

BY MATHIAS BROCHHAUSEN, PhD



How Upper Level Ontologies Deal With Functions and Other Realizable Entities

Before categorizing things, you have to decide on the categories. For material “things” (e.g., molecules, organs, etc.) or entities, the task is relatively straightforward. But often in biomedicine, you need to also categorize abstract aspects of these material entities, such as their function or role. To tackle that task, ontologists create what are called “upper level” ontologies. Such ontologies (e.g., DOLCE, BFO) provide a basic classification of reality without addressing domain-specific entities (such as heart, platelet, or patient). Upper ontologies support the process of ontology development by providing a first framework. Furthermore, they foster harmonization among ontologies by representing the root classes.

One upper level task that has been neglected to date by the most widely used terminology resources is the coherent representation of terms like function, role, dis-

position and tendency. These abstract aspects of material entities may encode more knowledge than the entities themselves. For example, the function of red blood cells to transport oxygen, the function of the heart to pump blood, and the function of sexual reproduction to generate genetic variability, are supremely important concepts in biomedicine, and understanding them can help us determine how to fight disease. Yet they are not easily described using today’s biomedical ontologies.

So, how should functions, roles, tendencies and dispositions be represented in biomedical ontologies? They are what we can call realizable entities. They are marked by their realizations: functions are realized by their bearers being active in a specific process, roles are realized by the processes being performed in the corresponding contexts (examples: the student role is realized when a person studies; the pathogen role is realized when a bacteria infects).

Ontologies need to represent realizable entities cor-

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position and tendency. These abstract aspects of material entities may encode more knowledge than the entities themselves. For example, the function of red blood cells to transport oxygen, the function of the heart to pump blood, and the function of sexual reproduction to generate genetic variability, are supremely important concepts in biomedicine, and understanding them can help us determine how to fight disease. Yet they are not easily described using today’s biomedical ontologies.

As another example, people and other entities can act in specific ways, what we can think of as roles—the role of my mother as a patient, the role of an electrode array as a prosthesis, the role of belladonna as a drug, or the

role of a bacterium as an infectious agent. There are also dispositions and tendencies—for example the tendency of smokers to develop a cancer, and the disposition of a zygote to develop into a morula. These, too, are entities that do not exist independently of their bearers. And all of these are critical to understanding biological processes.

From a theoretical point of view, scientists’ neglect of functions in ontologies and terminologies might reflect an aversion to introducing an unwelcome teleological element into the domain of biological reality. We scientists exploring functions talk as if biological systems worked towards aims in contradiction to commonly accepted interpretations of Darwinian biology. I am strongly convinced, however, that we should not shy away from talking about functional aspects of organisms and their behaviour. This should not arouse objections from true Darwinians since it is functionality, after all, that explains why organisms can be viewed as survival machines. It is functionality, too, which offers our most coherent understanding of what clinical medicine is all about. □

DETAILS

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For further information, see Realizable entities in Basic Formal Ontology (BFO) <http://www.ifomis.org/bfo>, & Robert Arp and Barry Smith: Function, Role; and Disposition in Basic Formal Ontology, in Proceedings of Bio-Ontologies Workshop (ISMB 2008), Toronto, 45-48, <http://bio-ontologies.org.uk/download/Bio-Ontologies2008.pdf>