COURSE DESCRIPTION CARD - SYLLABUS

Course name
SCIENTIFIC VISUALISATIONS WITH PYTHON [S5SD1>WNP]

Course

Proposed by Discipline
–

Year/Semester
2/3

Level of study
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture
4

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

1,00

Coordinators

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Lecturers

dr inż. Marcin Nowak
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Prerequisites

Knowledge: Basic Programming Knowledge - participants should have a foundational understanding of programming concepts, including variables, data types, loops, and functions. Skills: Familiarity with Python syntax. Ability to read and understand technical documentation. Ability to install and configure software and libraries. Social competences: Ability to work effectively in teams, sharing knowledge and tools, and providing constructive feedback to peers. Understanding the ethical implications of data visualization, ensuring accuracy, honesty, and integrity in representing research findings. Enhanced problem-solving abilities through collaborative projects, fostering a collective approach to overcoming visualization challenges.

Course objective

The primary objective of the course is to acquaint participants with the fundamentals of scientific visualization and the available programs for data visualization. During the course, students will learn how to create high-quality images for scientific publications and prepare their own scripts for automating the visualization process.

Course-related learning outcomes

Knowledge:
A PhD student who graduated from doctoral school knows and understands:

1) how to utilize Python for scientific visualization, [P8S_WG/SzD_W02]
2) relationship between data and its visual representation, current limitations of visualization techniques, such as potential misinterpretation of data and the challenges in handling large or complex datasets [P8S_WG/SzD_W01], [P8S_WG/SzD_W02].

Skills:
A PhD student who graduated from doctoral school can:
1) effectively use Python to create clear and compelling scientific visualizations, enhancing their ability to present and communicate complex data, [P8S_UW/SzD_U01].

Social competences:
A PhD student who graduated from doctoral school is ready to:
1) create informative and visually appealing plots and graphs, deal with complex scientific data, [P8S_KK/SzD_K01], [P8S_KK/SzD_K03].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes regarding knowledge:
active participation in discussions and solving small exercises; utilize standardized rubrics to observe and document students' engagement during discussions.

Learning outcomes regarding skills:
preparing a numerical program and its documentation using Python to visualize a given dataset; functionality of the program, accuracy of data processing and visualization techniques

Learning outcomes regarding social competences:
preparing a numerical program and its documentation using Python to visualize a given dataset; check if the program follows best practices in Python programming including coding standards, efficient use of libraries

Programme content

A comprehensive introduction to scientific visualization, emphasizing its definition and importance in data analysis and interpretation. The course explores Python's dominant role in scientific computing and visualization, introducing essential libraries such as Matplotlib, Bokeh, Seaborn, VTK, and OpenGL. Participants learn basic plotting techniques, including line plots, scatter plots, and histograms, with customization options for colours, labels, titles, and legends. The curriculum covers the anatomy of a plot, encompassing axes, ticks, and grids, and progresses to statistical visualization with Seaborn, featuring box plots, violin plots, and histograms. Advanced topics include swarm plots, joint plots,
interactive plotting, and dynamic visualization creation. Additionally, participants delve into 3D visualization techniques for surfaces, meshes, and volumes. They also acquire animation skills with Matplotlib and Manim, along with effective methods for visualizing multidimensional data.

Course topics

Introduction to scientific visualization.
Role of visualization in data analysis and interpretation.
Understanding the anatomy of a plot: axes, ticks, grids.
3D Visualization: plotting surfaces, meshes, and volumes.
Techniques for visualizing high-dimensional data.
Advanced statistical plots: swarm plots, joint plots.
Animations with Matplotlib and Manim.

Teaching methods

Multimedia presentation including illustrations and examples.

Bibliography

Basic:

Brad Eric Hollister, Alex Pang, A Concise Introduction to Scientific Visualization, Springer 2022

Additional:
Helen Wright, Introduction to Scientific Visualization, Springer 2007

Breakdown of average student's workload

	Hours	ECTS
Total workload	25	1,00
Classes requiring direct contact with the teacher	4	0,00
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	21	1,00