# **SYLLABUS**

# Empirical Research Methods for Computer Scientists

### University year 2025-2026

#### 1. Information regarding the programme

1.1. Higher education institution	Babes-Bolyai University
1.2. Faculty	Faculty of 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	Databases
1.7. Form of education	Full time

#### 2. Information regarding the discipline

2.1. Name of the dis	ciplir	1e Empirical Scientists	Empirical Research Methods for Computer Scientists				Discipline code	MME8190
2.2. Course coordinator								
2.3. Seminar coordinator								
2.4. Year of study	1	2.5. Semester	2	2.6. Type of evaluation	on	Е	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)				36	
Additional documentation (in libraries, on electronic platforms, field documentation)				20	
Preparation for seminars/labs, homework, papers, portfolios and essays				42	
Tutorship				10	
Evaluations				11	
Other activities:			0		
3.7. Total individual study hours119					
3.8. Total hours per semester	175				
3.9. Number of ECTS credits	Number of ECTS credits 7				

#### 4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

#### 5. Conditions (if necessary)

5.1. for the course	room with video projector, Internet
5.2. for the seminar /lab activities	room with video projector, Internet
5.2. for the seminar /lab activities	room with video projector, Internet

#### 6.1. Specific competencies acquired <sup>1</sup>

<sup>&</sup>lt;sup>1</sup> 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.

Professional/essential competencies	<ul> <li>advanced programming skills in high-level programming languages</li> <li>use of software tools in an interdisciplinary context</li> </ul>
	• efficient development of organized activities in an interdisciplinary group and the development of
rsal Icies	empathetic abilities for interpersonal communications, to relate to and cooperate with various groups
svei eter	• use of efficient methods and techniques to learn, inform, research and develop the abilities to bring value
l'ran omp	to knowledge, to adapt at the requirements of a dynamical society and to communicate efficiently in
[ <sup>-</sup> 5	Romanian language and in an international language

#### 6.2. Learning outcomes

	The student knows:
	<ul> <li>The graduate has the necessary knowledge for literature review.</li> </ul>
lge	
lec	• The graduate has the necessary skills to use research support tools.
Ň	
<u> </u>	
<b>–</b>	
	The student is able to:
	• The graduate is able to define/identify/understand research problems in computer science.
lls	
ŝki	• The graduate is able to write a scientific/technical report.
•	
	The student has the ability to work independently to obtain:
Ρż	• The graduate has the ability to understand and communicate information effectively.
ili mo	····· 8·······························
sib	• The graduate has the ability to observe and obtain information from various sources.
uto	
sp. d a	
Re	

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

7.1 General objective of the discipline	<ul> <li>Conduct a systematic literature review; identify gaps in the literature</li> <li>Formulate and motivate research questions</li> <li>Collect &amp; analyse qualitative and quantitative data</li> </ul>
7.2 Specific objective of the discipline	•

8.1 Course	Teaching methods	Remarks
1. Course 1	Interactive exposure	
Introduction- Course objectives &	Explanation	
Assessments	Conversation	
Intro to philosophy of science	Didactical demonstration	
2. Research Design: qualitative,	Interactive exposure	
quantitative, mixed methods	Explanation	
Systematic Literature Review	Conversation	
-	Didactical demonstration	
3. Doing Research	Interactive exposure	
Finding good research questions	Explanation	
Theory building	Conversation	
Evidence and Measurements	Didactical demonstration	
4. Experiments	Interactive exposure	
Controlled experiments	Explanation	
Quasi – experiments	Conversation	
Sampling	Didactical demonstration	
5. Quantitative analysis	Interactive exposure	
Basic Stats	Explanation	
Choosing a statistical model	Conversation	
Statistical Power Analysis	Didactical demonstration	
6. Qualitative analysis	Interactive exposure	
Grounded theory	Explanation	
Coding strategies	Conversation	
Phenomenography	Didactical demonstration	
7. Interviews and Observation	Interactive exposure	
Conducting Interviews	Explanation	
Focus Group	Conversation	
Participant Observation	Didactical demonstration	
8. Case studies	Interactive exposure	
Single and multi-case	Explanation	
Longitudinal Case studies	Conversation	
	Didactical demonstration	
9. Survey Research	Interactive exposure	
Designing questionnaires	Explanation	
Sample size	Didactical demonstration	
10 Intervention methods	Interactive exposure	
Action Desearch	Explanation	
Pilot Studios	Conversation	
Thot Studies	Didactical demonstration	
11.Replication		
Importance of replications	Interactive exposure	
Bias and influences	Explanation	
Threats to validity	Didactical domonstration	
12. Publishing and reviewing	Interactive exposure	
	Explanation	
	Conversation	
	Didactical demonstration	
<b>13</b> .Projects by students (1)	Interactive exposure	
Workshop	Explanation	

Peer review (anonymous+live)	Conversation Didactical demonstration	
14. Projects by students (2) Workshop	Interactive exposure Explanation	
Reflection/Debriefing Lessons learned	Conversation Didactical demonstration	

Bibliography

Books:

[1] Forrest ShullJanice SingerDag I. K. Sjøberg, Guide to Advanced Empirical Software Engineering, Springer, 2008

[2] Seltman, Experimental Design and Analysis, 2018

[3] Michael Felderer, Guilherme Horta Travassos, Contemporary Empirical Methods in Software Engineering, Springer, 2020

[4] Cohen, P. (1995). Empirical Methods in Artificial Intelligence. MIT Press.

[5] James, Witten, Hastie and Tibshirani, An Introduction to Statistical Learning, with Applications in R

# Articles

[1] Fagerholm F, Kuhrmann M, Münch J., Guidelines for using empirical studies in software engineering education, PeerJ Computer Science 3:e131, 2017

[2] Barbara Kitchenham, O. Pearl Brereton, David Budgen, Mark Turner, John Bailey, Stephen Linkman, Systematic literature reviews in software engineering – A systematic literature review, Information and Software Technology, Volume 51, Issue 1, 2009, Pages 7-15, ISSN 0950-5849,

[3] Arcuri A, Briand L (2011) A practical guide for using statistical tests to assess randomized algorithms in software engineering. In: International conference on software engineering, pp 1–10

[4] Carver JC (2010) Towards reporting guidelines for experimental replications: a proposal. In: The international workshop on replication in empirical software engineering, pp 2-5

[5] Carver JC, Juristo N, Baldassarre MT, Vegas S (2014) Replications of software engineering experiments. Empir Softw Eng 19(2):267–276

[6] Gomez OS, Juristo N, Vegas S (2014) Understanding replication of experiments in software engineering: a ' classification. Inform Softw Technol 56(8):1033–1048.

[7] Shepperd M, Ajienka N, Counsell S (2018) The role and value of replication in empirical software engineering results. Inf Softw Technol 99:120–132

[8] Fagerholm F, Becker C, Chatzigeorgiou A, Betz S, Duboc L, Penzenstadler B, Mohanani R, Venters CC (2019) Temporal discounting in software engineering: a replication study. In: 13Th ACM/IEEE international symposium on empirical software engineering and measurement, IEEE, pp 1–12.

8.2 Seminar / laboratory	Teaching methods	Remarks
Literature review. Theory.	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
Research questions	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	
Comparison of methods	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises	

Experiments	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises
Quantitative analysis	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises
Qualitative analysis (1)	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises
Qualitative analysis (2)	Presentation, Conversation, Problematizations, Discovery, Other methods – individual study, exercises
Bibliography	

The bibliography for the lectures.

For each seminar, a set of 2-3 papers will be provided in advance to be read and discussed during the seminars.

# 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

- The course exists in the studying program of all major universities in Romania and abroad;
- The course "Applications of Data Science for Software Engineering" at Eindhoven University of Technology
- The course "Empirical Methods" at Carnegie Mellon University
- The course "Empirical Software Engineering: Bridging Research and Practice" at University of Victoria

The course "Empirical Research Methods for Computer Scientists" at University of Toronto.

#### 10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.1 Course	-be able to implement	Project	
	course concepts	-documentation	
	- apply techniques for	-design	50%
	different classes of	-continous	
	research investigations	observations	
10.2 Seminar/laboratory	- know the concepts	Assignments	40%
	discussed during the		
	lectures and applied		
	during seminars		
	- class participation	Class participation	10%
	and in-class	_	
	presentations		

10.6 Minimum standard of performance

- Seminar/Laboratory assignments work may not be redone in the retake session.
- Project-based exam can be taken during the retake session.
- Students from Previous Years to the current academic year
- All the above rules apply to students from previous years.
- Seminar/Laboratory assignments must be redone during didactic activity time (in the 14 weeks before normal session).
- At least grade 5 (from a scale of 1 to 10) at written exam. The final grade computed with the given formula must be at least 5 in order to pass the exam. At least grade 5 (from a scale of 1 to 10) at project-based exams and laboratory/seminar activity

#### 11. Labels ODD (Sustainable Development Goals)<sup>2</sup>

#### Not applicable.

 Date:
 Signature of course coordinator
 Signature of seminar coordinator

 ...
 Assoc. Prof. dr. Vescan Andreea
 Assoc. Prof. dr. Vescan Andreea

Date of approval:

...

Signature of the head of department

Assoc.prof.phd. Adrian STERCA

<sup>&</sup>lt;sup>2</sup> Keep only the labels that, according to the <u>Procedure for applying ODD labels in the academic process</u>, 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*.".