

Scientific Methodology in Computer Science

MO430A

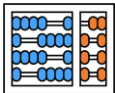
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University of Campinas



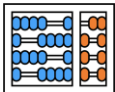
Agenda

- Overview of the scientific method
 - Introduction to the scientific method
 - Components of the scientific method
 - Importance of a systematic approach
 - Examples of scientific research in computer science
- Syllabus
 - Course description
 - Course goal
 - Class schedule
 - Assessment
 - Grading scale

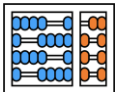
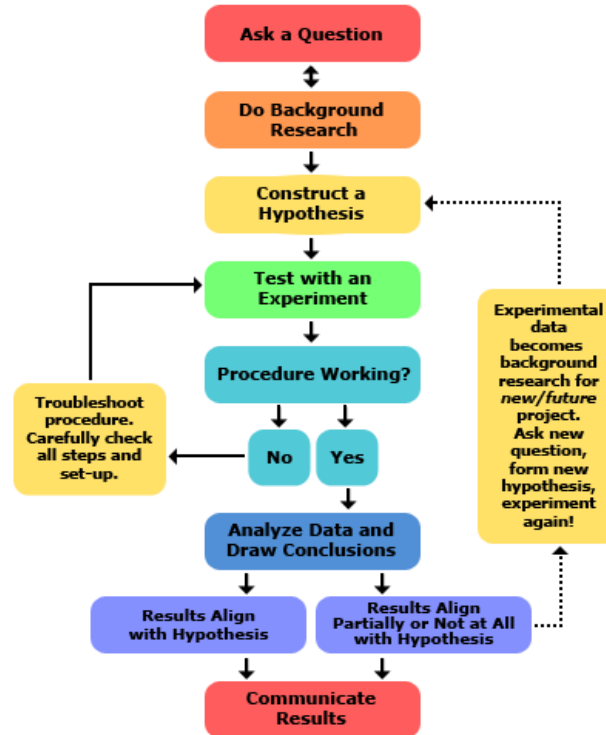


What is the Scientific Method?

- The Scientific Method is a systematic approach used by scientists to investigate natural phenomena.
- It involves a series of steps and techniques to gather, analyze, and interpret data.
- The Scientific Method provides a structured framework for making reliable and objective conclusions based on evidence.
- It is the foundation of empirical research in various scientific disciplines, including computer science.

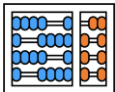


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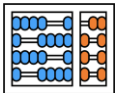
Components of the Scientific Method

- **Observation:** Start by carefully observing a phenomenon or asking a specific research question
 - Observations can arise from natural events, existing knowledge gaps, or practical problems.
- **Hypothesis:** Formulate a testable explanation or prediction based on your observations.
 - A hypothesis should be clear, specific, and capable of being proven or disproven through experimentation.



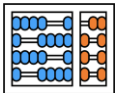
Components of the Scientific Method

- **Experimentation:** Design and conduct experiments to test the hypothesis.
 - Experiments are carefully planned and controlled procedures that allow for the manipulation of variables.
- **Data Collection:** Gather data through systematic observations, measurements, or experiments.
 - Data collection methods depend on the research context and the nature of the data.



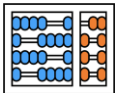
Components of the Scientific Method

- **Analysis:** Analyze and interpret the data to draw meaningful and unbiased conclusions.
 - Statistical analysis and data visualization techniques are often employed.
- **Conclusion:** Formulate conclusions based on the analysis and the evidence gathered.
 - Conclusions should address the original research question and support or reject the hypothesis.
- **Communication:** Share findings with the scientific community through research papers, presentations, or publications.
 - Effective communication ensures that research is disseminated and contributes to the broader body of knowledge.



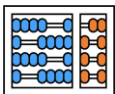
Importance of a Systematic Approach

- A systematic approach ensures that experiments are conducted consistently and can be replicated.
- It minimizes bias and helps maintain objectivity in research.
- Consistency allows for the development of reliable scientific knowledge.



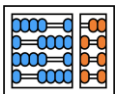
Why is the Scientific Method Important?

- In computer science, the scientific method is crucial for conducting rigorous and credible research.
- It helps researchers validate algorithms, test hypotheses about system behavior, and make informed decisions.



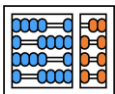
Examples of Scientific Research in Computer Science

- **Example 1:** Developing a new machine learning algorithm.
 - **Observations:** Recognizing inaccuracies in current machine learning models.
 - **Hypothesis:** Hypothesize that a novel algorithm will improve prediction accuracy.
 - **Experimentation:** Conduct experiments comparing the new algorithm with existing models.
 - **Data Collection:** Gather data on model performance and error rates.
 - **Analysis:** Analyze the experiment results to determine if the new algorithm outperforms existing ones.
 - **Conclusion:** Conclude whether the new algorithm is statistically superior.

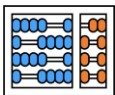


Examples of Scientific Research in Computer Science

- **Example 2:** Cybersecurity research.
 - **Observations:** Identifying an increase in cyberattacks on a particular system.
 - **Hypothesis:** Hypothesize that the system's vulnerabilities are exploited in these attacks.
 - **Experimentation:** Simulate various attack scenarios to test system vulnerabilities.
 - **Data Collection:** Collect data on simulated attacks and their success rates.
 - **Analysis:** Analyze attack patterns and vulnerabilities.
 - **Conclusion:** Determine the extent to which vulnerabilities are exploited and propose countermeasures.

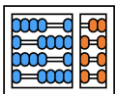


Syllabus



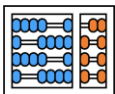
Course Description

This course introduces students to the fundamental principles of the scientific method and its application in computer science research. Students will learn how to formulate research questions, design experiments, collect and analyze data, and communicate their findings effectively.



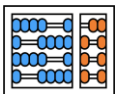
Course Goals

- Understand the scientific method and its relevance to computer science research.
- Develop skills in formulating research questions and hypotheses.
- Learn how to design experiments and choose appropriate data collection methods.
- Gain proficiency in data analysis techniques and statistical methods.
- Ethical considerations and bias in computer science research.
- Communicate research findings effectively through written reports and presentations.



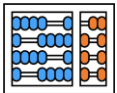
Class Schedule (*Subject to changes throughout the course*)

#	Date	Day of the week	Content/Activity	Note
1	02/10	Monday	Overview of the scientific method Syllabus	
2	04/10	Wednesday	Literature Review in Computer Science Research	
3	09/10	Monday	Research questions and hypotheses	
4	11/10	Wednesday	Types of experiments and their design	
5	16/10	Monday	Variables, controls, and randomization	ASSIGNMENT 1
-	18/10	Wednesday	NO CLASS	
6	23/10	Monday	Data collection methods	ASSIGNMENT 2
7	25/10	Wednesday	Measurement techniques and instruments	
8	30/10	Monday	Descriptive statistics	
9	01/11	Wednesday	Inferential statistics and hypothesis testing	ASSIGNMENT 3
10	06/11	Monday	Ethical considerations in computer science research	
11	08/11	Wednesday	Addressing bias in experiments	ASSIGNMENT 4
12	13/11	Monday	Recording and organizing data	
-	15/11	Wednesday	HOLIDAY	
-	20/11	Monday	HOLIDAY	ASSIGNMENT 5 - 21/11
13	22/11	Wednesday	Case studies in computer science research	
14	27/11	Monday	Final Project presentation	
15	29/11	Wednesday	Final Project presentation	



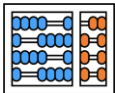
Assessment

- Assignments (60%)
- Final Project (40%)



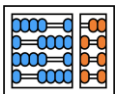
Grading Scale

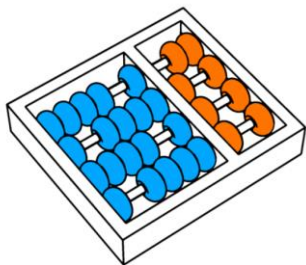
- A: 90-100%
- B: 70-89%
- C: 50-69%
- D: Below 50%
- E: Failed due to Attendance



Textbook, References and Additional Resources

- Scientific journals and research papers in computer science
- Online tutorials and resources on statistical analysis tools
- Books and courses shared on Google Classroom





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