

# FUZZY LOGIC

A PRACTICAL APPROACH

**F. MARTIN McNEILL • ELLEN THRO**

**Foreword by Ronald R. Yager**



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A PRACTICAL APPROACH

F. Martin McNeill  
Ellen Thro



AP PROFESSIONAL

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# **FUZZY LOGIC**

A PRACTICAL APPROACH

*Dedication of this book is to the memory of Merrill Meeks Flood, Ph.D. To the extent that the fact of existence is magic, he personified that magic.*

—FMM

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# FOREWORD

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The last decade has seen a large interest in technologies that have as their motivation some aspect of human function. Some of these, like artificial intelligence, can be seen to be rooted in the psychological domain. Others, like neural networks, genetic algorithms, and evolutionary programming, are inspired by reconsiderations of biological processes. Common to all these so-called “intelligent technologies” is a need to represent knowledge in a manner that is both faithful to the human style of processing information as well as a form amenable to computer manipulation.

Fuzzy sets were originally introduced in 1965; the related discipline of fuzzy logic is proving itself as the most appropriate medium to accomplish this task. At one level, fuzzy logic can be viewed as a language that allows one to translate sophisticated statements from natural language into a mathematical formalism. Once we have this mathematical form of knowledge, we are able to draw upon hundreds of years of recent history in technology to manipulate this knowledge.

While the original motivation was to help manage the pervasive imprecision in the world, the early practitioners of fuzzy logic dealt primarily with theoretical issues. Many early papers were devoted to basic foundations and to “potential” applications. This early phase was also marked by a strong need to distinguish fuzzy logic from probability theory. As is well understood now, fuzzy set theory and probability theory are directed at different types of uncertainty. The next phase of the development of the discipline was

driven by the success, particularly in Japan, of using fuzzy logic to design simple controllers. This success has sparked a worldwide interest in using this technology for the construction of complex systems models in engineering disciplines.

With the publication of this book we are beginning to see the emergence of the next phase of fuzzy logic. During this phase we will see the opening of the power of this methodology to middle-level "technocrats." In addition, the focus of this book, rather than being strictly on engineering problems, provides a number of broader applications. The authors are to be complimented on providing a book that will be very useful to those who desire to *use* fuzzy logic to solve their problems. The book has many examples and complementary software to help the novice.

I look forward to a future in which the techniques of fuzzy logic will become as pervasive on desktop computers as spreadsheets and databases. The authors of this book have taken an important step in helping realize this future.

Ronald R. Yager  
New York  
June 1994



# CONTENTS

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Foreword by Dr. Ronald Yager . . . . .	xv
Chapter 1. The Fuzzy World . . . . .	1
APPLES, ORANGES, OR IN BETWEEN?.....	3
IS THERE LIFE BEYOND MATH?.....	7
Vague Is Better . . . . .	9
Discovering Fuzziness. . . . .	11
THE USES OF FUZZY LOGIC.....	13
FUZZY CONTROL SYSTEMS.....	13
Other Commercial Fuzzy Systems.....	14
THE VALUE OF FUZZY SYSTEMS.....	15
Advantages and Disadvantages . . . . .	16
FUZZY DECISION-MAKING . . . . .	17
FUZZINESS AND ASIAN NATIONS.....	17
FUZZY SYSTEMS AND UNCERTAINTY . . . . .	18
Probability and Bayesian Methods. . . . .	19
Nonprobabilistic Methods . . . . .	19
FUZZY SYSTEMS AND NEURAL NETWORKS . . . . .	21

<b>Chapter 2. Fuzzy Numbers and Logic . . . . .</b>	<b>23</b>
<b>FUZZY NUMBERS . . . . .</b>	<b>25</b>
Meet FuzNum Calc . . . . .	26
Performing Fuzzy Arithmetic . . . . .	27
Behind the Scenes With FuzNum Calc . . . . .	30
<b>FUZZY SETS . . . . .</b>	<b>32</b>
Set Theory . . . . .	34
Touring UniCalc . . . . .	37
Multielement Sets . . . . .	41
Union, Intersection, and Implication . . . . .	42
Difference . . . . .	43
Complement . . . . .	44
<b>CRISP AND FUZZY LOGIC . . . . .</b>	<b>46</b>
Rules of Inference . . . . .	46
Logical Statements . . . . .	48
<b>AS-THEN AND AS-DO RULES—A SNEAK PREVIEW . . . . .</b>	<b>49</b>
<b>QUANTIFYING WORD-BASED RULES . . . . .</b>	<b>52</b>
 <b>Chapter 3. Fuzzy Systems on the Job. . . . .</b>	 <b>57</b>
<b>FUZZY TOOLS . . . . .</b>	<b>58</b>
Fuzzy Knowledge Builder™ for a Fuzzy Expert System . . . . .	58
Fuzzy Decision-Maker™ . . . . .	59
Fuzzy Thought Amplifier™ . . . . .	59
<b>FUZZY SYSTEMS . . . . .</b>	<b>59</b>
<b>CREATING A FUZZY CONTROL SYSTEM . . . . .</b>	<b>62</b>
Identify and Name Fuzzy Inputs . . . . .	62
Identify and Name Fuzzy Output . . . . .	63
Create the Fuzzy Membership Functions . . . . .	64
Construct the Rule Base . . . . .	65
Decide How to Execute the Actions . . . . .	70
<b>FUZZY BUSINESS SYSTEMS . . . . .</b>	<b>76</b>
<b>INDUSTRIAL FUZZY SYSTEMS . . . . .</b>	<b>78</b>
<b>FUZZY-NEURO SEWAGE PUMPING STATION . . . . .</b>	<b>79</b>
<b>FUZZY INSULIN INFUSION SYSTEM FOR DIABETICS . . . . .</b>	<b>79</b>
<b>FUZZY CONSUMER PRODUCTS . . . . .</b>	<b>80</b>

---

<b>Chapter 4. Fuzzy Knowledge Builder™</b> .....	<b>83</b>
<b>KNOWLEDGE BUILDER'S DESIGN</b> .....	<b>84</b>
Program Organization .....	85
Program File Structure .....	85
<b>LUNAR LANDER</b> .....	<b>89</b>
Lunar Lander's Vertical Axis.....	89
Lunar Lander's Horizontal Axis.....	105
Printing Your Graphics Displays .....	108
<b>PERSONNEL DETECTION SYSTEM</b> .....	<b>110</b>
Naming and Defining the Dimensions and Sets.....	111
Improving the Matrix's Operation.....	113
<b>FORMATTING THE KNOWLEDGE BASE FOR</b> <b>AN INFERENCE ENGINE</b> .....	<b>116</b>
<b>USING A KNOWLEDGE BASE IN AN INFERENCE ENGINE.....</b>	<b>118</b>
 <b>Chapter 5. Designing a Fuzzy Decision</b> .....	 <b>121</b>
<b>THE DECISION PROCESS</b> .....	<b>122</b>
<b>INTRODUCING THE FUZZY DECISION MAKER™</b> .....	<b>123</b>
<b>DECIDING WHICH COLLEGE TO ATTEND</b> .....	<b>124</b>
Naming Your Goals.....	127
Name Your Constraints .....	129
Name Your Alternatives.....	130
Rank the Importances of Your Goals and Constraints .....	132
How Well Do the Alternatives Satisfy the Goals? .....	134
<b>REGIONAL TRANSPORTATION SYSTEM</b> .....	<b>137</b>
Goals .....	139
Constraints.....	139
Alternatives .....	140
Importances .....	141

---

Satisfactions .....	142
The Decision Process .....	147
<b>MERGING INTERESTS .....</b>	<b>147</b>
The Scenario .....	148
The Alternatives .....	149
The Goals .....	149
The Constraints .....	150
George's Version .....	151
Martha's Version .....	153
Comparing the Two Versions .....	157
<b>INSIDE THE FUZZY DECISION MAKER.....</b>	<b>157</b>
Importances .....	157
Satisfactions .....	159
The Decision .....	160
 <b>Chapter 6. Fuzzy Thought Amplifier™</b>	
for Complex Situations .....	163
<b>DYNAMIC COMPLEXITIES IN EVERYDAY LIFE.....</b>	<b>164</b>
<b>ORIGINS OF COGNITIVE MAPS.....</b>	<b>165</b>
Crisp Cognitive Maps .....	165
Fuzzy Cognitive Maps .....	167
<b>FUZZY THOUGHT AMPLIFIER™ .....</b>	<b>170</b>
Normal Operation .....	170
"Trained" Operation .....	171
<b>SIMPLE FUZZY THOUGHT AMPLIFIERS™ .....</b>	<b>171</b>
Stable Map .....	173
Oscillation .....	175
Chaos.....	176
<b>CATPLANT.....</b>	<b>178</b>
Naming and Defining the States.....	179
Creating Events.....	179
Event Values and Names .....	179
Adding Dynamic Graphics .....	183
Running Cycles.....	184
Adding Bias .....	185
Running Cycles with the Added Bias .....	186

---

Adding Additional States.....	186
Running the Augmented CatPlant.....	187
<b>HEALTH CARE SYSTEM.....</b>	<b>188</b>
The States.....	188
The Events.....	193
Running the Healthcare Map Cycles.....	196
Importance of the Healthcare Map.....	197
<b>TRAINING A MAP TO PREDICT THE FUTURE.....</b>	<b>197</b>
The Scenario.....	197
The States.....	198
The Events.....	198
Training the Map.....	200
Predicting the Future.....	202
<b>HOW THE FUZZY THOUGHT AMPLIFIER™ WORKS.....</b>	<b>203</b>
Definition Method.....	203
Incremental Method.....	203
Training Function.....	204
<b>CONCLUDING THOUGHTS.....</b>	<b>204</b>
 Appendix A. Fuzzy Associative Memory (FAM).....	 207
FAMCALC.....	209
COMPOSING A MEMORY.....	209
CREATING A MEMORY.....	211
HOW FAMCalc WORKS.....	212
Step 1.....	212
Step 2.....	213
 Appendix B. Fuzzy Sets as Hypercube Points.....	 215
SETS AS POINTS.....	215
USING KOSKOCALC.....	217
INTERACTION OF A SET AND ITS COMPLEMENT.....	218
FAR CRISP AND NEAR CRISP.....	221
MEASURING A SET'S SIZE.....	221
INTERACTION OF TWO FUZZY SETS.....	223

---

Distance .....	225
Subsethood.....	225
 Appendix C. Disk Files and Descriptions .....	 229
LIBRARY FILES.....	229
DR. FUZZY'S CALCULATORS.....	230
FUZZY KNOWLEDGE BUILDER™ FILES.....	230
Example Knowledge Base .....	230
Example Inference Engines .....	230
Example Problems .....	232
FUZZY DECISION MAKER™ .....	233
Choosing a College .....	233
Legal Problem .....	234
Unemployment.....	234
Financial Planning .....	234
Changing Residence .....	234
FUZZY THOUGHT AMPLIFIER™ .....	235
README FILE .....	235
 Appendix D. Inference Engine Programs .....	 237
QUICKBASIC SIMPLE INFERENCE ENGINE .....	237
QUICKBASIC FAST INFERENCE ENGINE .....	249
C LANGUAGE INFERENCE ENGINE .....	261
FUZZ-C INFERENCE ENGINE .....	265
MOTOROLA 68HC05 ASSEMBLY SIMPLE INFERENCE ENGINE .....	266
 Appendix E. Other Fuzzy Architecture .....	 267
FLOPS.....	267
How FLOPS Works .....	269
BADGER—AN ANIMAL GUESSING GAME .....	269
Parallel FLOPS .....	270
STATE MACHINES .....	270
Crisp State Machine.....	270
Fuzzy State Machine .....	271

---

Putting a Fuzzy State Machine into Operation .....	272
The Rules and the Inference Method.....	273
 Bibliography .....	 275
ARTICLES .....	275
BOOKS.....	276
CONFERENCE PROCEEDINGS.....	278
 Index .....	 279

# CHAPTER 1

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## THE FUZZY WORLD

What's the process of parallel parking a car?

First you line up your car next to the one in front of your space. Then you angle the car back into the space, turning the steering wheel slightly to adjust your angle as you get closer to the curb. Now turn the wheel to back up straight and—nothing. Your rear tire's wedged against the curb.

OK. Go forward slowly, steering toward the curb until the rear tire straightens out. Fine—except, you're too far from the curb. Drive back and forth again, using shallower angles.

Now straight forward. Good, but a little too close to the car ahead. Back up a few inches. Thunk! Oops, that's the bumper of the car in back. Forward just a few inches. Stop! Perfect!! Congratulations. You've just parallel-parked your car.

And you've just performed a series of fuzzy operations.

Not fuzzy in the sense of being confused. But fuzzy in the real-world sense, like “going forward slowly” or “a bit hungry” or “partly cloudy”—the distinctions that people use in decision-making all the time, but that computers and other advanced technology haven't been able to handle.



What kind of problems? For one, waiting for an elevator at lunch hour. How do you program elevators so that they pick up the most people in the least amount of time? Or how do you program elevators to minimize the waiting time for the most people?

Suppose you're operating an automated subway system. How do you program a train to start up and slow down at stations so smoothly that the passengers hardly notice?

For that matter, how can you program a brake system on an automobile so that it works efficiently, taking road and tire conditions into account?

Perhaps you have a manufacturing process that requires a very steady temperature over a many hours. What's the most efficient and reliable method for achieving it?

Or, suppose you're filming an unpredictable and fast-moving event with your camcorder—say, a birthday party of 10 three-year-olds. What kind of a camera lets you move with the action and still end up with a very nonjerky image when you play it back?

Or, take a problem far from the realm of manufacturing and engineering, such as, how do you define the term *family* for the purposes of inclusion in health insurance policy?

Do all these situations have something in common? For one thing, they're all complex and dynamic. Also, like parallel parking, they're more easily characterized by words and shades of meaning than by mathematics.

In this book you'll be immersed in the fuzzy world, not an easy process. You'll meet the basics, manipulate the tools (simple and complex), and use them to solve real-world problems. You can make your experience interactive and hands on with a series of programs on the accompanying disk. (See the Preface for an explanation of how to load it onto your hard disk.) To make the trip easier, you'll be following in the many footsteps of our fuzzy field guide, Dr. Fuzzy. The good doctor will be on call through Help menus and will show up in the book chapters with hints, further information, and encouraging messages.



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**E-MAIL  
FROM  
DR. FUZZY**

The real world is up and down, constantly moving and changing, and full of surprises. In other words, fuzzy.

Fuzzy techniques let you successfully handle real-world situations.

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