Lecture 1

Introduction to Variables and Control Statements

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Computer Science and Mathematics
Preparatory Course

28.09.2021
Course Formalities

Goals:

▶ Learning basic programming with Python
▶ Refreshing elementary mathematical concepts

Concept:

▶ Each lecture will usually be split into a theoretical explanation and a programming session
▶ On the last day (08.10.) there will be an “ungraded” test
Overview

1. Motivation

2. Programming
   ➤ First Steps
   ➤ Variables
   ➤ Control Statements
   ➤ Utilities

3. Tasks
Motivation: Modeling a cognitive agent

Braitenberg Vehicles

[Braitenberg, 1986]
Motivation: Modeling a cognitive agent

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Motivation: Modeling a cognitive agent

Braitenberg Vehicles

[Braitenberg, 1986]
Motivation: Modeling a cognitive agent

Braitenberg Vehicles

[Braitenberg, 1986]
Motivation: Modeling a cognitive agent

Velocity and Position
(Differentiation and Integration)

Environmental Factors
(Numbers)

Distance and Orientation
(Trigonometry)

Relationships
(Functions)

Braitenberg Vehicles

[Braitenberg, 1986]
Motivation: Modeling a cognitive agent

Environmental Factors (Numbers)

Relationships (Functions)

$\alpha$

Distance and Orientation (Trigonometry)

Velocity and Position (Differentiation and Integration)

Behavior (Differential Equations)

Braitenberg Vehicles

[Braitenberg, 1986]
Motivation: Modeling a cognitive agent

- Environmental Factors (Numbers)
- Relationships (Functions)
- Distance and Orientation (Trigonometry)
- Velocity and Position (Differentiation and Integration)
- Connections (Matrices)
- Behavior (Differential Equations)

Braitenberg Vehicles

[Braitenberg, 1986]
Programming Goal
# Course Structure

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Title</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>28.09.</td>
<td>Variables and Control Statements</td>
<td>Data Types, Control Statements</td>
</tr>
<tr>
<td>2</td>
<td>29.09.</td>
<td>Functions in Math and Programming</td>
<td>Function Types and Properties, Plotting Functions, Lists</td>
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<tr>
<td>3</td>
<td>30.09.</td>
<td>Full-Time Programming Session</td>
<td>Deepen Programming Skills</td>
</tr>
<tr>
<td>4</td>
<td>01.10.</td>
<td>Coordinate Systems</td>
<td>Vectors, Trigonometry, The Pygame Module</td>
</tr>
<tr>
<td>5</td>
<td>04.10.</td>
<td>Differentiation</td>
<td>Derivative Definition, Calculating Derivatives, Numerical Differentiation, File-Input/Output</td>
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</tbody>
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Course Structure

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<thead>
<tr>
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<tbody>
<tr>
<td>6</td>
<td>05.10.</td>
<td>Integration</td>
<td>Geometrical Definition, Calculating Integrals, Numerical Integration</td>
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<tr>
<td>7</td>
<td>06.10.</td>
<td>Differential Equations</td>
<td>Properties of Differential Equations, Euler Approximation, Braitenberg Vehicle</td>
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<td>8</td>
<td>07.10.</td>
<td>Programming Session &amp; Recap</td>
<td>Repetition, Questions, Test Topics</td>
</tr>
<tr>
<td>9</td>
<td>07.10.</td>
<td>“Make a wish Lecture”</td>
<td>Individual Wishes, e.g. Object-Oriented Programming, Matrix Calculation</td>
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<tr>
<td>10</td>
<td>08.10.</td>
<td>“Test”</td>
<td>Self-evaluation</td>
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1. Motivation

2. Programming
   ➤ First Steps
   ➤ Variables
   ➤ Control Statements
   ➤ Utilities

3. Tasks
The Python Programming Language

Why Python?

▶ It is simple but high level
▶ It is interpreted “on the fly”
▶ It is the state of the art scripting language

Helpful Resources

▶ The Anaconda Distribution contains all necessary software: https://www.anaconda.com/distribution/
▶ You can find helpful documentation here: https://docs.python.org/3/
Setting Up

- Open the Spyder IDE (Integrated Development Environment)
- Create your first python script file
  - Close the default temporary file
  - Go to File → Save as …
  - *(Recommended)* Create a new folder for your python projects
  - Choose the name helloworld.py
- You are set up to write your first Python script!
Hello World

- Write the following line into the file:

```python
print("Hello World!")
```

- Press the green *Play* button in the toolbar to execute the script

- Observe the output in the console on the right
Hello World

- Write the following line into the file:

```python
print("Hello World!")
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- Press the green *Play* button in the toolbar to execute the script

- Observe the output in the console on the right

- The `print()` function writes its argument to the console
Script: A series of commands

- Code is executed from top to bottom - one line after each other

```python
print("Hello There!")
print("Haven't seen you in a while.")
print("How are you?")
```
Script: A series of commands

- Code is executed from top to bottom - one line after each other

```python
print("Hello There!")
print("Haven't seen you in a while.")
print("How are you?")
```

- You can write comments in your code using the # character

```python
print("Hello!")  # This is a comment
# Lines that start with # are ignored
print("How are you?")
# print("I am bored") This line is ignored
```
Variables

- Variables are the elementary building block of every program

```python
greeting = "Hello, Hello!"
print(greeting)  # prints "Hello, Hello!"
```
Variables

- Variables are the elementary building block of every program

```python
greeting = "Hello, Hello!"
print(greeting)  # prints "Hello, Hello!"
```

- Variables are assigned via `='

```python
var1 = "Hello"  # variable names may be chosen arbitrarily
long_variable_name5 = "Hi"
# letters, numbers and underscores may make up a name
```
Variables

- Variables are the elementary building block of every program

```python
greeting = "Hello, Hello!"
print(greeting) # prints "Hello, Hello!"
```

- Variables are assigned via `=`

```python
var1 = "Hello" # variable names may be chosen arbitrarily
long_variable_name5 = "Hi"
# letters, numbers and underscores may make up a name
```

- Assigned variables are available for code following the assignment

```python
print(greeting) # prints "Hello, Hello!"
greeting = "Hey!" # variables may be overwritten
print(greeting) # prints "Hey!"
```
Data Types and Operations

- Variables store information of various type:

```python
farewell = "Bye, Bye!"  # String Type
num1 = 5  # Integer Type
num2 = 3.0  # Float Type
```
Data Types and Operations

- Variables store information of various type:

```python
farewell = "Bye, Bye!" # String Type
num1 = 5 # Integer Type
num2 = 3.0 # Float Type
```

- Operations may be performed using variables

```python
print(num1+num2) # prints 8.0
```
Data Types and Operations

- Variables store information of various type:

```python
farewell = "Bye, Bye!"  # String Type
num1 = 5  # Integer Type
num2 = 3.0  # Float Type
```

- Operations may be performed using variables

```python
print(num1+num2)  # prints 8.0
```

- Results may again be stored in variables

```python
num3 = num1+num2  # num3 is now 8.0
print(num3)  # prints 8.0
num3 = num3+1  # num3 updates based on its current value
print(num3)  # prints 9.0
```
Excursion: The Spyder Debugger

- A debugger allows a look under the ‘hood’ of a program

These are the Debug Controls

- Start Debugging
- Execute Line by Line
- Stop Debugging

Click here to display the current variables

```python
1 num1=3
2 num2=5.0
3 num3 = num1+num2  # num3 is now 8.0
4 print(num3)      # prints 8.0
5 num3= num3 +1    # num3 updates based on its current value
6 print(num3)      # prints 9.0
```
Useful Operations on Data Types

Operations on Numbers

\[ 2+2 \quad #4 \]
\[ 50-5*6 \quad #20 \]
\[ (50-5*6)/4 \quad #5.0 \]
\[ 8/5 \quad #1.6 \]
\[ 17/3 \quad #5.666666666666667 \]
\[ 17//3 \quad #5 \text{ Integer Division} \]
\[ 17\%3 \quad #2 \text{ Rest of the Division} \]

Operations on Strings

\[ 'Wo' + 'rd' \quad #'Word' \text{ or } "Word" \]
\[ 'Isn't' \quad # \text{This results in an error!} \]
\[ 'Isn\\t' \quad #'Isn't' \text{ Use \ to escape characters} \]
Control Statements

▶ if-Statement

```python
x = 3.5
if x > 0:
    print("x is positive!")
    print("Program is finished!")
else:
    print("x is not positive!")
```

Control Statements

▶ if-Statement

```python
x = 3.5
if x > 0 : #Indentation organizes blocks
    print("x is positive!") #Indent with 4 spaces
print("Program is finished!")
```

▶ else-statement

```python
x = 3.5
if x > 0 : #Indentation organizes blocks
    print("x is positive!") #Indent with 4 spaces
else :
    print("x is not positive!")
print("Program is finished!")
```
Control Statements

- else if-statement

```python
x = 3.5
if x > 0:
    print("x is positive!")  # Indentation organizes blocks
elif x < 0:
    print("x is negative!")
elif x < 0:
    print("x is negative!")
else:
    print("x is zero!")
print("Program is finished!")
```
Variable Scope

- Python code is organized in blocks by indentation (4 spaces)

```python
a = 3
b = 4
if a > 2:
c = a + b
b = 1
if c > 5:
    print(a)
else:
    print(a)
    print(c)
print(b)
```
Variable Scope

- Python code is organized in blocks by indentation (4 spaces)
- Variables defined in the global scope are available at all positions in the code below its definition

```python
# Global
a = 3
b = 4
if a > 2:
c = a + b
else:
print(a)
print(c)
print(b)
```

- Variables defined in a block are available in the block and all blocks inside it
Variable Scope

- Python code is organized in blocks by indentation (4 spaces)
- Variables defined in the global scope are available at all positions in the code below its definition
- Variables defined in a block are available in the block and all blocks inside it

```python
a = 3
b = 4
if a > 2:
c = a + b
b = 1
if c > 5:
    print(a)
else:
    print(a)
    print(c)
print(b)
```
Variable Scope

Example

```python
a = 3  # Global Scope
b = 4
if a > 2:
    c = a + b  # Block 1
    b = 1
    if c > 5:
        print(a)  # Block 2
else:  # Global
    print(a)  # Block 3
    print(c)  # If a <= 2 this will result in an error
print(b)  # '1' or '4' if a <= 2
```

While Loops

- Print the numbers from 1 to 10

```python
a = 0
while a < 10 :
    a = a + 1  # Increase a by 1
    print(a)
```
While Loops

► Print the numbers from 1 to 10

\[
\begin{align*}
a &= 0 \\
\text{while } a < 10 : \\
\quad a &= a + 1 \quad \# \text{ Increase } a \text{ by 1} \\
\quad \text{print}(a)
\end{align*}
\]

► Be careful with the exit condition

\[
\begin{align*}
a &= 0 \\
\text{while } a < 10 : \\
\quad \text{print}(a) \quad \# \text{ Prints 0 until the end of time}
\end{align*}
\]

You can kill the running program by pressing the red terminate button
Boolean Statements

Examples

3 > 2  # True, greater than
3 < 3  # False, less than
3 <= 3  # True, equal or less than
4 == 5  # False, == checks equality
4 != 5  # True, != is the opposite of ==
"ello" in "Hello"  # True, only works for sequence types
"hel" not in "Hello"  # True, "in" is case sensitive
Boolean Statements

▶ Examples

3 > 2  # True, greater than
3 < 3  # False, less than
3 <= 3  # True, equal or less than
4 == 5  # False, == checks equality
4 != 5  # True, != is the opposite of ==
"ello" in "Hello"  # True, only works for sequence types
"hel" not in "Hello"  # True, "in" is case sensitive

▶ Boolean Variables

test = 7
isGreaterThanOne = test > 1
if isGreaterThanOne:
    print("The number is Greater than 1!")
User Input

- Use input to prompt the user

```python
person = input('Enter your name: ')
#whatever the user types is stored in person
print('Hello ' + person)
```
User Input

- Use input to prompt the user

```python
person = input('Enter your name: ')
#whatever the user types is stored in person
print('Hello ' + person)
```

- Invalid Data Types

```python
inputValue = input('Please enter a number: ')
result = 5 + inputValue # This results in an error!
```
User Input

▶ Use input to prompt the user

```python
person = input('Enter your name: ')
#whatever the user types is stored in person
print('Hello ' + person)
```

▶ Invalid Data Types

```python
inputValue = input('Please enter a number: ')
result = 5 + inputValue  # This results in an error!
```

▶ Variables might need to be type casted

```python
result = 5 + float(inputValue)
#This works if an actual number was typed
```
Type Casting

- Implicit Typecast

```python
a = 1.0  #float
b = 2  #int
c = a + b  #3.0 float
```
Type Casting

- Implicit Typecast
  
a = 1.0 #float
b = 2 #int
c = a + b #3.0 float

- Explicit Typecasts
  
d = float(b) #2.0
e = 3.7
f = int(3.7) #3 Any floating point is cut off
g = str(e) #String '3.7'
h = int(g) # This results in an error!
i = float(g) # 3.7
print('Variable i is: ' + str(i)) #Print expects strings
Useful built-in Functions

- **Rounding and Absolute Value**

  \[
  a = 3.898987897897 \\
  b = \text{round}(a,3) \# 3.899 \\
  c = \text{abs}(-3.2) \# |-3.2| = 3.2 \\
  t = \text{type}(c) \# t \text{ is } \text{<class 'float'>} \\
  \text{test} = t \text{ is float} \# \text{True}
  \]

- **The math module**

  \[
  \text{import math} \# \text{Import makes a module available} \\
  \text{squareTwo} = \text{math.sqrt}(2) \# \sqrt{2} \\
  \text{power} = \text{math.pow}(3,4) \# 3^4 \\
  \text{exponential} = \text{math.exp}(4) \# e^4 \\
  \text{piNumber} = \text{math.pi} \# 3.14159265359
  \]
Lecture Slides/Material

Use the following URL to access the lecture slides:

https://www.ini.rub.de/teaching/courses/computer_science_and_mathematics_preparatory_course_winter_term_2021/
Tasks Control Statements

1. Write a script that determines whether a number is greater than zero
   ▶ Define a variable `num` and assign it a number of your choice
   ▶ Use If and Else to print out either “The number is greater than zero” or “The number is smaller or equal to zero” to the console depending on the value of `num`

2. Write a script that takes a percentage and prints out the corresponding verbal grade.
   ▶ Define a variable `perc` and assign it a number between 1 and 100.
   ▶ Use If and Else to print out the correct grade depending on the value of `perc`.

<table>
<thead>
<tr>
<th>%</th>
<th>Grade</th>
<th>%</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-100</td>
<td>A</td>
<td>40-55</td>
<td>D</td>
</tr>
<tr>
<td>71-85</td>
<td>B</td>
<td>25-39</td>
<td>E</td>
</tr>
<tr>
<td>56-70</td>
<td>C</td>
<td>1-24</td>
<td>F</td>
</tr>
</tbody>
</table>
Tasks Variables and Loops

3. Write a script that asks the user for two different inputs and prints their sum

   ▶ Define a variable `num1` and assign it a value using the `input()` function
   ▶ Repeat the above step for a second variable `num2`
   ▶ Add `num1` and `num2` together in a third variable `sum` and print it
     (Do not forget to typecast `num1` and `num2`)

4*. Write a script that asks the user for number input until the sum of the inputs is greater than 20.

   ▶ Start with a variable `sum` that is initialized with the value 0.
   ▶ Create a while-loop that ends when `sum` is greater than 20.
   ▶ Inside the while-loop ask the user for input and add the input to `sum`
     (Do not forget to typecast the input)
Advanced Task

5*. Write a script that finds the maximum number out of 3 numbers.

▶ Example:
You choose the three numbers to be 13, 16 and 5.
The program should print: “The highest number is 16”.
▶ Define three variables each containing a different number.
▶ Use If and Else statements to find the highest of the three numbers.
▶ Print the number to the console.
▶ The script should work for any three numbers.
References