



APPROXIMATE REASONING USING FUZZY SET THEORY

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PRE-REQUISITES : An understanding of basic concepts of analysis and algebra at the level of an undergrad course is required. Familiarity with the following courses on NPTEL would be of added value:
<https://nptel.ac.in/courses/108104157>
<https://nptel.ac.in/courses/111102130>

INTENDED AUDIENCE : This course will be accessible to Science / Engineering students upwards of 4th year undergraduate. Specifically, 4th year B.Tech / BE (CSE / EE), M.Sc (Mathematics / Stats / Computing), M. Tech (CSE, EE)

INDUSTRY SUPPORT : Industries dealing with Data Analysis and Inference, Control Systems, Aerospace.

COURSE OUTLINE :

The main focus of this course is to provide an understanding of and the theoretical underpinning of the different schemes of Approximate Reasoning employing Fuzzy Sets. It is envisaged that the structure and approach of the course will be to make a student of Math appreciate how the different structural constructs, often consigned to theoretical studies, play a role in propping up working engineering models, and a student of engineering understand the variety of theoretical explorations that allow for some basic guarantees to their embedded models. A basic understanding of analysis and algebra is required, while the basics of fuzzy set theory, while being useful will also be covered as we go along. Thus it should be accessible to final year undergrads and any post-graduate student in Math / CSE or EE.

ABOUT INSTRUCTOR :

Prof. Balasubramaniam Jayaram received his PhD in Mathematics from the Sri Sathya Sai Institute of Higher Learning, India in 2004. After having been a visiting researcher with universities in Germany, Austria, Slovakia, and Czech Republic, he is currently a full professor in the Department of Mathematics, Indian Institute of Technology Hyderabad, India (<https://people.iith.ac.in/jbala/>). Prof. Jayaram's research interests are at the intersection of Math and Data Engineering, especially to study the theory behind practical and working models for inference, searching and reasoning. His contributions to fuzzy set theory are in the areas of aggregation operations - specifically, triangular norms and fuzzy implications, and approximate reasoning - specifically, dealing with their efficacy and efficiency. He has co-authored the only research monograph on Fuzzy Implications (<https://link.springer.com/book/10.1007/978-3-540-69082-5>) and is the author or co-author of nearly 100 refereed journal and conference papers. He is also a 4-time recipient of the "Excellence in Teaching" award at IIT Hyderabad. Prof. Jayaram is an experienced research fellow of the Alexander von Humboldt Foundation. He is on the editorial board of many of the leading journals in the field of fuzzy set theory, viz. IEEE Transactions on Fuzzy Systems (2014-), Fuzzy Sets and Systems (2016-), International Journal of Approximate Reasoning (2019 -) and Kybernetika (2020 -). He also continues to serve on the program committees of some of the top tier conferences in the field of fuzzy set theory like AGOP, IPMU, IFSA-EUSFLAT, FSTA, ISCAMI.

COURSE PLAN :

Week 1: Fuzzy Sets - Preliminaries

Week 2: Fuzzy Set Theoretic Connectives - Algebra of Fuzzy Sets

Week 3: Fuzzy Set Theoretic Connectives - Triangular Norms

Week 4: Fuzzy Set Theoretic Connectives - Fuzzy Implications

Week 5: Fuzzy Inference Mechanisms - Fuzzy Relations

Week 6: Fuzzy Inference Mechanisms - Fuzzy Relational Inference

Week 7: Fuzzy Inference Mechanisms - Similarity Based Reasoning

Week 8: Fuzzy Inference Mechanisms - Hands-On with Fuzzy Logic Toolbox in Matlab

Week 9: Properties of an FIS - Interpolativity

Week 10: Properties of an FIS - Continuity

Week 11: Properties of an FIS - Robustness

Week 12: Properties of an FIS - Monotonicity