The structure of a scientific paper

How to read and write papers more effectively

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ACIT 4100: RESEARCH METHODS AND ETHICS - STRUCTURE OF A PAPER

How this lecture will help you

- Broad goal: To understand how a scientific paper is structured

- This will help you:
  - Read papers more effectively and efficiently
  - Write your paper for this course
  - Write your master's thesis

Two main types of papers

- **Research papers** report novel *research findings* or *methodologies*

- **Review papers** give an *overview* of recent work on a given topic
  - Typically mention gaps in current knowledge or methodologies
  - Similar to a very extended version of the background section of an introduction
  - They do not follow the structure described here!

What is the point of a research paper?

What a paper does

- Asks a relevant research question
- Answers that question
- Makes a novel contribution

Why write a paper

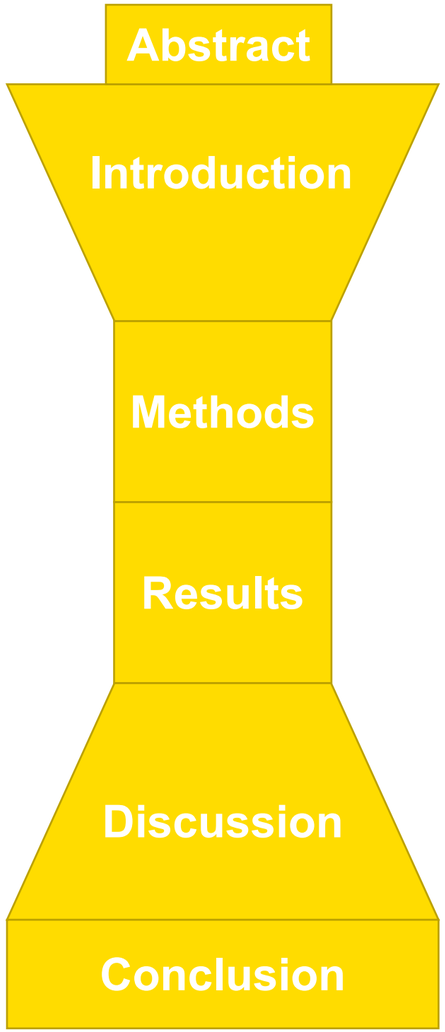
- For others to make use of your findings
- To claim ideas as your own
- To show productivity (to get funding, earn a degree, etc.)

Main parts of a paper

Front matter
- Title
- Authors
- Abstract

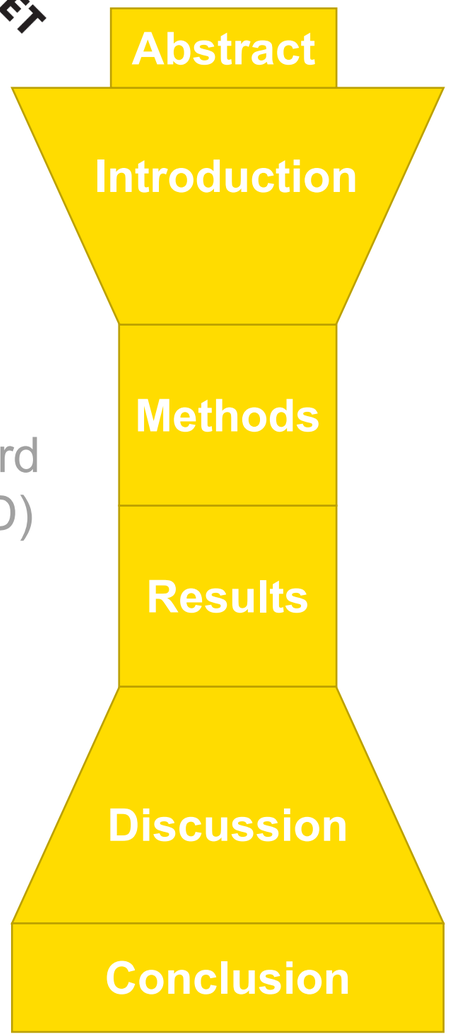
Main text
- **I**ntroduction
- **M**ethods
- **R**esults
- **D**iscussion
- Conclusion

IMRaD

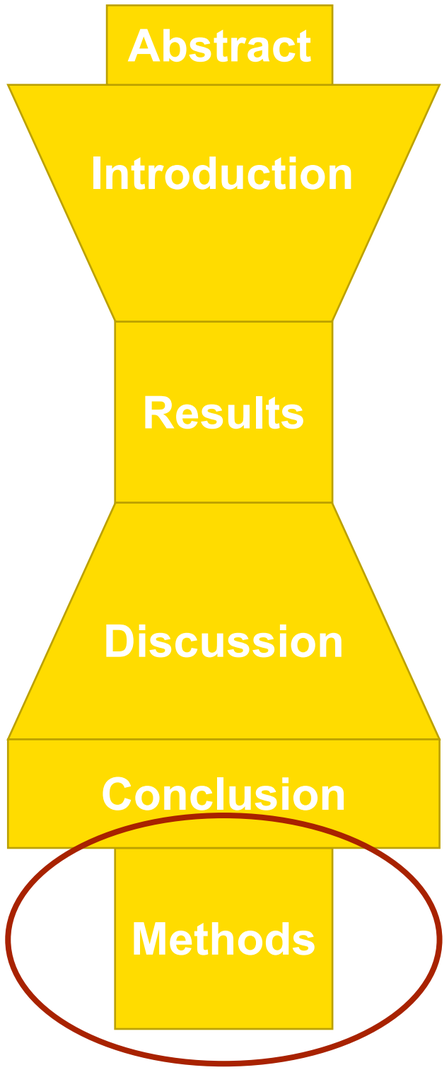


Other common paper formats

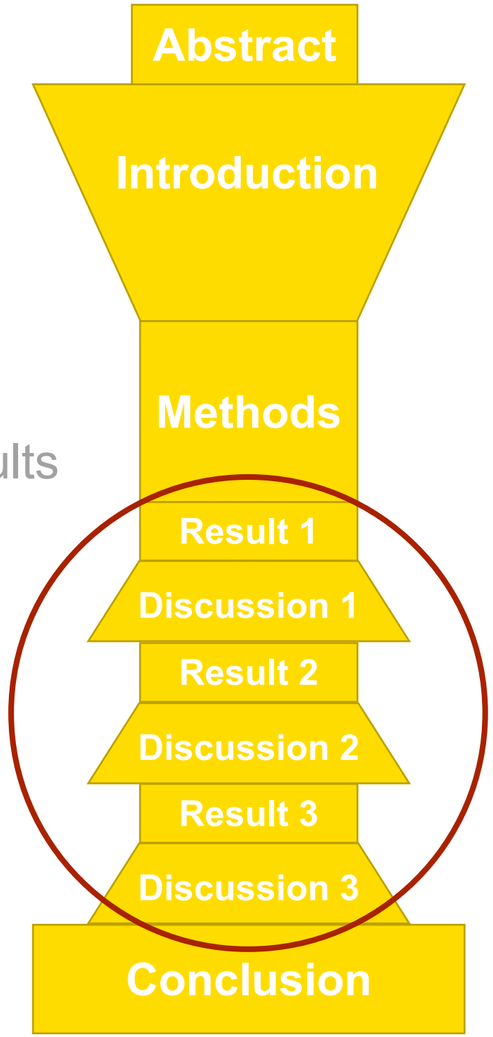
Standard (IMRaD)



Methods at the end

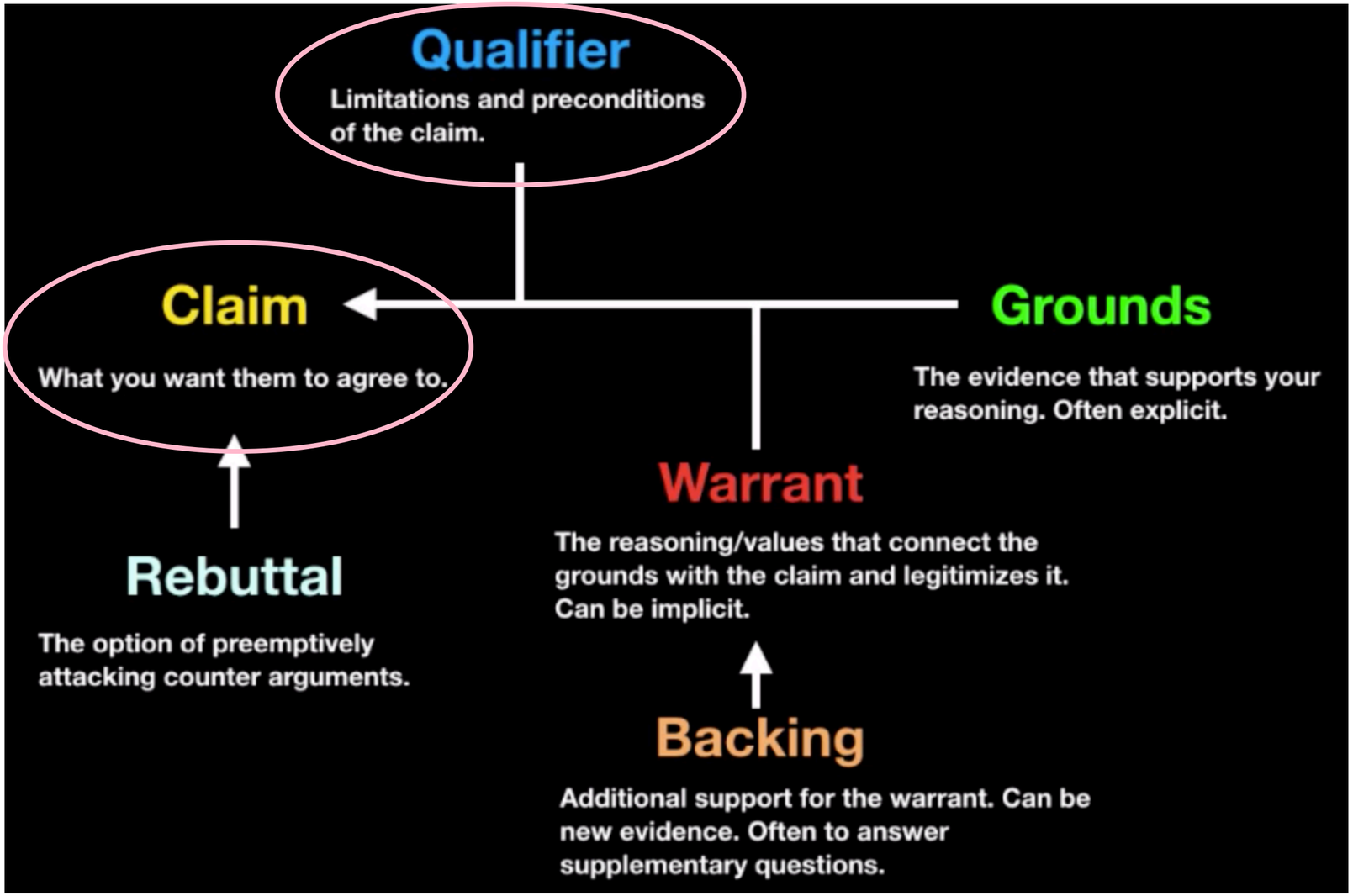


Discuss results as you go



Introduction: “What?” and “So what?”

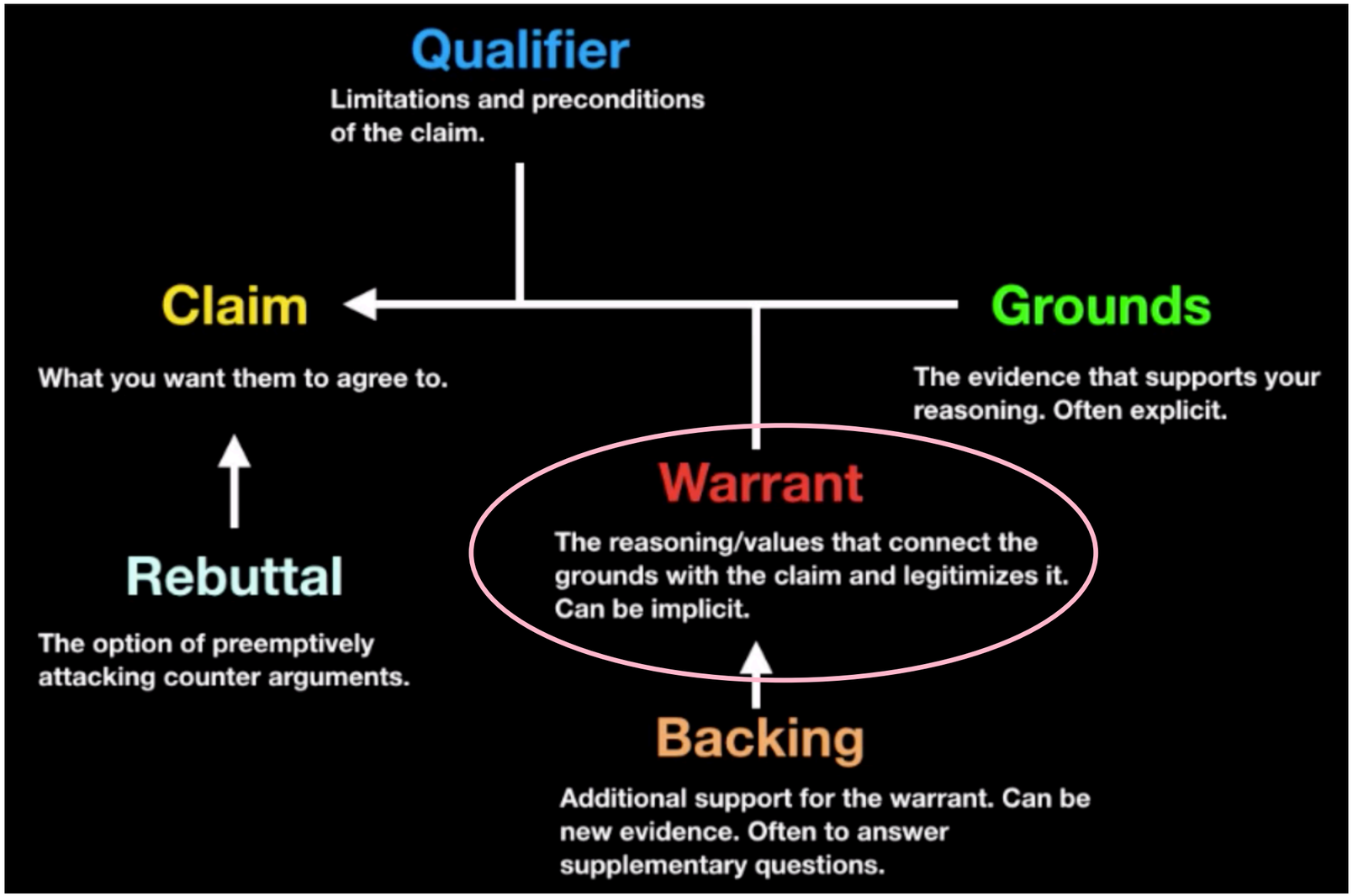
Introduction



Methods

- Should provide enough information for the study to be replicated
- Many methods sections give just enough information for the reader to understand how the study was conducted
  - Extra details needed for others to replicate are often given in “Supplementary Information”
  - If the method used is one developed by other researchers, it is enough to refer back to the original paper where the method was developed
    (Note: This is true for a research paper but not necessarily for a thesis!)

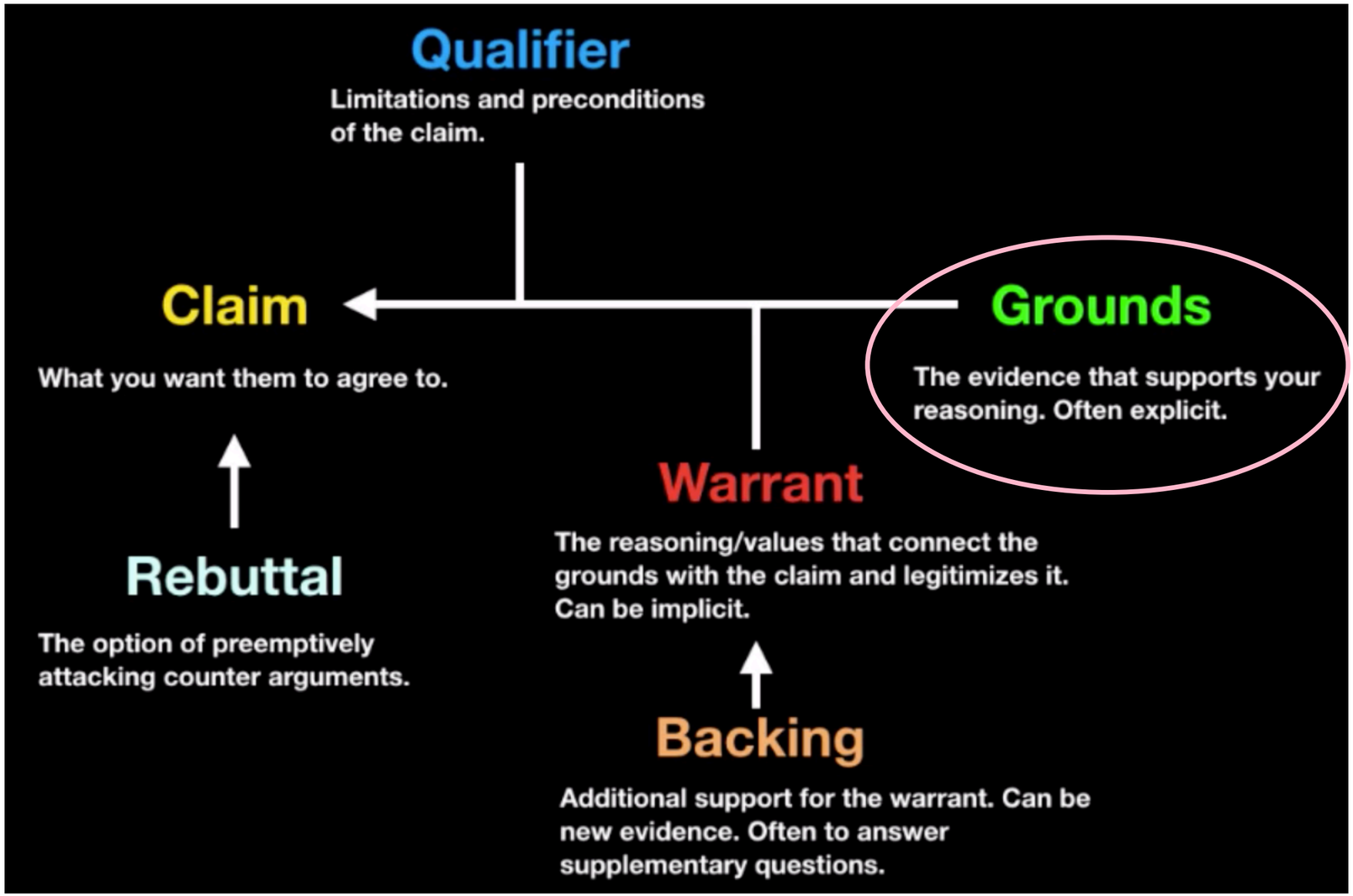
Methods


Qualifier
Limitations and preconditions of the claim.
Claim
What you want them to agree to.
Grounds
The evidence that supports your reasoning. Often explicit.
Warrant
The reasoning/values that connect the grounds with the claim and legitimizes it. Can be implicit.
Rebuttal
The option of preemptively attacking counter arguments.
Backing
Additional support for the warrant. Can be new evidence. Often to answer supplementary questions.

Results

- What was observed in the study?
- If the results section is separate from the discussion, there should be little to no interpretation of the observations
- Results sections are often figure-heavy: good figures require little explanation
- Results should be presented in a logical (not necessarily chronological) order

Results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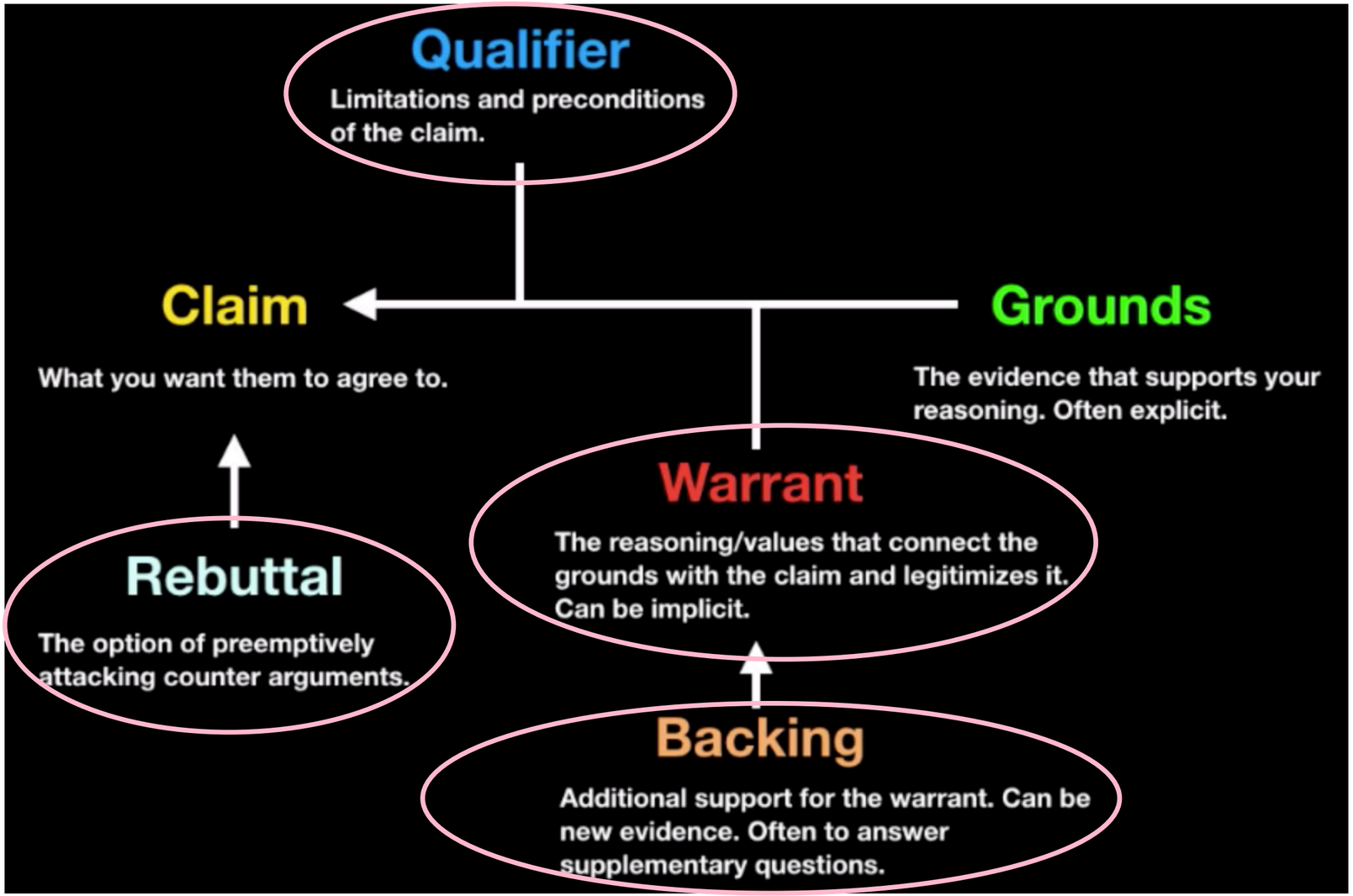
Discussion

- Interpret the results and explain how they support the claim
  - There shouldn’t be any leaps of logic from the results to the interpretations
- State if unexpected results were obtained
- Relate back to previous studies
- Consider the generality of the results
- Address any shortcomings of the study
- Plans for future work (may be in the conclusion instead)

Discussion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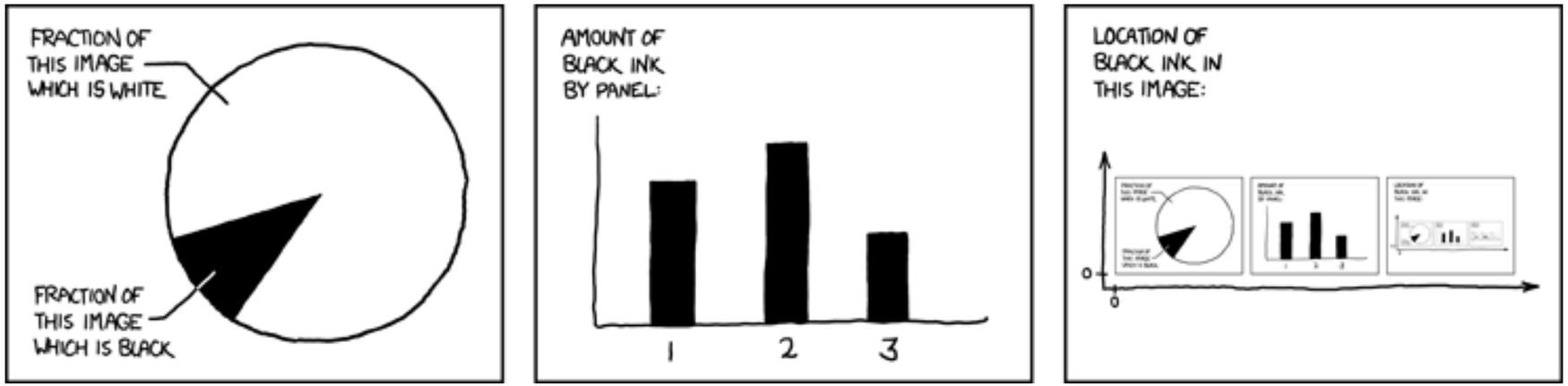
Conclusion

- May be combined with the discussion
- Summarize the main points of the paper
- Reiterate the claim and the most important implications of the results
- Concisely convey the main conclusions drawn from the results without reiterating the logical path to reach these conclusions

Additional parts of a paper

- Figures
- Abstract
- Title
- Authors
- References

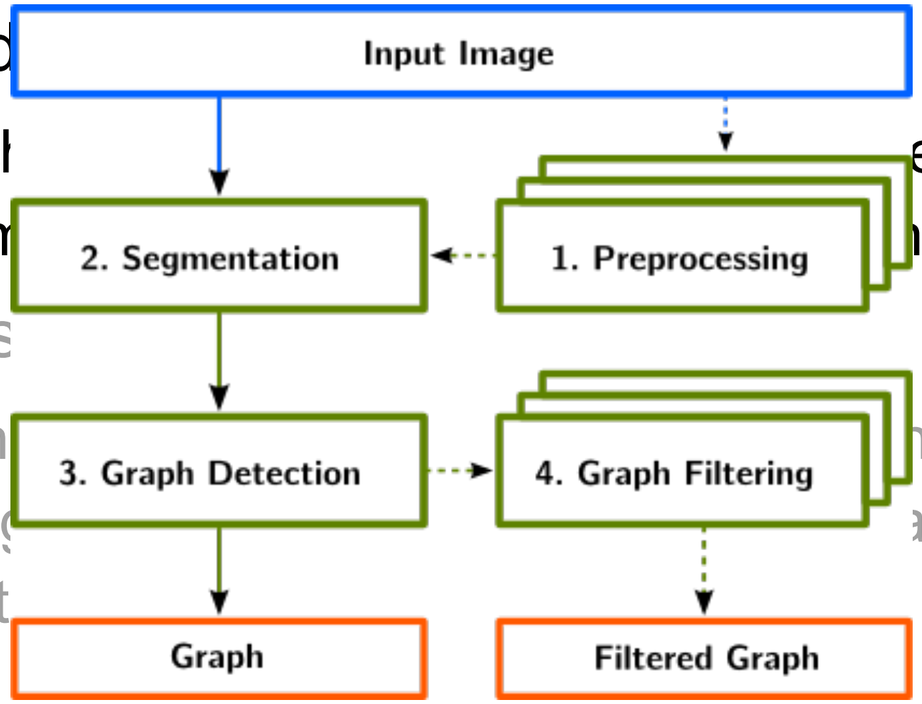
Figures

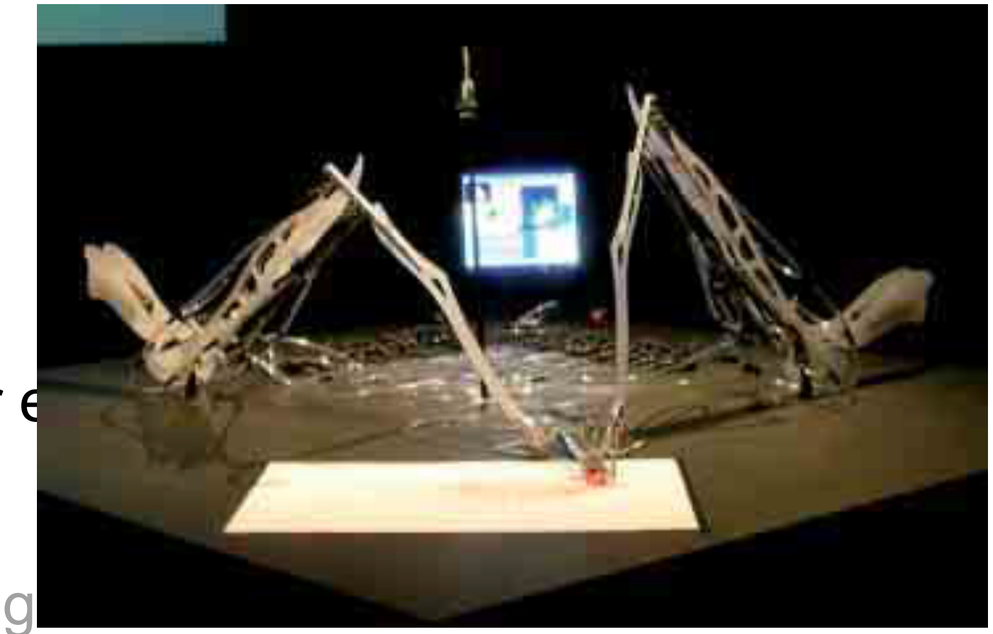


https://xkcd.com/688/

Figures

- Method
  - Flowcl ed
  - Schem t or e
- Results
  - Graph nding
  - Photo alitative findings
  - Statist

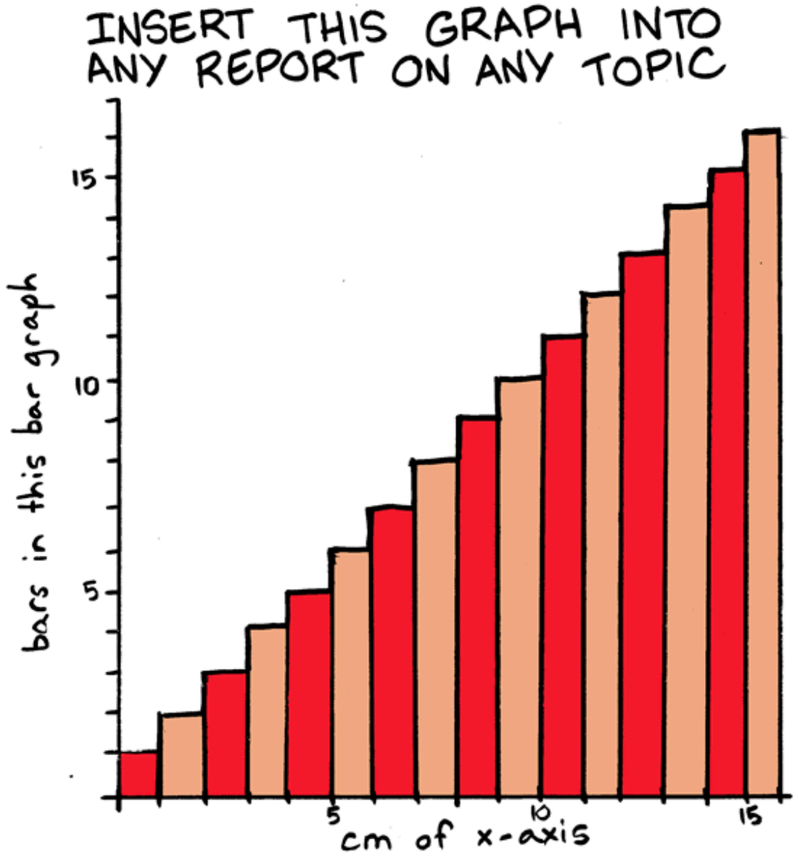




Figures

- Methods
  - Flowchart of algorithms or processes used
  - Schematics or photographs of equipment or experimental setup
- Results
  - Graphs showing the main quantitative findings
  - Photographs or schematics showing qualitative findings
  - Statistical analysis

Figures



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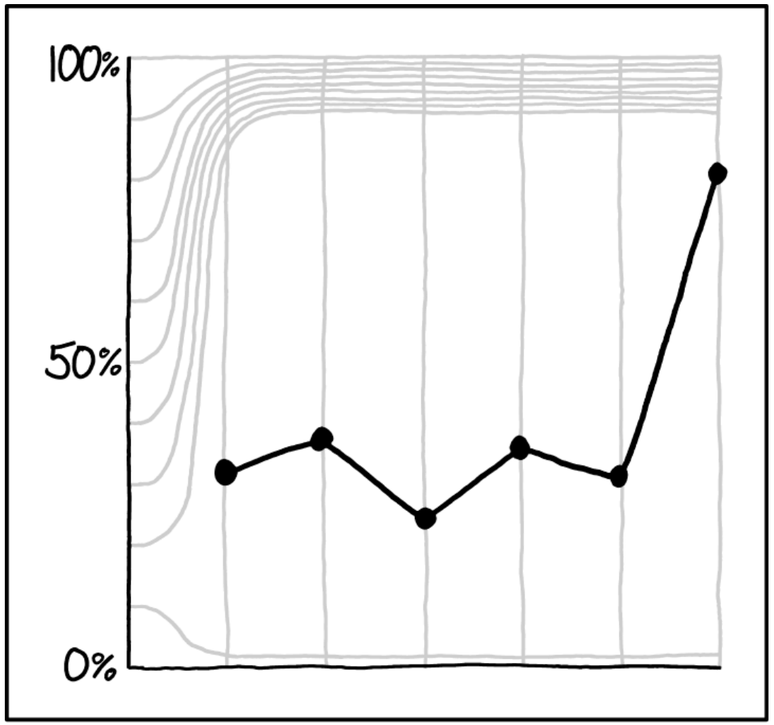
Figures



https://xkcd.com/2023/

Abstract

- Self-contained: the reader should not need to refer to the paper to understand the abstract, or vice versa
- Often follows the same IMRaD format, dedicating 1–3 sentences to each part of the structure
- All the important parts of the study should be in the abstract

Title and authors

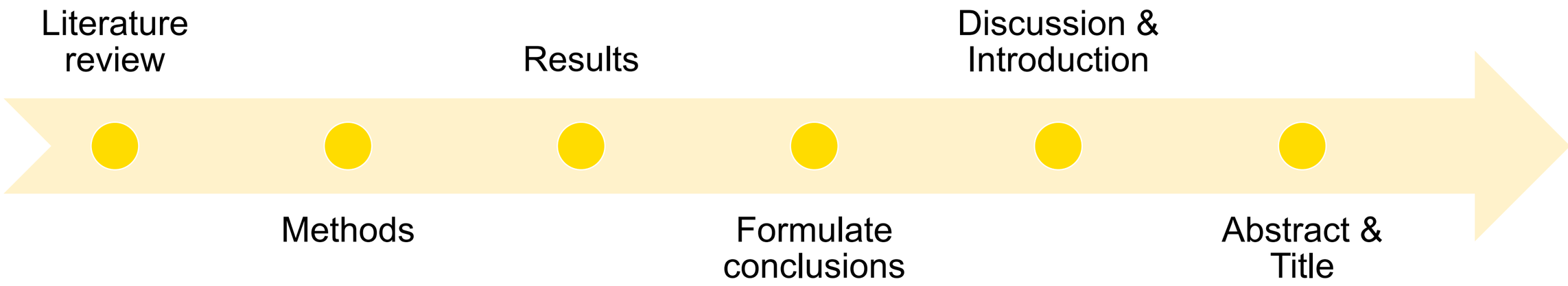
- Use titles to find relevant papers: they contain keywords about the topic and (often) the findings
- Informative titles are hard to write

- Last author is often the head of the lab or supervisor
- Check author affiliations for possible sources of bias (e.g., Do they belong to a company selling a product they use in the study?)

How to approach a literature search

- Identify your topic. Make sure it is specific!
- Find papers on your topic (or subtopics)
- Start with reviews
  - It’s good to read reviews more thoroughly to get a grasp on the topic
  - Reviews are great sources of more papers to seek out!
- *Do **not** scour every single research paper*—Read intelligently!
  - Read the title and abstract
  - Read the final paragraph of the introduction
  - Look at the figures (especially the results figures)
  - Read or skim the discussion
  - **Tailor what you read** to what you hope to gain from your literature search!

Suggested order to write a paper or thesis



Looking forward to working with you this semester!