

Lecture 3:

Control Structures in Python

Introduction to Python
efl Data Science Courses

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1. Program structures in general

2. Case Distinction

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1. Program structures in general

- **Program structures** can be divided into
 1. **Simple assignments** like **variable definitions**, **value assignments** or **output commands** (Lectures 1 & 2)
 2. **Control structures**: a construct which enables to control the sequence of a program and allows complex calculation (This lecture)
- The structure of a program can be depicted in a so-called **Nassi-Shneiderman-diagram** or **structogram** (Nassi & Shneiderman 1972)

1. Program structures in general

Process blocks

- No conditions
- Execute action inside of block and move to next block

Define variable var1
Assign value to var1
Compute $E = \text{var1} + 1$
Print E

Branching blocks

- Check condition statement
- Execute action inside of respective block

Check condition statement	
True	False
Process for condition True	Process for condition False

Loops

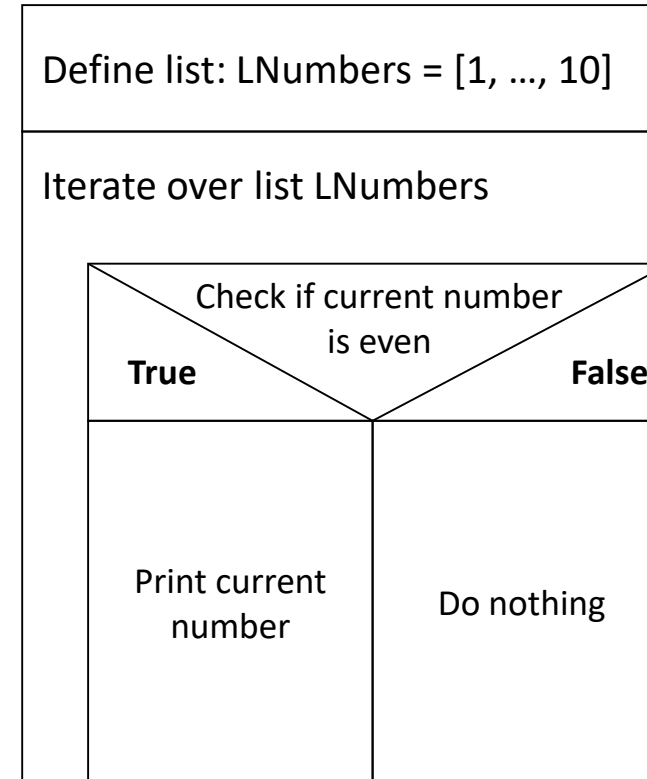
- Loop a process as long as particular condition is met

As long as condition is met	
	Subprocess 1
	...

Simple program example

Print all even numbers from a given list

→ We will use this example for explaining the Python code in the following sections



Simple program example

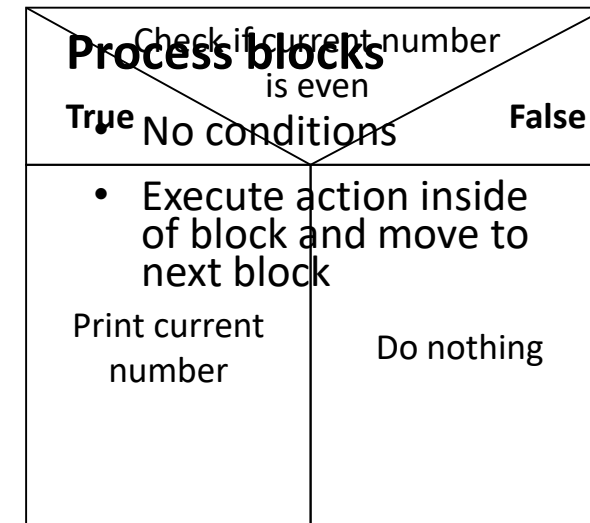
Python code

```
# Define list of numbers from 1 to 10
LNumbers = [1,2,3,4,5,6,7,8,9,10]
```

```
# Alternative:
LNumbers = list(range(1,11))
```

Define list: LNumbers = [1, ..., 10]

Iterate over list LNumbers



Simple program example

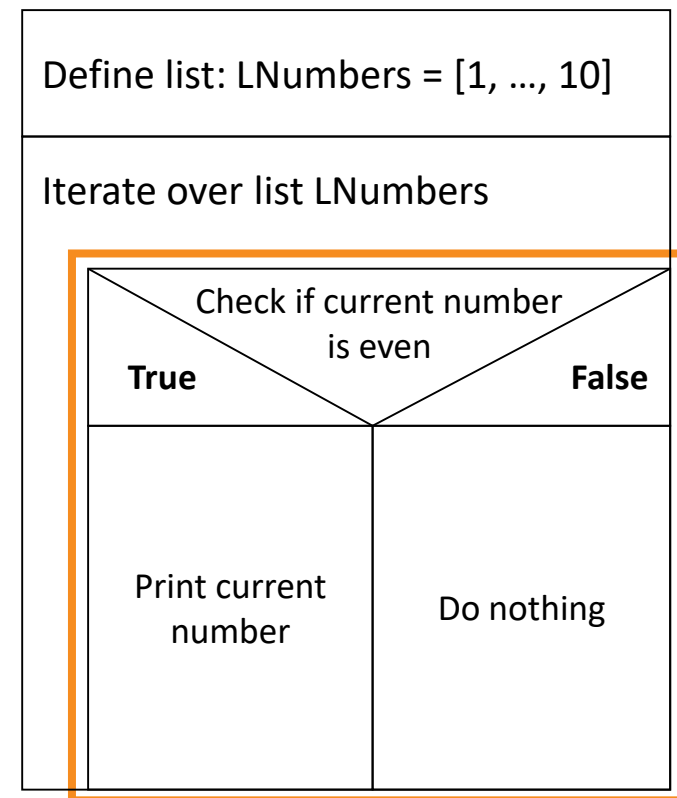


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1. Program structures in general

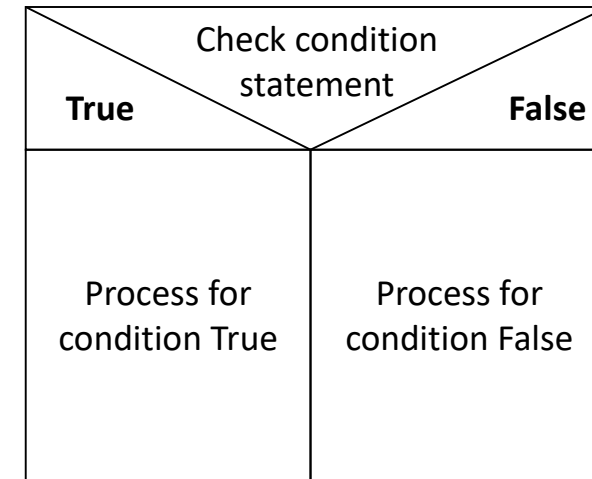
2. Case Distinction

3. Loops

2. Case Distinction

In programming, for defining different conditional paths (or branches) for your code, so-called **if-statements** can be used.

- For each statement, the subordinate code will only be executed, if the underlying condition is fulfilled
- There are three types of if-statements:
 1. One-sided
 2. Two-sided
 3. if ... elif ... else ladder



Branching blocks

- Check condition statement
- Execute action inside of respective block

2. Case Distinction

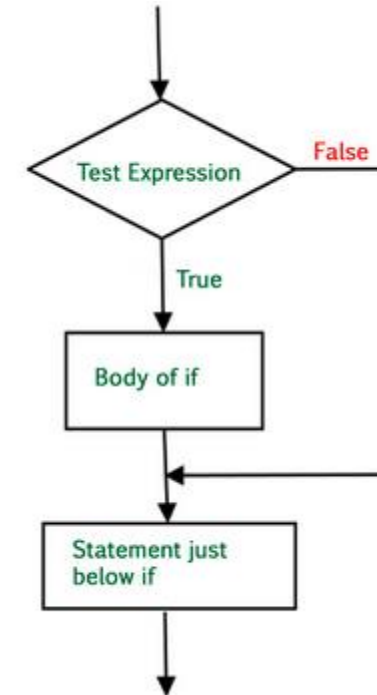
1. One-sided if-statement

Python syntax

```
if condition:  
    statement
```

Python example

```
iNumber = 5  
if iNumber < 10:  
    print('Number is less than 10')
```



Source: <https://www.geeksforgeeks.org/decision-making-python-else-nested-elif/>

2. Case Distinction

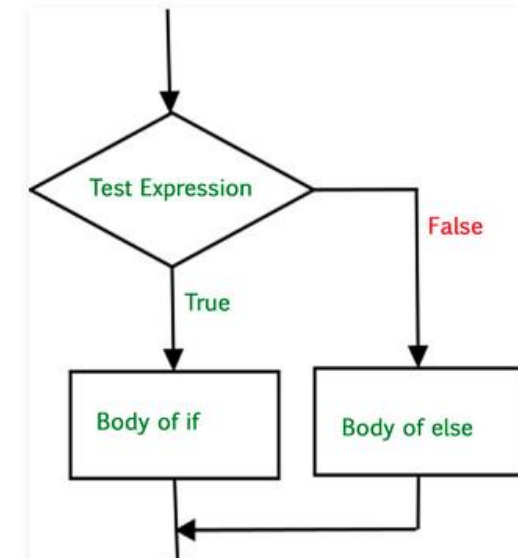
2. Two-sided if-statement

Python syntax

```
if condition:  
    statement if condition True  
else:  
    statement if condition False
```

Python example

```
iNumber = 5  
if iNumber < 10:  
    print('Number is less than 10')  
else:  
    print('Number is greater or equal to 10')
```



Info:

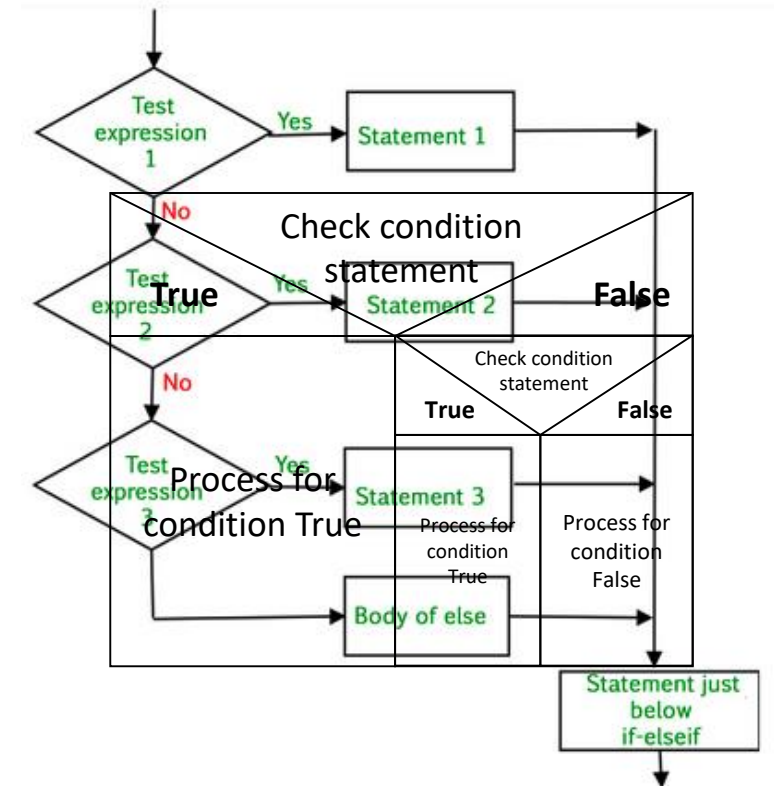
- The statement inside the body of an else-statement can be another if-statement
- Such program structures are called “nested if-statements”

2. Case Distinction

3. if ... elif ... else ladder

Python syntax

```
if condition:
    statement
elif condition :
    statement
.
.
else:
    statement
```



Source: <https://www.geeksforgeeks.org/decision-making-python-else-nested-elif/>

2. Case Distinction

- The condition in an if-statement is an expression with a boolean (**True**, **False**) as a results
- The conditional statement can also be a combination of multiple expressions
- For combining expressions, different operators can be used

Python syntax

```
if condition:
    statement
else:
    statement
```

1. Arithmetic operators

numeric → numeric

+	Addition
-	Subtraction
*	Multiplication
/	Division
%	Modulus

2. Comparative operators

numeric → boolean

<	Smaller
<=	Smaller or equal
>	Larger
>=	Larger or equal
==	Equal
!=	Not equal

3. Logical operators

boolean → boolean

and	If both operands are True then condition becomes True
or	If any of the two operands is True then condition becomes True
not	Used to reverse the logical state of ist operand

Simple program example

Python code

```
# Define list of numbers from 1 to 10
LNumbers = [1,2,3,4,5,6,7,8,9,10]

iNum = LNumbers[0]

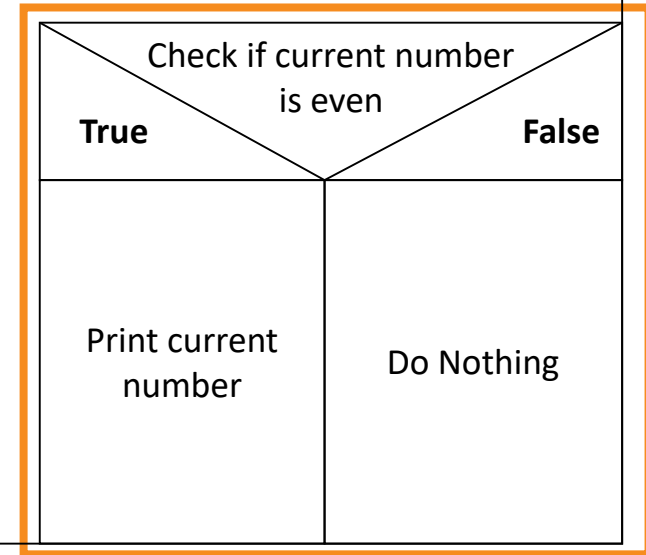
if iNum % 2 == 0:
    print(iNum)
```

Info:

- % is the modulo operator
- The modulo operation finds the remainder after division of one number by another
- Even numbers can always be divided by 2 with a remainder of 0

Define list: LNumbers = [1, ..., 10]

Iterate over list LNumbers



Exercise 1: Case Distinction

1.1 Simple case distinction

- Given are two random numbers
- Please write a conditional statement, which returns the minimum of both numbers

Solution 1.1

```
#returns minimum of both numbers
iNum1 = 8
iNum2 = 5

if iNum1 <= iNum2:
    print(iNum1)
else:
    print(iNum2)
```

1.2 Advanced case distinction

- Please write a conditional statement, which returns the grade for an exam.
- Please use the following thresholds:
 - Points >= 90: Grade 1
 - Points >= 75: Grade 2
 - Points >= 60: Grade 3
 - Points >= 50: Grade 4
 - Points < 50: Grade 5

Solution 1.2

```
#prints grade based on received points
iPoints = 77

if iPoints >= 90:
    print('Grade 1')
elif iPoints >= 75:
    print('Grade 2')
elif iPoints >= 60:
    print('Grade 3')
elif iPoints >= 50:
    print('Grade 4')
else:
    print('Grade 5')
```

Exercise 2: Booleans

2. Conditional statements

Given are the following expressions:

1. `(1+2) == 3`
2. `True != False`
3. `iNum = 4`
`(iNum != 0) and (20/iNum > 0)`
4. `iHour = 12`
`(iHour < 9) or (iHour > 18)`

Please determine the result of each expression

Solution 2

1. True
2. True
3. True
4. False

Simple program example

Python code

```
# Define list of numbers from 1 to 10
LNumbers = [1,2,3,4,5,6,7,8,9,10]

iNum = LNumbers[0]

if iNum % 2 == 0:
    print(iNum)
```

Define list: LNumbers = [1, ..., 10]

Iterate over list LNumbers

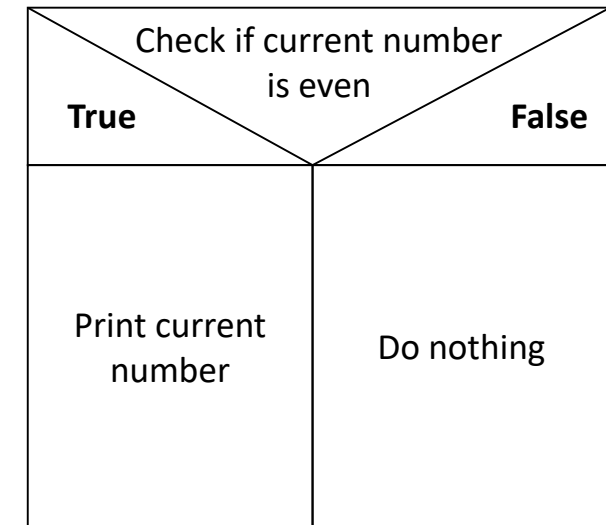


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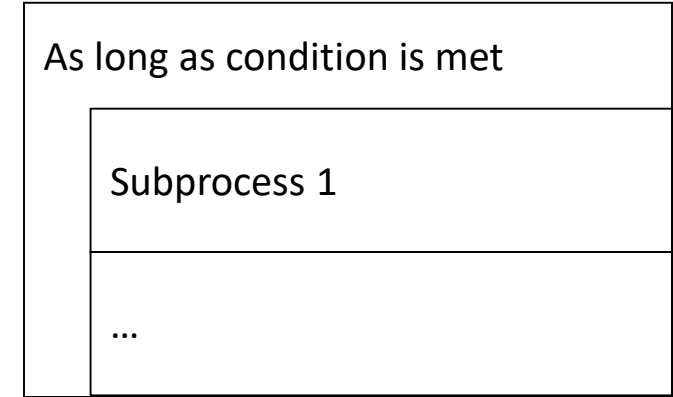
1. Program structures in general

2. Case Distinction

3. Loops

3. Loops

- Computers are often used to **automate repetitive tasks**
- A **repeated execution** of a set of statements is called **iteration**
- Python has **two statements** for iteration:
 1. The **while** loop
 2. The **for** loop
- Further, both loop statements can be controlled by three different loop control statements, i.e.:
 1. `continue`
 2. `break`
 3. `pass`



Loops

- Loop a process as long as particular condition is met

3. Loops

1. while loop:

- Executes a block of statements repeatedly until a given condition is satisfied
- When the condition becomes False, the statement immediately after the loop is executed

Python syntax

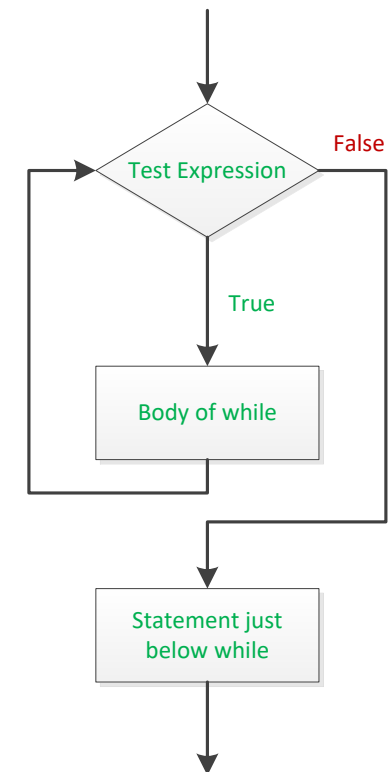
```
while condition:
    statement
```

Python example

```
count = 0
while (count < 3):
    count = count + 1
    print("Hello!")
```

Output:

```
Hello!
Hello!
Hello!
```



3. Loops

2.1 for in loops:

- for loops are used for sequential traversal of iterable objects
- The sequence can be a list, tuple, string, dictionary, or any other iterable object

Python syntax

```
for iterator_var in sequence:  
    statement
```

Python example

```
LNumbers = [1,2,3,4,5,6,7,8,9,10]  
  
for iNum in LNumbers:  
    print(iNum)
```

3. Loops

2.2 for loops using range

- the python build-in function **range** creates an iterable object which traverses all integer numbers in a pre-defined range
- All parameters forwarded to the range function need to be integers

Python syntax

```
range(stop)
```

```
range(start, stop)
```

```
range(start, stop, step)
```

- start = number to begin with
- stop = loop stops when this value is reached
(the loop iterator variable will never reach this value)
- step = increment, by which the loop iterator variable increases in each iteration

Python example 1

```
# Iterate over range
for i in range(1, 10, 2):
    print(i)
```

Python example 2

```
# Iterating by index of sequences
LWords = ['Iterating', 'by', 'index', 'of', 'sequences']
for i in range(len(LWords)):
    print(LWords[i])
```

3. Loops

3. Loop control statements

- Change execution from its normal sequence

1. **continue**: returns the control to the beginning of the loop

```
for letter in 'science':  
    if letter == 'e' or letter == 'c':  
        continue  
    print('Current Letter:', letter)
```

Output:
Current Letter: s
Current Letter: i
Current Letter: n

2. **break**: brings control out of the loop

```
for letter in 'science':  
    if letter == 'e' or letter == 'c':  
        break  
    print('Current Letter:', letter)
```

Output:
Current Letter: s

3. **pass**: for empty loops

```
for letter in 'science':  
    pass  
print('Last Letter :', letter)
```

Output:
Last Letter: e

Examples based on: <https://www.geeksforgeeks.org/loops-in-python/>

3. Loops

Choosing between for and while:

- Use a **for** loop if you know, **before you start looping**, the **maximum number of times** that you'll need to **execute the body**
 - For example, if you're traversing a list of elements, you know that the maximum number of loop iterations you can possibly need is "all the elements in the list"
- By contrast, if you are required to **repeat some computation until some condition is met**, and you **cannot calculate in advance when this will happen**, you'll need a **while** loop
- We call the first case **definite iteration** — we have some definite bounds for what is needed
- The latter case is called **indefinite iteration** — we're not sure how many iterations we'll need

Simple program example

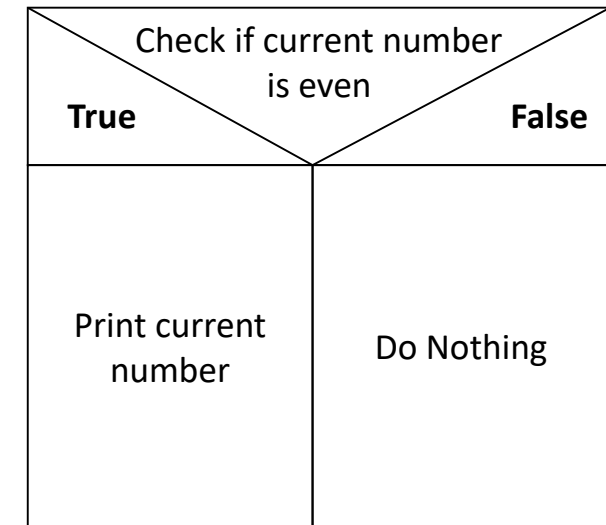
Python code

```
# Define list of numbers from 1 to 10
LNumbers = [1,2,3,4,5,6,7,8,9,10]

# Iterate over list
for iNum in LNumbers:
    # Check remainder of iNum
    if iNum % 2 == 0:
        # Print iNum if even
        print(iNum)
```

Define list: LNumbers = [1, ..., 10]

Iterate over list LNumbers



Exercise 3: Loops

Given is the following List of numbers:

```
LNumbers = [5, 23, 37, 49, 50, 46, 30, 46, 70]
```

Please write a code that counts the number of elements in the list that are greater than 30, and prints the result

1. Use a while loop
2. Use a for loop

Solution 3

```
LNumbers = [5, 23, 37, 49, 50, 46, 30, 46, 70]
```

```
# 1. while loop
```

```
iCount = 0
```

```
iSizeofList = len(LNumbers)
```

```
i = 0
```

```
while i < iSizeofList:
```

```
    if LNumbers[i] > 30:
```

```
        iCount = iCount + 1
```

```
    i = i + 1
```

```
print(iCount)
```

```
# 2. for loop
```

```
iCount = 0
```

```
for n in LNumbers:
```

```
    if n > 30:
```

```
        iCount = iCount + 1
```

```
print(iCount)
```

References

Ernesti, J.; Kaiser, P.: Python 3 – Das umfassende Handbuch. 4. 2015.

Schiedermeier, R.: Programmieren mit Java. 2. 2010.

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<https://www.geeksforgeeks.org/loops-in-python/>