1 Introduction

Our task is to create a taxonomy from an AP Biology textbook’s glossary terms [1] for Project Halo [2]. Project Halo’s goal is to build a reasoning system capable of answering novel questions and solving advanced problems in a broad range of scientific disciplines. In support of this goal, the resulting taxonomy is to be used as a foundation for translating passages within the biology textbook into logical formulas on which a reasoning system will operate.

In order to bootstrap our task, we imported ~2400 glossary terms and definition strings from the textbook’s electronic glossary into Collaborative Protégé in OWL format, as classes and comment strings. Our team consisted of biologists and KR specialists. We took an iterative approach, where the biologists of our team attempted initial classifications, restricted to the subclass-of relation, and were encouraged to add additional classes when they deemed it appropriate. As they proceeded, modeling issues were identified and discussed during workgroup sessions. The issues and the solutions that were implemented are as follows.

2 Results

2.1 Entity/Role Dichotomy

Initially the biologists of our team encoded classes for organic molecules both on the basis of their structure and on the basis of their function (see Figure 1). For instance, proteins and steroids are defined by their chemical composition. In contrast, hormones are defined by the function they perform, and there is overlap between Steroid and Hormone, i.e. some hormones are steroids while others are proteins.

As a solution, we define hormones as roles that certain chemicals play. However, Steroid-Hormone remains a class in the taxonomy, which represents a useful class of biologists’ intuitive thinking (see Figures 2 and 3).

2.2 Linnaean Classification

The biologists of our team wanted to classify the different kingdoms under the class Kingdom (see Figure 4). However, there are 5 instances of Kingdom (in the context of a U.S.-based textbook).

As a solution, we represent Linnaean taxonomy under organism, and used common English names for simplicity (see Figure 5). For example, “Cow is an Animal” is clearer than “Cow is an Animalia”:
As potential refinements, we can add the Latin-named classes as instances of their classification unit (see Figure 6). For example, Animalia is an instance of Kingdom, and Chordata is an instance of Phylum. As yet another approach (not pictured), we can treat classification units as meta-classes. For example, Chordate is an instance of the meta-class Phylum, and Animal is an instance of the meta-class Kingdom.

2.3 Entity/Process Dichotomy

The biologists of our team wanted to classify Light-Microscope under the subclass Technology (see Figure 7). They also wanted to classify Technology under the subclass Inquiry. These two uses of the term ‘Technology’ refer to two different senses. The glossary definition for Technology is “The application of scientific knowledge for a specific purpose, often involving industry or commerce but also including uses in basic research.”

Our solution in this case was to refactor the taxonomy (see Figures 8 and 9). We noted that some terms of the glossary are polysemous. Definitions including “; also” were a clear indicator of this. For example, Wild Type is “An individual with the phenotype most commonly observed in natural populations; also refers to the phenotype itself.”

2.4 Classifying Areas of Research

The initial tendency was to classify areas of research (e.g. Genetics, Anatomy, Ecology) under Inquiry. Areas of research are complex social entities, involving research activities and educational institutions constituted of departments, faculty members, programs and curricula. However, the definitions of the terms for each area of research is prefixed by “the scientific study of”. Given the commitment to processes, their classification under Inquiry is appropriate.

2.5 Subclass/Subprocess Dichotomy

There was a strong initial tendency to use the hierarchy to organize sub-parts or sub-processes (see Figure 10). For example Telophase is a subclass of Mitosis, instead of a sub-process.

Our solution was to move parts or sub-processes to appropriate locations whenever they are found (see Figure 11). During workgroup sessions, we reinforced how to use the subclass of relationship consistently.

3 Conclusions

Initially, the biologists of our team relied on prior knowledge and definitions for organizing the class hierarchy, and the classes were treated as organizational “buckets”. Ontological principles were iteratively applied to identify modeling issues and provide a foundation for the taxonomy building process.
After following this process for several workgroup sessions, the biologists had a much better sense for these types of modeling issues, and hence were more effective in continuing the taxonomy building process. These lessons and resulting taxonomy can help AURA better answer “What is” questions. Furthermore, these lessons can be applied to other ontologies, although it may depend on what formalism is used (e.g., for dealing with meta-classes).

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References
