Module B: Reviewing the literature

The literature review (LR), also known as **Related Work**, **Theory**, or even **Background,** should provide a *summary* of the subfield that you are working in, as well as show the *context* for your work. In this chapter, you **discuss** related work done by earlier researchers, **explain** how your thesis is linked to this earlier work, and **justify** why this knowledge is important for carrying out the aim that you promised at the end of your introduction in Chapter 1.

1. What, why, where, how?

Discussion

How would you answer these questions?

1.1 **What** is a Literature Review (LR)?

1.2 **Why** do you need to review **the** literature? What is the **function** of a LR?

1.3 **Where** will you put it in your thesis?
What is the **difference** between the information reviewed in the Introduction chapter and that in the Literature review chapter?

1.4 What **title** will you give to your LR chapter?

1.5 **What strategy** will you use to **organize** this information?

1.2 Why review the literature?

A review of the literature can have any of the following functions:

- To identify important information needed to **develop a <u>solution</u>** to the problem described in the introduction chapter

- To **display** (give evidence) that you are **familiar** with *earlier solutions* and/or *state-of-the-art technology* relevant to your topic

- To **justify** the **<u>approach</u>** or **<u>method</u>** that you will use for developing your solution

- To show how your thesis is **linked to <u>previous research</u>** (Are you continuing from where earlier research ended?)

The review traditionally provides a **historical overview** of the theory and research literature, with a special emphasis on the literature specific to developing the solution in your thesis. It also serves to support the argument/proposition behind your thesis, using evidence drawn from authorities or experts in your research field.

How to display knowledge?

The review should be shaped by a focus on key areas of interest, including research which provides a background to the topic. It should also **be selective**. A common mistake in writing the review is to comment on everything you have read regardless of its relevance. In your writing, it is useful to **think of the review as a <u>funnel</u>** – start wide with the overview (See [Section 5.1](#)) and then quickly narrow into discussing the research that relates to your specific topic.

Another way of looking at the process, particularly if you are examining several topics (or variables), is to think of yourself as a film director [2]. Provide your audience with

- **long shots** to provide a solid sense of the background
- **middle distance shots** where the key figures and elements to be examined are brought clearly into view
- **close-up shots** where the precise focus of your work is pinpointed

High-quality literature can include a range of sources:
- Journal articles
- Conferences proceedings
- MSc Theses and PhD Dissertations
- Government reports, technical standards, patents and reports from other bodies

A number of these may be available on the Internet. You should therefore approach such material with the same critical eye as you would approach printed material.

2. What do supervisors want?

A review of the literature should...

- demonstrate that you have a deep understanding of
    - the **key concepts**/**studies**/**models** related to solving the problem motivating your thesis
    - the **history** of your research area and any related **controversies**

- clarify important **definitions/terminology**
- further develop the **research gap** stated in the **Introduction section**
- narrow the **problem** in order to make the study feasible

To give you some sort of idea of what your professor is looking for when evaluating your review of the literature, read this extract for **'Command of the topic'** published in *Guideline for Master's Thesis Evaluation* (2012) by the School of Electrical Engineering at Aalto University.

Excellent (5)	The cited works have been *selected* not only *appropriately* but *critically*; the number of relevant works cited is *sufficient*, consisting primarily of *high-quality scientific publications* (journals or other refereed forums). **The [thesis] results have been *evaluated in the light of the cited works* and in that of *prior research* and theories on the topic**. In addition, the student demonstrates deep understanding of the research topic.
Very good (4)	The thesis combines the cited works and empirical data *consistently* and clearly. The cited works consist primarily of *high-quality scientific publications* (journals, other refereed forums), which are sufficiently numerous and appropriately chosen. The student demonstrates good command of the research topic.
Good (3)	The student demonstrates good command of the relevant literature and background material, and has applied them appropriately, but **the connection between the background material and the empirical data is not necessarily made sufficiently explicit**.
Very satisfactory (2)	The references are **few or of poor scientific quality**. There are notable shortcomings in the referencing. Source evaluation is lacking and the bibliography contains errors.
Satisfactory (1)	The references are too few, they are of **poor scientific quality or ill-suited** for the thesis. There are significant shortcomings in the command and referencing of the literature and prior research on the topic, and the bibliography contains errors.

3. Metatext

The writer's own voice is most clearly spoken through the use of metatext, also commonly referred to as metalanguage. Metatext comprises the comments concerning the text made by the writer within the text: they give signals to the reader that explain the function or intention of the text, where the text is going, where it has gone, and what it has achieved so far. The author intrudes to guide the reader and, more importantly in the master's thesis, to explain and justify the process leading to the outcome of the thesis.

Starting with the top level this can apply to

- The whole thesis (*The focus of this thesis is...*)

- Another chapter *(The physical properties will be presented and analysed in Chapter 3)*

- The current chapter *(The rest of this chapter will examine...)*

- Another section *(In the previous section, it was demonstrated that...)*

- The current section *(This section introduces...)*

- Passage immediately preceding or following *(The objectives are as follows:...)*

More specifically, these reader directions can fulfil three functions:

1. OVERVIEW (justification/content of current section/chapter)

[1]**In order to** explain the optimization model used for the design of fabric formed beams**,** three main principles need to be discussed**:** X**,** Y**, and** Z.

[20]**Having** establish**ed** relations for the form-finding process**,** **the next section** **explains** an approximation of the beam's strength-based design.

[36]However, in order to **minimize** the cost **of** the cross-section, **the** **next section** **develops** a cost model.

2. REVIEW

[42]**This chapter** **introduced** the main methodology for finding the form of a fabric subjected to hydrostatic pressure from a fluid.

[43]**An original approach** **was** **proposed** to use polynomial approximations of the dimensionless relationships for the optimization approach.

3. PREVIEW (purpose/content of next section/chapter)

[45]**The next chapter** **will** **introduce** the optimization methods for the design of reinforced fabric formed concrete.

Common Verbs in Chapter/Section Metatext

A quick-and-dirty analysis using **Google Scholar** < http://scholar.google.fi > revealed the following twenty-one verbs to be commonly used in **IEEE Journals** to describe the purpose of Chapter/ Sections. The verbs are arranged in <u>descending</u> order of frequency of occurrence (hits). The frequency of each verb was obtained by searching with the wildcard search phrase **"section * VERB"**. For example, searching with the wildcard phrase **"section * PRESENTS"** yielded the highest frequency at 296,000 occurrences.

Chapter 2	**presents**	[296,000 hits]	**MOST COMMON**
This chapter	**describes**	[273,000 hits]	
Section 2.3	**reviews**	[205,000 hits]	
This section	**discusses**	[147,000 hits]	
The next section	**provides**	[113,000 hits]	
	introduces	[111, 000 hits]	
	summarizes	[37,100 hits]	
	explains	[26,900 hits]	
	proposes	[11,500 hits]	
	outlines	[11,500 its]	
	reports	[8,650 hits]	
	analyzes	[8,500 hits]	
	defines	[7,900 hits]	
	evaluates	[6,200 hits]	
	derives	[3,620 hits]	
	examines	[2,850 hits]	
	surveys	[1,930 hits]	
	explores	[1,770 hits]	
	validates	[1,050 hits]	
	verifies	[646 hits]	
	assesses	[326 hits]	**LEAST COMMON**

The same in **alphabetical** order:

analyzes	describes	explains	presents	reviews
assesses	discusses	explores	proposes	summarizes
defines	evaluates	introduces	provides	surveys
derives	examines	outlines	reports	validates / verifies

3.1 Introducing and Summarizing Chapters

You need to keep two goals in mind when organizing your literature review: (1) you want your text to be as easy as possible for your supervisor to read, and (2) you also need to *explicitly* **explain** and **justify** how the information presented in your LR is *relevant*, *important*, and *necessary* to the aim that you described in the introduction to your thesis.

The **introductory paragraph** of your literature review chapter should not only introduce the **key terms** and **concepts** that will be discussed and defined, but it should also provide an **overview** outlining the structure of the chapter. Similarly, the **concluding paragraph** for each chapter should ideally provide a summary that does not simply list the contents of the chapter but should actually explain its relevance to your research—w*hy was this information important to know?* In addition to highlighting the relevance of the chapter, your concluding paragraph can also **preview** the topics of the next chapter and explain how they are connected to the current chapter. Figure 10 shows a typical example of an introductory paragraph.

Alexandr Vesselkov, "Forecasting of mobile handset feature diffusion: supply-related aspects," M.S. thesis, Dept. Elect. Eng., Aalto Univ., Espoo, Finland, 2014.

4 Evolution of mobile handset population in Finland

Purpose of chapter

[1]**This chapter presents** the results of quantitative study of mobile handset base evolution in Finland. [2]Analysis of the handset population **is necessary for** detecting and studying the development trends of the mobile handset market.

Justification

[3]**Understanding** these trends, in turn, **is an important prerequisite for** improving the forecasting of mobile handset feature diffusion.

Overview of structure and content

[4]**This chapter is organized as follows.** [5]**Section 4.1 presents** the shares of different device types in Finland. [6]The phenomenon of the fragmentation of mobile handset population **is investigated in Section 4.2.** [7]**Section 4.3 discusses** the evolution of mobile handset base by manufacturer and operating system. [8]**Finally,** historical diffusion of mobile handset features **is analyzed in Section 4.4**.

4.1 Evolution of the shares of mobile device types

Figure 10: Example introductory paragraph to a thesis LR in Electrical Engineering

Note how the writer explicitly justifies this chapter by referring back to the aim of the thesis (i.e., *improving the forecasting of mobile handset feature diffusion*). A typical strategy for linking the chapter contents to the thesis aim is to use either a **purpose clause** (in order to…, for + -ing) or a **cause-effect connector** (Since / Because / As).

[2]Analysis of the handset population **is necessary for** detect**ing** and study**ing**…

[2]Analysis of the handset population **is necessary in order to** detect and study …

[2]The handset population is analyzed**, since** this will allow detection and study of…

Exercise 1

What <u>information</u> has been used to organize these introductory and summarizing paragraphs in these two chapters from a master's thesis in civil engineering? What tenses have been used in each? Why?

Marwan Sarieddine. 2014. *Optimal Design of Fabric Formed Concrete Beams*, Master's thesis, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology. Retrieved 6 March 2016: http://dspace.mit.edu/handle/1721.1/90155

3. METHODOLOGY

[1]This chapter will explain the two methods developed in this thesis for optimizing a reinforced fabric formed beam. [2]Initially the analytical optimization method is introduced which relies on solving a constrained non-linear optimization problem using Matlab. [3]Then the feasible region method is introduced which is a more direct and approximate method that could be more convenient for designers to use.

3.4 Summary of Contributions

[37]This chapter has introduced two main methods for the optimization of the cross-section of a fabric formed reinforced concrete beam. [38]The first method is the analytical optimization method that is an original way to deal with the problem from a constrained optimization point of view. [39]The second method is the feasible region method, which might prove to be a more user-friendly method that the designer could conveniently use without having to undergo the same level of computation required by the analytical optimization method. [40]The next chapter will look at a sample result of both of the methods just introduced.

4. RESULTS

[1]This chapter will consider a specific sample problem which is then solved using both the analytical optimization model and the feasible region model. [2]The results are also benchmarked against the output from the model introduced by Garbett, Darby, & Ibell (2010).

4.3 Summary

[55]The results chapter has benchmarked the two methods proposed for the optimum design of fabric formed beams with the method of Garbett, Darby, & Ibell (2010). [56]The chapter also proposes a rough estimation of about 55% in cost savings. [57]This approximation is not exact, since only a total of three cross-sections were chosen and due to other assumptions which have been previously explained. [58]The next chapter will consider the topic of pre-stress design from a similar perspective to which the problem of reinforced concrete design was approached.

4.1. Avoiding Plagiarism

Many students mistakenly believe that to write about a topic, they must have something *original* to say. However, in science, knowledge is always the result of earlier work by other people. Since these ideas are not your own, it is vital that you acknowledge the original sources of your information. By doing so, you do not weaken your ideas, but instead you strengthen the credibility of your writing, and actually demonstrate to your teacher or professor that you have done the necessary background reading and study that are so central to a university education. Therefore, in your writing at the university, you should aim to **cite** your sources as much and as often as possible. This also helps you to avoid plagiarism.

What is 'plagiarism'?

Plagiarism is presenting an **idea**, **text**, **picture**, **piece of code** or **other work** created by someone else as your own. Plagiarism is defined at Aalto University as

> If **only a few words** or **the word order has been altered**, the text is **not** considered to be an independent contribution or product of independent thinking. In addition, **closely following** the **argumentation or text structure** of someone else may constitute plagiarism.

(Aalto University Code of Academic Integrity and Handling Violations Thereof[1], 2013)

Who is speaking (Voice)?

In academic writing, it is vitally important that you distinguish whether it is **you** or the voices of **others** who are speaking. You can make this clear through the use of **metatext**, **citations** to the original sources, and even the **verb tense** used in the text. Without these clues, your reader will be unable to determine which information introduced in your text are **your own** ideas, opinions, claims and observations, and which are **those of other writers** and past researchers. Citations also allow other researchers to find and read those sources of information in case they wish to learn more about the topic or particular research findings.

The main function of **citations** is to clearly separate and mark the writer's thought from those of other sources that are brought into the text. Your citations should make it possible for the reader to easily follow and conclude at any given time **whose "voice"** is speaking through your text. Voice in academic text can take three forms [3]:

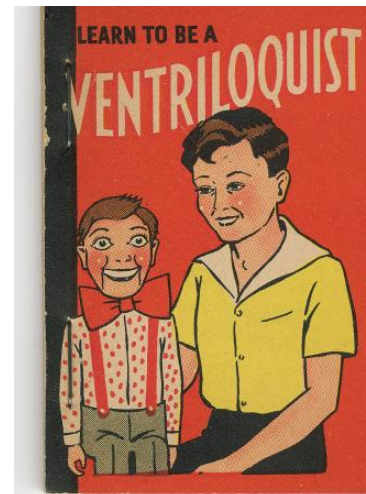1. **The shared general voice of your field**
   The *general knowledge* that is widely accepted throughout your field of study

2. **The voice of the source cited**
   The *ideas*, *wording* and *products* of others' work that you have introduced into your own text

3. **The voice of the writer**
   Your own *thoughts*, *opinions*, *comments* and *insights* expressed in the text

Kniivilä, S. Linblom-Ylänne, S., & A. Mäntynen (2012). Tiede ja Teksti: Tehoa ja Taitoa tutkielman Kirjoittamisen. SanomaPro Oy, Helsinki, Finland. p. 106.

How to avoid plagiarism?

1. **Summarise** or **paraphrase** (i.e., explain in your own words) ideas and information obtained from a source.

2. **Cite** the original sources within your text (e.g., Smith et al. (2012) or [5]).

3. Write clear, complete **references** describing sources in your **Bibliography/ References**. It is worthwhile to use reference management software (e.g., RefWorks or Mendeley) that will automatically format the reference entries according to a particular referencing format (e.g., IEEE or Harvard).

   Citing sources. Wikipedia. [Online] Available (2015, February 24)
   from: http://en.wikipedia.org/wiki/Wikipedia:Citing_sources

4. In engineering fields**, avoid quoting**, but if you do use a short extract from another writer's work, place the words within **quotation marks** [**" "**] and **cite** the source either before or after the quote.

5. Distinguish between (1) **your own ideas**, (2) **common knowledge** and (3) the **individual work or accomplishments** of earlier people. Reference to a source is not needed if a piece of information is considered *shared common knowledge* (i.e., *general* common knowledge or *field-specific* common knowledge).

As shown in Table 1, three strategies are commonly used to avoid to avoid plagiarism. However, science and technology only use summarizing and paraphrasing for reporting the work of others researchers.

Table 1: Three strategies for avoiding plagiarism

Quotations	Summarising	Paraphrasing
match the original source *word-for-word*	does ***not*** match the source text *word-for-word*	does ***not*** match the source text *word-for-word*
are usually very *short*	presents a *broad overview* of the *main idea(s)* in your own words	conveys the information/ideas from a source in *your own words*
are placed within *quotation marks* [**" "**]	always much *shorter* than the original	changes the *words* or *phrasing* of the text but fully maintains the original meaning, but ***not*** *structure*
must be attributed to the original source, ***not*** *secondary sources*, such as Wikipedia	must be attributed to the original source, ***not*** *secondary sources*, such as Wikipedia	must be attributed to the original source, ***not*** *secondary sources*, such as Wikipedia

Exercise 2

As shown in Turnitin (Figure 1), the first paragraph of this student's extended definition was **a word-by-word plagiarization** of work written by **Tohyama and Yamaguchi (2009)**. How would you paraphrase (re-write in your own words) their text?

Figure 1: View of Turnitin feedback showing sections plagiarized from other sources.

O. Tohyama and S.-I. Yamaguchi. "Photonic Crystal Fibers and Their Applications," *IEEJ Transactions on Electrical and Electronic Engineering*, vol. 4, no. 6, pp. 704–709, Nov. 2009

[1]Supercontinuum generation is a process where laser light is converted to light with a very broad spectral bandwidth, whereas the spatial coherence usually remains high. [2]The spectral broadening is usually accomplished by propagating optical pulses through a strongly nonlinear device, such as an optical fiber. [3]Of special interest are PCFs.

Your version:

Sentence 1:
Click or tap here to enter your version of Sentence 1.

Sentence 2
Click or tap here to enter your version of Sentence 2.

Citation Styles

Four formats are commonly used in science and engineering for citing sources (Table 2). In addition, individual fields differ in their preference between **author-** and **information-prominent** styles.

Table 2: Four formats applied using author- and information-prominent reporting styles

Formats	Author-prominent style	Information-prominent style
Author-date	<u>Smith</u> **(2012)** showed that... It was shown **by** <u>Smith</u> **(2012)** that ... **Several recent** <u>studies</u> **(Smith, 2012; Virtanen et al., 2005; Chao and Wang, 2011)** have suggested that...	<u>The theory</u> was first proposed for linear systems **(Smith, 1987).**
bracketed number	<u>Smith</u> **[2]** showed that... **In [2],** it was shown that... **Several recent** <u>studies</u> **[1], [3], [4]** have suggested that...	<u>The theory</u> was first proposed for linear systems **[1].**
superscripted number	<u>Smith</u>[2] showed that... It was shown **by** <u>Smith</u>[2] that ... **Several recent** <u>studies</u>[1,3,4] have suggested that...	<u>The theory</u> was first proposed for linear systems.[1]
parenthetic number	<u>Smith</u> **(2)** showed that... It was shown **by Smith (2)** that ... **Several recent** <u>studies</u> **(1), (3), (4)** have suggested that...	<u>The theory</u> was first proposed for linear systems **(1).**

Reference Styles

The style used to create references and in-text citations to these references differ from one field of study to another. The two most commonly used citation style in the engineering fields are **IEEE** and **Harvard**.   Examples are shown in Figure 2.

IEEE (numerical)

O. Tohyama and S. Yamaguchi, "Photonic Crystal Fibers and Their Applications," *IEEJ Trans Elec Electron Eng,* 4: 704-709, 2009. doi:<u>10.1002/tee.20468</u>

Harvard (Author-date)

Tohyama, O. and Yamaguchi, S. (2009), Photonic Crystal Fibers and Their Applications. IEEJ Trans Elec Electron Eng, 4: 704-709. doi:10.1002/tee.20468

Figure 2: the two most common referencing styles used in the engineering fields at Aalto University.

Introducing items in a list

In order to introduce *items in a list*, a sentence must meet two requirements. First, the sentence needs to have a **superordinate term**, which **links forward** and **describes** the 'class of things' to which the listed items belong. It is also important to decide on whether these items form a **closed** or an **open** set, as this determines the structure and punctuation used to introduce these listed items.

4.2 CLOSED SET

When the listed items comprise a **closed set** (i.e., the only items in that 'class of things'), use Strategy 1.1 or 1.2.

4.2.1 Closed set: **Number** + **superordinate** + colon [:] + *list of items*

A master's thesis can typically be divided into **five chapters:** *an introduction, literature review, methods, results,* **and** *conclusion.*

4.2.1 Closed set: **Superordinate** + the verb **to consist of** + *list of items*

The decision **variables** for optimization **consisted of** *temperature, volumetric flow* **and** *emission rate.*

4.3 OPEN SET

However, if the listed items form an **open set** (i.e., examples of some of the items that could be included in that group), then use Strategies 2.1-2.3.

4.3.1 Open set: **Superordinate** + **such as** + [*examples*]

Today's mobile lifestyle would not be possible without **vehicles, such as** *automobiles, buses, trams* **and** *aircraft.*

4.3.2 Open set: INDEFINITE QUANTIFIER + **superordinate** + **including** + [*examples*]

A new energy tax will be levied on MANY motorised **vehicles, including** *automobiles, lorries* **and** *motorcycles.*

VARIOUS	MULTIPLE	A NUMBER OF	A WIDE RANGE OF
NUMEROUS	DIVERSE	A VARIETY OF	

4.3.3 Open set: **Superordinate** + the verb **to include** + [*examples*]

The decision **variables** for optimization **include** *temperature, volumetric flow* **and** *emission rate.*

Superordinate Terms

Similar to closed lists, open lists require a **superordinate term** to introduce the example items in the list. Since identifying the correct superordinate can take some effort, most of the above problems can be attributed to either weak language skills, unfamiliarity with the vocabulary of the field, or simply laziness on the part of the writer. Superordinate terms (often also called *hypernyms, anaphoric nouns,* or *discourse-organizing words*) are nouns that can be used to stand for an entire **class** or **category** of things. Thus, a superordinate term acts as an **umbrella term** that includes within it the meaning of other words. For example, *vehicle* is the superordinate concept for *lorry*, *automobile*, *bicycle*, and *tram*.

Superordinate terms play an important role in promoting **cohesion** by providing writers with a more explicit means than would be possible using only pronouns (*it, they, this, these, those*) for linking their ideas either back to earlier presented text, or forward to upcoming information. Superordinates tell the reader what to expect when they occur before an idea. In this function, superordinate terms serve as the **class** in **definitions**, describe the *items* and *examples* presented in **lists**, and are important in creating **topic sentences** (See Appendix 5). The most common superordinates used in engineering are listed below in Figure 3.

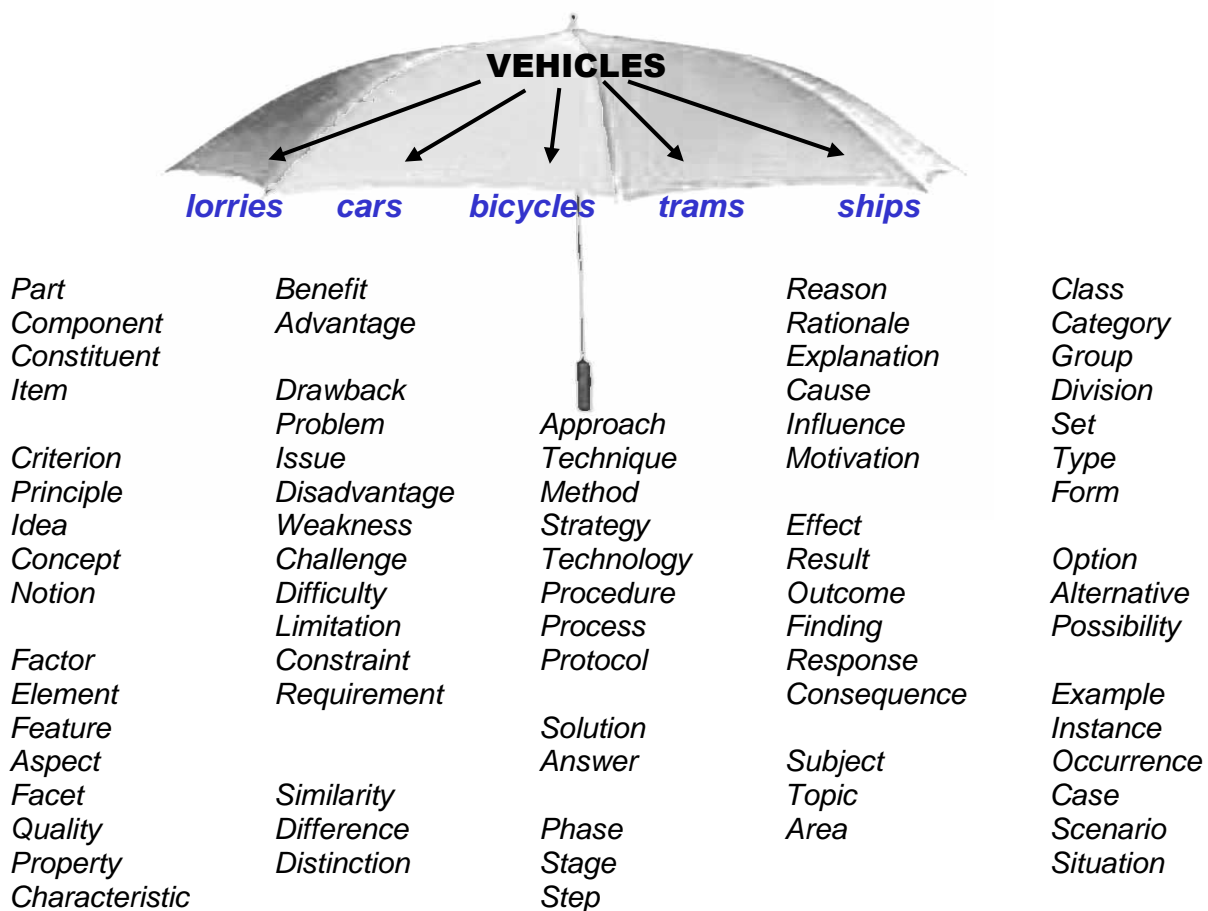|				
Part	*Benefit*		*Reason*	*Class*
Component	*Advantage*		*Rationale*	*Category*
Constituent			*Explanation*	*Group*
Item	*Drawback*		*Cause*	*Division*
	Problem	*Approach*	*Influence*	*Set*
Criterion	*Issue*	*Technique*	*Motivation*	*Type*
Principle	*Disadvantage*	*Method*		*Form*
Idea	*Weakness*	*Strategy*	*Effect*	
Concept	*Challenge*	*Technology*	*Result*	*Option*
Notion	*Difficulty*	*Procedure*	*Outcome*	*Alternative*
	Limitation	*Process*	*Finding*	*Possibility*
Factor	*Constraint*	*Protocol*	*Response*	
Element	*Requirement*		*Consequence*	*Example*
Feature		*Solution*		*Instance*
Aspect		*Answer*	*Subject*	*Occurrence*
Facet	*Similarity*		*Topic*	*Case*
Quality	*Difference*	*Phase*	*Area*	*Scenario*
Property	*Distinction*	*Stage*		*Situation*
Characteristic		*Step*		

Figure 3: Common superordinate terms used in engineering, grouped according to functional areas.

4.2 Closed-Set Lists

When describing or analyzing concepts for a literature review or a theory chapter, you will often need to either divide a concept into its *components* or classify previous solutions into *categories* based on *criteria* relevant to the aims of your research, since complex subjects are more easily understood when broken down into smaller groups. For this purpose, engineering texts tend to use a **classification-division** organizational structure, which first introduces the categories or sub-classes of the concept as either a **formatted** or **unformatted list**, and then describes each category in greater detail, preferably in the same order as presented in the introductory list. Formatted lists are those that present the items as a vertical list using either bullets [•], numbers [1. , 2. , 3. ,…] or letters [a., b., c.,..], whereas unformatted lists present the listed items as a horizontal list.

CLASSIFICATION-DIVISION

A key strategy for displaying knowledge, as well as moving down "the funnel," is to classify and divide your topic into its components or areas of enquiry. Not all of these areas should be given equal weight in your review. Strategically order these classes or areas least-to-most relevant in terms of the objectives of your own study:

[11]Lignocellulosic biomass comprises an intricate matrix composed of **three constituents:** **cellulose, lignin,** and **hemicelluloses**.
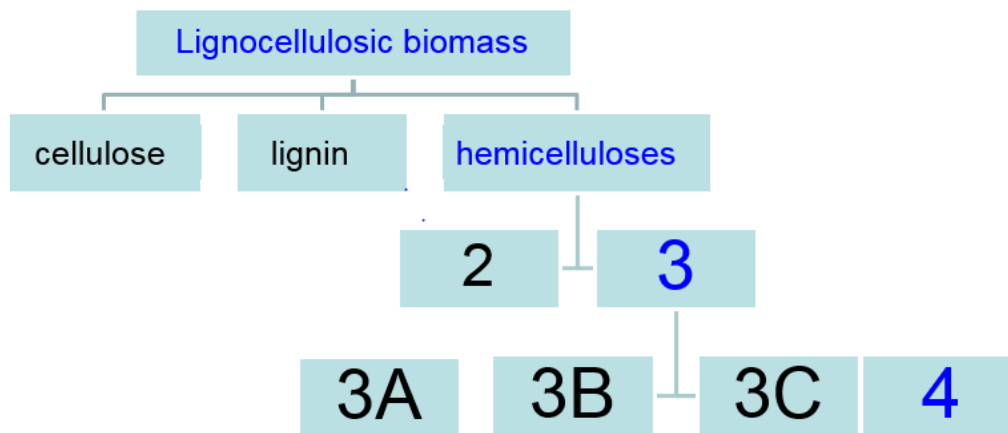
Note in the above figure how the classification-division strategy allows the writer to narrow the topic by first introducing with a **colon [:]** the three main components of lignocellulosic biomass. Thereafter, each component is briefly discussed moving in increasing order of its relevance to the problem to be solved in the thesis, eventually ending by discussing **hemicelluloses**, which in turn is then further divided and sub-divided into its subcategories, until the main focus of the thesis is eventually arrived at in **Topic 4**. This strategy enables the writer not only to display a deeper understanding the topic, but also to justify a certain method, theory or approach used in the thesis.

Such lists are fundamentally important not just for reporting theory and earlier research, but also for listing examples. The following pages describe the most common structures and language for introducing items in lists, as well as the correct punctuation for creating these lists.

4.2.1 Introducing a closed set using a colon [:]

Although an **Em dash [—]** or a **comma [,]** are widely used in the fields of **art**, **business** and the **humanities** for introducing items in a list, avoid using these in science and engineering. In science and engineering, a **closed set** of items is typically introduced with a <u>colon [:]</u> using the following structure and vocabulary (Figure 4):

[TOPIC]	**has been** ***can be**	**divided** **classified** **categorized** **grouped**	**into**	[HOW MANY?] **the following**	**subdivisions:** **classes:** **groups:**	[item$_1$]**,** [item$_2$]**, and** [item$_3$].

*Using *can* indicates that this is the writer's own interpretation, whereas the *present perfect tense* (i.e., **has been**) shows that the classification is widely accepted among the scientific community.

Figure 4: Typical sentence structure and vocabulary for presenting a closed set using a colon [:].

In order to use a colon [:], the text before the colon must contain three essential components:

1) A grammatically **complete sentence** before the colon [:]
2) A qualifier, either (a) a **numerical quantity** announcing the number of items in the list, or (b) the expression *the following*
3) A **superordinate term** that identifies the category to which the listed items belong

As shown in Figure 5, even the presentation of equations, where only one item is listed, requires a complete sentence*,* a qualifier (*the following*) and a superordinate term (*equation*) in order to use a colon [:]. In the example *without* a colon (right pane), note that a colon cannot be used, since the text before the equation does not form a complete sentence. Instead, the equation is integrated into the sentence and therefore requires a comma [**,**] after the equation and a period [**.**] at the end.

The increased spectral efficiency of the system can be represented by **the following** equation**:**

$$a = \frac{d_i(t)}{d_i} .$$

The effective bulk-like second-order susceptibility of TMDs is obtained from the sheet susceptibilities **as**

$$\left| \chi_{\text{eff}}^{(n)} \right| = \frac{\left| \chi_s^{(n)} \right|}{t} ,$$

where t is the thickness of the TMD monolayer, ~0.65 nm**.**

Figure 5: Presentation of an equation *with* (left pane) and *without* (right pane) a **colon [:]**.

In Figure 6 below, note that the text before the colon [:] meets all three of the requirements for using a colon: (1) It expresses a **complete sentence**. In othe words, it has a **subject** (*This study*), a **verb** (*has*) and a **compliment** (*three goals*); (2) it also announces the **number** of items in the list; and (3) the text before the colon uses a **superordinate term** (*goals*) that answers the question *What are these items?*.

<u>UNFORMATTED LISTS</u>	<u>FORMATTED LISTS</u>
Option 1 (Single sentence, colon, commas)	**Option 2** (topic sentence, colon, <u>no</u> commas)
This study has **three goals: To identify** the stages in the pavement management process**, to determine** the factors leading to the evolution of application user interfaces**, and to evaluate** the implementation of these user interfaces in a case study**.**	This study has **three goals:** 1. **To identify** the stages in the pavement management process 2. **To determine** the factors leading to the evolution of application user interfaces 3. **To evaluate** the implementation of these user interfaces in a case study

Figure 6: The same closed set of items presented <u>with</u> a colon as an *unformatted* and *formatted* list.

In engineering, closed-set lists are often used as topic sentences (Appendix 5) that first **preview** the items and then afterwards discuss them in the **same order** as they appeared in the list. Therefore, it is also important to strategically order these items **least relevant → most relevant** in terms of your topic, as shown below in Figure 7.
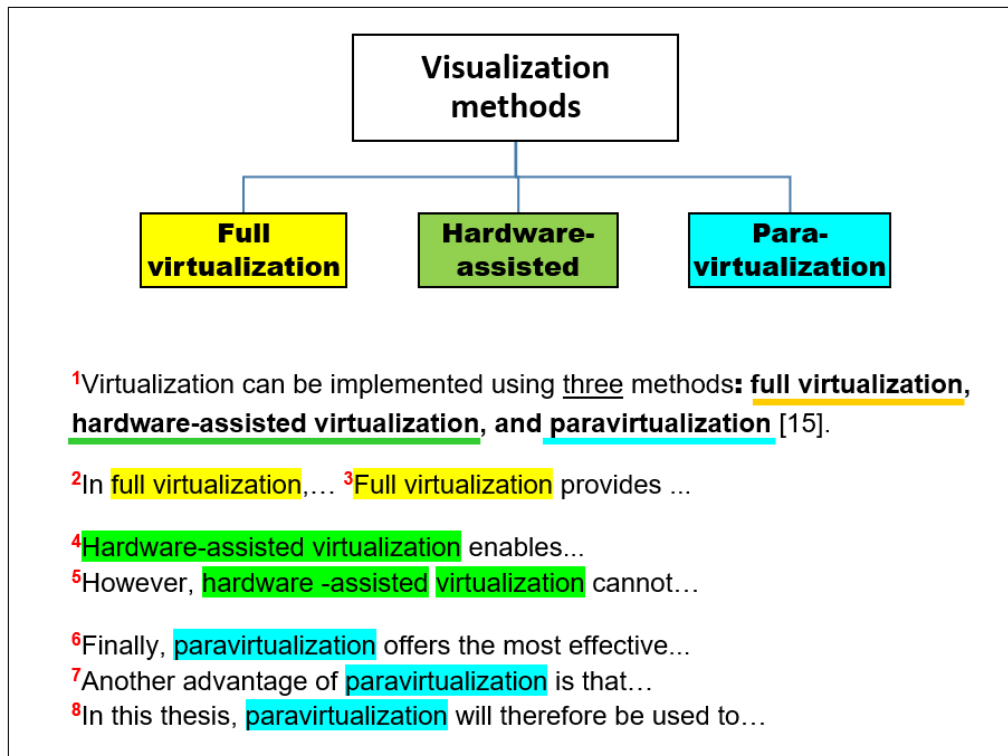

Figure 7: Strategic ordering of items in a list to allow placement of the most relevant or important item at the end of the list, where it can discussed at greater length and further divided into its subtopics.

4.2.2 Introducing a closed set without a colon

As can be seen from Figure 8, Options 3 and 4 both formulate the list as a single sentence. When packing a list into a single sentence, always use a **comma** [**,**] to separate each item in the list, remember to add the word **and** *before* the last item in the list, and end the list with a **full stop** (UK)/ a **period** (USA). However, note that no colon [:] can be used before the list, since the text introducing the list (i.e., *This study aims to*) does not form a complete sentence, nor does it have a superordinate.

UNFORMATTED LISTS	FORMATTED LISTS
Option 3 (single sentence)	**Option 4** (single sentence integrating a bulleted list)
This study aims **to identify** the stages in the pavement management process**, to determine** the factors leading to the evolution of application user interfaces**, and to evaluate** the implementation of these user interfaces in a case study**.**	This study aims ▪ **to identify** the stages in the pavement management process**,** ▪ **to determine** the factors leading to the evolution of application user interfaces**, and** ▪ **to evaluate** the implementation of these user interfaces in a case study**.**

Figure 8: The same closed set of items presented without a colon as an *unformatted* and *formatted* list.

The above examples illustrate the use of a colon to introduce items of the same status; in this case, the aims of a study. However, as mentioned earlier, another function of lists is to divide an entity into its parts, or to classify items into groups. This function is commonly referred to as **classification-division**. When using this pattern, inexperienced writers often over-rely on the use of the weak verb **to be** to describe the relationship between the parts and the whole. However, academic writing avoids using the verb **to be** in such cases. Figure 9 presents a list of the most common verbs used to replace the verb **to be** when introducing a closed set of items in a list (See Verbs to replace weak verbs).

BRAIN DEAD:

The decision **variables** for optimization **are** *temperature*, *volumetric flow,* **and** *emission rate*.

BETTER:

The decision **variables** for optimization **consist of** *temperature*, *volumetric flow,* **and** *emission rate*.

DIVISION (WHOLE→PARTS)

The proposed system	**consists of** **is composed of** **is comprised of** (USA) **comprises** (UK) ***is made up of**	an accelerometer, tilt sensor and gyroscope.

*Informal spoken form

Figure 9: Verbs commonly used to replace the verb **to be** when introducing a closed set of components.

4.3 Open-Set Lists

Unlike a closed set of items, an **open set** suggests that more items could be added to the list than have already been stated. Closed sets are used to present **examples** to help the reader in understanding the concept or, in the case of a master's thesis, to demonstrate the depth of your understanding. For this function, science has developed different language strategies for signaling that the ensuing information will provide examples. Table 3 shows some of the most common mistakes and how to correct them. Note that similar to structures used for introducing a closed set, presenting an open set of examples also requires a superordinate term that describes the class of things to which the listed items belong.

Table 3: Common problems when introducing examples (i.e., open set of items) and strategies to overcome them.

Poor (no superordinate)	Better (with superordinate)
..., etc. These processes have employed *acid hydrolysis, chlorination, alkaline extraction*, **etc**.	**4.3.1 Superordinate + such as + [*examples*]** These processes have employed **common chemical procedures**, **such as** *acid hydrolysis, chlorination*, **and** *alkaline extraction*. **4.3.2 QUANTIFIER + superordinate + including + [*examples*]** These processes have employed **VARIOUS** **common chemical proce-dures**, **including** *acid hydrolysis, chlorination*, **and** *alkaline extraction*. **4.3.3 Superordinate + the verb to include + [*examples*]** **Common chemical procedures** employed in these processes **include** *acid hydrolysis, chlorination*, **and** *alkaline extraction*.
..., for example, ... **..., among others,..** **..., e.g., ...** A major challenge of utilizing, **e.g.** *natural fibers*, for composite applications is their extremely hydrophilic nature.	**4.3.1 Superordinate + such as + [*examples*]** A major challenge of utilizing **cellulosic materials**, **such as** *natural fibers*, for composite applications is their extremely hydrophilic nature. **Superordinate (e.g., + *examples*)** A major challenge of utilizing **cellulosic materials** **(e.g.,** *natural fibers***)** for composite applications is their extremely hydrophilic nature.
...are ... **...are, for example, ...** **...are, among others, ...** **...are, e.g., ...** The **potential benefits** of biodegradable films **are** *food protection, preservation,* and *enhancing food appearance*.	**4.3.1 Superordinate + such as + [*examples*]** Biodegradable films offer **potential benefits**, **such as** *food protection, preservation*, **and** *enhancing food appearance*. **4.3.2 QUANTIFIER + superordinate + including + [*examples*]** Biodegradable films offer **MANY** **potential benefits**, **including** *food protection, preservation*, **and** *enhancing food appearance*. **4.3.3 Superordinate + the verb to include + [*examples*]** The **potential benefits** of biodegradable films **include** *food protection, preservation*, **and** *enhancing food appearance*.

4.4 Topic Sentences

Another form of metatext is the topic sentence. Topic sentences are not only an important tool for maintaining cohesion but are also a cornerstone of reader-friendly writing. When reviewing previous literature, the writer needs to relate **what** *has been done (or proposed)* with **who** *has done (or proposed) it.* However, before starting to list individual studies and their authors, it is important that you first present the reason for introducing them. For this purpose, good writers use the following three sentence patterns as strategies for introducing research in a topic area.

Strategies for introducing previous research:

5. {TIME} [INTENSIFIER] [RESEARCH ACTIVITY] has [VERB -ed] | [TOPIC]
| [PURPOSE]

Recently, much research has been devoted to improving the solubility and retrogradation of starches by reducing their molecular weight through chemical, physical, or enzymatic treatments (Becktel, 1959, Carrol et al., 1987 and Hebeda et al., 1990).

6. {TIME} [INTENSIFIER] progress has been [VERB -ed] in [TOPIC]

In recent years, much progress has been achieved in the development of biodegradable products using agricultural materials.

7. {TIME} [QUANTIFIER] [RESEARCH ACTIVITY] have (been) [VERB -ed] | [TOPIC]
| [PURPOSE]

A number of METHODS have recently been described to measure this property, including the Tarr-Baker gelometer (Bender, 2009) and the Herbstreith Pektinometer (Zedler, 2013).

Strategies 5-7 can serve as **(1)** a **topic sentence** that sets the scene for a listing of previous research work, in which each subsequent sentence uses an *author-prominent* strategy to support a claim made in the topic sentence; **(2)** as a **bridge** between two major topics; **(3)** as a quick summary describing the **current focus** of a research field [Move 1-3]; or **(4)** as the **first part** in a description of **a gap** in the introduction chapter [Move 2-2] by introducing a topic area that has already been filled by previous research, before going on to identify neglected areas that have received *little* or *no* attention in the literature. See Appendix 5: Topic sentences (Move 1-3) in our Mycourses class site for the specific language commonly used with these topic sentences.

Look at the following excerpt from a research article in electrical engineering. Is the writer simply **name-dropping** or just **dumping** a number of apparently unrelated studies? Moreover, this text seems to violate the given-new principle, since it has no unifying concept that would link together these six different topics (sentences 1-6). What is it that these studies all have in common? When the writer was asked to identify what these studies have in common, he stated that they all tried to make *TRM failure compensation algorithms for reconstructing the optimal beam pattern*.

Exercise 3

Write a suitable topic sentence for introducing this paragraph.

Click or tap here to enter your topic sentence.

[1]**Peters [3]** proposed a conjugate gradient method to reconfigure the amplitude and phase distributions; this method involves calculating the sum and difference of the beam pattern of each element. [2]**Yang and Stark [4]** proposed the vector space projection method for recovery of reasonable antenna performance when as many as 30% of the elements are inoperable. [3]**Levitas *et al*. [5]** introduced a practical method for amplitude and phase compensation using elements near the failed TRM. [4]For simulated annealing, **Rodriguez and Ares [6]** proposed array failure correction technique for planar arrays, and **Lozano *et al*. [7]** reported compensation while maintaining fixed nulls. [5]**Yeo and Lu [8]** described an approach based on a genetic algorithm (GA). [6]**Rodriguez *et al*. [9]** also applied a GA for recovering the pattern by changing the excitation of some of the array elements. [7]In previous studies, the optimization algorithms have been frequently used to resynthesize the optimal beam pattern. [8]While this approach is simple and useful, a faster and more accurate method is required for practical applications.

4.5 Verb Tense

When reviewing previous literature, the writer needs to relate **what** *has been done (or proposed)* with **who** *has done (or proposed) it.* However, before starting to list individual studies and their authors, it is important that you first introduce them. For this purpose, good writers use the following three sentence patterns as strategies introducing a topic area.

Strategies 5-7 can serve as **(1)** a **topic sentence** that sets the scene for a listing of previous research work, in which each subsequent sentence uses an *author-prominent* strategy to support a claim made in the topic sentence; **(2)** as a **bridge** between two major topics; **(3**) as a quick summary describing the **current focus** of a research field [Move 1-3]; or **(4)** as the **first part** in a description of **a gap** [Move 2-1] by introducing a topic area that has already been filled by previous research, before going on to identify neglected areas that have received *little* or *no* attention in the literature. See **Appendix 3** to find out more about the vocabulary typically used in these topic sentences.

Exercise 5: *Reviewing the literature*

This paragraph uses three different tenses: *(1) Present*, *(2) past* and *(3) present perfect*. What does the writer's choice of these tenses indicate?

---

[20]**Market-based mechanisms** have recently gained much attention for sensor management **[22]–[24].** [21]**In [22], the authors** explored the possibility of using economic concepts for sensor management without explicitly formulating a specific problem. [22]**The authors in [23]** used the concept of Walrasian equilibrium [25] to model market-based sensor management. [23]**In [24], the authors** also proposed a Walrasian equilibrium-based dynamic bit allocation scheme for target tracking in energy- constrained wireless sensor networks (WSNs) using quantized data. [24]However, as shown in [26], Walrasian markets can be unstable and can fail to converge to the equilibrium. [25]Moreover, computing the equilibrium prices and allocations can be computationally prohibitive. [26]Accordingly, **the authors ([23] and references therein)** proposed algorithms to compute an approximate equilibrium. [27]However, the mechanisms proposed **in [23], [24]** are not truthful and are, therefore, prone to market manipulations.

Tense choice

Tense choice in reviewing previous research is subtle and somewhat flexible. The following, therefore, are only general guidelines for tense usage. Several studies have shown that at least two-thirds of all citing statements fall into one of these three major patterns. For more information about tense, see Appendix 6 at our class web site.

I. **Past** /**Present**—**Researcher** as sentence *"subject"*:

Jones et al. (2014) developed a method for forecasting waste water flows.

Smith et al. [19] develop a method for partitioning tasks on network processors.

Pattern I—reference to *single* studies → **Past** (SCI, CHEM, ENG)
→ **Present** (ELEC)

II. **Present perfect**—**Research activity** as sentence *"subject"*:

An integrated **model has** recently **been** developed to forecast waste water flows **[34]**.

A **method** for partitioning tasks on network processors **has been** presented in **Smith [63]**

Various **studies have** focused on modelling higher order association rules.[1-3]

Pattern II—reference to *areas of inquiry* → **Present perfect**

III. **Present**—**no reference** to researcher activity (i.e., uses verbs *to be* or *to have*

Various **techniques are** typically **used** to spectrally estimate slowly varying noise.

Intelligent building **systems (IBS) are** integrated into many services and subsystems.

Pattern III—reference to state of *current knowledge* → **Present**

Exercise 6: *Citation and tense*

Click on the blue verbs to change them to the correct tenses.
Which tense pattern (I,II, or III) would be used for the following reporting verbs?

1. Previous work [3] **show** the limitations of the two protocols.

2. English, German, Japanese, Korean, and Greek **be** some of the languages for which complete ToBI system descriptions exist [8].

3. Multipath routing in ad hoc networks **propose** in [5]-[12].

4. Recently, several different multipath routing protocols based on DSR or AODV **propose.** In [5], Lee and Gerla **propose** Split Multipath Routing.

5. In [12], the authors **present** an automatic pitch accent and boundary tone labeling system which predicts pitch accent labels and boundary tone types using a multilevel hierarchical model based on a decision tree framework.

6. Various hybrids of the approximate continuous-time and exact sampled-data models **describe** in [14] and [15].

7. The smoothness of the resulting correlation measure with respect to shape perturbations and changes in transformation parameters **enable** the use of very efficient pruning and hierarchical techniques for matching [3] [12] [6].

8. Over the last decade, appearance models [4], [20] **become** increasingly prominent in computer vision.

9. Outside of the facial expression literature, unsupervised temporal segmentation and clustering of human and animal behavior **address** by several groups. Zelnik-Manor and Irani [33] **extract** spatio-temporal features at multiple temporal scales to isolate and cluster events. Guerra-Filho and Aloimonos [14] **present** a linguistic framework to learn human activity representations.

4.6 Reporting Verbs

There is a range of reporting verbs that you may use when referring to the work of previous researchers. A study by Ken Hyland [4] identified more than 400 different reporting verbs; however, nearly 50% of these were used only one time in his corpus of 80 research articles. Table 4 shows the most frequently used reporting verbs from a variety of disciplines, with the six most frequently used verbs being listed from the left to right in descending order of frequency. As you can see, there are very large differences between disciplines in the choice of verbs for reporting past research.

Table 4: The six most frequent reporting verbs according to discipline

Discipline	Verbs and frequency					
Rank	1	2	3	4	5	6
Biology	describe	find	report	show	suggest	observe
Physics	develop	report	study	find	expand	
Elec. eng.	propose	use	describe	show	publish	develop
Mech eng.	describe	show	report	discuss	give	develop
Medical	find	describe	suggest	report	examine	show
Marketing	suggest	argue	find	demonstrate	propose	show

If you want to say what has been *claimed, proposed*, or *discovered* either by previous researchers or in your own study, you can use **it** as the impersonal **subject** with the **passive form** of a reporting verb, followed by a *that-clause*. This form is most commonly used in **information-prominent** citations.

> Recently, **it has been suggested** *that a fully objective AEP* may be obtained using phase spectral analysis techniques [4]-[7].
>
> In [19], **it was shown** *that these approximations* are often considerably more accurate than the conventional approximations in [1], [7], and [26].
>
> In [8], **it was concluded** *that the robot system* requires a body inclination sensor, and a ground reaction force sensor for each foot.

Note in the above examples that the dummy *subject it* has only a grammatical function and does not act as the subject of the sentence, but instead serves as only a **"place holder"** that postpones the real topic or subject (*underlined* in the above examples) to a position immediately after the conjunction *that*. The reporting verbs that can be used in the **passive** form with a **"dummy"** *it* as their subject are listed on the following page in Table 5.

Table 5: Reporting Verbs that can be used in the passive with the introductory dummy *it*.

accept	comment	emphasize	*know	*show
acknowledge	concede	establish	note	*speculate
admit	conclude	estimate	*observe	state
agree	confirm	expect	postulate	*suggest
allege	conjecture	feel	predict	suppose
anticipate	consider	*find	presume	surmise
argue	decide	hold	propose	suspect
assert	*demonstrate	hope	*recognize	*think
assume	determine	*hypothesize	recommend	understand
*believe	discover	imply	record	
claim	document	indicate	*report	

*The verbs highlighted in **blue** above are the small group of verbs which can be used in the **passive form** with the **infinitives to be** and **to have**:

The differences in the density of defects created by these two kinds of particles **have been suggested to have** an important influence on thermal generation [18].

These **have been shown to be** a useful component in the design of reconfigurable multi-band antennas where the feed network of a patch array is reconfigured [25].

For a long time, *the application of Si-based bipolar technology* **has been believed to be** limited up to 10 Gb/s systems mainly due to its operation speed limit, despite advantages such as high reliability and low cost.

For a more complete discussion of reporting verbs, see Appendix 7: Reporting verbs at the Aalto Writing Clinic web site.

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