

# Role and Significance of Case-based Reasoning in the Health Sciences

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Computational intelligence researchers have often applied their systems and methods to health sciences domains. Some of the most famous expert systems were developed in these domains. This particular interest also holds for case-based reasoning (CBR). This article first discusses the motivations for applying CBR to health sciences domains and the characteristics of these domains. It then provides a survey of CBR systems in health sciences from its history to the impact on case-based reasoning research and on the application domains. Finally, the article presents a comparison between case-based reasoning and statistics in health sciences domains. As a matter of fact, both statistics and case-based reasoning are data analysis methods, and both deal with variation inherent to health sciences domains. However, both methods present main differences in their methodologies for addressing the characteristics of health sciences domains. Of particular interest is the specific role played by cases within the knowledge spectrum as individual contextual knowledge. This kind of knowledge, representing an experience or an example, also called a case, can serve as a bridge between data, in which knowledge is implicit, and models, in which knowledge is explicit.

## 1 Introduction

Case-based reasoning (CBR) in the health sciences studies how CBR can be applied to health sciences domains. It has developed as a specialized niche within case-based reasoning applications and has also fostered CBR research in general. This paper presents main characteristics of health sciences domains and some of the accomplishments of CBR in the health sciences, before focusing on how statistics and CBR can cooperate in these domains.

CBR is a valued knowledge management and reasoning methodology in biomedical domains because it finds its recommendations on contextual knowledge by capturing unique clinical experience. This type of knowledge is much more detailed and to the point for solving clinical problems, and allows to account for some of the complexity inherent to working in clinical domains [1]. As a matter of fact, cases play an essential role in medical training and expertise acquisition, and a comprehensive set of CBR systems in medicine now has been built and evaluated successfully [1]. Their usefulness in clinical settings has been shown for decision-support, explanation, and quality control [1].

The preeminence of health sciences domains for computer science, artificial intelligence, and CBR is discussed in the second section. The third section reviews progress in case-based reasoning in biology and medicine, and highlights its contributions. The following section highlights complementarity and synergies with statistics. It is followed by the conclusion.

Rank	Category (linked to category information)	Total Cites	Median Impact Factor	# Journals	Articles
1	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	110705	0.930	85	5298
2	COMPUTER SCIENCE, CYBERNETICS	12031	0.859	18	894
3	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	52929	0.694	44	3245
4	COMPUTER SCIENCE, INFORMATION SYSTEMS	78203	0.830	87	6379
5	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	121793	0.862	87	7531
6	COMPUTER SCIENCE, SOFTWARE ENGINEERING	63797	0.782	82	4936
7	COMPUTER SCIENCE, THEORY & METHODS	76451	0.840	75	4372

Figure 1: Interdisciplinary applications of computer science represent the most cited literature within computer science in the Journal Citation Reports in the ISI Web of Knowledge.

## 2 Health Sciences Domains

Health Sciences domains encompass healthcare and health research, with in particular human biology, genetics, proteomics, phylogenetics, and patient-centered aspects.

### 2.1 Importance

Forecasts for the development of computer science highlight a general trend to be more and more infused by application areas. The emblematic application infused areas are health informatics and bioinformatics. The predominant role plaid by health sciences sectors is confirmed by labor statistics predicting its exceptional growth. The strength of health related industries answers a need for increased access to healthcare. This social need also fosters research funding and endeavors. It is notable that the Science Citation Index (Institute for Scientific Information – ISI – Web of Knowledge) lists among computer science a specialty called “Computer science, Interdisciplinary applications”. Moreover this area of computer science ranks the highest within the computer science discipline in terms of number of articles produced as well as in terms of total cites (see Fig. 1). Among the journals within this category, many relate to bioinformatics or medical informatics. The best example of this trend is the fact that the most cited journal within computer science as a whole is Bioinformatics.

### 2.2 Domain characteristics

CBR has found in biomedicine one of its most fruitful application areas, but also one of its most complex ones. The main reason for these achievements and interest from the biomedical community is that case-based reasoning capitalizes on the reuse of existing cases, or experiences. These abound in biology and medicine, since they belong to the family of descriptive experimental sciences, where knowledge stems from the study of natural phenomena, patient problem situations, or other living beings and their sets of problems. In particular, the important variability in the natural and life sciences plays an active role in fostering the development of case-based approaches in these sciences where complete, causal models fully explaining occurring phenomena are not available. One consequence of this fact is that biomedicine is a domain