Components of a Scientific Paper

Abstract

A concise summary of the paper and its results. A good template is here: https://cbs.umn.edu/sites/cbs.umn.edu/files/public/downloads/Annotated_Nature_abstract.pdf

Introduction

This is an argument for why the reader should continue to read.

What is the question/topic you will address? Why is it interesting and/or important?

What is currently stopping us from answering that question/what is an existing gap in our understanding? Explain what is currently known and not known, citing relevant previous research.

Briefly summarize what you do in this paper to address the challenges you have raised.

Methods

For observational research: How was the data obtained? How was it reduced? What analyses were performed? What software did you use to perform these tasks?

For theoretical research: What equations or models did you use to address your question? What simplifications were made, and why are they acceptable?

Be sure to cite all relevant sources.

Results

Before you write anything: What is your most important result? How can you best present that result? (What is your "key plot")? What information needs to be provided to understand that result?

Make an outline of what figures and/or tables are needed to explain each point.

I recommend making your figures before writing, then writing text to explain the results using your figures to guide the reader. There should be a linear, logical flow to the text.

Consider your sources of error or uncertainty in your analysis and how they affect your results and interpretations. Be clear about how you calculate or estimate your errors/uncertainties.

Discussion

What is the meaning of your results? Connect the numbers you have obtained/calculated to the question or problem you brought up in the introduction.

Compare to previous work and discuss discrepancies (if any).

(This section is often merged or interspersed with the results or conclusion.)

Conclusion

A summary of the paper. (Often similar to the abstract.)

Many papers will discuss next steps or future work.

References

Don't forget this!

For more information

Tom Statler OSU (http://www.phy.ohiou.edu/~tss/ASTR410/writing.html)

Academic Writing Blog (https://academiccoachingandwriting.org/?/categories/academicwriting/category/good-academic-writing/)

Caltech undergraduate writing course (http://www.astro.caltech.edu/~lah/ay31/)

Recommendations for writing

1. What do I want to communicate? Who am I communicating to?
2. Write a detailed outline. Check your outline for logical consistency.
3. Ask for advice about your outline from someone else (another student, an advisor, etc).
4. Use your outline to write a rough first draft that is just filling in your outline. Don't worry about anything other than getting your thoughts down.
5. Go through and edit each part of your outline one at a time. (Repeat as needed.)
6. Read through the whole paper and see if it holds together.
7. Ask for edits from someone else.

Everyone has their own way to write; these are just recommendations based on what has worked for me.

Recommendations for editing

For every sentence you write, check that:

- Each sentence has one idea.
- The subject/topic is at the beginning of the sentence.
- The verb closely follows the subject.
- The verb actually describes the relevant action.
- The most important ideas occur at the end of the sentence.
- Old information precedes new information.
- There are no logical gaps between sentences.

These aren't hard rules, but most English readers have the expectation that sentences are usually structured this way. Deviations from this structure are internally emphasized in readers' minds.

Useful Links

- Advice: `https://lavinia.as.arizona.edu/~gbesla/ASTR_520_Spring2017_files/Lecture21.pdf`
- Advice: `http://www.phy.ohiou.edu/~tss/ASTR410/writing.html`
- Editing: `https://www.rsmas.miami.edu/users/pzuidema/gopenswan_1pgsummary.pdf`
- Editing: `http://www.writing.engr.psu.edu/handbook/exercises.html`

Common Forms of Ambiguous and Unclear Writing

Some examples from `http://writing.engr.psu.edu/exercises/key4.html`, `https://cgi.duke.edu/web/sciwriting/index.php?action=lesson1`.

- Pronoun confusion and ambiguity
  Example: The Hindenburg was filled with hydrogen because it is lighter than air. The report claimed that a hull wire could have ruptured a gas cell if it fractured.

  Example: The star has a planet with orbital period P, so it is very hot.

- Dangling or misplaced prepositions
  Example: Most people are diagnosed with phenylketonuria at birth.

- Long lists before their purpose
  Example: Peanuts, shrimp, almonds, milk or anything else with lactose, and wheat or anything with gluten all represent things that people are commonly allergic to.

  Example: Old ages, metal-poor stars, and large mass-to-light ratios are typical properties of faint dwarf galaxies.

- Excessive nominalization ("noun-ing" verbs)
  Example: The ABC database has been subject to different improvements, modifications, and extensions in structure and content over the years.

- Long, overly complex sentences
  Example: The possibility that some termini have a base composition different from that of DNA simply because they are the nearest neighbors of termini specifically recognized by the enzymes can be checked by comparing the experimental results with those expected from the nearest neighbor data.

  Example: It would be difficult to produce neutron-capture elements in mixing-and-fallback models of supernovae, as those elements are unable to escape in such models due to being produced in the very center of massive stars, in the interior of the iron core.

Helpful LaTeX Pages

- Installing Latex
  - Windows: `https://miktex.org/howto/install-miktex`
  - Mac: `http://www.tug.org/mactex/`
  - Online at Overleaf (recommended): `https://www.overleaf.com/`
- Math and Equations
  - Symbol finder: `http://detexify.kirelabs.org/classify.html`
  - `https://www.sharelatex.com/learn/Aligning_equations_with_amsmath`
  - `http://people.cs.uchicago.edu/~ivan/math/amsldoc.pdf`
  - `https://www.math.hkbu.edu.hk/TeX/short-math-guide.pdf`
- Page Layout: `http://www.andy-roberts.net/writing/latex/page_layout`
- Graphics and figures:
  - `https://en.wikibooks.org/wiki/LaTeX/Importing_Graphics#Including_graphics`
  - `http://www.andy-roberts.net/writing/latex/floats_figures_captions`
- References (Bibtex)
  - `https://www.overleaf.com/help/45-how-can-i-add-a-bibliography`
  - Get Bibtex entries easily from ADS abstract search