

Creating a Knowledge Base of Biological Research Papers*

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Keywords: knowledge representation, natural language, text retrieval, semantic nets, taxonomy, frames, parsing, object oriented databases.

Abstract

Intelligent text-oriented tools for representing and searching the biological research literature are being developed, which combine object-oriented databases with artificial intelligence techniques to create a richly structured knowledge base of Materials and Methods sections of biological research papers. A knowledge model of experimental processes, biological and chemical substances, and analytical techniques is described, based on the representation techniques of taxonomic semantic nets and knowledge frames. Two approaches to populating the knowledge base with the contents of biological research papers are described: natural language processing and an interactive knowledge definition tool.

1. Introduction

Biological data and research results are rapidly becoming electronically accessible on CD-ROM or through computer networks such as Internet. Since published papers represent the primary output of biological research - about 600,000 are published each year - the prospect of a "digital library" presents an opportunity for computer scientists and biologists to move beyond exact reproduction of hard-copy resources to create intelligent text-oriented tools for representing and searching the biological research literature.

Our project is investigating the potential for using artificial intelligence techniques in combination with object oriented databases to create a richly structured knowledge base of biological research papers. Several electronic text and knowledge resources are being utilized:

- a. A corpus of 132 papers in Bacterial Chemotaxis, annotated using the Standard Generalized Markup Language [Bryan 1988]. This is the primary corpus around which we are building our prototype tools and knowledge base.
- b. The Unified Medical Language System, a large taxonomy of medical concepts created by the National Library of Medicine [UMLS 1993]. The UMLS provides a valuable point of comparison for our knowledge model.

Initially we are dealing only with papers in the field of bacterial chemotaxis, but the techniques and tools we

develop will be applicable to other branches of molecular biology. We are focusing on the Materials and Methods sections of these papers, as being both typical of texts in experimental biology and sufficiently narrow and patterned to be amenable to knowledge engineering techniques.

This report describes research aimed at creating a knowledge base of the Materials and Methods sections of the 132 bacterial chemotaxis papers, including both the text and associated knowledge frames in an integrated object-oriented structure. This knowledge base will be used to create a prototype of an intelligent retrieval system for biological research, and to experiment with a variety of information retrieval techniques.

The major challenges we face are: first, to create a knowledge model capable of expressing a significant range of biological concepts (Section 2); and second, to overcome the "knowledge bottleneck" by creating automated or semi-automated tools to populate the knowledge base with frames for a corpus of papers (Section 3). Although 132 documents is a very small corpus which might be represented without automated tools (although this is still a non-trivial effort), the aim of our research is to develop techniques and tools that will help us "scale up" to larger knowledge bases in the future.

We are also investigating concept-based retrieval algorithms for large document collections [Baclawski 1994] and developing an interactive query system for the knowledge base described in this report [Baclawski 1993b]. Software is being developed on the Apple Macintosh computer, using the WOOD object-oriented database system [St. Clair 1993].

2. Knowledge Model

Intelligent processing of language requires background knowledge, which permits an agent (whether computer or human) to make connections between a current input and other objects and events that have been or are being observed. In the sample text (Figure 1) [Kuo 1986], an instance of a complex method called **Immunoblots** is described, and details are provided for a large number of specific sub-processes, as indicated in the following quotations:

Electrophoretic transfer of proteins from the gel to nitrocellulose

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