1 Introduction

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Lecturer

- Eva Isakeit
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- Appointments via Zoom
- Master‘s student in Mathematical Finance

This Course

- **English**

- **Keep a journal. It is a prerequisite to pass this course**
  - **Document your progress, programs, questions, learning experience**
  - **Helps you whenever you come back to topics covered in this course**
  - **~10 pages**

- **Slides and coding examples are available on homepage. The password will be announced in the first meeting**

- **Class**
  - **Interactive online meeting: Q&A and revision of assignment**
  - **Weekly upload of new material on the homepage (substantive video + assignment)**

How to get the 3 ECTS

- **Rules to pass the course**

- **Weekly Assignments**
  - **Up to 10 points per homework**
  - **You need to have on average 5 points**
  - **Assignment not handed in = 0 points**
  - **Homework you cannot present in class = 0 points**

- **Send to eva.isakeit@uni-konstanz.de until Saturday 8pm**

- **Journal**
  - **to be handed in at semester end**

Table of Contents

Literature

- Sweigart, A., 2019. Automate The Boring Stuff With Python, 2Nd Edition. No Starch Press, Incorporated.
- Liang, Y., 2013. Introduction To Programming Using Python. Boston: Pearson.
- Downey, A., 2015. Think Python: How To Think Like A Computer Scientist, 2Nd Edition. O'Reilly Media.

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Why Python for Finance

- What is Python?
- Why do we need it?
- Comparison to other languages
- Shift from MATLAB to Python

Motivation

- “Python is a general-purpose, versatile and popular programming language. It is great as a first programming language because it is concise and easy to read and it is also a good language to have in any programmers stack as it can be used for everything from web development to software development and scientific applications”
- Python is becoming de facto standard in finance industry
- Easy and high-level introduction to programming
- Major feature is its ecosystem, e.g., libraries and tools
- Might be useful for Bachelor thesis

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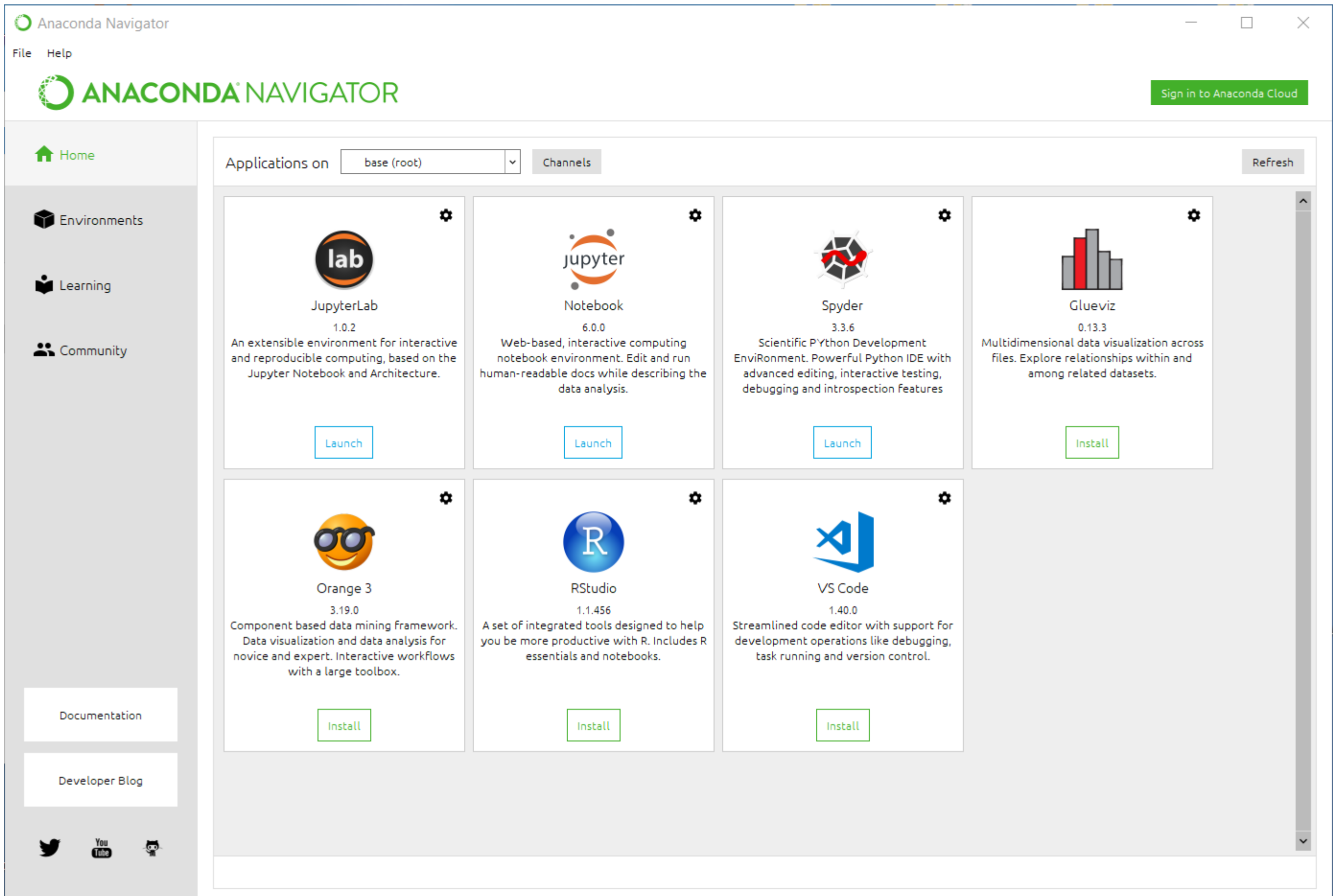
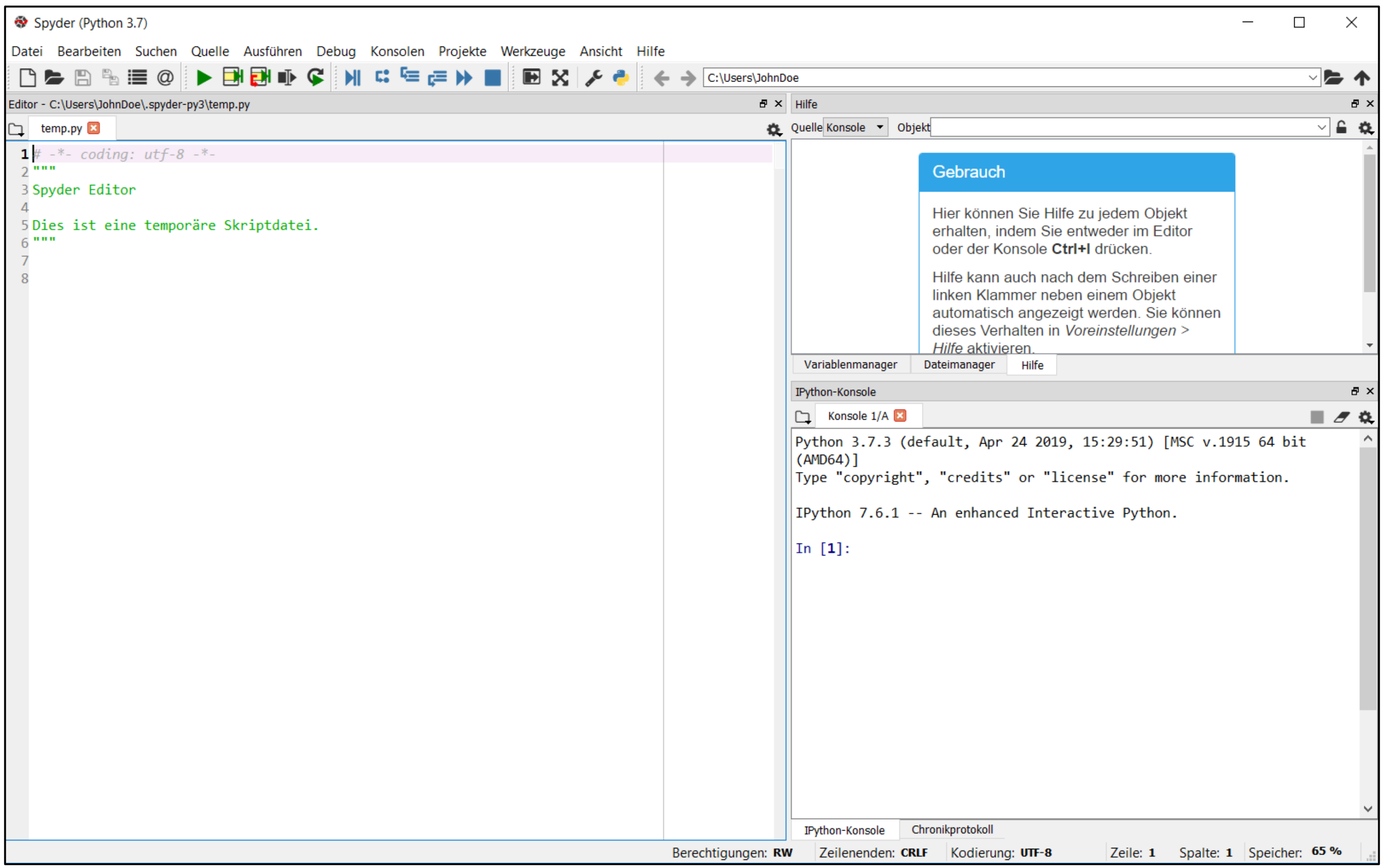
Starting Python

https://www.anaconda.com/



Starting Python II

- **Launch Spyder**



Calculation of NPV in Python I

- **A “Great Deal“: Assume the following cashflows:**

year	**0**	**1**	**2**	**3**
cashflow	**-100**	**-50**	**30**	**200**

- **Assume that r=0.1**

- **The NPV formula is given by**

$$NPV=C_0+\frac{C_1}{1+r}+\frac{C_2}{(1+r)^2}+\frac{C_3}{(1+r)^3}$$

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Operations

- **The order of operations is given as:**
  1. **Terms inside parentheses ( ) or brackets [ ]**
  2. **Functions in Python**
  3. **Exponents and roots**
  4. **Multiplication and division**
  5. **Addition and subtraction**

- **Attention: a^b → `a**b` or `pow(a, b)`**

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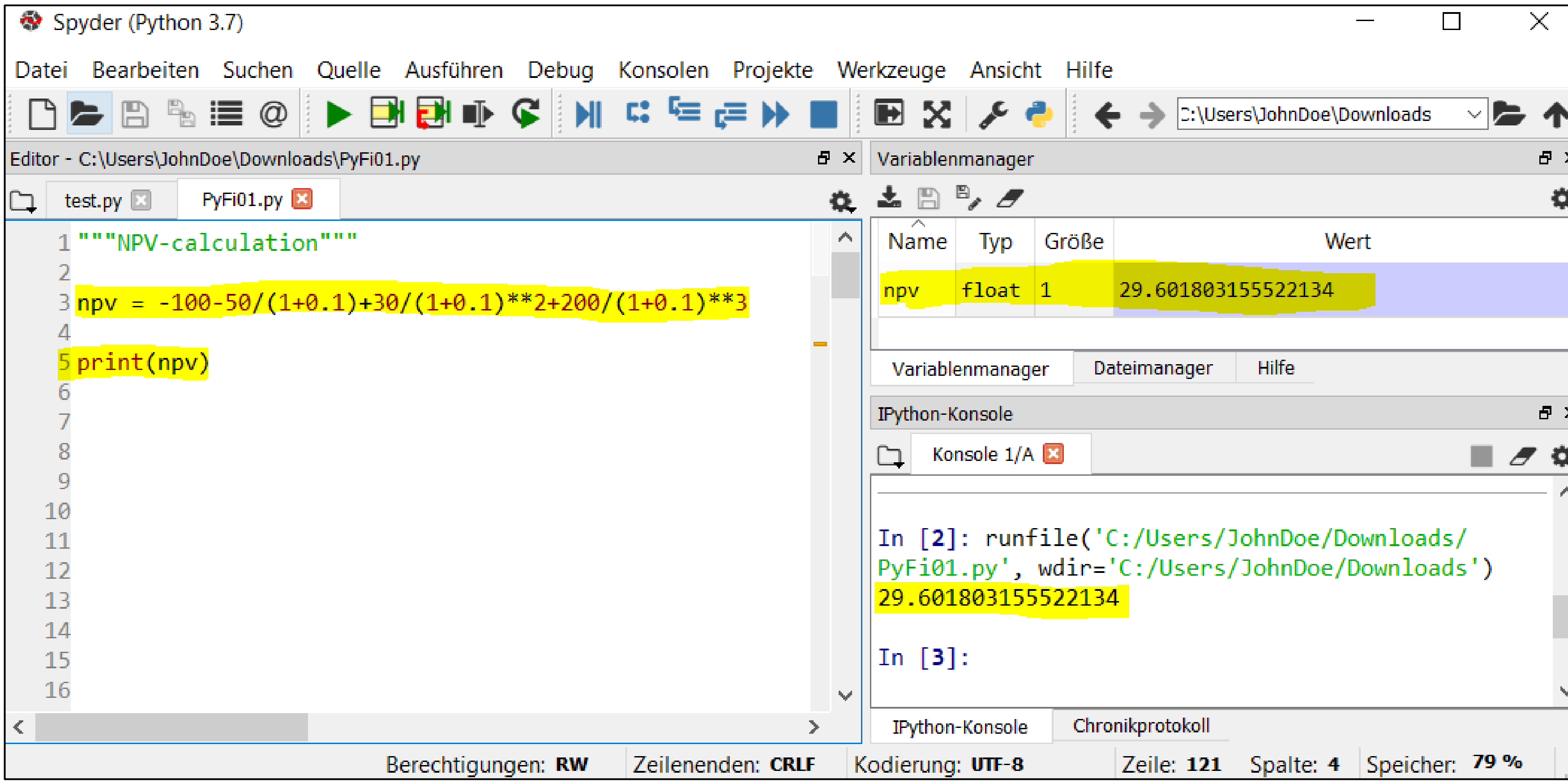
Calculation of NPV in Python II



Calculation of NPV in Python III

- **Example: Now assume that you can sell your machine in year 4 for 100. How does the NPV change?**

```
npv = -100 - 50/(1+0.1) + 30/(1+0.1)**2 + 200/(1+0.1)**3
npv += 100/(1+0.1)**4
# npv = npv + 100/(1+0.1)**4
```

= 97.90314869202919

Assignments

- The new NPV is 97.903 (in comparison to the old one: 29.601)

- The variable `npv` will be re-defined and the value of 29.601 will be lost

Numpy

- **numpy is the main library for scientific computing with Python**

```python
import numpy as np
```

- **Use it as the main library for any calculations with vectors and matrices**

Defining Variables I

```python
#Variables you want to define always stand on the left-hand side of the equal sign, the following
# commands save the values of cashflows in a numpy-array (works here like a row vector)
cashflows = np.array([-100, -50, 30, 200])
print(cashflows)

#To create a column vector we use the option of a two-dimensional array
cashflows_column = np.array([[-100], [-50], [30], [200]])
print(cashflows_column)

#you will recognize that every new row will be build with new brackets: "[]"
dim2 = np.array([[1, 2], [3, 4]])
print(dim2)
```

Getting Help

```
#Another useful command is help
help(np.array)
```

- Other resources:

Defining Variables II

- **To extend a row vector with one entry, use a comma:**
  `np.array([a, b])`

- **To extend a column vector with one entry, use [brackets]:**
  `np.array([a], [b])`

- **Define a matrix with** `np.array([[a , b], [c, d]])`. **Watch out: Dimensions must agree for a matrix!**

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Defining Variables III

- **Variable names can consist of letters, numbers and "_", but should not start with a number. Do not use names which already exist in Python. Variable names are case sensitive**

- **Variables store values that can be re-used in a different part of the program**

- **All written after a #-sign in the same line will not be considered from Python**

- **Alternatively you can use “““…””” to make comments for more than one line**

Calling Variables for Calculations

- **The variable `cashflows` is a row vector (remember that we have redefined it). Therefore `cashflows @ discount_r` is a vector multiplication**

```
cashflows= np.array([-100, -50, 30, 200])
r = 0.1
discount_r = np.array([1, 1/(1+r)**1, 1/(1+r)**2, 1/(1+r)**3])

#Define the variable NPV to store the value of the computation:
npv = cashflows @ discount_r


print(npv)
```

In-Class Exercise

1. **Create the following matrices in Python:**

$$A = \begin{pmatrix} 2 & 5 & 7 \\ 0 & 0 & 1 \end{pmatrix}, B = \begin{pmatrix} 3 & 3 \\ -1 & 0 \\ 2 & 4 \end{pmatrix}$$

2. **What is the result of the matrix multiplication:**

$$\mathbf{X} = A \,@\, B$$

3. **What is the result for the following command:**

$$\mathbf{X}[1, 0]$$

4. **What is the result of the matrix multiplication?**

$$\mathbf{X} = A * B.T$$

Exercise I

1. **Open Python and examine all windows. Make sure everything is in the correct order as explained above. Define a folder for your lecture examples and exercises in a new folder. Change the current directory of Python to the folder you defined for the lecture examples**

2. **Calculate the NPV of a bond which matures at t=4, pays an annual coupon of 10 beginning in year 1, and you will receive in year t=4 the last coupon and an additional payment (value at maturity) of 100. Assume that r=0.1**

3. **What is the value of the bond if r=0.08?**

$$\text{Bond price } P = \frac{CP}{1+r} + \frac{CP}{(1+r)^2} + \frac{CP}{(1+r)^3} + \frac{CP + \text{value at maturity}}{(1+r)^4}$$

You should define variables for these calculations as described in the lecture

Exercise II

4. **Now assume there is uncertainty and you estimate that you only receive the last payment (value at maturity) with a probability of 0.6. What is the value of the bond now?**

5. **What might be the advantage of using variables?**

6. **Create the following matrix in Python:**

$$p = \begin{pmatrix} 1 & -0.4 & 0.6 \\ -0.4 & 1 & 0 \\ 0.6 & 0 & 1 \end{pmatrix}$$