How to Write the Introduction of a Scientific Paper

Advanced English

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Outline

What is scientific writing for?

Scientific writing is not literary writing, journalistic writing, or advertising.

Its purpose is simple:

> to communicate ideas, methods, results, and limitations clearly.

A good scientific text allows a reader to understand:

- what problem is being studied,
- why it matters,
- what is new,
- how the claims are supported.

The goal is not to impress the reader. The goal is to let the reader understand quickly and correctly.

Where do these principles apply?

Everything discussed today applies not only to research articles, but more generally to:

- scientific texts of any kind,
- project reports,
- internship reports,
- MSc or PhD theses,
- technical notes and design documents,
- grant proposals.

In all these genres, the reader must be able to identify the problem, the context, the contribution, and the limits of the work.

Clear (English) writing is a core scientific skill.

General principles of scientific writing

- Be precise. Prefer exact claims to vague claims.
- Be concise. Remove words that do not add meaning.
- Be honest. Do not oversell results.
- Be readable. Grammar, spelling, typography, and terminology matter.
- Be structured. Make the logic of the text visible.

These principles sound simple, but most weak scientific texts fail on one or more of them.

Be precise

Bad:

This method performs well in many situations.

Better:

This method reduces runtime by 30% on the XXX benchmark.

Precision means:

- defining technical terms,
- avoiding ambiguous pronouns and vague quantifiers,
- quantifying when possible,
- stating exactly what has been shown.

Be concise

Bad:

It is important to note that the algorithm is efficient and that this efficiency is something that matters in practice.

Better:

The algorithm is efficient in practice.

Conciseness does not mean brutality. It means that every sentence earns its place.

Be honest

Bad:

This revolutionary method completely transforms the field.

Better:

This method improves performance in the setting considered here.

Scientific credibility depends on restraint.

If the claims sound bigger than the evidence, the reader will stop trusting the text.

Be readable

Even strong ideas can be weakened by poor presentation.

You will be judged on:

- grammar,
- spelling,
- punctuation,
- typography,
- consistency of terminology,
- sentence and paragraph structure.

A text full of avoidable errors signals carelessness, even when the science is good.

Be structured

A scientific article typically contains:

- Abstract (short summary of the content)
- Introduction
- Related work, detailed context
- Model or problem statement
- Methodology, theorems, algorithms, or system description
- Experiments, proofs, or other forms of validation
- Conclusion

This structure (and sometimes ordering) varies by field and specific type of paper, but the logic is stable.
Each part also has its inherent structure, which needs to be made explicit (subsections, etc.).

The introduction is the gateway to the paper

Many readers decide whether to keep reading based on:

- the title,
- the abstract,
- the introduction.

A weak introduction can make a strong paper look unimportant, confused, or derivative.

A strong introduction gives the reader a good idea of the content of the paper, and makes him or her want to read the rest.

What must an introduction achieve?

After reading the introduction, the reader should know:

- what scientific area the paper belongs to,
- what specific problem is being addressed,
- why this problem matters,
- what makes the problem difficult,
- what the paper contributes,
- how the work relates to previous work,
- how the rest of the paper is organized.

If several of these points are missing, the introduction is incomplete.

Audience matters

The same scientific content should not be introduced in the same way for all audiences.

A good introduction is adapted to:

- what the audience already knows,
- what kind of motivation the audience expects,
- how much formalism is appropriate,
- what counts as a convincing contribution in that venue.

The same idea written for different audiences

Suppose the scientific idea is: explaining why a database query produced a result.

Popularization:

> *When a database gives an answer, it is often difficult to understand where that answer comes from.*

Systems:

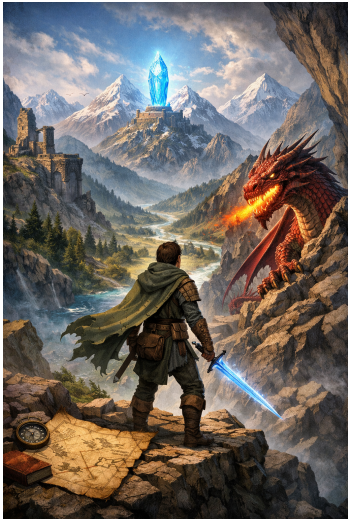
> *Modern data systems need efficient support for explaining query results for debugging and auditing.*

Theory:

> *We study provenance computation for expressive query languages under the following formal assumptions.*

Outline

The Sapphire of the Northern Mountains



Beyond the green plains stretches a little-known land, crossed by winding rivers and ringed by cold blue mountains. Travelers tell of a treasure hidden there: a sapphire of rare brilliance, said to reveal the hidden workings of the world to whoever holds it.

Many have set out in search of it, and many have failed. The narrow pass leading into the mountains is guarded by an ancient dragon who has turned back every expedition.

One traveler, however, sets out differently. Instead of following the paths of earlier seekers, they carry a newly forged adamantium blade and a plan no one has tried before, defeating the dragon with a single blow of this magical weapon.

Let me recount this story. First we cross the land and recall what earlier travelers learned about it; then we examine the new weapon and the idea behind it; finally we follow the traveler into the mountain pass, to see whether the dragon can be overcome and the sapphire claimed.

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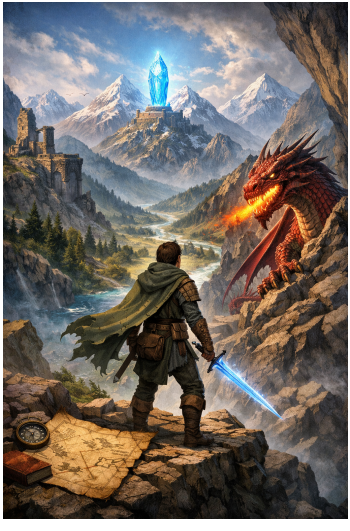

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Land

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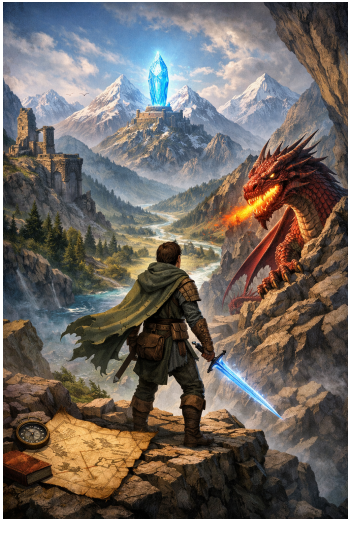

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Treasure

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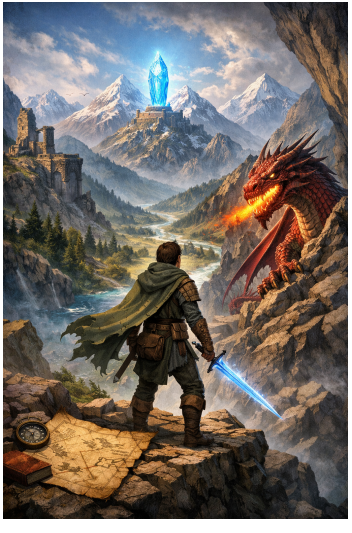

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Past expeditions

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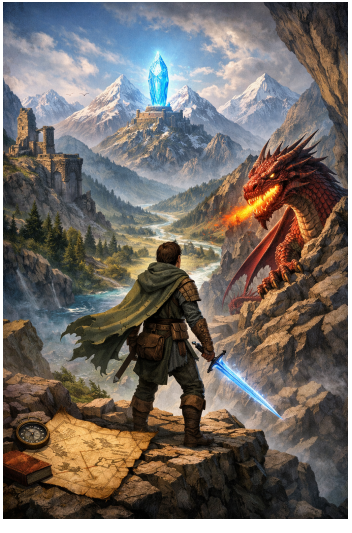

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Dragon

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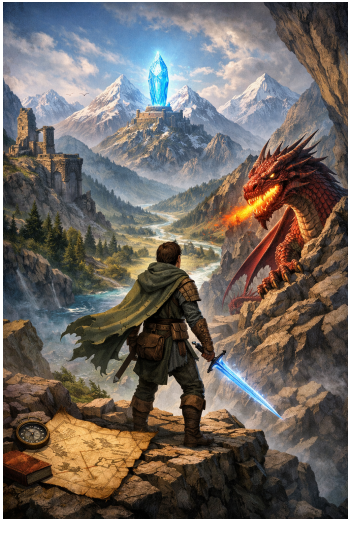

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Weapon

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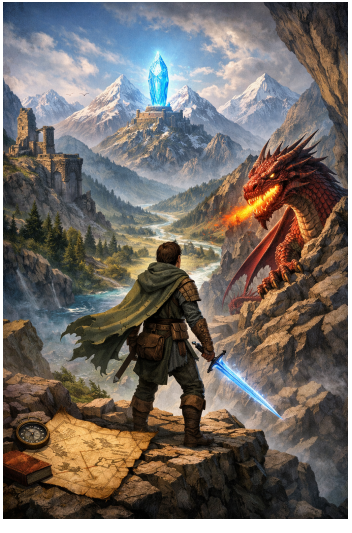

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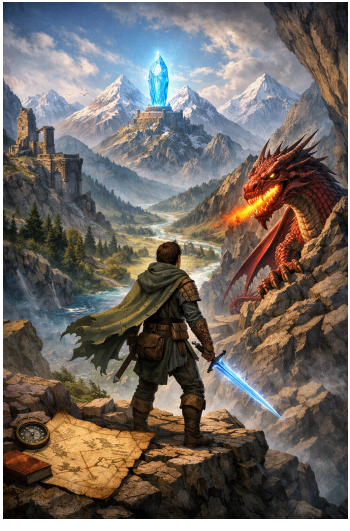
Dragon defeat

The Sapphire of the Northern Mountains



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Story plan

Mapping the story to an introduction

Story element	Scientific equivalent
Land	Research area, broader domain, the setting
Treasure	Goal, scientific question, object we want to reach
Past expeditions	Related work
Dragon	Difficulty, limitation of existing work, unresolved gap
Weapon	Method, theorem, system
Dragon defeat	Contributions of the paper
Story plan	Organization/outline of the paper

The land

The introduction begins by describing the world in which the paper takes place.

This means:

- introducing the research area,
- naming the central concepts,
- giving enough context for the problem to be intelligible.

It should be broad enough to orient the reader, but not so broad that it becomes empty.

Bad opening: “Since the dawn of computing…”

The treasure

The treasure is the thing the paper is trying to obtain.

This is the problem, the goal, or the research question. The value in reaching this goal should be clear.

The reader should be able to answer:

What is this paper trying to achieve? Why is this important?

If the reader cannot identify the treasure, the paper will feel unfocused.

Past expeditions

Past expeditions are the related work.

- How was this problem tackled in the past?
- By whom?
- With which limitations?

The dragon

The dragon is the obstacle.

In a scientific introduction, this may be:

- an open problem,
- a limitation of current methods,
- a computational difficulty,
- a missing theoretical framework,
- a practical obstacle in existing systems.

No dragon, no paper.

If the introduction does not make the obstacle visible, the reader may wonder why the work needed to be done at all.

The weapon

The weapon is the approach.

This may be:

- a new algorithm,
- a new theorem,
- a system,
- a framework,
- an experimental methodology,
- a conceptual clarification.

The dragon defeat

The dragon defeat is a high-level view of how the weapon was used and what it achieved, i.e., the contribution of the work.
The contribution should be very clear from the introduction. The reader should not have to search for it.

The story plan

The story plan is the description of the organization or outline of the paper: the different parts, how to read, any necessary extra context before embarking on the detailed journey.

Sometimes, when appropriate, it can be combined with the list of contributions.

Outline

Bad vs. good: the general pattern

Bad introduction:

X is an important field. Many works have studied X. Recently, several approaches have been proposed for X. In this paper, we study X.

What is wrong?

- too broad,
- no clear problem,
- no clear obstacle,
- no explicit contribution.

Bad vs. good: the improved version

Improved introduction:

> *X is important because it enables Y. However, existing approaches [C] fail to handle Z efficiently. In this paper, we propose a method based on W that addresses this limitation and makes it possible to do T.*

This version now contains:

- the treasure (X) and why it matters (Y)
- the dragon (Z) and past expeditions (C),
- the weapon (W) and the dragon defeat (T).

Machine learning example

Bad:

> *Machine learning has become very popular in recent years and has been used in many applications. Many methods have been proposed for neural networks. In this paper we study regularization.*

Why it is weak:

- generic opening,
- no specific problem,
- no explicit difficulty,
- vague contribution.

Machine learning example: improved

Improved:

> *Neural networks often overfit when training data is limited. Effective regularization is therefore essential for reliable machine learning. However, existing regularization methods are often computationally costly or impose restrictive design choices. In this paper, we introduce a lightweight regularization method that improves generalization while preserving the efficiency of standard training.*

Land: neural network training. Treasure: good generalization. Dragon: overfitting and costly existing methods. Weapon: the new regularization method.

Algebra example

Bad:

> *Algebra is a central area of mathematics, and many algebraic structures have been studied in depth. In particular, semirings arise in many contexts. In this paper we investigate a class of semirings.*

Why it is weak:

- too general,
- no reason to care about this exact class,
- no specific obstacle,
- no visible originality.

Algebra example: improved

Improved:

> *Idempotent semirings play an important role in several areas, including automata theory and tropical mathematics. Yet non-monotone behavior remains poorly understood in existing algebraic frameworks. In this paper, we introduce a new class of semirings equipped with an additional subtraction-like operation and study the algebraic consequences of this extension.*

Land: idempotent semirings. Treasure: structural understanding. Dragon: missing general framework for non-monotone behavior. Weapon: the new class and its analysis.

Algorithms example

Bad:

> *Graphs are widely used in computer science and many graph algorithms have been studied. Shortest path problems are fundamental. In this paper we consider a shortest path variant.*

Why it is weak:

- generic background,
- no clear practical or theoretical issue,
- contribution invisible.

Algorithms example: improved

Improved:

> *Shortest path computation is a fundamental graph problem with applications in routing and network analysis. Classical algorithms, however, assume static edge costs, while many real applications involve weights that change over time. In this paper, we present an algorithm that efficiently maintains shortest paths under dynamic edge-cost updates.*

Land: shortest path algorithms. Treasure: efficient path computation. Dragon: dynamic costs. Weapon: the new algorithm.

Statistics example

Bad:

Statistics is used in many domains such as economics and biology. Many methods have been proposed for analyzing observational data. In this paper we study causal effects.

Why it is weak:

- broad and generic,
- no identified obstacle,
- unclear specific contribution.

Statistics example: improved

Improved:

> *Estimating causal effects from observational data is central in the social sciences and in medicine. The main difficulty is that hidden confounders can make genuine causal relationships indistinguishable from spurious correlations. In this paper, we propose an estimation method that combines causal graph models with robust statistical techniques to improve inference under confounding.*

Land: causal inference. Treasure: estimating causal effects. Dragon: hidden confounding. Weapon: the proposed estimation method.

Common mistakes in introductions

Typical problems include:

- starting far too broadly,
- confusing the introduction with a deep dive into the related work,
- failing to state the research gap,
- hiding the contribution,
- giving too much technical detail too early,
- writing an introduction that could fit almost any paper in the area.

The contribution paragraph

In many scientific papers, especially in computer science, it is useful to make the contribution very explicit.

A common pattern is:

> *The contributions of this paper are as follows.*

Then list, for example:

- a new model,
- a theorem,
- an algorithm,
- an implementation,
- an experimental evaluation.

Not always elegant, but simple and often effective.

Outline

How your introduction will be evaluated

- In the two written evaluations for this class, you will be asked to write an introduction of a (simple) paper whose introduction has been removed.
- Two hours:
  - one hour to read the content of the paper
  - one hour to write a (short, one-page) introduction
- You will be evaluated on:
  1. Form and language
  2. Structure
  3. Content and faithfulness
  4. Overall clarity

Grading rubric (out of 20)

Criterion	Points
Grammar, spelling, punctuation, sentence quality	5
Structuring: area, problem, gap, contribution	8
Faithfulness to the paper being introduced	4
Concision and overall readability	3

Final message

An introduction is a story
about a problem and its solution.

A good introduction tells the reader:

- where we are (land),
- what we want (treasure),
- why it is difficult (dragon),
- how we achieve it (weapon).