We now turn to the main theme of this section, which is how to evaluate the validity of a formal argument.

As defined earlier, ***a formal argument is an argument which establishes its validity based on its FORM*** – that is, the logical relations between its premises and conclusion.

An invalid formal argument can be described as a **formal fallacy**. A formal fallacy is one where the conclusion does not logically follow from the premises, even if each individual premise is true.

In a formal argument, the premises **necessarily** (in a deductive argument) or **probably** (in an inductive argument) establish the truth of the conclusion.

Some kinds of formal argument can be represented using formal or symbolic language, such as:

- numbers,
- letters or symbols in symbolic logic,
- propositions placed in truth tables or Venn diagrams.

Why use numbers, letters, symbols, tables or diagrams to present statements and the relations between statements? Because it will help us to focus on the FORM and STRUCTURE of an argument, without being distracted by the persuasive and rhetorical aspects of natural language. The exercises in this section help us to think clearly about formal, logical relations, and the truth status of claims which are structured by and based on, such relations.

Think about it
Why use numbers, letters, symbols, tables or diagrams to present statements and the relations between statements? Because it will help us to focus on the FORM and STRUCTURE of an argument, without being distracted by the persuasive and rhetorical aspects of natural language. The exercises in this section help us to think clearly about formal, logical relations, and the truth status of claims which are structured by and based on, such relations.

5.5.1 Some examples of formal, symbolic language

In this program of critical thinking, we want to draw a clear distinction between formal and informal argument. Therefore, it is important to give some brief examples of the use of formal/symbolic language which can be used to represent an argument.

Recall our definition of formal language:

A formal language can be described as a rule-governed set of symbols whose arrangement expresses certain relations. For example, in logic and mathematics.

Formal language can be presented in a number of ways:

- as numbers,
- as letters or symbols in symbolic logic,
- as propositions represented in the form of truth tables.

The following are examples of some symbols commonly used in formal logic:

¬	P ¬ Q	P not Q	(negation)
•	P • Q	P and Q	(conjunction)
v	P v Q	P or Q	(disjunction)
⇒	P ⇒ Q	If P then Q	(condition)

5.5.2 Truth tables

A Truth table is a table which shows whether a proposition is true based on variations in the combinations of input values. It shows which combinations make the proposition (taken as a whole) true, and which combinations make it false.

Why use truth tables?

To perform a critique of formal arguments, it is useful to begin at the level of the sentence. By doing so, we aim to establish the truth of specific claims which appear in certain kinds of sentences. These sentence forms will be explained below.

In an earlier section, we referred to Aristotle's well-known 'Law of Non Contradiction', which states that a proposition cannot be true and untrue at the same time and in the same way.

The idea that if a proposition is true, it cannot also be untrue, sounds obvious and self-evident. And yet, if we use this idea as a simple starting point and express it in the form of a truth table, it then becomes possible to more closely assess the truth status of sentences which have more than one idea.

The concept of non-contradiction can be expressed in a truth table, using the symbol ¬ for 'negation', as in the following Example 1**.** The concepts of 'conjunction', 'disjunction' and 'condition' are likewise expressed, consecutively, in examples 2, 3 and 4.

Truth table examples

Example 1

"not" ¬ (negation)

P

"On July 21, 1969, the first manned spacecraft landed on the moon."

P	¬ P
T	T
F	F

Truth possibilities:

(i) If "P" is true, "not P" is false.

(ii) If "P" is false, "not P" is true.

Explanation:

This demonstrates that the Law of Non-Contradiction is a useful starting point for us to think about the truth status of specific claims. Claims are the basic building blocks of arguments.

In this next section, we are moving beyond the simple sentence which asserts one thing, to a more complex sentence with two assertions.

In doing so, we need to ask: <u>what happens if only one part of the sentence is true?</u> Can we still say that the whole statement is true? How we respond to this question is important, because we may be evaluating a formal argument which requires that each premise supporting an inference or conclusion be true, if the conclusion is to be considered true (therefore making the argument valid).

Example 2

“and” • (conjunction)

P	Q
“On July 21, 1969, the first manned spacecraft landed on the moon,	**and the first man to walk on the moon’s surface was an American.”**

P	Q	P • Q
T	T	T
T	F	F
F	T	F
F	F	F

Truth possibilities:

(i) “If P and Q are true, then the whole conjunction is true.”

(ii) “If one part of the conjunction is false, then the whole conjunction is false.”

Explanation:

This shows that for a proposition involving conjunction, each part must be true – otherwise the entire proposition is considered false.

Example 3

“or” v (disjunction)

P **Q**

“Either artistic ability is inherited or it is learnt.”

P	Q	P v Q
T	T	T
T	F	T
F	T	T
F	F	F

Truth possibilities:

(i) If either P or Q is true, then the whole disjunction is true.
(ii) If both P and Q are true, the disjunction is also true.

Explanation:

This shows that the proposition is false only if both parts are false. In all other cases it must be true – including the case in which both parts are true. In the latter case, the proposition can be described as inclusive, because the truth of one part does not necessarily exclude the possibility that the other part is true. That is, it is possible that artistic ability may be both inherited and learnt.

Example 4

"If… then" ⇒ (conditional)

P **Q**

"If my wallet is not in my bag, then it has been stolen."

P	Q	P ⇒ Q
T	T	T
T	F	F
F	T	F
F	F	F

Truth possibilities:

(i) If both P and Q are true, then the whole statement is true.
(ii) If P is true and Q is false, then the whole statement is false.
(iii) If P is false and Q is true, then the whole statement is false.
(iv) If both P and Q are false, then the whole statement is false.

Explanation:

This shows that the proposition as a whole can only be true when both parts are true. If either part is false, then the whole proposition must be considered false.

5.5.3 Expressing natural language in formal language

As we have seen, truth tables allow us to express natural language in formal language in order to represent the truth possibilities of different kinds of sentences.

Thinking about the difference between natural language and formal language is very important for developing effective critical thinking skills. This is because when we are evaluating the arguments of others, the following questions naturally arise:

- Should we focus on the formal structure of the argument?
- Should we focus on the properties of language, representation, and so on?

It is clear that **we actually need to look closely at both these dimensions of arguments**.

However, by breaking them up into formal and informal dimensions, and considering these dimensions one at a time, we can make our task of critique more manageable.

Recall that earlier in this section, we defined the distinction between formal and natural language as follows:

Formal Language:	is useful for expressing relations in **abstract** form, based on **clear** and **unambiguous** terms.
Natural Language:	is used for communication and expressing relations in terms which may be **ambiguous** and **open to wide interpretation**.

As we have seen in the case of truth tables, when we are seeking clarity about the meaning of a sentence given in natural language, it may be useful to express it in formal language. Apart from using a truth table, there are other ways of expressing natural language in formal language. Consider the way in which the following sentence can be recast in formal, symbolic language:

Expressing natural language in formal language

Natural	“In the long run, all industrial development (A) has negative environmental (B) and human health effects (C).”
	⇓
Natural	$A \Rightarrow B, C$

In other words, “the occurrence of **A** will result in the occurrence of **B** and **C”** – or, to put it in terms of a conditional sentence, “If A, then B, C.”

However,

> **It is often difficult to accurately express natural language in terms of formal language.**

This is because natural language is used primarily for the purpose of communication. We might think that by putting the argument in purely ‘formal’ terms using letters like ‘A’, ‘B’ and ‘C’ we are communicating a clear message. In purely formal terms, this seems to be the case:

> **‘A’ (industrial development) causes both ‘B’ and ‘C’ (negative environmental and human health effects.)**

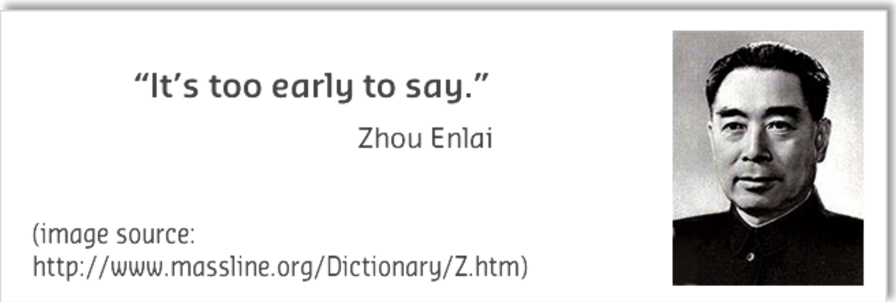
In terms of a causal or conditional connection, the relations between ‘A’, ‘B’ & ‘C’ seem unproblematic. Yet, as soon as we seek clarification of the precise meaning of certain terms, we encounter a problem.

In trying to offer a clear definition of each term, we need to overcome and (any) uncertainty and ambiguity. We are forced to ask: what exactly is meant by the following terms?

- ‘the long run’
- ‘all industrial development’
- ‘negative environmental effects’
- ‘negative human health effects’

Our interpretation of the meaning of each of these terms will invariably be influenced by our cultural and historical circumstances, as well as our direct experience of and encounter with these phenomena – either as words, or lived experience.

For example, in certain cultures, the idea of ‘the long run’ may mean 5 - 10 years. In others, it may indicate 50 - 100 years! When asked for his evaluation of the effects of the French Revolution of 1789, former Chinese Premier Zhou Enlai famously responded:



Similarly, the term ‘all industrial development’ is ambiguous. Does it include what happens in newly industrializing economies, which focus on the building of physical infrastructure, factories and manufacturing? To what extent does it refer to development in the so-called ‘post-industrial’ societies, where there is more emphasis on the production of knowledge, information and services?

Problems might also be encountered in attempting to define precisely what is meant by 'negative environmental effects' and 'negative human health effects'.

This example clearly demonstrates the fact that while 'formal language' is useful for expressing claims and relations clearly and without ambiguity, 'natural language' communicates in ways which are much more open to interpretation.

5.5.4 Add the sentence:

Sentences in natural language assert that **something is the case – they make a claim**.

Such sentences take the so-called 'subject-predicate' form.

In any sentence, the **subject** is the agent or 'doer' of the action, and the **predicate** is the thing that is being done - even if this 'doing' is only to exist, as expressed by the verbs 'is', 'am' and 'are'.

For example:

A dolphin (subject)	is a mammal. (predicate - verbal clause which modifies subject)
The government (subject)	closed the prison. (predicate - verbal clause which modifies subject)
I (subject)	don't like pizza. (predicate - verbal clause which modifies subject)

An argument is comprised of subject-predicate statements, such as the examples given above.

Recall that earlier, an argument was described as being valid if it could be shown that its ***conclusion follows necessarily from its premises (which are true).***

Recall, also, that we established a clear distinction between 'natural' and 'formal' language. Furthermore, it was shown that even though we can use formal language as a tool to express some claims which are made in natural language, when evaluating arguments, we often have to deal with the problems of the interpretation of words given in natural language.

This is important!

Remember:

When practicing critical thinking, we are interested in assessing the validity of arguments expressed in natural language.

But, in relation to an argument expressed in natural language, do we have to dismiss the idea of the 'formal' altogether?

The simple answer is no.

We are able to talk about the formal validity or invalidity of an argument presented in natural language – as long as the terms being used are clear and unambiguous.

It goes without saying that a community of language users will reach common agreement about the meanings of words, even if these meanings are not regularly tested or challenged.

On the other hand, sometimes the meaning of a term will be subject to a sudden challenge, revision or re-definition. In Australia, this happened when, in media discourses, the term 'mysoginist' was used in a range of widely differing contexts and varying connotations, prompting some commentators to call for an immediate revision of its dictionary definition(s)! [https://en.wikipedia.org/wiki/Misogyny_Speech]

This development points to the inherently unstable nature of meanings given in words and groups of words comprising natural language. Of course, over time, the meanings of all words and phrases will be subject to change.

Despite all of the above considerations, we are able to confidently evaluate the validity of a formal argument given in natural language. This brings us to the ideas of 'formal validity' and 'formal fallacy'.

The term '**formal validity**' applies to an argument which is **valid based purely on its logical form**.

As long as there is general agreement about the meanings of the terms in each premise and conclusion, then a formally valid argument will be described as **valid because of the relations between its premises and conclusions.**

On the other hand, the term **'formal fallacy'** indicates an argument which is **invalid because of a flaw in its logical form.**

An argument has formal validity if it has a form whereby its premises logically support its conclusion.

To understand how we can evaluate the formal validity of certain kinds of arguments, it is useful to look at some examples. In the final part of this section on the critique of formal arguments, we will consider examples of three kinds of arguments:

- deductive arguments
- inductive arguments
- conductive arguments.

Before we begin our evaluation of the formal validity of certain kinds of arguments, it is useful to consider the following:

Question	What is the point at looking at short, de-contextualized examples of formal arguments in order to sharpen our critical thinking skills?
Response	Because doing so gives us practice in evaluating the formal, logical structures of an argument, and enhances our ability to effectively critique a piece of academic writing. It also assists us in constructing valid arguments in our own writing.

