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CENTER FOR SYSTEMS BIOLOGY DRESDEN

# Python Algorithms

## Conditions, loops, functions and custom libraries

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Using material from Benoit Lombardot, Scientific Computing Facility, MPI CBG

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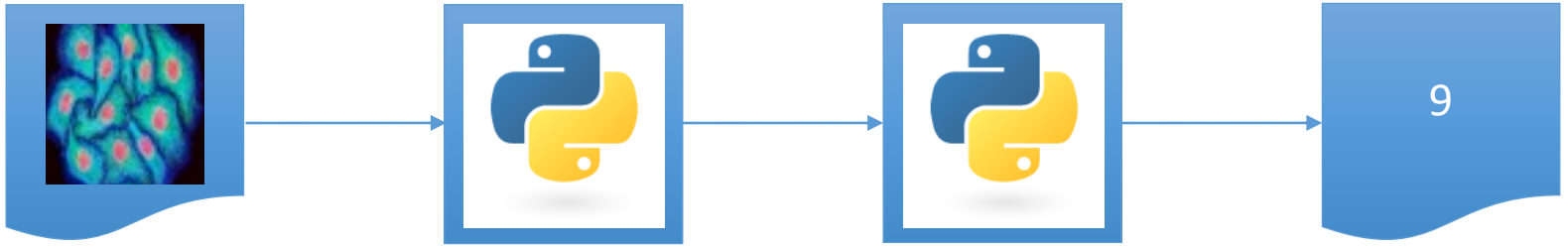
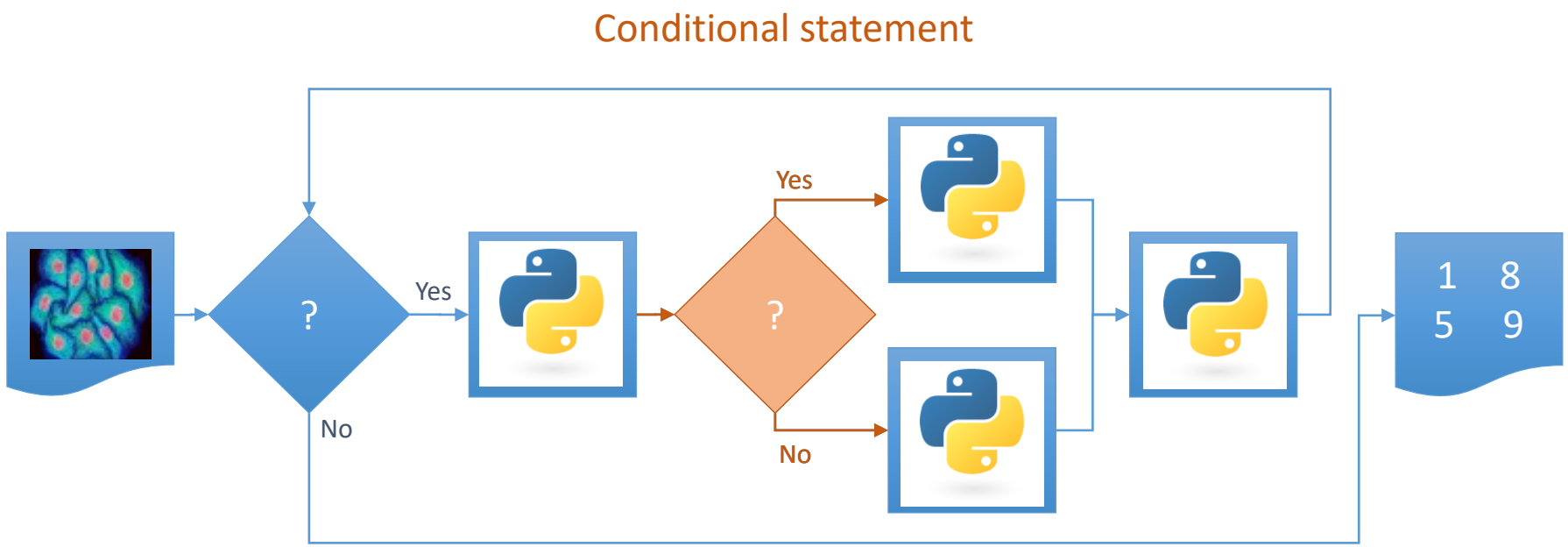
# Conditions

- Data science workflows *rarely* look like this



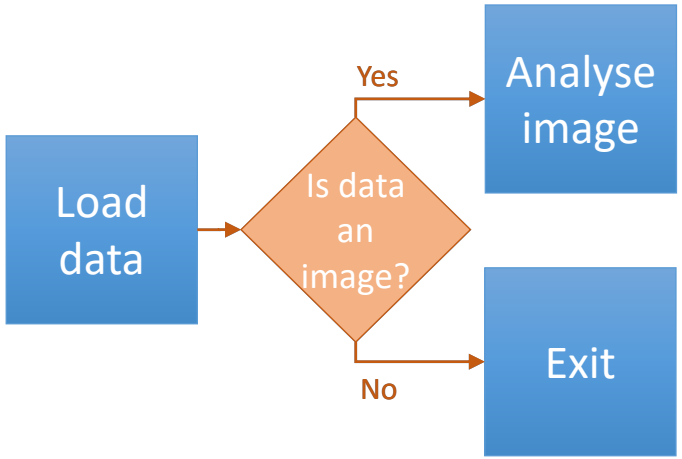
# Conditions

- Data science workflows *rather* look like this



# Conditions

- Conditional statements can be used to
  - Check if pre-requisites are met
  - Check if data has the right format
  - Check if processing results are within an expected range
  - Check for errors



# If-statement

- Depending on a condition, some lines of code are executed or not.

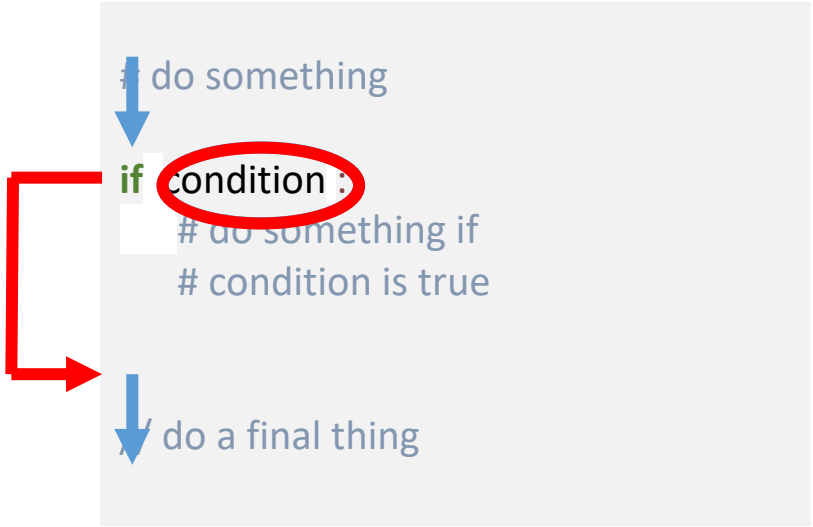
```
# do something

if condition :
    # do something if
    # condition is true

# do a final thing
```

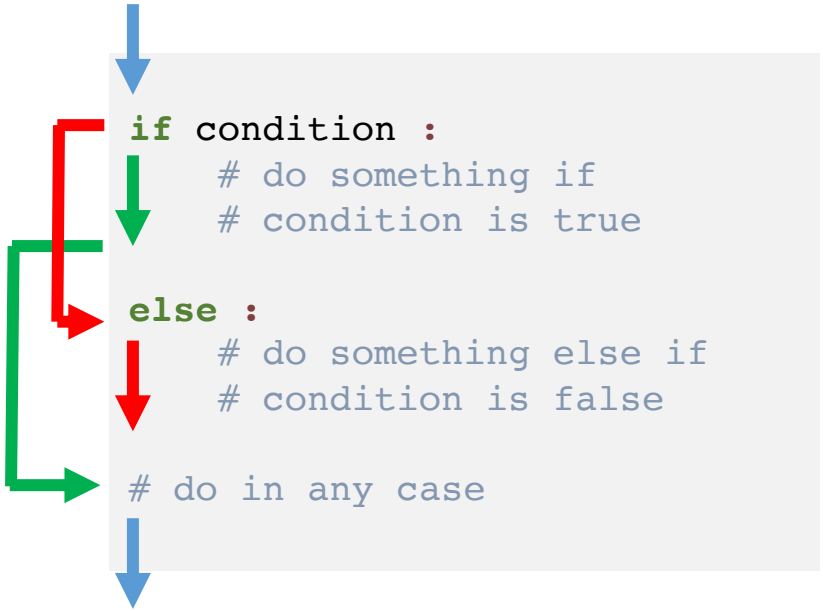
# If-statement

- Depending on a condition, some lines of code are executed or not.



# If-statement

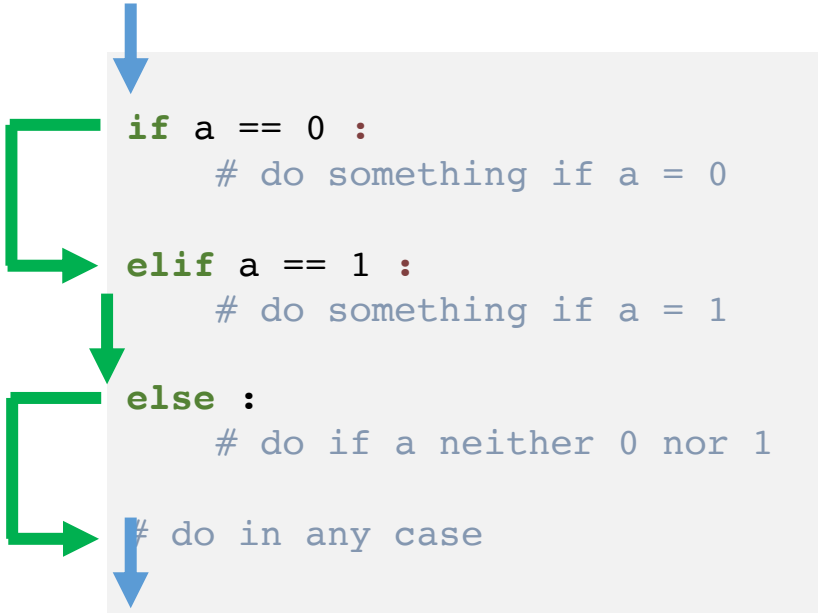
- The **if** / **elif** / **else** statement allows to program alternatives.
- Depending on conditions, only one block is computed
- Indentation is used to mark where a block starts and ends.
- Indentation helps reading blocks,



```
if condition :
    # do something if
    # condition is true

else :
    # do something else if
    # condition is false

# do in any case
```



```
if a == 0 :
    # do something if a = 0

elif a == 1 :
    # do something if a = 1

else :
    # do if a neither 0 nor 1

# do in any case
```

# If-statement

- Comparison operators always have True (1) or False (0) as results.

```
# initialise program
quality = 99.5

# evaluate result
if quality > 99.9 :
    print("Everything is fine.")
else :
    print("We need to improve!")
```

```
In [1]: a = 4

        if a = 5:
            print("Hello world")

  File "<ipython-input-1-13fb587c9332>", line 3
    if a = 5:
         ^
SyntaxError: invalid syntax
```

Note: These are two equal signs!

| Operator | Description | Example |
|---|---|---|
| <, <= | smaller than, smaller or equal to | a < b |
| >, >= | greater than, greater or equal to | a > b |
| == | equal to | a == b |
| != | not equal to | a != 1 |

# Combined conditions

- Logic operators always take conditions as operands and result in a condition.
  - and
  - or
  - not
- Also combined conditions can be either True (1) or False (0).

```
# initialise program
quality = 99.9
age = 3

if quality >= 99.9 and age > 5 :
    print("The item is ok.")
```

```
# initialise program
quality = 99.9


if not quality < 99.9 :
    print("The item is ok.")
```

# Conditions with arrays

- Checking contents of lists can be done intuitively using the `in` statement

```
# initialise program
my_list = [1, 5, 7, 8]
item = 3

if item in my_list :
    print("The item is in the list.")
else :
    print("There is no”, item, "in", my_list )
```

```
# initialise program
my_list = [1, 5, 7, 8]
item = 3

if item not in my_list :
    print("There is no”, item, "in", my_list )
else :
    print("The item is in the list.")
```

# Readable code

Rules for readable code

- Every command belongs on its own line

```
# initialise program
a = 5
b = 3
c = 8

# execute algorithm
d = (a + b) / c

# evaluate result
```

- Insert empty lines to separate important processing steps
- Put spaces between operators and operands, because:

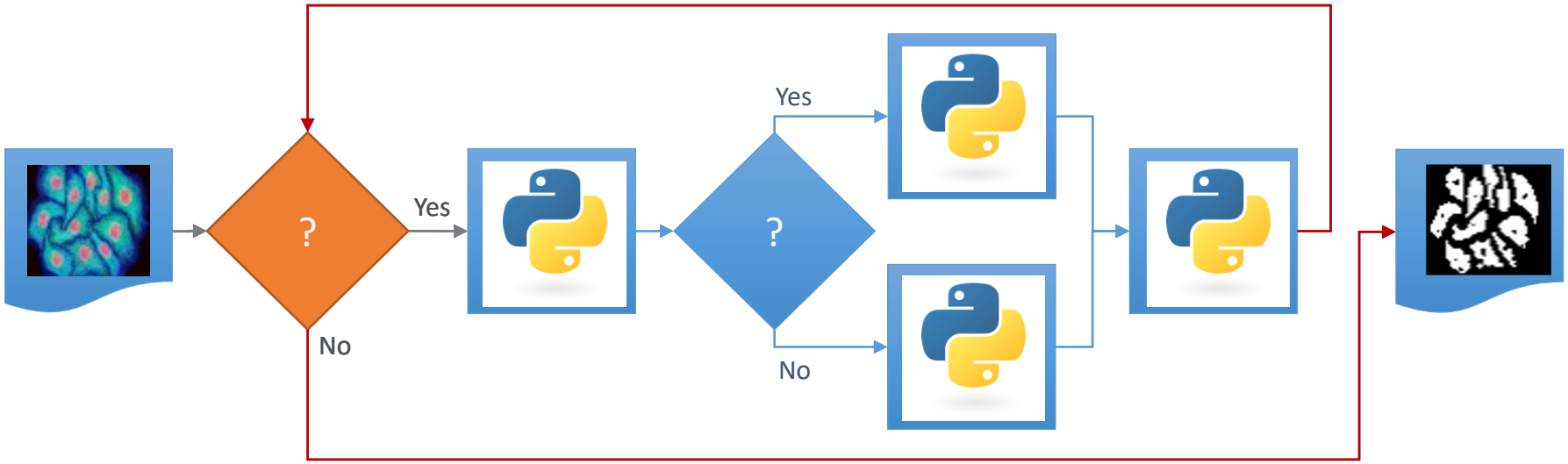
This is easier to read thanthat,orisnt'it?

```
if a == 5 :
    print("Yin")
else :
    print("Yang")
```

- Indent every conditional block (if/else) using the TAB key

# Loops

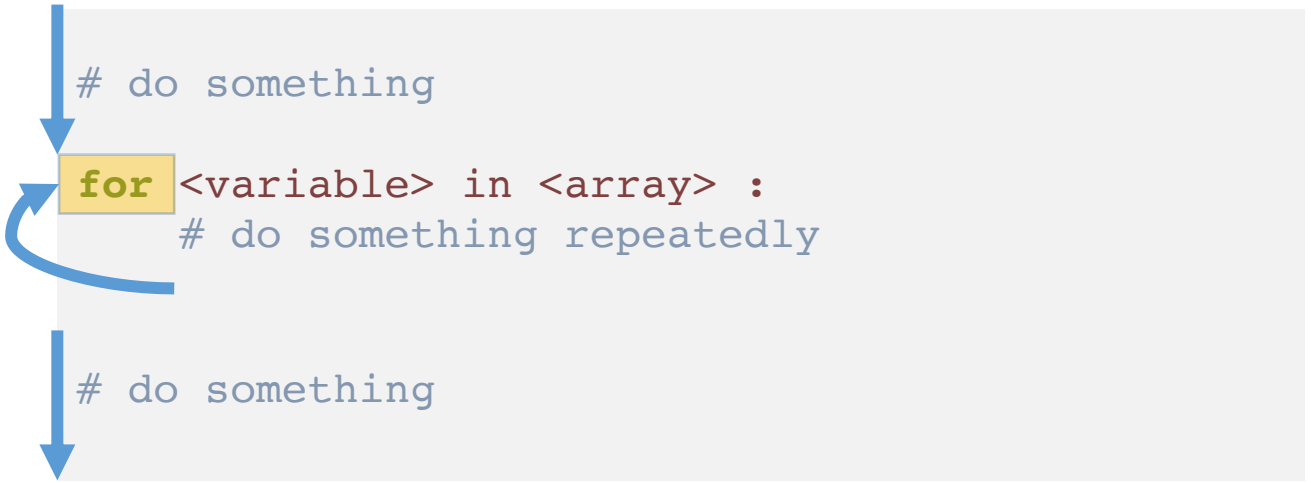
- To repeat actions, you run code in loops




Loop statement

# Loops

- The `for` statement allows us to execute some lines of code *for* several times,
- typically for all items in an array-like thing (lists, tuples, images)



# For-loops

- Example list : `range(start, stop, step)`

```
# for loops
for i in range(0, 5):
    print(i)
```

```
0
1
2
3
4
```

```
animal_set = ["Cat", "Dog", "Mouse"]

for animal in animal_set:
    print(animal)
```

```
Cat
Dog
Mouse
```

# For-loops

- Indentation *means* combining operations to a block

```
# for loops
for i in range(0, 5):
print(i)
```

```
  File "<ipython-input-15-59c457ae0ac9>", line 3
    print(i)
        ^
IndentationError: expected an indented block
```

Don’t forget to indent!

- Colon necessary

```
# for loops
for i in range(0, 5)
    print(i)
```

```
  File "<ipython-input-13-23157c0ed137>", line 2
    for i in range(0, 5)
                       ^
SyntaxError: invalid syntax
```

Don’t forget the colon!

# Generating arrays within for-loops

- There is a long and a short way for creating arrays with numbers.

```python
# we start with an empty list
numbers = []

# and add elements
for i in range(0, 5):
    numbers.append(i * 2)

print(numbers)
```

```python
numbers = [i * 2 for i in range(0, 5)]

print(numbers)
```

```
[0, 2, 4, 6, 8]
```

# Generating arrays within for-loops

- Also a combination with the if-statement is possible

```
# we start with an empty list
numbers = []

# and add elements
for i in range(0, 5):
    # check if the number is odd
    if i % 2:
        numbers.append(i * 2)

print(numbers)
```

```
[2, 6]
```

```
numbers = [i * 2 for i in range(0, 5) if i % 2]

print(numbers)
```

```
[2, 6]
```

# While-loops

- While loops keep executing indented code as long as a condition is met:

```
number = 1024

while (number > 1):
    number = number / 2
    print(number)
```

Works the same as with the **if** statement

```
512.0
256.0
128.0
64.0
32.0
16.0
8.0
4.0
2.0
1.0
```

# Executing loops

- Using the break statement, you can leave a loop

```
number = 1024

while (True):
    number = number / 2
    print(number)

    if number < 1:
        break
```

```
512.0
256.0
128.0
64.0
32.0
16.0
8.0
4.0
2.0
1.0
0.5
```

# Skipping iterations

- The continue statement allows to skip iterations

```
for i in range(0, 10):
    if i >= 3 and i <= 6:
        continue
    print(i)
```

```
0
1
2
7
8
9
```

# Functions

- In case repetitive tasks appear that cannot be handled in a loop, custom functions are the way to go.
- Functions allow to re-use code in different contexts.
- Indentation is crucial.
- Functions must be defined before called

- Definition

```
def sum_numbers(a, b):
    result = a + b
    return result
```

name (parameters)

body commands

return statement (optional)

- Call

```
c = sum_numbers(4, 5)
print(c)
```

```
9
```

```
sum_numbers(5, 6)
```

```
11
```

```
sum_numbers(3, 4)
```

```
7
```

# Functions

- In case repetitive tasks appear that cannot be handled in a loop, custom functions are the way to go.
- Functions allow to re-use code in different contexts.
- Indentation is crucial.
- Functions must be defined before called

- Definition

```
def sum_numbers(a, b):
    result = a + b
    return result
```

- Call

```
c = sum_numbers(4, 5)
print(c)
```

```
9
```

# Functions

- Document your functions to keep track of what they do.
- Describe what the functions does and what the parameters are meant to be

```
def square(number):
    '''
    Squares a number by multiplying it with itself  and returns its result.
    '''

    return number * number
```

- You can then later print the *documentation* if you can't recall how a function works.

```
square?
```

```
Signature: square(number)
Docstring: Squares a number by multiplying it with itself and returns its
result.
```

- Hint: most integrated development environments (=coding software) provide automatisms to create a documentation template for your function. Look for *autodocstring* or similar.

# Summary

Today, you learned

- Python
  - Conditions
  - Loops
  - Functions