Creating and Comprehending Arguments

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Discussion and dispute are everyday activities for most of us. Impassioned or coldly rational, the process of argument is central to our relations with others and to our understanding of the world in general. The way we make and support conclusions reflects not only our capacity for reason but the way we structure any type of knowledge. Much of the argument we come across is in the form of small bits of text. Advertisements and editorial are explicit attempts to influence our choices in what we buy or how we vote. In other types of expository text, such as in newspaper or magazine articles, the argument is more subtle and often appears as description. Common to all is the statement of premises and the evidence used to support them.

Arguments are written to serve two goals: to communicate ideas and to persuade others that those ideas have value. The relative weight of these goals determines how the writer will structure the text. The *argument structure* is the organization of support and conclusions that represents the line of argument. If a writer's ideas are controversial or his or her audience is unreceptive, much attention will have to be given to the argument structure. Potentially weak assumptions must be buttressed and tentative premises substantiated. Undisputed points still require support but the amount of text devoted to plain description can be proportionately larger; the writer need not go far back in the chain of reasoning to support his conclusions. In arguing for an increase in military spending to the joint chiefs of staff, the president would only need point to the value of a strong defense. When arguing the same issue to congress, however, he may wish to provide evidence for accepting the premise "strong defense is a good thing". What was to one group an acceptable assumption was to the other a conclusion requiring support.

The Structure of Arguments

Upon examination of a large number of arguments, we found that support structures can be divided up into three basic types: argument by analogy, categorical argument and causal argument. The distinction between the first two is the difference in level of generality between the support and conclusion. In an argument by analogy, the conclusion and support are at the same level. Cats can be compared with dogs and one president can be compared to another. If I wanted to argue that Reagan's reform will have little lasting effect on the income tax process, I could point out that Eisenhower's attempts to simplify the tax structure had little effect. Eisenhower's case is analogous to Reagan's, both are examples of American presidents who tried to change the federal income tax system. Any other relevant similarities, such a both being Republican s, strengthens the effect of the analogy. With enough examples, an arguer can create a category that contains the features common to all the examples. Conclusions that come from generalization across several examples are the product of induction. The reverse process is deduction. The arguer has a category more general than the conclusion, attributes category membership to the object or idea, and by virtue of membership attributes other features of the category to the object. This form can be expressed as a syllogism. " President Reagan has a tax reform plan. All presidential tax reforms have little lasting effect. Therefore, Reagan's tax reform will have little lasting effect. "

Reagan's tax plan is a member of the category *presidents' tax reform* which has the feature *has little lasting effect*. The same point could have been made with both inductive and deductive support. The arguer could enumerate other examples of failed presidents' tax reforms, induced the category,

asserted membership for Reagan's plan, and then attributed the feature as the conclusion. The third type of support uses knowledge of cause or process to support the conclusion. Causal knowledge can exist at any level of generality, from what a specific president does at one moment to how people in positions of power are likely to behave at any time. Whereas categories or analogies are a slice of time or atemporal, cause and effect involve temporal sequence. We use the phrase "cause or process" to avoid the philosophical debate on the nature of *causality*. For purposes of argument, causes precede effects in time and allow either prediction of the effect given the cause or given the effect, explanation of its occurrence through the hypothesis of a cause. For example, Reagan's plan will fail because special interest groups will pressure congress to make myriad exceptions to any general simplification. The pressure must precede the change or the argument is not a causal one. These three support types are complimentary. Categories can be formed or modified from the examples used in analogy. Causal knowledge can be (and is ultimately always) derived from analogies and con be use to construct and alter categories.

The three support types do not exist merely for arguments sake but are part of the natural understanding process. People notice similarities are found between two objects or events. The first event or object provides the information for understanding the second. With only two examples, people cannot determine which features are important and which accidental, yet they can still generate expectations that will help guide further processing and later behaviors. When people have several examples of an object or event stored in memory, they can more efficiently retrieve the information necessary for processing a new instance if the features shared across instances is collected in a category. Though it seems obvious that any understanding system must make generalizations, the ubiquity and flexibility of the process of category formation are important for understanding arguments. The chain of potential hierarchies can be long and complex. Categories themselves can be grouped to form more general categories or can be split up to form subcategories that entail a more specific collection of features. What level of generality the arguer can begin with depends upon his audience. If the receivers of the argument are accepting, the arguer can begin close in level to his conclusion. If the receivers are not, however, the arguer will need to move further up or down the hierarchy. Moving up the hierarchy allows the arguer to derive her conclusions deductively. Moving down provide her with evidence to induce her conclusions. Causal or predictive knowledge concerns the ordering of events and is potentially the most useful. Knowing that earth tremors can predict volcanic eruption or that hitting the keys "control" and "C" stops the run of a loop can be to islander or cognitive scientist.

Counter Argument

People create counter-argument with the same processes used for constructing arguments. Perhaps the most common counter-argument is the counter-example. If you compare Reagan to Eisenhower, I could point out that a comparison with Nixon is more appropriate. Both are Republican s but Nixon's term of office is closer in time to Reagan's. You could use Ford as another analogy to counter my counter, but this leaves the possibility of another counter-analogy, using another criterion for similarity than temporal proximity. Instead, you can attack my counter-analogy and defend your initial analogy by examining the relevant features. Eisenhower and Reagan have more ideological similarities, both have shown concern for the growth of government and with the wage-earning tax-payer. A good analogy, therefore, is one which shares *relevant* features with the original instance. The number of distinguishing features can be compared to the number of shared features to produce an index of similarity. Relevance is determined by the feature under debate or the current needs of the understander. Arguers need to know what features discriminate between analogies to judge which comparisons are most apt.

For answering categorical arguments, two strategies are available. Initial category membership can be shown to be inappropriate by a feature conflict or another category can be shown to be more

appropriate due to greater relevant feature overlap. The argument " All Republican president's tax reforms are doomed. Ronald Reagan is a Republican president. Therefore Reagan's tax plan is doomed. " can be countered by showing that in fact there are two types of Republican s, conservative and liberal. Perhaps only the tax plans of liberal Republican s are doomed to failure and Reagan is a conservative Republican .

Causal arguments are vulnerable along any step of the causal chain beyond that which is known explicitly. The chain " Republican presidents create plans for tax reforms, give the plan to congress which alters the plan for special interest groups due to lobbying pressure. " is vulnerable at a number of points without contradicting any of the facts in the series. Special interests may not always conflict with good tax reform or the reforms are too watered down by the president before they even reach congress. Although knowledge that allows prediction to future events may be the most desirable, it is also the most fragile.

The Memory Representation of Arguments

We have developed a model of argument generation and comprehension (MAGAC) that simulates how people create and evaluate arguments. We use a frame architecture to represent the knowledge and procedures for filling slots and linking frames. We will now work through an example argument. Suppose the reader is confronted with the following text:

> Computers have affected all aspect of everyday life in the United States. The introduction of new technologies, over a short period of time, causes a disruption of the current, established culture. Therefore, the spread of computers will result in great unhappiness for many people.

The first sentence introduces the domain, the recent inroads of of computers into everyday life. This has been a fairly controversial topic and has received some play in the press. When the text is fully processed, the representation will be organized around the conclusion in a conclusion organization frame (COF). After the first sentence, the representation looks like COF1.

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COF1: INTRODUCTION OF Computers
AKO: New Technology
TIME: Current
TIME COURSE: Short
RESULT: ?
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The heading slot for COF1 is the "introduction of computers". The *A Kind Of* (AKO) slot tells of what more general class of things this specific knowledge is a member. The TIME slot indicates the time frame to which the knowledge or event being represented belongs. As the INTRODUCTION of an object is a process, it must take place over a period of time. The slot TIME COURSE is filled with information concerning how long an event took or will take in the future. In this case, "short" is a term relative to the introduction time of other technologies, such as the manufacturing of steel or the production of clocks, both of which took hundreds of years. The effects of the process represented or procedures for determining the effects are stored under the RESULT SLOT. Goals and plans of people or entities are stored under GOALS and PLANS SLOTs. The actual representation of the goals and plans would be stored elsewhere.

The second sentence of the argument gives the reader a general information which is represented in of SOF1. SOF1 is an instantiation of a "support organization frame."

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SOF1: New Technology
AKO: Social Change
PROPERTY: origins in science
GOALS: Achieve new goals, previously blocked
       or
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        Achieve old goals more efficiently

RESULT: (change in work force)
        (less resources needed to accomplish
         goal)
        ((If TIME course is short
           then disrupted culture)
         (If TIME course is long
           then no disruption))
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Even if the receiver has not heard this argument before, it will not conflict with related knowledge. New objects or processes cause change and change can be disruptive. From this knowledge, SOF1 could be constructed for the purpose of understanding and storing the argument should it be encountered again. The goal knowledge is also very general. Technology is meant to achieve new goals, such as rapid communication by satellite, the efficiency of achieving old goals, such as generating power from nuclear reactions. Such improvements are accompanied by problems and dissent. The third sentence forms the conclusion. The reader already knows from experience that people often find change upsetting, especially swift and pervasive changes. SOF2 is constructed or instantiated to handle this information.

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SOF2: Change
AKO: Cultural Process
PROPERTIES: disruptive
          creates unhappiness
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Several general procedures are necessary for connecting the three frames. The first procedure is that which connects the topic to the evidence. For this example, inheritance from the AKO (a kind of) slot is used to fill empty slots. If we know that X is a kind of mammal but nothing else about it is explicitly known, We could assume default characteristics of a general "mammal" which would be stored in that higher level frame. In this case, "computers" are a kind of new technology. The result slot of "computers" is open and thus can be filled with the result slot of "new technology". In this causal argument, the process is applied and the result is calculated.

Procedure 1

If *SLOT* is empty then fill with corresponding RESULT *SLOT* from AKO *FRAME*.

Next, the connection between "new technology" and "social change" must be found. In this case, *procedure 1* again provides the link. New technologies are one kind of social change. It is important that it be a kind of social change (rather than personal) so that the generalization in the conclusion is warranted. The result is not given but requires calculation because it is dependent on the time course of events. Gradual social change is not disruptive. We believe it makes little sense to have this procedure stored outside the frame in a general list for two reasons. First, given a large number of special cases, the list would become unmanageable as more domain specific knowledge is added. Second, this information is only needed under "social change". Though other kinds of swift change (i.e geological) may be disruptive, it is not in the same way. The knowledge for calculating the result is stored where it is accessed automatically with the declarative knowledge.

The same conclusion could have been supported in a different way. Instead of referring to a general causal principle, the writer could have made an analogy to when something similar had happened in the past. In the absence of more definite knowledge, a similar instance can be used to understand a new one. This process of understanding is often used in argument. The analogy shows that X *can* have quality Y, that this is (at least) a possibility. In our example, the first and third sentences of the

paragraph remain the same but the body of the argument is changed to: " Automatic looms were also considered a great innovation in their day and resulted in a redistribution of the work force. " The comparison of computers and the automatic loom is based on their both being an example of a new technology that have radically affected the surrounding community. The implication is that use of computers will also cause loss of jobs. From there, it is a fairly straight forward inference that people will be unhappy. The representation for "Automatic Loom" looks like SOF3.

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SOF3: INTRODUCTION OF Automatic Loom
AKO: New Technology
TIME: Past
TIME COURSE: Short
RESULT: Unhappiness
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Both the AKO and TIME COURSE slots match those for COMPUTERS frame. If two frames have the same AKO SLOTs, then they are both members of the same general category and may be compared. No alteration of the category structure will occur nor is any feature from the category frame being used to make the argument. The more slots two frames share the stronger the comparison. If one frame has a slot filled that the other has blank, an IF-NEEDED connection is made from one slot to the other. In this case, the result slot from COMPUTERS can be filled with that from AUTO LOOM, if the information is desired. The slot filling is not a logical necessity and this is reflected in the IF-NEEDED connection. The result here, redistribution of the work force, is AKO social change. The conclusion derives from the frame SOCIAL CHANGE's RESULT slot. The connections in this argument are not as direct as in the previous one. The procedure for connecting the frames is:

Procedure 2

If AKO *SLOT* of X matchs AKO *SLOT* of Y then create pointer from X to Y.

The deductive or categorical argument has the traditional syllogistic structure underlying it. First category membership is asserted for the object or idea being debated. Then, by virtue of membership, other features from the category are attributed to it. With the same topic, a categorical argument would be

> New technologies are a feature of social change. Social change is alway disruptive for those living in the current established culture.

On the surface, this support is similar to the causal or analogical argument and a similar causal structure underlies this category. The representation and procedures of this argument, however, are different. Unlike analogy based arguments, the AKO slot is used to proceed to a higher level, in this case to the frame SOCIAL CHANGE. As a member of the category SOCIAL CHANGE, the frame COMPUTERS inherits any slots that do not contradict existings ones. The relationship is a necessary one, if something is a member of a category, then it must possess features *stored* at the category level. The slot is filled with procedure 3.

Procedure 3

Fill empty COF* slot with PROPERTY slot(s) from SOF* indicated in AKO slot.

The three procedures represent the way frames are connected for the three basic supports. These same processes are general enough for other uses and capture our intuitions of how knowledge is structured. The model handles counter-argument as the creation of new arguments or new links to existing structures. We will expand this model to include an evaluation of relevance to determine which features are most important in each case of calculated similarity. Argument provides a domain for exploring the creation and modification of knowledge structures and dynamic interplay of new information and past experience.