Biomedical ontologies are systems of terminology that both human beings and computers can understand. They arise at the intersection of philosophy and modern information technology. As the scale, scope, and pace of medical science continue to increase, ontologies can help us to think and communicate more clearly. In this paper we describe domain ontologies, explain how they are built, and argue that radiologists can benefit greatly from their use.

1 INTRODUCTION

Radiology is central to the network of modern medical specialties. From general practitioners and specialists requesting tests, to pathologists checking biopsies, to surgeons and oncologists selecting targets, the radiologist must communicate clearly and effectively with his colleagues. The radiologist is the ‘eyes’ of the medical team inside the body. But how the radiologist sees though an MRI or ultrasound is nothing like how we see with our eyes, and medical images require very careful interpretation. In addition to the inherent difficulty of reading medical images, there are important practical difficulties of communicating clearly and effectively across language barriers and using specialized medical jargon. The stakes are high, since miscommunication is potentially fatal.

Radiology is a relatively new field, driven by rapid innovation in imaging modalities and information technology. Philosophy, on the other hand, is an ancient field, with roots that extend (in the Western tradition) to fifth century BCE Greece. Philosophers continue to consider perennial questions, many of which Socrates himself asked. But philosophy has not stood still these 2500 years. Contemporary philosophy is engaged with modern science and medicine and the new challenges they present.

In this paper we consider some of the ways in which contemporary philosophy can benefit modern radiology, and vice versa. Our main focus will be domain ontologies: carefully designed systems of terminology that can help radiologist conceptualize their work more precisely and communicate more clearly.

We begin by describing some of the challenges facing modern biomedicine in general and radiology in particular – challenges that domain ontologies can help solve. Domain ontologies developed at the intersection of two traditions: a venerable branch of philosophy and the modern field of artificial intelligence research. We
then show how a domain ontology is built, and give examples of ontologies in bio-
medicine. As we will explain, there remains work to be done to develop a domain
ontology for radiology. Finally, we argue that ontologies are the best foundation on
which to build next-generation structured reporting tools for radiology.

2 PROBLEMS IN MODERN RADIOLOGY

Modern science and medicine are rapidly increasing in scope, scale, and pace. Do-
main ontologies can help with three broad challenges which these changes bring:
worldwide scope, massive scale, and electronic mediation.

Modern medicine operates on a global scale. New techniques and technologies
are shared in international journals and developed by multinational companies. In-
ternational exchanges are common, and patients move all over the world. Doctors
and scientist speak different languages, but increasingly need to communicate
across those language barriers. English is, in many ways, the de facto international
language of science and medicine, but each field has its own specialized jargon. The
solution to this problem is to establish a lingua franca, a standardized core of termi-
nology that will be understood by anyone in the field. Sometimes this will require
changing local practice to match the global standard.

The second challenge is the sheer amount of information that must be commu-
nicated. Radiologists now handle cases with hundreds of images, stored in massive
electronic picture archiving and communications systems (PACS). These systems
make new kinds of workflows possible, but they also constrain what can be done,
and which systems can communicate with which other systems. In biomedical sci-
ence more generally, scientists are dealing with larger and larger databases, which
require specialized tools and knowledge to use effectively. We have to be careful to
build systems that implement our best practices, rather than adapting our practices
to whatever tool is easiest to build.

The third challenge is that communication is largely electronic, rather than per-
sonal and face-to-face. Human beings are surprisingly good at figuring out what
other humans beings mean to say, especially when given the rich context of a face-
to-face conversation. However we increasingly rely on machine-mediated commu-
nication, where context is impoverished. A fragment of data might have been dic-
tated by one person, transcribed by another, selected by a text-mining program, re-
trieved by a database query, and read by another person years later and miles away.
When the context is lost, small inconsistencies can easily multiply and lead to dan-
gerous misinterpretation.

Domain ontologies are a step toward solving these three problems. Domain
ontologies standardize the specialized terminology within a given field. Each do-
main ontology is limited to its domain, but they link together in an interoperable
network. And domain ontologies are designed to be useful both to human beings
and to computers. They are a partial but valuable solution to the challenges of bio-
medicine with worldwide scope, massive scale, and mediated by information tech-
nology.
We believe that the key to good structured reports is good conceptual foundations, which means using high-quality domain ontologies.

8 CONCLUSION

It takes years of training to read medical images well. Radiologists are challenged daily to communicate clearly and effectively about what they see. These challenges are increasing as modern medicine increases in scale, scope, and pace.

Domain ontologies are a step toward meeting these challenges. They define and systematize terminology in a way that human beings and computers can both understand. The Open Biomedical Ontologies Consortium is leading the way in best practices for ontology development and use, because they have recognized both the technical and the philosophical problems involved. We have come a long way since Aristotle, but more than ever before we need to think clearly about how we understand the world and how we communicate that understanding.

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