Sustainability Analysis in Python

Lecture 1.1: Course Introduction (incl. Virtual Environments)
Lecture 1.2: Pandas
Lecture 1.3: Flowcharts (+ Assignment)

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CML
Institute of Environmental Sciences

Sustainability Analysis in Python

Course Introduction

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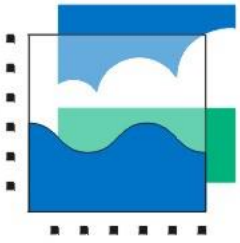


CML
Institute of Environmental Sciences

Outline

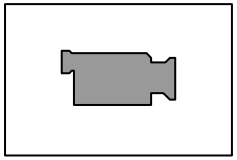
Motivation for this course

Practical information

Virtual environments

Parson problem

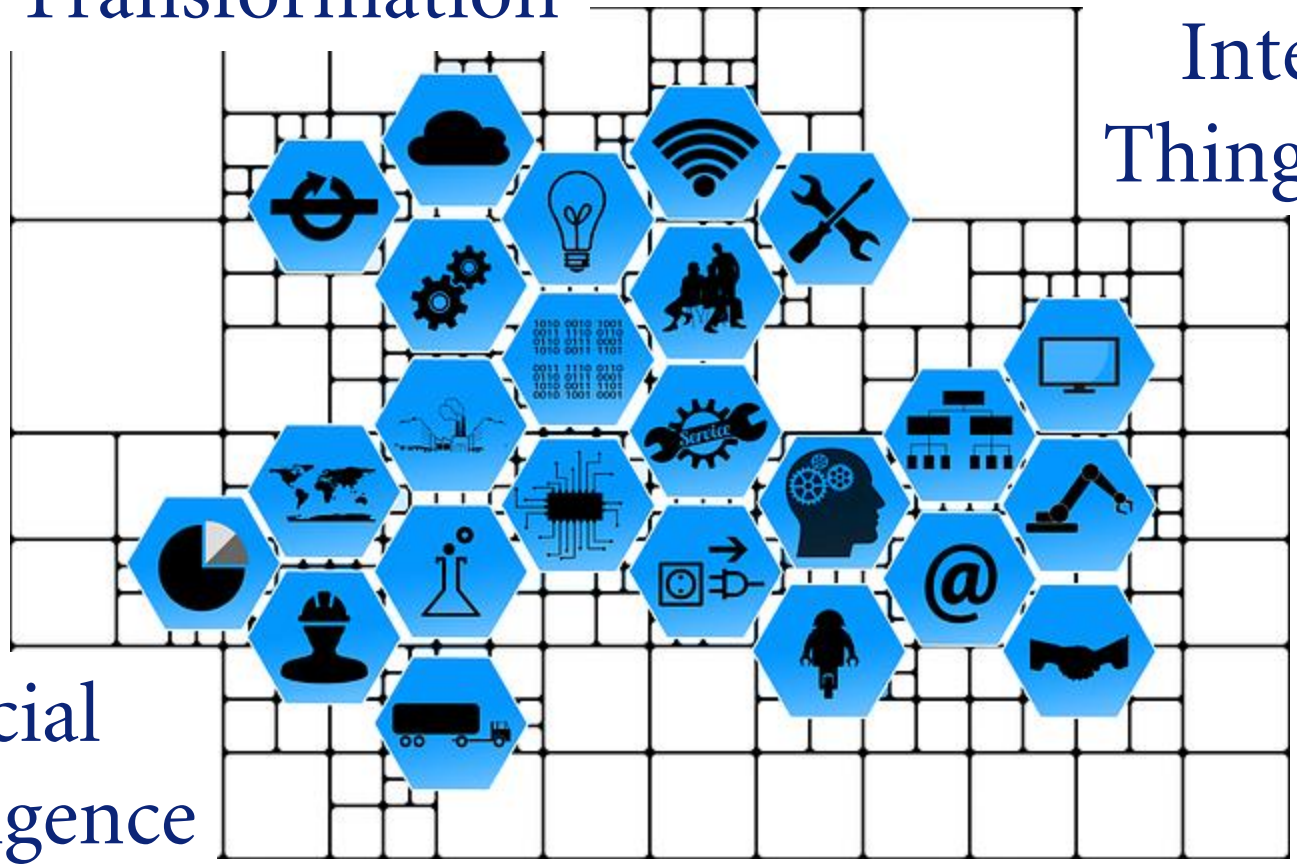
How not to be ignorant about the world
(Hans and Ola Rosling)



Big Data

Digital Transformation

Internet of Things (IoT)



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Artificial Intelligence

Smart City

Why learning how to code?

Advantages of programming

Image credit: CollegeDegrees360 / Flickr (CC-BY-SA-2.0)

Why learning how to code?

Specific knowledge

- Methods: MFA, LCA, IOA
- Technical knowledge: Agriculture, Energy, Waste

Transferable skills

- Soft skills: Communication, management
- Analytical skills: Problem/solving, critical thinking, programming

➢ Skills that are in high demand in almost any job

Why learning how to code in Python?

How many programming languages exist?

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Course structure

- Lectures on Tuesdays
  (**13:15-17:00** in room E001 in **Van Steenis**)
  - Programming
  - Data analysis
  - Exercises
- Workshops on Thursdays
  (**13:15-17:00** in room 2.26 in **Huygens**)
  - Tutors: Stephanie, Sander, and me
  - Work on assignment
  - Questions concerning Python implementation

Subjects covered
this morning

- Programming:
  - **Virtual environments**
  - **Pandas**
  - **Flowcharts**
  - Git and GitHub
  - Documentation
  - Optimization
  - Object-oriented programming
  - GUIs
- Data analysis:
  - Fair data
  - Data cleaning
  - Hypothesis tests
  - Model validation
  - Uncertainty assessment
- Application
  - World Bank data related to sustainability
  - ...

Assessment

No exam!

100% of the grade will come from one assignment, which involves

- writing code (70%),
- giving peer feedback (10%),
- presenting results (10%), and
- writing a short reflection (10%).

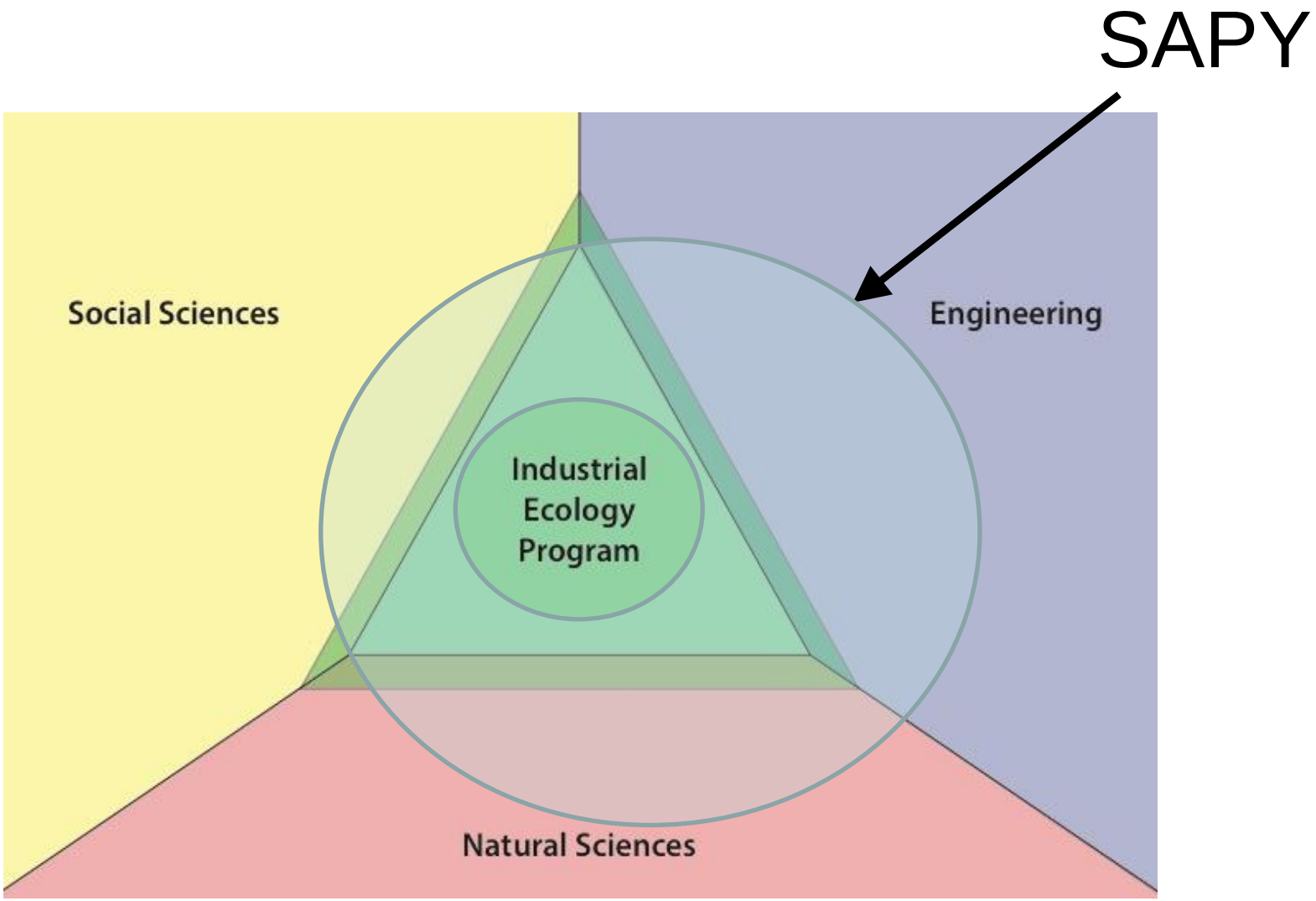
Another smaller assignment and a quiz will not be graded but need to be completed to obtain a grade for this course.

Course schedule

Week	Significance	Important dates
1-5	Main lectures	
2	Ungraded assignment	26 Sep
4	Preliminary code for peer-feedback	12 Oct
5	**Peer-feedback**	**18 Oct**
6	Review lecture	
	Quiz	24 Oct
7	Presentation slides	31 Oct
	Presentation Preference?	**31 Oct or 2 Nov**
8	**Final code**	**7 Nov**
	Written reflection	**12 Nov**

Weekly course structure

SAPY within IE curriculum

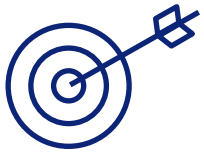


Relevant programme objectives

Graduates from the master's programme Industrial Ecology will:

- be able to **perform scientific research** in the field of Industrial Ecology.
- be capable of **applying and improving the methods, techniques and tools** of Industrial Ecology in order to design science-based solutions for sustainability problems.

Course objectives



The main learning goal is to gain more practice with Python programming. Sustainability analysis is not a learning goal but serves as the application of Python. More specifically, after completing this course, students are able to…

- process unclean data, describe datasets with metadata, and apply fair data principles
- validate and assess uncertainties of models
- test hypotheses and verify the underlying assumptions
- develop clear and efficient code in Python, integrate user interaction, and keep track of versions

Relation to other courses

Python Programming is also used in:

- Environmental Input-Output Analysis (Ranran Wang and Franco Donati)
- Agent-based modelling (TU Delft, library ema_workbench with connector to NetLogo)
- Some Sustainability Challenges
- Some master's theses

Evaluation of course

- Oral evaluation at the end of the course
- Online survey after the quarter – please fill out!
- Education Committee discusses outcomes of survey and input from students (educom@cml.leidenuniv.nl)

➢ Apart from the above: If something is unclear, or you have remarks about the course: please already speak up during the semester. I will also do a midterm tip & top evaluation.

Survival tips

- "Anyone who has never made a mistake has never tried anything new." (Albert Einstein)
- There are no dumb questions!
- Use Stack Overflow, Google, etc.: you are not alone.
- You must make the first step: try, fail, retry, ask for help during workshops. Watch out for FAQs on the Brightspace discussion forum.
- Practice makes perfect …

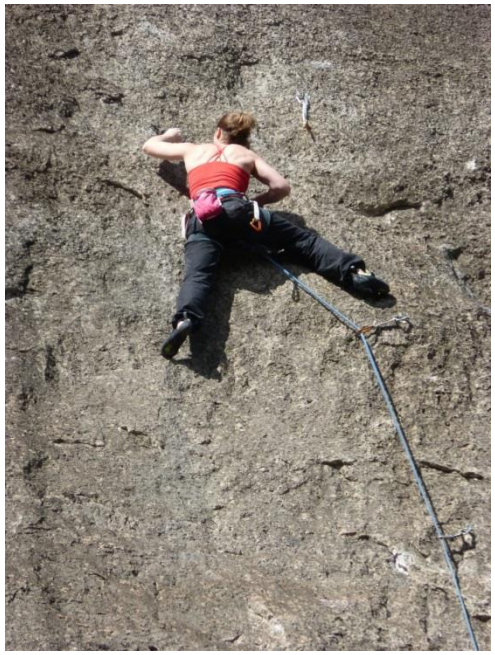


Image credit: Peakpx (CC0)

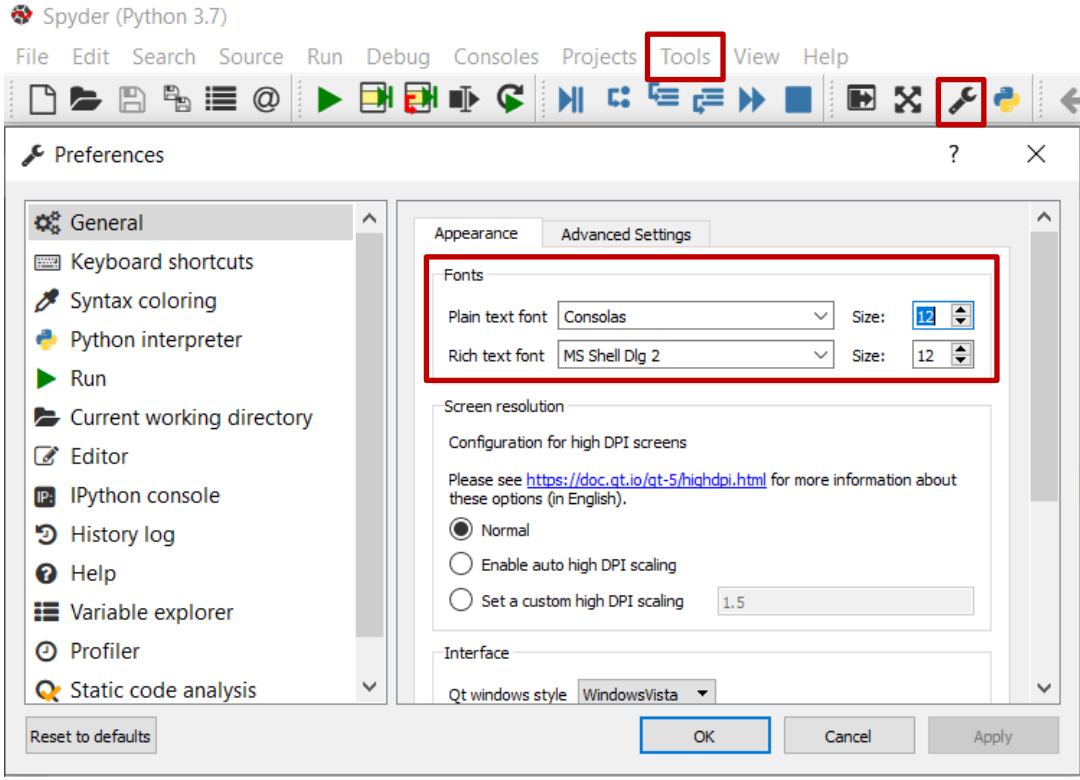
Practical information

- Enrol via MyStudyMap Leiden University and Brightspace Leiden University or ask the study advisor of Industrial Ecology
- Communicate with me through **l.a.scherer@cml.leidenuniv.nl**

- Bring your laptop
- Use Python 3 and Spyder (Anaconda package)
  Have you previously installed Spyder without Anaconda? Ideally, uninstall it and use Anaconda to exploit its advantages.

COVID-19 measures

- Increase the **font size** in Spyder: Tools > Preferences
- Wear a **mask** when teachers or teaching assistants get close to you to help you during workshops
- Get **tested** especially on days of workshops → Pick up self-tests at the reception of Van Steenis



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Virtual environments (Task 1 in assignment)

Parson problem

Virtual environments

→ To ensure **reproducibility** and **avoid conflicts** with outdated versions or among certain packages

In Anaconda prompt (placeholders in *italic*)

- conda **create** --name *myenv* python (or e.g. python=3.9)
- conda info --envs (list environments)
- conda **install** -n *myenv* **spyder** (or *package*)
- conda list -n *myenv* (all packages or a specific package)
- conda **activate** *myenv*
- conda env **export** > environment.**yaml**
  (yaml preferred over yml)

Virtual environments

In **Spyder**

- Tools > Preferences > Python Interpreter

or

- click on the environment at the bottom of Spyder > Change default environment in Preferences

then

- Use the following **Python interpreter**: …Anaconda3/envs/*myenv*/python.exe
- **Restart kernel** in the console's menu

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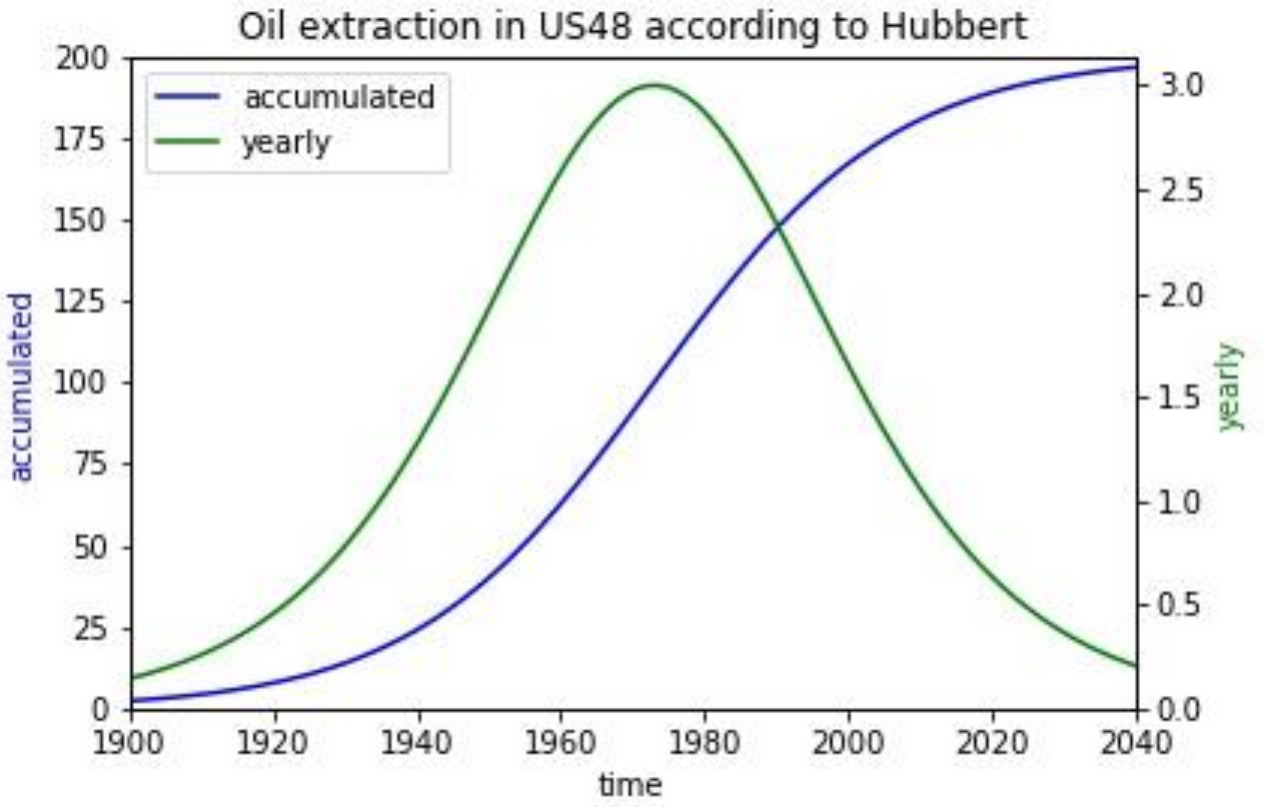
When will yearly extraction of oil drop below 1 Gbarrel?

→class_1_depletion-parson.py and class_1_depletion-comments.py

Icon made by Tomas Knop from Flaticon

Resource Depletion (ESSA 4a)



Logistic Function (ESSA 4a)

$$f(x) = \frac{K}{1 + e^{r(x_{peak} - x)}}$$

f(x) = Cumulative quantity

x = Independent variable

x_{peak} = Peak value

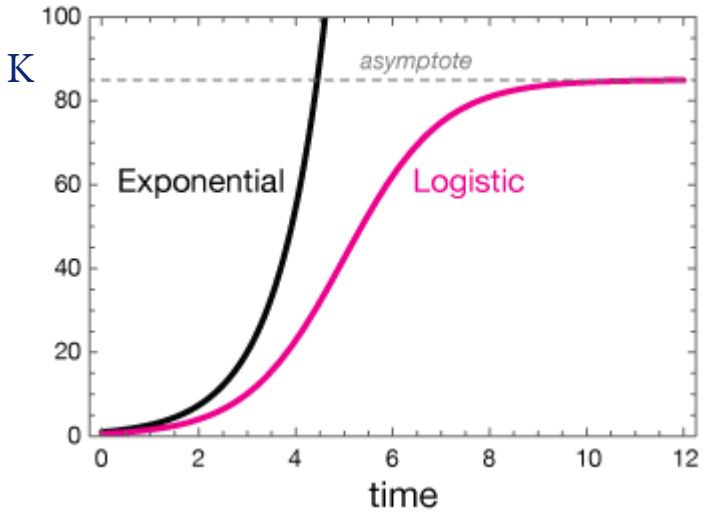
r = Growth rate

K = Maximum value (carrying capacity)

$f(-\infty) = 0$

$f(\infty) = K$

$f(x_{peak}) = 0.5 \cdot K$



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