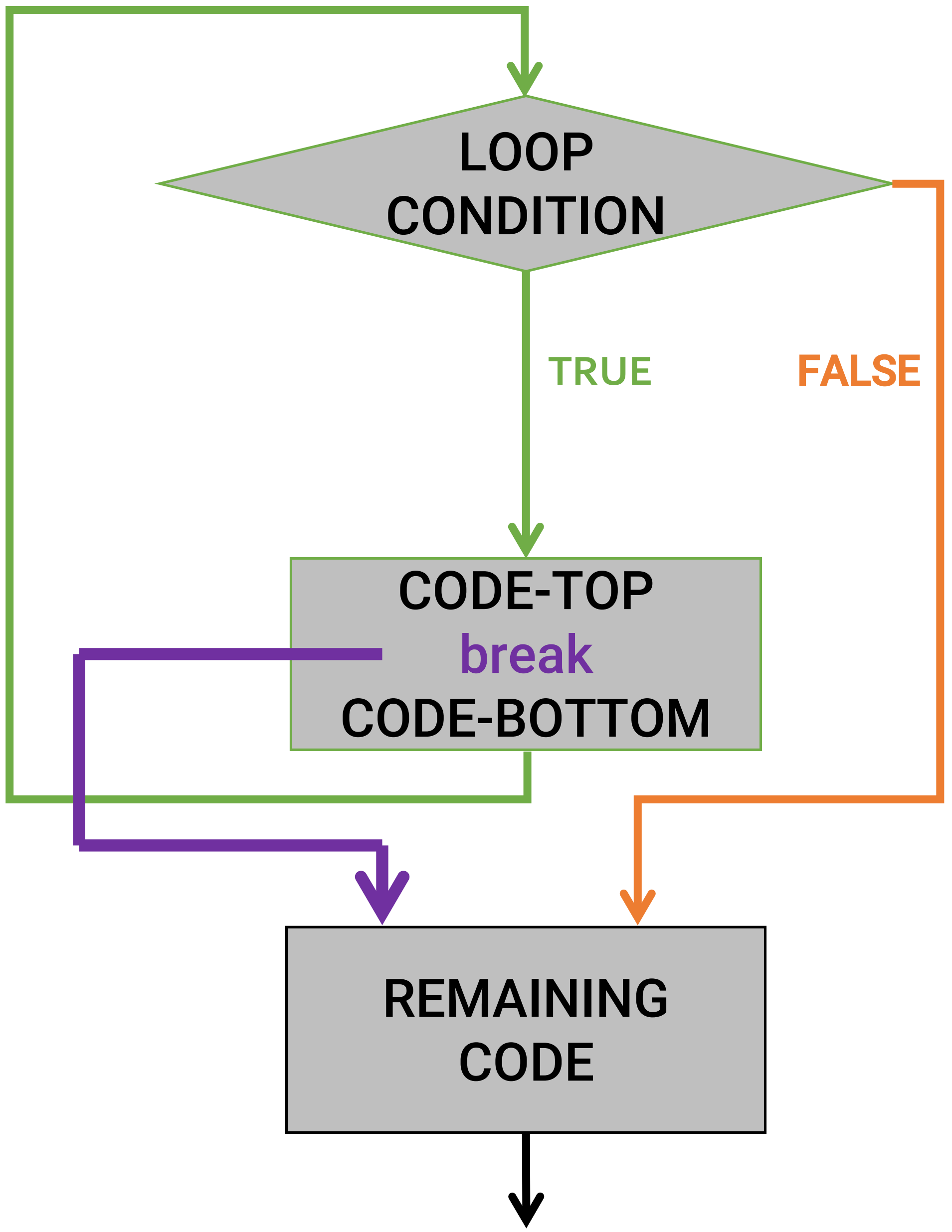
Loops: Early Exit

- `break` keyword is used to terminate the loop before its end is due
- Can be used in `while` and `for`
- If used inside a nested loop, `break` affects the **closest** of the loops



Loops: Early Exit

```
# while or for loop
while loop-again:
     # If loop-again is true,
     # repeat the loop
     code-top

     # If should-exit-early is true,
     # end the loop
     if should-exit-early:
          break

     code-bottom
```



Example: Early Exit from Loops

Write code that reads the elements of an input list **`in_list`**, sorted in increasing order, and copies them to the output list **`out_list`**. Copying stops when a value larger than the **`threshold`** is encountered in the input list or when the list is entirely copied.

Example: *in_list = [9, 10, 14, 17, 25, 28, 29, 44, 46, 54, 56, 57, 59, 61, 64, 71, 74, 90, 94, 95]*

threshold = 50

Output: *out_list = [9, 10, 14, 17, 25, 28, 29, 44, 46]*

Output list has 9 elements.

Example: Early Exit from Loops

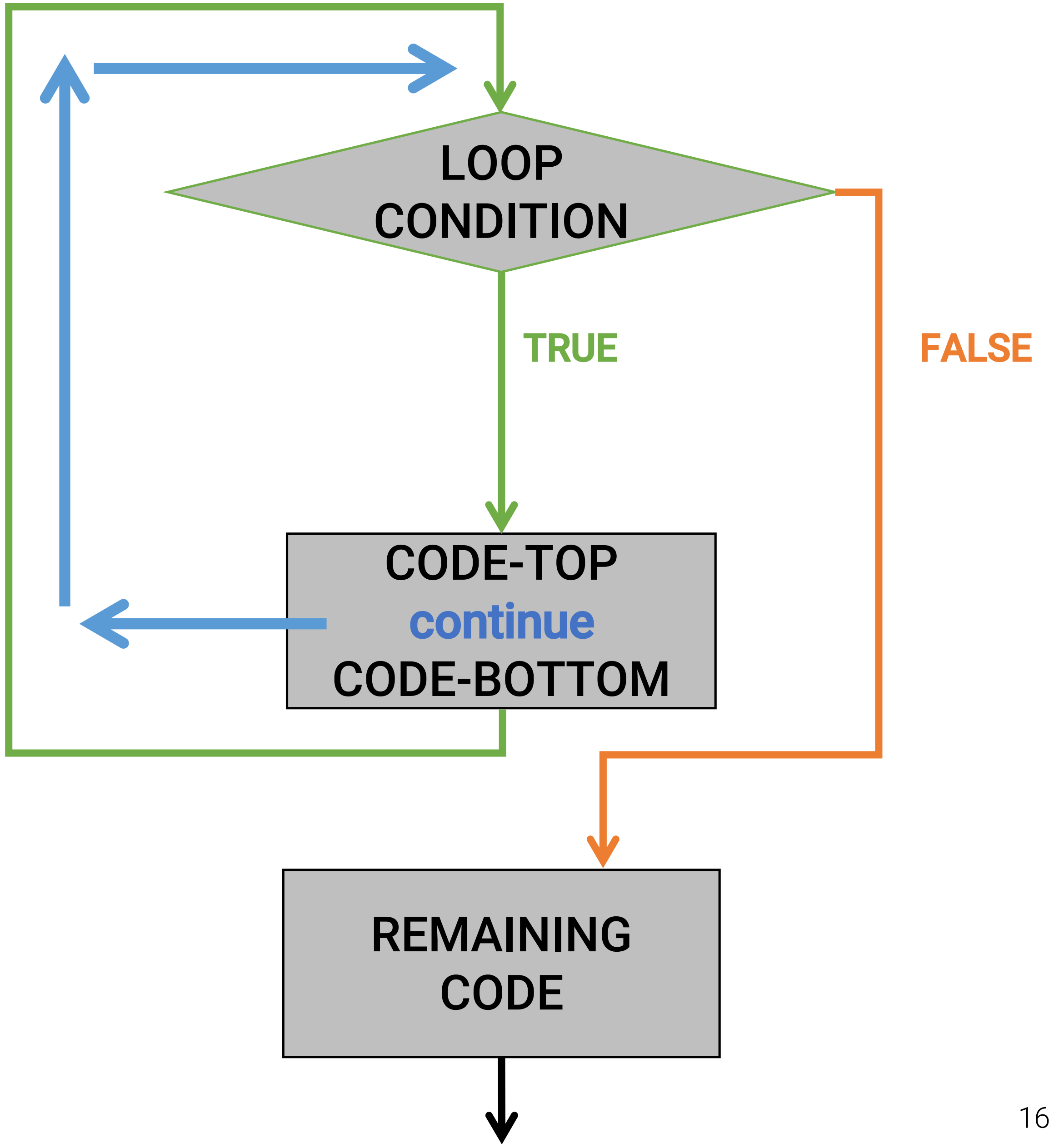
```python
# Create an empty list to store the output
out_list = []

# Iterate through each element in the sorted input list
for elem in in_list:

    # Check if the current element exceeds the threshold
    if elem > threshold:
        # If it does, exit the loop
        break
    out_list.append(elem)  # copy

# Print
print(out_list)
print(f"Output list has {len(out_list)} elements.")
```

Skipping Loop Iterations

- `continue`

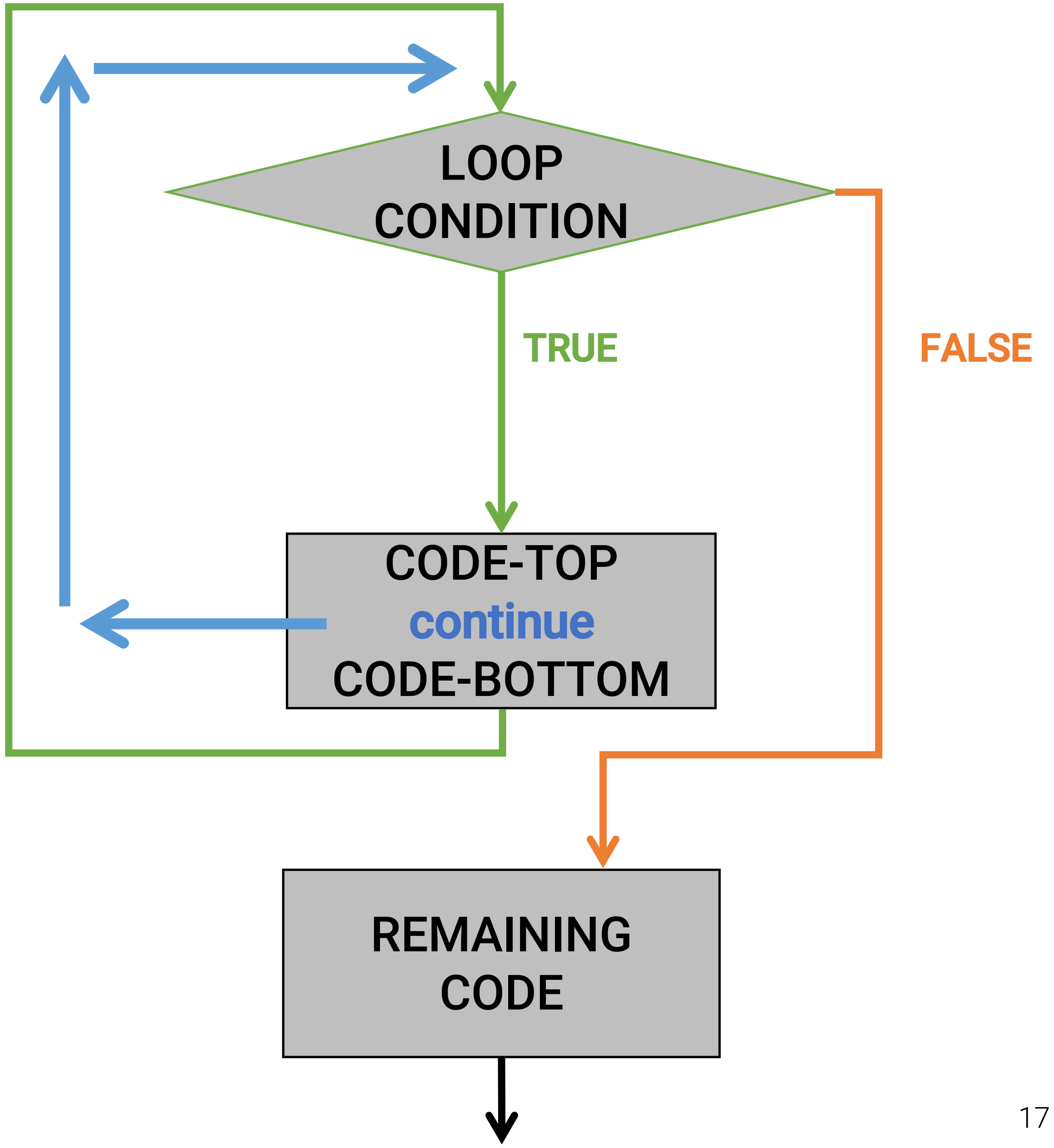
Loops: Skipping (Part of) an Iteration

- `continue` keyword is used to **interrupt** the current loop iteration and continue the loop by starting the **next** iteration provided that the loop condition is still True
- If used inside a nested loop, `continue` affects the **closest** of the loops



Loops: Skipping (Part of) an Iteration

```
# while or for loop
while loop-again:
     # If loop-again is true,
     # repeat the loop
     code-top

     # If should-skip is true,
     # skip code-bottom
     if should-skip:
          continue

     code-bottom
```



Example: Skipping (Part of) an Iteration

Write code that copies only odd numbers from a list of numbers **`in_list`** to an output list **`out_list`**, skipping over even numbers.

Example: *in_list = [9, 10, 14, 17, 25, 28, 29, 44, 46, 54, 56, 57, 59, 61, 64, 71, 74, 90, 94, 95]*

Output: *out_list = [9, 17, 25, 29, 57, 59, 61, 71, 95]*

EXAMPLES

Example: Skipping (Part of) an Iteration

```
# Create an empty list to store the output
out_list = []

for num in in_list:  # Iterate through the list of numbers
    # If the number is even, skip the remaining instructions
    # and move to the next iteration
    if not (num % 2):
        continue
    # If the number is odd, append it to the output list
    out_list.append(num)

print(out_list)
```

Nested Lists

…and Matrices

Nested Lists

- … are lists that contain other lists
- Nested lists are how we represent matrices, for example, but they are not limited to two dimensions

Example: Creating a Matrix

- Write a block of code that creates a 5×5 matrix using a nested list, such that each row contains values 0, 1, 2, 3, 4.

```
matrix = []  # Create an empty list
for row in range(5): # For every row
    matrix.append([])  # Append an empty sublist to the list
    for col in range(5):  # For every column
        matrix[row].append(col)  # Append to the row

print(matrix)
# Output:
# [[0, 1, 2, 3, 4], [0, 1, 2, 3, 4], [0, 1, 2, 3, 4],
   [0, 1, 2, 3, 4], [0, 1, 2, 3, 4]]
```

Creating a Matrix using List Comprehension

- Write a block of code that creates a 5×5 matrix using a nested list, such that each row contains values 0, 1, 2, 3, 4.

```
# Nested list comprehension
matrix = [[col for col in range(5)] for row in range(5)]



print(matrix)

# Output:
# [[0, 1, 2, 3, 4], [0, 1, 2, 3, 4], [0, 1, 2, 3, 4],
   [0, 1, 2, 3, 4], [0, 1, 2, 3, 4]]
```

Example: Filtering Matrices

- Write a block of code that traverses an input matrix and generates a list of odd numbers found in the matrix.

Example: *input matrix: [[1, 2, 3], [4, 5, 6], [7, 8, 9]]*

Output: *output list: [1, 3, 5, 7, 9]*

Example: Filtering Matrices

- Write a block of code that traverses an input matrix and generates a list of odd numbers found in the matrix.

```
matrix = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
odd_numbers = []
# Loop through each row in the matrix
for row in matrix:
    # Loop through each element in the current row
    for element in row:
        if element % 2:
            odd_numbers.append(element)
print(odd_numbers)
# Output:
# [1, 3, 5, 7, 9]
```

Filtering Matrices Using List Comprehension

- Write a block of code that traverses an input matrix and generates a list of odd numbers found in the matrix.

```
matrix = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]

odd_numbers = [element for row in matrix
                 for element in row
                   if element % 2]

print(odd_numbers)

# Output:
# [1, 3, 5, 7, 9]
```

Next: Midterm Exam
1-Nov-2024, @8:15, 3h