Written & Oral Presentation:
Structure of a Research Article

Aleksandar Donev
Courant Institute, NYU[1]
donev@courant.nyu.edu

[1]Course MATH-GA.2840-004, Spring 2018

March 7th, 2018

Traditional article structure

Much of the content taken from the book "Stylish Academic Writing" by Helen Sword.

- Most scientific articles employ a traditional structure:
  Introduction, Method, Results, and Discussion (IMRAD)
- IMRAD model in the words of Sword:
  - Open the article with an introductory section that clearly states the **purpose and scope of the current research**, sums up **previous work in the field**, and probes **gaps and flaws in the existing literature**.
  - Next, in sections with titles such as "Data," "Methodology," and "Results" (the exact labels vary from field to field), describe the **research methods, data collection and results.**
  - Finally, in the "Analysis," "Discussion," and/or "Conclusion" sections, **review the main findings**, explore the **wider implications of the work,** and offer suggestions for **further research**.

What's the introduction all about?

An introduction's main goals are (go through example introductions by Martin Hairer and Miranda Holmes-Cerfon from course webpage and discuss in class):

- To **hook the reader** into reading the rest of the article!
  See chapter 7 "Hooks and Sinkers" of Sword's book.
- To set the stage for the research: **motivation** and **significance**.
- To point out the **novelty** of this research and **how it fits** in the literature and current state of the field.

CARS approach to intros

Sword points out that:

- "Stylish writers understand that if you are still reading three pages later, they have probably got you for the long haul. By contrast, nothing sinks a piece of prose more efficiently than a leaden first paragraph."

- In the sciences and social sciences, researchers frequently follow a four-step rhetorical sequence identified by John Swales as "**Creating a Research Space**," or CARS, with the following moves:

    1. Establish that your particular area of research has some significance.
    2. Selectively summarize the relevant previous research.
    3. Show that the reported research is not complete.
    4. Turn the gap into the research space for the present article.

Pitfalls of Move 1

- Move 1: Make the significance statement **as specific as possible** using examples, prior results, other people's conclusions, etc. **Avoid making vague or obvious/boring statements**.
- As Sword says: Move 1 of CARS encourages authors to begin with a **sweeping statement of the obvious**.
- Example in "Spotlight on Style" on page 78 in Sword (show in class).
- Hinghan suggests that "A possible way to improve an introduction is to delete the first one or more sentences, which are often unimportant general statements." Example:
  1. Instead of "Polynomials are widely used as approximating functions in many areas of mathematics and they can be expressed in various bases. We consider here how to choose the basis to minimize the error of evaluation in floating point arithmetic."
  2. How about "In which basis should we express a polynomial to minimize the error of evaluation in floating point arithmetic?"

Pitfalls of Move 2

- Move 2: You are the **curator of prior work, not a historian**. Do not just make a list of papers and name drop, rather, give the context (what did that work address that was missing before), explain the key contributions (novelty and significance), the historical development (inspired by or inspired), and give activity to actors, e.g.:
  - Smith et al. [REF] found a creative way to avoid the problem with the classical algorithm by using a hierarchical data decomposition, rather than
  - Smith et al. proposed a hierarchical decomposition algorithm [REF].

Pitfalls of Move 3 and 4

- Sword points out that "Move 3 invites authors to take a crowbar to the existing literature, jimmying open alleged research gaps whether or not they actually exist".

- Instead, **be honest**. Emphasize why your work is different and important, but acknowledge other contributions and point limitations of your own approach.

- Sword also points out that "Finally, with Move 4, the author steps boldly into the breach, making claims, frequently inflated, for the novelty and importance of his or her own research"

- Instead, **point out future directions, unanswered questions, alternative approaches**. Encourage thought in the community and a critical approach to your work instead of asking for praise.

- Take a look at the Outlook section of the review article by Miranda Holmes-Cerfon (in-class discussion).

The Story Line

- Although we think of science/math articles as objective pieces of "truth", Sword points out that:
  "Every research project is made up of stories—the researcher's story, the research story, the stories of individual subjects and participants, the backstory—each of which contains various plot twists of its own."

- For stylish academic writers, then, the fundamental question to ask is not "Do I have a story to tell?" but "**Which story or stories do I want to tell, and how can I tell them most effectively?**"

- **An article is a story** about a specific problem and a proposed solution. It should flow like a fiction story would. Start with a setting, introduce a problem/riddle, then attempt to solve it, and teach the reader a lesson of broader importance/relevance.

The Big Picture

- Sword summarizes in Chapter 13 of her book:
  "stylish academic writers **express complex ideas clearly and succinctly, clearly and elegantly, clearly and engagingly, or clearly and persuasively**... Central ... is the **elusive art of abstraction**; that is, the stylish academic writer's ability to paint a big picture on a small canvas, sketching the contours of an intricate argument in just a few broad strokes."

- "The secret ingredient of ... a persuasive abstract, article, or book—is a **strong thesis or argument** ... writers who put forth a bold, defensible claim are much more likely to generate engaging, persuasive prose than those who offer bland statements of fact with which no one could possibly disagree. In the sciences and social sciences, a strong thesis follows naturally from a **compelling research question**, as when a group of behavioralists ask how seagulls solve the height versus energy problem when dropping cockles onto the rocks below."

Structure and sectioning

- Sword says: "A well-structured article or book, like a well-built house, requires **careful thought and planning**."
- Use **informative titles of sections**:
  'Generic section titles such as "Method" and "Conclusion" provide very little real information about an article's content, a handicap for skimmers as well as for readers.'
- Use **parallel sequencing** among sections to emphasize the logical structure of an article.
- Good example from CS on page 126 in ch. 11 of Sword, or look at TOC from my own most recent article (in class).
- Papers should be structured so as to be **easy to skim**: key definitions, equations and results should be clearly displayed and easy to find.

Section structuring

- Sections are like a mini paper. They should be organized to focus on a single question / topic, and require a short **section introduction** to guide the reader.

- In particular, there should be no empty paragraphs between a section and subsection titles. For example:
  Section X
  [Should **not be empty** — put a section header paragraph]
  Subsection X.1

- In an **introductory paragraph** or two, explain what the section is about, and how it is organized.

- Put **material common to all subsections**, like notation, in the header of the section, not in a subsection; subsections should be as self-contained as possible.

Exercises

- **Exercises** suggested by Sword that are good to do each time you write an article:
  1. "Make an outline of your article or book based only on its chapter titles or section headings. How well does that outline, on its own, communicate what your work is about? Are you using section headings to inform, engage, and direct your readers, or merely to carve up space?"
  2. "To fine-tune your structure, make a paragraph outline. First, identify the topic sentence of each paragraph (that is, the sentence that most clearly states its overall argument); next, arrange those sentences in a numbered sequence. This process can help you identify structural weaknesses both within and between paragraphs: for example, a paragraph that has no clearly stated argument or one that does not logically build on the one before."

Abstracts/Introductions

- Hingham points out that "The reader should not have to refer to the paper to understand the abstract."
- Avoid equations in the abstract, and if you need to cite a key paper in the abstract, inline the citation as in [Donev et al., Journal of Nothing, 3:454, 2018].
- The abstract should give some indication of the conclusions of the paper and lay claim to some novelty.
- Avoid trite common phrases like "In this paper we..." - use simply "We..."
- Don't start papers with a list of notations and definitions.
- For references, include specific section/equation to help the reader identify the referenced material — be as specific as possible.

Value-added by TOCs and Conclusions

- Many papers give a **table of content paragraph** at the end of the introduction. Make it active and enganging — a mental map of the paper that guides the reader about the order in which things go, what is important and what can be skipped, etc. **Make it informative and useful**.

- Hingham says "*It is best not simply to list the section titles; instead, give a summary that could only be obtained by reading the sections.*"

- Same goes for **conclusions**. Do not simply make a list of what the paper did – it is boring and serves no purpose. Instead, infuse it with new insights, different ways to see what the paper did, or draw conclusions that could not be drawn until the whole paper was layed out. **Make it informative and useful**, not trite and repetitive.

- Hingham says that the Conclusions section "should not simply repeat earlier sections in the same words. It should offer another viewpoint, discuss limitations of the work, or give suggestions for further research."

The academic (lack of) style

- Sword argues that: "The purpose of a scholarly abstract is not merely to summarize an article's content but to **persuade** one's discipline-based **peers that the research is important** and the article is therefore worth reading."
- and notes that the Oxford English Dictionary defines persuasion as "the addressing of arguments or appeals to a **person** in order to induce cooperation, submission, or agreement."Authors who adopt an impersonal, "academic" tone are neglecting one of the most powerfully persuasive tools at the stylish writer's disposal: **the human touch**.
- Evolutionary biologist Richard Dawkins offers this advice: "Do not talk down. Try to **inspire everybody** with the poetry of science and make your explanations **as easy as honesty allows**, but at the same time do not neglect the difficult. Put extra effort into explaining to those readers prepared to put matching effort into understanding."

Exercises

(Great exercise from Sword) Answer the following questions in simple, conversational language, avoiding disciplinary jargon:

- What is the main point of your article, dissertation, or book? (Why is it important, whether to you or to anyone else?)
- Who is your intended audience?
- What research question(s) do you aim to answer?
- What new contribution(s) does your research make to theory? to practice?
- What is your overarching thesis or argument?
- What evidence do you offer in support?

More exercises

(Great exercise from Sword) Show your abstract to a few trusted friends or colleagues, both from within and outside your discipline. Ask them to give you candid answers to the following questions:

- Do you understand what my research is about and why it's important?
- Does my abstract make you want to keep reading?

Titles, puns, and academic reputation

- Claim by Sword: "it is possible to write **compelling titles** and to be a respected researcher at the same time."

- 'the simplest way to generate an "engaging and informative" title is to **join together two disparate phrases** (one catchy, the other descriptive) using a colon, semicolon, or question mark.'

- Great example is "The Economics of Getting High: Decisions Made by Common Gulls Dropping their Cockles to Open Them"

- Compare to "Evaluating the E-learning Guidelines Implementation Project: Formative and Process Evaluations"

Titles and information

- A title should **not be too vague or general but also not too specific or detaile**d: the balance is tricky!
- Hingham writes in section 6.3 of his Handbook:
  - *A note on the interpolation problem* is too vague a title: what is the breakthrough heralded by "A note", and which interpolation problem is under discussion?
  - *Approximation by cubic splines* is too vague (except for a thorough survey of the topic), since the problem being addressed is not clear.
  - A lively and informative title is *Computing the eigenvalues and eigenvectors of symmetric arrowhead matrices*.
  - Another great one is *Nineteen dubious ways to compute the matrix exponential.*

Good figures and captions

- Sword says: "The most effective illustrations, by and large, are those that **complement rather than duplicate the text**: a well-chosen diagram, graph, or screen shot speaks mostly for itself without requiring a long-winded explanation. At the same time, authors do no one a favor by dropping in illustrations that never get mentioned in the text [same goes for tables, Appendices, and any other info not part of main text: **each must be referenced in text**] ... Convoluted flow charts and snazzy 3-D bar graphs can end up alienating rather than enlightening readers..."

- Quantitative graphics require care in constructing: Use **varying symbols, line styles, colors**, detailed legends. Use analog constructions to group related sets of data together (e.g., all triangles or all dashed lines are related).

- **Captions** should be detailed and **self-contained** as a "float" separate from the text. A reader should get a lot just by looking at the figures and reading the captions (many readers will!).
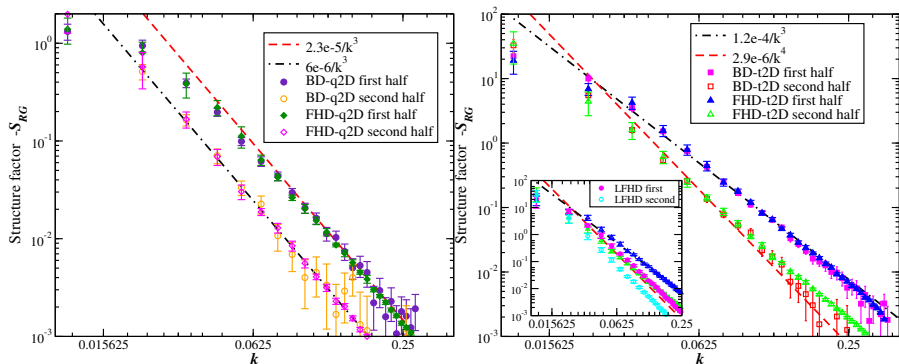
Figure: Caption on next slide. Note that the latex **subfigure package** allows you to label and reference panels individually.

Example caption

- Caption: "Spectrum of the fluctuations of color density during diffusive mixing for Quasi2D (left) and True2D (right) hydrodynamics. The spectrum is averaged over the two halves of the simulations (filled symbols for first half and empty symbols for second half). **(Left)** Results from BD-q2D (circles) for the first (solid circles) and second half (empty circles), compared to the k^{-3} asymptotic power-law predicted by (eq). Diamonds show results from a pseudo-spectral solver for (eq). **(Right)** ..."

- The **text** should explain the **figure content** (guide the reader through the visual), without going into details that can be covered in the caption and legend. Example:
  "For a more quantitative study of giant color fluctuations, in Fig. 1 we show the ensemble- and time-averaged structure factor $S_{RG}(k_x = k, k_y = 0)$...The right panel of Fig. 1 shows that results from BD-t2D (squares) deviate from the theoretical k^{-4} decay..."