

Short essay on the “Ontology of scale”.

Ontology and scale are two core issues that lie respectively at the heart of GIScience and of Geography as a whole. Their interplay generates a new set of problems mainly concerning representation. In particular, the meaning of “scale” and its ontology can be abstracted from the common usage of the word. This essay will resort to the intermediate concept of field in order to put scale and its ontology in a context that can be approached conceptually, in a more specific manner than the title would suggest. The ontology of scale in a field context combines concepts of fractal analysis with analogies between conceptual and technical issues concerning scale. What will be suggested here is to see the ontology of scale equivalent to a definition of conceptual perspective over spatial aspects. This ontology can be related to the forms in which scale is technically related to geographic problems.

The definition of scale, as proposed in Lam & Quattrochi (1992), includes the different dimensions of spatial scale, spatio-temporal scale and temporal scale, suggesting respectively the different aspects of varying scale limited to space (the different extent of a territory being considered), integrated in space-time (the daily versus monthly precipitation over a variable topographic surface) and purely in time (the different time slicing of a phenomenon). There are three main meanings of scale. In the first, it denotes

the spatial extent of a phenomenon being studied, from the large-scale study of a country to the medium-scale of a region, to the small-scale of a city. According to the second, scale is meant in a cartographic sense whereby large-scale maps cover a smaller area at higher resolution than small-scale, lower resolution, greater extent maps. Finally, the third meaning of scale refers to the spatial extent at which a particular phenomenon operates, thus termed “operational scale”.

According to Smith (1998) ontology can be considered as either “an abstraction of the formal features that characterize all scientific areas, or a statement of the necessary and sufficient conditions for something to be a particular kind of entity within a given domain”. The former is considered formal ontology (a mathematics of entities), the latter materialistic ontology. Through the development of theories about a particular domain we can define materialistic ontologies that ultimately will lead us to the formulation of formal ontologies. The previous definition adds to the more general definition of ontology as the nature and organization of reality the appreciation of the process by which the structure of reality is extracted and its organization is correctly described.

A first attempt at relating the concepts of scale and ontology would be to examine the varying characteristics (or the varying ontology) of geographical entities such as topography when seen under the effect of the scale variable, that is, with a varying geographic scale. Topography is an entity that can be conceptualized as a field. A field, as in Peuquet (1998) and Sachs (1973), is a continuous entity having a spatial extent, characterized by a value at every point and existing without the necessity of

conceptualizing discrete objects defining its properties. In the case of topography, the field is termed of a continuity type, because the entity “topography” is referred to a base entity “terrain” that is likewise continuous (continuity, in other words, is not only a form of representation, but it is an ontology of the entity).

In the “Ontology of Fields” Report, the ontology of scale for fields is under the “Operations on fields” group of research ideas, and it has been not developed into a theme besides a statement that deems it relevant for field-to-objects transitions. By speculating on the topic, it seems possible to state that the ontology of scale for a field entails a transition from the ontology of field (the original, continuous representation of a spatial extent) to the ontology of an object that is a surrogate of the field (for example, a set of descriptors that reduce the spatial extent of the field to a smaller area or to a point by summarizing its original properties). This transition can be seen as a technical operation, but its meaning needs to be framed into an ontological context. For example, what are the properties of the scaled-down object? What information is lost in the transition? And ultimately, what differences in ontology does the scale variation induce in a field entity?

The fact that the ontology of a field changes with scale is reminiscent of the concept of fractal dimension, the number that summarizes the characteristics of a landscape in terms of properties of self-similarity (see also previous essay). There have been several researchers that proposed the idea that a landscape is never self-similar at all scales, but instead the property of self-similarity is discontinuous across scales (Lam & Quattrochi

1992). Thus, the ontology of topography as a field, in terms of both the (formal) abstraction of properties and the (materialistic) constituent characteristics that define its reality, depends on the scale at which we analyze such field. In practical terms a more detailed sample of the field would have an ontology different from that of a more sparsely sampled field, simply because the fractal properties change. This can be seen as a field version of the ecological fallacy concept, whereby the measured properties of an area change according to the scale at which that area is considered.

In conclusion, the previous field example indicates how scale and ontology are closely interrelated. But what is the ontology of scale? In other words, what are the abstracted properties of scale as an entity, and what are the sufficient conditions for defining scale? The definitions provided at the beginning indicate that scale operates in multiple domains (time, space and space-time) in multiple forms (extent-based, cartographic, and operational). It is therefore appropriate to define its ontology close to the idea of Lam and Quattrochi (1992), of a concept central to geography that allows a unified perception of spatial attributes in terms of form, process and dimension. In other words, scale is a dynamic abstract entity that interacts with other spatial and temporal entities by proposing other perspectives, rather than simply points of view, on them. Scale as an ontology is as important as scale as a technical issue, because the two things cannot be separated.

References

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