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Every week in my senior thesis writing class, I go over some of the things I saw in student writing that I think need to be fixed. I've decided to try to collect some of the notes here, though I doubt that I'll ever get a full set, since a lot of the talk is extemporaneous or prompted by questions. They are not in any particular order.

- One of the first things I tell students about the structure of a thesis, is that it must start with a clear statement of the research question or design goal of the thesis. (This is traditionally called the "thesis statement," but I don't use that term.) Without explicit demands to put the statement in the first paragraph, and (if possible) the first sentence, students tend to write pages of background material before getting to the point of their thesis. In journalism, this mistake is called "burying the lede", and it is just as serious a problem in a thesis or thesis proposal as it is in a newspaper article.

  Even after getting this instruction, a lot of students want to write about the overall goals of the lab they are working in, rather than giving the specific goal of their thesis. It sometimes takes two or three iterations before students get a clear, correct statement of the research question or engineering design goal that they are addressing in their thesis.

- One pervasive problem (often encouraged by the students' research mentors) is to write the entire thesis in the passive voice. Writing journal articles in passive voice is fairly common, and some people have gotten the mistaken notion that passive is somehow more formal and correct than active voice. But passive is wholly inappropriate for a thesis.The point of a thesis is to establish the research skills of the person writing the thesis. So most of the thesis should be written in first-person singular: I developed a new protocol … ; I transfected the cells … ; I analyzed the data … ; I hypothesize that … Plural is strongly discouraged—"we" should only be used where other people are explicitly called out by name. Passive voice, which amounts to an assertion that the actor is unknown or unimportant should be avoided.

  I don't want to prohibit passive voice, though, as there is an important use for it in technical writing, even in theses. That use is inverting sentences, to put the object before the subject: "X did Y" ➜ "Y was done by X". This reordering can be very useful for improving flow, which relies on putting the old information at the beginning of a sentence and the new information at the end of the sentence.

- Students often borrow figures from lab mates or from published papers to put in their theses, particularly in the background section. I'd like students to create their own figures as much as possible, but there are plenty of times when copying a figure is the right thing to do. What

students usually miss, however, is the need to put an explicit figure credit at the end of the figure caption—something of the form "Figure copied from Smith and Ng [Smith and Ng, 1999]". A simple citation is not enough, just as a citation is not sufficient defense against plagiarism for copied text, unless there are explicit markings indicating a direct quotation. When a figure is redrawn or modified, the figure credit should have the form "Figure adapted from …", rather than "Figure copied from …", but the explicit credit is still needed.

One reason I object to copied figures is that students usually do a very bad job of it, copying a low-resolution image off the internet, often with screen-capture tools, so that the image in their thesis is blurry or jagged. Going to the original articles and extracting the PDF images would eliminate at least a little of the awfulness of the copies.

- Speaking of citations, students often ask what citation format they need to use for their theses. There aren't any standards for senior theses at our campus, but there are for PhD theses, so I suggest using that style. The PhD thesis citation style on our campus calls for parenthesized author and year format: (Smith and Ng, 1999). That style, though rather long-winded, has the advantage of not requiring the reader to keep flipping to the reference list to see what the citation refers to (a huge advantage in the days of microfilm, but slightly less important now).

  The citation list itself can be in any standard format—I prefer to have the list sorted alphabetically be author and using the full author names, article titles, full journal names, and URLs and DOIs when available. Many journals use a much terser style to save space, but having the full information is useful to scholars, as it provides some redundancy to help correct for typos in the citation.

- I have to tell a number of students about the concepts of paragraphs and making the first sentence of each paragraph be a topic sentence. Many of the students otherwise start stream-of-consciousness dumps of ideas that go on for pages with no internal structure. Stream of consciousness may have worked for James Joyce (I wouldn't know, as I could never read more than a page or two of his stuff), but it doesn't work for scientific writing. Every sentence of a paragraph should be supporting or amplifying the topic sentence.

- Students often have trouble with vague antecedents for their pronouns—particularly when they use "this" as a pronoun. I strongly suggest that they check every "this" and "that" in their writing, and if it is used as a pronoun, replace it with a noun phrase: "this technique", "this method", "this protein", … Where they can't find the appropriate noun to use, their readers certainly won't be able to figure out the intended antecedent. Incidentally, this usage of "this" is referred to as a *demonstrative adjective*, though it might be more useful to refer to it as an article (like "the" or "an"), since that is the position in the noun phrase that it occupies.

- A lot of what I tell students has to do with typography and copy editing, rather than with writing *per se*. For example, I tell them about the 4 types of dashes:

  hyphen -
  a very short mark used inside compound words, to turn a noun phrase into a modifier of another noun, or to mark the end of a line where the word continues onto the next line.
  en-dash –
  a somewhat wider mark (about the width of a lower-case "n") that is used to represent ranges, such as 1–10 or Jan–Jul.

em-dash —
a much wider mark, used for sentence-level punctuation—somewhat like a semicolon or
parentheses
a minus sign –
used only in mathematics, the minus sign is usually the same size as the en-dash, but has
different spacing rules. The text marks (hyphen, en-dash, and em-dash) have no space around
them (though some typographers will put thin spaces around em-dashes), but the minus sign
has the same spacing rules as the plus sign (with different rules depending whether it
represents a unary or binary operator). Basically, if you are not an expert in math typography,
you should use LaTeX to typeset your math and trust it to do a better job than you can.

While I'm on the subject of hyphens, I usually tell students that when they use a noun phrase to
modify another noun, they should hyphenate the whole modifying noun phrase. For example,
the process of synthesizing amino acids is called amino-acid synthesis, and the pathway that
does it is the amino-acid-synthesis pathway.

- A lot of biology acronyms and gene names are case-sensitive and start with lower-case letters
  (like tRNA, siRNA, dsDNA, p53, …). Sentences should not be started with uncapitalizable
  symbols. If you need to start a sentence with "p53", try "Tumor suppressor p53" instead.
  Sometimes just adding an article helps: "tRNA genes" ➜ "The tRNA genes".
- Biology papers have two major uses for italics: for new jargon terms in the context where they
  are first defined and for genus-species names (like *Escherichia coli* or *C. elegans*). The genus-
  species typesetting rules are a bit complicated —genus is capitalized, but species is not; genus
  can be abbreviated to a single letter with a period, if unambiguous; subspecies or strain names
  are not italicized. Italicizing words when they are first defined is a simpler concept, one which
  can be applied to almost any academic writing.
- There a few words that I object to also. Perhaps the most common problem is the ugly
  neologism "utilize", which is used far too often by students, when what they mean is "use".
  (The older meaning of "utilize"—to make useful—has disappeared.

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I previously posted some Senior thesis pet peeves. Here is another list, triggered by another group of first drafts (in no particular order):

- An *abstract* is not an introduction. Technically, an abstract isn't really a part of a document, but a separate piece of writing that summarizes everything important in the document. Usually the abstract is written last, after everything in the thesis has been written, so that the most important stuff can be determined. Most readers will never read anything of a document but the abstract.
- Every paragraph (in technical writing) should start with a topic sentence, and the remaining sentences in the paragraph should support and expand that topic sentence. If you drift away from the topic, start a new paragraph! The lack of coherent paragraphs is probably the most common writing problem I see in senior theses.
- I don't mark every error I see in student writing. It is the student's responsibility to learn to recognize problems that I point out and to hunt down other instances themselves. Students need to learn to do their own copy editing (or copy edit each other's work)—I'm not interested in grading my own copy editing on subsequent drafts of the thesis.
- Every draft of every document that is turned in for a class or to a boss should have a title, author, and date as part of the documents. Including this meta-information should be a habitual action of every engineer and every engineering student—I shouldn't be seeing last-minute hand-scrawled names and titles on senior thesis drafts.
- Page numbers! Every technical document over a page long should have page numbers. If you don't know how to get automatic page numbers with your document processor, either stop using it or learn how!
- Earlier this quarter I said that I did not care what reference and citation style you used, as long as it was one of the many standard ones. I've decided to change my mind on that—I do care somewhat what style you use for the reference list. Use a reference style that contains as much information as possible: full author names, full journal name, dates, locations of conferences, URLs, DOIs, … . You may format it in any consistent manner, but provide all the information.
- Use kernel density estimates instead of histograms when showing empirical probability distributions. My previous post explains the reasons.
- Avoid using red-green distinctions in graphics. About 6% of the male population is red-green colorblind. There are color-blindness simulators on the web (such as http://www.color-blindness.com/coblis-color-blindness-simulator/) that you can use to check whether your color images will work. Modern gene-expression heat maps use red for overexpression, blue for underexpression, and fade to white in the middle. This scheme has the advantage of having the strong signals in saturated colors and the weak ones in white or pastels, blending into the white background.

- Comma usage continues to be a problem for many students. I discussed three common comma situations in English:
  - Comma splices. Two sentences cannot be stuck together with just a comma—one needs a conjunction to join them. If a conjunction is not desired, an em-dash can be used (as in the previous sentence). Sometimes a semicolon can be used, but never a bare comma.
  - Serial comma. There are two different conventions in English about the use of commas before the conjunction in a list of three or more items. In American English, the comma is always required, but in British English the comma is often omitted. I strongly favor the American convention (also known as the *serial comma* or the *Oxford comma*), and I will insist on it for the senior theses—even for those students raised in the British punctuation tradition.
  - When using "which" to introduce a relative clause, the clause should be non-restrictive. That is, omitting the clause beginning with "which" should not change the meaning of the noun phrase that is being modified by the relative clause. Non-restrictive relative clauses should be separated from the noun phrase they modify with a comma. If you have "which" without a comma starting a relative clause, then check to see whether you need a comma, or whether you need to change "which" to "that", because the clause is really restrictive. Note: "which" is gradually taking over the role of "that" in spoken English, but this language change is still not accepted in formal writing, which is more conservative than speech.
- The noun "however" is a sentence adjective, but it is not a conjunction. You can't join two sentences with "however". You can, however, use it to modify a separate sentence that contrasts with the previous one.
- Colons are not list-introducers. Colons are used to separate a noun phrase from its restatement, and the restatement is often a list. The mistaken notion that colons are list-introducers comes from the following construction: theuse of "the following" before a list. The colon is there because the list isa restatement of "the following", not because it is a list. Note that two sentence back, I used a colon where the restatement was not a list. Similarly, I don't use a colon when the list is
  - the object of a verb,
  - the object of a prepositional phrase,
  - or any other grammatical construct that is not a restatement or amplification of what came before the colon.
- Most students in the class use "i.e." and "e.g." without knowing the Latin phrases that they are abbreviations for. I suggested that they not use the abbreviations if they wouldn't use the Latin, but use the plain English phrases that they would normally use: "that is" and "for example". If they must use the Latin abbreviations, they should at least punctuate them correctly—commas are needed to separate the "i.e." and "e.g." from what follows, just as a comma would be used with "that is" or "for example".
- Some students use the colloquial phrase "X is where …", when what they mean is "X is …". The "where" creeps in in some dialects of English to serve as a way of holding the floor while you think how to finish the sentence—it doesn't really belong in formal technical writing.
- "First", "second", and "last" are already adverbs. They don't need (and can't really take) an "-ly" suffix. It grates on me the way same way that "nextly" does. "Next" has exactly the same dual status as an adjective and an adverb, but for some reason does not often suffer the indignity of being draped with a superfluous "-ly".
- I recommend that students not use the verb "comprise", as few use it correctly. You can say that "x, y, and z compose A", "A is composed of x, y, and z", or "A comprises x, y, and z". The

construction "is comprised of" is strongly frowned on by most grammarists—avoid it completely, and avoid "comprise", unless its usage comes naturally to you. "Compose" and "is composed of" are less likely to get you in trouble.

- "Thus" does not mean "therefore"—"thus" means "in this manner". Note that "thus" is an adverb, so there is no "thusly".
- "Amount" is used for uncountable nouns (like "information"), while "number" is used for countable nouns (like "cells"). There are many distinctions in English that depend on whether a noun is countable or not (the use of articles, the use of plural, "many" vs. "much"), but "number" vs. "amount" seems to be the one that causes senior thesis writers the most difficulty.

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