

# How to clock a research study and article in one go

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## What is the thinking

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Contrary to what you may have learnt, research is not searching on Google, reading books, reviewing blogs, watching YouTube or summarising existing research papers (commonly referred to as a literature survey). The main objective of the research is a systematic and creative endeavour to create new knowledge. This process involves the following activities:

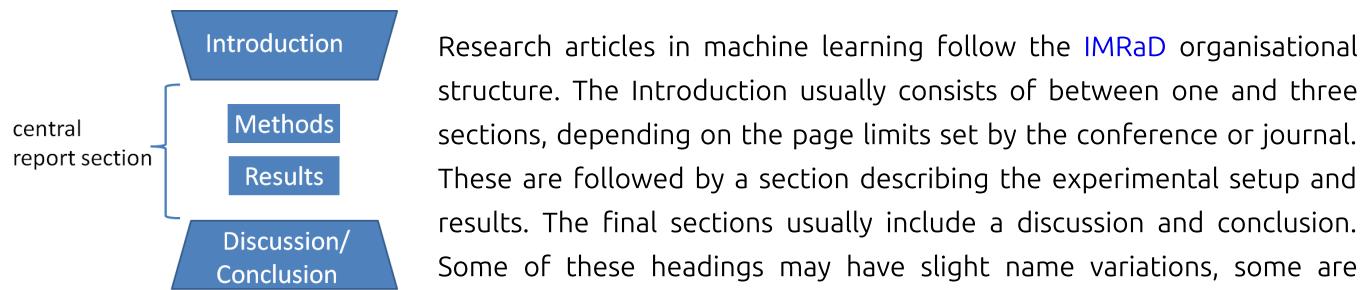
1. **Selecting a research topic:** *The researcher identifies an area of interest for exploration.*
2. **Finding an open research problem within the topic:** *The researcher identifies a gap or problem within the chosen topic that warrants investigation.*
3. **Proposing a hypothetical solution to the research problem:** *The hypothesis is a proposed idea to address the research problem.*
4. **Coming up with research questions/objectives:** *Research questions and objectives provide a framework for investigating and potentially falsifying the hypothesis.*
5. **Formulating the experimental design:** *The experimental design is a plan made up of methods to reach the objectives and answer the research questions.*
6. **Implementing the experimental design:** *The planned experiments are carried out, generating data for analysis.*
7. **Analysing the results:** *The collected data is analysed to draw insights and conclusions relevant to the research questions.*
8. **Writing up the study:** *Documenting the entire process and reporting on the outcomes.*

If you want to succeed, you have to manage this process carefully. Incorporating writing from the start can be a successful strategy. By embedding **writing** from the beginning of the process, we provide a dynamic and adaptable approach, enabling the exploration of ideas, surmounting obstacles, pinpointing research gaps, and sustaining motivation. These benefits in more detail:

1. **Exploring Research Gaps:** *Writing may reveal knowledge gaps, guiding subsequent research efforts and formulating new and refined research questions.*
2. **Generating New Ideas:** *Academic writing allows for exploring thoughts and initial ideas that may help formulate a hypothesis.*
3. **Maintaining Motivating:** *Engaging with the material through writing can motivate, maintain enthusiasm for the project and foster a sense of ownership over evolving ideas.*

In effect, by starting with the writing first, we flip the script, start at the bottom, and jumble things around. More to follow, but first, we need to understand the structure of a research article.

## Structure of a research paper



Research articles in machine learning follow the [IMRaD](#) organisational structure. The Introduction usually consists of between one and three sections, depending on the page limits set by the conference or journal. These are followed by a section describing the experimental setup and results. The final sections usually include a discussion and conclusion. Some of these headings may have slight name variations, some are collapsed into a single section with subsections, and some are left out depending on the type of research article. For instance, a more complete structure would follow something like this:

```
%---Introduction---
\section{Introduction}
\section{Related Work}

%----Methods----
\section{Detailed Idea/Proposed Method} % Heading is its name
\section{Experimental Setup}
    \subsection{Datasets}
    \subsection{Implementation Details}
    \subsection{Evaluation metrics}
    \subsection{Tools and Libraries}

%----Results----
\section{Experiments/Results}
    \subsection{Main Results}
    \subsection{Ablation Study}

%---Discussion---
\section{Discussion}
\section{Conclusion}
```

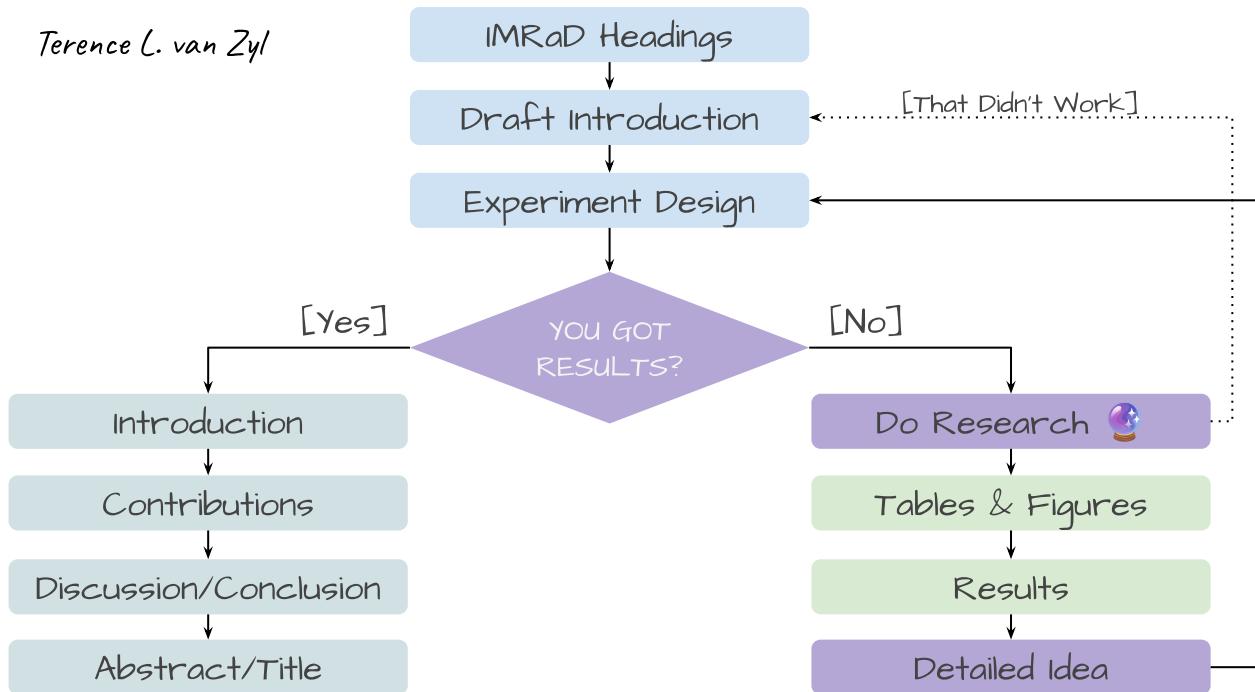
Seldom will an article have this exact structure. It may follow a different naming convention, change the hierarchy, or fuse/expand some headings. However, they will always follow this order.

[Further Watching](#)

[Further Reading](#)

## Big picture step-by-step guide

Now that we have the outline of a typical research article, we can return to our process. As I said, we flip the script. So, we can see here in this figure that we start with an empty research article and then slowly work our way backwards to finish with the title.



Here are the high level steps we will follow. In the next chapter we will take a look at a more detailed breakdown.

1. Use a latex template in [Overleaf](#) (IEEE or [LNCS](#) conference).
  - Use [BibLaTeX](#) for managing your references in a [.bib file](#).
2. Put down the IMRaD section headings.
3. Write a draft of the introduction to Create a Research Space ([CARS](#)).
  - **Here is an interesting problem.** (*The Territory*) - [Paragraphs 2](#)
  - **It is unsolved!** (*The Niche*) - [Paragraphs 1](#)
  - **Here is an idea on how to solve it.** (*Occupy The Niche*) - [Paragraphs 1-2](#)
4. Write up the intended experimental design
  - **How to falsify the idea** - [Paragraphs 5-6](#)

**Do the research:** Analyse the results as you are going.



**When you are done:** You should know the study's 1-3 main contributions.

5. Add a single figure that expresses the main idea of the study.
  - This figure is the **bootstrap** for an exceptional paper.
6. Fill in the rest of the tables and figures for the results.
  - Each contribution should be backed by a single table or figure.
  - These are the **kernels** of the paper, all linked hierarchically back to the **bootstrap**
7. Writup results with description of the results. - **One/two pages**
8. Write the details of your idea in the prpoosed method. - **One/two pages**
9. Revist experimental design with details (e.g. hyperparameters used). - **One/two pages**
10. Expand the Introduction and include contributions. - **One page**
11. Write up the related work. - **One page**
12. Write up the discussion. - **Half a page**
13. Add conclusion. - **Half a page**
14. Add abstract. - **200/250 words**
15. Finalise the title. - **Ten words or less**

**Any time you change your mind:** Go back to the start.

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## Small picture step-by-step guide (IMRaD)

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### 1. Introduction (the moves)

#### 1.1 Establishing the territory - **Here is an interesting problem.**

Describe the current state of research on the topic. [From phrase bank](#) start with two paragraphs with a sentence from each of:

1. Establishing the importance of the topic [...]
2. Referring to previous work to establish what is already known

Eventually these paragraphs should have references to all the key studies that lead to identifying your niche.

#### 1.2 Identifying a niche - **It is unsolved!**

Provides a problem statement for the study that can be addressed in a paragraph. [From phrase bank](#) select one or two of these as sentences to start:

1. Identifying a knowledge gap in the field of study
2. Claim something is wrong with the previous research
3. Explaining the inadequacies of previous studies
4. Identifying the scarcity or lack of previous research

#### 1.3 Occupying the niche - **Here is an idea on how to solve it.**

Describes how the research contributes to solving the problem statement. [From phrase bank](#) start by selecting one sentence from each of:

1. Stating the focus, aim, or argument of a short paper
2. Stating the purpose of the current research
3. Explaining the significance of the current study

#### 1.4 Stake your claim - **Here is how I solve it.**

After you have completed your study revisit the introduction, and add paragraph:

1. Describing the research design and the methods used
2. Share the contributions

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## 2. Related Work (Optional)

If you have the space you would expand on the related work that was briefly introduced in the introduction to create a research space. This section is typically more fully developed in journal articles than in conference articles and would capture the full literature survey.

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## 3. Idea Background (Optional)

### The idea.

Suppose you have devised a novel idea and compared it to several other baselines and state-of-the-art methods. Then you would describe the idea and how it links to the other methods here.

1. Describe the idea, algorithm, mathematics, etc.
2. Describe other background needed to understand the idea

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## 4. Method (the moves)

### How to falsifying the idea.

From phrase bank contextualizing why the study method is used:

1. Restate research purpose, hypothesis or gaps in research
2. Provide relevant theoretical or empirical information to show connections to the field
3. Substantiate your methodology in relation to previous studies with referencing

e.g.

(1) To test the primary hypothesis that A outperforms B, we conducted an empirical evaluation of the two models. (2) Traditionally, forecast accuracy has been assessed by measuring the MSE. (3) To this end, our experiment follows the procedure used by Joe Soap et al. (2001).

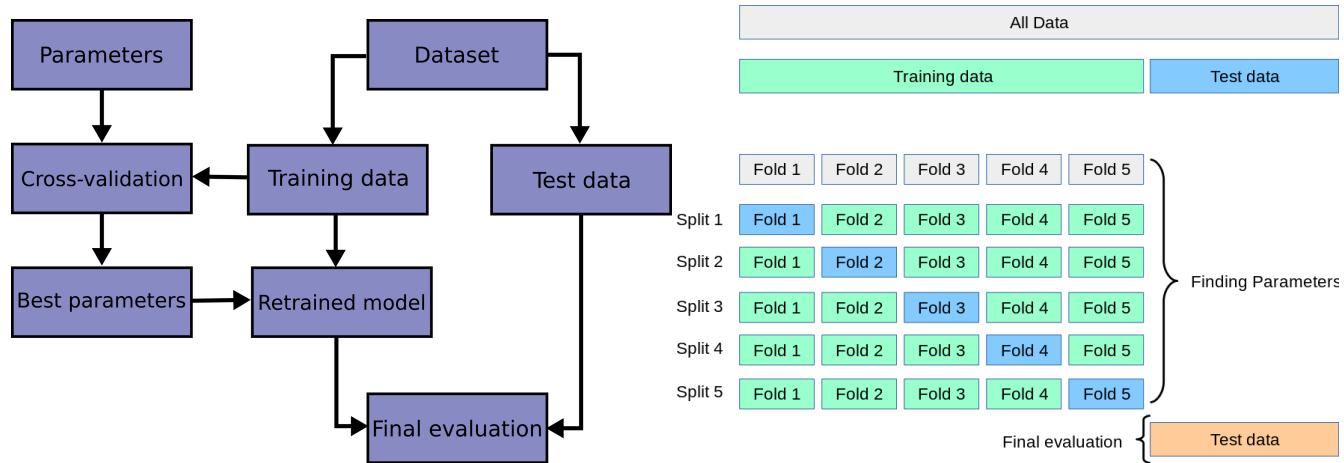
### 4.1 Datasets

1. Describe the dataset(s) used
2. Describe any preporocessing on the dataset(s) used

### 4.2 Experimental Setup

See [model Selection and Evaluation](#).

1. Describe the step-by-step study procedures in a paragraph or two.



Figures taken from SciKit Learn.

1. Briefly reiterate models to be compared to yours:
  1. baseline models
  2. state-of-the-art models
2. Should cover and substantiate choices for:
  1. how many experiment repeats (e.g. 10),
  2. train test split (e.g. 80-20),
  3. K-fold cross validation (e.g. 5-fold),
  4. model initialisation,
  5. hyperparameter selection (e.g. grid-search), and
  6. parameter optimisation (e.g. Adam).

#### 4.3 Analysis

1. Describe the analysis and metrics used for selection and evaluation
2. Describe the final evaluation procedure and significance test on results (p-values)

#### 4.4 Tools and Libraries

1. Describe tools and libraries used to do the study

e.g.

All experiments were run on an Intel 80286 running MS-Dos 6.22. The algorithms were implemented using Microsoft BASIC. All codes, datasets and the results from these experiments can be found on [\[GitHub\]](#).

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#### 5. Results (the moves)

##### What did you find?

The result's section identifies the tables or figures and indicates their content, and highlights, and point out and describe the relevant or significant outcomes.

For each result (figure or table), [From phrase bank](#), take a sentence from each of:

1. Referring back to the research aims or procedures
2. Referring to data in a table or chart
3. Highlighting significant data in a table or chart

Then possibly a sentence or two for:

1. Stating a positive or negative result
2. Highlighting exciting or surprising results

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## 6. Discussion ([the moves](#))

### **What does it mean?**

1. First sentence - What is 'the answer' to the problem
2. Second sentence and on - justify your answer.

Then **with reference to previous literature (Literature Survey)** [From phrase bank](#) for each significant result, do one or more of:

1. Providing background information
  1. reference to the question
  2. reference to the literature
2. Restating the result or one of several results
3. Indicating an unexpected outcome
4. Comparing the result
  1. supporting previous findings
  2. contradicting previous findings
5. Offering an explanation for the findings

Finally:

1. Advising cautious interpretation of findings
2. Suggesting general hypothesis
3. Noting implications of the findings

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## 7. Conclusion ([the moves](#))

### **Bring together the main ideas and speculate on the implications.**

Give a final judgement on the study and comment on suggestions for improvement and speculate on future.

[From phrase bank](#):

1. Restating the aims of the study

2. Summarising main research findings
3. Explaining the significance of the findings or contribution of the study
4. Recognising the limitations of the current study
5. Making recommendations for further research work

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## 8. Abstract (the moves)

### Summary of the entire study.

1. **Locate** the paper to the larger field to give perspective,
2. **Focus** on the questions/issues/problems to be explored/examined,
3. **Anchor** the argument by outlining research, samples and analysis,
4. **Report** on major findings relevant to the argument, and
5. **Argue** out the argument and close with this article's perspective.

e.g.

[LOCATE] Adaptive bandwidth kernel density estimators (AB-KDEs) have received attention from the academic community due to an analytical promise of increased performance over classical estimators. [FOCUS] However, the field is fragmented and there exists no comprehensive comparison of the existing state-of-the-art AB-KDEs. [ANCHOR] We provide a comparison of some state-of-the-art and classical AB-KDE methods as well a computational framework along with a novel implementation of a full principal axes rotation hyper-ellipsoid variant of the k-Nearest Neighbours algorithm. [REPORT] The extensive experimental results show that the fixed bandwidth rule-of-thumb methods achieve satisfactory results. Further, the balloon estimators are shown to be superior in the higher dimensional spaces, with higher modes or with data on non-linear manifolds. The sample point estimators show additional utility when data are scarce in low dimensions. [ARGUE] The experimental results lead us to conclude that balloon estimators such as the full rotation hyper-ellipsoid estimator will have a significant impact on data analysis algorithms which depend upon an underlying density estimates with larger volumes of higher dimensional data.

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## 9. References

Must include at a minimum:

1. The name of the author or authors
2. The full title of the source material
3. The name of the publisher
4. The date of publication

Bonus:

5. The page number of the source material