Introductory Linux Course

Python I

Martin Dahlö – UPPMAX

Author: Nina Fischer
Dept. for Cell and Molecular Biology, Uppsala University

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Outline

- Python basics – get started with Python
- Data types
- Control structures
  - Loops: for and while
  - Conditions: if-else
- Our first Python program
Python Basics

- We use Python 3 (version 3.6.0) in this course. For this we need to load a module:

  [dahlo@rackham1 ~]$ module load python3/3.6.0
Python Basics

- We use Python 3 (version 3.6.0) in this course. For this we need to load a module:

  ```bash
  [dahlo@rackham1 ~]$ module load python3/3.6.0
  ```

- When you type `python3` on the command line the Python-Interpreter comes ready:

  ```bash
  [dahlo@rackham1 ~]$ python3
  Python 3.6.0 (default, Nov 21 2017, 09:52:46)
  [GCC 4.4.7 20120313 (Red Hat 4.4.7-18)] on linux
  Type "help", "copyright", "credits" or "license" for more information.
  >>>
  ```
Python Basics

- We use Python 3 (version 3.6.0) in this course. For this we need to load a module:
  
  ```bash
[dahlo@rackham1 ~]$ module load python3/3.6.0
  
[dahlo@rackham1 ~]$ python3
  
Python 3.6.0 (default, Nov 21 2017, 09:52:46) 
[GCC 4.4.7 20120313 (Red Hat 4.4.7-18)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> 
  
Note: If you type "python", you start Python 2 (version 2.7.5)!
Python Basics

- With `quit()`, `exit()`, or `Ctrl-D` you can close the Python-interpreter.

```
[dahlo@rackham1 ~]$ python3
Python 3.6.0 (default, Aug  4 2017, 00:39:18)
[GCC 4.8.5 20150623 (Red Hat 4.8.5-16)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> quit()
[dahlo@rackham1 ~]$ 
```

- With arrow keys "up" (↑) and "down" (↓) you can scroll through previous commands.
Python as Calculator

```python
>>> 2 + 2
4
>>> 50 - 5*6
20
>>> (50 - 5*6) / 4
5.0
>>> 12.45 / 100 + 7.5e-3
0.132
>>> 
```
Python Output

- By default the output appears in the terminal (the window you are working in)
- With the `print()` function you can write text

```python
>>> print("Welcome to our Introductory Linux Course!")
Welcome to our Introductory Linux Course!
>>> print(2)
2
>>> print(2+2)
4
```
Python Assignment

• We can store text or values in variables (assign text or values to variables) in order to
  ○ Conveniently refer to them
  ○ Separate Python code from data

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!
```

• The assignment is done with the equal sign ( = )
Python Assignment

- We can store text or values in variables (assign text or values to variables) in order to
  - Conveniently refer to them
  - Separate Python code from data

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!
>>> number = 2
>>> print(number)
2
>>> 
```

- The assignment is done with the equal sign ( = )
Python Assignment

• Variable names must follow these rules
  ○ No spaces
  ○ Only letters, numbers and _
  ○ Must start with a letter

• Valid names are: my_variable, Value15
• Invalid names are: my-variable, 15th_value
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!
>>>
Python Assignment

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!

>>> number = 2
>>> print(number)
2
```
Python Assignment

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!

>>> number = 2
>>> print(number)
2

>>> print(greeting*number)
Welcome to our Introductory Linux Course!Welcome to our Introductory Linux Course!
```
Python Assignment

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!

>>> number = 2
>>> print(number)
2

>>> print(greeting+number)
Welcome to our Introductory Linux Course!Welcome to our Introductory Linux Course!

>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting*4)
Welcome to our Introductory Linux Course!
Welcome to our Introductory Linux Course!
Welcome to our Introductory Linux Course!
Welcome to our Introductory Linux Course!

>>> 
```
Python Assignment

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> print(greeting)
Welcome to our Introductory Linux Course!

>>> number = 2
>>> print(number)
2

>>> print(greeting * number)
Welcome to our Introductory Linux Course!Welcome to our Introductory Linux Course!

>>> greeting = "Hello!\n"
>>> print(greeting*4)
Hello!
Hello!
Hello!
Hello!

```
Python Assignment

```python
>>> greeting = "Welcome to our Introductory Linux Course!"
>>> number = 2
>>> print(greeting + number)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: Can't convert 'int' object to str implicitly
```
Python knows different **types** of data

- **int/float** for numeric data (integer or floating point numbers)
- **str** for text (or sequences of characters, so-called strings)
Data Types

>>> 4 + 2
6
>>>
Data Types

```python
>>> 4 + 2
6
```

```python
>>> 4 + 2.0
6.0
```

```python
>>> 
```
Data Types

```python
>>> 4 + 2
6
>>> 4 + 2.0
6.0
>>> 8 / 5
1.6
```
## Data Types

```python
>>> 4 + 2
6
>>> 4 + 2.0
6.0
>>> 8 / 5
1.6
>>> 8 / 5.0
1.6
>>> 
```

**Note:** In Python 2 division of two integer numbers results in an integer: \(8/5 = 1\)
Data Types

```
>>> type(8 / 5)
<class 'float'>
```
The function `type()` yields information on the type of a variable.
The function `type()` yields information on the type of a variable
Python Strings

- Text, or *strings of characters*, easy to handle
- Given two strings:

\[
A = "\text{ABCD}" \quad \text{B} = "\text{EFG}\"
\]

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Note: Python starts counting from zero!
## Python Strings

- Text, or **strings of characters**, easy to handle
- Given two strings:

  \[
  A = "ABCD" \quad \text{and} \quad B = "EFG"
  \]

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Python Strings

- **Text, or strings of characters, easy to handle**
- **Given two strings:**

\[ A = "ABCD" \quad B = "EFG" \]

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</tr>
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**Note:** Python starts counting from zero!
Methods

```python
>>> greeting = "Welcome!"
>>> dir(greeting)
```
Methods

```python
>>> greeting = "Welcome!"
>>> dir(greeting)
['__add__', '__class__', '__contains__', '__delattr__',
 '__dir__', '__doc__', '__eq__', '__format__', '__ge__',
 '__getattribute__', '__getitem__', '__getnewargs__',
 '__gt__', '__hash__', '__init__', '__iter__', '__le__',
 '__len__', '__lt__', '__mod__', '__mul__', '__ne__',
 '__new__', '__reduce__', '__reduce_ex__', '__repr__',
 '__rmod__', '__rmul__', '__setattr__', '__sizeof__',
 '__str__', '__subclasshook__', 'capitalize', 'casefold',
 'center', 'count', 'encode', 'endswith', 'expandtabs',
 'find', 'format', 'format_map', 'index', 'isalnum',
 'isalpha', 'isdecimal', 'isdigit', 'isidentifier',
 'islower', 'isnumeric', 'isprintable', 'isspace',
 'istitle', 'isupper', 'join', 'ljust', 'lower', 'lstrip',
 'maketrans', 'partition', 'replace', 'rfind', 'rindex',
 'rjust', 'rpartition', 'rsplit', 'rstrip', 'split',
 'splitlines', 'startswith', 'strip', 'swapcase', 'title',
 'translate', 'upper', 'zfill']
```
Methods

```python
>>> greeting = "Welcome!"
>>> dir(greeting)
[...,'count',...]
```

- The function `dir()` yields information on the methods of a specific data type or object
Methods

>>> greeting = "Welcome!"
>>> dir(greeting)
[...,'count',...]

>>> help(greeting.count)
Help on built-in function count:

count(...) method of builtins.str instance
    S.count(sub[, start[, end]]) -> int

    Return the number of non-overlapping occurrences of
    substring sub in string S[start:end]. Optional
    arguments start and end are interpreted as in slice
    notation.

• The function help() yields further information on
  how to use these methods (press "q" to quit)
Methods

```python
>>> greeting = "Welcome!"
>>> dir(greeting)
[..., 'count', ...]
>>> help(greeting.count)
```

```
Help on built-in function count:

count(...)  
S.count(sub[, start[, end]]) -> int

Return the number of non-overlapping occurrences of substring sub in string S[start:end]. Optional arguments start and end are interpreted as in slice notation.
```

```python
>>> greeting.count('e')
2
>>> 
```
Methods

```python
>>> greeting = "Welcome!"
>>> dir(greeting)
[..., 'count', ...]
>>> help(greeting.count)
>>> greeting.count('e')
2
>>> greeting.count('e', 2)
1
```
Methods

>>> greeting = "Welcome!"
>>> dir(greeting)
[... , 'count', ...]
>>> help(greeting.count)

>>> greeting.count('e')
2
>>> greeting.count('e', 2)
1
>>> greeting.count('e', 2, 4)
0
>>>
Methods

```python
>>> greeting = "Welcome!"
>>> dir(greeting)
[... , 'count', ...]
>>> help(greeting.count)

Help on built-in function count:

count(...)
    S.count(sub[, start[, end]]) -> int

Return the number of non-overlapping occurrences of substring sub in string S[start:end]. Optional arguments start and end are interpreted as in slice notation.

>>> greeting.count('e')
2
>>> greeting.count('e', 2)
1
>>> greeting.count('e', 2, 4)
0
>>> greeting.count('ome')
1
```
Python Lists

- **Lists** contain series of arbitrary values (to be precise: objects)
- Lists are defined by writing the individual values separated by commas inside square brackets
- One can define empty lists:

  ```python
  >>> l = []
  ```

- Lists can contain different data types

  ```python
  >>> l = [1, 2, "ABC", 7.1]
  ```
Python Lists

```python
>>> l = []
>>> l.append(0)
>>> l.append(1)
>>> print(l)
[0, 1]

• With **append** one can add elements to a list
• Lists can be concatenated with the operator **+**
• Lists can be accessed via index operations in the same way as strings
```
Python Lists

```python
>>> l = []
>>> l.append(0)
>>> l.append(1)
>>> print(l)
[0, 1]
>>> m = [2, 3, 4]
>>> n = l + m
>>> print(n)
[0, 1, 2, 3, 4]
```  
- With **append** one can add elements to a list
- Lists can be concatenated with the operator **+**
- Lists can be accessed via index operations in the same way as strings
Python Lists

- With `append` one can add elements to a list
- Lists can be concatenated with the operator `+`
- Lists can be accessed via index operations in the same way as strings
Python Lists

>>> l = []
>>> l.append(0)
>>> l.append(1)
>>> print(l)
[0, 1]
>>> m = [2, 3, 4]
>>> n = l + m
>>> print(n)
[0, 1, 2, 3, 4]
>>> print(n[2])
2

- With `append` one can add elements to a list
- Lists can be concatenated with the operator `+`
- Lists can be accessed via index operations in the same way as strings
Python Lists

```python
>>> l = []
>>> l.append(0)
>>> l.append(1)
>>> print(l)
[0, 1]
```

```python
>>> m = [2, 3, 4]
>>> n = l + m
>>> print(n)
[0, 1, 2, 3, 4]
```

- With `append` one can add elements to a list
- Lists can be concatenated with the operator `+`
- Lists can be accessed via index operations in the same way as strings
With **append** one can add elements to a list

Lists can be concatenated with the operator `+`

Lists can be accessed via index operations in the same way as strings
Python Lists

- Python has more useful built-in functions

```python
>>> l = [170, 50, 3, 244]
>>> print(min(l))
3
>>> 
```
Python Lists

- Python has more useful built-in functions

```python
>>> l = [170, 50, 3, 244]
>>> print(min(l))
3
>>> print(max(l))
244
>>> 
```
Python Lists

- Python has more useful built-in functions

```python
>>> l = [170, 50, 3, 244]
>>> print(min(l))
3
>>> print(max(l))
244
>>> print(sorted(l))
[3, 50, 170, 244]
```
Python Lists

- Python has more useful built-in functions

```python
>>> l = [170, 50, 3, 244]
>>> print(min(l))
3
>>> print(max(l))
244
>>> print(sorted(l))
[3, 50, 170, 244]
>>> print(sum(l))
467
>>> 
```
Python Lists

- Python has more useful built-in functions

```python
>>> l = [170, 50, 3, 244]
>>> print(min(l))
3
>>> print(max(l))
244
>>> print(sorted(l))
[3, 50, 170, 244]
>>> print(sum(l))
467
>>> print(len(l))
4
```
Python Dictionary

• Dictionaries (dict) uses keys instead of index numbers, which makes them unordered
• Dicts are defined by writing key-value pairs separated by commas inside curly brackets
• One can define empty dicts:

```python
>>> l = {}
```

• Dicts can contain different data types

```python
>>> D = ["key1":5, "nextKey":"look, a string", "car":"vw"]
```
You add elements by assigning a value to a key
You add elements by assigning a value to a key
You add elements by assigning a value to a key
• You add elements by assigning a value to a key
Control Structures

- Control structures determine the logical flow of a program
- There are two types of key control structures in Python:
  - Loops: *for, while*
  - Conditions: *if-else*
- These two types of control structures permit the modeling of all possible program flows
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
>>> l = [170, 50, 3, 244]  # list
>>> for i in l:
   ... print(i)  # head with loop variable i
   ...  # body
   ... # press ENTER a second time
```
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
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```python
>>> l = [170, 50, 3, 244]  # list
>>> for i in l:
...    print(i)  # head with loop variable i
...    print(i)  # body
170  # press ENTER a second time
```
Python Loops

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- The body is executed for each of the values of the loop variable

```python
>>> l = [170, 50, 3, 244]  # list
>>> for i in l:
...     print(i)  # head with loop variable i
...     print(i)  # body
... 170
... 50
```

```python
>>>  # press ENTER a second time
```
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
gle = [170, 50, 3, 244]  # list
for i in l:  # head with loop variable i
    print(i)  # body
    # press ENTER a second time
>>> 170
>>> 50
>>> 3
```
Python Loops

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- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
>>> l = [170, 50, 3, 244]  # list
>>> for i in l:
    ... print(i)  # head with loop variable i
    ... print(i)  # body
>>>  # press ENTER a second time
170
50
3
244
```
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
>>> l = [170, 50, 3, 244]  # list
>>> for my_loop_variable in l:  # head with loop variable i
...     print(my_loop_variable)  # body
... # press ENTER a second time
170
50
3
244
>>> 
```
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
- The head defines the loop variable
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```python
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• The head defines the loop variable
• The body is executed for each of the values of the loop variable

```python
>>> l = [170, 50, 3, 244]  # list
>>> for i in l:
...    print(i)            # head with loop variable i
...                        # body
...                        # press ENTER a second time
  File "<stdin>", line 2
    print(i)             # press ENTER a second time
  ^
IndentationError: expected an indented block
```
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
>>> A = "ABCD"
>>> for i in A:
...     print(i)
... # press ENTER a second time
```
Python Loops

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- The head defines the loop variable
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```python
>>> A = "ABCD"
>>> for i in A:
    ...     print(i)
...   # press ENTER a second time
>>> A
```
Python Loops

• One can iterate with for-loops over elements of a list (e.g., list, string)
• The head defines the loop variable
• The body is executed for each of the values of the loop variable

```python
>>> A = "ABCD"
# string
>>> for i in A:
...     print(i)
# head with loop variable i
...     # body
# press ENTER a second time
A
B

>>>`
```
Python Loops

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- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
>>> A = "ABCD"
>>> for i in A:
...     print(i)
... A
A
B
C
```
Python Loops

- One can iterate with for-loops over elements of a list (e.g., list, string)
- The head defines the loop variable
- The body is executed for each of the values of the loop variable

```python
>>> A = "ABCD"
>>> for i in A:
...     print(i)
...     # press ENTER a second time
A
B
C
D
```
### Python Loops

- **The body may contain multiple lines of code**

```python
>>> A = "ABCD"  # string
>>> l = []
>>> for i in A:
...     print(i)  # head with loop variable i
...     l.append(i)  # body
...  # press ENTER a second time
A
B
C
D
```

---

**Python I**
Python Loops

- The body may contain multiple lines of code

```python
>>> A = "ABCD"  # string
>>> l = []
>>> for i in A:
...     print(i)  # head with loop variable i
...     l.append(i)  # body
...  # press ENTER a second time
A
B
C
D

>>> print(l)
['A', 'B', 'C', 'D']
>>> 
```
Python Loops

```python
>>> for i in range(5):
...     print(i)

0
1
2
3
4
```

**Note:** Python starts counting from zero!

- The build-in function `range()` creates a list of values
- The list elements can be used to iterate through during a for-loop
Python Loops

>>> A = "ABCD"
>>> print(len(A))
4
>>> for i in range(len(A)):
...     print(i)
...
0
1
2
3

- The build-in function `range()` creates a list of values
- The list elements can be used to iterate through during a for-loop
The build-in function `range()` creates a list of values

The list elements can be used to iterate through during a for-loop
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{\text{DNA}}$:

```python
>>> A = "ACGT"
>>> for i in A:
...     for j in A:
...         print(i + j)
...```
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{\text{DNA}}$:

```python
>>> A = "ACGT"
>>> for i in A:
...     ACGT
...     for j in A:
...         ACGT
...     print(i + j)
...```

Python I
 Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{DNA}$:

```python
>>> A = "ACGT"
>>> for i in A:
...     for j in A:
...         print(i + j)
... AA
```
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{\text{DNA}}$:

```python
>>> A = "ACGT"
>>> for i in A:       A
...     for j in A:   C
...         print(i + j)
... A
AA
AC
```
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{\text{DNA}}$:

```python
>>> A = "ACGT"
>>> for i in A:
...     for j in A:
...         print(i + j)
...
AA
AC
AG
```
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{\text{DNA}}$:

```python
>>> A = "ACGT"
>>> for i in A:        ACGT
...     for j in A:      ACGT
...         print(i + j)
... AA
AC
AG
AT
```
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{\text{DNA}}$:

```python
>>> A = "ACGT"
>>> for i in A:       ACGT
...     for j in A:     ACGT
...         print(i + j)
...  AA
  AC
  AG
  AT
  CA
```
Nested Loops

- The body of the first loop (also called outer loop) includes the body of the second loop (called inner loop)
- Prints all words of length 2 of $\Sigma_{DNA}$:

```python
>>> A = "ACGT"
>>> for i in A:       ACGT
...     for j in A:     ACGT
...         print(i + j)

AA
AC
AG
AT
CA
CC
```
Python While-Loops

- While-loops iterate as long as a certain condition is met
- Before each iteration of a while-loop is executed, the condition in the head is tested, while it is still true, the body is executed

```python
>>> A = "ABCD"
>>> i = 0
>>> while i < len(A):
...     print(A[i])
...     i = i + 1
```

```python
>>> A = "ABCD"
>>> for i in range(len(A)):
...     print(A[i])
```
Python Conditions

- Conditions limit the execution of parts of the program
- In Python this construct is called if-else

```
>>> A = "ACGT"
>>> B = "AAT"
>>> if len(A) < len(B):
...    print("Sequence A is smaller than B.")
```

- If the condition is fulfilled the block following if is executed
Python Conditions

- Conditions limit the execution of parts of the program.
- In Python, this construct is called if-else.

```python
>>> A = "ACGT"
>>> B = "AAT"
>>> if len(A) < len(B):
...     print("Sequence A is smaller than B.")
... else:
...     print("Sequence A is greater or equal than B.")
```

- If the condition is fulfilled the block following if is executed, otherwise the block after else is executed.
Python Conditions

- Conditions limit the execution of parts of the program
- In Python this construct is called if-else

```python
>>> A = "ACGT"
>>> B = "AAT"
>>> if len(A) < len(B):
...     print("Sequence A is smaller than B."")
... else:
...     print("Sequence A is greater or equal than B."")
```

- For comparisons different operators are used
  
  ```
  ==  equal  
  <   less   
  <=  equal to or less  
  !=  not equal  
  >   greater  
  >=  greater or equal  
  ```
The if-else condition can be extended with `elif` to consider multiple conditions (as many as necessary)

```python
>>> A = "ABCD"
>>> if len(A) <= 3:
...     print("Sequence A is smaller or equal than 3."")
... elif (len(A) > 3) and (len(A) < 5):
...     print("Sequence A is greater than 3 and smaller than 5."")
... elif len(A) == 5:
...     print("Sequence A is equal to 5."")
... else:
...     print("Sequence A is greater than 5.")
```
Note: Assignment and Comparison

- **Assignment:**
  store a value in a variable

```python
>>> A = "ACGT"
>>> B = "AAT"
>>> number = 5
>>> sum = 10
```

- **Comparison:**
  compare two values

```python
>>> if len(A) == len(B):
...     print("Sequence", A, "is equal to sequence", B)
... else:
...     print("Sequence", A, "is not equal to sequence", B)
...
Sequence ACGT is not equal to sequence AAT
```
Writing and Executing a Program

- Python allows not only interactive work, but also the execution of a full program which is saved as a file
- It reads the full program and executes each line consecutively, starting with the first
- This program calculates the product of two numbers

```python
x = 15
print("x = ", x)
y = 456
print("y = ", y)
print("Product of x and y is ", x*y)
```
Writing and Executing a Program

- One can use an arbitrary editor (gedit, nano, emacs, vi, ...) to write the program and save it as a file, named e.g. "product.py"

```python
x = 15
print("x = ", x)
y = 456
print("y = ", y)
print("Product of x and y is", x*y)
```

[dahlo@rackham1 ~]$ gedit product.py &
Writing and Executing a Program

- Python-Interpreter vs. editor written program
Writing and Executing a Program

- To execute the program we call the interpreter from the command line using the filename as argument

```
[dahlo@rackham1 ~]$ python3 sequence.py
Sequence A is greater than 3 and smaller than 5.
```
References

• http://www.diveintopython.net
  ○ A full book about Python freely available for download
• http://openbookproject.net/thinkcs/python/english2e/
  ○ „How to think like a computer scientist“
  ○ With examples in Python!
• More information on http://python.org
• For example:
  ○ A Python Tutorial: https://docs.python.org/2/tutorial/
  ○ https://www.codecademy.com/learn/learn-python
• You can easily install python on your own computer:
  ○ http://www.python.org
• Integrated development environment for python (IDLE)
  ○ https://wiki.python.org/moin[IDLE or https://code.visualstudio.com/