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

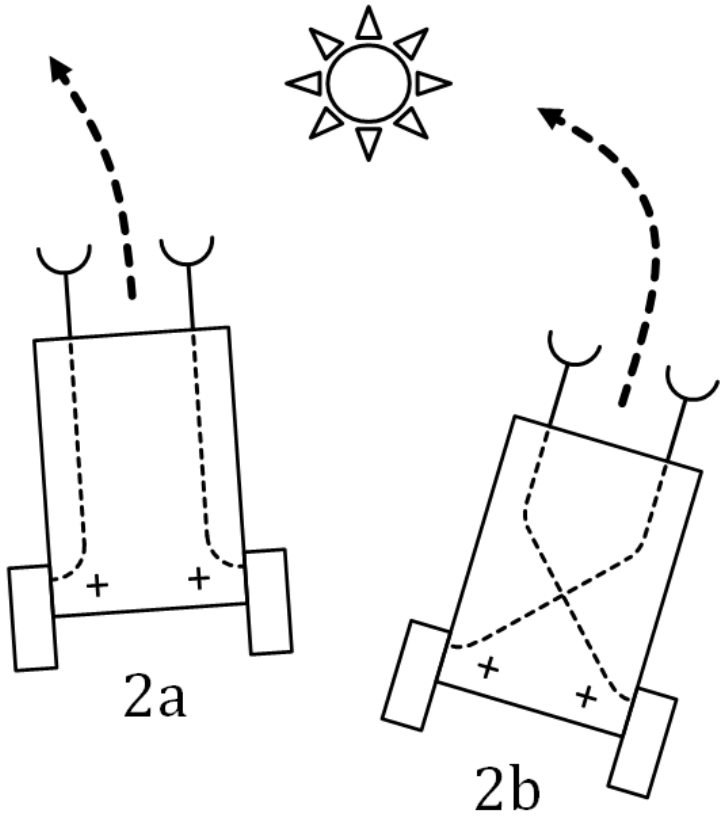
Overview

1. **Motivation**

2. **Programming**
   - First Steps
   - Variables
   - Control Statements
   - Utilities

3. **Tasks**

Motivation: Modeling a cognitive agent



Braitenberg Vehicles

[Braitenberg, 1986]

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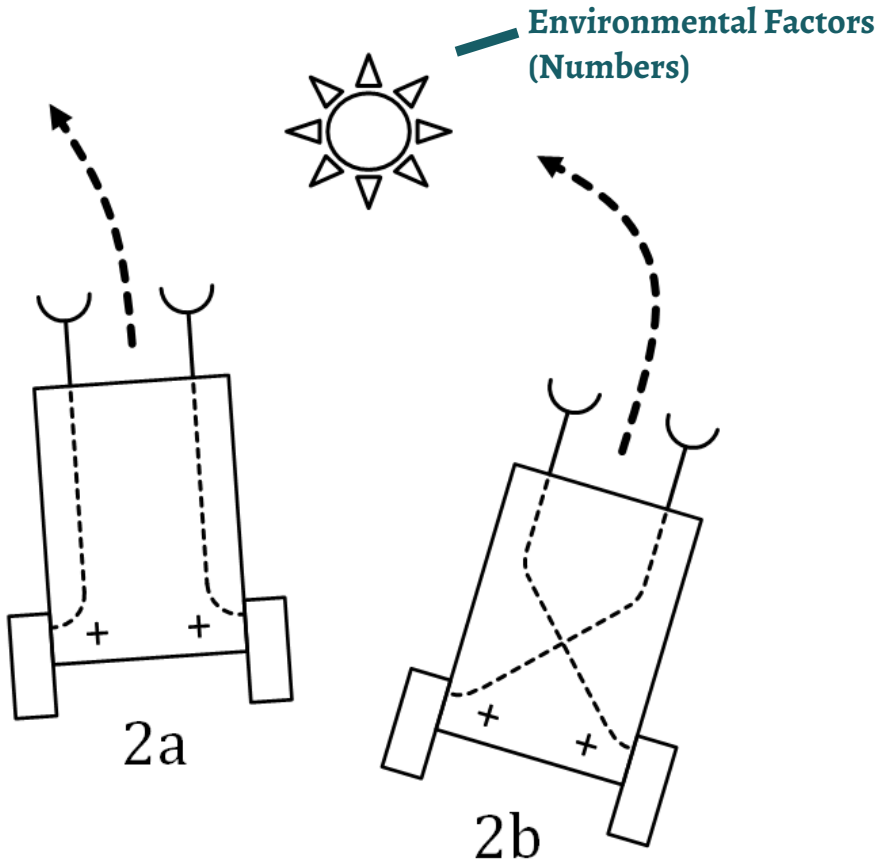

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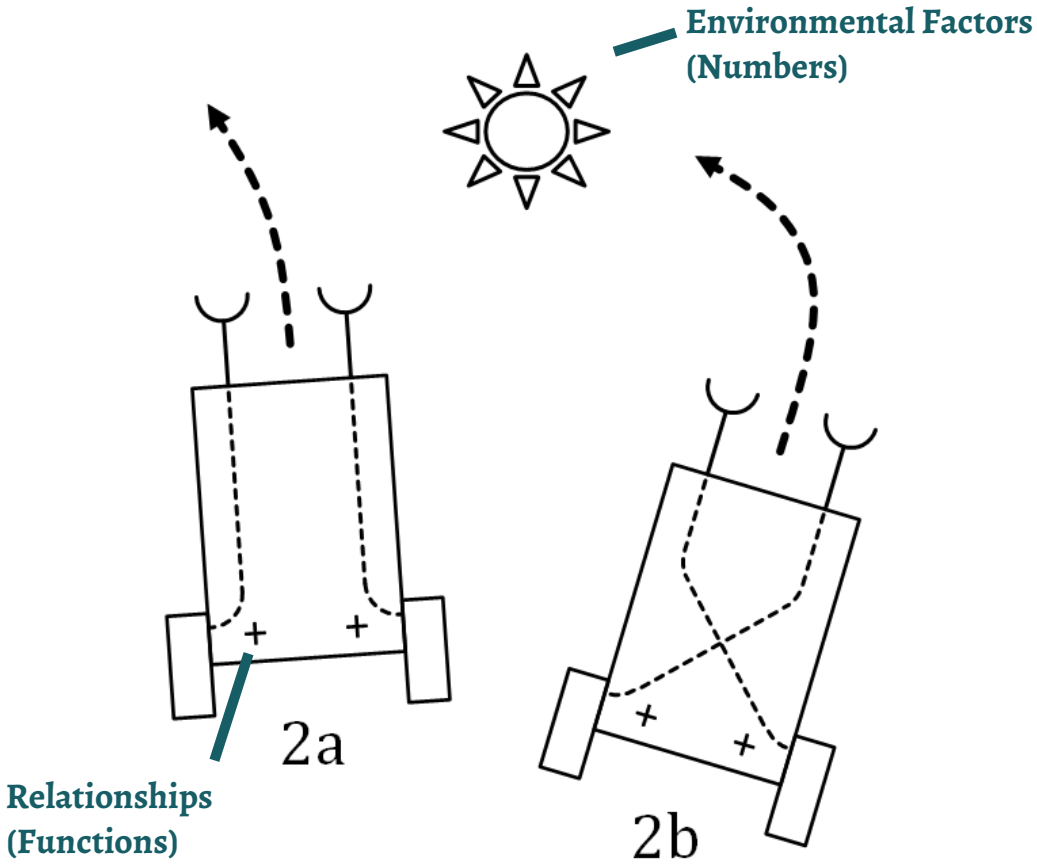

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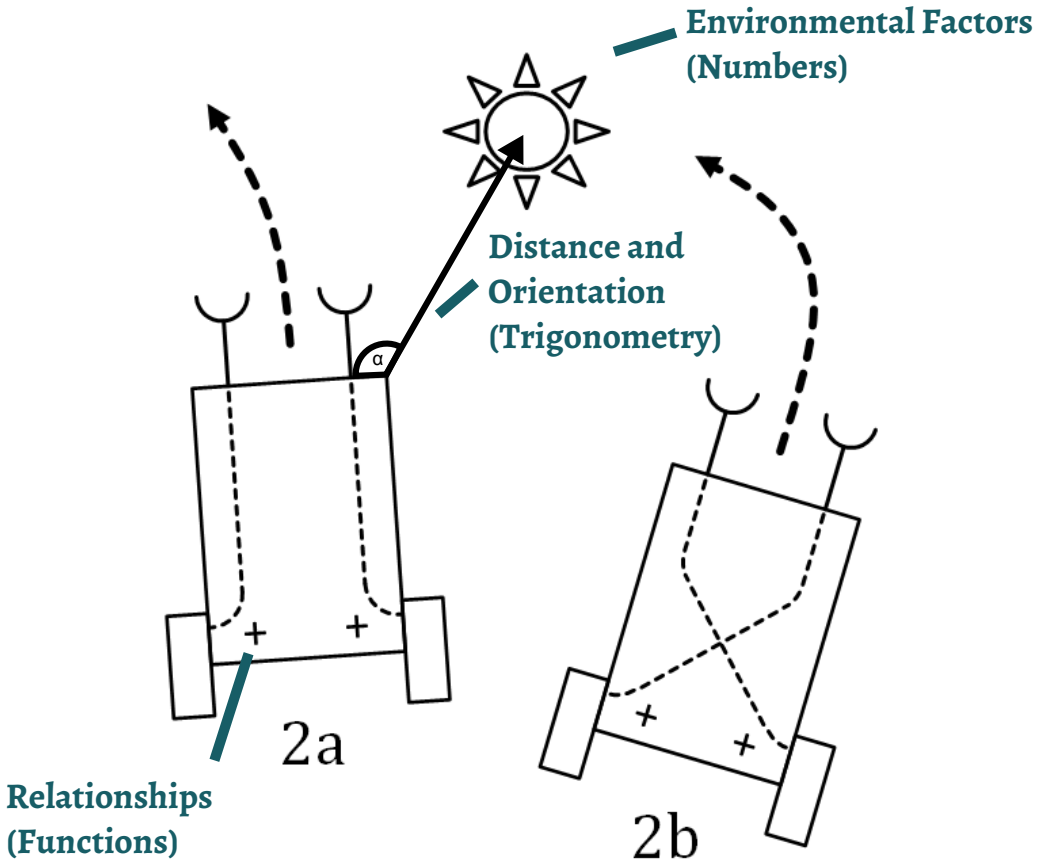

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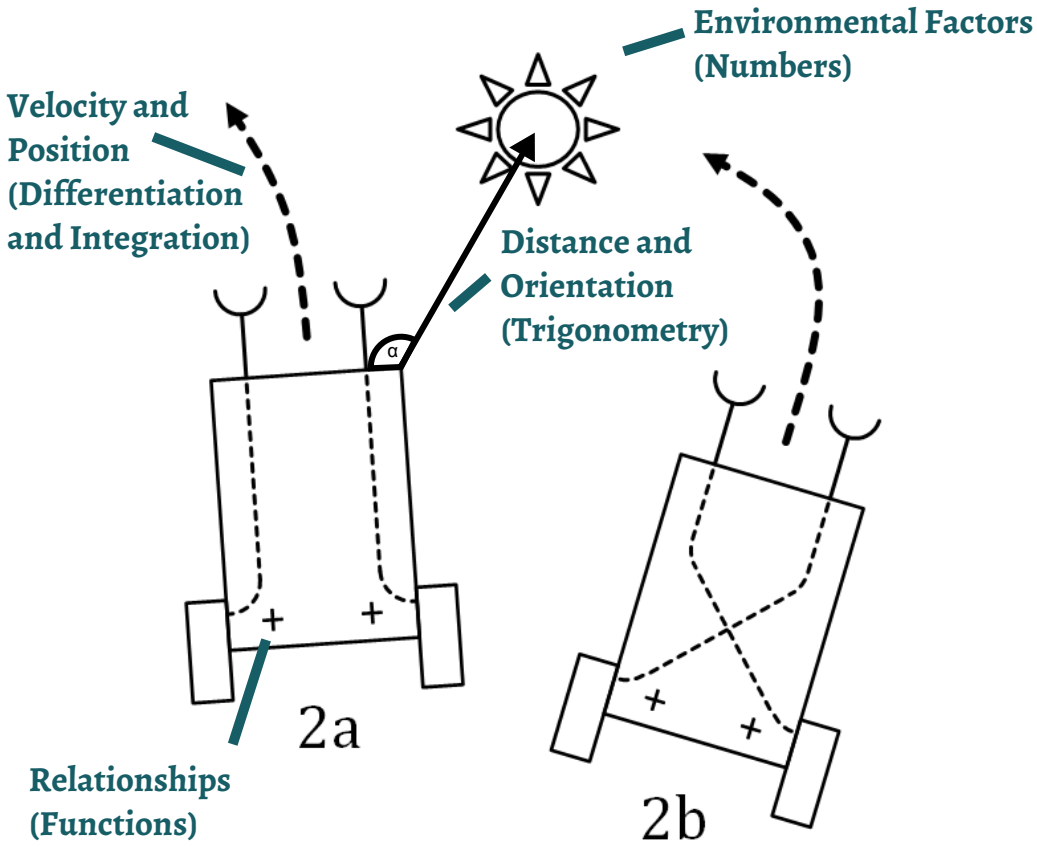

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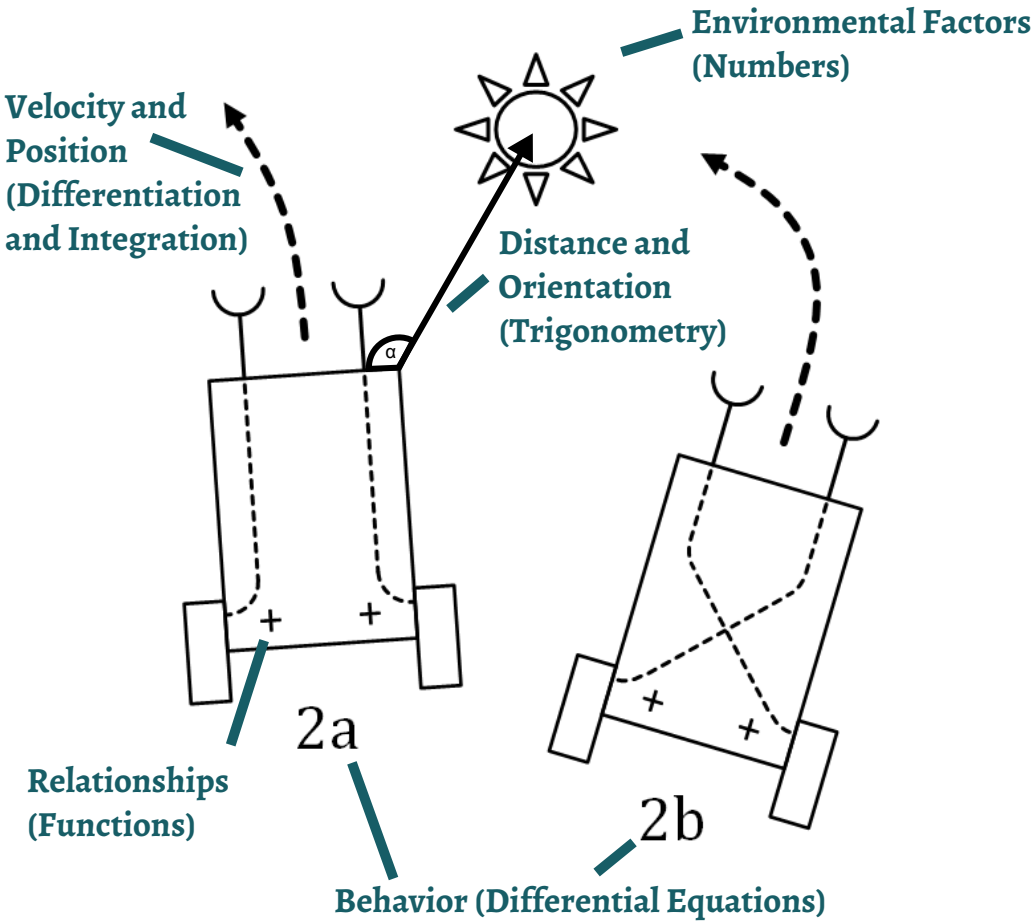

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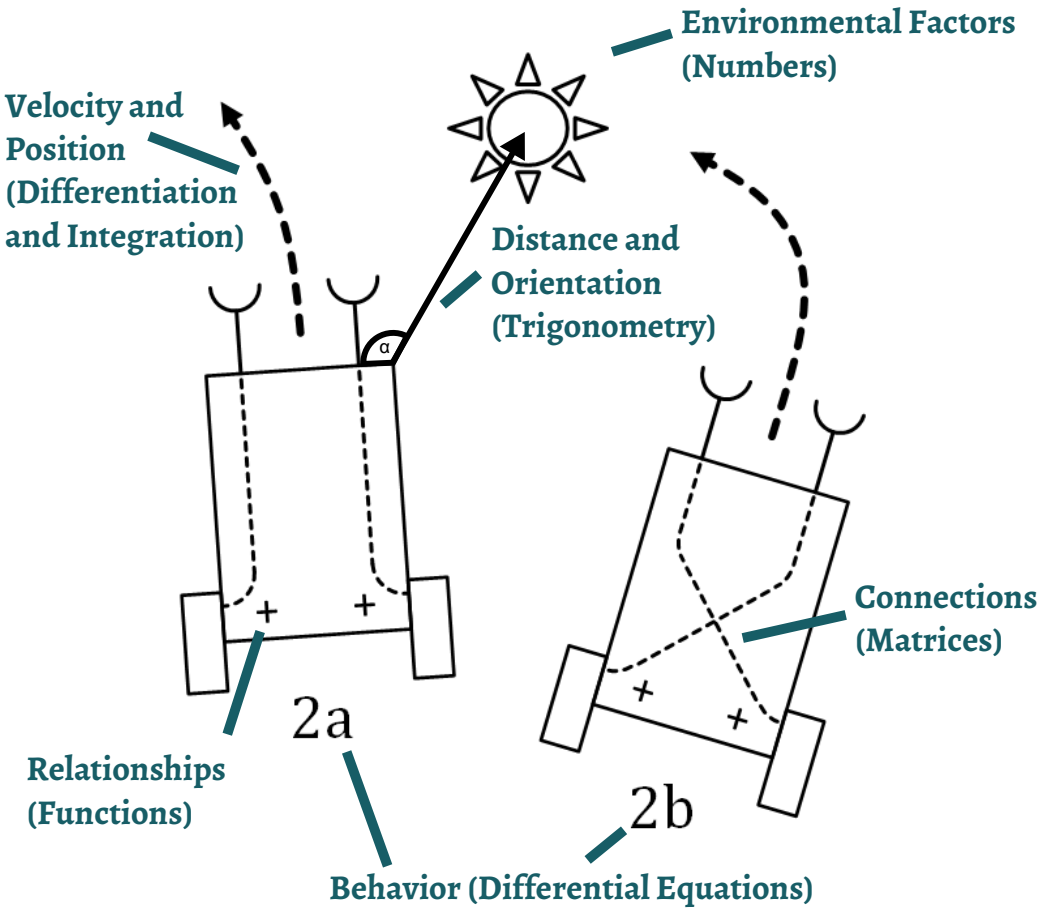

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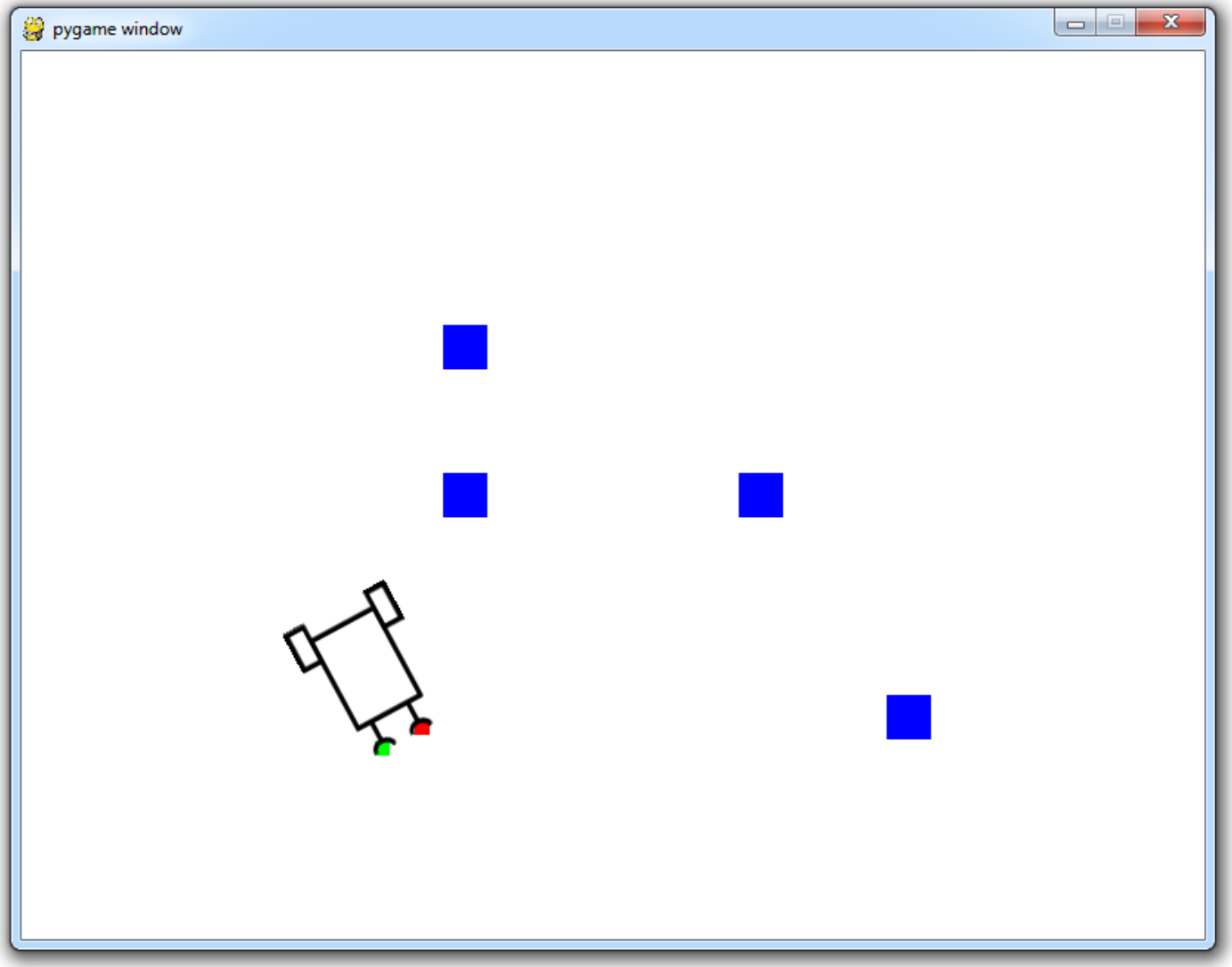
Programming Goal



Course Structure

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

Course Structure

#	Date	Title	Topics
6	05.10.	Integration	*Geometrical Definition, Calculating Integrals, Numerical Integration*
7	06.10.	Differential Equations	*Properties of Differential Equations, Euler Approximation, Braitenberg Vehicle*
8	07.10.	Programming Session & Recap	*Repetition, Questions, Test Topics*
~~9~~	~~07.10.~~	~~"Make a wish Lecture"~~	~~*Individual Wishes, e.g. Object-Oriented Programming, Matrix Calculation*~~
10	08.10.	"Test"	*Self-evaluation*

1. Motivation

2. **Programming**
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   - 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* $\rightarrow$ *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:

```
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

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- 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

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

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

```
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

```
greeting = "Hello, Hello!"
print(greeting) #prints "Hello, Hello!"
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- Variables are assigned via '='

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

```
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:

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

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farewell = "Bye, Bye!" #String Type
num1 = 5 # Integer Type
num2 = 3.0 # Float Type
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- Operations may be performed using variables

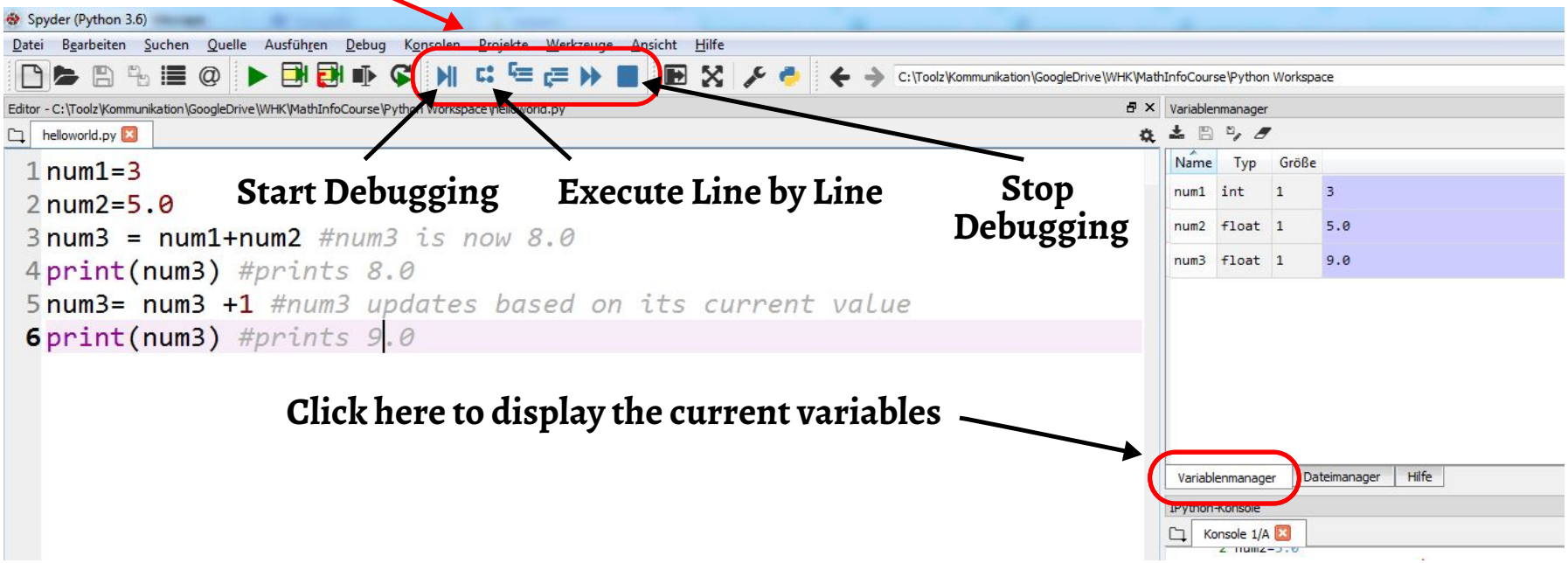
```
print(num1+num2) #prints 8.0
```

- Results may again be stored in variables

```
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



Useful Operations on Data Types

- Operations on Numbers

```
2+2 #4
50-5*6 #20
(50-5*6)/4 #5.0
8/5 #1.6
17/3 #5.666666666666667
17//3 #5 Integer Division
17%3 #2 Rest of the Division
```

- Operations on Strings

```
'Wo' + 'rd' #'Word' or "Word"
'Isn't' # This results in an error!
'Isn\'t' #'Isn't' Use \ to escape characters
```

Control Statements

- if-Statement

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

Control Statements

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print("Program is finished!")
```

- else-statement

```
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!")
```

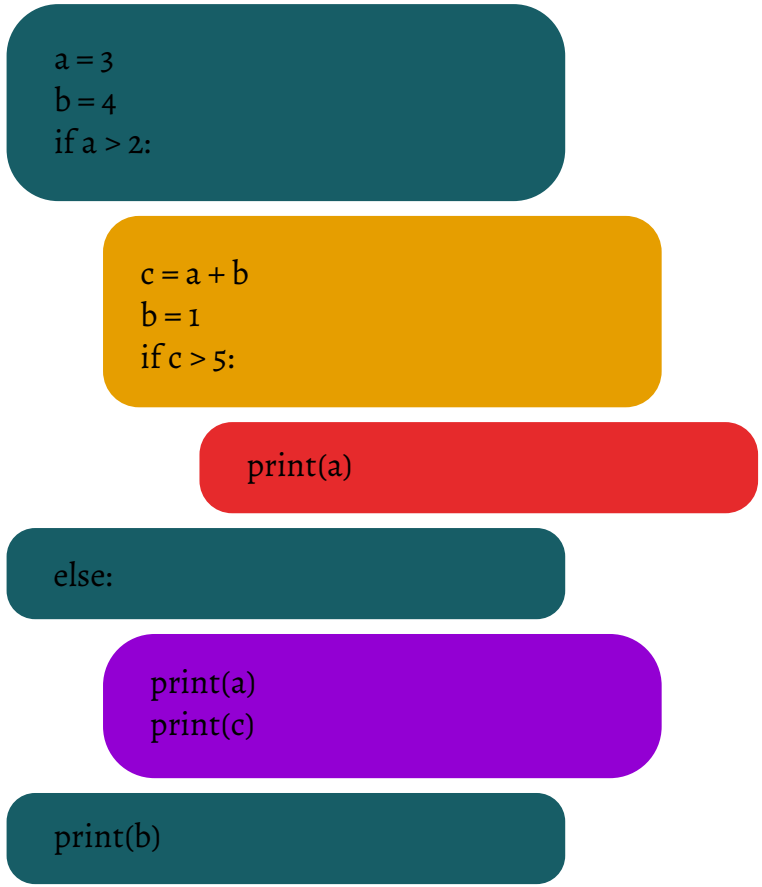
Control Statements

- else if-statement

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

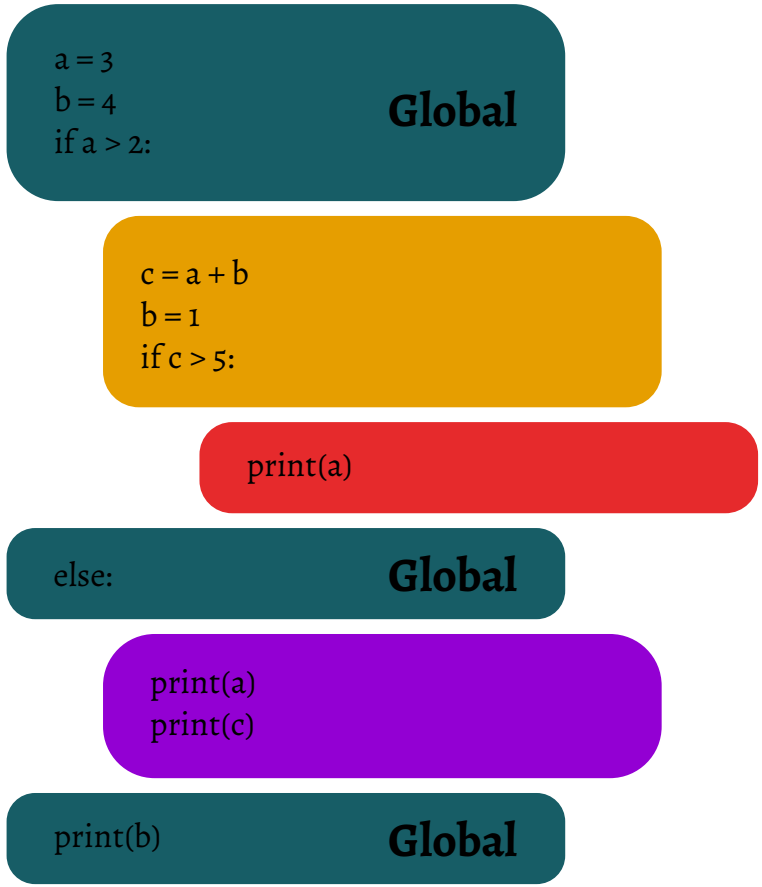
Variable Scope

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



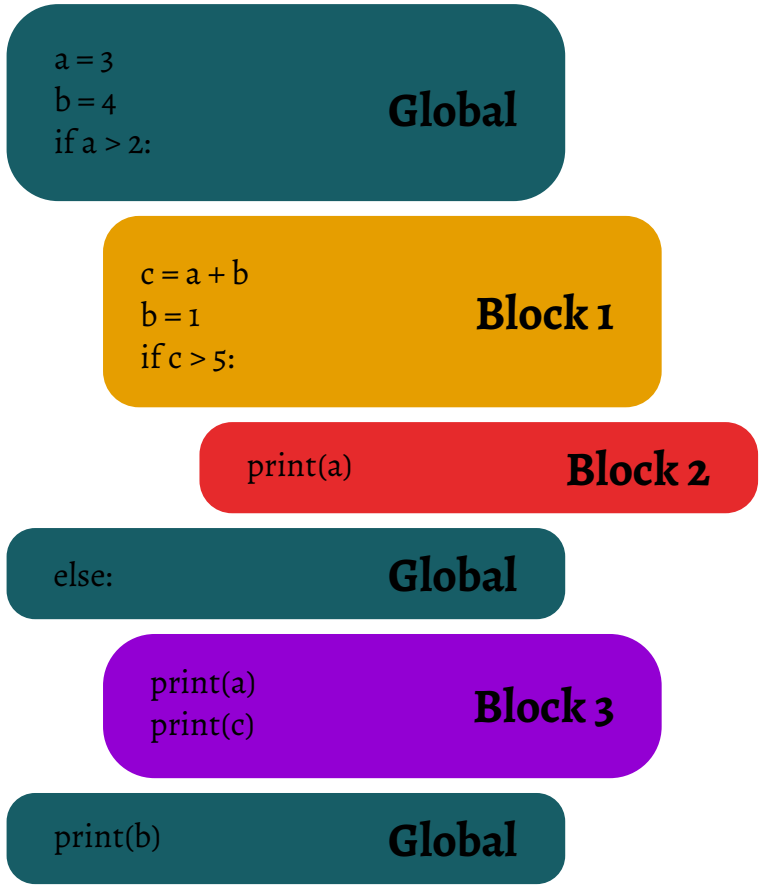
Variable Scope

- 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



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



Variable Scope

- Example

```
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

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

While Loops

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

- Be careful with the exit condition

```
a = 0
while a < 10 :
        print(a) # Prints 0 until the end of time
```

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

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"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

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

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person = input('Enter your name: ')
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- Invalid Data Types

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

User Input

- Use input to prompt the user

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

- Invalid Data Types

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

- Variables might need to be *type casted*

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

Type Casting

- Implicit Typecast

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

Type Casting

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```
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 = round(a,3) #3.899
c = abs(-3.2) #|-3.2| = 3.2
t = type(c) #t is <class 'float'>
test = t is float # True
```

- The math module

```
import math #Import makes a module available
squareTwo = math.sqrt(2) #√2
power = math.pow(3,4) # 3^4
exponential = math.exp(4) #e^4
piNumber = 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*.

%	Grade	%	Grade
86-100	A	40-55	D
71-85	B	25 -39	E
56-70	C	1 - 24	F

Tasks Variables and Loops

3. Write a script that asks the user for two different inputs and prints their sum
   - Define a variable *num*1 and assign it a value using the *input*() function
   - Repeat the above step for a second variable *num*2
   - Add *num*1 and *num*2 together in a third variable *sum* and print it
     (Do not forget to typecast *num*1 and *num*2)

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

Braitenberg, V. (1986).
Vehicles: Experiments in synthetic psychology.
MIT press.