Overview

- Brief overview of research
- A Guide to Conducting Research
- Steps involved in Research
- Types of Research Papers
- Key Considerations for Writing a Review Paper
- Key Considerations for Writing a Research Paper
- Common Pitfalls in Writing Review & Research Papers
- Plagiarism & AI

Brief overview of research

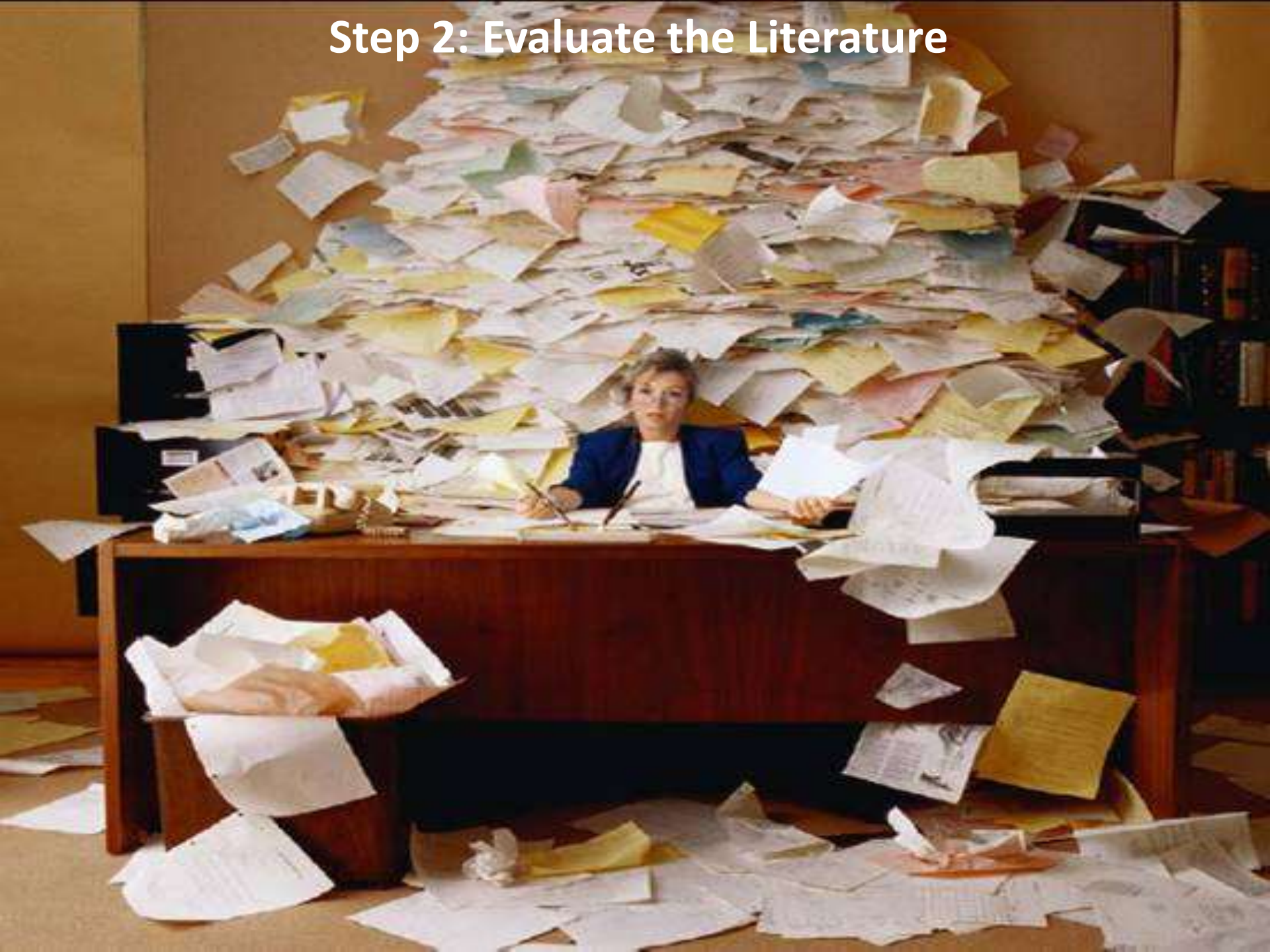
- *Systematic collection, analysis and interpretation of data to solve a problem*
  - ✓ **Defining and redefining problems**
  - ✓ **Formulating hypothesis**
  - ✓ **Setting objectives;**
  - ✓ **Collecting, organizing and evaluating data;**
  - ✓ **Making deductions and reaching conclusions;**
  - ✓ **Testing the conclusions to determine whether they fit the formulated hypothesis/objectives**

RESEARCH PROCESS STEPS

Research Process Steps

Step 1: Identify Research Problem

Step 2: Evaluate the Literature



Step 2: Evaluate the Literature

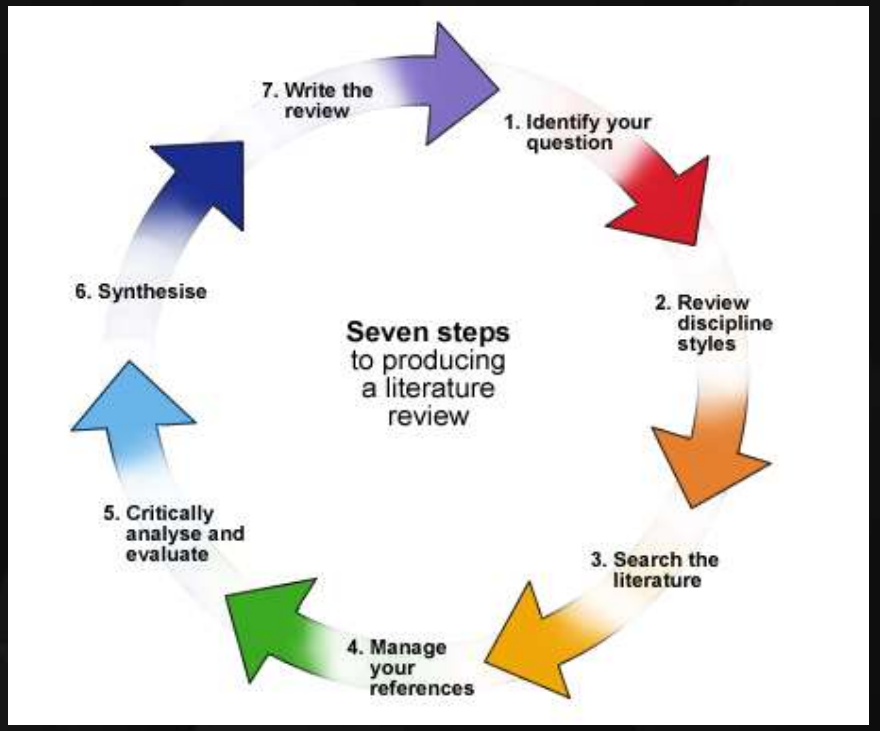
- **Identify the Focus**
- **Set Boundaries**
- **Search for Relevant Literature**
- **Use Academic Databases: Access databases like Google Scholar, PubMed, Scopus, or others relevant to your field**
- **Open Access & Subscription based Journals**

Step 2: Evaluate the Literature: Search Strategies

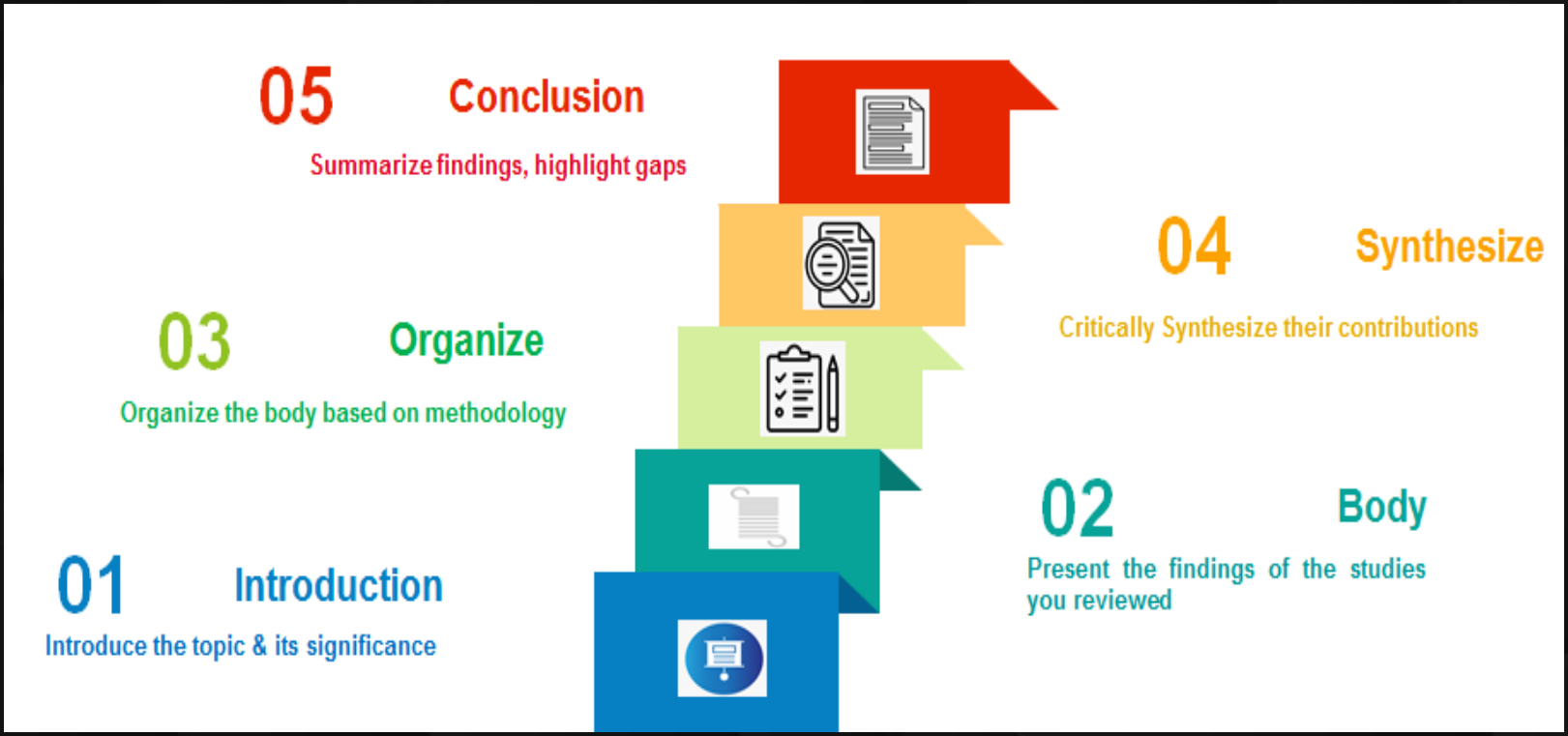
- **Begin with broad searches and gradually narrow down**
- **Look for:**
  - ✓ **Peer-reviewed journal articles**
  - ✓ **Books and book chapters**
  - ✓ **Conference papers**
  - ✓ **Dissertations and theses**
  - ✓ **Government and policy documents**
- **Inclusion and Exclusion Criteria:**
  - ✓ **Set criteria for including studies in your review, such as relevance, quality, publication date, language, and methodological process**
  - ✓ Avoid Non-refereed materials
  - ✓ **Evaluate and Select Sources**
    - ☐ **Assess Relevance: Read abstracts and conclusions to determine if the study addresses your research question or topic**
    - ☐ **Assess Quality: Check the credibility of the sources (Whether reputable journals, methodology, validity)**
  - ✓ **Examine Citations**
  - ✓ **Top Publishers : Elsevier, Springer Nature, Wiley, MDPI , IEEE**

Step 2: Evaluate the Literature

- Analyze and organize the Literature by
  - **Date of publication** (to identify trends over time)
  - **Relevance** (how directly they contribute to your question)
  - **Similar Methodology**
- Focus on Studies that specifically address your research question
- Take short notes on key findings, arguments, methods, strengths, limitations and research gaps
- Identify new ways to interpret, and shed light on any gaps in previous research



Step 2: Evaluate the Literature: Structure of Writing a Literature Review



Example of a Good Literature Review: Machine learning based heart disease prediction system

- **Heart disease remains one of the leading causes of death globally, making early prediction crucial for improving outcomes. Recent advancements in machine learning (ML) techniques have shown promise in predicting heart disease, offering potential improvements over traditional diagnostic methods.**

- **Supervised learning** techniques, particularly **Support Vector Machines (SVM), Random Forests (RF), and Logistic Regression**, have been the most commonly employed. For instance, Hussein et al. (2022) demonstrated that SVM outperformed other methods in predicting heart disease based on a dataset of patient features, including age, cholesterol levels, and blood pressure achieving an accuracy of 87% [1]. Another study by Meliisa et al. (2023) confirmed the effectiveness of Random Forests, reporting high accuracy in predicting cardiovascular conditions through achieving 90%. [2] **SVM models** have reported up to 90% accuracy in majority of the cases based on the literature review. [Similar approaches to be continued].

- A growing number of studies are also incorporating **multimodal data**, such as combining clinical data with imaging or sensor-based data, to enhance predictive accuracy. Mill et al. (2023) demonstrated how ECG signals and chest X-ray images, when processed using deep learning techniques, could improve prediction accuracy. [Similar approaches to be continued].

- Despite the advancements, several challenges persist in developing reliable ML-based heart disease prediction systems. A significant amount of publicly available heart disease data is imbalanced, with fewer examples of critical heart failure cases. Machine learning models, particularly deep learning approaches, are often criticized for their **black-box nature**, making it difficult for clinicians to trust the predictions. Efforts to improve model explainability, such as **LIME** and have been proposed to address this issue by some researchers [11-15]. While models may perform well in academic settings, their application in real-world clinical environments remains challenging. Issues such as **data preprocessing**, **data integration**, and **integration into clinical workflows** often hinder widespread deployment

Step 3: Create Hypothesis

- **Prediction based on existing knowledge that can be tested**
- **A Clear, Testable Statement**
- **Involve Clear and measurable variables**
- **Must be Specific and Measurable**

- **Example:**

Deep Learning based algorithms can predict the risk of heart disease more accurately than traditional methods, such as logistic regression and decision trees, when trained on clinical and demographic data.

Step 4: Research Design

- Plan for achieving objectives and answering research questions.
- Typically involves
  - ✓Surveys
  - ✓Experiment/Simulation/Simulation+ Experiment
  - ✓Data Analysis
  - ✓Observation
- Consider Ethical Issues

Step 5: Describe Population

- Specific group of people, facilities or anything relevant to your topic
- Can be human or non-human (A group of people/ animals/ objects/phenomena that share certain characteristics

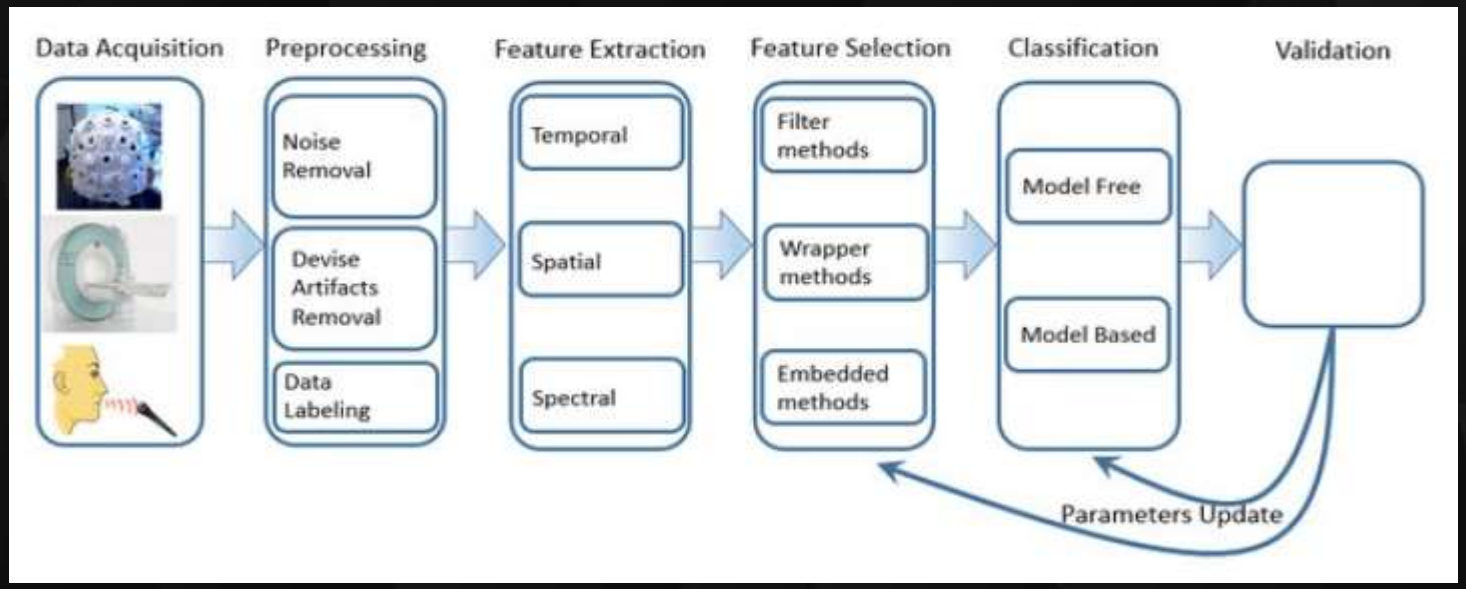
- For example, if you want to work on a disease prediction system using Machine learning, you may conduct an extensive experiment on a certain number of potential patients. You may apply your developed model on this study group and extract data and formulate conclusion as well

Step 6: Data Collection

- Sources of Data
  - Primary data
    - ✓ Experiment
    - ✓ Questionnaire
    - ✓ Observation
    - ✓ Interview
  - Secondary data
    - ✓ Literature survey
    - ✓ Official/unofficial reports
    - ✓ An approach based on library resources

Step 7: Data Analysis

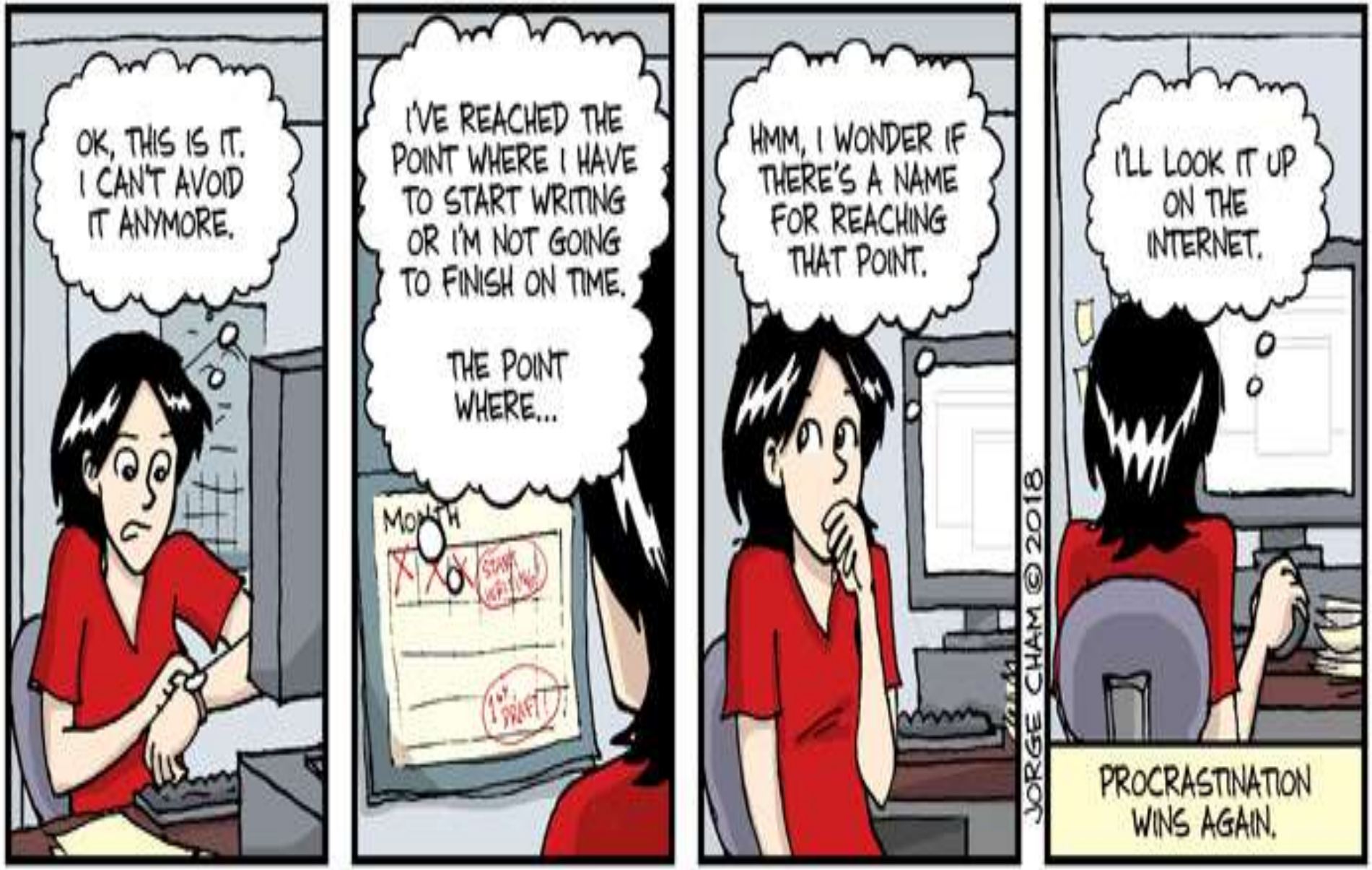
- **Data Cleaning and Preparation**: Handle missing data, outliers, and data transformation.
- **Exploratory Data Analysis (EDA)**: Summarize the data with statistics and visualizations.
- **Formulate the Analysis Plan**: Select appropriate statistical methods.
- **Conduct Statistical Analysis**: Apply descriptive and inferential methods to test hypotheses.
- **Interpret Results**: Summarize and contextualize findings.
- **Validate Results**: Confirm robustness and accuracy of results using evaluation metrics.
- **Checking the viability of hypothesis**
- **Result interpretation and drawing conclusions**
- **Example of a Data Analysis Structure for Machine Learning Based Approach id here:**



Step 8: Report/Thesis or Paper Writing

- Report/ Thesis Writing
- Paper Writing
  - –Review Paper Writing
  - –Research Paper Writing

Fear of Writing



How to Write a Review Paper?

Why write a review Paper?

- Not So Good Reasons
  - You want to learn about a new subfield
  - Its seems like an easy way to get another line on your CV
- Practical Reasons
  - It's an opportunity to think deeply and demonstrate expertise in your subfield
  - On average, reviews are cited and downloaded more than primary research articles
- A Great Reason
  - You can provide an insight that cannot be directly obtained from reading the primary empirical literature

Organization of a Review Paper

- Make an outline

- 4-6 main sections
- And perhaps 2-3 subsections in some of those main sections
  - But **do NOT** subdivide the introduction or concluding sections

- Use parallel structure in headings
  - Help organize information sensibly
  - Ensure you're giving adequate attention to all aspects of the review
  - Good subsection length: 2-4 paragraphs

Format of a Review Paper

1. Title

The title should be concise and descriptive, providing a clear idea of the review's focus.

Example: "A Comprehensive Review of Machine Learning Approaches for Heart Disease Prediction“

2. Abstract

- The abstract summarizes some key points.
- **Key Points**:
  - Purpose and scope of the review
  - Main findings or trends
  - Significance of the review
  - Research gaps or future directions
- Typically 150-250 words in length [Check the Journal’s Template]

Format of a Review Paper

3. Introduction

- **Context and Importance**: Introduce the topic and explain why it is important.
- **Research Questions**: Define the main questions or issues that the review addresses.
- **Scope of the Review**: Clarify the scope (e.g. specific methodologies).
- **Objective**: State the purpose of the review (e.g., summarizing the field, comparing methodologies, identifying trends).
- Use the active voice as much as possible
- Avoid lengthy or unfocused reviews of previous research.
- Cite peer-reviewed scientific literature or scholarly reviews. Avoid general reference works such as textbooks.
- Define any specialized terms or abbreviations

Format of a Review Paper

4. Main Body:

- **Divide the review into sub-sections, each focusing on a specific theme, trend, methodology, or aspect of the topic.**

- **Subsections** might include:
  - Overview of theories or models
  - Comparison of methodologies used in related studies
  - Synthesis of findings across different studies
  - Discussion of controversial or unresolved issues
  - Identification of gaps in relevant papers
  - **Critical Analysis**: Discuss the strengths and weaknesses of studies.
  - Point out methodological limitations, biases, and any gaps in the existing research.

5. Comparison of Studies: Compare and contrast different approaches or findings

6. Conclusion

Sample of a Comparative Table to be included in a Review Paper

Study	Contributions	Algorithm	Dataset	Data Type	Performance Evaluation
[41]	Predict coronary heart disease	Gaussian NB, Bernoulli NB, and RF	Cleveland dataset	Tabular	Accuracy— 85.00%, 85.00% and 75.00%
[42]	Predicting heart diseases	RF, CNN	Cleveland dataset	Tabular	RF (Accuracy—80.327%, Precision—82%, Recall—80%, F1-score—80%), CNN (Accuracy—78.688, Precision—80%, Recall—79%, F1-score—78%)
[43]	Heart disease classification	SVM	Cleveland database	Tabular	Accuracy—73–91%
[44]	Heart disease classification	Back-propagation NN, LR	Cleveland dataset	Tabular	Accuracy (BNN—85.074%, LR—92.58%)
[45]	ECG arrhythmia for heart disease detection	SVM and Cuckoo search optimized NN	Cleveland dataset	Tabular	Accuracy (SVM—94.44%)
[46]	Intelligent scoring system for the prediction of cardiac arrest within 72 h	SVM	Privately ownend	Tabular	Specificity—78.8%, Sensitivity—62.3%, Positive predictive value—10%, Negative predictive value—98.2%
[47]	Automatically identify 5 different categories of heartbeats in ECG signals	CNN	MIT-BIH	Tabular	Accuracy—94% (balance data) Accuracy—89.07% (imbalance data)
[48]	Novel heartbeat recognition method is presented	SVM	MIT-BIH	Tabular	Accuracy—97.77% (imbalance data), Accuracy—97.08% (noise-free ECGs)

SAMPLE of PUBLISHED REVIEW PAPERS

- **Published in MDPI**

https://www.mdpi.com/2227-9032/10/3/541

- **Published in Springer Nature**

https://link.springer.com/article/10.1007/s10462-024-10899-9

- **Published in Elsevier**

https://www.sciencedirect.com/science/article/abs/pii/S001048251930215X?via%3Dihub

Key Considerations: Make Sure you say something New

- A review is not a collection of results

- Readers should learn something they couldn't get just by reading the titles
  - Comparison, critique, assessment—including your own work
  - Figures and Tables are a must
  - Synthesis of each ideas of relevant sections
  - Actual ideas for future experiments (not just "future work is needed")
  - Path to translation, market, industrial scale-up

- Avoid jargon
  - The broader the journal's scope, the harder this is
  - If you have the option to include a Glossary, do it

Key Considerations: Word Count & Number of References

- There might or might not be some flexibility in word count and number of references
  - ✓ Probably safe to assume that if you're 50% over stated limits, you're going to need to cut down
  - ✓ If you're unsure about limit strictness, ask the editor

- Minor formatting requirements (reference formatting, figure call-outs, etc.) might be addressed later
  - ✓ Saves you, the reviewers, the editor, and the production team a lot of time

Key Considerations: Presubmission inquiries

- Check the suitability of an already-conducted study for that journal

- Understand the journal's model
  - Direct submission (not all journals allow this)
  - Check the target journal's Published Paper
  - Some journals are okay with this
  - If you aren't sure, email the editor

- Why?
  - Editors don't want you to waste your time on something out of scope or format
  - Editor's job is to help you make the tone and content a good fit

Key Considerations: Submitting a Review Paper to a Journal

- Follow the intended journal's formatting
- Should be available on the journal's website, but if not, ask the editor
- Must haves
  - Format (Review vs. Opinion vs. short article)
  - Authors and affiliations
  - Summary of the scientific content (extended abstract and/or outline)
  - Why is it timely and why should we be interested?
  - Are there other reviews on this topic, and if so, how is yours different?
  - What is your personal expertise on the topic and what novel perspective can you include?
  - What are some key references on the topic?

Key Considerations

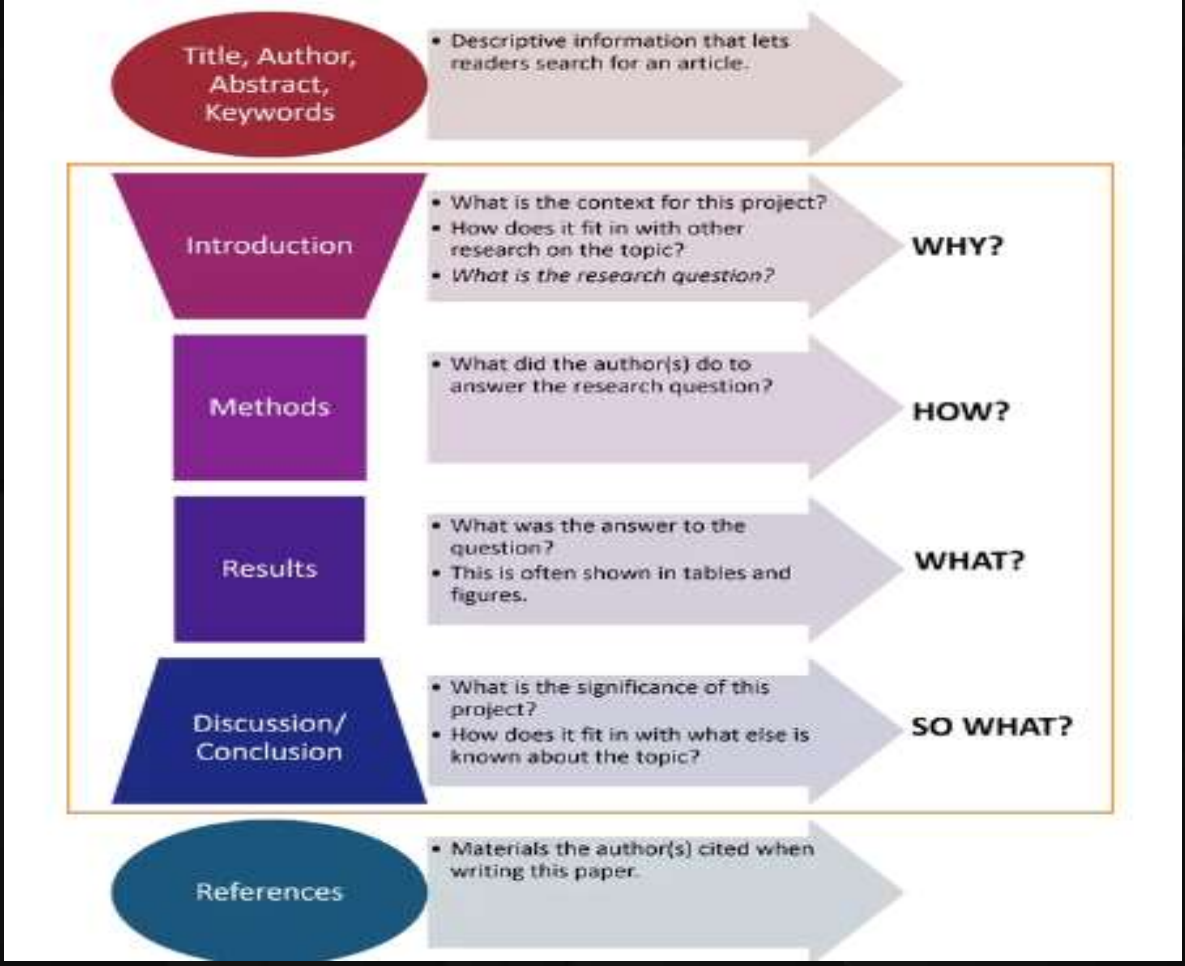
- Consistency and accessibility
- Avoid repetition of similar topics
- A review is not a list of results
- Only write a review if you feel you have something to say
- Know what journey you want to take your readers on
- Manage readers' expectations from the beginning
- Avoid jargon
- Expect to *heavily* revise the first draft
- Follow the journal's formatting guidelines
- Remember, if you've been invited to submit a review, the editor wants you to succeed!

Common Pitfalls in Writing a Review Paper

1. Lack of Clear Focus
2. Failure to Synthesize, Instead of Just Summarizing
4. Inadequate Critical Analysis
5. Neglecting Recent Studies
6. Overloading the Paper with Too Many Studies
7. Not Clearly Defining Key Terms and Concepts
8. Lack of Structure and Organization
10. Ignoring the Research Gaps
11. Lack of Clear Conclusion

How to Write a Research Paper?

Steps of Writing a Research Paper



Essential Parts of a Research paper

- Title: Describe concisely the core contents of the paper
- Abstract: Summarize the major elements of the paper
- Introduction: provide context and rationale for the study
- Materials: Describe the experimental design so it is reproducible
- Methods: Describe the experimental procedures
- Results: Summarize the findings without interpretation
- Discussion: Interpret the findings of the study
- Summary: Summarize the findings
- Acknowledgement: Give credit to those who helped you
- References: List all scientific papers and books you cited

How to write the Materials and Methods section

- Provide full details so that the experiments are reproducible
- Organize the methods under subheadings, with related methods described together (e.g. system architecture, experimental design, Measurement of…, …).
- Describe the experimental design in detail
- Do *not* mix some of the Results in this section
- Write in the past tense

Materials

- The source of subjects studied, number of individuals in each group used, their sex, age, and other specifications must be clearly stated
- If human subjects are used, the criteria for selection should be described, and consent (Ethical Consideration)

Methods

- The method details must be provided (Preferable using Picture)
- If the method has been previously published in a scientific journal, only the reference should be given with some identification:
- Questions such as “how” or “how much” must be answered and not left to be puzzled over
- Methods used for statistical analyses must be mentioned
- Ordinary ones do not need citations, but advanced or unusual ones require literature citation

How to write the Results

- Results section is written in the past tense
- It needs to be clearly and simply stated since it constitutes the new knowledge contributed to the world
- The purpose of this section is to summarize and illustrate the findings in an orderly and logical sequence, without interpretation
- The text should guide the reader through the findings, stressing the major points
- Do not describe any methods that have already been described in the previous section

Methods of presenting the data

1. Directly in the text
2. In a table
3. In a figure

- All figures and tables ***must*** be accompanied by a textual presentation of the key findings
- Do not give a table or figure that is not mentioned in the text

Tables and figures

- Tables are appropriate for large or complicated data sets that would be difficult to explain clearly in text.
- Figures are appropriate for data sets that exhibit trends, patterns, or relationships that are best conveyed visually.
- Any table or figure must be sufficiently described by its title and caption or legend, to be understandable without reading the main text of the results section.
- Do not include both a table and a figure showing the same information

How to write the Discussion

- It is the hardest section to write.
- Its primary purpose is to show the relationships among observed facts
- It should end with a short summary or conclusion regarding the significance of the work.

Components of the discussion

- Try to present the principles, relationships, and generalizations shown by the Results
- Point out any exceptions or any lack of correlation and define unsettled points
- Show how your results and interpretations agree or contrast with previously published work
- Discuss the theoretical implications of your work, and any possible practical applications.
- State your conclusions as clearly as possible
- Summarize your evidence for each conclusion

How to State the Acknowledgments

- You should acknowledge:

  1. Any significant technical help that you have received from any individual in your lab or elsewhere
  2. The source of special equipment, cultures, or any other material
  3. Any outside financial assistance, such as grants, contracts or fellowships

- Do not use the word “wish”, simply write “I would like to thank …..” and not “I wish to thank…”

Sample of a Research Paper

- MDPI

https://www.mdpi.com/2075-4418/12/12/3215

Common Pitfalls in Writing a Research Paper

1. Lack of Clear Thesis or Research Question
2. Weak or Unfocused Introduction
3. Poor Structure and Organization
4. Inadequate Literature Review
6. Lack of Proper Methodology or Justification
7. Inadequate Data Analysis or Interpretation
8. Failure to Cite Sources Properly
9. Overloading the Paper with Excessive Details
10. Poor Writing Quality, Grammar Issues, Plagiarism & Use of AI

References

- A list of ALL the references used in the text must be written.
- Reference format varies widely:
  - APA
  - Harvard format (the name and year system) is the most widely used

Plagiarism & AI

- Check plagiarism using Turnitin (Not more than 10%)
- Grammarly is known for its grammar and style suggestions, as well as improving overall readability.
- Do not rely entirely on AI
- Avoid using chatgpt for writing (For idea generation only)
- QuillBot: QuillBot is primarily used for paraphrasing
- Do check AI content using Turnitin AI checker before final submission
- If required, change the AI content (AI must be 0%)

‘Research is your will to find out’

Thank you