



**RESEARCH METHODOLOGY**

**&**

**RESPONSIBLE AI ETHICS IN COMPUTING**

# Research Methodology and Responsible AI Ethics in Computing

[As per Choice Based Credit System (CBCS) scheme]

## SEMESTER — V

<b>Course Code</b>	—	<b>Credits</b>	02
<b>Hours / Week</b>	02 Hours	<b>Total Hours</b>	39 Hours
<b>L-T-P-J</b>	2-0-0-0		

### Course Learning Objectives:

1. Understand fundamental and advanced research methods in computing.
2. Familiarize with intellectual property rights, copyright, and patents.
3. Apply modern research tools for literature survey, writing, and plagiarism checking.
4. Formulate research problems, hypotheses, and publishable outcomes with modern AI Ethics.

# Course Outcomes (COs)

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
CO1	Understand the fundamentals of research and ethics in computer science.	L2
CO2	Apply modern tools for literature review, citation, and plagiarism checking.	L3
CO3	Demonstrate understanding of copyright, patents, and research data management.	L2
CO4	Formulate research questions and hypotheses using suitable methodologies.	L4
CO5	Draft technical papers with structured content and clarity for publication.	L4 & L6

## TEXT BOOKS:

**Kothari, C. R., & Garg, G.** (2019). *Research Methodology: Methods and Techniques* (4th ed.). New Age International Publishers. ISBN: 978-9386649225

**Kumar, Ranjit** (2022). *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.). SAGE Publications Ltd. ISBN: 978-1529783695

## REFERENCES:

**Best, John W., & Kahn, James V.** (2014). *Research in Education* (10th ed.). Pearson Education. ISBN: 978-9332586051

**Creswell, John W., & Creswell, J. David** (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications. ISBN: 978-1506386706

**WIPO – World Intellectual Property Organization** (2020). *Understanding Industrial Property*. Geneva: WIPO Publication No. 895E. Free PDF available at: <https://www.wipo.int/publications/en/details.jsp?id=4085>

**OECD** (2019). *OECD Principles on Artificial Intelligence*. Online resource: <https://oecd.ai/en/ai-principles>

**Stanford HAI – Human-Centered Artificial Intelligence** (Annual). *AI Index Report*. Stanford University. Online resource: <https://aiindex.stanford.edu>

**IEEE Author Center**. *IEEE Guidelines for Authors and Researchers*. Online: <https://journals.ieeeauthorcenter.ieee.org>

# UNIT — I: Introduction to Research (06 Hours)

## Topics to be covered:

Meaning and objectives of research, Types of research: Fundamental, Applied, Experimental, and Descriptive, Criteria of good research, Ethics in research and academic integrity, Case studies in computing research.

# 1. Meaning of Research

## **Definition:**

Research is the **systematic** and **scientific** process of **collecting**, **analyzing**, and **interpreting** information (data) to **answer questions** or **solve problems**.

It aims to explore *what is unknown*, build *new knowledge*, or validate *existing concepts* through a disciplined approach.

# 1. Meaning of Research

- **Etymology:**
- The word “**research**” comes from:
- “**Re**” (Latin: again)
- “**Search**” (to find)
- So, **research** literally means “**to search again**”, emphasizing its repetitive and investigative nature – revisiting known ideas, re-examining them, and generating new insights.

# What is good research?

Good research in academics is

- 1. purposeful,**
- 2. methodical,**
- 3. accurate,**
- 4. ethical, and**
- 5. contributes to the advancement of knowledge**

while being transparent and reproducible.

# What is good research?

In academics, **good research** means more than just collecting data and writing a paper — it refers to a **systematic, ethical, and meaningful process** of inquiry that produces reliable knowledge and contributes to the understanding of a subject.

- **1. Clear Purpose and Relevance**
- Good research starts with a **well-defined problem or question** that addresses a real gap in knowledge.
- It should be relevant to the academic field and, ideally, have practical or theoretical value.
- *Example:* Instead of vaguely studying “student habits,” a good research topic might be “Impact of active recall techniques on academic performance in engineering students.”

# What is good research?

## 2. Systematic and Well-Designed Methodology

- The research process follows a **logical, step-by-step approach**.
- Methodology is chosen based on the research question (qualitative, quantitative, or mixed methods).
- It ensures **consistency, repeatability, and validity**.

*Example:* If studying human behavior, sampling methods, questionnaires, and statistical tools must be carefully planned.

## 3. Accuracy and Objectivity

- Findings are **based on facts, evidence, and logical reasoning** — not personal bias or assumptions.
- Data is collected and analyzed **without manipulating results** to fit expectations.

*Example:* Reporting results even if they contradict the original hypothesis.

# What is good research?

## 4. Ethical Standards

- The research **respects participants' rights**, privacy, and safety.
- Proper **citations** and avoidance of plagiarism.
- Honest reporting of methods, data, and limitations.
- *Example:* Gaining informed consent from participants in a psychology study.

## 5. Contribution to Knowledge

- A good study should **add something new** — a fresh perspective, a new method, or an innovative application of theory.
- It should help other researchers build on the work.
- *Example:* Introducing a modified machine learning algorithm that improves accuracy in medical diagnosis.

# What is good research?

## 6. Clarity and Transparency

- Research should be **well-documented**, making it possible for others to replicate or verify.
- Clear writing, proper structure, and transparent data presentation are key.

**Example:** Sharing datasets and coding scripts in open-access repositories

## 7. Critical Thinking and Analysis

- Goes beyond mere description — it **interprets results**, connects them with existing theories, and discusses implications.
- Identifies limitations and areas for future research.

**Example:** Explaining why an AI model failed in certain cases and suggesting improvements

# 1. Meaning of Research

Research is **not just Googling stuff**. It's about **deep investigation** that follows rules — like a detective solving a mystery with facts and proof, not guesses.

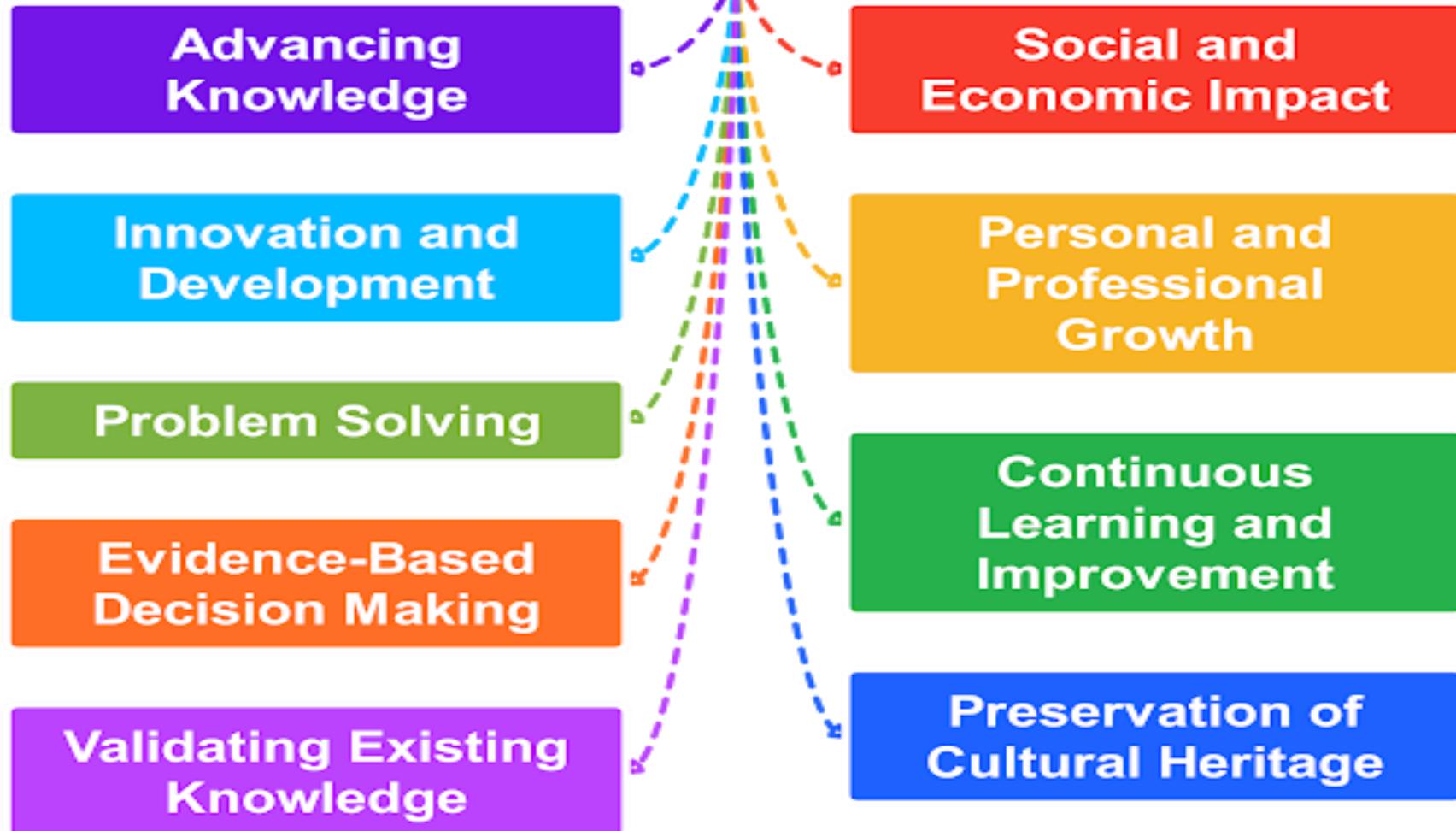
In computer science, this means **writing code, running tests, analyzing results**, and then **sharing findings** that others can build on or verify.

# 2. Objectives of Research

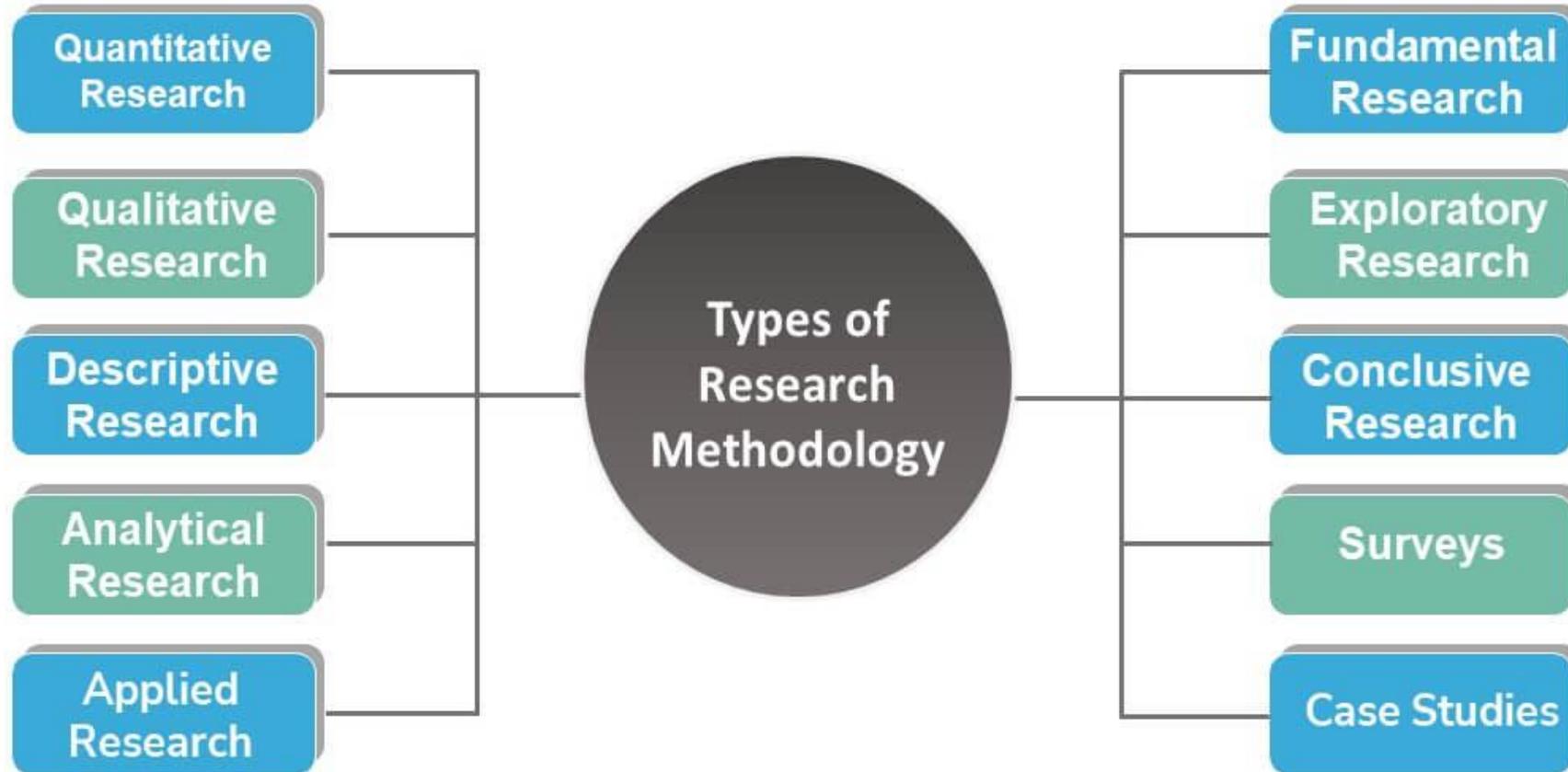
Research is conducted with **specific goals** in mind. These objectives guide the **purpose, direction,** and **design** of any research project.

Objective	Explanation	Example in Computing
<b>Discover new facts</b>	Explore unknowns; expand knowledge	Quantum computing behavior, new AI concepts
<b>Verify/test facts</b>	Revalidate known theories	Testing Moore's Law or algorithm performance
<b>Analyze relationships</b>	Study connections between variables	Link between screen time and well-being
<b>Develop tools/models</b>	Build systems to aid future research	AI models, simulation software
<b>Solve problems</b>	Address real-world challenges	Accessibility apps, cybersecurity solutions

## Importance of Research



# Types of Research Methodology



# 3. Types of Research

## A. Fundamental (Pure) Research

- Seeks knowledge for the sake of knowledge.
- Theoretical in nature.
- No immediate application.
  
- **Example:**  
Study on the theoretical limitations of AI consciousness.

# 3. Types of Research

## B. Applied Research

- Solves practical problems using known theories.
- Direct application.
  
- **Example:**  
Building a real-time fraud detection system using machine learning.

# 3. Types of Research

## C. Experimental Research

- Research involving controlled testing.
- Focus on cause-effect relationships.
- **Example:**  
Testing the performance impact of a new compression algorithm on image quality.

# 3. Types of Research

## D. Descriptive Research

- Describes characteristics or phenomena.
- Involves surveys, case studies, observational data.
- **Example:**  
Survey on mobile app usage among teenagers for mental health monitoring.

# 4. Criteria of Good Research

<b>Criterion</b>	<b>Description</b>
<b>Systematic</b>	Follows a structured procedure.
<b>Logical</b>	Based on sound reasoning.
<b>Empirical</b>	Depends on real-world data.
<b>Replicable</b>	Can be repeated with the same results.
<b>Ethical</b>	Respects rights of participants and data.

## **Example in Practice:**

Using a clearly defined methodology, gathering user consent for app usage data, and publishing code for reproducibility.

# 5. Ethics in Research and Academic Integrity

## A. Research Ethics

- Respect for **intellectual property** (no plagiarism).
- Ensuring **informed consent** of participants.
- Maintaining **data privacy and confidentiality**.
- **Avoiding fabrication/falsification** of data.
- **Disclosure of conflicts of interest**.

# 5. Ethics in Research and Academic Integrity

- **B. Academic Integrity**
- Honesty in authorship.
- Transparent peer review.
- Citing sources appropriately.
- Use of tools like Turnitin, Grammarly, Quillbot.
  
- **Example:**  
Using Grammarly and Turnitin to ensure the originality of an IEEE-format technical paper.

# 6. Case Studies in Computing Research

## Case Study 1: AI Tool Evaluation

- **Topic:** AI in Healthcare

**Tools:** Elicit vs Semantic Scholar

**Observation:** Elicit provides synthesized evidence, while Semantic Scholar gives broad citation networks.

**Ethical Reflection:** Which tool is more transparent? Does it mislead by favoring high-citation papers?

# 6. Case Studies in Computing Research

- **Case Study 2: Patent Search & Ethics**

- **Topic:** Drone Delivery Systems

**Platform:** WIPO Patent Search

**Discussion:** Ethical concerns over surveillance, dual-use technology.

# 6. Case Studies in Computing Research

- **Case Study 3: Technical Paper Writing**

- **Topic:** Quantum AI

**Tools:** LaTeX (Overleaf), Grammarly, Turnitin

**Task:** Draft abstract, generate citation list using Zotero, and run plagiarism check.

# Core Elements of Academic Integrity

- **Avoiding Plagiarism**

- Credit all sources properly; do not copy others' work without acknowledgment.

- **Original Work**

- Produce and submit work that is genuinely your own. Avoid duplication or self-plagiarism.

- **Accurate Citation and Referencing**

- Use appropriate citation styles (APA, MLA, IEEE, etc.) to give credit to authors.

- **Acknowledging Contributions**

- Recognize collaborators, funding bodies, and any assistance received.

- **Responsible Authorship**

- Only those who made substantial contributions should be listed as authors.

- **Avoiding Academic Misconduct**

- Do not cheat, falsify data, or manipulate peer review processes.

# Case Study 1 – AI Facial Recognition and Privacy

## **Background:**

A research team develops an AI facial recognition system for crime detection. They collect images from CCTV footage without informing the individuals captured.

**Ethical/Integrity Issue:** Lack of **informed consent** from individuals.

Potential misuse of data for surveillance without legal clearance.

## **Key Learning:**

Even if data is publicly accessible, researchers must follow **privacy and data protection laws** (e.g., GDPR) and obtain ethical clearance before use.

# Case Study 2 – Data Fabrication in Machine Learning

- **Background:**

A PhD student trains a machine learning model on a dataset for predicting heart disease but **invents additional data points** to improve accuracy.

- **Ethical/Integrity Issue:**

- **Fabrication of data** (academic misconduct).

- Misleading results that could cause harm if used in medical applications.

- **Key Learning:**

Fabricating or falsifying data undermines **academic integrity** and can lead to unsafe real-world applications

# Case Study 3 – Plagiarism in Software Code

- **Background:**

A researcher publishes an open-source software tool but later it's discovered that **large parts of the code were copied** from another GitHub repository without acknowledgment.

- **Ethical/Integrity Issue:**

- **Plagiarism** in code is as serious as in text.

- Violates intellectual property rights and licensing agreements.

- **Key Learning:**

Always **credit the original author** and follow license terms (MIT, GPL, Apache, etc.) in software research.

# Case Study 4 – Biased AI in Recruitment Systems

- **Background:**

A tech company tests an AI recruitment tool developed by researchers. The system shows bias against female applicants because it was trained on historical hiring data dominated by men.

- **Ethical/Integrity Issue:**

- **Algorithmic bias** due to unbalanced datasets.

- Discrimination in decision-making.

- **Key Learning:**

Researchers must ensure **fairness and bias mitigation** in AI models and disclose dataset limitations.

# Case Study 5 – Unauthorized Use of Student Data

- **Background:**

A computing department uses students' LMS (Learning Management System) data for a research project without informing them.

- **Ethical/Integrity Issue:**

- Violation of **privacy and confidentiality.**

- Lack of informed consent for research use.

- **Key Learning:**

Student or user data should only be used with **clear consent** and institutional approval

..... Any questions?