



# Critical Thinking

THE THREE RS OF COLLEGE LIFE: READING, REASONING, AND WRITING



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## Why critical thinking?

The aim of a college education is partly to provide you with information, partly to provide you with intellectual and aesthetic experiences, but above all it is to teach you how to think. The objective is not so much to fill your mind as to give you a new mind. What kind? In two words, a critical and analytic mind. You should emerge with a critical attitude whereby you will not just accept information, whoever hands it to you, but will examine the information in the light of reason, and reject that found wanting. You should also have the intellectual equipment to do this, and this means that you must be able to think analytically: to read with point and purpose, extract claims and the reasons given for them, determine which claims should be accepted and which should not be, and (since the views you arrive at are typically not things you want to keep to yourself) to effectively communicate your views to others.

Some advantages of having a critical attitude will be indicated below, but we assume you regard that as something desirable. Our aim in what follows is to help you develop the analytic abilities without which a critical attitude will come to nothing. We set out some basic principles of how to read, think, and write which can be mastered in an easy afternoon's reading. You cannot, of course, expect to have the skills after that reading, any more that you could expect to be able to play tennis after reading a book on how to do it. In both cases, as with all skills, practice is necessary. But practice is pointless or harmful if one does not know what to practice. And that is something you can learn in an afternoon.

But first there is a motivational question. Why should you want to have these analytic abilities? It is easy to reel off a number of answers. They promote freedom: once you can effectively enquire on your own you will be freed from intellectual dependency on others. They are a logical armour against the welter of misinformation we are daily exposed to: you will be able to safely consult the internet, read advertising, listen to the media, and be turned loose in libraries or a psychic fair. Finally, they promote true beliefs: analytic abilities plus a critical attitude can be counted on to give you a more accurate picture of the world. And true beliefs may be valued partly for their own sake--it is nice to know how things are--and partly because they help you get what you want--if you want to get to Metrotown or enjoy good health, you had better have reliable information about the bus service and diet.

But such grandiose promises may not be motivation enough for harried students who want more immediate gratification. What, you may want to know, will skill in critical thinking do for me here and now? So we add one more advantage: it will help you with your courses. Think about the kinds of things you are asked to do in them. An assignment may ask you to take a claim (e.g., Human life began in Africa; At one time the continents were all joined), identify the evidence for the claim, and say whether it convinces you, explaining why or why not. Or an assignment may set you a question (e.g., Should deep tax cuts be made to stimulate the economy?; Is privatization of health care a good idea?) and ask you to say what you think and why you think that, explaining why alternative answers are not as good as yours. Helping with these kinds of questions is the bread and butter of critical thinking, and that should give you immediate incentive.



This manual is designed to be a companion to your classes. We hope that it will enable you to see things and give direction to your thoughts that will help you with your course-work, and that your course-work will provide examples and exercises which will help you make the theory we present a part of your intellectual equipment.

### **What is critical thinking about?**

Reading, thinking, and writing are all activities done with the use of language. Language will thus be central to our concerns, but not all uses of language. We use language for a variety of purposes, for example, to raise questions (What time is it?), give orders (Shut the door), express emotions (Wow!), evoke images ("I have measured out my life with coffee spoons"), and state facts (My apartment has mice). We are only interested in fact-stating discourse.

By limiting our interest to this, we are not saying that the other uses of language are second class citizens of the linguistic world. We do so because critical thinking is only concerned with what we should believe. To believe something is to think that it is true. And only fact-stating discourse can be regarded as true or false. That is why we are only interested here in fact-stating discourse; but we are not interested in all fact-stating discourse.

Sometimes one claims that something is true on the basis of observations. These can be simple (The cat is on the mat) or complex (Uranium has a melting point of 1132.3 degrees C). Alternatively, sometimes the claim is made on the basis of a definition, not any observations at all. The definition may report how speakers of the language use a word (e.g., An aunt is a sister of one's mother or father), or it may be the result of someone inventing a word and giving it a technical meaning (e.g., A moron is a person with an IQ between 50 and 70).

We will not be concerned with any of this kind of fact-stating discourse. Our sole concern will be with fact-stating discourse where one claims something is true and then goes on to give some reason or reasons to think it is true, i.e., where one claims things like "The collapse of Enron will be followed by a downturn in the market because ....." or "The reason why Robert Latimer should not stay in jail is ....." where what fills in the blanks gives grounds for thinking the claims to be true.

Our subject-matter is thus claims backed by reasons, or, more simply, arguments. It is important to remember that, in logic, the word "argument" just means this: a structured group of sentences where a person tries to establish one, called the conclusion, by appealing to the others, called the premises. This is what we will use the word to refer to in what follows, not (as it is often used in ordinary language) to some kind of acrimonious discord. It is also important to understand that the primary function of an argument is not to persuade one to accept a view, but to establish a view, i.e., to give good reasons for it. An argument is good if one ought to accept the conclusion, whether or not anyone actually does.



We encounter arguments in many ways. Sometimes others present them to us. Sometimes we present them to others. These are familiar enough occurrences. But equally important is something we do not always keep in mind: we present ourselves with arguments. This may sound odd, but we do this whenever we try to make up our mind about what to think. For example, take something that you are not sure about, and wonder what position you should hold on it, e.g., Medicare should cover naturopathic health care; The universe will continue to expand forever; Sea-life emerged before land-life. Now reflect on what you do when you do this. You read or think some, frame a preliminary view, and assemble reasons for it. Then you reflect on whether those reasons are good enough. You look at the other side, see what reasons can be offered for it, consider whether they can be rebutted, and ask whether those left standing support their conclusion better than your reasons support your conclusion. That is, when you try to make up your mind, you argue with yourself.

If it is true information that we are interested in accepting and communicating, we must be interested in arguments. One can hold beliefs on all kinds of grounds that have nothing to do with arguments, and nonrational means of persuasion are often more effective than rational. But the only way we can have any assurance that information is true is to enquire after the reasons for thinking it true, and whether those reasons are good enough, i.e., considering whether the arguments for it are good ones.

### How to read

Whether you are attending to an argument presented by someone else, or rummaging around in your own thoughts, the first thing to do is to get a clear picture of what the claim being made is, and the reasons that are given for that claim. One common way in which arguments come to us is in written material, and we thus begin with some advice on how to read. With suitable alterations, the same principles apply to how to listen and how to edit and understand your own thoughts.

Reading is typically hard work, and if a first reading does not provide a clear understanding, students often conclude one of two things. If they are modest, that the material is too hard for them. If they are arrogant, that since it does not make sense to them, it does not make sense period. Both reactions are likely premature. To avoid them, it is important to go about reading in the right way. The 17th Century philosopher-mathematician-physicist Rene Descartes recognized this, and at the beginning of one of his works, the *Principles of Philosophy* (which was, incidentally, written as a textbook), gave readers some splendid advice on how to proceed.

"I should desire that it [the book] may first of all be run through in its entirety like a novel, without forcing the attention unduly upon it, or stopping at difficulties which may be met with, so that a general knowledge may be arrived at of the matters of which I have treated; and after that, if it is found that they deserve to be examined more carefully, and if the reader has the curiosity to inquire about their causes, it may be read a second time in order to notice the sequence of my reasoning. But though the reader cannot follow the argument adequately throughout, or understand the whole of its bearing, he must not therefore immediately cast it aside. It is only necessary to mark with a pen the places where difficulty is found, and continue to read without interruption to the end. Then if the



book is taken up for a third time, I venture to say that he will discover the solution of the greater part of the difficulties which have formerly been marked, and that if certain still remain, their solution will be discovered on a further perusal."

To this advice, we add the following. Reading material where an author is trying to establish certain claims is not something that can be done with the mind comfortably placed in neutral. The first thing one should do is to ask oneself the obvious but often unasked question: What is the book (or chapter or article) about? What problem is the author out to provide an answer to? Most authors take great pains at the beginning of anything they write to make it plain what the point of it is. This typically takes the form of stating a problem and trying to excite the reader about it. If one does not give a damn about the problem, then the reading will be about as interesting and make as much sense as the phonebook. An interest in the subject-matter is thus the first thing to cultivate; resolve to give it a fair try. And then, having understood the question or questions the author seeks to address, approach the text aggressively, looking for the author's answers, and her reasons for those answers. This may take the three readings Descartes suggests. Or it may take more. Or if you are lucky or smart, less. But unless you have a grip on this material, you have not understood the text.

Everyone has had the experience of reading an article in which an author quotes a lengthy and densely-written passage, and then says: What Marx (or Freud or whoever) is arguing here is ....., and boils it down into a few sentences where the premises and conclusion are identified. A flood of light is suddenly shed on what at first seemed impenetrable, and now that the Marx's thought is out in the open, you may also be able to do what you could not before, namely, say whether you agree or disagree with it.

The reading you do should result in a similar understanding: a clear identification of the author's conclusion and the premises on which that conclusion relies. Sometimes a piece of writing only has one argument in it. The author may have three premises and a conclusion. Thus the argument would look like this:

- Premise 1
- Premise 2
- Premise 3
- Conclusion

Sometimes the text is more complex than this. The author may have more than one argument for the conclusion. There may be a number of different angles from which a conclusion can be approached, all of which are independently sufficient to establish that conclusion. Including these adds richness to a thesis. The more reasons one can give for a conclusion the better established the conclusion will be, and it is nice to have back-up arguments in the event that some arguments fail. The individual arguments the author presents also may be more complex than the above. The whole point of arguing is to take readers from views--premises--that they will readily accept to views--conclusions--that they will not readily accept. Thus when an author notices that a premise in her argument may be disputed



by the audience she is addressing, she may provide reasons for accepting that premise. Thus the argument may look something like this:

- Premise 1a
- Premise 1b
- Premise 1 (conclusion from Premises 1a & 1b)
- Premise 2a
- Premise 2 (conclusion from Premise 2a)
- Premise 3
- Conclusion

The argumentation may be even more complex, as when the author notices that some of the premises of the sub-arguments are open to question, and has provided reasons to accept those. Thus the argument may have the shape:

- Premise 1ai
- Premise 1a ii
- Premise 1a (conclusion from Premises 1ai & 1a ii)
- Premise 1b
- Premise 1 (conclusion from Premises 1a & 1b)
- Premise 2ai
- Premise 2a (conclusion from Premise 2ai)
- Premise 2 (conclusion from Premise 2a)
- Premise 3
- Conclusion

And so on through other variations. All this may occur in a single paragraph, or an entire article, or as chapters in a book that add up to the conclusion. Understanding the author's argument gives you reason to accept the conclusion. Sometimes that is all there is to it; there is no case for another side, and the argument is conclusive. But sometimes a contrary conclusion is backed by a good-looking argument or set of arguments. When this is so, having reason for a view is not a sufficient reason to accept that view until there is reason to think that the arguments on the other side are defective. Thus we find authors anticipating arguments against their theses and responding to them. This often gives a text a complex structure. But the complexity is (we hope you now see) unavoidable. Until an author gives a reader reasons to accept her conclusion, and reasons to think that everyone who disagrees with that conclusion is wrong, the author has not given the reader sufficient reason to agree with her.

Mastering a text, whether simple or complex, always thus consists in identifying arguments. Readers can be helped to do this by looking out for certain words. Some words tip us off that what follows them is a conclusion, e.g., "therefore", "thus", "hence", "it follows that", "from this we may conclude", &c. Other words suggest that what follows is a premise or set of premises, e.g., "because", "since", "for", "given that", "for the reason that", &c. But these words can only be used as hints, collateral evi-







In interpreting and formulating an author's views, do the best you can for the text. Assume that the author is not an idiot, and read it in the most charitable and sensible way possible. If you think that what the author says is just plain silly, there is a very good chance that you have misunderstood. Thus a careful re-reading is called for. Ask yourself: Does the author really want to say that? Is there some more plausible way of interpreting his remarks? The purpose of spending time with texts is to learn something, and if you do not treat them with some care you are likely not to learn as much as you could. Of course, sometimes authors do say silly things, and when they do it is perfectly apt to attribute them to them. But when you do, be sure you have the goods on the author, and that there is textual evidence for your formulation and no more plausible way of reading the text.

One final word. Do not look down upon the task of giving an exposition of another's thoughts. That is often more difficult and time-consuming than it looks, and is a genuine intellectual exercise. So treat it with respect, and do not be impatient to get on with your critical remarks. If you have not interpreted the text properly, your evaluations will miss their mark. If you have a nice clean formulation of the author's views you will not only treat them fairly, you will be in a position to make a systematic assessment of them.

### Arguments for claims

It will be useful to distinguish between two kinds of arguments in support of a claim. The first is one that invites us to accept the conclusion on the basis of premises that lay out the full chain of reasoning, i.e., where the argument reads something like:

P1 All men are mortal.  
P2 Socrates is a man.  
Therefore, Socrates is mortal.

The second is one that invites us to accept the conclusion because some authority has asserted it, and has the form:

P1 Linus Pauling says that vitamin C cures colds.  
Therefore, Vitamin C cures colds.

Reasoning and authority are enormously important sources of information. If we could not appeal to them, the sphere of what we know would be limited to information immediately present to our senses and memory, i.e., to things like I see a cat on the chair, or I saw a cat on the chair. Since we could know precious little if we could only know these sorts of things, and since the only way in which we can expand our circle of information beyond them by is by chains of reasoning and appeals to authority, these sources of information must be of great interest to us. But they must also be treated with caution. We cannot accept any argument of either type uncritically without filling our minds with rubbish. Two questions thus arise. When should the conclusion of a piece of reasoning be accepted? When should information be taken on authority? We will take the second question first.



## Evaluating appeals to authority

Consider the following claims:  $E = mc^2$ ; Jupiter has no solid core; Fermat's last theorem has been proved; Matriarchal societies are common in Polynesia; Caesar crossed the Rubicon; Reptiles appeared on earth before birds. Most of us accept these. If asked why, the answer is authority: someone has told us they are true. If we now ask how they knew those things, the answer is often that they got them from some other authorities, and this chain may continue for some time. But ultimately the chain of authority must stop. Ultimately, someone must have done one of three things: made a direct observation (e.g., Margaret Mead's encounters with the matriarchal societies); produced a chain of reasoning (e.g., Andrew Wile's proof of Fermat's last theorem); or made a judgement which is not based simply on observations or reasoning, but on a "feeling" or "intuition" born of long experience in a field (e.g., Alan Greenspan's claim that we should be pessimistic about an early economic recovery).

Whether we should accept a claim on the basis of an authority depends on two things: the confidence we can place in the ultimate basis of the authority's claim, and how accurately those findings have been communicated to us. Where there is reason to question either, there is reason to be skeptical of claims based on authority. This is the basic idea to be borne in mind when examining appeals to authority. It is not possible or useful to provide a complete list of when we have reason to question authority, but four guidelines expanding on the basic idea may be helpful.

(1) Claims made on the basis of observations will be questionable to the extent that there is reason to think the observers were unreliable: uneducated, gullible, had a love of the wonderful, or had something to gain from making the report.

(2) Claims made on the basis of reasoning or studies will be questionable to the extent that they are contested by other experts in the field. Where opinions of equally qualified experts are equally divided we have a mutual destruction of the evidence, and can conclude nothing. We can likewise conclude nothing from a preponderance of opinion unless we have reason to think that what most think true probably is true. Sometimes we do, as when everyone is equally well-informed and of equal stature, but sometimes the minority has better credentials. We must also be wary of claims which are uncontested by experts in the field because they have not been reviewed. There are plenty of cautionary tales here. Professors Stanley Pons and Martin Fleischmann claimed they had shown that cold fusion (producing energy through nuclear fusion at room temperature) is possible and the University of Utah patented the process, but no one could replicate the experiment. Rafts of proofs of Fermat's last theorem have been generated since he propounded it in the 17th C, but none until Professor Wile's has stood the test of peer review. The practical counsel we offer is that you should not accept any claim until you have searched the peer-reviewed literature and seen what others in the field think.

(3) Claims which rest ultimately on the basis of how things seem to a person (vs. observations or argument) are never entirely reliable, but are seriously questionable to the extent that the person is



not an expert in the field. A clear example is Robert Welch (of Welch's chocolates), who was a candy-manufacturer all his adult life, making pronouncements about Russia's foreign policy. A less clear example is Linus Pauling, whose intuitions about physical chemistry would be accorded great weight by anyone in that field, making an intuitive claim about something in the neighbouring field of bio-chemistry, namely that Vitamin C cures colds.

(4) However reliable the original source may be, we also need confidence that the information has been reliably transmitted to us, especially when it passes through the hands of different authorities with all their possible weaknesses and agendas. We can quickly acquire a healthy skepticism about this by reflecting on the familiar children's game of "pass it on," where one person tells something to another, the other repeats what she heard to a third, and so on, with the predictable result that the final information is quite different from the original.

In closing this section, we emphasize that the authority-discrediting reasons we have been considering do not show that what the authorities say is false. Unreliable and self-interested persons may make accurate reports; one who breaks with tradition may be right against the community of scholars; non-experts may have deep insight. The point is that in appeals to authority, the authority is the sole reason to accept the claim, and when there is reason to doubt the authority, there is reason to doubt the authority's claim.

### Evaluating reasoning

We now turn to those flesh and blood arguments that set out the premises and conclusions in detail. It will be well to remind ourselves that the purpose of an argument is to give one reasons to accept something as true. A good argument can thus be defined as one which gives one good reasons to accept something as true. To do this, two conditions must be satisfied: (1) We must have good reason to think the premises true, and (2) The premises must adequately support the conclusion. Both conditions call for further discussion.

### The truth condition

The premises of an argument provide a good reason for accepting the conclusion only if there is good reason for thinking that the premises are true. It does not help to establish C by appealing to P if there is no good reason to think that P is true. To know whether there is a good reason to think a premise is true requires that we know something about particular subjects. One cannot say whether a premise which tells us that Ocean Falls BC has a greater average rainfall than that of the Amazon basin should be accepted unless one knows something about geography; and similarly if the premise concerns a matter of physics, current affairs, history, common experience, an acceptable moral view, and so on. Logic thus cannot tell us whether there is a good reason to accept a premise. But there are two ways in which we should not understand the view that P provides a good reason for C only if there is a good reason to think that P is true. And logic can warn us about these.



The first is that we must not think that P is a good reason for C only if a good reason for P is actually supplied. If P is a good reason for C only if a good reason for P is provided, and Q is a good reason for P only if a good reason for Q is provided, and R is a good reason ..., we could not begin to argue because we could never have premises. If argument is to be possible, there must be premises which provide good reasons for accepting conclusions where we do not need to provide good reasons for those premises. And so there are. The bedrock of claims about the world is sense-experience, where observations provide a good reason for claims but are not derived from anything more basic. And moral claims likewise seem to come to rest in things accepted without proof, such as pain is bad and it is wrong to cause one unjustified pain. And even where there are good reasons for a premise, it is implausible to insist that they must be supplied before the premise is admitted. It would be odd, for example, to refuse to accept premises such as kittens like milk or the moon goes round the earth as good reasons for a conclusion until good reasons have been given for those claims, or that a physicist or economist cannot appeal to theorems unless they derive them from first principles.

The second is that we must be careful not to equate “good reason” with “logically conclusive reason,” i.e., to hold that we only have good reason to think a premise is true when we have evidence beyond all shadow of doubt for it. If we took that view we would not have good reason to think that hardly any premise is true, and so argument would again be made virtually impossible. We could not, for example, say that we have two hands or are on planet earth, for it is possible that we are only brains in vats on the planet Alpha Centauri, and scientists are stimulating electrodes placed in the brain to produce the experiences we have. Thus if we are not to deprive ourselves of virtually all premises, we need a more relaxed standard, and the fact is that we have good reason to accept things on weaker evidence. For example, we have good reason to accept something if there is evidence beyond reasonable doubt for it, or where the evidence is clear and convincing, or where we have evidence which establishes something on balance of probability. An argument cannot establish a conclusion that is more certain than its weakest premise. But we can have good reasons for premises which fall short of absolute certainty, and conclusions based on such premises are worth arriving at. Aristotle once commented that it is the mark of a wise person not to look for more precision in a subject than that subject is capable of, and many of the topics we are vitally interested in such as ethics, law, and most of science, are not amenable to absolute precision.

While it would be inappropriate to demand that premises satisfy the above conditions of proof, it is perfectly appropriate to approach premises with a skeptical temper. Since our conclusions rest on our premises we should be careful about what we accept, and arguments can often be rejected because the premises are problematic. But if you reject an argument for this reason, you should go on to say why you think that the premises are doubtful. Students sometimes explain why they do not accept an argument by zipping through the premises saying of each “Not enough evidence.” But notice how badly you would take it if someone treated an argument of yours like that. “What’s the problem?” you may want to know, and so will someone reading your assessment. Giving reasons for rejecting premises will protect you against mindless skepticism and be informative both to others and yourself.



## The support condition: deductive & inductive arguments

Having good reason to accept the premises of an argument does not mean that we should accept the conclusion. We do not make progress towards establishing a conclusion if the premises (however true) do not offer any support to the conclusion. Thus the following argument is worthless:

P1 The moon goes round the earth.  
P2 Mice like cheese.  
Therefore, the Canucks will win the Stanley Cup.

Nor is it enough that the premises only give the conclusion some support, as is shown by the argument:

P1 Smith was killed.  
P2 Jones hated Smith.  
Therefore, Jones killed Smith.

To be good, an argument must not only have premises that we have good reason to accept, those premises must adequately support the conclusion. What constitutes such support?

At the one end of the scale are those arguments where there is a very tight connexion between the premises and the conclusion, so tight that it is inconsistent for one to agree to the premises and yet to refuse to accept the conclusion. Arguments which allege such a connexion are called “deductive.” Aristotle’s favourite example of an argument has this form:

P1 All men are mortal.  
P2 Socrates is a man.  
Therefore, Socrates is mortal.

One cannot, on pain of contradiction, say Yes to the premises and No to the conclusion. When it is inconsistent to assert the premises and deny the conclusion the premises are said to entail the conclusion, and the aim of any deductive argument is to have premises that are so related to its conclusion.

But just because arguments do not have this tight connexion, it does not mean that they are worthless. For the premises may provide support sufficient to give one good reasons, though not logically conclusive reasons, to accept the conclusion. The premises may be so related to the conclusion as to make it unreasonable to accept the premises and yet to refuse to accept the conclusion. Arguments which allege to have this feature are called “inductive” (or sometimes “non-deductive”). Inductive arguments can vary in the degree of support the premises give the conclusion: they can make the conclusion virtually certain, or put it beyond reasonable doubt, or give clear and convincing reasons, or establish the conclusion on balance of probability. The aim of any inductive argument is to establish its conclusion in some such way, i.e., to (to use an ugly but useful word) probabilify its conclusion.



Acute readers will have noticed that deductive and inductive arguments are defined above in terms of the intention of the person producing the argument or what the argument alleges to do, viz., force the hearer to accept the conclusion on pain of being inconsistent or on pain of being unreasonable. But alleging such a connexion is one thing, actually having it another. Clearly one can attempt to give good reasons of either sort and fail. We must thus turn to ask how we can distinguish structurally good deductive arguments (or deductive arguments that do what they allege to), and structurally good inductive arguments (or inductive arguments that do what they allege to), from those deductive and inductive arguments that fail to conclusively establish or to probabilify their conclusions.

### Structurally good deductive arguments

We begin with deductive arguments. The biologist Lord Haldane, on discovering so many different kinds of beetles in the world, commented that God is inordinately fond of beetles. By this criterion, God is inordinately fond of deductive arguments, for there are literally thousands of different kinds of them. Logicians (who are like beetle-hunters) capture them, pin them down, and go on to classify them noting similarities and differences. Here are some examples of structurally good ones:

P1 All men are mortal.  
P2 Socrates is a man.  
Therefore, Socrates is mortal.

P1 If it is raining then the streets will be wet.  
P2 It is raining.  
Therefore, the streets will be wet.

Others look like they are structurally good, but are not; they can be viewed as counterfeits of good arguments. Examples are:

P1 All men are mortal.  
P2 Socrates is not a man.  
Therefore, Socrates is not mortal.

P1 If it is raining then the streets will be wet.  
P2 It is not raining.  
Therefore, the streets will not be wet.

Formal logic has provided techniques for distinguishing structurally good deductive arguments from defective ones. But these are typically of little use in everyday arguments. The main strategy is to seek a counter-example: to see if one can think of any case in which the premises can be true and the conclusion is false. A structurally good deductive argument (technically called a “valid” argument) is one in which the premises entail the conclusion, where this means that if the premises are true the



conclusion must also be true. So if one can think of some way in which the premises can be true and yet the conclusion false, one will have shown that the argument is invalid.

Thus, to stay with our above examples, the following argument is invalid:

P1 All men are mortal.  
P2 Socrates is not a man.  
Therefore, Socrates is not mortal.

The reason is that we can imagine a case where the premises can be true but the conclusion is false: Socrates may not be a man but a dog. Thus the premises can all be true and the conclusion false. Likewise the following is invalid:

P1 If it is raining then the streets will be wet.  
P2 It is not raining.  
Therefore, the streets will not be wet.

For we can imagine a circumstance in which the premises are true and yet the conclusion false: the streets may be wet from some other source such as a street-washer.

The arguments which interest us in real life are often more complex than these, but the technique for detecting invalidity is the same: look for counter-examples, i.e., ways in which the premises can be true and the conclusion false. To get the feel of identifying valid deductive arguments it may be useful to enter the logician's equivalent of an entomological museum and look at some of the valid logical forms of arguments logicians have isolated. We get the logical form of an argument by taking out words or sentences, and replacing them with letters such as A, B, P, Q and so forth. To get flesh and blood arguments out of a logical form, all one needs to do is to fill in suitable words such as "men", "mortals", "politicians" for the As and Bs, and sentences such as "It is raining" and "The streets will be wet" for the Ps and Qs. To say that these argument forms are valid means that no matter what is filled in for the letters, if the resulting sentences in the premises are true, the conclusions are guaranteed to be true. Valid argument-forms are thus argument-generators that will spew out an indefinite number of valid arguments.



If P then Q  
P  
Therefore, Q

If P then Q  
Not Q  
Therefore, Not P

If P then Q  
If Q then R  
Therefore, if P then R

P or Q  
Not P  
Therefore, Q

If P then Q  
Therefore, if Not Q then Not P

All A are B  
All C are A  
Therefore, All C are B

No A are B  
All C are A  
Therefore, No C are B

All A are B  
Some C are A  
Therefore, Some C are B

By contrast, it will be useful to get a feel for invalid deductive arguments by looking at some examples which are so common that logicians have identified their logical forms. This is to enter the logicians's equivalent of the part of the pathology museum that contains monstrosities of birth:

If P then Q  
Q  
Therefore, P

If P then Q  
Not P  
Therefore, Not Q

If P then Q  
If P then R  
Therefore, if Q then R

P or Q  
Not P  
Therefore, Not Q 17

If P then Q  
Therefore, if Not P then Not Q

All A are B  
All C are B  
Therefore, All C are A

All A are B  
No C are A  
Therefore, No C are B

Some A are B  
All C are A  
Therefore, Some C are B

We do not want to give you the impression that reasoning in everyday life is a matter that one cannot do without technical expertise. Nor do we want to encourage you to use these argument forms to measure arguments in the way in which you would use a ruler to measure objects. Sometimes a readily identifiable logical form just jumps out at you which makes for a quick and clean assessment of validity or invalidity. But not all valid and invalid arguments have shapes which you can recognize in advance, and for the most part you have to think through the arguments you want to assess anew. Our aim in presenting the logical forms is to give you a feel for the concepts of validity and invalidity by way of inspecting examples, and so enable you to make those determinations in fresh cases.





## Structurally good inductive arguments

By Lord Haldane's criterion, God does not much like inductive arguments, for there are only three chief kinds of them. These all have in common the feature that they only allege to render the conclusion probable. Those which are structurally good--there is no standard term equivalent to "valid" to apply to inductive arguments--not only allege to do this, but actually do so. A structurally good inductive argument is one where the premises are so related to the conclusion that if the premises are true, the conclusion is probably true. The conclusion may be that there is a 99.9% chance of surviving an illness, or a 3% chance of doing so; that it is highly likely that God exists, or that it is highly unlikely. Whatever the conclusion is, a structurally good inductive argument guarantees that, if its premises are true, we can assert the conclusion with a better than 50-50 chance of being right. If an argument does not tell us with greater than 50% accuracy that a conclusion follows, one has as good a chance of hitting upon the truth by ignoring the argument as by following it, and thus the argument is worthless. Structurally good inductive arguments range from that minimum to providing clear and convincing reasons for the conclusion, to establishing the conclusion beyond reasonable doubt, to rendering the conclusion virtually certain. Inductive arguments are thus unlike deductive arguments in that while validity/invalidity is an all or nothing matter, inductive arguments can be stronger or weaker and admit of degrees. Here are the three basic forms, with brief commentaries on what makes them better or worse.

### Induction by simple enumeration

In this kind of inductive argument, one examines a number of objects of a certain type, observes they all have a certain property, and then concludes that all objects of that type have that property (or, if one is more cautious, that the next observed object of that type will have it). For example, one who is interested in the characteristics of Monarch butterflies may argue as follows:

P1 Monarch butterfly #1 had yellow wing-tips.

P2 Monarch butterfly #2 had yellow wing-tips.

P3 Monarch butterfly #N had yellow wing-tips.

Therefore, all Monarch butterflies have yellow wing-tips.

How structurally strong such arguments are depends on two things. First, the number of the sample. If one has only observed three Monarch butterflies, the argument has no strength. There is no exact number of objects of the kind under examination that one must have seen in order for the argument to rise to the level of probability. But one has to have seen a goodly number, and the more the better. Second, the representativeness of the sample. If one has only seen Monarch butterflies in Vancouver, one can be less sure of the generalization that if one had seen them in Winnipeg too, and less certain if one had only seen them in those two places than if one had seen them in all the places Monarch butterflies are found. This is why, if one wants to sample some grains of wheat to say something about the batch of wheat, one must stir the wheat first. Or why one cannot conclude anything about the number of defective Fords manufactured only by looking at those made on Fridays.



## Analogy

In an analogical argument, one compares two objects, A and B, observes that they are similar in a number of important ways and not known to be dissimilar in any important ways, and concludes that since A has property N, B likely also has that property. Here is an example:

P1 Jones smokes 6 packets of unfiltered Camels a day, does not exercise, works in an asbestos factory, lives in Los Angeles, and has lung problems.

P2 Smith is similar to Jones in that he has smoked 6 packets of unfiltered Camels a day, does not exercise, works beside Jones in the asbestos factory, and lives in Los Angeles.

Therefore, Smith also has lung problems.

The strength of analogical arguments likewise depends on two features. The first is the number of relevant similarities that are shared by the objects compared. The word “relevant” must be stressed. In the above example, the features that Jones and Smith have in common are causally related to the property that we are interested in, namely lung problems. But it would not help to say that Jones and Smith both have red hair, go to the same barber, drive Mustangs, and so forth. These shared properties do not add to the strength of the argument, and we must be on the look-out for analogical arguments which are founded on shared properties that have nothing to do with the property that the argument seeks to attribute to the second object. It is manifestly bad to argue that since Michael Jordan and the authors of this book have college degrees, cannot swim, and did not make their high school basketball team, the authors must be able to play basketball well because Michael Jordan does. The second thing that affects the strength of analogical arguments is the number of relevant (note again this word) dissimilarities. In the above example, for example, it would make a big difference if Jones was 65 and Smith 18. As is the case with inductions by simple enumeration, it is impossible to quantify the number of similarities and differences that would make an analogical argument probabilify its conclusion, and one must guard against the view that it is just a matter of numbers. One big difference is enough to cancel any number of small similarities.

## Inference to the best explanation

According to this type of inductive argument, we conclude that something is probably so because that is the best explanation of a certain fact or set of facts. For example:



P1 Smith was found murdered.  
P2 Jones hated Smith.  
P3 Smith was killed by a 45.  
P4 Jones collects 45s.  
P5 Jones and Smith were heard quarreling at midnight.  
P6 Jones was seen fleeing Smith's house at midnight.  
P7 Jones's clothing was splattered with blood of Smith's type.  
Therefore, Jones murdered Smith.

This is a simple example of the kind of argument used in many different kinds of research. Scientists conclude that a planet has a moon which we are unable to directly observe because of eccentricities in its orbit; or that a molecule must have a certain structure because of tracings in a cloud chamber; or that there were flying reptiles because of fossil findings.

When one infers a conclusion as the "best explanation," one is claiming that the explanation--call it hypothesis 1 (H1)--is better than any rival explanations--call them hypotheses 2, 3, 4, &c. (H2-Hn). H1 will be better than H2-Hn if any one of three conditions is satisfied. These are the criteria by which we can assess inferences to the best explanation.

H1 explains the observable phenomena, but H2-Hn do not. For example, suppose I have a pain in my chest. It may be angina (caused by the heart), a muscle spasm, or indigestion. Which is the best explanation? If the pain gets worse when I exercise, the angina hypothesis explains something that the other hypotheses do not, and hence (unfortunately) is the more probable cause.

H1 and H2-Hn all explain the observable phenomena, but H1 is backed by stronger evidence. The killing of Smith may be explained by both the hypothesis that Jones did it or the hypothesis that the butler did it. If, however, both Jones and the butler hated Smith and collected 45s, but only Jones was seen fleeing the house soon after the time of death, the Jones did it hypothesis is better. This is what doctors have in mind when they say that when you hear hoofbeats, think of horses not zebras. There is more evidence for the hypothesis.

H1 and H2-Hn all explain the observable phenomena and are equally backed by evidence, but H1 is a simpler explanation. It was on this ground that the Copernican hypothesis (the earth revolves around the sun) won out over the Ptolmaic hypothesis (the sun revolves around the earth). Each hypothesis could explain all the observable phenomena such as the phases of the moon, the changing constellations of stars, and so on. There was no more evidence for one than the other. But the calculations necessary to make predictions about the behaviour of the heavens was much simpler on the Copernican view.

If we have no reason to prefer H1 over H2-Hn, we cannot call H1 the "best explanation," and so no conclusion can be drawn from the facts adduced. Thus the way to evaluate inductive arguments of this stripe is to see if rival hypotheses that are better or as good as the one we are invited to accept



can be found. If they can be, the argument is destroyed; if they cannot be, the hypothesis which is its conclusion can continue to be seriously entertained.

### Summing up

We can now draw this material together in a set of questions by which we can assess any argument whatsoever.

First, ask: Is there good reason to think the premises true? If the answer is No, score out the premises that are problematic. We cannot have a good reason to accept a conclusion that rests on premises which there is no good reason to accept. But the argument does not die just because one or more of its premises are problematic, for the remaining premises which are acceptable may be sufficient to support the conclusion. 21

Then ask: Do the premises entail the conclusion? i.e., is it inconsistent to assert the premises and to deny the conclusion? i.e., if the premises are true must the conclusion be true? (All three questions say the same thing.) If the answer to this is Yes, the argument is a good one. It is a valid deductive argument with premises that we have good reason to accept; thus we should accept the conclusion in proportion to the degree of confidence we have in the premises.

If the answer is No, we know that the argument is a bad deductive argument. But we do not know that it is a bad argument period, for the possibility remain that it is a good inductive argument. So we need to ask another question: Do the premises probabilify the conclusion? i.e., is it unreasonable to assert the premises and to deny the conclusion? (Both questions mean the same.) If the answer is Yes, then again the argument is a good one. It is a structurally good inductive argument with premises that we have good reason to accept; thus we should accept the conclusion in proportion to the degree of support the premises give the conclusion, and the degree of confidence we have in the premises.

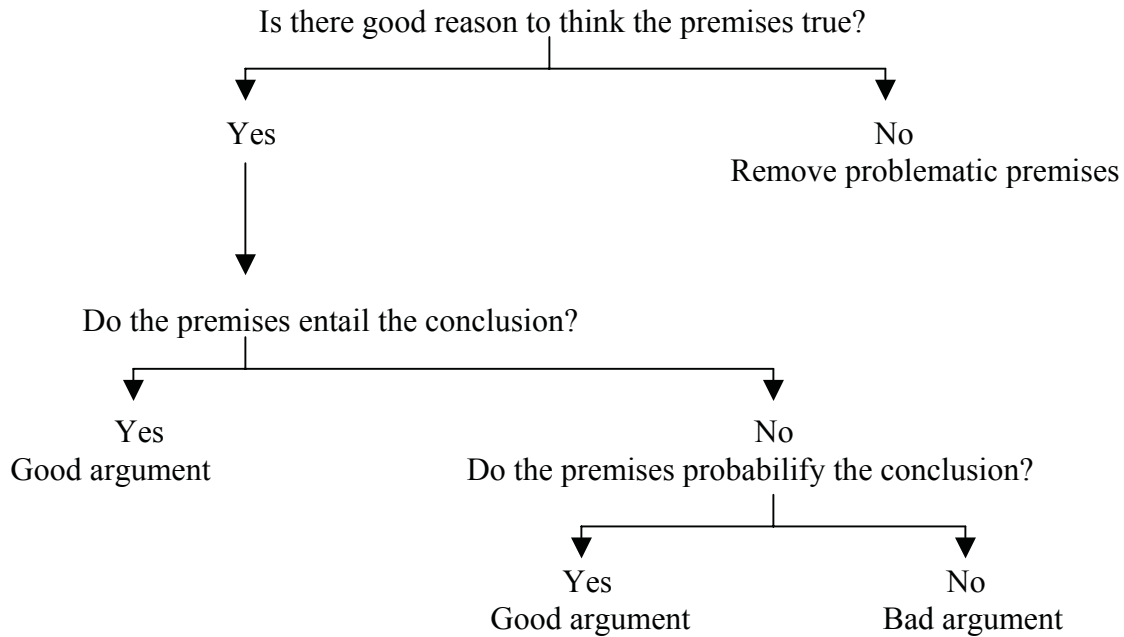
If the answer is No, the argument is a bad one. If the premises (however true) do not entail the conclusion, and do not probabilify the conclusion, they do not support the conclusion at all.

Two final comments. First, in assessing an argument, do a thorough job. You may immediately see that an argument fails because crucial premises are problematic, or the premises (even if true) inadequately support the conclusion. If so, you know the argument is bad. But do not stop as soon as you know the argument is dead. Go on to dismember the corpse by finding as many faults as possible with it. If you are hostile to the conclusion and want to destroy the argument, you have a back-up if one criticism fails, e.g., you are wrong about calling a premise false. If you are friendly towards the conclusion and want to find a good argument for it, you know what has to be done to fix it, and sometimes it can be fixed. It is thus useful, in practice, to say whether the argument is structurally good as it stands, i.e., whether the premises if true would adequately support the conclusion; whether there is good reason to accept the premises; and whether the argument remains structurally good once any problematic premises are removed.



Second, we may notice that we do not have to identify arguments as deductive or inductive before assessing them. Students often worry about sorting arguments into these categories. This is fair enough, as whether the argument is deductive or inductive depends on what the author's intention is, and it is hard to read another's mind. But we can see from the above that we can determine whether a conclusion should be accepted without having to make that identification.

Here are the above questions in the form of a decision-tree:



That's it. You now have all the theory you need in order to assess arguments. And knowing how to assess arguments presented to you, you know the criteria that arguments you construct need to satisfy to pass muster. Of course it is easier to criticise than to construct, for to set aside a conclusion one only needs to find one counter-example or problem, while to establish a conclusion one needs to devise something which is not subject to any counter-examples or problems. But the criteria that must be satisfied are the same.



## Fallacies

There are some mistakes in reasoning, called fallacies, that are so seductive and so common that they deserve special identification and discussion. The forms of these fallacies are generally easy to spot. But we must also not be too quick to condemn all arguments that have these forms. For good arguments can have them too--that is why people are taken in by the fallacies--and we must be careful not to throw out good arguments with the bad.

Logicians have identified over 100 fallacies; we pick out 5 for special mention, and many bad arguments will be avoided by being on guard for these. We state the fallacies in simple ways that most clearly bring out their logical structure. They often occur in flesh 23

and blood arguments in different forms, but understanding the paradigms should enable you to identify reasoning that you should be suspicious of.

### Ad hominem

"A is just a M (e.g., housewife, academic), or does or has done N (e.g., had an affair, abandoned his children); therefore we can dismiss what A says." This is not a fallacy if the attack on A shows A not to be an authority about what he says, and the sole ground for accepting what he says is his claim to be an authority. Otherwise, the conclusion we are invited to draw does not follow. That Rousseau left his children at foundling homes, and Martin Luther King plagiarized his PhD thesis, does nothing to discredit their philosophic or social views.

### Popularity

"Everyone thinks X is so; therefore X is so." Sometimes agreement makes something so. When everyone agrees that the word "chair" or "electron" means such-and-such, it just does mean that; in a democratic election when everyone wants A to be president A is president. But on most factual matters, everyone may think that something is so and everyone can be wrong. There was a time when (nearly) everyone thought there were witches, the earth was the centre of the universe, &c. This fallacy commonly carries with it a touch of intimidation--if everyone thinks.....who are you to say otherwise? This may make it an effective way of arguing, but it is still a bad way.

### False cause

"X was (or is) followed or accompanied by Y; therefore X is the cause of Y." The seductiveness of this fallacy comes from taking part of the evidence for saying that one event is the cause of another for complete evidence. If X is followed or accompanied by Y, we have some evidence that X is the cause of Y. But we do not have enough evidence. Before we can say that X is the cause of Y, it must be the case that if X had not occurred, Y would not have occurred. Until we can say this, the possibility remains that it is just coincidence. Taking Contac-C may be followed by one's cold disappearing in 1 week, but colds may typically go away in that time anyway. Even if both conditions are satisfied,



viz., X is regularly followed or accompanied by Y, and if X does not occur Y will not, we still cannot say that X is the cause of Y. For both events may be causally unrelated to each other but the result of a common cause. Flipping a switch in a bathroom may be regularly followed or accompanied by a light going on and a fan starting. It may also be the case that if the light did not go on the fan would not start. But there may not be any causal relation between the light and fan; a third event, flipping the switch, may cause both. Thus even if invariable correlations were found between X and Y (e.g., reading pornography and sexual assault, use of marijuana and heroin), we cannot conclude anything about causation until the possibility of a common cause (e.g., some physiological/psychological condition) is ruled out. 24

### Slippery slope

“X will lead to Y and Y will lead to Z; Z is a bad thing; therefore X should be prohibited.” There is nothing wrong with this argument if (1) X will in fact lead to Y and Y to Z (the causal chain here can be longer or shorter), and (2) Z is, all things considered, a bad thing. But sometimes both can be questioned. It is often not clear that X is causally related to Z, and thus slippery slope arguments often rely on the false cause fallacy. Sometimes the false cause fallacy is avoided by weakening the claim from X will lead to Z to X may lead to Z. The problem with doing this is that virtually everything, from reading the Bible to allowing beer at hockey games, may lead to bad results (e.g., child abuse from parents following the maxim of spare the rod and spoil the child, riots at the coliseum) and it is up to one who uses the argument in this form to show why we should pay special attention to the risk in this case. It is also often not clear that even if Z will result, and Z is a bad thing, that avoiding Z is worth prohibiting X. Over 100 children are beaten to death each year in America by parents impressed by the spare the rod maxim; still, no one can seriously conclude that the Bible should be censored. Before one can conclude that X (whether this is the Bible, pornography, marijuana, or anything else) ought to be prohibited because it leads to some acknowledged evil, Z, it must be demonstrated that the prohibition will be effective and not bring about evils greater than those which it prevents.

### Questionable classification

“X is D; D is always bad; therefore X is bad.” In this formula, “D” stands for some description such as “murder” (e.g., abortion is murder), “commodification” (e.g., surrogate mothers sell babies, i.e., commodify human life), “terrorism” (e.g., suicide bombers are terrorists). If X really is a D (murder, selling babies, terrorism), the conclusions follow; the fallacy comes when X is classified as a D and there are unaddressed differences between this and the normal application of D. For example, murder is the wrongful killing of a person. But it is not clear that the fetus is a person as opposed to a potential person. Exchanging little Edgar for \$500 is selling a baby. But this is not exactly what a surrogate mother does when she consents to have one of her eggs artificially inseminated and then carry the resulting zygote to term for a fee. The label “terrorism” is quickly applied, but the criteria for application are seldom made clear, and we must bear in mind that one person’s terrorist is another’s freedom fighter. The point of these examples is not to say that classifications cannot be made, but that they cannot be made without careful argumentation.



As illustrated by the above, fallacies substitute theft for honest toil. They are all seductive ways of getting to conclusions without providing rigorous argumentation, and are most often used when one wants badly to get to a conclusion that is going to be hard to argue for. Do not let anyone (including--perhaps especially--yourself) get away with that.

### How to write

We typically want to communicate what we think to others. To do this, we have to speak or write, and that in turn requires that we have to organize our thoughts. We will discuss how to write, but the principles we offer apply equally to speaking as well. And please bear in mind that the advice we offer about how to write only applies to that kind of writing where one wants to put forward some view and support that view with reasons.

Any writing of this kind should begin with a question. This may appear as your title as an interrogative sentence with a question mark at the end, or in your introduction where you say "The question I am going to address is.....," or it may not appear anywhere at all but be simply something you have in mind when you announce what you are going to do in your essay as when you say "In what follows I will argue that....." Whatever your approach, it is vitally important to have some clear and determinate question in mind. All writing must have some point; this means there must be some main question (or set of questions) that you are out to answer. Identifying this and keeping it in mind provides you with a standard of relevance. Anything that helps answer that question is a part of your essay, anything that does not (however true and interesting it may be) must go. If you do not have a clear standard of relevance, your writing is bound to wander.

Sometimes the main question or questions raises a number of subsidiary questions that have to be answered before the main question(s) can be answered. If this is so, identify each of these questions clearly and explain how they fit in. Identifying what the right questions are, and sorting out what is relevant to what, is a large part of your essay. Do not be impatient to get on with the arguments and substantive conclusions. Size up your topic and understand what questions are involved before plunging in.

Also do not think that this is easy to do. Life is a messy business, and so is writing. One cannot always expect to cleanly identify in advance exactly what all the relevant questions are, and the best order in which to ask them. These things often only become clear as one starts to write out what one thinks. You must therefore be prepared to constantly revise your original outline in the light of this clarity. And this may even force you to change your main question(s). As your thinking develops, you may be able to make it (or them) more precise, or add dimensions that you could not have anticipated in advance. 26

Once you have identified your main question(s), tell the reader what conclusions you will argue for. You are not writing a mystery novel, and if the reader knows where you want to go it helps the reader follow what you say. You will not be able to definitively state what conclusions you will argue for





until you finish your essay, for only then will you know what you really think. But it is very useful for you to put down what conclusions you are aiming at in your first draft. That helps you to direct your thoughts; it is, as it were, a kind of hypothesis. If it turns out that you cannot establish that conclusion, you may have to revise your initial hypothesis and change your “is’s” to “is not’s.” That is the way writing helps your thinking.

After you have identified (at least in a preliminary way) your questions and conclusions, your next task is to trace a path to those conclusions. There is no formula for doing this, and different writers proceed in different ways. Some work out elaborate outlines first, and then cast the ideas into smoother prose. Others begin by writing complete sentences, getting something down on paper, and then impose some structure on them, working out their outlines. It doesn’t matter which way you begin. However you do, you cannot expect to get it right the first time. Everything you write must be rewritten, typically many times, and there is constant interaction between your outline and your writing. Writers will constantly revise their outlines in the light of the direction their thoughts take when they flesh them out, and revise their prose in the light of the logic of their outlines.

In the end, your essay should have a structure of the kind we earlier suggested should emerge from the writing of a good writer. There should be an overall structure which shines through, where the reader can see what your main points are and how they add up to the conclusion. Each of the main points should be supported with enough argumentation so that a thoughtful reader will accept it. Where readers will naturally have doubts about what you say, these doubts should be anticipated and responded to. As long as one can have doubts about a premise you are appealing to, or there is a good-looking argument with a contrary conclusion to that which you want to establish, your conclusion will not be convincing. Writing is thus reading in reverse, and the criteria of good reasoning that you apply when evaluating the work of others are the criteria you must meet when developing your own views.

Good writing and good reasoning are inseparable. Your words are your ideas. Your syntax and paragraphing are your logic. So pick your words and string them together carefully. It is a good practice to write in short paragraphs, where each paragraph contains only one main idea, consisting of simple sentences composed of familiar words. That is the way clarity is achieved, and clear writing is writing of the highest style. 27

## Beyond

It is now up to you to practice what we have preached, and develop the corresponding skills. Opportunities to do this abound. Newspapers, TV shows, discussions with friends, and so on daily provide us with arguments, and you can do much to develop your reasoning abilities by mentally putting them into premise-conclusion form and evaluating their cogency. Also, most people write something every day: a letter to a friend, an email, a note explaining why your car should not be towed away. These things can be done better or worse, and your writing will improve if you take pride in what you put down, and never miss a chance to write as well as you can. But your main prac-



tice-field will be your classes. There you will have the opportunity to apply our advice to topics about which you (hopefully) want to develop reasoned opinions, and to receive evaluations of your efforts.

You also may like to take the Critical Thinking course offered through the Philosophy Department (Philosophy 1104), which will pursue the material we have sketched in greater depth, and give you practice with it. There are many books on critical thinking, all of which cover essentially the same material in different ways. The one that best matches the account of the foregoing is Dale Beyerstein, *Thinking Critically* (Langara CourseWare; forthcoming by Prentice-Hall in January 2003).

The best short style-book on writing, for beginners and professionals alike, is William Strunk, E.B. White, and (in the latest edition) Roger Angell, *The Elements of Style* (Macmillan; any edition is fine). But you cannot learn how to write from manuals. If you want to write well, you have to read. Reading anything is better than nothing, but the better the writers you read, the better your writing will be. Any list of writers to emulate will be idiosyncratic, but you cannot go wrong by trying to absorb by osmosis the styles of the following. Read anything by them; most have written books and short stories. Jane Austin, Margaret Atwood, Robertson Davies, Charles Dickens, Fyodor Dostoevsky, George Orwell, Mavis Gallant, Ernest Hemingway, George Plimpton, V.S. Pritchett, Muriel Spark, Leo Tolstoy, Mark Twain, Evelyn Waugh, P.G. Wodehouse. To see that technical writing need not be stiff and dreary, have a look at the writings of Isaac Asimov, Stephen Jay Gould, Arnold Toynbee, and the essays of Bertrand Russell.