Experimental Methods in Computer Science
(Metodologias Experimentais em Informática)

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2023/2024

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Course profile

Experimental Methods in Computer Science (and Informatics Engineering) ⬅

- **Scientific Area**: Informatics
- **School Year**: 1st year MEI
- **Semester**: 1st semester
- **Classes**
  - Lectures **(T)**, concepts and discussion: 2:00h per week
  - Practice-Lab. **(PL)**, assignment support + training exercises: 2:00h per week
- **ECTS**: 6
- **Teacher: Henrique Madeira**
  - Email: henrique@dei.uc.pt
  - Office: D3.2
  - Available for students: Wednesday, from 9:00h to 14:00h. And at any time through email or Skype (live:1420d368f61973)

> **Goal**: 30 minutes lectures followed by dedicated time for questions and discussions as necessary, with the aim of fostering greater student autonomy in the learning process.

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Course profile

Henrique Madeira

- **SSE Group** (Software and Systems Engineering) from **CISUC** (Centre for Informatics and Systems of University of Coimbra)
- Works on computer dependability, software engineering, and AI in safety critical systems
- Co-founder of Critical Software SA
- Some recent research projects:

  - **ADVANCE** (Addressing Verification and Validation Challenges in Future Cyber-Physical Systems), H2020, 2018-2024
  - **BUBBLES** (Defining the BUilding Basic BLocks for a U-Space SEparation Management Service), H2020-SESAR, 2020-2023
  - **VALU3S** (Verification and Validation of Automated Systems' Safety and Security), H2020-ECSEL and FCT, 2020-2023
  - **AI4EU** (A European AI On Demand Platform and Ecosystem), H2020, 2018-2022
  - **BASE** (Biofeedback Augmented Software Engineering), FCT, 2018-2022

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Syllabus

- The experimental method: experimental scenarios in computer science and <u>informatics engineering</u>

- Exploratory data analysis

- Data analysis: distributions, correlation, linear regression, etc.

- Measurements and benchmarking

- Experiment design (covering different types)

- Hypothesis testing

- Experiments with people

- Experimental software engineering: overview and examples of experiments

(do not follow exactly this order in the lectures)

> **We need basic statistics**
> **But that is easy…**

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Assignments

- Two small projects:
  - Assignment 1 – **Exploratory data analysis** → deadline **November 3**, 2023
  - Assignment 2 – **Experiment design** → deadline **December 15**, 2023

- The output of the assignments is a written report. We need to rethink this!

- Assignment are a group activity: up to 3 students per group

- The same group of students for the two assignments

- Students can propose their own assignments (but following a similar idea of the original assignments). The proposals will be discussed with the teacher and, if approved, will be included in the set of the assignments (replacing one of the assignments proposed by the teacher).

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Course organization

- Lectures **(T)**:
  - Overview of the topics of the syllabuses
  - Discussion of key aspects
  - Discussion of examples

- Practice-Lab./Assignment support **(PL)**:
  - Assignment support oriented
    - Present and discuss the assignments that will be made by the students
    - Discuss specific questions related to the assignments
    - Evaluate the progress of the assignments periodically

  - Exercises for concept consolidation and preparation for the written exam.

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Bibliography

- Documents provided by the teacher and papers available online

- "Experimental Methods for the Analysis of Optimization Algorithms", T. Bartz-Beielstein, M. Chiarandini, L. Paquete, M. Preuss, Springer, 2010

- "Basics of Software Engineering Experimentation", Natalia Juristo and Ana M. Moreno, Springer Publishing Company, 2010.

- NIST/SEMATECH e-Handbook of Statistical Methods:
  https://itl.nist.gov/div898/handbook/

- "The Art of Computer Systems Performance Analysis", R. Jain, Wiley 1991.

- "Measuring Computer Performance", D. J. Lilja, Cambridge University Press, 2000

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Tools and other resources

For the assignments and for the PL classes
- R (http://www.r-project.org/)
- MS Excel, SPSS, or any other statistical application
- Online statistics calculator tools
  - https://datatab.net/tutorial/get-started (DATAtab is particularly nice!)
  - https://www.socscistatistics.com/tests/
  - https://www.meta-calculator.com/statistics-calculator.php
  - (there are many more!)

- Statistical tables (for the written exams)

No problem in using LLM tools such as ChatGPT, Perplexity, etc., provided that these tools are used to learn the concepts and skills defined as learning targets for this course.

Obviously, students' knowledge and skills will be evaluated without such tools.

"A fool with a tool is still a fool."
It is not clear who is the author of this quote… Grady Booch?, Kishor Trivedi?, ??

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Assessment

- Assignments: **50%**
  - **Assignment 1 – 15%**
    The final grade results from the evaluation of the report, follow up in the PL classes and the assignment discussion in the defense.

  - **Assignment 2 – 35%**
    The evaluation will consider the report and the follow up in the PL classes, similarly to the Assignment 1. But in the Assignment 2 the defense will be replaced by an individual written test. The students cannot use any auxiliary documentation or tools during such test ("teste sem consulta").

- Written exam: **50%**
  - Questions about the topics addressed in the lectures (T).
  - Written exercises similar to the ones practiced in PL classes.
  - Questions related to issues found in the assignments and discussed in the PL classes.
  - Students can use any printed material in the written exam *("teste com consulta").*

- Minimum of 35% in assignments and written exam

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Other issues

- Classes are highly relevant to save time for students…

- Plagiarism → Mandatory fail in the course + internal (UC) disciplinary procedure

- Questions and difficulties → Henrique Madeira <henrique@dei.uc.pt>

- Feedback from students is very welcome ☺

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Questions?

Suggestions?

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