# Scientific Writing in a Nutshell Part I

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# Inspiration

“clear thinking can emerge from clear writing” – Scott Montgomery

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# Writing in Science

- Writing is as important a tool in your toolbox as algorithms, data structures, design patterns, etc.
- Improving your writing will help you become successful
- Writing forms the bridge to your audience

Remember: It is the author's job to make the reader's job easy



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# Writing vs. Rewriting

- Get something down on paper as fast as possible
- Then take this and revise.
  - Goal: each revision, or draft, is clearer and easier to understand
- This rewriting cycle develops both your writing and your thinking -> yielding clarity and power

# Storytelling

- It is our job to communicate the story of our science.
  - This requires you to assess your data and evaluate the possible explanations consistent with existing knowledge and theory
  - The story grows from the data, thus we should not go into it with a story in mind before we collect the data.
- Our characters are not people (well sometimes) but rather code, statements, classes, objects, methods, build scripts, docker instances, algorithms, and variables (among others)
  - We develop these characters in our papers and we discuss them and what makes them tick
- We must do more than simply present facts

# Finding the Story

- It seems reasonable to simply write a paper as follows:
  - outline everything you did
  - then say something abut it
- But within this there is a story waiting to come out
- Our ultimate goal is not to simply present results
- Rather, we want to tell the story of the understanding we derived from them
- From the limits of our data, comes our story
  - What did the outliers tell us?

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# Aspects of Story Telling

1. Content – what makes a story engage and stay with us?
2. Structure – how do you put together that content to make it easy for us to get?
3. Language – how do you write the story in the most compelling ways possible?



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# Making a Story Sticky

Why do some ideas stay with you while others are eminently forgettable?

- **S**imple
- **U**nexpected
- **C**oncrete
- **C**redible
- **E**motional
- **S**tories



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# Making a Story Sticky

**Simple** (not simplistic)

- Simple ideas stick
  - contains core essence of an important idea
  - presented in clear compact way

**Unexpected** (novelty)

- Unexpectedness lies in:
  - Questions you ask
  - Interpretations you develop
- Goal is to highlight the unexpected knowledge
  - engage the readers curiosity

**Concrete**

- Connect readers to your concepts (abstractions) and theory
- Do this through the use of concrete examples
- Through this, the concept becomes concrete

**Credible**

- Credibility emerges from grounding our ideas in previous work
- Data credibility is established through describing our methods
- Conclusion credibility grows from credible data
- This all builds a chain extending from past work into future directions
  - Don't break the chain



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# Making a Story Sticky

## Emotional

- Unexpected things create curiosity
- Use this to engage emotion
  - Shift from “what information do I have to offer?”,
  - To “what knowledge do I have to offer?”
- Thus, you must learn to excite your readers

## Stories

- Stories are modular
  - A single large story is composed of smaller story units threaded together
- To write a good paper, think about
  - internal structure
  - integration of story modules



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# Story Structure - OCAR

There are four elements that underlie the structure of all stories (The OCAR Model):

- **Opening (O)**:
  - Whom is the story about?
  - Who are the characters?
  - When does it take place?
  - What do you need to understand about the situation to follow the story?
  - What is the larger problem you are addressing?
- **Challenge (C)**:
  - What specific question do you propose to answer?
- **Action (A)**:
  - What happens to address the challenge? In a paper this describes the work you did; in a proposal, it describes the work you hope to do.
- **Resolution (R)**:
  - How have the characters and their world changed as a result of the action? This is your conclusion – what did you learn from your work?

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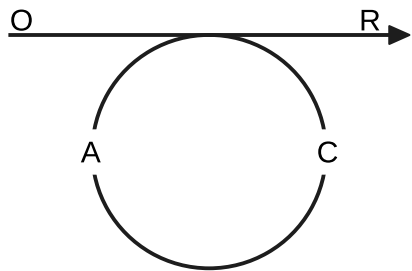
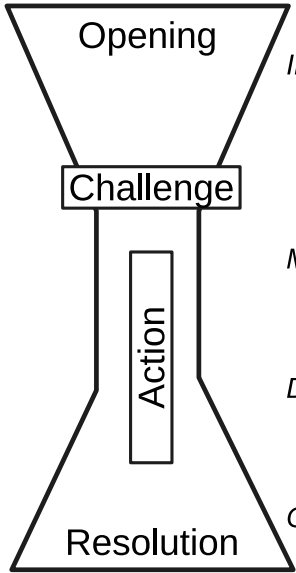
# Story Structure

- We want and need to know how our characters have changed for a story to be satisfying
- Thus we must close the loop
  - A good story is a spiral
  - At the end it must come back to the beginning
  - But the beginning has moved



# OCAR




*Introduction: introduce characters and question. Narrow down to your specific questions.*

*M&M and Results: What you did and what you found.*

*Discussion: What it means.*

*Conclusions: Take home message.*

# The Opening

- You must start well.
- Your first sentences get readers moving and set the direction
- The opening begins with a single sentence but typically encompasses the first paragraph

**Bad Openings**

- Misdirection
- No Direction

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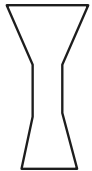
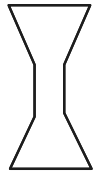
# Targeting Your Audience

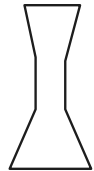
- Know your audience
- Tailor your opening to them
- For a very broad audience, use a two-step opening
  1. Open with an issue for your target audience, but modulate it for the general audience
  2. Redefine the focus as you develop the opening
- Your opening should only be as wide as the resolution allows



Opening wider than
Resolution: over-promising
Your readers will feel cheated.



On target.
Your readers will be
Satisfied.



Resolution wider than
Opening: under-promising.
Your readers won't ever see
That you are telling a story that
Would interest them



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# The Funnel

- The opening identifies a large problem
- The challenge defines a specific question
- The body of the introduction must connect these two
  - This is done through the framing of a knowledge gap.
  - Furthermore, this taps the U of SUCCES
- Remember to first define the problem, then propose a solution
- The goal of the background section should be:
  - To connect the introduction and challenge such that
  - Readers feel the questions you pose are obvious and essential

# The Challenge

- Describe the knowledge you hope to gain:
  - First state your research questions
  - Then briefly summarize your approach

- **Good challenges**
  - Clearly state the objectives and questions
  - Clearly lay out the approach
  - Build unexpectedness and curiosity in the reader

- **Bad challenges**
  - Unclear
  - leave reader adrift
  - focus on objectives rather than questions

# Action

- The main body of the story including:
  - Methods and Materials
  - Results
  - Discussion (most of it at least)
- In a proposal, this is a description of what you intend to do.
- This section gives your story structure and direction

# Methods

- Meant to report the results you achieved and the methods used
- Should follow the Lead/Development (LD) structure
  - provide an initial overview for all
  - then the details for those who need them

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# Results & Discussion

- Describe the outcome: your findings and interpretations
- Two core principles
  1. Make the reader's job easy: present results and interpretation in a way that develops the story
  2. Readers must be able to distinguish between your findings and your thoughts
- There are 3 types of material in a paper
  1. Data: the actual results
  2. Inference: clear and robust interpretations of data that any practitioner would draw
  3. Interpretation: your thoughts, hypotheses, and speculation about the results within the context of the larger problem



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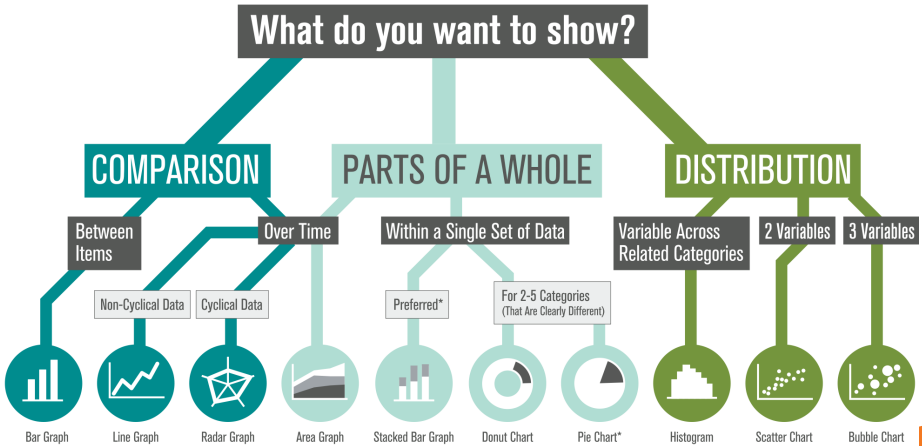
# Presenting Data

- You can't show the raw data
- So select the data that confers the story



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# Statistics & Stories

- Statistics are quite useful
  - they allow us to distinguish treatment effects from random variation
  - they establish credibility of your conclusions
- Remember, the story is not the statistics, it is the data
  - make the stats support
  - focus on the data
  - your story stays engaging without forgoing rigor
- Statistics values (such as a p-value) are results
- Leave the significance tests to interpretation

# Discussion

- This is where you present your thoughts and interpretations
- Presenting your answers to the questions
- Where you show your contribution to the larger problem framed in the opening

- This takes a bit of creativity

# The Resolution

- This is your “Take-Home Message”, your strongest and most memorable words
- You want to
  - show how our understanding has been advanced
  - offer new insights into the problem
  - wrap up your story
- If you include anything but the new insight, then
  - you undercut the resolution
  - and with that, the entire paper
  - DON’T BLOW IT

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# Bad Resolutions

- Are Weak
  - they do not say something concrete
- Are Distracting
  - they neither synopsize nor synthesize results
- Undermine Your Conclusions

## Fixing a Bad Resolution

- Pare away dead tissue
  - remove the fluff, distractions, and new ideas
- Condense to do the following
  1. Synopsize the key results
  2. Synthesize those results (show how they answer the questions)
  3. Show how this contributes to solving the larger problem

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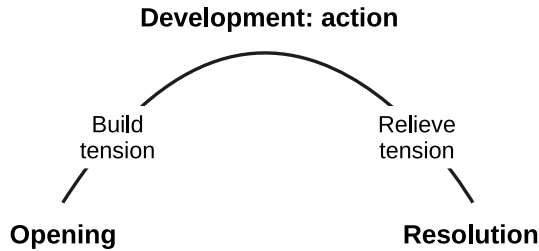
# Internal Structure

- OCAR defines the overall structure
  - Opening - grabs attention with characters and setting
  - Challenge - creates uncertainty and curiosity
  - Action - provides info and develops story
  - Resolution - rewards the reader and relieves the tension
- This creates an overall story arc



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# Are there any questions?