IPM component 3 – STEM
Week 5: Topic sentences

Introduction

In these notes we focus on the idea of topic sentences. We begin with some explanation of what topic sentences are then move onto a few example texts.

What are topic sentences?

Topic sentences are sentences which are usually the first sentence of a paragraph. They are

1. written in a way to project the general idea of a paragraph, but not so general as to be too vague. In other words, they describe the main overall idea of the paragraph which is then developed in more detail in the rest of the paragraph;

2. written in such a way that the reader will be confident s/he knows what the rest of the paragraph will focus on. In other words, it lets the reader know what the rest of the paragraph will be referring to.

To see this consider the following examples:

o "Much has been written about task design and the features desired in an ideal task or set of tasks. Stein et al. [22] discuss the importance of engaging students in thinking, reasoning, and sense-making. The features of a mathematical task they identify as promoting these activities are its potential for multiple representations, the existence of multiple solution-strategies, and the extent to which the task demands explanations and/or justifications from the students. Swan [23] focuses on promoting conceptual understanding in secondary school students and identifies five types of tasks he deems suitable for this purpose: classifying mathematical objects; interpreting multiple representations; evaluating mathematical statements; creating problems; and analyzing reasoning and solutions." [4].

o "Consider some single activity of the project. We suppose that a preliminary level of effort, θ_0 (dollars, manpower, or other resources) has been determined for this activity, and that a distribution, $F(t) = \Pr\{\text{activity time} \leqq t\}$ is given for this level of effort. The planner must estimate the interval needed for completion of this activity by a decision variable, z. Then, using these estimates for each activity, a minimal time schedule is determined for the entire project. This fixes the event times once and for all." [5].

o "As a field of study, machine learning sits at the crossroads of computer science, statistics and a variety of other disciplines concerned with automatic improvement over time, and inference and decision-making under uncertainty. Related disciplines include the psychological study of human learning, the study of evolution, adaptive control theory, the study of educational practices, neuro-science, organizational behavior, and economics." [10]

o "There are many reasons why one might decide that one measure of central tendency should be considered preferable to another for descriptive purposes. There are also many quantitative criteria that might be used as a basis for choice. One criterion is to select the measure that minimizes the variation around it. This variation is most frequently described by computing either the sum of the squares of the deviations (the numerator of the variance) or the sum of the absolute values of the deviations (the numerator of the average deviation). […]." [1].

o "The clinching is one of the most common metal joining processes in the manufacturing of metal plate-based products, especially when [it is required to assemble parts without adding major joining elements]. This joining technique is indicated for coupling, similar or dissimilar, pre-coated or galvanized, material sheets up to a total thickness of 3 mm. (Nong et al. 2003; Mucha 2007; Mucha et al. 2011; Di Lorenzo and Landolfo 2004; Varis 2003; Borsellino et al. 2004." (adapted from [11]).

o "Although the ellipsoid method is a powerful tool in proving polynomial solvability, it is not used in practice because of its poor average performance. A primal simplex method starting with constraints (1) and adding the violated constraint detected by the separation algorithm as a cutting plane, is a promising approach in solving LP(k). The size of the simplex tableau can be controlled by removing an added constraint whenever it becomes non-binding." [3].

So we might say that topic sentences acts as introductions to the rest of the paragraph. We might then have the following definition of topic sentences:

Topic sentence = A sentence describing the main idea of a paragraph in order to orient the reader's attention towards what is to come in the rest of the paragraph.

Caveat: As you read more widely you will find that not all paragraphs start with topic sentences in the way written above. In fact, it might look as if the first sentence of a paragraph is not a topic sentence at all. One might write the topic sentence as the second sentence of the paragraph, or one may write the first sentence of a paragraph in a very different manner. This is ok, but to write like this requires experience. At the end of the day, whatever the style of the first sentence of a paragraph, the first sentence (or first two sentences at most) of a paragraph should be written in a way to best lead the reader _into the greater development_ of an idea, opinion, example, theory, discussion literature review, etc.

Also, not all paragraphs need a topic sentence. For example if the second paragraph of a section continues, or elaborates on the idea of the first paragraph then no topic sentence is needed.

Comment: At what point during the writing process do you write a topic sentence? Do you write it first before writing the main idea or do you write your main idea first so that you know what the topic sentence needs to be? In my experience, I do both of these:

- If I already have a general idea in my mind then I write my topic sentence first. I then continue elaborating on the details of my idea from my second sentence onwards. However, it is possible that as I continue to write the paragraph I find I want to change the focus or emphasis of the paragraph. In that case I will probably need to re-write my topic sentence.
  In this kind of writing process I am writing my topic sentence and paragraph in an iterative manner, refining the topic sentence and paragraph at each pass through my writing.

- On the other hand if a very specific point of detail comes to mind, I write this down, expand upon it, and develop an overall paragraph around it which then leads me to wanting to write a topic sentence.

When I write maths notes for students I also build a table of contents (TOC) for the notes. I then read the TOC as if it was a coherent text, where the headings and subheadings of the TOC act as types of topic sentences. Based on how the TOC reads I then edit the headings and subheadings of the main text to more clearly reflect the flow and development of the themes I want to write about. Reading the TOC as a piece of text actually helps me clarify my ideas about what I want to write and how I should organise my ideas and writing. An example of this can be seen below (to be discussed in class).

1.8 On the geometric construction of numbers and arithmetic
    1.8.1   Introduction
    1.8.2   On geometric constructability
    1.8.3   Constructing natural numbers geometrically
    1.8.4   The principle of homogeneity and the unit line segment of arbitrary length
    1.8.5   Constructing fractions geometrically
    1.8.6   Constructing incommensurable magnitudes (square roots) geometrically
    1.8.7   Constructing arithmetic geometrically – Addition and subtraction
    1.8.8   Constructing arithmetic geometrically – Multiplication and division
    1.8.9   Geometric multiplication and division as inverse processes
    1.8.10 Conclusion

Exercises

1) Identify topic sentences from a paper of your own choice.

2) If you have started writing your extended essay identify any paragraph where topic sentences are missing, or where these could be improved upon. Then include or improve a topic sentence.

3) Write a topic sentence relating to your own discipline. Keep the sentence simple, and think about how this guides the readers towards what idea you want him/her to pick up on or focus on.

Exercises

1) *A general mathematics text*

Consider the texts below, taken from "The concept of function", J. F. Wampler, *The Mathematics Teacher*, Vol. 53, No. 7 (NOVEMBER 1960), pp. 581-583, then answer the questions below:

> "It has become evident that most of the current college texts which attempt to integrate the traditional topics of first year mathematics are using as their unifying concept that of function. Because of the great importance of this concept in mathematics and because of the recent emphasis upon it as a unifying principle, I feel that we should be particularly careful in our presentation of this idea to students. I believe that there is a serious need for agreement on the part of mathematics teachers concerning the definition, notation, and language used in working with functions.
>
> Eves and Newsom give a concise account of the development of the function concept from Descartes to the present day. The early part of this account reads as follows[2]:
>
> The concept of function . . . has undergone a marked evolution, and every student of mathematics encounters various refinements of this evolution as his studies progress from the elementary courses of high school into the more advanced and sophisticated courses of the graduate college level."

Questions:
1. Can you identify relevant topic sentence(s)?
2. Does the topic sentence focus on a single point? Paragraphs always work better when they explore a single idea and your topic sentence should reflect that.
3. Does the rest of the paragraph elaborate on the topic sentence?

The following questions are also added here for completeness, although they do not apply to the example above because i) it consists only of one paragraph, ii) we have not yet talked about the idea of a thesis:

4. Is the topic sentence linked to the previous paragraph? If the topic sentence creates an abrupt change in the idea or theme of the previous text, then you'll need to add in appropriate transitions (either on this topic sentence or the previous paragraph) to maintain the flow;

5. Is the topic sentence relevant to the main thesis? The relevance of your topic sentence to the bigger picture in the text should be clear to the reader. If it isn't, rewrite the topic sentence.

2) *A statistics text*

Consider the text below taken from "Mean Streets: The Median of a Size-Biased Sample and the Population Mean", Woollcott Smith and Milton Parnes, *The American Statistician*, Vol. 48, No. 2 (May, 1994), pp. 106-110, then answer the questions below:

"Many statistical ideas can be simply presented by stressing the close relationship between the population distribution and the distribution of the sample data; for example, the sample median can be thought of as an analog of the population median. Although this approach is useful, it ignores a large class of interesting real-world problems in which this simple analogy breaks down. Exposing students to these kinds of problems stresses the importance and richness of underlying sampling mechanisms. In this article, we humorously describe a problem of this type that was inadvertently placed on an elementary statistics exam."

Questions:
1. Can you identify relevant topic sentence(s)?
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3. Does the rest of the paragraph elaborate on the topic sentence?

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3) *An operational research text*

Consider the texts below, taken from "Linear Programming", W. Allen Spivey, *Science* , Jan. 5, 1962, New Series, Vol. 135, No. 3497 (Jan. 5, 1962), pp. 23-27, then answer the questions below:

The goal of maximizing or minimizing an objective [function] (say profits or costs), where the choice of means is not unrestricted but must be made under one or more constraints, is common to many different problems in the physical and social sciences, in industry, in agriculture, and in national defence. When the objective can be approximated satisfactorily by a linear function and the constraints can be expressed as linear qualities or inequalities, the problem can then be treated mathematically as a problem in linear programming. Linear programming techniques, largely because of their relative simplicity and flexibility, have found increasingly wide application since systematic development of the theory began in 1948 with the work of George Dantzig and his associates, [...]

By 1955 there had been a remarkable development of the underlying mathe-matical theory (the work of A. W. Tucker, of Princeton University, in particular, and of a host of other brilliant mathematicians). Moreover, with the parallel development of data-processing and computer machines, it became possible to quickly solve large- scale linear programming problems, so that by 1960 – only 12 years after the initial work – linear programming techniques had been successfully applied to the study of such diverse problems as production smoothing, traffic control at toll booths, investment scheduling in an electric-power industry, job assignment, transportation and warehousing of commodities, railway freight movements, blending of aviation gasoline, optimal crop rotation, Air Force contract bidding and the scheduling of aircraft maintenance, plastic limit analysis of structures, chemical composition at equilibrium, and many others."

Questions:
1. Can you identify relevant topic sentence(s)?
2. Does the topic sentence focus on a single point? Paragraphs always work better when they explore a single idea and your topic sentence should reflect that.
3. Does the rest of the paragraph elaborate on the topic sentence?

The following questions are also added here for completeness, although they do not apply to the example above because i) it consists only of one paragraph, ii) we have not yet talked about the idea of a thesis:

4. Is the topic sentence linked to the previous paragraph? If the topic sentence creates an abrupt change in the idea or theme of the previous text, then you'll need to add in appropriate transitions (either on this topic sentence or the previous paragraph) to maintain the flow;

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The language and discourse of topic sentences

The examples above on topic sentences involved a certain style of writing or phrasing which distinguished them from the rest of the paragraph. The main factor which distinguishes a topic sentence from the rest of the paragraph is the level of generality in projecting the idea of the paragraph. Particular phrasing is needed in order to achieve this generality

The aim of the examples in the table below is to show you the *underlying principle* of what makes a topic sentence style of writing. This underlying principle is what you should aim to learn and understand. Then you will know how to write topic sentences in your own way. These examples are taken/adapted from https://www.ref-n-write.com/trial/academic-phrasebank/. Note how these phrases or sentences focus on the general not the specific.

The past decade has seen an increase in the use of …	Recent years have seen a rise in the number of …
The arrival of … has highlighted the need for improvements in …	There have been a large number of improvements achieved in the last few years relating to …
A number of alternative technologies have appeared in the last few years.	These findings are only a few years old, but they suggest that …
Research in these areas are usually carried out using …	This is often chosen as the default approach since …

Typical strategies currently used to achieve this are …	The usual way of performing … is …
There is a long history of … in a number of discipline.	In recent years, there has been significant advances in …

Focusing topic sentences in particular ways

There are some specific ways in which you can start your paragraphs. For example, you can

1) *Present a statistic*: "In 2001-2002 the leading causes of death in the USA were heart disease, cancer, and stroke (Jackson, Kubansky, & Wright, 2006)."

2) *Identify the scope of the research*: "The idea that there are "critical" or sensitive periods in neural, cognitive, and behavioral development has a long history."

3) *Use common knowledge for the general audience*: "The ability of humans to accurately recognize thousands of faces is remarkable considering that all faces have roughly the same configuration."

4) *Use of common knowledge for the expert audience*: "Marine organisms have proven to be rich sources of unique alkaloids."

5) *Start with a definition*: "Creativity is typically *defined* as the ability to generate novel associations that are adaptive in some way."

   "Creativity *typically means* ….

6) *Indicate the lack of previous research*: "Despite the fact that almost everyone uses Likert-type scales, little is known about how variability in their format can affect the data that we obtain."

7) *Expand on a previous study*: "In a previous article (Duncan, Emslie, Williams, Johnson, & Freer, 1996), we introduced the term goal neglect to describe a striking form of performance failure."

8) *Give an overview*: "This study considers age-related differences in collision avoidance behavior in traffic accidents."

(all example above taken from "Writing an introduction to the introduction", J. Hartley, *Journal of technical writing and communication*, Vol. 39(3), p321-329, 2009).

References

[1]   "Comparing the Mean and the Median as Measures of Centrality", Gordon R. Stavig and Jean D. Gibbons,: *International Statistical Review / Revue Internationale de Statistique*, Vol. 45, No. 1(Apr., 1977), pp. 63-70.

[2]   *Analysis I (Third edition)*, Terence Tao, from the series *Teachings and readings in mathematics*, Vol 37, Springer, 2015

[3]   "K-Sum Linear Programming", Abraham P. Punnen, *The Journal of the Operational Research Society*, Apr., 1992, Vol. 43, No. 4 (Apr., 1992), pp. 359-363.

[4]   "Designing Mathematical Thinking Tasks", Sinéad Breen & Ann O'Shea, *PRIMUS*, 29:1 (2019), pp9-20

[5]   "Risk-Taking in Critical Path Analysis", William S. Jewell, *Management Science*, Jan., 1965, Vol. 11, No. 3, Series A, Sciences (Jan., 1965), pp. 438-443.

[6]   "High-frequency wave generation in magnetotail reconnection: Linear dispersion Analysis", Burch, J. L., Dokgo, K., Hwang, K. J., Torbert, R. B., Graham, D. B., Webster, J.M.,et al.(2019), *Geophysical Research Letters*, 46, 4089–409.

[7]   Chapter: Mathematics for Big Data, from "The Best Writing on Mathematics 2019", Alessandro Di Bucchianico, Laura Iapichino, Nelly Litvak, Frank van der Meulen and Ron Wehrens (2019), Princeton University Press.

[8]   "Doing Much About Nothing", Allan Franklin (2004), *Arch. Hist. Exact Sci*. 58 (2004) 323-37

[9]   "Moving to a World Beyond "$p < 0.05$"", R. L. Wasserstein, A. L. Schirm & N. A. Lazar (2019), *The American Statistician*, 73:sup1, 1-19.

[10]   "Machine learning: Trends, perspectives, and prospects", M. I. Jordan and T. M. Mitchell, *Science, New Series*, Vol. 349, No. 6245 (17 JULY 2015), pp. 255-260.

[11]   "Effects of ageing on mechanical durability of round clinched steel/aluminium joints", Luigi Calabrese et. al. (2014), *International Journal of Mechanical and Materials Engineering* 2014, 9:23

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o "As a field of study, machine learning sits at the crossroads of computer science, statistics and a variety of other disciplines concerned with automatic improvement over time, and inference and decision-making under uncertainty" [10]. Here I expect the paragraph to move onto either the other disciplines or the aspect of improvements over time or inference and decision-making under uncertainty. The actual text reads as follows:

o "The clinching is one of the most common metal joining processes in the manufacturing of metal plate-based products, especially when [it is required to assemble parts without adding major joining elements]." (adapted from [11]). Here I would expect to see the paragraph develop either the idea of the clinching process or the idea of not requiring the addition of major joining elements. The actual text reads as follows:

o "Let $a < b$ be real number, and let $f : [a, b] \to \mathbb{R}$ be a function which is continuous on $[a, b]$ and differentiable on (a, b)." [2]. Here I expect the rest of the text to be either a definition of the statement of a theorem. The actual text reads as follows:

> **Corollary 10.2.9** (Mean value theorem). *Let $a < b$ be real numbers, and let $f : [a, b] \to \mathbf{R}$ be a function which is continuous on $[a, b]$ and differentiable on (a, b). Then there exists an $x \in (a, b)$ such that $f'(x) = \frac{f(b)-f(a)}{b-a}$.*