

Scientific Methodology in Computer Science

MO430A

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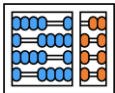
Agenda

- Definition and Classification of Research

- Data source
- Data analysis
- Purpose
- Objective
- Scope
- Application
- Target
- Other

- Design Frames

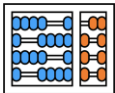
- Action Research
- Case Study
- Ethnography
- Ethnomethodology
- Evaluation
- Experiment
- Longitudinal
- Cross-sectional
- Surveys
- Comparative
- Mixed methods



Research definition

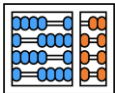
"Research is a systematic search for new knowledge."

- Specific research questions
- Reliance on external sources
- Beyond personal experiences and opinions



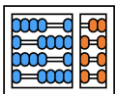
Classification of Research

- Research varies based on several criteria
- Subject matter, research methods, data sources, objectives, purpose, scope, etc..



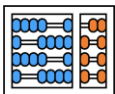
Classification Based on Data Source

- Primary Research:
 - Original research, following the scientific method.
 - Researchers gather first-hand data.
 - Example in Computer Science: *“Conducting experiments to measure the performance of a new algorithm.”*
- Secondary Research:
 - Analysis and interpretation of primary research.
 - Researchers analyze existing data to draw conclusions.
 - Example in Computer Science: *“Analyzing published research papers to gather insights on cybersecurity trends.”*



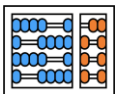
Classification Based on Data Analysis

- Qualitative Research:
 - Exploratory, focusing on understanding underlying reasons.
 - Often used to develop ideas or hypotheses.
 - Example in Computer Science: *“Conducting interviews to explore user experiences with a new software interface.”*
- Quantitative Research:
 - Quantifying data and generating numerical results.
 - Aims to generalize findings from a larger sample.
 - Example in Computer Science: *“Surveying a large group of users to collect statistical data on software preferences.”*



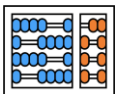
Classification Based on Purpose

- Theoretical Research:
 - Non-empirical, driven by curiosity.
 - Expands knowledge but may not result in practical applications.
 - Example in Computer Science: *“Investigating the theoretical limits of artificial intelligence.”*
- Applied Research:
 - Empirical, focused on solving practical problems.
 - Often hands-on and aimed at immediate application.
 - Example in Computer Science: *“Developing new algorithms for real-time data analysis in network security.”*



Classification Based on Objective

- Exploratory Research:
 - Aims to formulate a problem for more in-depth investigation.
 - Provides insights and lays the groundwork for further research.
 - Example in Computer Science: *“Preliminary research on emerging trends in cloud computing.”*
- Descriptive Research:
 - Explains the characteristics of individuals, groups, or situations.
 - Focuses on specific predictions, features, or functions.
 - Example in Computer Science: *“Describing the user interaction patterns in a mobile app.”*



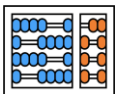
Classification Based on Scope

- Exploratory Research:

- Identifies the causes of problems and proposes solutions.
- Often involves causal relations and hypothesis testing.
- Example in Computer Science: *“Investigating the root causes of software crashes in open source studies.”*

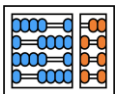
- Evaluation Study:

- Assesses the quality and quantity of an activity or project.
- Provides valuable feedback for improvement.
- Example in Computer Science: *“Evaluating the effectiveness of a software development project.”*



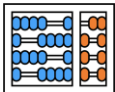
Classification Based on Application

- Action Research:
 - Action-oriented, aims to solve immediate problems.
 - Often conducted in specific contexts and through collaboration.
 - Example in Computer Science: *“Working with a software development team to troubleshoot and improve code efficiency in real-time.”*
- Educational Research:
 - Focused on the improvement of education and learning.
 - Aims to develop educational theory and derive generalizations.
 - Example in Computer Science: *“Investigating the effectiveness of online coding courses in enhancing programming skills.”*



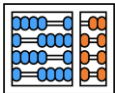
Classification Based on Target

- Problem-Oriented Research:
 - Conducted by institutions or agencies to identify development barriers.
 - Focuses on broader sectoral issues.
 - Example in Computer Science: *"Identifying barriers to the adoption of open-source software in government organizations."*
- Problem-Solving Research:
 - Conducted by individual organizations to solve specific internal problems.
 - Aimed at improving the organization's operations.
 - Example in Computer Science: *"A software company conducting research to optimize its project management processes."*



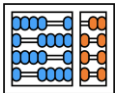
Other types of research

- Experimental research
- Ex post Facto research
- Comparative research
- Historical research
- Ethnographic research
- Correlational research
- Grounded Theory research
- Phenomenological research
- Explanatory research
- Predictive research



Design Frames

- Research design frames provide a structured approach to conducting research.
 - *Action Research*
 - *Case Study*
 - *Ethnography*
 - *Ethnomethodology*
 - *Evaluation*
 - *Experiment*
 - *Longitudinal*
 - *Cross-sectional*
 - *Surveys*
 - *Comparative*
 - *Mixed methods*

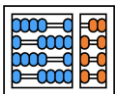


Action Research

Action research is research initiated to solve an immediate problem or improve a specific practice. It is a reflective process of problem-solving led by individuals or teams in specific contexts.

- Key Characteristics:
 - Collaborative and action-oriented.
 - Often conducted in real-world settings.
- Application in Computer Science:
 - Collaborating with a software development team to identify and solve real-time coding issues.
- Example:

A software development team facing performance issues in their application might use action research to analyze and improve the code in an iterative manner.

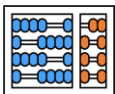


Case Study

Case study research involves an in-depth investigation of a single instance or a small number of instances. It provides a comprehensive understanding of a particular phenomenon.

- Key Characteristics:
 - In-depth exploration of a specific case.
 - Collects data through various sources, such as interviews, observations, and documents.
- Application in Computer Science:
 - Analyzing a specific software implementation to understand its design, functionality, performance, etc..
- Example:

A case study might focus on the development and deployment of a unique blockchain application to assess its impact on data security in financial transactions.

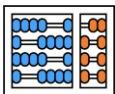


Ethnography

Ethnography is a qualitative research method that involves the study of people in their natural environment. It aims to understand the culture and behaviors of a particular group or community.

- Key Characteristics:
 - Immersion in the research environment.
 - Participant observation and open-ended interviews.
- Application in Computer Science:
 - Observing how users interact with a software system in their workplace to improve user experience.
- Example:

Ethnographic research in a tech company's office space might uncover how employees use collaboration tools and identify areas for software improvements based on real user behaviors.

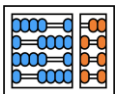


Ethnomethodology

Ethnomethodology focuses on the study of how people create and maintain social order, emphasizing everyday practices and interactions.

- Key Characteristics:
 - Examines the implicit rules and structures in social interactions.
 - Often involves detailed analysis of conversations and actions.
- Application in Computer Science:
 - Investigating how online communities self-regulate and moderate discussions on a programming forum.
- Example:

Ethnomethodological research might explore how online programming communities maintain order through social norms and unwritten rules, providing insights into community dynamics.

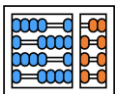


Evaluation

Evaluation research assesses the quality, quantity, and effectiveness of a program or activity. It measures the extent to which goals are achieved.

- Key Characteristics:
 - Focuses on assessing the success of a program or intervention.
 - Uses various methods to collect data, such as surveys, interviews, and observations.
- Application in Computer Science:
 - Evaluating the usability and performance of a newly developed mobile app.
- Example:

An evaluation study might involve collecting user feedback and performance data to assess the effectiveness and user satisfaction of a mobile app designed for project management in the software industry.

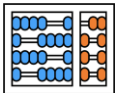


Experiment

Experimentation involves the systematic manipulation of variables to measure changes in others. It helps establish causal relationships.

- Key Characteristics:
 - Involves controlled manipulation of variables.
 - Typically uses a randomized approach to assign subjects to groups.
- Application in Computer Science:
 - Conducting experiments to test the impact of different algorithms on data processing speed.
- Example:

An experiment in computer science might involve comparing the processing speed of two different sorting algorithms to determine which one is more efficient.

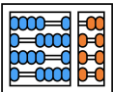


Longitudinal

Longitudinal studies follow the same subjects over a long period to observe changes over time.

- Key Characteristics:
 - In-depth analysis over an extended timeframe.
 - Valuable for tracking trends and developments.
- Application in Computer Science:
 - Conducting a longitudinal study to track the evolution of cybersecurity threats over several years.
- Example:

A longitudinal study in computer science could track changes in cybersecurity threats and defenses over a decade to identify evolving patterns.

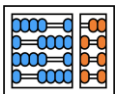


Cross-Sectional

Cross-sectional studies analyze a population at a specific point in time, providing a snapshot of the current situation.

- Key Characteristics:
 - Examines a diverse group at one moment.
 - Useful for understanding the present state.
- Application in Computer Science:
 - Conducting a cross-sectional study to assess the adoption of specific programming languages in the industry.
- Example:

A cross-sectional study in computer science might analyze the preferences and usage patterns of various programming languages in a particular year.

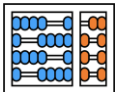


Surveys

Surveys collect data from a sample of a population through structured questionnaires or interviews to gather insights and opinions.

- Key Characteristics:
 - Systematic collection of data through standardized questions.
 - Provides a quantitative overview of a topic.
- Application in Computer Science:
 - Using surveys to assess user satisfaction with a software application.
- Example:

Surveys in computer science can be employed to gather feedback from users regarding the functionality, usability, and overall satisfaction with a software tool or platform.

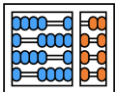


Comparative

Comparative study research is conducted to compare two or more phenomena to identify similarities, differences, and relationships between them.

- Key Characteristics:
 - Focuses on examining multiple cases.
 - Often used to draw generalizations or make comparisons.
- Application in Computer Science:
 - Comparing the performance and security features of different cloud computing providers.
- Example:

A comparative study in computer science could assess the performance, cost, and security of various cloud platforms, such as AWS, Azure, and Google Cloud, to help organizations make informed choices.

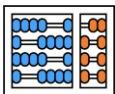


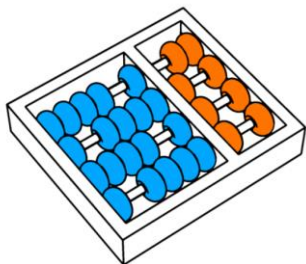
Mixed methods

Mixed methods research combines qualitative and quantitative research approaches to provide a comprehensive understanding of a research question.

- Key Characteristics:
 - Uses a combination of data collection methods.
 - Aims to offer a more complete perspective.
- Application in Computer Science:
 - Using both surveys and in-depth interviews to understand user perceptions of a new software tool.
- Example:

In computer science, a mixed methods study might involve collecting quantitative data on software usage through surveys and qualitative data through interviews to gain a holistic understanding of user experiences and preferences.





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