CODE WITH PURPOSE

A Practical Research Paper Path

From learning research → reading papers → finding gaps → conducting experiments → writing your own paper

The Big Picture

The goal is not simply to publish a paper. The goal is to learn how researchers think: identify a meaningful problem, understand what has already been done, find an opportunity for improvement, test an idea scientifically, and communicate the evidence clearly.

1	**Research**	**Understand the problem and why it matters.**
2	Read Papers	Learn how existing researchers approached the problem.
3	Problem	Define a focused, measurable research question.
4	Literature	Study existing methods, datasets, and findings.
5	Research Gap	Identify what is missing, weak, unexplored, or worth testing.
6	Hypothesis	State what you expect your experiment to show.
7	Method	Design the model, pipeline, dataset, and experiment.
8	Experiment	Run controlled experiments and comparisons.
9	Results	Measure performance and report the evidence.
10	Paper	Explain the work, findings, limitations, and references.

1. Learn How Research Papers Work

Before writing, become comfortable with the structure of a typical machine-learning or AI paper.

- **Abstract:** What problem was studied, what was done, and what was found?
- **Introduction:** Why does the problem matter?
- **Literature Review / Related Work:** What have other researchers already done?
- **Methodology:** What approach, data, models, and experimental setup were used?
- **Experiments:** How was the approach tested?
- **Results:** What did the measurements show?
- **Discussion:** What do the results mean?
- **Conclusion:** What are the main takeaways?
- **References:** Which previous research supports the work?

2. Read Papers Before Writing Papers

Start by reading papers in an area you genuinely want to understand. Do not try to understand every mathematical detail on the first pass. First learn the research story.

- First pass: title, abstract, introduction, figures/tables, conclusion.
- Second pass: understand the methodology and experimental setup.
- Third pass: inspect equations, implementation details, and related work.
- Write down the problem, dataset, baseline methods, proposed method, metrics, results, and limitations.

Researcher's question: “What exactly did this paper add compared with what was already known?”

3. Define a Real Research Problem

A project becomes research-oriented when you move from simply building something to asking a question that can be tested with evidence.

Weak framing

“I want to build a movie recommendation system.”

Stronger research framing

“How does adding content-based similarity to collaborative filtering affect recommendation quality compared with collaborative filtering alone on a defined dataset?”

4. Literature Review

- Find relevant papers and group them by approach.
- Record what dataset each paper uses.
- Record which models and baselines they compare.
- Record which evaluation metrics they use.
- Note reported strengths and weaknesses.
- Look for conflicting results, limitations, or areas that have not been tested.

5. Find the Research Gap

A research gap is not necessarily a completely untouched topic. A useful gap can be a missing comparison, an unexplored dataset, a limitation of an existing method, an efficiency problem, a robustness issue, or a method that has not been evaluated under a particular condition.

- Existing methods work well, but are computationally expensive.
- Two approaches are common, but their trade-offs have not been fairly compared.
- A model performs well on one type of data but has not been tested for robustness.
- A known method could potentially be improved with a carefully justified modification.

6. Form a Hypothesis

A hypothesis gives the experiment something specific to test. It should be measurable.

Example: “Adding feature X to baseline model Y will improve metric Z without increasing inference time beyond a defined threshold.”

7. Design the Methodology

- Choose or construct a suitable dataset.
- Define preprocessing and feature engineering.
- Choose baseline models.
- Define your proposed method or modification.

- Choose evaluation metrics before looking at final results.
- Keep the comparison fair and reproducible.
- Document libraries, versions, parameters, hardware, and random seeds where appropriate.

8. Run Experiments

Research depends on evidence. A single model score is rarely enough. Compare against sensible baselines and perform experiments that isolate what caused an improvement.

- Baseline experiment
- Proposed method
- Ablation or component-removal experiment
- Parameter or sensitivity experiment when appropriate
- Efficiency/resource comparison when relevant

9. Analyze the Results

Do not write the conclusion you hoped to get. Write what the evidence supports. If your method does not improve the baseline, that is still a useful result when the experiment is well designed and the limitation is explained.

- Use appropriate evaluation metrics.
- Compare models using the same experimental conditions.
- Report meaningful differences rather than only the best number.
- Use tables and plots where they improve understanding.
- Discuss unexpected results.
- Separate observed results from speculation.

10. Turn the Work Into a Paper

Once the experiments are complete, organize the work into a clear scientific story:

- What problem are we solving?
- What is already known?
- What is missing?
- What did we propose or investigate?
- How did we test it?
- What happened?
- Why do the results matter?
- What are the limitations and next steps?

A Practical First Research Project

For your first paper, do not attempt to invent a completely new field-changing algorithm. A realistic first goal is a small, reproducible research study.

Phase	What to do
Choose topic	Pick one focused Data Science / ML / AI problem.
Read	Study roughly 5–10 closely related papers and identify common methods.
Gap	Find one specific comparison, limitation, or improvement worth testing.
Baseline	Implement or reproduce at least one established approach.
Experiment	Implement your proposed change and compare fairly.
Evaluate	Use appropriate metrics and document results.
Analyze	Explain why the results happened, including failures.

Phase	What to do
Write	Produce a structured paper with figures, tables, and references.

Research Mindset

The most valuable outcome is not the PDF at the end. It is learning to think scientifically: question assumptions, examine prior evidence, design fair experiments, measure carefully, reproduce results, accept negative findings, and clearly communicate what the evidence does and does not show.

Suggested Learning Sequence

Step 1: Learn the anatomy of a research paper.

Step 2: Read several papers in one focused AI/ML topic.

Step 3: Learn how to identify problem statements and research gaps.

Step 4: Reproduce a small existing experiment.

Step 5: Design one controlled improvement or comparison.

Step 6: Run experiments and analyze the results.

Step 7: Write the research paper from the evidence.

Step 8: Get feedback, revise, and improve reproducibility.

Code With Purpose — Learn the skill, build the system, test the idea, and create something meaningful.