

Technical Writing

Data Science Enrichment

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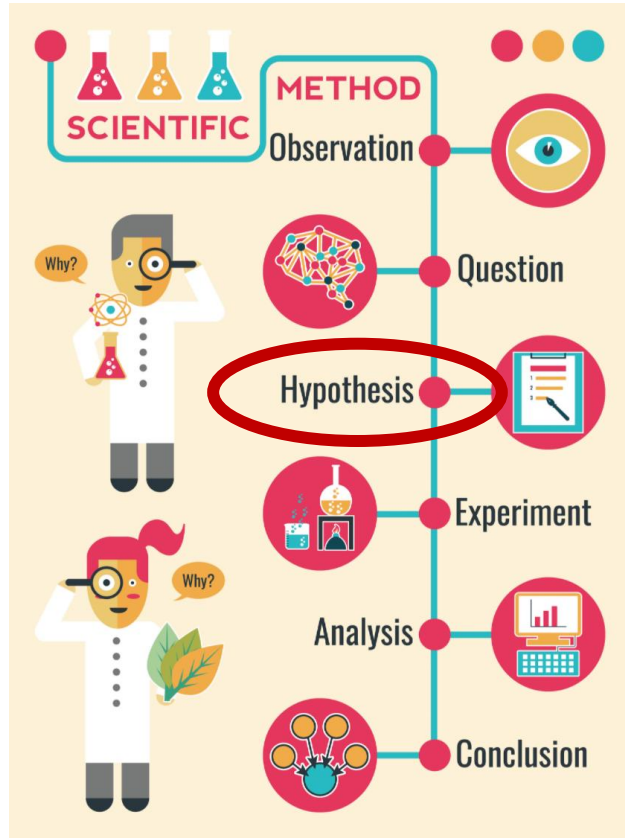
Goals for today's session

- Explain principles of good scientific/technical writing, and why they are important
- Consider the many ways bad writing can occur;
- Highlight the support available to you;

Disclaimer

- My writing style is **idiosyncratic** – as is everyone's
- There are many ways to write well
 - But there are an *infinite* number of ways to write poorly
- The goal of scientific/technical writing is **persuasion**
 - Not archiving and hoping someone sees/understands your work
 - **Teaching** someone your results
 - Getting a paper accepted
 - Getting funded
 - Getting a **degree**!
- My approach has been (somewhat) successful and may be successful for you
 - But my approach (nor anybody's) should be taken as the only or final word

The Scientific Method



The first thing we learn...
... and the first thing we forget

Have a good hypothesis

- A good project is organised around at least one central hypothesis.
- Coming up with an elegant hypothesis is the **key** to doing meaningful research, and the hardest thing to come up with when prompted (like inventing a new melody).
- A hypothesis is a proposed explanation based on existing evidence.
- In basic research, one puts forth a mechanism, pathway, effect, etc. to explain a phenomenon.
- In engineering (*i.e.*, device, material, system), one hypothesises the mechanism by which the engineered solution should work.
- “My hypothesis is that my idea will work” is **not** a hypothesis.
- A proposal (before) or research report/paper (after) is a logical argument in which the outcome of the proposed experiments either falsify or are consistent with your hypothesis.



What is a paper (or proposal, dissertation)?

[Whitesides' Adv. Mater. 2004](#)



- Organised description of hypotheses, data and conclusions
- Intended to instruct the reader and ultimately to change his or her behaviour
- “unpublished” or “unsubmitted” = “nonexistent”
- Not only archival
- Integral to planning and organisation of research
- A project is never “complete”
- It is always easier to have your hypothesis written down, even if you have to modify it later

Outline

- Start with first paragraph that states the hypothesis or goal
- Figures (for better or worse, you will be judged on the quality of your images/plots/schematic drawings)
- Section headings
- Bullet points
- Text comes later

(Bad) First Drafts

[Anne Lamott, *Bird by Bird*](#)



- Start by writing everything you can think of in bullet form, then organise it (not chronologically)
- When you're ready to start drafting text, get it all down first, no matter how ugly
- Write your first draft as if **no one will ever read it!**
- “Silly sausage!”
- Refine
- Follow examples of writing to emulate
 - The best writers are avid readers

Components

- A paper/dissertation/etc should be layered; not every reader wants the same level of detail.
- Title -> Abstract/Conclusions -> Experimental Design/Results -> Methods: all represent different levels of commitment of the reader
 - The title is an abstract of the abstract
 - Two types of titles: descriptive titles and catchy titles, or a hybrid
 - *How to make water roll uphill* (Science, 1992)

vs.

- *Patterning of gradients of hydrophobic potential energy on inclined planes of glass and how to use them to counterbalance the gravitational force between water and the earth*

Components II

- Abstract

- Write at end, or have a coauthor write it
- State the problem
- A one-sentence summary
- A description of the methodology
- The key results (be specific)
- Final sentence is why one should care
- Always 3rd person
- Always present tense (for me) but styles vary

- Introduction

- Eye-catching first sentence
- What we did
- Why we did it
- What's new?
- Who cares?

Components III

- Background
 - Be nice to other people in the field (mention by name: “first author *et al.*” or “senior author and coworkers”)
 - Where has other work fallen short?
 - What are the holes in the literature and why is filling them important?
- Experimental design
 - Justify selection of techniques/methods/materials
- Results and Discussion
 - What were the results of the experiments/fabrication procedures?
 - How do the results compare to the results or predictions of others?
- Conclusions
 - Not simply a summary or a recap of the abstract
 - View from 10,000 meters
 - What did we learn and to what extent is it extendable to other systems
 - What are the shortcomings and what remains to be done

Why is there So Much Bad Writing?

Steven Pinker *The sense of style*



- Speaking is natural
- Writing is unnatural
- Unlike with speaking, there is no counterpart to ask questions, stare quizzically, or offer counter arguments.
- The writer must imagine the education, background, intelligence, and prejudices of (all) possible reader(s).
- The reaction of the unknown reader is the **only** thing that matters (convincing others of the truth of your claims, getting the paper accepted, a good mark, a grant funded, or the job you are applying for).

Good Writing Styles

- Plain style (egalitarian)
 - Everything is in full view; the world is not seen from a particular vantage point
 - *The early bird gets the worm*
- Classic style (aristocratic)
 - Text is a “window into the world”; the writer views the reader as an equal and intelligent
 - *The early bird gets the worm, but the second mouse gets the cheese*
- Practical style (writer and reader have defined roles, e.g. student/teacher, instruction manual/handyman)
 - The text is completely explicit
 - *The bird sets his alarm for 5 am is likely to find and eat an earthworm; birds who set their alarms for 6 am are less likely to find earthworms.*
 - Depending on your audience: *The timing is important because worms come to the surface after it rains or dews which often occurs in the early morning.*

Academese

- Larding with apologies, compulsive hedging
 - *To the best of our knowledge, somewhat, fairly, nearly, seemingly, in part, relatively, comparatively, predominantly, to some extent, presumably*
 - *Bristol is a relatively rainy city*
 - *Unoptimised*
 - *More research needs to be done*
- Metadiscourse (professional narcissism & discourse abt discourse)
 - *Artificial intelligence has attracted increasing interest in the research community*
 - *In recent years, scientists and engineers have turned their attention to...*
 - Don't be a follower

Academese

- Signposting
 - *First, I am going to talk to you about virtual machines; After telling you about virtual machines, I will switch to databases, before then going to storage models, and then finally I will return to virtual machines.*
 - OK if useful to structure your work but should be eliminated in final version
- Jargon
 - *The drug was tested in a murine model*
 - Almost all of this should be eliminated.

The Curse of Knowledge

- It simply doesn't occur to the writer that the reader doesn't know what (s)he knows
- A three-year-old who sees a toy being hidden while a second child is out of the room assumes that the other child will look for it in its actual location rather than where (s)he last saw it!
- Adults have only a slightly more sophisticated theory of mind
- Abbreviations and jargon are tempting to thoughtless writers... but for every few seconds they add to their own lives, many hours are wasted on the part of readers.

Simple Rules to Make your Writing More Like Professional writing

Some have a legitimate basis, others are more a matter of personal style/preference...

Noun piles: don't use nouns as adjectives

- Professional writers don't use nouns as adjectives... or at least they do not do so very often
- “*an aluminium foil covered plate*” -> “*a plate covered with aluminium foil*”
- “*I put my sample on the materials parameter analyser table*” -> “*I put my sample on the table with the materials parameter analyser*”
- But on the other hand “*I put my sample on the table with the analyser that measures the parameters of materials*”...
- Use best judgement (“*pineapple pizza*” ok) but err on the sides of using nouns as nouns “*composite fabrication*” -> “*fabrication of composite*”.
- The reason it is better to avoid noun piles is that the verb needs to act on the direct object, not on the first in a string of modifiers.

Dangling participles (, ing)

- Make all references explicit
- “*The banker’s name is Mrs Helena Anne Beatrix Wentworth Fitzwilliam and she drives a Rolls Royce, indicating that she is a rich woman*”
- “*The banker’s name is Mrs Helena Anne Beatrix Wentworth Fitzwilliam and she drives a Rolls Royce; this name indicates that she is a rich woman.*”

This

- Make references explicit
- “This” is always followed by a noun
- No exceptions
- Problematic: “*The banker’s name is Mrs Helena Anne Beatrix Wentworth Fitzwilliam and she drives a Rolls Royce. This indicates she is a rich woman*” [this what? Job? Name? Drives? Car?]
- Preferred: “*The banker’s name is Mrs Helena Anne Beatrix Wentworth Fitzwilliam and she drives a Rolls Royce; this car indicates she is a rich woman.*”

Which/That (a bit controversial)

- “which” adds detail, “that” is exclusive
- “which” is preceded by a comma and refers to the nouns immediately before the comma
- See the difference in meaning:
 - He took the ball, which was orange
 - He took the ball that was orange
- “which” can also be exclusive (dual role) but “that” cannot add detail
 - ~~He took the ball, that was orange~~

Tense

- Abstract: present tense (3rd person)
- Your results and others in the literature: past tense “Smith et al. invented this database model”
- Scientific facts: present tense. (E *equals* mc^2)
- If you forget: just stay consistent

Active/Passive voice

- Active voice preferred, but not exclusively
- First person (“we”) preferred to avoid ridiculousness “*an oven treated the material at 120 C*” -> “*we treated the material at 120 C in an oven*”
 - In this case, the passive voice would have been better
- Some passive voice is ok for emphasis “*your dog is chasing my cat*” -> “*my cat is being chased by **your dog***”
- Put the heaviest or most important word at the end of a sentence, or at the end of a list of terms.

Figures

- The reader is not going to *study* your figures (the meaning needs to be obvious at nearly first glance)
- Arrange your figures (in Powerpoint, Illustrator, etc.) with the font size that will seem **monstrously** big until shrunk to one column.
 - Divide the age of the oldest audience member by 2 to get the font size...
- Is colour necessary or distracting? Especially in plots?

Copyediting

- A copyeditor will do all this stuff, but if you do it in your work, you will look savvy.
- Variables are italicised $E = mc^2$ (sub/superscripts are not!)
- Superscripted references go outside the punctuation when placed at the end of a sentence.⁵
- In the UK, commas and periods go outside “quotation marks”. In the US, they “go inside.”
- One space after a period
- Double space drafts
- Arial in figures (or other sans-serif font)
- Use bigger fonts than you think you will need

Further Reading

- **5 minutes:** George Whitesides article on writing a paper in *Advanced Materials*
- **5-10 hours:** Steven Pinker – *The Sense of Style: the Thinking Person's Guide to Writing in the 21st Century*
- Anne Lamott *Shitty First Drafts*
- Style guides from the RAEng, the Guardian and Observer, etc.
- Strunk and White *The Elements of Style*, boiled down to the most useful advice: **Omit needless words.**