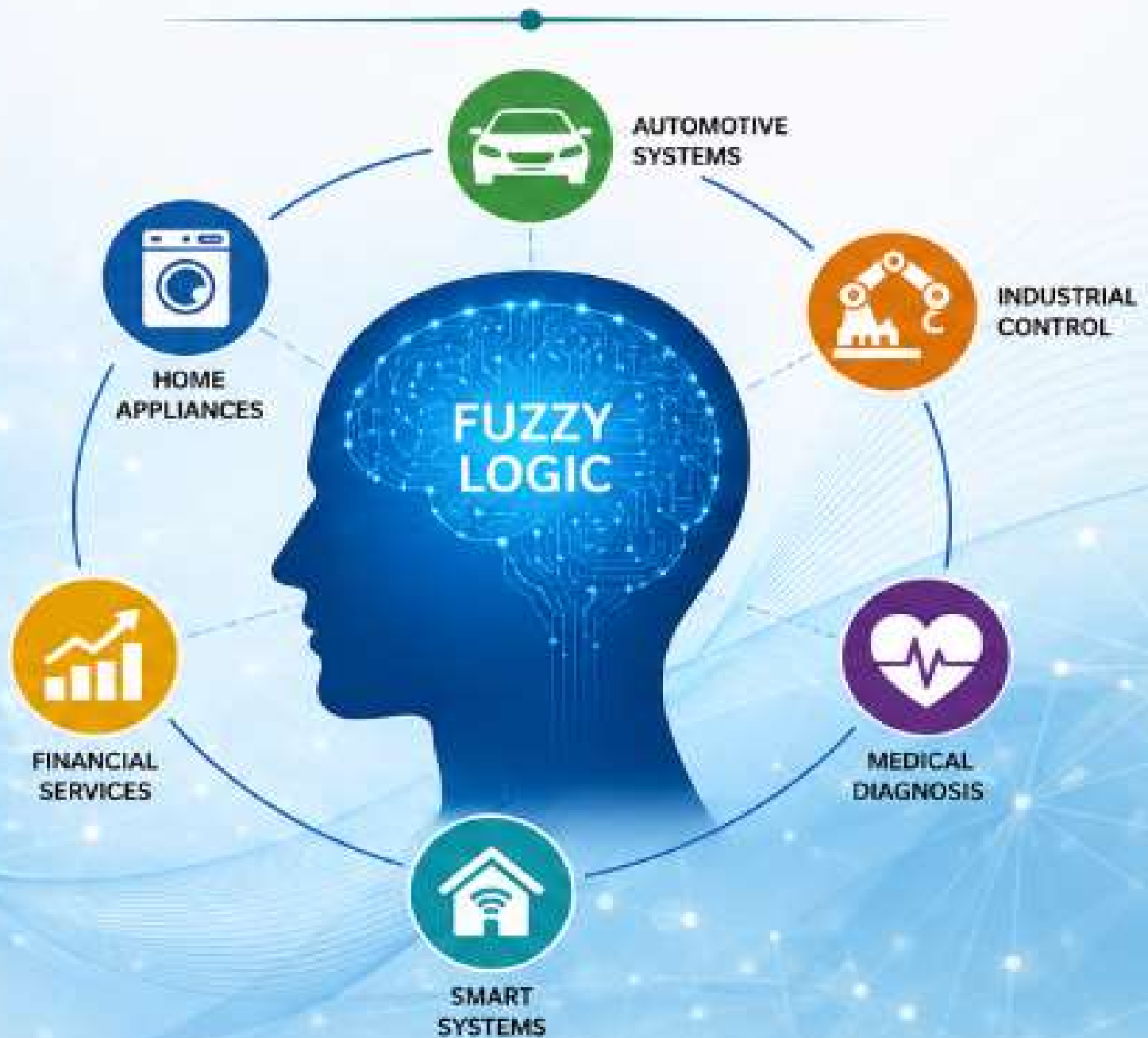


FUZZY LOGIC AND ITS APPLICATIONS



Ms. Sohini Banerjee
Ms. Sudeshna Das
Mr. Avishek Gupta

FUZZY LOGIC AND ITS APPLICATIONS

Sohini Banerjee

Sudeshna Das

Avishek Gupta

Copyright © 2026 Sohini Banerjee, Sudeshna Das, Avishek Gupta

All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, transmitted, distributed, or utilized in any form or by any means, whether electronic, mechanical, photocopying, recording, scanning, or otherwise, without the prior written permission of the Publisher, except in the case of brief quotations embodied in critical reviews, scholarly works, and other non-commercial uses permitted under applicable copyright legislation.

ISBN No.: 978-81-687571-3-4 (Digital download and online)

First published in June, 2026 by

Learnet Publishing

19/B, Kali Kumar Majumder Road, P.O. Santoshpur Avenue, P.S. Survey Park, Kolkata – 700075, West Bengal, India

Email IDs: learnetpublishing@gmail.com | info@learnetpub.co.in

Mobile No. / WhatsApp: +91-9836423405

Website: www.learnetpub.co.in | www.jctmg.in | www.eolearnet.co.in

MRP: INR 599 (Digital Edition)

© The authors have asserted their moral rights to be identified as the authors of this work in accordance with applicable copyright laws.

The views and opinions expressed in this publication are those of the individual author(s) and do not necessarily reflect the views, policies, or positions of Learnet Publishing. The publication of this work does not imply endorsement by the Publisher of any opinions, findings, conclusions, or recommendations contained herein.

Every reasonable effort has been made to ensure the accuracy, reliability, and completeness of the information presented in this publication. However, neither the authors nor the Publisher shall be liable for any loss, damage, liability, or expense incurred or suffered that is claimed to result from the use of the information contained in this work.

The responsibility for the originality, authenticity, and integrity of the content rests solely with the respective author(s). Any claims relating to plagiarism, copyright infringement, defamation, data misuse, or other legal matters arising from the content shall remain the sole responsibility of the author(s), and the Publisher disclaims any liability in this regard.

The use of registered names, trademarks, service marks, trade names, or product names in this publication does not imply that such names are exempt from the relevant protective laws and regulations and may therefore be used freely.

Cover design and production by **Learnet Publishing**.

Preface

Fuzzy Logic has emerged as one of the most significant tools for handling uncertainty, imprecision, and vagueness in real-world decision-making processes. Unlike classical binary logic, which operates on precise true or false values, fuzzy logic provides a mathematical framework for representing and processing information that is inherently ambiguous or subjective. Since its introduction by Lotfi A. Zadeh in 1965, fuzzy logic has found widespread applications in engineering, artificial intelligence, control systems, pattern recognition, data mining, medical diagnosis, and numerous other fields.

This book is designed to provide students, researchers, and professionals with a comprehensive understanding of fuzzy logic and its practical applications. The content has been organized in a systematic manner, beginning with the fundamental concepts of fuzzy sets and gradually progressing toward advanced topics such as fuzzy relations, fuzzy inference systems, fuzzy clustering, and fuzzy decision-making techniques.

A distinctive feature of this book is the inclusion of numerous solved examples and exercises after each topic. These examples are carefully selected to bridge the gap between theoretical concepts and practical implementation, enabling readers to develop both conceptual clarity and problem-solving skills. Mathematical derivations have been presented in a simple and structured manner so that learners from diverse academic backgrounds can easily grasp the concepts.

The objective of this book is not only to introduce the principles of fuzzy logic but also to demonstrate how these principles can be applied to solve real-world problems where traditional methods may prove inadequate. Readers are encouraged to work through the examples and exercises to gain a deeper appreciation of the power and versatility of fuzzy systems.

I sincerely hope that this book will serve as a valuable resource for undergraduate and postgraduate students, educators, researchers, and practitioners interested in the field of Computational Intelligence and Artificial Intelligence.

Any suggestions for improving the quality and usefulness of this book will be greatly appreciated.

Acknowledgement

The authors wishes to thank all of the colleagues in the Department of Computer Science and Engineering at Abacus Institute of Engineering and Management, whose constant encouragement and timely help have resulted in the completion of this book. Special thanks go to Dr. Sourav Das, Assistant Professor, Civil Engineering Department. with whom the author had long technical discussions, which helped in writing the book. Thanks are due to the institution for providing all of the infrastructural facilities and tools for a timely completion of this book.

The author would particularly like to acknowledge Ms. Sudeshna Das and Mr. Avishek Gupta for their invaluable help and support from time to time. Finally, the author wishes to thank all of his students.

Contents

Contents	Page No.
Chapter 1: Introduction to Fuzzy Logic	1-5
<i>1.1 Terminology:</i> <i>1.2 What is Fuzzy?</i> <i>1.3 Why fuzzy?</i> <i>1.4 Applications of Fuzzy</i> <i>1.5 Crisp Set</i> <i>1.6 Representation of Crisp Set</i> <i>1.7 Fuzzy Set</i> <i>1.8 Crisp vs. Fuzzy Set</i>	
Chapter 2: Concept of Fuzzy Set Theory	6-26
<i>2.1 Classical Set Theory</i> <i>2.2 Fuzzy Set Theory</i> <i>2.3 Fuzzy vs. Probability</i> <i>2.4 Representation of a Fuzzy Set</i> <i>2.5 Fuzzy Set with Discrete Universe</i> <i>2.6 Fuzzy Set with Continuous Universe</i> <i>2.7 Linguistic Variables</i> <i>2.8 Proper subset of a fuzzy set</i> <i>2.9 Few Properties of Fuzzy Sets</i> <i>2.10 Fuzziness of Fuzzy Sets</i>	
Chapter 3: Membership Function	27-42
<i>3.1 What is Membership Function</i> <i>3.2 MF and Parameterization</i> <i>3.3 Linguistic Variables</i>	
Chapter 4: Fuzzy Complement Operation	43-45
<i>4.1 Fuzzy Complement</i> <i>4.2 Sugeno's Fuzzy Complement</i> <i>4.3 Yager's Fuzzy Complement</i>	
Chapter 5: T-Norm and S-Norm Operators	46-58
<i>5.1 T-norm / Triangular norm</i> <i>5.2 -norm / T-conorm</i>	
Chapter 6: Fuzzy Relation	59-67
<i>6.1 Motivation</i> <i>6.2 Crisp Relation</i>	

6.3 Fuzzy Relation	
6.4 Operations on Fuzzy Relations	
Chapter 7: Fuzzy Proposition	68-72
7.1 Fuzzy Proposition	
Chapter 8: Fuzzy Rules	73-81
8.1 Fuzzy Extension Principle	
8.2 Fuzzy Implication/Fuzzy Rule	
8.3 Interpretation of Fuzzy Rule	
Chapter 9: Fuzzy Reasoning / Inference	82-100
9.1 Inferring Procedures Used in Fuzzy Systems	
9.2 Generalized Modus Tollens (GMT)	
9.3 Different Forms of Fuzzy Rules	
9.5 Fuzzy Reasoning/Approximate Reasoning/Fuzzy Inference	
9.5 Fuzzy Inference Process	
Chapter 10: Fuzzy Inference Systems (FIS)	101-112
10.1 What is Fuzzy Inference Systems	
10.2 Types of FIS/ Fuzzy Model	
10.3 Mamdani Fuzzy Inference Systems	
10.4 Different Types of Mamdani FIS	
10.5 Sugeno Fuzzy Inference Systems	
10.6 Fuzzy Inference System Examples	
Chapter 11: Defuzzification	113-140
11.1 Defuzzification Methods	



Sohini banerjee working as Assistant Professor of Computer Science and Engineering Department (B.Tech) in ABACUS Institute of Engineering and Management, Magra, West Bengal. Her current areas of Interest are AI, Deep Learning, Cloud Computing .



Sudeshna Das is working as Assistant Professor of Computer Science and Engineering Department (B.Tech) in ABACUS Institute of Engineering and Management, Magra, West Bengal since 2017. Her current areas of Interest are Image Processing, Machine Learning etc .



Avishek Gupta is working as Assistant Professor of Computer Science and Engineering Department (B.Tech) in ABACUS Institute of Engineering and Management, Magra, West Bengal. Prior to this, he was engaged as Software Developer in various organizations since August,2006 without any break. His current areas of Interest are Data Analysis .



Published by:

LEARNET PUBLISHING

**19/b, Kali Kumar Majumder Road,
P.O.-Santoshpur Avenue, P.S.- Survey Park,
Kolkata-700075, West Bengal**

Email: learnnetpublishing@gmail.com

Website: www.learnrtpub.co.in

www.jctmg.in

ISBN 978-81-687571-3-4

