MSc Research Skills

Structured technical writing

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Topics

The purpose of technical writing is to **communicate information** to the reader in a compact, clear, and efficient manner. This has three aspects:

1. **Structure** of the technical writing;

2. **Argumentation**;

3. Proper use of the (English) **language** (*separate lecture*).

Why are these important?

All three aspects help us **communicate** to the reader:

1. The **structure** of the document:
   - shows the **main topics**, the **sequence** of their presentation, which then implies their **relation**;
2. The **argument**:
   - gives the **logic** by which you reach conclusions;
3. The **correct use of language** (grammar, vocabulary, expression)
   - is how the structure and logic are worked out for the reader.

Topic : Structured technical writing

The MSc thesis is the **'story'** of a research project, telling other scientists can determine **what** you have done and **how well** you have done it.

A good story has first of all a **structure** that is:

- easy to follow, and
- leads the reader through the (often complex) research.

This structure can also be used when **writing**.

Structuring a document by outlining

One way to impose structure on a document is by **outlining** it before beginning to write.

Outlining:

- working from the overall structure of the document . . .
- in a **hierarchical** manner . . .
- to arrive at the specifics.

This ensures that all the **pieces** of the story will be **in place** before you have to write.

The outline shows their **inter-relation**, in particular, the **order of argumentation** (not yet the argument itself).

Example structure: the stereotypical research paper

A simple paper or thesis often follows this structure:

1. Introduction
2. Materials & Methods
3. Results
4. Discussion
5. Conclusions

These headings are at the **same level** of importance.

The author implies that this is the **sequence** in which they should be read (can't understand results without methods etc.)

Example structure (2)

Note that this is just an example to illustrate structuring; other structures are possible for a thesis (*separate lecture*).

Question: Is this the best order for these elements? Hint: look at an article in *Nature*; the main conclusions come first.

Expand one level

1. Introduction

2. Materials & Methods

2.1. Sampling design
2.2. Field methods
2.3. Data processing
2.4. Data analysis

3. . . .

Note that the order of subsections has a logic: here, the **sequence** in which the methods are carried out (design, then go to the field, then process . . .).

Notice how we ensure every method will have a place where it is best described, before we have to write anything.

Expand a second level

1. Introduction

2. Materials & Methods

2.1. Sampling design
2.2. Field methods
2.2.1. Infiltration and saturated water content
2.2.2. Soil profile description
2.2.3. Bulk density
2.3. Data processing
2.4. Data analysis

3. . . .

The order of subsections here is arbitrary, there is no priority to any of the methods.

Text processor support for outlining

MS-Word "Outlining" mode; heading styles; table of contents derived from these

LaTeX sectioning macros (e.g. `\section`); table of contents derived from these (with `\tableofcontents`)

Paragraphs

Each named sections in the outline is made up of one or more **paragraphs**

These can be considered the **final level** of the outline.

> A **paragraph** is a **set of sentences** that **work together** to make **one point**.

> "[A] **unit of thought**, not of length; it must be **homogeneous in subject matter** and **sequential in treatment**"
>
> — Fowler, H. W. & Gowers, E. (1965) *A dictionary of modern English usage*; Oxford: Clarendon Press

Example of a coherent paragraph

"Reaching the University of Twente (UT) in Enschede from anywhere in the world is easy. Flights from hundreds of cities all over the world arrive at Amsterdam's Schiphol airport, from which the traveller can take a comfortable train every two hours direct to Enschede station, from early morning till almost midnight. Trains on the other half-hours require one change of trains, either in Hengelo or Amersfoort. The train takes a bit over two hours from Schiphol to Enschede. From Enschede station the ITC building of the UT is an easy five-minute walk; to the main campus of the UT on the outskirts of Enschede there is frequent bus service from the bus terminal directly in front of the train station."

Question: What is the function of the first sentence in this paragraph?

Question: Why do we call this paragraph "coherent"?

Example of an incoherent paragraph

"Reaching the University of Twente (UT) in Enschede from anywhere in the world is easy. The ITC faculty of the UT specializes is the application of geoinformation and earth observation to pressing societal problems, especially in developing countries. The causes of underdevelopment have been debated for years, and recently a new critique of the traditional development aid approach has been presented to the Dutch parliament for its consideration. Remote sensing has become increasingly important for rapid assessment of earth system processes that may result in natural hazards; ITC is specialized in remote sensing."

Question: What is wrong with this paragraph?

Sections vs. paragraphs

- Sections go deeper into a topic than a paragraph;
- Sections consider several closely-related aspects of a topic; paragraphs make one point only;
- Sections usually require several related paragraphs.

There are different ideas on the maximum length of a paragraphs, and what constitutes “one” point; finally it is a matter of style and opinion.

The topic-sentence method

This is a method for continuing the outlining into full paragraphs.

Some people make great progress with this structured technique; others find it confining (stifles their creativity).

If you have a system for writing that results in rapid progress towards a properly-structured document, don't change!

If you have trouble organizing your thoughts and writing, this topic-sentence method may well work for you.

Writing paragraphs by topic sentences

Each paragraph has a narrowly-defined **topic**.

The **topic sentence** technique is often used to begin paragraphs.

The idea is to:

- write a sentence that **introduces** the topic of the paragraph, and
- leave the **details** of that paragraph for following **filling** sentences.

(Note: readers will **skim** a document exactly this way)

Example topic sentence

This text is adapted from Leisz *et al.*, *Agricultural Systems* 85:340.

Note: the original text has **citations** where appropriate; see below.

"In large areas of the Vietnamese uplands, swidden agriculture (also known as slash-and-burn or shifting cultivation) is thought to constitute the most serious threat to the natural environment."

This sentence already tells us the **area**, **lands**, and **problem** which will be further worked out in following sentences.

Note the phrase **"thought to constitute"**, this is key to the topic; compare the topic if this were **"constitutes"**.

Example filling sentences

1. “This viewpoint is found in many places throughout the world and across all of Southeast Asia, causing the practice to be outlawed at various times in almost every country in the region.”

2. “The Vietnamese government has subscribed to this belief and has repeatedly attempted to prohibit its practice through a major program intended to ‘sedentarize’ upland populations.”

3. “Despite heavy expenditures, this program has enjoyed little success, because it is unable to provide the swiddeners with alternative methods of earning livelihoods that are commercially viable, culturally acceptable, and ecologically sustainable.”

Note: these are not numbered in the text.

Original text, with citations

"In large areas of the uplands, swidden agriculture (also known as slash-and-burn or shifting cultivation) is thought to constitute the most serious threat to the natural environment (Fox et al., 2000; Tachibana et al., 2001). This viewpoint is found in many places throughout the world (Myers, 1993; Riswan and Hartanti, 1996) and across all of Southeast Asia, causing it to be outlawed at various times in almost every country in the region (Padoch and Coffey, 2003). The Vietnamese government has subscribed to this belief (Dang, 1991; Morrison and Dubois, 1998) and has repeatedly attempted to prohibit its practice through a major program intended to 'sedentarize' upland populations (Tran, 2003). Despite heavy expenditures, it is believed that this program has enjoyed little success, because it is unable to provide the swiddeners with alternative methods of earning livelihoods that are commercially viable, culturally acceptable, and ecologically sustainable (Tran, 1998)."

References:

Dang Nghiem, Van., 1991. La culture sure brulis et le nomadisme. Etudes Vietnamiennes 1 (99), 16–28.

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. . .

Fox, J., Truong, D.M., Rambo, A.T., Tuyen, N.P., Cuc, L.T., Leisz, S., 2000. Shifting cultivation: a new old paradigm for managing tropical forests. Bio-Science 50, 521–528.

Morrison, E., Dubois, O., 1998. Sustainable livelihoods in upland Vietnam: land allocation and beyondForestry and Land Use Series, 14. International Institute for Environment and Development (IIED), London, England, pp. 64.

Myers, N., 1993. Tropical forests: the main deforestation fronts. Environmental Conservation 20, 9– 16.

Padoch, C., Coffey, K., 2003. Monitoring the demise of swidden in Southeast Asia: local realities and regional ambiguities. In: Mertz, O., Wadley, R., Christensen, A.E., (Eds.), Local Land Use Strategies in a Globalizing World: Shaping Sustainable Social and Natural Environments. Proceedings of the International Conference August 21–23, 2003, vol. 1. DUCED SLUSE, Institute of Geography, University of Copenhagen, Copenhagen, pp. 103–124.

Riswan, R., Hartanti, L., 1996. Human impacts on tropical forest dynamics. Vegetatio 121, 41–52.

Tachibana, T., Nguyen, T.M., Otsuka, K., 2001. Agricultural intensification versus extensification: A case study of deforestation in the northern-hill region of Vietnam. Journal of Environmental Economics and Management 41, 44–69.

Tran, D., 2003. The Farm Economy in Vietnam. The Gioi Publishers, Hanoi.

Tran, D.V., 1998. Soil erosion and nutrient balance in swidden fields of the composite swiddening agroecosystem in the Northwestern mountains of Vietnam. In: Patanothai, A. (Ed.), Land Degradation and Agricultural Sustainability: Case Studies from Southeast and East Asia. Regional Secretariat The Southeast Asian Universities Agroecosystem Network (SUAN), Khon Kaen University, Khon Kaen, Thailand, pp. 65–84.

Questions about these filling sentences

1. Do these all fill in the topic given by the topic sentence?
2. How does the second sentence connect to the topic sentence?
3. What is the sequence? Is there a logic to this?
4. How does the final sentence “wrap up” this paragraph?
5. What do we expect the next paragraph will deal with?

Structure of the sentences within the paragraph

Note the **sequence** of the filling sentences, which build the argument:

viewpoint → **action** → **consequences** of that action.

The reader is now prepared for the next paragraph; topic sentence:

"The composite swiddening agriculture system is an alternative farming system that appears to overcome these problems."

Linking words and phrases

(Also called **connectives**)

This is a common way to show the **flow of ideas** within a paragraph – it emphasizes the **coherence** of the ideas.

They explicitly draw the reader's attention to the **connection** between sentences.

Example

Without connectives:

> The guitar is ubiquitous in popular music. This was not always the case. The guitar has a long history. Before the early part of the 20th century it was hardly used. Popular music was accompanied by the piano.

With connectives:

> The guitar is ubiquitous in popular music. **However**, this was not always the case. **Although** the guitar has a long history, **until** the early part of the 20th century it was hardly used. **Instead**, popular music was accompanied by the piano.

Some common linking words and phrases

In addition	Also	Similarly	Further(more)
By contrast	However	Despite	Even though
Thus	In this way	Therefore	Hence
On the one hand	On the other hand	First(ly)	Second(ly)
Initially	Later	During	Finally
Because (of)	As a consequence (of)	Since	As a result
Assuming that	Presuming that	Supposing that	Consequently
With respect to	With regard to	Considering	Regarding
Fortunately	Unfortunately	By coincidence	Incidentally
Still	Nonetheless	And yet	Nevertheless
In short	In summary	In conclusion	To summarize
Surprisingly	To our surprise	As expected	Unsurprisingly

Topic: Argumentation

Argumentation: "methodical reasoning; debate".

To **argue a position** is to maintain its truth by **reasoned debate**.

Argumentation is a **constructive debate** to reach a **solution**.

But, what is then **"reasoned"** debate? What sorts of **"reasonable"** arguments are valid?

Note: not about "winning an argument" or "arguing" ($\approx$ "fighting verbally").

Aristotle's three elements of persuasion

From *The Art of Rhetoric*, 4th century BCE

- *logos*: logical **reasoning**

  Claims, evidence, warrant, backing, rebuttal – see details below.

- *ethos*: **trust** in the author, especially their reputation and credibility;

  "My previous research projects were successful, so you should give me the resources to do another one."

- *pathos*: appeal to **emotions**, especially in relation to the reader's values.

  "Agriculture is the soul of a country and must not be ignored in setting research priorities."

The three elements in a research proposal

- *logos*: the **main method of scientific argument**

- *ethos*: increase the reader's trust and **confidence** that the researcher can carry out the proposed research by:

  * a well-crafted proposal . . .
  * showing evidence of **thorough literature search** . . .
  * and **careful argument**.

- *pathos*: **no place in a scientific document**; a research proposal or thesis must be based primarily on evidence, not emotion.

  Pathos may be an important part of policy documents or political arguments.

Elements of an argument

Stereotypical **structure** (due to Toulmin)

1. a **claim** to be established; this asserts something that, at this point, the reader may or may not accept, and so needs to be supported;

2. **evidence** to **support** the claim;

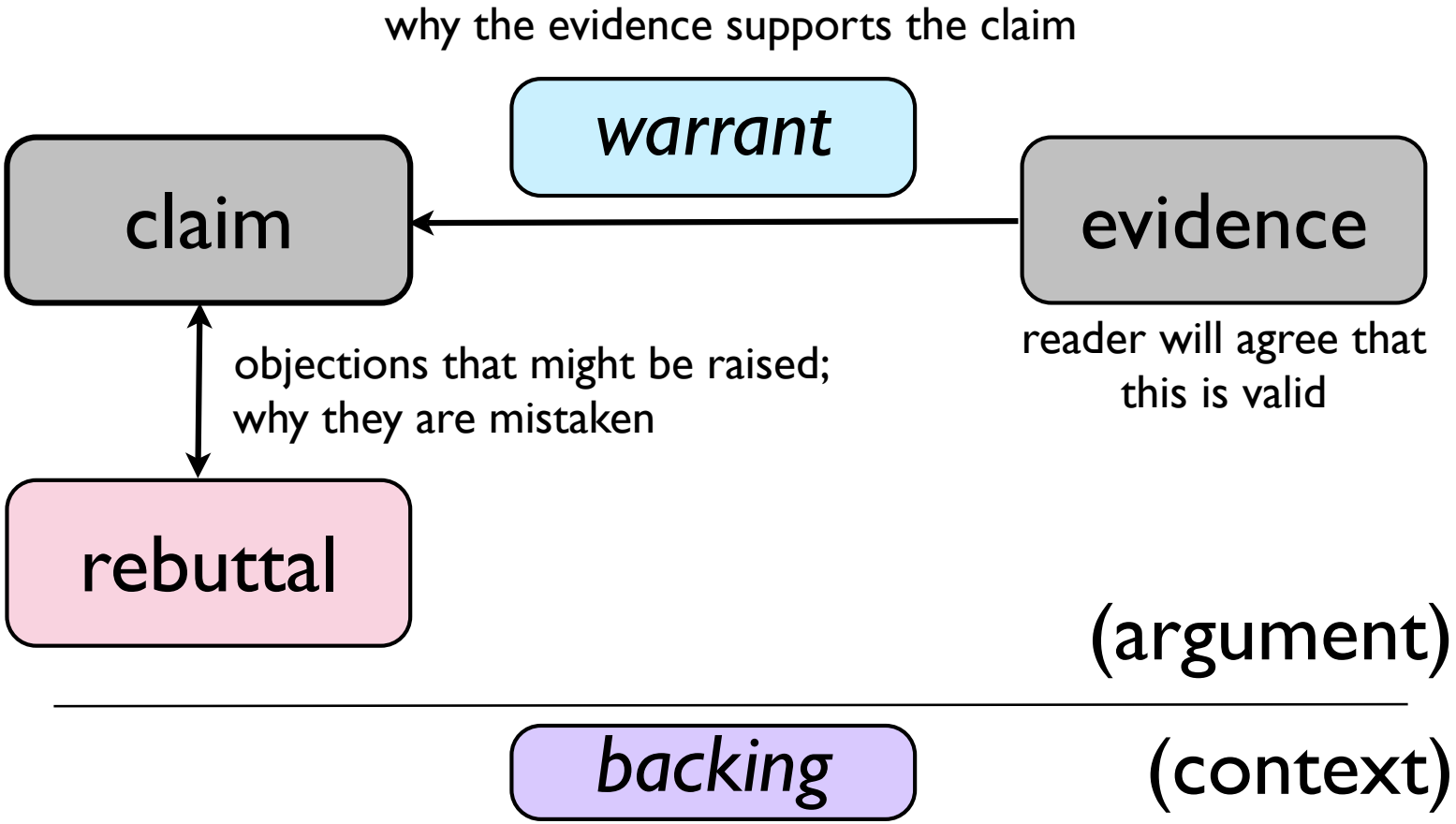
3. a **warrant** or justification: the "since . . . " which provides the link from evidence to claim;

4. a **backing** that provides the context (not to be argued);

5. an optional **modal qualifier** that limits the extent of the claim;

6. an optional **rebuttal** of anticipated counter-arguments.

Argument flow



Note: The claim may have a **modal qualifier** to limit its scope.

Example of stereotypical argument structure

1. **Claim**: (what we want to convince the reader)
   - "Crop yield forecasting using models coupled to daily weather satellite observations should be operationalised and used by the national agencies responsible for import/export policy."

   (continued . . .)

   Note that this could be the main argument of a reseach proposal. The "operationalization at full scale" would be the novel part of the research.

Example (continued)

2. **Evidence**: (facts the reader will agree with)

   - "Current yield forecasting methods give poor results."
   - "Import/export policy for staple crops has been erratic and not in line with actual supply."
   - "Research results with these new methods have shown good ability to predict yields."

   Note 1: In scientific argument these would each have a **citation**.

   Note 2: If the reader needs convincing of these points, they become **prerequisite claims**, to be established by argument before the current claim.

   (continued . . .)

Example (continued)

3. **Warrant**:

   This is a general principle, assumption or premise that connects the claim and its supporting evidence.

   It is the **link** between evidence and claim: i.e. why the claim can be inferred from the evidence.

   - "Accurate yield forecasts are necessary for efficient agricultural markets and sound import/export policy."
   - "The proposed methods can provide these."

   (continued . . .)

Implicit warrants

In normal conversation these are usually supplied by the common knowledge of the speaker and listener.

That is, the warrants are **implicit**; both parties automatically infer them from the claim and evidence.

Example (from Booth *et al.* "The Craft of Research"):

Claim "It rained last night."
Evidence "The streets are wet."
Warrant "Rain makes streets wet; no other cause wets the whole street so uniformly."

In this example the implicit warrant is fairly self-evident, so would rarely be stated explicitly.

However, in scientific argument the writer and reader may not share implicit warrants, so they must be spelled out.

Example (continued)

4. **Backing**: (unstated assumptions behind the warrant)

   - The entire context to the agricultural sector and its economy;
   - The entire context of current remote sensing and information technology.

   (continued . . .)

   This is the part of the **warrant** that is **implicit within the field** and accepted by any target reader.

   If the argument is re-written for a **different audience**, some of the backing may need to be stated as warrant.

Example (continued)

5. **Modal qualifier**:

   - "However, if yields are affected by extreme weather such as typhoons, yield forecasts from any method will be gross over-estimates."

   (continued . . .)

   This **limits the claim** and may be necessary for the warrant to provide a valid link from evidence to claim.

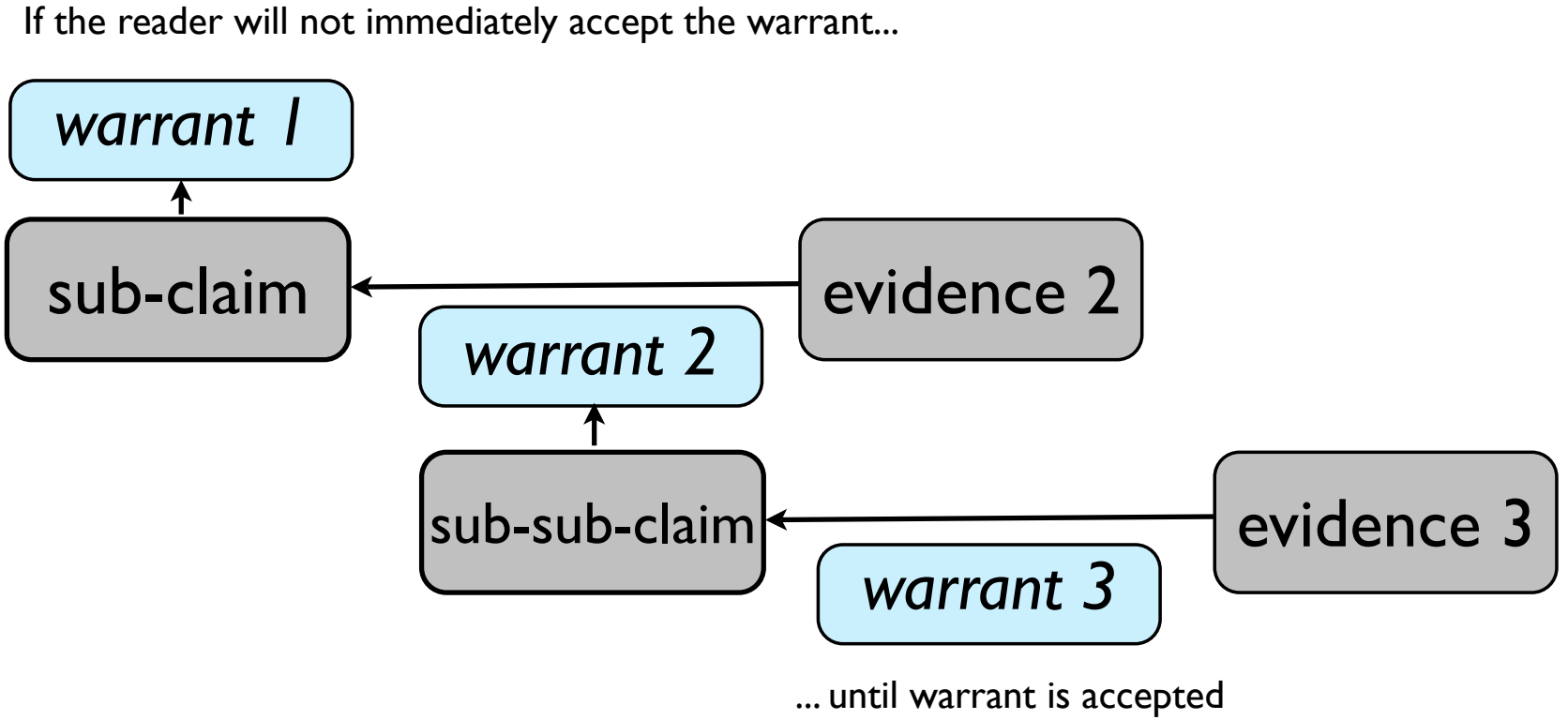
Example (continued)

6. **Rebuttal**:

   - Anticipated **counter-argument**: Costs will be too high for routine use.
   - Rebuttal: "Costs of acquiring daily weather images are very low and processing can be done on any desktop computer with free software."

These allow us to anticipate counter-arguments and deal with them. The **target audience** helps determine the nature of counter-arguments that may be made.

Extending the argument



The “since . . . ” may be accepted by some readers, but others may not have the background to understand it, or may object to the direct statement.

So the **warrant** in one argument becomes a **claim** in a **sub**-argument.

Analyzing an argument

1. Is the **reasoning** (logic) correct as such?
2. Is the **evidence** correct? Is it complete?
3. Is the **warrant** (if present) a sufficient justification?
4. If the warrant is only **implicit**, should it be made **explicit**?
5. Is the implicit **backing** shared by author and reader, and accepted by the reader?
6. Does the **modal qualifier** (if present) increase confidence in the main argument?
7. Does the **rebuttal** (if present) strengthen the argument?

Argumentation styles

1. From **definitions**, "define the problem away"
   - may set up a more focused argument

2. From **cause and effect**
   - these may be difficult to separate, and to distinguish from correlation;
   - must occur in a time sequence, but a stronger argument (about processes) is needed

3. From **time sequence**
   - a weaker form of cause and effect
   - avoid the logic fault *post hoc ergo propter hoc* ("after this, therefore because of this")

(continued . . .)

4. From **contributions and impacts**

   - a weaker form of cause and effect

5. By **analogy** or **comparison** with similar cases

   - establish similar context (geographic, social, environmental . . .) for the analogy to be valid; the argument must clearly state what is different in this case, and how it affects the argument;

Flawed argument

Three classes of flawed argument:

1. **Material**: mis-statement of facts;
2. **Verbal**: wrong use of words;
3. **Logical** (formal): process of inference.

Material flaws

A material flaw is a **mis-statement of fact**.

Without correct information, the rest of the argument can not be valid.

> "The sun rises in the west, therefore . . ."

Verbal flaws

A verbal flaw is a **mis-use of words**.

Fallacy of **ambiguity** (also called fallacy of **equivocation**): using a word in **more than one sense** in the same argument.

> "**Models** have been used by engineers for many years to investigate the behaviour of full-scale systems before they are built. A well-known example is scale **models** of aircraft in wind tunnels. Therefore, a geo-database **model** of the soil-landscape of the is an appropriate method to investigate soil conservation practices."

Logic flaws

Logic deals with the way in which:

- **antecedent** statements . . .
- . . . and **inferential premises** . . .
- . . . are **related** to each other . . .
- . . . to reach conclusions, also called **consequents**.

Logic does not deal with the truth of the antecedents or premises (**material** flaws).

Logic also does not deal with mis-use of words (**verbal** flaws).

Types of logic flaws

Humans seem to have a lot of trouble arguing with correct logic. Because of this, many logic flaws have been identified and analyzed.

Among the most common logic flaws are:

1. **Invalid inferences**
2. ***Post-hoc* reasoning**
3. **Spurious correlations**
4. **Correlation vs. causation**
5. **Lurking variables**

   (more . . .)

(continued)

6. **Circular reasoning**
7. **False dilemmas**
8. ***Ad-hominem* argument**
9. **Fallacy of composition**
10. **Fallacy of division**

See the lecture notes for examples of these.