Foreword

Bioinformatics is one of the youngest and most exciting fields in modern science. During the past decade, bioinformatics has become a challenging arena of applications of a wide variety of concepts and sophisticated techniques drawn from mathematics, computer science and probability theory. Within the fuzzy logic community, the meteoric ascent of bioinformatics has led to a contentious question: Can fuzzy logic make a substantive contribution to advancement of bioinformatics? The pioneering work "Applications of Fuzzy Logic to Bioinformatics," co-authored by Professors Dong Xu, James Keller, Mihail Popescu and Dr. Rajkumar Bondugula, may be viewed as a persuasive argument in support of an affirmative answer to the question. The core argument is that fuzzy logic is needed to solve problems in bioinformatics which are beyond the reach of existing techniques. It should be noted that "Applications of Fuzzy Logic to Bioinformatics," is the first book on this subject.

Today, fuzzy logic plays a relatively minor role in the armamentarium of bioinformatics. A metric is the number of publications with "fuzzy" in title or abstract—publications which are listed in the PubMed database. The current rate is 300-400 papers per year. Will the same be true in a few years from now? My belief is that in coming years there will be a rapid growth in the visibility and importance of fuzzy-logic-based techniques in the literature of bioinformatics and, more generally, in the literature of biological and medical sciences. However, my belief is based not on a detailed familiarity with bioinformatics—a familiarity which I do not have—but on my understanding of what fuzzy logic has to offer.

There are many misconceptions about fuzzy logic. Fuzzy logic is not fuzzy. Basically, fuzzy logic is a precise logic of imprecision. The principal objective of fuzzy logic is formalization/mechanization of imprecision, uncertainty, incompleteness of information and partiality of truth. Bioinformatics data fit this description, in addition to having a huge mass and high dimensionality.

Science deals not with reality but with models of reality. Concomitantly, scientific progress is driven by a quest for better models of reality. In bioinformatics, modeling is focused on genes, genomes and related biological entities. Brilliant successes have been achieved through the use of models based on bivalent logic and probability theory. However, there are many problems, such as those discussed in "Applications of Fuzzy Logic to Bioinformatics," in which better results can be achieved with better models based on the use of fuzzy logic. What is widely unrecognized is that modeling techniques based on bivalent logic and probability theory are intrinsically less powerful than techniques which are based on fuzzy logic and fuzzy-logic-based probability theory. An important contribution of "Applications of Fuzzy Logic to Bioinformatics" is making the bioinformatics community aware of the powerful modeling capability of fuzzy logic.

The superior capability of fuzzy logic as a modeling language is one of the principal rationales for its use in bioinformatics and, more generally, in scientific theories. An elaboration of this assertion is in order.

In a general setting, let M(S) be a model of S. There are two basic metrics which might be associated with M(S). First, the goodness of M(S) as a model of S, call it cointension; and second, the computational complexity of M(S). In general, cointension and computational complexity are covariant in the sense that an increase in cointension of M(S) results in an increase in the computational complexity of M(S). Bivalent logic and probability theory are, respectively, special cases of fuzzy logic and fuzzy-logic-based probability theory. What this implies is that, viewed as a modeling language, bivalent logic and probability theory have an intrinsically lower power of cointension than fuzzy logic and fuzzy-logic-based probability theory. However, the reverse is true so far as computational complexity is concerned. What gives fuzzy logic an advantage is that an increase in the computational complexity is far less important than an increase in cointension. This, in principle, is one of the main rationales for the use of fuzzy logic in bioinformatics. It should be noted that the relation between bivalent logic and fuzzy logic is similar in spirit to the relation between linear system theory and nonlinear system theory.

"Applications of Fuzzy Logic to Bioinformatics," serves three major purposes. First, it introduces fuzzy logic to the bioinformatics community. Second, it introduces bioinformatics to the fuzzy logic community; and third, it demonstrates that fuzzy logic has much to contribute to the advancement of bioinformatics. Professors James Keller, Dong Xu, Mihail Popescu and Dr. Rajkumar Bondugula, and the Imperial College Press deserve our thanks and congratulations for producing a work whose importance is hard to exaggerate. They deserve a loud applause.

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