

# Writing a Research Paper

## Overview

1. goal
2. constructing the paper
3. common errors
4. publication process



## Goal

Prepare a manuscript so that, with high probability, it will be

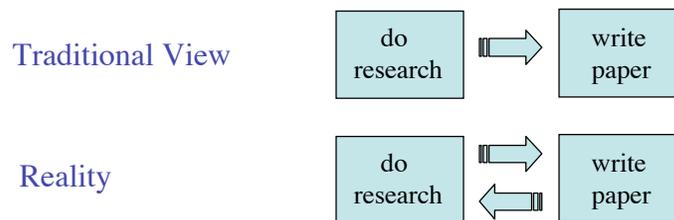
- accepted for publication
- read and understood when published

## Why should you care?

- you will be judged based on your publications
- makes acceptance of papers more likely
- writing is very difficult for most of us

Many papers are poorly written.  
The good news is that technical  
writing is a learnable skill.

## The Process of Writing



Writing the paper can

- help develop and clarify your ideas
- force you to be clear and focused
- predict anticipated interesting results
- promote collaboration with others

## Assumptions

- already have results
- specific journal selected
- structure and content
- pirates' code of honor



## Top Level Structure

- Title Page
  - **Introduction**
  - **Methods**
  - **Results**
  - **Discussion**
  - References
  - Appendices
- Whatever they are called, there are four critical components.

## Introduction

- **key questions to answer ...**
  - **What **problem** was studied, and why?**
  - **What is your primary **contribution**?**
- you are teaching the reader your idea and why it is important
- explicitly state your key idea
- conveying the intuition is primary
- examine your assumptions about the reader

## Organization of the Introduction

### 1. Context and Background

### 2. Make the Problem Clear

- explicitly state the problem
- explain why it is important, interesting
- make it clear the problem is unsolved
- briefly relate to past work

### 3. Explain Your Contributions

- explicitly state your solution or key idea
- describe how it works, what questions it answers
- explain how it differs from past solutions
- identify relevant hypothesis
- explicitly state what you show (be specific)

### 4. Overview? (integrate in above)

## Use Concrete Examples!

- clarify new ideas, especially if abstract
- choose examples carefully
  - illustrate key ideas
  - but simple enough to understand
- running examples can be economical

Clarify new concepts by presenting them in more than one way.

e.g., picture + text

e.g., equation + picture

e.g., text + example

## Methods

- **key question to answer ...**

**How** was the problem studied?

- method/model/algorithm
- experimental procedures
- analysis methodology



## Results

- **key question to answer ...**

**What were the findings?**

- measurements, analysis, theorems, etc.
- results presented should provide evidence for each contribution\*
- check this is so against the introduction
- state each claim first then provide supporting evidence, not vice versa

\*top-down organization

## Visualizing Information

**Heuristic** for figures vs. tables ...

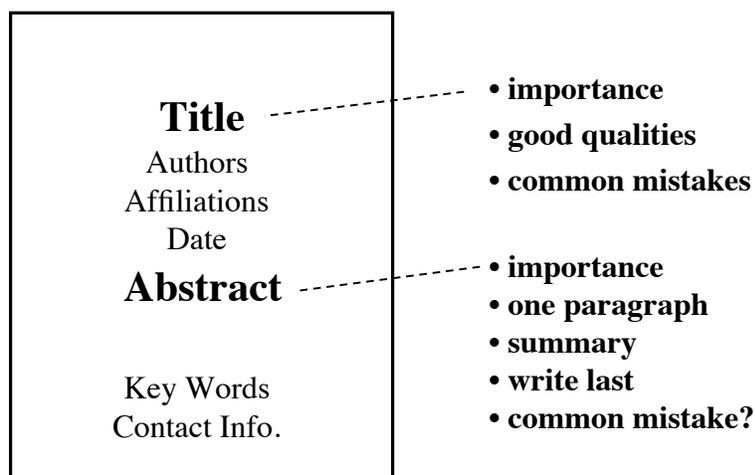
figures to show trends/differences, tables just for exact values

## Discussion

- **key question to answer ...**  
**What do findings mean?**
- **how to organize ...**
  - summary + limitations
  - include your conclusions
  - relate to past work + significance
  - directions for future research



## Title Page



## Common Mistake: Omitting Results

**The abstract is a summary, not an introduction.**

**Always include something like “Here we show ...”**

*“Previous computational models of self-replication using cellular automata have been manually designed, a difficult and time-consuming process. **We show here** how genetic algorithms can be applied to discover rules governing self-replicating structures. ... Experimental yields of discovered self-replicating structures are statistically significant, and the structures compared favorably in terms of simplicity with those generated manually in the past, but differed in unexpected ways. ...”*

} problem

} results

J. Lohn, J. Reggia, *IEEE Trans. Evol. Comp.*, 3, 1997, 165-178.

## Other Material

- acknowledgements
- references
- appendices
- online supplemental material



## Common Mistakes

- writing at the wrong level
- excessive background material
- not explicitly explaining innovation
- overstating significance of your work
- failure to give credit to others
- insulting the reviewer
- describing a system/implementation
- no explicit conclusions

## Technical Errors

- material put into wrong section
- no results given in abstract
- including Background after Introduction
- omit key methodology info. (reproducible)
- recapitulating journey in obtaining results
- tabular rather than figure presentation
- inadequate figure captions
- giving tables captions
- failure to use spell checker
  
- royal we, passive voice, forward refs.

## Recurring Issues

- scope of material
- journal vs. conference
- which one
- authorship - who - order
- permissions
- conflict of interest
- multiple submissions
- pre-submission critiques



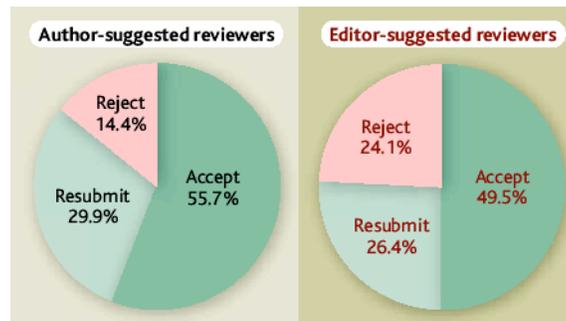
## Publication Process

- start early ... very early
- always have your manuscript read by others  
(colleagues, experts, naïve readers)
- clarify comments that you want

Common error: starting a paper too late for deadline

## Submission Procedure

- journal selection
- suggest/exclude reviewers?



*Science, 2005*

## Review and Publication Process

- review process
- outcome possibilities:
  1. reject
  2. revise and resubmit
    - cover letter
    - common mistake
  3. accept
- value reviewer comments as suggestions for improvement
- this is very difficult but very important

## Citation Statistics

- increasingly used to measure researcher “impact”
- caution:
  - name confusions, inaccurate numbers, etc.
  - extraneous influences (length, web posting, etc.)

<http://arxiv.org/abs/0809.0692>

## References and Further Information

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