DEFLATIONARY METAPHYSICS AND THE NATURES OF MAPS

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Abstract: "Scientific theories are maps of the natural world." This metaphor is often used as part of a deflationary argument for a weak but relatively global version of scientific realism, a version that recognizes the place of conventions, goals, and contingencies in scientific representations, while maintaining that they are typically true in a clear and literal sense. By examining, in a naturalistic way, some relationships between maps and what they map, we question the scope and value of realist construals of maps — and by extension of scientific representations. Deflationary philosophy of science requires more variegated metaphysical stances.

1. Introduction

In their *The Nature of Maps* (1976) Arthur Robinson and Barbara Bartz Petchenik express some dismay when they turn to philosophy to learn about representation. Hoping to understand cartographic representation they find that “the universal metaphor turns out to be map itself!” (p. 3). In philosophy of science this metaphor is often used to argue for a roughly deflationary account of representation, intended to allow for rapprochement between realists and anti-realists. In this paper we argue that deflationism should be pushed further. Standard uses of the map metaphor assume that good maps represent in a way compatible with a metaphysically modest but globally applicable realism — we might call it “diffuse realism.” This position fails, however, to describe many obvious features of maps, their construction, and use. The relationships between maps and what is mapped are various, some better described in realist terms, some in instrumentalist terms, and some in constructivist terms. The map metaphor should therefore lead us to deny that there is single philosophical account of scientific representation. This, we argue, is not a problem with the metaphor; the successes and failures of diffuse realism about maps are paralleled by successes and failures of scientific representations.

2. Deflationary Philosophy of Science

In philosophy of science deflationism can be exemplified by Arthur Fine’s attempt to formulate the overlap of realism and anti-realism, in his “Natural Ontological Attitude” (NOA) (Fine 1986a, b). According to Fine, realisms and anti-realisms approach science with “ready-made philosophical engines” that add something to science; instead “the ‘naturalness’ of NOA … is the ‘California natural’ — no additives please!” (Fine 1986b, 177).

There are two connected components of NOA: an anti-essentialist stance and an anti-interpretive stance. The most universalistic versions of scientific realism, instrumentalism and constructivism depend on essentialist or even functionalist images of science, seeing scientific activities as contributions to some uniform or unified project. Such pictures of science, however, miss the complexity of scientific actions, events, and institutions. Recent work in history, philosophy, and social studies of science shows that science is far too heterogeneous to merit essentialist descriptions (e.g. Galison & Stump 1996). There is no scientific method that unifies and demarcates (Feyerabend 1975; Schuster & Yeo 1986), and other boundaries are contingent (Gieryn 1999). Deflationists draw the lesson that we should return to a grounding in scientific practice, leaving the aetherial heights of essentialist description.

Fine’s central case for the anti-interpretive stance is built around the fact that the best-established scientific claims are typically well-justified, and thus we have every reason to think of them as true. Because realists and anti-realists can roughly agree on this much, Fine calls it the “core position.” But realists and anti-realists add to this core position different accounts of truth: correspondence, pragmatic, instrumentalist, or conventionalist accounts. Given the apparently interminable disagreements over these accounts, Fine argues that we should drop everything except the core position itself, which amounts to adopting a disquotational account of truth: to say that it is true that trichloroethylene causes cancer is simply to say that trichloroethylene causes cancer, something about which we can have or fail to have good evidence. The deflationist hopes to adopt what we might see as a modest form of realism — so modest that Fine prefers to see NOA as non-realist — without metaphysical baggage: when the "desk-thumping, foot-stamping" realist shouts that electrons are *really* real, the deflationist calmly agrees, because there is plenty of good scientific evidence for electrons. If disquotationalism is right, mundane considerations of scientific evidence apparently give us a modest but global realism, what we are calling "diffuse realism."

We do not here want to take a stance on the disquotational theory of truth (for a recent discussion see Soames 1997). Instead, we argue that attention to practice poses challenges to the position that the disquotational theory is taken to license: diffuse realism (or non-realism) is far too global and essentialist to take account of the complexity of scientific representations. As a result, the anti-essentialist and anti-interpretivist stances conflict.

3. The Map Metaphor in Philosophy of Science

What does any of this have to do with maps? A recurring deflationist strategy involves recourse to a common metaphor: scientific theories are maps of the natural world (e.g. Toulmin 1953; Ziman 1978; Giere 1999, Azevedo 1997). For example, Ronald Giere argues that there is no difficulty in understanding how models can simultaneously represent independent features of the world, telling the literal truth, and yet be bound by conventions, goals, and contingencies. To see this, we need only look at maps. While there is no one truth that maps of an area will eventually converge on, maps are representations, telling the truth about the world.

> Maps … represent spatial regions from particular perspectives determined by various human interests. Imagine, for example, four different maps of Manhattan

> Island: a street map, a subway map, a neighborhood map, and a geological map. Each, I would say, represents the island of Manhattan from a different perspective, appropriate, for example, for a taxi driver, a subway rider, a social worker, and a geologist. (Giere 1999, 81)

(We should note that Giere adopts a semantic account of theories, and would therefore claim that scientific *models*, not *theories*, are maps of the natural world. For our purposes the distinction is unimportant.) As John Ziman says, in the context of a very similar argument, "No sane person would suppose a map to be identical with the land that it represents. In ways that we understand in practice … a map is necessarily an *abstract* representation" (Ziman 1978, p.85). Stephen Toulmin puts the point in largely geometric terms:

> Cartographers and surveyors have to choose a base-line, orientation, scale, method of projection, and system of signs, before they can even begin to map an area. … [T]he alternative to a map of which the method of projection, scale and so on were chosen in this way, is not a truer map — a map undistorted by abstraction: the only alternative is no map at all. (Toulmin 1953, 127)

What maps depict depends upon their intended uses, their scales, the resources of the map makers, and so forth. To the extent that they are accurate, however, they represent the territory: for a map to fail to represent is for it to fail as a map.

This metaphor is intended to capture the diffuse realist position, keeping to the spirit of deflationism by setting aside metaphysical interpretation, but also keeping intact commonsense intuitions that the best scientific theories describe features of the natural world. Aside from labels and metaphors, the central position is essentially identical to Fine's non-realism: maps don't embody any strong correspondence relation, but good maps, like good theories, brutely represent their subject matter.

The map metaphor is attractive for many reasons. What we will argue in the remainder of this paper, however, is that diffuse realists have replaced correspondence with another problematic construct, brute representationality. Brute representationality misses nuances of maps' relationships to their objects. As a result it has more ideological value than explanatory value: it does not particularly help us to understand maps — or scientific representations. The problem is that diffuse realists like Giere and Fine subordinate their attention to practice behind their interpretive (or anti-interpretive) goals, accepting too readily the face value of science. Attention to practices of representation, however, creates new opportunities and imperatives for interpretation.

Our goal here is to show the value of something like metaphysical interpretation — though a very down-to-earth sort of metaphysical interpretation. When we investigate how maps are made and used, we can be quickly led to versions of the metaphysical questions that deflationists are trying to avoid. At the least, the "core position" that we can accept many maps as true to their subjects demands metaphysical work to understand abstractions, distortions, instrumentalities, and constructions as truths. This is because much mapping does not straightforwardly participate in a realist style in the artistic or literary sense; in many cases cartographic practices are not attempts to simply reflect reality.

A more consistently deflationary stance accepts that piecemeal realism, instrumentalism, and constructivism have their places, and that it is sometimes possible to decide which of these positions is the best one. Thus a deflationary attitude should take anti-essentialism to heart but need not signal an end to philosophical inquiry. Some attention to practice may take us away from metaphysics, but only a little more can take us right back.

4. Applying the Map Metaphor to Maps

As users of the metaphor point out, the mapping process involves an enormous number of different decisions. Artful abstractions and other decisions are particularly apparent in specialized maps, but they are part even of the “all-purpose” maps with which we are most familiar. Following Toulmin, we take the choice of geometry as an example to illustrate the diffuse realist’s point. Geometries are connected to whole sets of community practices, resources, and traditions. The choice of geometric properties do not only involve representational accuracy, but also ease of construction, simplicity of explanation, and historical contingency.

The Mercator projection was developed for navigators at sea, and is the projection used even now on nautical charts. It is a conformal projection, meaning that it preserves angles: bearings observed from ship should be the same as angles on the map. Obviously this is important for navigators, who need to continually evaluate locations. Among conformal projections, the Mercator preserves constant compass bearings as straight lines, so that a ship travelling in a straight line according to the compass will be travelling in a straight line according to the chart. Used as a computational system, the chart, the compass and the angular measurement devices such as alidades are used to “plot a fix” as the ship sails. Hutchins (1995) gives an ethnographic account of the interdependencies between sailors and their equipment as a series of practices. These practices place priority on angles, leaving estimates of distance to be determined as a consequences of points plotted. The largest disadvantage of the Mercator projection is that distances are not preserved between the ground and the map.

Because nautical charts are the resources most commonly available for mapping the oceans, when diplomats meet to determine maritime boundaries these charts will be on the table. When the diplomats choose a mid-point between points on their land territories, they quite often choose a mid-point on the chart, relying on the seemingly Euclidean properties of the chart. At least half of the 137 international maritime boundaries appear to have been plotted as equidistant lines on the chart without accounting for the differences in scale (Lathrop, 1997). Even in the relatively equatorial situation of Australia and Indonesia, the agreement specifies positions that are 4 nautical miles (7.4 km) south of the actual line of equidistance (Prescott, 1993, p. 1198). This amount of error is large enough for a sizable oil platform or two — in fact, the agreement between Iran and Saudia Arabia requires mutual agreement for any drilling within 500 m of the international boundary (Lathrop, 1997).

The use and mis-use of Mercator-based charts fits well with the diffuse realist picture: diplomat map-readers often fail to understand the geometric choices that cartographers have made, and draw lines that don't have the properties they want. Nonetheless, this case illustrates something that realist readings tend to obscure. The Mercator projection is a good one only in conjunction with a specific set of map-reading practices, particularly practices of angular construction. These practices do not simply jump off the page; they are not in the map itself. It is only by ignoring the skilled work done to use the map, that we can say that maps represent. The sheer quantity of decisions about how and what to depict on a map thus poses a problem for realist metaphors: what counts as truth in mapping is determined by the community of cartographers and map users, relativized to agreement.

On the other hand, to the extent that they can be made explicit, techniques for using maps can stand in for correspondence between the map and what they represent. So while there is no single correspondence relation connecting maps and their objects, there are some very precise and well-understood relations, giving substance to the normally empty notion of a correspondence relation. Only in the contexts of cartographic traditions can one say that a depiction is a good or bad map, but within those contexts there *are* good and bad maps.

5. Interests, Choices, and Lies

Under a purist form of realism, the spatial relationships on a map should mirror those on the ground. Yet maps have certain basic communicative properties such as legibility that supercede geometric accuracy, and in extreme situations, the concept of metric accuracy is abandoned in order to preserve other parts of the map's message.

Let us start with the simplest of lies. The USGS topographic mapping manual (USGS 1967) specifies that the minimum width of a road symbol will be 0.02 inch on the map. At the scale of the USGS base product (1:24,000), all roads narrower than 40 feet are shown as 40 feet wide. While in some cases this doubles the size of two-lane streets, this exaggeration might seem harmless. Railroads, though only 4 feet 8.5 inches between the tracks, must be spaced a minimum of 20 feet apart to allow each track to be legible. When a double-tracked railroad runs between a road and a river, the road will be displaced away from the river by a significant amount (frequently larger than its actual width). Legibility overrides geometric fidelity.

In some cases, the pretense of geometric fidelity is abandoned altogether. On the perennial London Underground diagram, the structure of colored lines with nearly equally spaced stations expands distances in the core and shrinks them in the periphery. The one-block (200 meter) distance from Monument to Bank is shown as about two-stations distance, to keep the Central Line running straight through Bank while the District and Circle lines curve past Monument. Other stations shown just a single “stop” apart might be 1200 meters apart even *within* the ring of the Circle Line. The London Underground map is successful because it emphasizes topological properties, and reduces the metric distances to a cartoon rendition. Other cities wrestle with their subway maps. The “Revised Map of Rapid Transit Faciltiies of New York City Transit Authority” of 1974 used a rigorous one-stop topological metric; even the East River was shown as one-stop wide. In the 1996 replacement, much of the ground distances have been restored, but in the corner it contains this note: “Please note that this is primarily a diagram of subway services and has been geographically distorted to portray the service clearly.”

Given such distortions, why should we understand the style of representation of these maps as realistic, rather than as some sort of instrumentalism? The cartographers are trying to construct maps to allow lay users, who are typically unaware of the details of the map construction, to find their way through the networks of roads or subway lines. While a certain measure of realism may be useful, so is a measure of deviation from the truth.

The lesson need not be confined to cartographic representations designed for wide use. As Nancy Cartwright (1983) has shown, ordinary pure and applied science abounds with examples of distortions. Circuit diagrams, like the London Underground map, are topological views of their subjects, created for both professional and lay users. They also encode idealizations which are necessary for their use. As Cartwright says, following a discussion of parameters of transistors:

> Generality and simplicity are the substance of explanation. But they are also crucial to application. In engineering, one wants laws with a reasonably wide scope, models that can be used first in one place then another. If I am right, a law that actually covered any specific case, without much change or correction, would be so specific that it would not be likely to work anywhere else. (Cartwright 1983, 112)

The effectiveness of explanation and application will often depend, then, on deviations from realism. Scientists could in principle make some representations more precise, but their usefulness would suffer as a result.

6. The Instrumentalism of Contours

The nautical chart, we have seen, is a framework for calculating fixes of position. An even clearer case of instrumentalism can be seen in the development of technologies to represent topographic surfaces, from the contour to more sophisticated structures.

The contour depicts the locations where a particular abstract plane would intersect with the landscape. Each point along a contour line has a given height, and the map user can estimate the height of any other point by interpolation between the adjacent contour lines. Similarly, by measuring the spacing between contours, the map user can estimate the gradient of the slope. As a graphic depiction, however, the contour map is not as visually effective as more pictorial techniques (Wood 1992). The reasons for its commonness are instrumental: it was adopted for use by every major military power as a basis for calculations for artillery, logistics and military movements; and civil engineers developed procedures using contours to estimate volumes of dirt cut-and-fill, drainage, and other properties. Born of abstract operations, contours proved to be useful tools.

When the computer arrived in cartography, it quickly became obvious that computers made much less skilled map users than topographic engineers. A computer data representation of a contour line does not have the inherent spatial structure of the map. Rather than slicing through the surface in regular heights, it was more important to provide a value at regular horizontal spacings. This “Digital Elevation Matrix” (DEM) structure was first applied to provide instructions to a computer-driven milling machine that cut molds to form plastic relief maps. While the DEM stores the elevation value for each point, an alternative structure - Triangular Irregular Network (or TIN) divides the surface into a set of triangular finite elements (Peucker & Chrisman 1974). The TIN arranges an explicit set of neighbors, so that water can be passed over the surface until it arrives in a channel (Silfer et al. 1987).

These “models” are doing more and more work, embedding more complex relationships for more direct retrieval. The result is that the analyst selects a model more for how it facilitates analysis than for its accuracy in the traditional representational sense (Chrisman 1999a).

7. Natural and Unnatural Objects

The artificial is often easier to map and to navigate around than the natural. Humanly-constructed objects can be seen to have, or can be made to have, sharply defined edges often lacking in features of the natural terrain that we might be interested in. Like most other human endeavors, cartography uses an ontology of “objects” much better than one of “stuff.”

A park is defined legally so as to create neat boundaries, while many features inside it are considerably less neatly defined. Where, exactly, is the edge of a wetland, particularly one that expands and contracts depending on the season? To decide requires active definition, the application of a discrete boundary that is not present in nature as such. It turns out that there are many approaches and definitions in play, in the public sphere alone. In 1995 the Wetland Subcommittee of the Federal Geographic Data Committee published report of a comparative study of different official designations of wetlands in Wicomico County, Maryland. Comparing only the four most compatible sources, only 8% of the area defined as wetland by one source was defined as wetland by all four (Chrisman 1999b). Each of these four had used particular practices, particular sources, and often different standards to reference their work. It is not surprising that they differ, though it is troubling that they differ so much.

Human interest is also often focused on human structures, even just as convenient sign-posts: both the making and reading of maps is made considerably easier if there are parallel markers on maps and in the territory being mapped. The typical use of a road-map, for example, involves looking back and forth between the map and physical markers. Street names, then, might be philosophically interesting because they exist largely to allow people to create correspondences between maps and territories.

If the objects and processes that scientific representations are best at depicting can be construed as artifacts or importantly non-natural, this flies in the face of realist images of science. If scientific objects are frequently artifacts, they are artifacts of scientific practice, which means that they are not fully independent in the way that realism usually suggests. Yet this is the case for most of our prime examples of scientific objects: experimentation typically construct its own objects, in the form of purified or enhanced phenomena, or phenomena that appear nowhere outside of the laboratory (Hacking 1992; Knorr-Cetina 1981; Sismondo 2000).

8. Creating Boundaries

Philosophy's main use of cartographic metaphors is to tell roughly realist stories about the description of independent features of the world. In the rest of the humanities, however, cartographic metaphors have become popular as means of telling roughly constructivist stories about the creation of boundaries. Maps are used to define states, territories, routes, and the like. In nation- and empire-building, maps have often represented a first claim on a territory, followed by more mapping to solidify claims (e.g. Godlewska & Smith 1988). Brian Harley says:

> As much as guns and warships, maps have been the weapons of imperialism. Insofar as maps were used in colonial promotion, and lands claimed on paper before they were effectively occupied, maps anticipated empire. Surveyors marched alongside soldiers, initially mapping for reconnaissance, then for general information, and eventually as a tool of pacification, civilisation, and exploitation in the defined colonies. (Harley 1988)

Artificial boundaries created by such exercises have lasted well beyond the empires that created them, and continue to have very real effects, involving the lives of millions of people.

Similar processes continue, on large and small scales: voting districts or ridings, private and public property, and regulated land or water are defined using maps. We have already seen how states divide territorial waters on nautical charts. The siting of roads, housing developments, factories, dumps, and sewer lines also proceeds with reference to maps, and controversies over these sitings are quite often settled through the skilful creation of a map which allows compromise (Monmonier 1996). And there are controversies because decisions have concrete effects on the territories themselves: definitions change the landscape itself.

These cartographic structures precede territorial structures, rather than vice-versa. The maps create the territories, and therefore cannot simply represent the territories in any realist way. Similarly, boundary lines that scientists draw can have concrete effects. Trivial cases are examples such as the designation of a material as a high-temperature superconductor, which creates more of that material, and more variations on it: as a result there are many more high-temperature superconductors in the universe today than there were in 1985. The boundaries between species are contestable, and can have important effects, as conservationists and their opponents have been quick to understand. And more remarkably, the definition of mental illnesses apparently creates categories that people are fit into, or fit themselves into (Hacking 1996). So scientific boundaries and categories change the very things that they describe, too.

9. Back to Metaphysics?

We have been exploring realist construals of maps, in a naturalist mode: none of the relationships we have tried to display are in any way mysterious, but are simply read off of the surface of maps and their use. Geographers have a term, "ground truth," for observational corrections or confirmations of aerial photographs and the like. The term, and the activity of "ground truthing," show that geographers are aware that diffuse realism by itself is inadequate as an account of maps.

There is no uniform surface relationship between maps and their objects. To the extent that map users can draw correspondences between features on maps and features in territories, realism about maps is right. It can be right in a stronger way than the deflationist normally acknowledges, because practices of map use can set up very concrete and precise correspondence relations.

Yet maps are made to be used. As a result, they typically contain what the realist should see as lies, points at which strict correspondence is avoided to better serve particular interests. Especially when this point is taken in conjunction with some attention to issues of measurement, we can build up an instrumentalist interpretation of at least some features of maps. In some contexts maps become useful tools because they systematically encode measurements, which can be translated into actions.

Maps also display a number of artificial objects. Some of these exist only for the purposes of navigation, like street signs. Others, like marketing constructs, are products of the mapping process, and do not in any straightforward sense exist in the material world; they are the products of standardization and idealization. Still others, like neatly bounded political spaces, are again products and by-products of mapping. Thus, there are a number of ways in which mundane constructivist interpretations of maps can be revealing. Representers construct neat systems in order to escape the messiness of the everyday and original world, to study and enable action in controlled, cleaned and purified worlds, about which models and through which paths can be more easily made.

This collection of aspects and uses of maps suggests that we shouldn't try to find a single philosophical perspective like realism, instrumentalism, or constructivism that makes sense of maps as a whole. Such unifying perspectives try to turn interesting and complex objects into simple ones, whose essence is to do one thing. That is probably wrong for almost any object, but is clearly wrong for maps.

Realist and anti-realist philosophers alike should agree that maps represent, create objects and are instruments in the mundane ways we describe. Nonetheless, much of the language and some of the strategies used in debates between realists and anti-realists imply that the relation between such paradigmatic representations as maps and their objects is relatively transparent. Even our cursory study suggests that these paradigmatic representations call out for interpretation. What is called for is deflationary metaphysics. By this oxymoron we mean interpretive stances that provide metaphors and contexts for understanding knowledge and its uses. Although this may seem a very basic project, it is metaphysics: often running parallel to traditional metaphysical stances, and sometimes addressing what there is in the world.

How easy is it to translate these lessons back into scientific contexts? From our examples it should be clear that cartography is not a special case. Its tools are typically the tools of other disciplines, much cartography is explicitly scientific, and many scientific representations are obviously cartographic. In addition, there are many cases of scientific representation that behave like our cartographic examples even while otherwise having little in common with maps. "Diffuse realism" is too global and essentialist a position for maps, and it is also too global and essentialist for science. Deflationary philosophy of science, it turns out, needs deflationary metaphysics.

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