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Cormen's Rules of Usage

This document contains a list of 39 rules pertaining to usage and punctuation. Some of them appear in the classic *The Elements of Style* by Strunk and White. Others are drawn from *Bugs in Writing* by Lyn Dupré, and yet others are my own (perhaps idiosyncratic) rules.

Examples are written with a *slanted font*.

Rule 1: Form the possessive singular of nouns by adding *'s*.

You need to do so even if the noun ends in the letter *s*. Examples:

> *Dijkstra's algorithm*
> *Farkas's Lemma*

For the plural, use an apostrophe without the *s*:

> *the computers' monitors*

It is a common error to confuse *it's* and *its*. *It's* is a contraction meaning *it is*. *Its* means *belonging to it*.

> *It's a valuable disk that protects its own surface.*

Rule 2: Use the serial comma.

In lists of three or more elements, put commas between the terms. It is better to write *Aho, Hopcroft, and Ullman* than *Aho, Hopcroft and Ullman*.

The serial comma makes the logical structure of your list clear. Although you can often omit the serial comma without loss of clarity, I find that writers who omit the serial comma in one place often use it somewhere else, leading to an inconsistent style. To ensure consistency, I insist that you always use the serial comma.

If the elements of your list are themselves sequences, use semicolons between them and commas within the sequences:

> *Some of my favorite books were written by Aho, Hopcroft, and Ullman; Stein, Drysdale, and Bogart; and Graham, Knuth, and Patashnik.*

Rule 3: Enclose parenthetical expressions between commas, parentheses, or em-dashes.

Note: an em-dash is the longest kind of dash that you can create on your computer. In T_EXor L^AT_EX, type three hyphens in a row. On a Mac, you produce one by typing Shift-Option-Hyphen. I don't know how to produce an em-dash in Windows, and I don't care. I never put spaces around an em-dash, but the *Chicago Manual of Style* now allows them.

The choice of commas, parentheses, or em-dashes depends on how parenthetical you want to make the expression. Commas are the least parenthetical, whereas parentheses and em-dashes are more parenthetical.

My guideline (not quite a rule) about when to use dashes versus parentheses is as follows. Check whether you would lower your voice when saying the parenthetical expression. If you would lower your voice, use parentheses. If not, use dashes. Many writers overuse em-dashes, however, and so I urge you to use them in moderation.

Have you ever seen the opening to the old *Adventures of Superman* TV show? The announcer lowered his voice in the midst of the sentence, and so we'd write it within parentheses:

> *And who (disguised as Clark Kent, mild-mannered reporter for a great metropolitan newspaper) fights a never-ending battle for Truth, Justice, and the American Way.*

In the next example, you would probably not lower your voice, and so we write it with em-dashes:

> *C++—an attempt to shoehorn object-oriented programming into C—presents many pitfalls for the unsuspecting programmer.*

Use commas around garden-variety nonrestrictive clauses:

> *I first tried the top search engine, Google, to find the part.*

If the clause is restrictive, do not use commas:

> *The part that I ordered arrived damaged.*

Rule 4: In a compound sentence, separate the two parts by a comma, followed by *and*.

A compound sentence consists of two clauses that each have their own subject and verb.

> *The program is correct, and it runs in linear time.*

If you have one subject and two verbs, you do not have a compound sentence, and you do not put in the comma.

> *The program is correct and runs in linear time.*

Try not to put a comma in a sentence to insert a pause if you do not have two clauses, each with its own subject and verb. Although sometimes it's good to have the comma to help the reader parse the sentence, consider rewriting the sentence if you really need a pause.

The following sentence seems to need a pause before *and*. Putting a comma here would be wrong, however.

> *The program is correct and runs quickly on a cluster when properly parallelized.*

Instead, you can write one of the following:

The program is correct. It runs quickly on a cluster when properly parallelized.

The program is correct; it runs quickly on a cluster when properly parallelized.

You may place a comma before *but*, even if the second part of the expression does not have a subject.

The program is correct, but is horribly written.

Rule 5: Do not join independent clauses by a comma.

Use a full stop or a semicolon. The following is incorrect:

The program is correct, it runs in linear time.

The above sentence exhibits a *comma splice*. Comma splices are bad. You can rewrite the offending sentence as one of the following:

The program is correct. It runs in linear time.

The program is correct; it runs in linear time.

Rule 6: Use a colon to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation. If you can eliminate the colon and get a sentence that is gramatically correct and means the same thing, then eliminate the colon.

The following is wrong:

The cluster includes: 32 nodes, a rack, and a high-speed network.

If we omit the colon, we get a sentence that is grammatically correct and means the same thing:

The cluster includes 32 nodes, a rack, and a high-speed network.

So omit the comma in this case.

According to Strunk and White, a colon tells the reader that what follows is closely related to the preceding clause. A colon has more effect than a comma, less separation power than a semicolon, and more formality than a dash.

Here are some examples of correct colon usage.

- List of particulars:

    To be a good programmer requires the following: patience, memory, and love of pizza.

- Appositive:

    I wrote the program in my favorite language: APL.

- Amplification:

    Always check the denominator: dividing by zero will make your computer explode.

- Quotation:

    And then I heard those dreadful words: "the blue screen of death."

Rule 7: A participial phrase at the beginning of a sentence must refer to the grammatical object.

The following statement is unclear:

> *Having crashed, I rebooted the computer.*

This example implies that *I* crashed, not the computer. A better way to convey the correct image would be

> *I rebooted the computer, because it had crashed.*

Rule 8: Use exclamations sparingly.

Don't overuse exclamations! When you use them too much, your writing reads as though you're always shouting! It's hard for the reader to understand what's really important when everything is shouted! It really is! No kidding!

In the 1200 pages of *Introduction to Algorithms*, second edition, there are exactly 11 exclamations, which works out to one exclamation per 109.1 pages. In fact, I would say that even some of these should not have been exclamations. One such example occurs in a parenthetical expression. If you're supposed to lower your voice when saying a parenthetical expression, how can it be an exclamation?

Rule 9: Hyphenate compound adjectives.

Put the hyphen when a compound phrase is (1) used as an adjective and (2) the first word of the adjective phrase modifies the second word of the adjective phrase, and not the noun following it.

If you want to write about the algorithm that is the most famous, then you should write *best-known algorithm*; here, *best* modifies *known*, not *algorithm*. If, however, you want to write about the algorithm that, of all known algorithms, is the best, then you should write *best known algorithm*; here, *best* modifies *algorithm*.

Similarly, do not write *real world problem*. Write *real-world problem*.

How about *well studied problem*? Here, *well* is an adverb, and so it cannot be construed as modifying *problem*; you wouldn't write about a *well problem*, would you? Thus, *well* must be modifying *studied*, and so we omit the hyphen.

In some cases with two adjectives and a noun, it's hard to imagine the first adjective modifying the noun. Still, you should include the hyphen: *second-largest element*. But if the adjectives follow the noun, and it's clear that the first adjective can modify only the second adjective and not the noun, then omit the hyphen:

> *This element is the second largest.*

Rule 10: Use parentheses and punctuation correctly.

A parenthetical passage is either part of a sentence or it is one or more whole sentences. Punctuate it as such.

- If it is a part of the sentence, put the period after the right parenthesis.
  Bad: *I went home (by way of the bar.)*
  Good: *I went home (by way of the bar).*

- If it is one or more sentences, put the period before the parenthesis so that the sentences inside parentheses are properly punctuated.
  Bad: *I went home. (But first, I stopped at the bar).*
  Good: *I went home. (But first, he stopped at the bar.)*

Think of it this way: sentences and parentheses nest. So if you begin a sentence and it contains a left parenthesis, then the right parenthesis must appear before the punctuation that ends the sentence. And if you have a left parenthesis before the start of a sentence, then the punctuation that ends the sentence must appear before the right parenthesis.

Rule 11: Use *between* for two and *among* for three or more.

> *The records are distributed among four disks.*

> *The system switches between two states.*

Rule 12: Use *can* for ability and *may* for permission.

I can tell you that you may leave at 12:20.

Rule 13: *Compare with* and *compare to* are different.

When you want to point out differences between similar things, use *compare with*. When you want to point out similarities between different kinds of things, use *compare to*.

> *Reagan was compared to Teflon.* [Reagon was not low-friction material, but someone observed that nothing stuck to either one.]

> *Compared with Carter, Reagan was more decisive.* [Both Reagan and Carter were U.S. presidents, but Reagan made decisions quicker.]

Rule 14: *Comprise* does not mean *compose*, and you don't use *comprise* in the passive form.

It is correct to write

> *The cluster is composed of compute nodes and a network.*

It is not correct to write

> *The cluster is comprised of compute nodes and a network.*

But it is correct to write

> *The cluster comprises compute nodes and a network.*

A former student put the rule succinctly: *The whole comprises the parts.*

Rule 15: There is no such phrase as *different than*.

But *different from* is fine.

Rule 16: *Affect* is different from *effect.*

Many Dartmouth students confuse these words in their writing. *Effect* means "to cause to happen," whereas *affect* means "to influence."

> *The faculty effected reforms in the curriculum that affected all new students.*

Rule 17: Try to avoid using *etc.*

The abbreviation *etc.* stands for the Latin phrase *et cetera*, and it means "and others." If used in a phrase beginning *such as* or *for example*, it is unnecessary because there is already a notion that not all examples are being listed. Thus, the following is bad:

> *The heterogeneous cluster has machines from vendors such as Dell, Hewlett-Packard, etc.*

Rule 18: *Farther* refers to physical distance, and *further* does not.

We typically use *further* for time, quantity, or some conceptual distance.

> *As I went further into my education, I lived increasingly farther from my parents.*

Rule 19: *Hopefully* means "with hope."

Do not use *hopefully* at the beginning of a sentence to mean "I hope" or "it is hoped." This use of *hopefully* is vague and makes the expression timid.

Rule 20: The worst place to use *however* is at the beginning of a sentence.

However is a wonderful word to denote a small contradiction, but it gives a much better rhythm in the middle or at the end of a sentence than at the beginning.
    This example is choppy:

> *I looked over your program. However, I have yet to find the bug.*

Either of the following has a better flow:

> *I looked over your program. I have yet to find the bug, however.*

> *I looked over your program. After reading it for over an hour, however, I have yet to find the bug.*

When *however* means "in whatever way" or "to whatever extent," it's fine at the start of a sentence:

> *However you write a program, it won't solve the halting problem. However many times you try, you won't succeed.*

Rule 21: Use *fewer* for countable objects and *less* for quantities that are not discretely countable.

You can count gigabytes of RAM, but *memory* is a mass noun that is not discretely countable:

> *My laptop has fewer gigabytes of RAM than the cluster, and therefore it has less memory.*

Rule 22: Use *such as* when your example is one of the things, and use *like* when your example is not one of the things.

This rule is perhaps best explained by example. If we write about *programming languages such as COBOL*, we are writing about some set of programming languages and COBOL is one of the languages in the set. If we write about *programming languages like COBOL*, we are writing about some set of programming languages that bear some similarity to COBOL (perhaps they are no longer taught in universities, are intended to be English-like, or were designed in the 1950s), but COBOL is *not* in this set.

Rule 23: Use *as* for verbs and *like* for nouns.

The following are correct:

> *Your program runs as my program does.*

> *Your program runs like the wind.*

Rule 24: Avoid using *one* to mean a generic person.

When I was a kid, I had a friend who would play baseball inside the house. His sister would yell at him, "One does not play baseball inside the house." His response was, "Can two?"
    Using *one* for a generic person is stilted. You can almost always reword to avoid the need for it. Instead of

> *One must take care not to divide by zero.*

you can write

> *Do not divide by zero.*

Rule 25: Try to avoid using *they*, *their*, and *them* to refer to just one person.

English has no pronoun for a gender-neutral, third-person, singular human. We are forced to attach a gender:

> *A thief robs a store. He wants to take as valuable a load as he can.*

How do we know that the thief is male? We don't. Perhaps we could instead write

> *A thief robs a store. They want to take as valuable a load as they can.*

The problem here is that, strictly speaking, *they*, *their*, and *them* are plural pronouns. Granted, in speech, we often use *they*, *their*, and *them* for a gender-neutral, third-person, singular human. If the subject is not human, we can use *it* or *its*, but what to do for third-person, singular humans when the gender is not known in advance? I have seen various suggestions:

- Always use male gender: *he*, *him*, *his*.

- Always use female gender: *she*, *her*, *hers*.

- Switch back and forth. Make some characters male and some female. An interesting variation is to always choose the less expected gender, so that the doctors are female and the nurses are male.

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- Use *he or she*, *him or her*, and *his or hers*.

- Use *s/he* or *he/she*, *him/her*, and *his/hers*.

- Join the small bandwagon of those who use new, gender-neutral words such as *ze* and its possessive form, *zer*.

- Give up, and use *they*, *their*, and *them*.

- Rewrite to avoid the pronouns altogether.

None of these choices is perfect. I used to prefer the first choice: always use male gender. As I've become more attuned to the issue of women in computer science, I've become more sensitive to how exclusionary this language can be. But writing *s/he* or *he/she* looks bad, in my opinion. The female-only and switching-gender approaches have their merits, but is formal, academic writing really the forum for making a social statement? For a while, I would write—with lukewarm enthusiasm—*he or she*, *him or her*, and *his or hers*. Lately, I have rewritten to avoid the pronouns altogether. For example, in the fourth edition of *Introduction to Algorithms*, I've rewritten the passage about the thief to read as follows:

> *A thief robbing a store is carrying a knapsack that can hold at most W pounds of loot. The thief can choose to take any subset of n items in the store. The i th item is worth v_i dollars and weighs w_i pounds, where v_i and w_i are integers. Which items should the thief take? (We call this the 0-1 knapsack problem because for each item, the thief must either take it or leave it behind. The thief cannot take a fractional amount of an item or take an item more than once.)*

The *Chicago Manual of Style* is softening its stance on *they*, *their*, and *them* as singular pronouns; see https://www.chicagomanualofstyle.org/book/ed17/part2/ch05/psec048.html.

Rule 26: Avoid wimpy expressions such as *one of the most*.

My wife and I drove the Trans-Canada Highway on our honeymoon. In Saskatchewan, we saw a sign that read, "One of southern Saskatchewan's fastest growing churches." *Any* church in southern Saskatchewan could make that claim: make a list of churches in southern Saskatchewan, order the list by how fast they grow, and sure enough, the church is somewhere in the list.

Rule 27: Avoid *secondly*, *thirdly*, and so forth.

Would you write *firstly*? I hope not. While you're at it, avoid *lastly*; use *finally* instead.

Rule 28: Use *shall* for belief and *will* for determination.

Actually, Strunk and White recommend using *shall* for first person and *will* for second and third person.

But a better way to think about *shall* and *will* is that *shall* expresses belief regarding the future, and *will* expresses determination or consent. Here is a pithy example:

A swimmer in distress: *I shall drown; no one will save me!*

A suicidal swimmer: *I will drown; no one shall save me!*

Rule 29: Use Latin abbreviations correctly.

When you use *i.e.*, you mean *that is*, since *i.e.* is an abbreviation for the Latin *id est.* Just as you would put a comma after *that is*, you should put one after *i.e.*:

> *We are at the northermost Ivy, i.e., Dartmouth.*

When you use *e.g.*, you mean *for example*, since *e.g.* is an abbreviation for the Latin *examplia gratia.* Again, put a comma afterward:

> *Consider some Ivy, e.g., Dartmouth.*

When you use *et al.*, you mean *and others*, since *et al.* is an abbreviation for the Latin *et alia.*:

> *The book on design patterns was written by Gamma et al.*

Note that you put a period after both the *i* and *e* in *i.e.*, after both the *e* and *g* in *e.g.*, but after only the *al* in *et al.*

Try not to begin a sentence with these abbreviations, and put them in the same font as the surrounding text. (In other words, if you're using a garden-variety roman font, don't switch to italics for *i.e.*, *e.g.*, or *et al.*)

Rule 30: *That* is restrictive, and *which* is not.

Use *that* when you are narrowing down the space of possibilities. Use *which* when you are providing amplification.

> *The program that computes pi to a trillion places ran for five days.* [Of all the programs, only the one that computes pi to a trillion places ran for five days.]

> *The program, which computes pi to a trillion places, ran for five days.* [The program ran for five days. By the way, said program computes pi to a trillion places.]

If you remove a *that* (i.e., restrictive) clause, you destroy the original meaning of the sentence. If you remove a *which* (i.e., nonrestrictive) clause, you leave the meaning intact.

Do not set off *that* clauses by commas. You usually should set off *which* clauses by commas.

When you write, use the search feature of your word processor to find each *which* and verify that it really should be a *which* and not a *that.* This process is known as *which hunting*, and you do it to remove *wicked whiches*.

Another pitfall of using *which* is that it refers to whatever word precedes the comma before the *which.* The following sentence is incorrect:

> *I dropped my laptop, which was clumsy.* [Asserts that the laptop was clumsy.]

Either of the following would be better:

> *I dropped my laptop; doing so was clumsy of me.*

> *I clumsily dropped my laptop.*

One exception occurs when you would have two *that*s closely spaced in a sentence. In this case, you may change the second *that* to *which*:

> *We found that the sorting algorithm which is oblivious ran faster than expected.*

Rule 31: None of *this, that, these,* or *some* is, on its own, a noun phrase.

Consider the following example:

> *I asked Priya to work harder. This proved to be a mistake.*

This what?

1. Asking Priya to work harder?

2. Priya actually working harder?

3. The work produced by Priya because she worked harder?

Once we pick one of the above, we can clarify what we mean:

1. *This request upset Priya to the point that she ran me over with her car.*

2. *Priya's extra effort caused her to become irritable.*

3. *al-Qaeda used the information in Priya's publications to launch terrorist attacks.*

If you are tempted to use *this* or *that* as a full noun phrase, first answer the following question:

> This *what*?
> or
> That *what*?

Then insert the noun that answers this question after *this* or *that*.

> *This decision proved to be a mistake.*

In some circumstances, you may omit the noun if the omitted noun appears soon thereafter and there is no ambiguity:

> *To be or not to be: that is the question.*

Shakespeare knew not to write

> *To be or not to be: that question is the question.*

Rule 32: Do not use *aforementioned*.

Using *aforementioned* is just a pet peeve of mine. I consider it a pretentious, sophomoric word. I should know: I used it enough back when I was a pretentious sophomore.

Rule 33: *Try* takes the infinitive.

Try and prove that P = NP is wrong. *Try to prove that P = NP* is correct.

Rule 34: Use *very* sparingly.

Mark Twain once wrote

> Substitute "damn" every time you're inclined to write "very"; your editor will delete it and the writing will be just as it should be.

Rule 35: *While* refers to time or duration.

Do not use *while* when you should use *and*, *but*, or *although*. (I admint that I'm a bit pedantic about this rule.)

This sentence is incorrect:

> *While most theoreticians believe that P $\neq$ NP, a handful think the opposite.*

Because *while* has a temporal meaning, this sentence implies that that during those time periods in which most theoreticians believe that P $\neq$ NP, a few others believe that P $=$ NP. We have no idea what this radical fringe thinks during those time periods in which most theoreticians do not believe that P $\neq$ NP. A better way to write this sentence would be to use *although*:

> *Although most theoreticians believe that P $\neq$ NP, a handful think the opposite.*

In this example, you can use *but* instead of *while*, moving it to the start of the second part of the sentence:

> *Most theoreticians believe that P $\neq$ NP, but a handful think the opposite.*

Here are some correct uses of *while*:

> *The FG software makes it easier to write a program that uses the CPU while disk accesses occur.*

> *While I was a MIT, Tip O'Neill retired from Congress.*

To bring home the point, there's a computer-science joke about *while*:

> Did you hear about the computer scientist at the supermarket? A call came from home: "While you're there, get eggs." The computer scientist came home with all the eggs.

Rule 36: *Only* modifies only the term that follows it.

It's easy to misplace *only* in a sentence, so always keep this rule in mind. Here are some sentences that differ only in their placement of *only*, along with the proper interpretation of each:

> *Only we concentrate on finding the running time.* [In all the world, we are the only people who concentrate on finding the running time.]

> *We only concentrate on finding the running time.* [We do nothing but concentrate on finding the running time. We don't eat, sleep, or go to the bathroom. All we do is concentrate on finding the running time.]

> *We concentrate only on finding the running time.* [When we concentrate, the only thing we concentrate on is finding the running time.]

> *We concentrate on finding only the running time.* [Whenever we concentrate on finding something, that something is the running time.]

Rule 37: When enclosing a colloquialism in quotation marks, make sure that it's really a colloquialism.

Quotation marks are good for indicating irony:

> *The "fast" program turns out to be slower than the "slow" program.*

And they're good for true colloquialisms:

> *If you had invested in Google in the 1990s, you could be "living the life of Riley."*

But there's little that's sadder than quotation marks meant to indicate a colloquialism that isn't. A supermarket near where my parents lived had a sign outside the entrance reading

> *For your convenience please take a "shopping cart" before entering the store*

which always leaves me wondering in what way the conveyance is like a shopping cart but is not actually one.

Rule 38: Commas and periods go inside quotation marks. Colons and semicolons go outside quotation marks. Exclamation marks and question marks go inside our outside, depending on the context.

This rule is the American style of punctuation.

> *The error messages were "null pointer exception," "array index error," "and stack overflow."* [The commas and period didn't actually appear in the error messages, but they need to be in the sentence. Hence, they go inside the quotation marks.]

> *The error message was "null pointer exception"; this message was more helpful than "segmentation fault."* [The semicolon didn't appear in the message, and so it goes outside the quotation marks.]

> *Windows offers the following "advantages": difficulty of use, bugginess, and security holes.* [The colon is not part of the ironic phrase, and so it goes outside the quotation marks.]

> *The first section is titled "Why Study Out-of-Core Sorting?"* [The question mark is part of the title, so it goes inside the quotation marks.]

> *Why did you call the second section "Out-of-Core Sorting for Dummies"?* [The question mark is not part of the title. The entire sentence is a question, so the question mark goes outside the quotation marks.]

If you read British English, you might notice that the British convention is different from the above rules. In British English, commas and periods are placed according to the context, so you'd see

> *The error messages were "null pointer exception", "array index error", "and stack overflow".*

The logician in me prefers the British system, but we're in America, and we'll use the American system.

Rule 39: Know when to write out numbers and when to use digits.

Unfortunately, the rules for writing out numbers vs. using digits are rather complicated. There is no universal agreement, but here are the rules that I'd like you to observe.

The most general rule is to spell out *zero*, *one*, *two*, . . . , *nine* and use digits for all other numbers. There are many exceptions, however.

- If a number begins the sentence or follows a colon, spell it out.

    - BAD: *32 nodes constitute the cluster.*
    - OK: *Thirty-two nodes constitute the cluster.*
    - BETTER: *The cluster contains 32 nodes.* [Reword the sentence to not start with the number.]

- If a number is coupled with units of measure, use digits.

    The cable is 3 meters long.

    It took only 6 seconds to compile the program.

    Using threads made columnsort run 2 times faster.

- If the number appears in a series, and some number in the series is written in digits, then they should all be written in digits:

    We ran the program on 4, 8, and 16 nodes. [Even though 4 and 8 are less than 10, they are part of a series in which some numbers are written in digits, and so we write 4 and 8 in digits as well.]

- Use numerals with *thousand*, *million*, *billion*, and so on. Use *$* for money.

    The cluster cost $2 million.

- Spell out the ordinals *first*, *second*, *third*, *fourth*, *fifth*, and so on. If you must use digits followed by *th*, do not raise the *th*, and do not let Microsoft Word force you to raise the *th*.

    It is the 78th fastest computer in the world. [78th would be wrong, despite what the good folks in Redmond think.]

- Spell out fractions according to whether you would spell out an integer in the same position in the sentence.

    - BAD: *I wrote 1/2 of the bugs in the team's program.* [Bad because you would write *I wrote two of the bugs in the team's program.*]
    - OK: *I wrote one-half of the bugs in the team's program.* [Note that spelled out fractions take a hyphen.]

    For *one-half*, you can often just write *half*, but you cannot do that for other fractions.

    - OK: *I wrote half of the bugs in the team's program.*
    - BAD: *I wrote quarter of the bugs in the team' program.*