

Data analysis and visualisation (KI/EDAV)

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1. Course Syllabus

Lesson	Date	Topic
1		Introduction to Python, Programming and plotting in Python
		Matrices and matrix operation in Python
2		Function of one real variable, numerical differentiation and integration
		Ordinary differential equations
3		Signal and image processing: filtering, transformation (Fourier, wavelets)

2. Study materials

Github: <https://github.com/pavelberanek91/EDAV/tree/main>

Lesson 1

- Numpy: <https://numpy.org/doc/stable/user/quickstart.html>
- Pandas: https://pandas.pydata.org/pandas-docs/stable/user_guide/10min.html
- Seaborn: <https://seaborn.pydata.org/tutorial/introduction.html>

Lesson 2

- Root finding: https://en.wikibooks.org/wiki/Introduction_to_Numerical_Methods/Roots_of_Equations
- Numerical integration: https://en.wikibooks.org/wiki/Introduction_to_Numerical_Methods/Integration
- Numerical differentiation:
https://en.wikibooks.org/wiki/Introduction_to_Numerical_Methods/Numerical_Differentiation
- Ordinary differential equations:
https://en.wikibooks.org/wiki/Introduction_to_Numerical_Methods/Ordinary_Differential_Equations
- Epidemiology models: https://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology

Lesson 3

- Fourier transformation:
<https://betterexplained.com/articles/an-interactive-guide-to-the-fourier-transform/>
- Wavelet transformation:
<https://ataspinar.com/2018/12/21/a-guide-for-using-the-wavelet-transform-in-machine-learning/>
- Signal processing:
<https://www.freecodecamp.org/news/signal-processing-and-systems-in-programming/>
- Image processing: <https://www.v7labs.com/blog/image-processing-guide>

3. Requirements

To successfully obtain credit, the student must submit solutions for the following 3 tasks in Python and must be able to discuss them.

Topic 1: Analyzing weather patterns

Use Python to analyze historical temperature data from various locations. Employ matrices to organize the data and perform operations to find trends, averages, or anomalies. Visualize the data using different types of plots to illustrate seasonal changes or compare climates between regions.

Drawing on the insights from the presented charts, address the following inquiries:

1. Does data support the existence of global warming?
2. Do certain areas exhibit a more rapid acceleration in warming compared to others?

Dataset:

<https://www.kaggle.com/datasets/berkeleyearth/climate-change-earth-surface-temperature-data>

Topic 2: Population dynamics simulation

Create a simulation in Python to model the growth of a population using ordinary differential equations. Explore different growth models and factors that can influence population dynamics, such as carrying capacity and growth rate. Visualize the simulation results to show how the population changes over time.

Drawing on the insights from the presented charts, address the following inquiries:

1. Does global population dynamic follow the trends from population models simulations?
2. Is there any country that has a similar growth trend as in simulations?

Datasets:

<https://www.kaggle.com/datasets/omarsobhy14/population-growth-from-1950/data>

<https://www.kaggle.com/datasets/whenamancodes/world-population-live-dataset/data>

Population models:

<https://www.khanacademy.org/science/ap-biology/ecology-ap/population-ecology-ap/a/exponential-logistic-growth>

Topic 3: Audio signal analysis

Analyze audio signals using Python by applying filtering techniques and transformations (e.g., Fourier Transform, Wavelet Transform). Explore the characteristics of different audio files, identify patterns or anomalies, and visualize the frequency components of the audio signals.

Drawing on the insights from the presented charts, address the following inquiries:

1. Can dogs and cats be recognized based on frequency components of their sounds?
2. Can bird species be recognized based on frequency components of their sounds?

Datasets:

<https://www.kaggle.com/datasets/mmoreaux/audio-cats-and-dogs>

<https://www.kaggle.com/datasets/soumendraprasad/sound-of-114-species-of-birds-till-2022>

Similar code:

<https://www.kaggle.com/code/mistag/extracting-bird-song-signatures-with-wavelets/notebook>