

Argument Mapping for Scientific Articles

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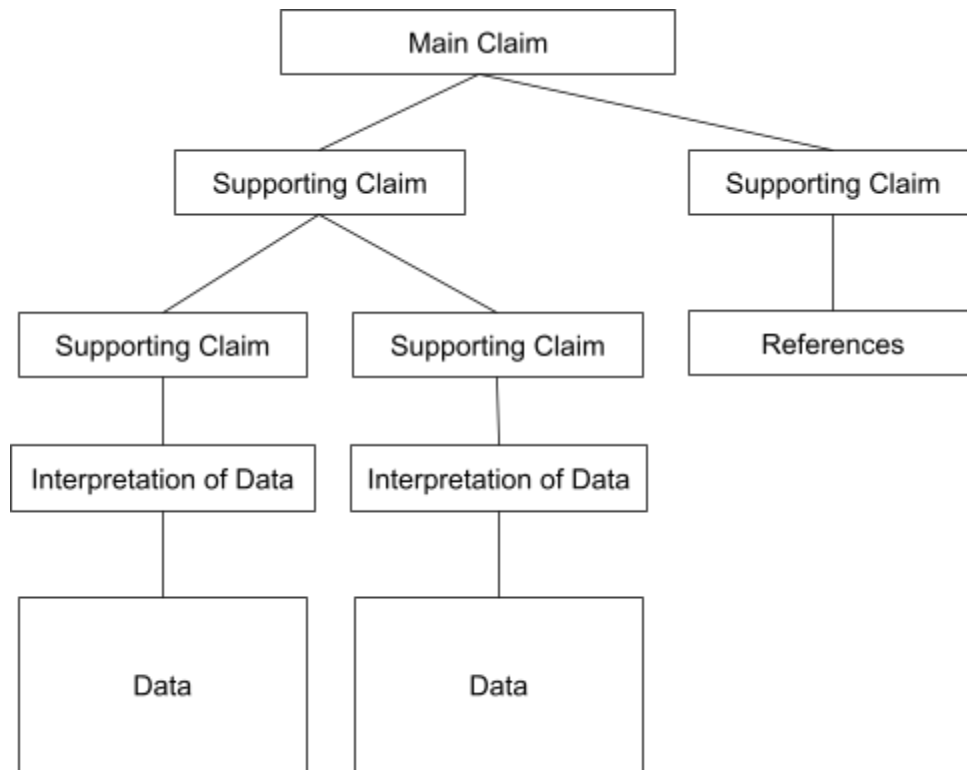
Introduction

What are they?

Argument maps are visual tools that allow us to see the steps that take an argument from the premises or evidence to the conclusions they support.

There are many ways to create argument maps and they have been implemented in many different ways for different purposes. Here we use them to understand the structure of a scientific argument. Therefore, in this document I use the term “argument map” to mean “argument map for empirical, scientific, or academic arguments”.

The following diagram shows the general structure of an argument map the way we use them.



The most important aspect of the tree structure above is that its branches end in “data” and “evidence”. This is what differentiates a scientific (empirical) argument from other types of arguments. A scientific argument relies on data and empirical evidence for its validity. Data is the ultimate arbiter. Sometimes we rely on others who have provided empirical evidence to support a claim. In such cases a claim is supported by a “reference” to other scholars. It is important to remember that a scientific argument is not valid just because a scientist has said so.

What are they useful for?

For our purposes, argument maps help us understand the reasoning of researchers and figure out areas where they may be wrong. By discovering error in other researchers arguments, we have a chance to create new arguments that lead to new conclusions and discoveries. This process of detecting errors and improving on previous work is an essential core of scientific research and scientific progress. Science is a collaborative and constructive endeavor, where previous discoveries and arguments build the path for future ones. It is important to make sure that we build scientific knowledge that is true, accurate, and as error-free as possible. Argument maps can help us achieve this goal.

Argument mapping is also extremely helpful in structuring our own thoughts and making our own arguments more clear for other researchers. If you are interested in writing a

scholarly piece, you can use an argument map to structure your thoughts and create a blueprint of what you need to write. Then you can expand on that map to create the actual sections and subsections of your paper. Finally you add the paragraphs that create the smooth transitions from each claim to the next, connecting your data/evidence to your main claim/conclusion.

Why should I care?

Not every argument made by a scientist or researcher is equally valid. Some arguments are more erroneous than others. Errors can seep into our reasoning from various sources. It might be the way we collected our evidence. It might be the way we defined our theoretical concepts. Or it might be that we did not think of alternative explanations. Sometimes such errors are harmless, and we or others can catch and correct them if need be. However, sometimes such errors are extremely harmful. An example of a terribly harmful case is the research that claimed a link between the MMR vaccine and autism. The study was erroneous in many many ways and has caused damage at an extremely large and international scale. If you would like to know more, [this article provides a relatively good summary of its problems](#). You can read [the original report on all the errors in that study here](#). The bottom line is that we need to make sure we have a way to spot errors in our arguments and reasoning if we want to avoid causing harm to ourselves and others.

Making sure we don't have errors in our reasoning and arguments is in some ways similar to house cleaning and maintenance. We need to know the structure of the house and what needs repair or cleaning. This is what argument maps can do for our arguments and thoughts. But we should also know that it is impossible to have everything 100% clean and repaired all the time. Some things are more important to be clean and functioning than others. It depends on how they affect us and what our limitations are. So it is important to do our knowledge maintenance in a way that satisfies our goals. Finally, similar to an unclean house, the cause of reasoning full of errors is often laziness. If we put the time and care into how we think, we can make sure that we remove the harmful errors and make life easier for ourselves and others.

Research on the Role of Argument Maps in Improving Analytical Reasoning

There is growing research showing argument maps help the development of analytical and critical thinking. Here is a recent study:

[Cullen, Fan, van der Brugge & Elga \(2018\): Improving analytical reasoning and argument understanding: a quasi-experimental field study of argument visualization. *npi Science of Learning*. 3: 21.](#)

Elements of an Argument Map

What elements you use to construct your argument map depends on the type of argument and what your goal is for argument mapping. Here I present a list of common and useful elements for mapping arguments in scientific studies.

Data

Every scientific paper has a way of presenting you with the data that they collected. This is often in the form of a graph or summary statistics such as percentages or means. A lot can happen at this stage to result in erroneous inference.

Interpretation of Data

The same graph or pattern of data may receive different interpretations. It is important to understand how the authors of a paper interpret their data and what are possible alternative interpretations of what they found. It is common in scientific studies to miss alternative interpretations at this stage and reach conclusions that do not necessarily follow.

(Supporting) Claims

Claims are propositions that the authors are committed to, so that they can conclude the main point or the main claim. Claims can provide support for each other and clarify the chain of reasoning in an argument.

Main Claim

There is often a main claim or a few main claims in a scientific paper. The main claim of a paper is the conclusion or culmination of its arguments. For it to be valid, all the prior steps that lead to it must be valid. The process of making a scientific argument is difficult precisely because inferential errors can appear at any step that leads to the main conclusion. An argument map helps us understand the steps that lead to a main conclusion and makes tracking the sources of errors easier.

References

Sometimes authors do not provide data and evidence to support a particular claim but rather refer to other researchers who have done so. We can include the references in our argument map underneath the claim that they support.

Definitions

As we create argument maps, we often notice that whether an argument is valid or not crucially depends on precise definitions of some concepts or theoretical constructs. We can include the definitions that the authors provide, perhaps as a footnote to our argument map.

Assumptions

Sometimes we notice that the authors have implicit or explicit assumptions that are critical for the validity of the argument. We can include these assumptions as well and keep track of them. If we believe that these assumptions do not hold, then the argument is not going to be valid and we need to find a way to address the issue and improve the argument.

Objections

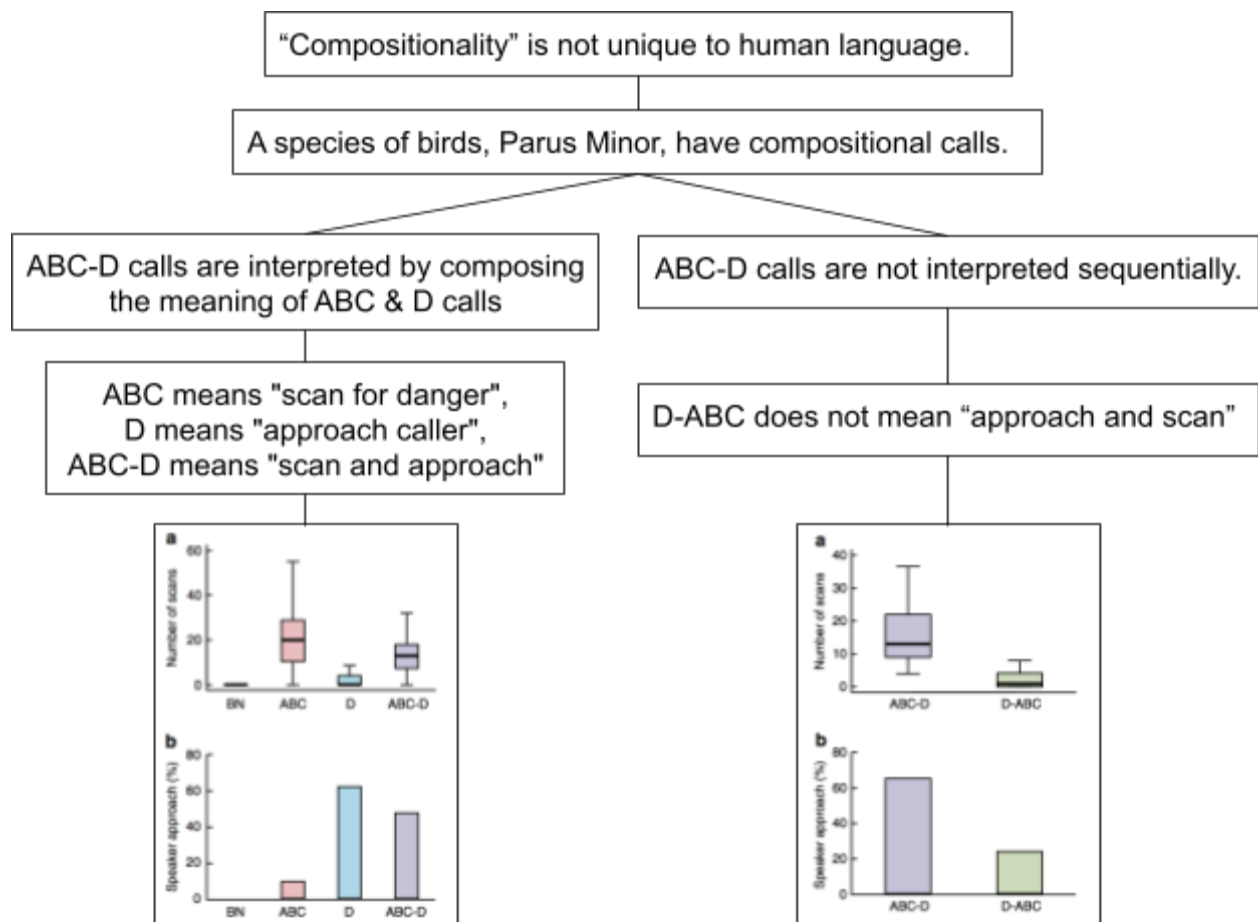
Sometimes we can find problems with the reasoning that the authors provide. We can also add those problems as “objections” to the argument map so that we remember where the errors were and where improvements need to happen.

A worked-out example

Take a look at the following scientific article:

[Suzuki, Wheatcroft, & Griesser \(2016\). Experimental evidence for compositional syntax in bird calls. *Nature Communications*](#)

The diagram is a small argument map I made for the scientific paper above:



At the lowest level we have the graphs (presentation of data) that the paper provides for its arguments. Higher up I have summarized how the authors interpreted the data they collected. Higher up I have shown how those interpretations connect to two theoretical constructs: "compositional" interpretation and "sequential" interpretation. The authors have argued for compositional calls in Parus Minor by showing that: 1) it is compositional and 2) it is not sequential. Finally at the top of the map we have their main claims: that compositionality is not unique to humans.

At this point, the argument map makes one issue clear. The theoretical constructs "sequential" and "compositional" interpretation are central to the arguments of the paper. Therefore, the paper needs to provide a clear definition of these concepts. I have included the definition that the paper implicitly alludes to below. I have also included an objection to this definition provided by a linguist, Mark Liberman.

- **DEFINITION:** combination of symbols like A+B can be interpreted compositionally or sequentially. In sequential interpretation, every ordering of

symbols is interpretable. This is not the case in rule-based interpretation. Only symbol combinations that have corresponding rules are interpretable.

- **OBJECTION:** Even in sequential interpretation, a sequence might not be interpretable due to pragmatic reasons. (Mark Liberman, language log post <http://languagelog.idc.upenn.edu/nll/?p=24561>)

Take a look at the argument map above again. What types of errors can we expect at each level of the argument? How important are they for the purpose of the argument? How can we address these errors?

Research in the News

Take a look at the following news articles reporting on the original study you just read.

1. [Syntax is not unique to humans! \(phys.org\)](#)
2. [Japanese great tits use syntax to communicate – just like humans \(IBT\)](#)
3. [Birds have syntax just like humans do](#)
4. [Great Tits Use Linguistic Traits Including Phrases Thought To Be Unique To Humans](#)
5. [Good Grammar Is a Matter of Life or Death for Japanese Tits](#)

Discuss how accurately these news articles reflect the true content of the research article?

What are the consequences of representing scientific research inaccurately?

How can we make sure we are not contributing to the spread of misinformation?