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# On Appeals to (Visual) Models

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**Abstract:** In some visual cases, especially those in which one reasons from a visual model to a conclusion, it is tempting to think that some new normative base, perhaps a visual logic is in order. I show that, at least in the case of what I'll call appeal to visual models, the same criteria are required in visual and verbal cases.

**Keywords:** analogical reasoning, appeal to analogy, argumentation schemes, models, model-based reasoning

## 1. Introduction

Models are ubiquitous, not just in science, but also in everyday life. We use maps to negotiate all manner of space. Doctors use x-rays, ultrasound images, MRIs, and other *imaging* technologies to locate breaks on bones, detect foetal heartbeats, distinguish tumours, and the like. And forensic scientists can use photographs to analyze crime scenes or discern whether a suspect was at a location at some specified time. Indeed, people seem to use models to reason to conclusions all the time. As this seems uncontroversially true, one would expect there to be general patterns for these inferential uses of models such that we could appeal to schemes to identify, reconstruct, and evaluate such reasoning. Yet, Walton, Reed, and Macagno (2008) have no specific scheme for handling the kinds of inference we are here considering.[1] A goal, then, of this paper, is to remedy this lack.

In science there are many kinds of models—physical models, visual models, theoretical models composed of general principles and equations, and mediating models (Suarez, p. 168; Morrison, p. 69), to name but a few. However, for the present purpose, we shall here focus on models in the neighbourhood of what Swoyer (1991) calls structural representations, of which we will say much more in the next section. Strictly speaking, and following Swoyer, structural representations recapitulate features of the object they represent—either completely or partially through embedding. By capturing some structural features of the represented object, the model can serve as a surrogate. In this way, the reasoning that leads to real-world conclusions can be carried out wholly through the mediation or surrogacy of the model. This is partly why, say, argument from analogy, doesn't quite fit as a scheme for this kind of reasoning. Later, we shall explain this lack in more detail. As a preview, though, analogies seem to be chosen precisely for their ability to project features. Yet, the analogy doesn't mediate in the same way as a model would. The projected feature, for example, the having of a creator for Paley's watchmaker argument, was surely accepted by Paley in advance of offering the argument. There is a kind of epistemological game that one would need to play were one to think that for Paley the argument might have gone the other way had the base of the analogy led in the direction of no creator.

[1] This is no criticism of Walton, Reed, and Macagno (2008). There is no claim that their study was exhaustive. Rather, this is merely a descriptive claim regarding where some research energy could be spent.

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Models needn't have this kind of epistemic priority. The reasoning based on appealing to models can appear to have the features of a discovery. This is, perhaps, obvious when one considers how by the investigation of a map, one finds a quicker route to one's destination. The map serves as the locus of inquiry, though it is expected that the results of inquiry will be projected onto represented objects.

In order for a scheme to be useful for the complete process of assessment, it needs to have associated with it critical questions which apply normative pressure on the reasons and reasoning. The focus of this pressure is typically the acceptability of the reasons, the sufficiency or strength of the support the reasons supply their conclusion, and the relevance of the reasons in the situation. Other foci for this pressure could include the likelihood of defeaters or related epistemic notions. Though these elements are general, the point of associating particular critical questions with a scheme is to draw attention to the standard but unique ways that such inferences can fail. Thus, it is one's duty to provide thoughtful critical questions whenever one proposes a novel scheme.

## 2. Models as structural representations

The standard presentation of structural representations is Swoyer (1991). Although he has a very wide target in his paper, there are several general elements of structural representations that are relevant to the present discussion. Swoyer's motivation overlaps with our own.

> Nevertheless, I think that the central point of *much* representation—one reason why it plays so vital a role in our lives—is that it allows us to reason directly about a representation in order to draw conclusions about some phenomenon that it represents. (Swoyer, 1991, p. 450)

There are two parts of this motivation to which you should focus attention. First, by having a representation or model, one is able to "reason directly" about it, i.e., the representation itself. The representation stands in for the thing it represents—maps for cities, for example. Sometimes this is a practical necessity insofar as a city block might not lend itself to the kind of reasoning one uses when planning a route. If you are trying to discover the quickest route to some destination, one could simply experiment with different routes until one discovers which is quickest. But this is impractical when one needs a quick route in advance of such experimentation. In this case, the map can serve this purpose. Indeed, were folks *arguing* regarding the quickest route, a map would lend itself to the solution to the argument as much as actually racing to the destination.

Second, the reasoning about the representation can be projected onto the object of representation. In the imagined scenario regarding discovering the quickest route to some destination, it is possible that one of the participants disagrees with the solution suggested by consulting a map—in which case perhaps only the race would satisfy—but it is likely that the results of consulting the map would be considered definitive. That is, the results of reasoning *with the map* would be taken as applying to the actual routes.[2] This ability of the results of

[2] Below we discuss the apparent ease with which people switch between model and modeled as *unity*. Not only are the results of reasoning about the map projectable onto the actual streets, most people don't seem to behave as if there is a projection at all. People act as if the map is unified or identified with the actual streets. This identification

reasoning with representations to project onto the objects represented make representations so useful.

> […] the pattern of relations among the constituents of the represented phenomenon is mirrored by the pattern of relations among the constituents of representation itself. And because the arrangements of things in the representation are like shadows cast by the things they portray, we can encode information about the original situation as information about the representation. Much of this information is preserved in the inferences about the constituents of the representation , so it can be transferred back into information about the original situation. (Swoyer, 1991, p. 452)

For Swoyer (1991), though, the "preservation" of the information that is encoded in the representation comes by way of isomorphism. And for most (non-scientific) purposes, this is too strong of a requirement. Indeed, what one needs, instead, is some rough similarity—though this will need to be specifically interrogated by a critical question.

What makes a representation or model a structural representation is that the model *captures* or *recapitulates* features of the object it represents. And here we have to rely on the cagy notion of similarity to explain what we mean be capture. On the one hand, though it is possible for a model to be an exact replica of the thing it models, this is unlikely in actual cases. Hence, only some of the features of the original will find adequate or accurate representation in the model. Of these *represented* features, perhaps only some will be relevant to the inferences. So, for example, some maps might capture distance while obscuring fine features of road intersection, and other maps will capture details of intersection while obscuring accurate distance relations. So not every representation will be equally useful.

On the other hand, the accuracy and adequacy of the represented features will come in degrees. Scale models, like scaled distances on maps, have informational limits. At some level of scaling some, perhaps, important differences are obscured by the attempt to cram too much detail in to too small of a space. This can happen with photos and x-rays, for example, too. This means that the preservation of features of the represented in the representation must also be interrogated by specific critical questions regarding the adequacy-to-accuracy trade-off that may occur by using mere similarity as the guide to preservation.

Because there are so many types of features that may be represented and perhaps an innumerable manifold of possible representation substrata, we ought not prejudice any account of such representation with desiderata that may limit the scope of potential representations. Instead, we will require that our structural representations model some features of the represented objects by being roughly similar; and we will probe the adequacy of these representations with explicit critical questions.

## 3. Reasoning *in* the model

It should be tempting to think that appeals to models follow the basic structure of appeals to analogy. An analogy, after all, is a comparison that also takes similarity as its machinery. Moreover, the base of an analogy is used to project some of its features onto a target—and this

is so strong, that people don't recognize the map and streets as separate at all. They draw conclusions about the map as if they were talking about the actual streets all along—even when pointing at the map.

appears similar to the discussion of structured models so far. Perhaps both fall under some more general category of reasoning. Or, perhaps one is a species of the other. Whatever the correct classification, there are significant differences that ought to separate them, at least for the present purpose. Analogies, at least as they seem to be used, are chosen because of the projected property, not for the similarity of the base and target. That is, and this is perhaps controversial, the conclusion of an *argument from analogy* is what's important in finding the right analogy. It is not as if arguers are casting about for the right analogy in terms of its nice fit with the target; and then, whatever the projected property turns out to be, the arguer projects the feature of the base onto the target. Instead, the conclusion of the appeal is known in advance. And then one casts about for an analogy from which to project the conclusion.

Moreover, the feature that is projected from base onto target is often a feature or property of the base—like having a watchmaker, i.e., being the result of manufacture rather than accident. These features aren't deduced from the base. They are there in the base. Models, at least one could argue, don't (typically) work this way. Instead, a model is chosen because tests on the model are like tests on the object modeled. To see this, consider two examples. First, suppose there is an argument regarding the quickest route from UNLV's philosophy department and a nearby establishment serving adult beverages—this is an eminently practical question given the nature of faculty meetings, for example. Let us further suppose that the mode of transport is walking. Three philosophers, A, B, and C, champion three different routes, a, b, and c respectively. As typically happens, no philosopher wants to cede the argument. So, they are at an impasse. A fourth philosopher suggests consulting a map to move the argument forward, see Figure 1. The point in consulting the map rather than sending each philosopher on their own quest for tipple is to send the philosophers on the quest *in* the map. That is, each philosopher can trace his or her route on the map in an effort to justify (or falsify) it's being the quickest route.

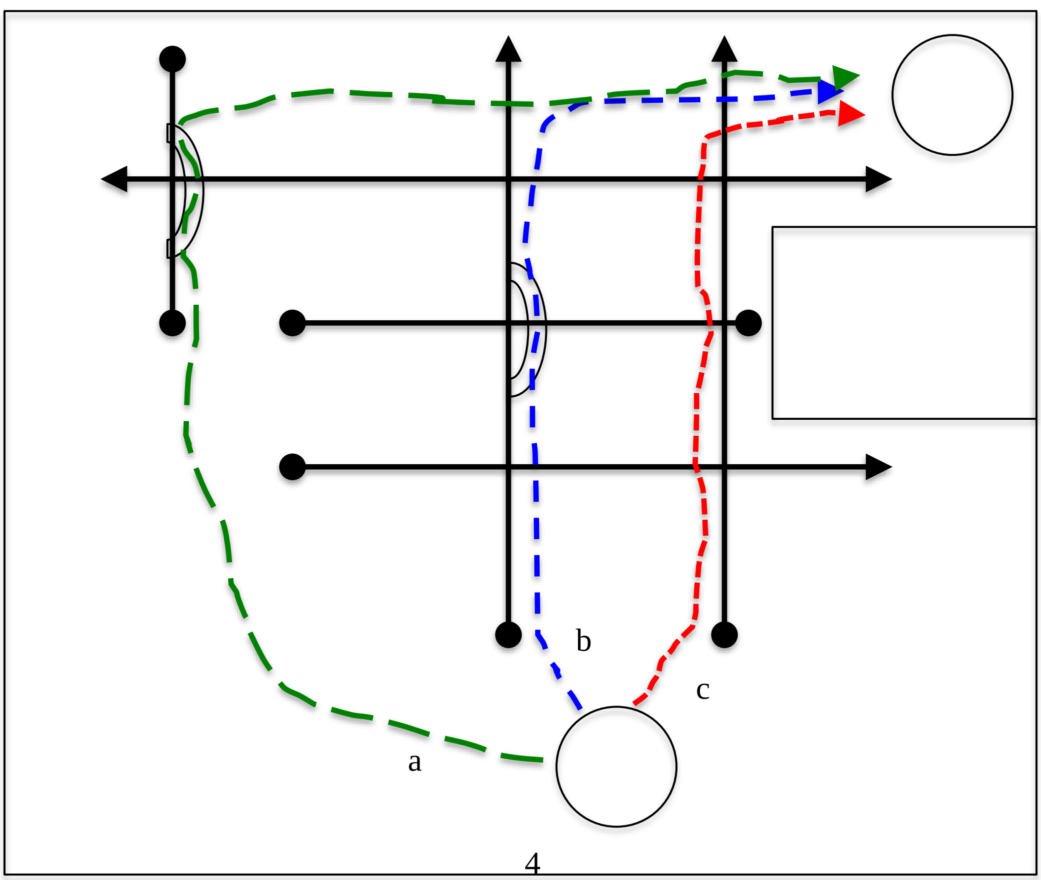

Figure 1

The philosophers reason as follows. A claims that route a—the dotted red line—is quickest because it is the shortest. B disagrees claiming that route a needs to cross the slowest intersection, which route b bypasses because of a pedestrian bridge. Hence, b—the blue dotted line—is the quickest route because, though it is longer than route a, it crosses fewer slow intersections, and it is a shorter distance than route c. C disagrees about route b, though agrees with B regarding route a. Instead, C argues that c is the quickest route because route c crosses the fewest intersections and bypasses the second slowest intersection via a pedestrian bridge. Hence, though it covers a longer distance, any extra time added by the longer distance is more than made up for by waiting to cross fewer intersections.

This reasoning is reminiscent of arguing from analogy. In this case, one might take the map as the base and the actual place as the target. Then, because of a feature of the base, that one route appears quickest, it is projected onto the target, viz., that route is the quickest on the real streets. However, this obscures a feature of the actual reasoning that seems important. The claim regarding the quickness of the routes was tested in the model. That is, the reasoning had a kind of unity; though this unity is easy to gloss over given how actual reasoning involving models often speaks as if the model were the object modeled.[3] The test for quickness was run on the map, though it was treated as if it were run on the streets. So, a conclusion, really a sub-conclusion, was drawn on the basis of the test in the model. And this isn't some feature that was simply read-off a list of properties the model has. Instead, it was a conclusion reached on the basis claims and inferences drawn on the model. It is the conclusion that is projected onto the modeled object.

Consider a case of a doctor and patient, the latter of whom has a potentially broken bone. The doctor sends the patient for an x-ray. Some time later the x-ray arrives at the doctor's office, and she determines that the patient indeed has a broken bone. She says, "See here, the bone has a hairline fracture. You will need a cast for about four weeks. Afterwards, for about another three weeks you will need to avoid putting your full weight on it." In saying "here" the doctor points at the x-ray; she needn't point at the patient's leg. They both understand that the x-ray *represents* the patient's leg bone. The doctor examined the x-ray. The x-ray didn't show a hairline fracture. Rather, the x-ray had a fine light-coloured or white line across the represented bone. The doctor *interpreted* the light line as a fracture in the represented bone. And on the basis of this interpretation of the representation, she treats the patient's actual leg. Again, the important feature here is that the model modeled an object. And, because of the structural similarities between the model and modeled, as well as a result in the model, some conclusion is drawn regarding the modeled object.

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[3] In actual consultation with maps, most users speak of the streets, for example, as if they were the actual streets, not the representations of streets on the map. Thus, someone might say, while pointing at a dotted line on a map, "Baker Street doesn't intersect 82nd Avenue." And though they are pointing at the map, they seem to be, perhaps paraphrasing Kendall Walton's (1984) phrase about photographs, pointing through the map to the actual streets. Analogies don't seem to have this same unity. People don't substitute talk of the target for the base when discussing the analogies. Indeed, they seem to want to carefully distinguish the base and target.

**4. Scheming**

The elements of an appeal to model are threefold. First, there ought to be a claim about the representation relation, i.e., that something is a model/representation of something else. Second, there needs to be some sub-reasoning on the model, though this might be as simple as noticing some feature about the model as was the case with the x-ray and the broken leg. Third, there is a projection of the sub-conclusion from the model to the modeled object. Although in actual practice, this last element is probably tacit—perhaps owing to the unity of the treatment of models as both the model and the modeled—we should make this step explicit in our analysis and evaluation of the reasoning.

> ***Appeal to Visual Model***
> *Representation Relation*: R models O.
> *Reasoning On Model*: In R, r obtains.
> *Conclusion*: In O, o obtains (where o is the feature represented by r in R).

The *representation relation* is often standardized. For example, x-rays are simply taken as pictorial representations of internal features of bodies without comment. So, outsiders to a practice may not find the representation relation explicitly stated in actual uses of these arguments. Still, it is important to make this claim explicit when this is the case. Doctors can and do make these representation relations explicit when discussing more recondite representations or models. They might point to a feature of an MRI and identify it as some part of the brain. They do this lest the justification for treatment appear mysterious to a patient. The patient needs to see the representation relation in order to accept any conclusions drawn by appeal to the model.

The *reasoning on the model* is here given as a single claim. In actual practice, this will need to include as many statements as are given (or needed) to draw the sub-conclusion on the model. For instance, in the reasoning regarding the quickest route to the bar, the reasoning to the conclusion that route c is the quickest would include all of the claims that were needed to make that case on the map—that it crossed the fewest intersections, and therefore, would be quicker than shorter routes that crossed additional intersections, which, at least in Las Vegas, adds considerable time to a walking route. This element would be a single statement in the case of the doctor identifying the break through the x-ray.

The *conclusion* is probably typically tacit, at least insofar as arguers tend not to distinguish the model from the modeled. As is always the case for the purposes of argument assessment, one should strive for maximum practical explicitness. Hence, we will want to make the conclusion of any such reasoning explicit.

With these meagre elements, we have at least a start on the analytic endeavour of argument assessment. That is, we can start to identify cases of appeals to visual models. Moreover, we can start to distinguish the relevant components of such reasoning. The evaluative components require a bit more consideration.

Let's start with the closest scheme's critical questions. In Walton, Reed, and Macagno's (2008) presentation of argument from analogy (p. 315), they offer three critical questions. Here is a paraphrase. CQ1: Are there any differences between the base and the target that would tend to make the comparison weak? CQ2: Is the feature to be projected truly predicated of the base? CQ3: Are there other comparisons (other bases, for example) that don't have the feature to be projected? If there are undermining differences, false predications, or alternative competing comparisons, then the stated analogy is judged weak. How does this help with appeals to visual models? On the one hand, both models and analogies project a feature, characteristic, property, or conclusion from some element onto another. The ability to make this projection depends on similarity. So, we can use these critical questions as a guide.

As the first critical question for analogies probes the differences between base and target, for models, the appropriate related question should probe the quality of the representation. Earlier, we noted that modeling might run up against issues of informational compression. For example, maps, unless they are drawn to the humorous dimensions of a one-to-one scale, need to scale down geographical relations. Thus, as the scale becomes greater, the specificity decreases. At some level of scaling all the important details would be lost. Sometimes we will trade accuracy for adequacy. This means that we need to enquire about the adequacy and accuracy in our critical question. Let's split these into two questions.

*Critical Question 1*: Is the representation/model adequate for the given reasoning?
*Critical Question 2*: Does the representation/model accurately portray the relevant relations?

So, for example, if we were discussing how to get to a restaurant after this talk, a globe would be an inadequate representation for our purposes. Likewise, if we learn that the map in Figure 1 greatly compressed distances so that the actual distances traveled along the three routes varied by miles rather than feet, we would think the model inaccurate for the intended purpose.

Walton, Reed, and Macagno's (2008) second question regards premise acceptability (or truth). But it isn't just a generic question of whether the premises are acceptable. Rather, this question regards the actual features of the base. It is easy to take some apparent feature of an object as a real feature. And this would be problematic. Hence, one needs to be on guard against mistaken attributions. Likewise, with models, there is a danger in glossing over the representation relation, as a doctor might do in pointing to a line on an x-ray and describing it as *the* break in your bone. The line is a feature on the representation. Given the way this representation works, the line also represents a gap or void in the modeled bone. But what the doctor is actually pointing at is a line on the model. Hence, we will likewise guard against accidental attribution on the model.

*Critical Question 3*: Is the result, r on R, properly attributed?

There are as many ways that a model can misattribute features as there are models. With maps there are scale issues. With x-rays there can be issues with movement. With photographs there can be issues regarding the perspective. Etc. Particular models will have different problems with proper attribution. The critical question is here to put you on guard, not to delineate the complete class of potential misattributions.

Lastly, in the case of analogies, we inquire about the existence of competing comparisons. This seems apt for the case of models too. We need to question whether there exist alternative competing models in which the result fails.

*Critical Question 4*: Are there competing representations/models of O?

The qualifier "competing" is meant to capture the notion that the result doesn't hold in/of that model. Although it would require a separate scheme, as it seems it is a different pattern of reasoning, one would expect that some of the same issues would arise in comparing competing models as arise in reasoning from a single model. We should like to know, one would expect, which of two competing models is more accurate, whether the result is properly attributed, and so on. But, the mere existence of a competing model could weaken our confidence in the projection from model to modeled.

## 5. Models, visual and otherwise

It can be tempting to think that there must be some alternative normative base for reasoning that appeals to visuals. There is a history, at least since Plato, in taking the visual and the verbal to be incommensurable. Hence, if some reasoning appeals to visual elements, given this incommensurability, one shouldn't expect the same norms to apply. This historical argument depends upon the incommensurability of visual and verbal elements. And, at least on some limited or local cases, it is less than clear that such elements are incomparable. Indeed, as Swoyer (1991) notes in a passage quoted above, "we can encode information about the original situation as information about the representation" (p. 452). For the present purposes, this "encoding" needn't be understood as verbal. Geographical relations encoded in a map could be restated as verbal representations, but that obscures the actual use of the map. Distance relations in actual geography, for example, can be expressed as distance relations on the map. They could likewise be stated verbally. But the information encoded is still the same. Hence, at least in some limited cases, we don't need to be sceptical regarding the possibility of verbal information.

Given the comparability of visual and verbal elements across some domains, it becomes somewhat more palatable to think that individual schemes can handle both visual and verbal cases. And indeed, this is the case with appeals to visual models. There is a verbal/symbolic version of this scheme to cover models that appeal to scientific generalizations, systems of equations, and the like. Though these models encode the information about the modeled objects in terms of mathematical formulae, general laws of nature, and equations, the pattern of reasoning is the same. Moreover, the worries that prompted the particular critical questions regarding visual models are likewise prompted in non-visual cases. We want to know the adequacy and accuracy of the models. We want to know whether the results obtained in the model are properly attributed to the model. And we want to know whether there are competing models that would/could undermine our confidence in projecting the results from the model onto the modeled object. Whatever these norms are, they are the same for visual and non-visual cases.

## 6. Conclusion

Given the ubiquity of reasoning with models, we need some normative guidance—both for their proper use, but also for their proper assessment. As a start, we have suggested a new scheme, *appeal to visual model*. This scheme identifies the typical components of this form of reasoning as well as offering evaluative guidance in the form of critical questions. Although it may not cover all kinds of reasoning with models, it will handle models that are so-called structural representations in which relations of the object to be modeled are captured in the model.

Finally, though the scheme is keyed to visual models, this is a bit of a red herring insofar as the components of the scheme along with the critical questions are generalizable to non-visual cases. Though proponents of visual argumentation have spent much time discussing the proper interpretations of visual elements, they have not, one could argue, spent enough energy in developing tools for the assessment of such reasoning. It seems unlikely that the norms for argument assessment have been exhausted; hence, we should be looking for ways to expand the set of normative tools available for analysis and evaluation of argumentation.

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