Notes on writing

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The following notes contain mostly sentence-specific guidelines for writing about operations research (OR). These suggestions aren't particularly organized. Rather, they have simply been added in the order I encountered these issues while editing articles, theses and dissertations of OR students.

1. Read the following article: Brown, G.G., 2004, "How To Write About Operations Research," *PHALANX*, Vol. 37, No. 3, p. 7, which may be downloaded from http://faculty.nps.edu/gbrown/browngpu.htm.

2. If you're writing about optimization, read the following article: Brown, G.G., Dell, R.F., 2007, "Formulating Linear and Integer Linear Programs: A Rogues' Gallery," *INFORMS Transactions on Education*, 7(2), which may be downloaded from http://faculty.nps.edu/gbrown/browngpa.htm.

3. Put your name and the date on everything you write.

4. Be consistent. This includes selecting a lexicon and sticking to it. So, don't call a queueing buffer, a *buffer* in one place and a *waiting room behind the server* in another. Don't use the term *item* in one place and *component* when referring to the same thing in another. Being consistent also includes formatting issues. So, don't use: "Figure 1: This is a picture of a sea gull." and then later use: "Figure 2: This is a Photo of a Sea Otter." I prefer the former format. Be consistent in the mathematic notation you use. Don't use two different symbols to represent the same thing. Don't write x_i one time and x_k another without good reason. And, don't use the same symbol to mean two different things. Resist the urge to rationalize that this is simply an instance of "local usage."

5. In this *article*, we do such and such. Let's use *article* in place of other alternatives like, *work*, *paper*, *research*, *opus*, etc. If instead you're writing a *report*, *thesis* or *dissertation* use that term, or perhaps the local term *chapter*. If you're writing a book chapter, use *chapter*.

6. When listing items following a colon and separated by semicolons, capitalize the first letter if each entry forms a sentence. Example: In this article, we make the following contributions: (i) We provide a concise proof of Fermat's Last Theorem; (ii) We establish that $P = NP$; and, (iii) We provide an $O(n)$ sorting algorithm.

7. Despite what Microsoft says, in OR we use the spelling *queueing* rather than the alternative *queuing*. (There was once a comment on this in the journal *Operations Research*. If you stumble across it please let me know.)

8. We usually introduce notation when presenting a model, like "$i \in I$ indexes workers and $j \in J$ indexes jobs, and c_{ij} is the cost (\$) of working i performing job j." Later, when presenting numerical results (say) there is a tendency to ignore the notation that we have already presented. Avoid that tendency. Don't hesitate to say: We consider a problem instance with $|I| = 22$ workers and $|J| = 32$ jobs with unit costs, c_{ij}, as shown in Table 5. Furthermore, when presenting computational results, to the extent possible, present them so that the reader should be able to replicate your results. In other words, present a numerical example in sufficient detail that your results can be replicated.

9. The word "notation" is already plural. You don't need to write "notations."

10. Use so-called smart quotes, i.e., "quotes," not "quotes."

11. When writing a literature review, don't rely excessively on the terminology of the article you're reviewing. Rather, place the *ideas* from the article you're reviewing in *your* terminology.

12. Table 3, Figure 2, and Section 1 are proper nouns, and so are Lemma 1, Theorem 2 and Corollary 3. So, capitalize them.

13. We use e to denote the vector of all 1s. Write 1s and not 1's.

14. Clearly, we must then have
$$x \geq 0. \tag{1}$$
Equation (1) implies it is impossible for the following condition to hold:
$$x < 0.$$
Note both *sentences* include mathematics as part of the sentence and are punctuated accordingly. Also, these two examples show when we should, and should not, use a colon.

15. Don't number an equation, such as equation (1), *unless* you subsequently reference that equation. There is no reason to have an article with the clutter of equation (147). Editors at some journals let you write: In (1) we establish that x cannot be negative. Others rewrite that sentence as: In Equation (1) we establish that x

cannot be negative. I dislike calling (1) an "equation" since it's not an equation. I try to preempt such editing by writing: In inequality (1) we establish that x cannot be negative. Also, don't refer to inequality (1) as inequality 1. Similarly, don't refer to a numbered theorem or figure as Theorem (1) or Figure (3).

16. It's fine to say: The average number in queue, denoted L_q, may grow large. You can also say: The average number in queue is denoted by L_q, and L_q may grow large.

17. Using $\cdots$ (i.e., `\cdots`) versus ... (i.e., `\ldots`). Use the former in $1 + 2 + \cdots + n$, $x_1 = x_2 = \cdots = x_n$, $X_1 \subset X_2 \subset \cdots \subset X_n$ and the latter in $1, 2, \ldots, n$.

18. Avoid one-sentence paragraphs.

19. Just because a problem is NP-hard does not mean you should label it *intractable*. It is computationally feasible to solve large-scale instances of many "hard" problems.

20. Avoid footnotes. Most OR journals don't use footnotes.

21. When you put a period, latex assumes it is the end of a sentence. However, sometimes you write something like i.i.d. and don't really want the sentence to end. In that case, write `i.i.d.\` so that the previous sentence instead looks like: Sometimes you write something like i.i.d. and don't ...

22. Even if they seem obvious, things like i.i.d. and w.p.1., as well as things like, $I(\cdot)$ and $(\cdot)^+$, should be defined on first use.

23. Sometimes the use of "will" is necessary but often it is not. Instead of saying, "Later, we will show that $x = y$." it is enough to just say: "Later, we show that $x = y$."

24. We don't write, e.g., $O(2n)$ but rather $O(n)$ because the "2" is absorbed by the O. For the same reason, it doesn't make sense to write $O(\log_2 n)$ or $O(\ln n)$. Rather, we simply write $O(\log n)$.

25. When citing a series of references, e.g., [14,15,10], be sure to instead express them in numerical order, i.e., [10,14,15].

26. Make proper use of "i.e." which stands for "that is" and "e.g." which stands for "for example."

27. Always put a comma after "i.e." and "e.g." Also, write "i.e.," not "ie," "i.e," "i.e," or some other variant. Same for "e.g.,".

28. The word "impact" should not be used in place of "affect." The following sentence should replace *impact* by *affect*: "A batch arrival to a queue can significantly impact the waiting time of subsequent customers."

29. The words *affect* and *effect* are sometimes misused. The former is a verb and the latter is usually a noun. So, we can say: "The effect of rain is that the sidewalks become wet." Or, "The rain affects the sidewalks. They become wet." We can also use *effect* as a verb meaning "to bring about."

30. Suppose an article has three or more authors, e.g., Jones, Smith and Turner (2009). When you cite it, write Jones et al. (2009). Note that it is *et al.*, not *et al* or *et. al.* or some other variant. As indicated above, this is written in latex using `et al.\` to avoid excess space after the period.

31. When you have an indexed sum, integral, product, etc., that is "in-line" it should appear like $\sum_{t=1}^{T} x_t$. In contrast, when the same formula appears in so-called "display mode" it should appear like

$$\sum_{t=1}^{T} x_t,$$

i.e., with indices above and below the operator (summation sign).

32. Avoid writing things like "the above model," "the example we have just presented," "the previous theorem," etc., especially when these entities have labels. Instead, be precise and write things like "model (1)", "Example 3," and "Theorem 2."

33. In the context of an optimization model, avoid using the word "objective" as a noun. When we write "objective function," the word "objective" is an adjective. If we later write "the objective of model (1)" then we're (mis)using "objective" as a noun. Instead, write "the objective function of model (1)."

34. Consider the optimization model:

$$z^* = \min_{x \in X} f(x). \tag{2}$$

The function f is called the *objective function*. The set X is the *constraint set* and $x \in X$ are the *constraints*. A *feasible solution* is any x satisfying $x \in X$. An *optimal solution* is any x^* satisfying $x^* \in X$ and $f(x^*) \leq f(x)$ for all $x \in X$. Model (2)'s *optimal value* is z^*, and model (2)'s *optimal solution* is x^*. Please use this terminology. Avoid writing things like "x^* is the optimal value", "z^* is the solution", and "we solve model (2) optimally."