SYLLABUS

Scientific data visualization

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeș-Bolyai University
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Computer Science
1.4. Field of study	Computer Science
1.5. Study cycle	Master
1.6. Study programme/Qualification	High Performance Computing and Big Data Analytics
1.7. Form of education	Full time

2. Information regarding the disciplines

2.1. Name of the discipline	**Scientific data visualization**					Discipline code	**MME8199**
2.2. Course coordinator					Assoc.prof.phd. Mihai SUCIU		
2.3. Seminar coordinator					Assoc.prof.phd. Mihai SUCIU		
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	E	2.7. Discipline regime	Optional

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory/project	**2**
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory/project	**28**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					39
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					50
Tutorship					5
Evaluations					5
Other activities:					
3.7. Total individual study hours	**119**				
3.8. Total hours per semester	**175**				
3.9. Number of ECTS credits	**7**				

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions (if necessary)

5.1. for the course	course room with video projector
5.2. for the seminar /lab activities	laboratory room with computers

6.1. Specific competencies acquired [1]

Professional/essential competencies	• Advanced ability for modeling and conceptualizing design and implementation patterns for distributed systems and database. • Advanced knowledge of theoretical, methodological, and practical developments in computer science.
Transversal competencies	• Systematic use of computer science knowledge to model and interpret new situations, within application contexts larger than the known ones. • Advanced communication skills within different professional environments, appropriate use of computer science vocabulary

6.2. Learning outcomes

Knowledge	The student possesses the fundamental knowledge for modelling, being able to analyse real life problems and to translate them in concrete requirements and to design a corresponding software model; knows and respects the ethical and legal principles and rules in scientific research.
Skills	The student has the skills to perform research in the domain of educational sciences especially for algorithmic thinking and for critical thinking; uses efficient strategies, methods and techniques for lifelong education, in order to self educate and self develop his/her personal and professional skills.
Responsibility and autonomy:	The student has the ability to work independently in order to obtain knowledge necessary for designing, managing and evaluating research activities.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Be able to apply theories, principles and concepts with technologies to design, develop, and verify computational solutions; • Be able to use data visualization (technique tool used to help researchers understand and/or interpret data)

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

7.2 Specific objective of the discipline	• To assimilate data visualization techniques and the visualization as a method of studying the real phenomenon. To gain skills related to problem solving through visualization of data. • To teach the students the concepts used in the field of modelling and visualization of simulation and to acquire the methods for validation of simulation using Scientific Data Visualization. • Know the main visualization techniques for scalar, vector, and tensor datasets and understand their strengths and limitations. • Be able to implement sophisticated interactive visualizations using open source software. • Be able to devise a complete visualization solution to study a practical dataset. • After promotion the students should be able to use data visualization as a method of solving real problems.

8. Content

8.1 Course	Teaching methods	Remarks
Scientific data, Introduction	Expositions: description, explanation, introductory lectures. Conversations: debate, dialog, introduction conversations. Other methods: individual study, exercise, homework.	
Data visualization, Overview of Python visualization libraries		
Visualization techniques, Plotting basics, Integrity		
Data visualization, Declarative vs. Procedural visualization		
Data modelling, Perception		
Colors, Vector, and Bitmaps		
Grids and interpolation, Data Types and 1-D data		
Tidy data		
Histograms, box-plots		
Estimation		
Log scales		
Topological methods		
Advanced flow visualization, Text and Networks		
High-dimensional data		

Bibliography

• Andy Kirk. 2016. Data Visualisation: A Handbook for Data Driven Design. Sage Publications Ltd.
• Matthew O. Ward, Georges Grinstein, and Daniel Keim. 2015. Interactive Data Visualization: Foundations, Techniques, and Applications, Second Edition - 360 Degree Business (2nd. ed.). A. K. Peters, Ltd., USA.
• Telea, A. C. 2015. Data visualization: Principles and practice. Boca Raton: CRC Press.
• Georges-Pierre Bonneau, Thomas Ertl, and Gregory M. Nielson. 2005. Scientific Visualization: The Visual Extraction of Knowledge from Data (Mathematics and Visualization). Springer-Verlag, Berlin, Heidelberg.

8.2 Seminar / laboratory	Teaching methods	Remarks
The first two seminars are dedicated to surveying information sources available on Internet and Intranet, and planning of the assignments.	Expositions: description, explanation, introductory lectures. Conversations: debate, dialog, introduction conversations. Other methods: individual study, exercise, homework.	
The next three seminars are dedicated to paper presentations.		
The project demos will be scheduled in the last two seminars.		

Bibliography
1. Beatriz Sousa Santos, Introduction to Data and Information Visualization, Universidade de Aveiro Departamento de Electrónica, Telecomunicações e Informática, Universidade de Aveiro, 2010 http://www.ieeta.pt/~bss/MAPI/Introduction-to-Vis-5-10.pdf
2. Brodlie, K., L. Carpenter, R. Earnshaw, J. Gallop, R. Hubbold, A. Mumford, C. Osland, P. Quarendon, Scientific Visualization, Techniques and Applications, Springer Verlag, 1992
3. Card, S., J. Mackinlay, B. Schneiderman (ed.), Readings in Information Visualization- Using Vision to Think, Morgan Kaufmann, 1999

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- This course exists in the curriculum of many universities in the world;
- The results of course are considered by companies of software particularly useful and topical.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	know the basic elements and concepts of the Scientific Data Visualization;	written exam	50%
10.5 Seminar/laboratory	- complexity, importance and degree of timeliness of the synthesis made	Paper presentation	10%
	- apply the course concepts - problem solving	Project presentation	40%

10.6 Minimum standard of performance

- Grade: minimum 5 at each grading activity.
- Attendances: 75% attendance at seminar activities.
- Students with more than 2 unmotivated absences at the seminar will not be able to take the exam in the normal session and or in the retake examination session (seminar activities are activities that take place on the following principle “activity along the semester ”, and they cannot be recovered or repeated for a possible retake examination (these students will have to repeat this course in the next academic year)). Students with medical certificates for each of their absences are exempted from this rule.

11. Labels ODD (Sustainable Development Goals)[2]

Not applicable.

Date: 13.04.2025	Signature of course coordinator Assoc.prof.phd. Mihai SUCIU	Signature of seminar coordinator Assoc.prof.phd. Mihai SUCIU

Date of approval:	Signature of the head of department Assoc.prof.phd. Adrian STERCA

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.".