外文资料翻译-外文原文

Fuzzy Logic

Welcome to the wonderful world of fuzzy logic, the new science you can use to powerfully get things done. Add the ability to utilize personal computer based fuzzy logic analysis and control to your technical and management skills and you can do things that humans and machines cannot otherwise do.

Following is the base on which fuzzy logic is built: As the complexity of a system increases, it becomes more difficult and eventually impossible to make a precise statement about its behavior, eventually arriving at a point of complexity where the fuzzy logic method born in humans is the only way to get at the problem. Fuzzy logic is used in system control and analysis design, because it shortens the time for engineering development and sometimes, in the case of highly complex systems, is the only way to solve the problem. Although most of the time we think of "control" as having to do with controlling a physical system, there is no such limitation in the concept as initially presented by Dr. Zadeh. Fuzzy logic can apply also to economics, psychology, marketing, weather forecasting, biology, politics ..... to any large complex system.

The term "fuzzy" was first used by Dr. Lotfi Zadeh in the engineering journal, "Proceedings of the IRE," a leading engineering journal, in 1962. Dr. Zadeh became, in 1963, the Chairman of the Electrical Engineering department of the University of California at Berkeley. That is about as high as you can go in the electrical engineering field. Dr. Zadeh thoughts are not to be taken lightly. Fuzzy logic is not the wave of the future. It is now! There are already hundreds of millions of dollars of successful, fuzzy logic based commercial products, everything from self-focusing cameras to washing machines that adjust themselves according to how dirty the clothes are, automobile engine controls, anti-lock braking systems, color film developing systems, subway control systems and computer programs trading successfully in the financial markets. Note that when you go searching for fuzzy-logic applications in the United States, it is difficult to impossible to find a control system acknowledged as based on fuzzy logic. Just imagine the impact on sales if General Motors announced their anti-lock braking was

accomplished with fuzzy logic! The general public is not ready for such an announcement.

Objectives of the following chapters include:

1)To introduce to individuals in the fields of business, industry, science, invention and day-to-day living the power and benefits available to them through the fuzzy logic method and to help them understand how fuzzy logic works.

2)To provide a fuzzy logic "how-to-do-it" guide, in terms everyone can understand, so everyone can put fuzzy logic to work doing something useful for them.

This book is being written so "Just Plain Folks" can understand the concept of fuzzy logic sufficiently to utilize it, or to at least determine if they need to dig deeply into the subject in the great quantity of Ph.D. level literature existing on the subject. This book is a guide, so you can do something with fuzzy logic, even if you are not a Ph.D. specializing in the field or an advanced digital systems electronics engineer. It should be noted there is controversy and criticism regarding fuzzy logic. One must read various sides of the controversy and reach their own conclusion. Personally, the author, who has been both praised and reviled for his writings regarding fuzzy logic, feels the critics are too rigid in their grasp of the universe and "just do not get it." But, do not take my word for it. You must look at all sides and make up your own mind. The paragraphs directly below say in a few short words, "what fuzzy logic is." But, reading much of the rest of this book and other publications on the subject will be helpful for a fuller understanding.

Suppose you are driving down a typical, two way, 6 lane street in a large city, one mile between signal lights. The speed limit is posted at 45 Mph. It is usually optimum and safest to "drive with the traffic," which will usually be going about 48 Mph. How do you define with specific, precise instructions "driving with the traffic?" It is difficult. But, it is the kind of thing humans do every day and do well. There will be some drivers weaving in and out and going more than 48 Mph and a few drivers driving exactly the posted 45 Mph. But, most drivers will be driving 48 Mph. They do this by exercising "fuzzy logic" - receiving a large number of fuzzy inputs, somehow evaluating all the inputs in their human brains and summarizing, weighting and averaging all these

inputs to yield an optimum output decision. Inputs being evaluated may include several images and considerations such as: How many cars are in front. How fast are they driving. Any "old clunkers" going real slow. Do the police ever set up radar surveillance on this stretch of road. How much leeway do the police allow over the 45 Mph limit. What do you see in the rear view mirror. Even with all this, and more, to think about, those who are driving with the traffic will all be going along together at the same speed.

The same ability you have to drive down a modern city street was used by our ancestors to successfully organize and carry out chases to drive wooly mammoths into pits, to obtain food, clothing and bone tools.

Human beings have the ability to take in and evaluate all sorts of information from the physical world they are in contact with and to mentally analyze, average and summarize all this input data into an optimum course of action. All living things do this, but humans do it more and do it better and have become the dominant species of the planet.

If you think about it, much of the information you take in is not very precisely defined, such as the speed of a vehicle coming up from behind. We call this fuzzy input. However, some of your "input" is reasonably precise and non-fuzzy such as the speedometer reading. Your processing of all this information is not very precisely definable. We call this fuzzy processing. Fuzzy logic theorists would call it using fuzzy algorithms (algorithm is another word for procedure or program, as in a computer program). Fuzzy logic is the way the human brain works, and we can mimic this in machines so they will perform somewhat like humans (not to be confused with Artificial Intelligence, where the goal is for machines to perform EXACTLY like humans). Fuzzy logic control and analysis systems may be electro-mechanical in nature, or concerned only with data, for example economic data, in all cases guided by "If-Then rules" stated in human language.

The fuzzy logic analysis and control method is, therefore:

1)Receiving of one, or a large number, of measurement or other assessment of conditions existing in some system we wish to analyze or control.

2)Processing all these inputs according to human based, fuzzy "If-Then" rules, which can be expressed in plain language words, in combination with traditional non-fuzzy processing.

3)Averaging and weighting the resulting outputs from all the individual rules into one single output decision or signal which decides what to do or tells a controlled system what to do. The output signal eventually arrived at is a precise appearing defuzzified, "crisp" value.

Measured, non-fuzzy data is the primary input for the fuzzy logic method. Examples: temperature measured by a temperature transducer, motor speed, economic data, financial markets data, etc. It would not be usual in an electro-mechanical control system or a financial or economic analysis system, but humans with their fuzzy perceptions could also provide input. There could be a human "in-the-loop." In the fuzzy logic literature, you will see the term "fuzzy set." A fuzzy set is a group of anything that cannot be precisely defined. Consider the fuzzy set of "old houses." How old is an old house? Where is the dividing line between new houses and old houses? Is a fifteen year old house an old house? How about 40 years? What about 39.9 years? The assessment is in the eyes of the beholder. Other examples of fuzzy sets are: tall women, short men, warm days, high pressure gas, small crowd, medium viscosity, hot shower water, etc. When humans are the basis for an analysis, we must have a way to assign some rational value to intuitive assessments of individual elements of a fuzzy set. We must translate from human fuzziness to numbers that can be used by a computer. We do this by assigning assessment of conditions a value from zero to 1.0. For "how hot the room is" the human might rate it at .2 if the temperature were below freezing, and the human might rate the room at .9, or even 1.0, if it is a hot day in summer with the air conditioner off. You can see these perceptions are fuzzy, just intuitive assessments, not precisely measured facts. By making fuzzy evaluations, with zero at the bottom of the scale and 1.0 at the top, we have a basis for analysis rules for the fuzzy logic method, and we can accomplish our analysis or control project. The results seem to turn out well for complex systems or systems where human experience is the only base from which to proceed,

certainly better than doing nothing at all, which is where we would be if unwilling to proceed with fuzzy rules.[12]

Novices using personal computers and the fuzzy logic method can beat Ph.D. mathematicians using formulas and conventional programmable logic controllers. Fuzzy logic makes use of human common sense. This common sense is either applied from what seems reasonable, for a new system, or from experience, for a system that has previously had a human operator. Here is an example of converting human experience for use in a control system: I read of an attempt to automate a cement manufacturing operation. Cement manufacturing is a lot more difficult than you would think. Through the centuries it has evolved with human "feel" being absolutely necessary. Engineers were not able to automate with conventional control. Eventually, they translated the human "feel" into lots and lots of fuzzy logic "If-Then" rules based on human experience. Reasonable success was thereby obtained in automating the plant. Objects of fuzzy logic analysis and control may include: physical control, such as machine speed, or operating a cement plant; financial and economic decisions; psychological conditions; physiological conditions; safety conditions; security conditions; production improvement and much more.

This book will talk about fuzzy logic in control applications - controlling machines, physical conditions, processing plants, etc. It should be noted that when Dr. Zadeh invented fuzzy logic, it appears he had in mind applying fuzzy logic in many applications in addition to controlling machines, such as economics, politics, biology, etc. Thank You Wozniak (Apple Computer), Jobs (Apple Computer), Gates (Microsoft) and Ed Roberts (the MITS, Altair entrepreneur) for the Personal Computer.

Without personal computers, it would be difficult to use fuzzy logic to control machines and production plants, or do other analyses. Without the speed and versatility of the personal computer, we would never undertake the laborious and time consuming tasks of fuzzy logic based analyses and we could not handle the complexity, speed requirement and endurance needed for machine control. You can do far more with a simple fuzzy logic BASIC or C++ program in a personal computer running in conjunction with a low cost input/output controller than with a whole array of expensive,

conventional, programmable logic controllers. Programmable logic controllers have their place! They are simple, reliable and keep American industry operating where the application is relatively simple and on-off in nature.

For a more complicated system control application, an optimum solution may be patching things together with a personal computer and fuzzy logic rules, especially if the project is being done by someone who is not a professional, control systems engineer.

A Milestone Passed for Intelligent Life On Earth。If intelligent life has appeared anywhere in the universe, "they" are probably using fuzzy logic. It is a universal principle and concept. Becoming aware of, defining and starting to use fuzzy logic is an important moment in the development of an intelligent civilization. On earth, we have just arrived at that important moment. You need to know and begin using fuzzy logic.

The discussion so far does not adequately prepare us for reading and understanding most books and articles about fuzzy logic, because of the terminology used by sophisticated authors. Following are explanations of some terms which should help in this regard. This terminology was initially established by Dr. Zadeh when he originated the fuzzy logic concept.

Fuzzy - The degree of fuzziness of a system analysis rule can vary between being very precise, in which case we would not call it "fuzzy", to being based on an opinion held by a human, which would be "fuzzy." Being fuzzy or not fuzzy, therefore, has to do with the degree of precision of a system analysis rule. A system analysis rule need not be based on human fuzzy perception. For example, you could have a rule, "If the boiler pressure rises to a danger point of 600 P as measured by a pressure transducer, then turn everything off. That rule is not "fuzzy".

Principle of Incompatibility (previously stated; repeated here) –

As the complexity of a system increases, it becomes more difficult and eventually impossible to make a precise statement about its behavior, eventually arriving at a point of complexity where the fuzzy logic method born in humans is the only way to get at the problem.

Fuzzy Sets - A fuzzy set is almost any condition for which we have words: short men, tall women, hot, cold, new buildings, accelerator setting, ripe bananas, high

intelligence, speed, weight, spongy, etc., where the condition can be given a value between 0 and 1. Example: A woman is 6 feet, 3 inches tall. In my experience, I think she is one of the tallest women I have ever met, so I rate her height at .98. This line of reasoning can go on indefinitely rating a great number of things between 0 and 1.

In fuzzy logic method control systems, degree of membership is used in the following way. A measurement of speed, for example, might be found to have a degree of membership in "too fast of" .6 and a degree of membership in "no change needed" of .2. The system program would then calculate the center of mass between "too fast" and "no change needed" to determine feedback action to send to the input of the control system. This is discussed in more detail in subsequent chapters. Summarizing Information - Human processing of information is not based on two-valued, off-on, either-or logic. It is based on fuzzy perceptions, fuzzy truths, fuzzy inferences, etc., all resulting in an averaged, summarized, normalized output, which is given by the human a precise number or decision value which he or she verbalizes, writes down or acts on. It is the goal of fuzzy logic control systems to also do this.

The input may be large masses of data, but humans can handle it. The ability to manipulate fuzzy sets and the subsequent summarizing capability to arrive at an output we can act on is one of the greatest assets of the human brain. This characteristic is the big difference between humans and digital computers. Emulating this human ability is the challenge facing those who would create computer based artificial intelligence. It is proving very, very difficult to program a computer to have human-like intelligence.

Fuzzy Variable - Words like red, blue, etc., are fuzzy and can have many shades and tints. They are just human opinions, not based on precise measurement in angstroms. These words are fuzzy variables.

If, for example, speed of a system is the attrribute being evaluated by fuzzy, "fuzzy" rules, then "speed" is a fuzzy variable.

Linguistic Variable - Linguistic means relating to language, in our case plain language words.

Speed is a fuzzy variable. Accelerator setting is a fuzzy variable. Examples of linguistic variables are: somewhat fast speed, very high speed, real slow speed,

excessively high accelerator setting, accelerator setting about right, etc. A fuzzy variable becomes a linguistic variable when we modify it with descriptive words, such as somewhat fast, very high, real slow, etc. The main function of linguistic variables is to provide a means of working with the complex systems mentioned above as being too complex to handle by conventional mathematics and engineering formulas. Linguistic variables appear in control systems with feedback loop control and can be related to each other with conditional, "if-then" statements. Example: If the speed is too fast, then back off on the high accelerator setting.

Universe of Discourse - Let us make women the object of our consideration. All the women everywhere would be the universe of women. If we choose to discourse about (talk about) women, then all the women everywhere would be our Universe of Discourse. Universe of Discourse then, is a way to say all the objects in the universe of a particular kind, usually designated by one word, that we happen to be talking about or working with in a fuzzy logic solution. A Universe of Discourse is made up of fuzzy sets. Example: The Universe of Discourse of women is made up of professional women, tall women, Asian women, short women, beautiful women, and on and on.

The World's First Fuzzy Logic Controller，In England in 1973 at the University of London, a professor and student were trying to stabilize the speed of a small steam engine the student had built. They had a lot going for them, sophisticated equipment like a PDP-8 minicomputer and conventional digital control equipment. But, they could not control the engine as well as they wanted. Engine speed would either overshoot the target speed and arrive at the target speed after a series of oscillations, or the speed control would be too sluggish, taking too long for the speed to arrive at the desired setting,

The professor, E. Mamdani, had read of a control method proposed by Dr. Lotfi Zadeh, head of the electrical engineering department at the University of California at Berkeley, in the United States. Dr. Zadeh is the originator of the designation "fuzzy", which everyone suspects was selected to throw a little "pie in the face" of his more orthodox engineering colleagues, some of whom strongly opposed the fuzzy logic concept under any name.

Professor Mamdani and the student, S. Assilian, decided to give fuzzy logic a

try. They spent a weekend setting their steam engine up with the world's first ever fuzzy logic control system ..... and went directly into the history books by harnessing the power of a force in use by humans for 3 million years, but never before defined and used for the control of machines. The controller worked right away, and worked better than anything they had done with any other method. The steam engine speed control graph using the fuzzy logic controller appeared 。

As you can see, the speed approached the desired value very quickly, did not overshoot and remained stable. It was an exciting and important moment in the history of scientific development. The Mamdani project made use of four inputs: boiler pressure error (how many temperature degrees away from the set point), rate of change of boiler pressure error, engine speed error and rate of change of engine speed error. There were two outputs: control of heat to the boiler and control of the throttle. They operated independently.

A fuzzy logic system does not have to include a continuous feedback control loop as in the above described Mamdani system in order to be a fuzzy-logic system, an impression you might receive from reading much of the fuzzy logic literature. There could be continuous feedback loop control, a combination of feedback loop control and on-off control or on-off control alone. A fuzzy logic control system could be as simple as: "If the motor temperature feels like it is too hot, turn the motor off and leave it off." Or, "If the company's president and all the directors just sold every share of stock they own, then WE sell!"

A fuzzy logic system does not have to be directed toward electro-mechanical systems. The fuzzy logic system could be, for example, to provide buy-sell decisions to trade 30 million US dollars against the Japanese yen. Fuzzy logic controllers can control solenoids, stepper motors, linear positioners , etc., as well as, or concurrently with, continuous feedback control loops. Where there is continuous feedback control of a control loop, the response for varying degrees of error can be non-linear, tailoring the response to meet unique or experience determined system requirements, even anomalies.

Controllers typically have several inputs and outputs. The handling of various tasks, such as monitoring and commanding a control loop and monitoring various inputs, with

commands issued as appropriate, would all be sequenced in the computer program. The program would step from one task to the other, the program receiving inputs from and sending commands to the converter/controller. Inputs for a fuzzy logic controlled mechanical/physical system could be derived from any of thousands of real world, physical sensors/transducers. The Thomas Register has over 110 pages of these devices. Inputs for financial trading could come from personal assessments or from an ASCII data communication feed provided by a financial markets quote service.

Progress in Fuzzy Logic，From a slow beginning, fuzzy logic grew in applications and importance, until now it is a significant concept worldwide. Intelligent beings on the other side of our galaxy and throughout the universe have probably noted and defined the concept. Personal computer based fuzzy logic control is pretty amazing. It lets novices build control systems that work in places where even the best mathematicians and engineers, using conventional approaches to control, cannot define and solve the problem. A control system is an electronic or mechanical system that causes the output of the controlled system to automatically remain at some desired output (the "set point") set by the operator. The thermostat on your air conditioner is a control system. Your car's cruise control is a control system. Control may be an on-off signal or a continuous feedback loop.

In Japan, a professor built a fuzzy logic control system that will fly a helicopter with one of the rotor blades off! Human helicopter pilots cannot do that. And, the Japanese went further and built a fuzzy logic controlled subway that is as smooth as walking in your living room. You do not have to hang on to a strap to keep your balance. If you did not look out the window at things flashing by, you would hardly know you had started and were in motion.

In the United States, fuzzy logic control is gaining popularity, but is not as widely used as in Japan, where it is a multi-million dollar industry. Japan sells fuzzy logic controlled cameras, washing machines and more. One Internet search engine returns over 16,000 pages when you search on “fuzzy-logic”. Personal computer based fuzzy logic control follows the pattern of human "fuzzy" activity. However, humans usually receive, process and act on more inputs than the typical computer based fuzzy logic controller.

(This is not necessarily so; a computer based fuzzy logic control system in Japan trades in the financial markets and utilizes 800 inputs.)

Fuzzy Logic Control Input - Human and Computer，Computer based fuzzy logic machine control is like human fuzzy logic control, but there is a difference when the nature of the computer's input is considered. Humans evaluate input from their surroundings in a fuzzy manner, whereas machines/computers obtain precise appearing values, such as 112 degrees F, obtained with a transducer and an analog to digital converter. The computer input would be the computer measuring, let's say, 112 degrees F. The human input would be a fuzzy feeling of being too warm. The human says, "The shower water is too hot." The computer as a result of analog input measurement says, "The shower water is 112 degrees F and 'If-Then' statements in my program tell me the water is too warm." A human says, "I see two tall people and one short one." The computer says, "I measure two people, 6' 6" and 6' 9", respectively, and one person 5' 1" tall, and 'If-Then' statements in my program tell me there are two tall people and one short person."[13]

Even though transducer derived, measured inputs for computers appear to be more precise, from the point of input forward we still use them in a fuzzy logic method approach that follows our fuzzy, human approach to control. For a human, if the shower water gets too warm, the valve handle is turned to make the temperature go down a little. For a computer, an "If-Then" statement in the program would initiate the lowering of temperature based on a human provided "If-Then" rule, with a command output operating a valve. To create a personal computer based fuzzy logic control system, we:

1)Determine the inputs.

2)Describe the cause and effect action of the system with "fuzzy rules" stated in plain English words.

3)Write a computer program to act on the inputs and determine the output, considering each input separately.The rules become "If-Then" statements in the program.(As will be seen below, where feedback loop control is involved, use of graphical triangles can help visualize and compute this input-output action.)

4)In the program, use a weighted average to merge the various actions called for by the individual inputs into one crisp output acting on the controlled system.(In the event there is only one output, then merging is not necessary, only scaling the output as needed.)

The fuzzy logic approach makes it easier to conceptualize and implement control systems. The process is reduced to a set of visualizable steps. This is a very important point. Actually implementing a control system, even a simple control system, is more difficult than it appears. Unexpected aberrations and physical anomalies inevitably occur. Getting the process working correctly ends up being a "cut and try" effort.

Experienced, professional digital control engineers using conventional control might know how to proceed to fine tune a system. But, it can be difficult for us just plain folks. Fuzzy logic control makes it easier to visualize and set up a system and proceed through the cut and try process. It is only necessary to change a few plain English rules resulting in changing a few numbers in the program. In reading about fuzzy logic control applications in industry, one of the significant points that stands out is: fuzzy logic is used because it shortens the time for engineering development. Fuzzy logic enables engineers to configure systems quickly without extensive experimentation and to make use of information from expert human operators who have been performing the task manually. Perhaps your control need is something a lot more down to earth than flying helicopters or running subways. Maybe all you want to do is keep your small business sawmill running smoothly, with the wood changing and the blade sharpness changing. Or, perhaps you operate a natural gas compressor for some stripper wells that are always coming on and going off, and you need to have the compressor automatically adjust in order to stay on line and keep the suction pressure low to get optimum production. Perhaps you dream of a race car that would automatically adjust to changing conditions, the setup remaining optimum as effectively as the above mentioned helicopter adjusts to being without a rotor blade.

There are a million stories, and we cannot guess what yours is, but chances are, if there is something you want to control, and you are not an experienced, full time, professional control engineer financed by a multi-million dollar corporation, then fuzzy

logic may be for you. If you are all those things, it still may be for you. Some of the greatest minds in the technical world try to explain to others why fuzzy logic works, for us just plain folks, the fact is fuzzy logic does work, seems to work better than many expensive and complicated systems and is understandable and affordable.

外文资料翻译-译文

模糊逻辑

欢迎进入模糊逻辑的精彩世界，你可以用新科学有力地实现一些东西。在你的技术与管理技能的领域中，增加了基于模糊逻辑分析和控制的能力，你就可以实现除此之外的其他人与物无法做到的事情。

以下就是模糊逻辑的基础知识：随着系统复杂性的增加，对系统精确的阐述变得越来越难，最终变得无法阐述。于是，终于到达了一个只有靠人类发明的模糊逻辑才能解决的复杂程度。模糊逻辑用于系统的分析和控制设计，因为它可以缩短工程发展的时间；有时，在一些高度复杂的系统中，这是唯一可以解决问题的方法。虽然，我们经常认为控制是和控制一个物理系统有关系的，但是，扎德博士最初设计这个概念的时候本意并非如此。实际上，模糊逻辑适用于生物，经济，市场营销和其他大而复杂的系统。

模糊这个词最早出现在扎德博士于 1962 年在一个工程学权威刊物上发表论文中。1963 年，扎德博士成为加州大学伯克利分校电气工程学院院长。那就意味着达到了电气工程领域的顶尖。扎德博士认为模糊控制是那时的热点，不是以后的热点，更不应该受到轻视。目前已经有了成千上万基于模糊逻辑的产品，从聚焦照相机到可以根据衣服脏度自我控制洗涤方式的洗衣机等。如果你在美国，你会很容易找到基于模糊的系统。想一想，当通用汽车告诉大众，她生产的汽车其反刹车是根据模糊逻辑而造成的时候，那会对其销售造成多么大的影响。

以下的章节包括：

1)介绍处于商业等各个领域的人们他们如果从模糊逻辑演变而来的利益中得到好处，以及帮助大家理解模糊逻辑是怎么工作的。

2)提供模糊逻辑是怎么工作的一种指导，只有人们知道了这一点，才能运用它用于做一些对自己有利的事情。

这本书就是一个指导，因此尽管你不是电气领域的专家，你也可以运用模糊逻辑。需要指出的是有一些针对模糊逻辑的相反观点和批评。一个人应该学会观察反面的各个观点，从而得出自己的观点。我个人认为，身为被表扬以及因写关于模糊逻辑论文而受到赞赏的作者，他会认为，在这个领域中的这种批评有点过激。但是，请不要总相信我的观点。你应该耳听四方，然后做出自己的看法。

这一本书还未正式出版，如此“正直的简单人们” 能充分地了解模糊逻辑的观念并且利用它，或至少决定如果他们需要深深地深入在主题上存在的博士水平文学的很不错的主题。这一本书是引导者，因此，你能对模糊逻辑做某事,即使你不是一个专攻领域或一个先进的数传系统电子学工程师的博士。我们应该被注意有论争和关于模糊逻辑的批评。一定要读争论的各种不同立场并且达成他们自己的结论。亲自地，为他的关于模糊逻辑的写作，两者都已经被称赞而且辱骂，感觉批评家是太硬的在他们的宇宙把握中并且 “不应该那么做的”. 但是,为它大家可以不用在意我所说的话。你一定看所有的立场而且组成你自己的思想。段落直接地在下面在一些短字中说,“什么是模糊逻辑”。但是，我们看看这一本书的余下部分和其他的相关文章，相信会对我们进一步理解模糊逻辑有所帮助。

假设你开着车行驶在传统的双向道，6 个车道的公路上，交通灯之间距离是 1 公里。车速限制在 45M 之内，而最好的速度应该在 48M。你如何定义“遵守交通规则”呢？很难！但是，这却是人类经常要做并且做的很好的事情。将会有一些车手的车速总是在 48M 前后，也有一些人的车速总是定在 45M。实际上，大部分的人会将车速控制在 48M，他们用的就是模糊推理。在交通中还存在着一系列此类的案例。

你在城镇中驾驶车辆的这个模糊推理能力，也曾被我们的祖先用于获得食物，衣服，骨具等。

人类和外界的物理世界相接触的时候，有能力吸纳和分清从物理世界中得到的信息。并且综合它们而得到最好的行为方式。所有的动物都会这么做，只不过，人类做的比较好，因此他成为了地球的主宰者。

你想一想，我们摄入的大部分信息都是不精确的。比如：汽车的冲刺速度。我们将这称为模糊输入；但是也有一些是很合理的，精确的输入，比如：你的阅读速度。我们称为模糊处理。模糊学理论家就会建议运用所谓的模糊推理。

模糊逻辑是人脑工作的方式。我们可以将这移植到机器身上，所以，有时，机器具有了人脑的相似思维。模糊逻辑和分析系统可以使自然界中的电气自动化。比如经济数据等内，人类语言中总是含有：“如果-那么”的规则。

模糊逻辑分析和控制的过程是：

1)接受一个或者多个我们希望去分析的数据量或者其他的变量。

2)综合传统的非模糊系统，用简便的“如果—那么”模式来表示，并将要处理的量进行处理。

3)从由不同规则里得到的输出结果中进行平衡。得出的结果要求芯片如果工作。最后得到的就是一个不再是模糊而是精确的量。

模糊就是一种用于估算无法精确测量的系统的概念。事实上，在宇宙中，人们评估任何事情都存在一定的模糊。不论你对某工具的测量是多么的精确，模糊概念始终是模糊逻辑中模糊分析和控制的基础。

对模糊逻辑系统来说，可测量的，非模糊的输入数据是最主要的。例如：温度传感器检测到的温度，经济数据。人类进行模糊控制的时候，应该将模糊转化成为计算机可以识别的信号。我们将它的值域定在 0 到 1 之间。比如，房屋内部的温度是多少，人们可能定在 0.2，如果温度处于零下，那么可能定为 0.9 甚至 1。你可以看出来，这些就是模糊概念。通过模糊评估，值域定在 0 到 1 之间。这就给我们进行模糊推理提供了一种规则，这样，我们就可以完成控制工程。

诺瓦瓷利用运用模糊逻辑的电脑就可以打败数学家们靠公式和传统编程的控制器。模糊逻辑利用人们的一般思维；这种一般思维对一个新的系统来说合情合理，并且对一个曾有人控制的系统来说，它又能显示出很有经验。这里有一个将人类的一般思维运用到一个控制系统的例子。元件产品的难度远远超出了你的想象。最后，他们将人类的大量经验通过“如果-那么”的规则输入机器中。

模糊逻辑分析和控制的部件包括：物理控制，比如机器速度或者操作一个元件；经济和财政决策；心理情景；安全状态以及其他一些改善产品的众多例子。

这本书要探讨的是模糊逻辑在控制机器，经济决策等方面的应用。看起来，当初，扎德博士发明模糊逻辑时，想将它运用到经济，政治等各个方面。

如果没有个人电脑，就很难将模糊逻辑运用于控制机器和其他一些地方。没有了个人电脑的速度，就很难运用人力控制机器以及具有足够的持久力去控制机器。你用一台内含模糊逻辑的BASIC或者C++的个人电脑比用一台其他的电脑更节省钱。编程逻辑控制器拥有了自己的地方，他们简单，可靠，并且维持着美国工业的运转。

对于一个更为复杂的系统，最好的方法就是用电脑和模糊逻辑将系统组合，尤其当一个非专业人士来主持重大工程项目的时候。

这是地球上智能生命里的一个里程碑：

在宇宙任何地方出现的智能生命，都可能应用到模糊逻辑。它是一个广泛的规则和概念。我们开始认识到在智能化的进程中，定义和应用模糊逻辑是一个重要的阶段。在地球上，我们只是刚刚到达那个时刻，你需要知道并开始应用模糊逻辑。

至今的争论并没有使我们适应和理解模糊逻辑的大部分书籍和论文。因为，那些作者大多是圆滑老练的。以下是一些可以帮助我们理解的解释性语言。这些最早是由扎德博士发明模糊逻辑的时候建立的。

模糊—系统分析可以精确区分的模糊的程度。在这里我们不能称之为模糊，因为是基于一个人的观点的。因此，模糊还是不模糊就和系统分析精确的程度有关。一个系统分析规则的精确与一个人的模糊意念不相干。不如你有一个这样的规则：如果气压上升到 600P，那么关掉一切设备。这个规则就不是模糊的。

随着系统复杂性的增加，对系统精确的阐述变得越来越难，最终变得无法阐述。于是，终于到达了一个只有靠人类发明的模糊逻辑才能解决的复杂程度。

模糊集合—模糊集合几乎存在于任何场合，比如：高的，矮的，速度快，慢等。我们给它们定了一个从 0 到 1 的值域。例如，我遇到了一个 6 尺 3 寸的人，我认为他是我见过的最高的人了。于是，我将值定位在 0.98。

在一个模糊控制系统中，模糊集是以下列方法进行的。以测量速度来作为例子。系统编程便会在“太快”和“无须改变”之间选择，最终进行反馈并将数据输入系统当中。这样的情况我们在以下的章节中将会有进一步的谈讨。

摘要信息—人们处理信息不是基于开关的两个端点，而是基于模糊概念的。所有的输入最后处理得到精确的数值输出，这些可以指导人们进行行动。模糊逻辑控制系统的目的也是在此。

输入的数据可能是极大的，但是人们可以处理它。操纵这些并最终变成人们可以执行的输出是人类大脑的特有功能。这是人类和电脑之间存在的一个重要特性。人们创造基于人工智能的电脑来挑战人类的这种能力，但是很难建造一种这样的电脑。

模糊多样化—一些概念如红色等，都是模糊的，他们都是基于人类概念的，而不是精确的。这些词就具有模糊多样化。

语言多样化—这些语言和我们平常用的语言有关联。

速度是一种模糊多样化。模糊多样化变成语言多样化，这是当我们应用语言去描述它的时候。比如：非常快，极慢等。语言多样化最主要的功能就是，它可以处理那些靠公式等难以处理的复杂系统。语言多样化在控制系统中带有反馈的功能以及和其他的状态相联系。比如：速度太快，则关掉加速器。

讨论范围—拿女人当例子，如果我们谈到女人，那么各个地方的女人都成了我

们谈论的对象。讨论范围是一种将同类的物质组合在一起的概念。它是由模糊集合组成的。比如：女人的讨论范围是由专业女士，高的女人等组成的。

世界上的第一个模糊逻辑控制器。

1973 年，英国伦敦大学的师生正试图稳定一个先前制造的流动动力机，虽然，他们拥有各种不同的先进物质，但是却无法按照自己的意愿来控制动力机。它的速度不是太快，就是太慢，无法与其他器件相配套。玛达尼教授读了一篇扎德博士写的文章，扎德博士是加州大学伯克利分校电气工程学院院长。那就意味着达到了电气工程领域的顶尖。他是模糊方面的权威，但是当时有一些人以不同名义反对模糊概念。玛达尼教授和他的学生决定用模糊逻辑来试一试。在周末，他们给自己的流动动力机安装了世界上第一个模糊系统。并且载入了历史。这个模糊控制器运行的相当好，比以往他们用过的各个方案都要好。流动动力机运行的速度控制的很好。正如你想的那样，它运行的不错，总是可以定在某个区域，不会抖动并且总处于稳定。这是科学发展历史上一个令人兴奋并且重要的时刻。

玛达尼教授的模糊控制系统有四个输入：温度检测偏差纠正，速度，气压等的纠正等。并且，这个系统有两个输出。他们是独立工作的。

要想制造一个模糊系统，我们无须上述玛达尼教授的模糊控制系统中的持续反馈系统。你能从模糊逻辑文章中得到不少深刻的印象。一个模糊逻辑控制系统应该简单成“如果摩托车的缸体温度有点太高，那么就应该关掉热源如发动机等。”或者“公司的老总和其他高层人士正在出售公司的股票，那么我们也应该尽快卖掉”。

模糊逻辑系统无须变成一个电子机械系统。比如，模糊逻辑系统可以用于 3 千万美元和日元的兑换决策。模糊逻辑控制器可以控制摩托车和其他的一些东西并进行持续的反馈控制。

控制器典型的有多输入和多输出。在计算机中输入了各个适当的程序，那么模糊逻辑控制器就可以进行监测和控制各种输入。程序可以从一个任务跳转到另外一个任务，程序获得数据输入并且向命令控制器发出指令。

向模糊逻辑控制系统输入的各种输入数据是由现实世界中得来的。向财政交易系统输入的也是从人们的评估中得到的。

模糊逻辑的进步，从一开始，模糊系统就是在不断应用和重要性中发展起来的，现在，这已经是应用广泛的概念。基于模糊逻辑的个人电脑是很迷人的。用从前的传统方法是无法定义和解决这些问题的。

一个系统是一个电子和机械的系统，它能使被控制系统的输出能够自动地停留在操作者所预定的位置上。在你空调里面的温度检测器是一个控制系统。你车上的线路控制是一个控制系统。控制可能是间断的信号或者是持续的控制流。在日本，一个教授创立了一个可以控制直升飞机的模糊逻辑控制系统。而这是人类直升飞机飞行员无法作到的。并且日本在这方面研究深入，建立了一个舒适的就像卧室里面通道一样的地铁。

在美国，模糊逻辑控制正在得到名声，但是不是同样地广泛地使用，像在日本一样。日本卖被控制的照相机，洗衣机和更多的模糊逻辑。一个英特网搜寻引擎归还超过16,000 页，当你搜寻的时候在模糊+逻辑。被建立控制跟随人类"模糊"的式样活动的模糊逻辑的个人计算机。然而，人类通常接受,处理而且有所反应较多的输入超过被建立模糊逻辑控制器的典型计算机。(这是不一定如此；一部在日本被建立模糊逻辑控制系统的计算机在财政的市场中交易并且利用 800 输入)。模糊逻辑控制输入-人类和被建立模糊逻辑机器控制的计算机，计算机像人类的模糊逻辑控制,但是当计算机的输入性质被考虑的时候有一种不同的特性。人类以模糊样子评估来自他们的环境输入,然而机器/ 计算机获得像 112 度 F 这样的精确价值,以对数传转换器的一个转换器和一个类比获得。计算机输入会是计算机测定,让我们说,112 度 F.人类的输入会是太温暖的模糊感觉。人类的发言权：雨水太热 。计算机类比输入测量的结果说,雨水是我的计划112度和“如果 - 然后”陈述告诉我水太温暖.一个人类的发言权：我见到二个高的人和一个短的。计算机说：我测量二个人,6’6″ 和 6’9″,分别比一个人 5’1″ 高和如果-然后我的计划陈述告诉我有二个高的人和一个矮人。

即使测量了输入因为计算机变得更精确，转换器源自输入的点向前地我们仍然在模糊逻辑方法方式中使用他们追从我们的模糊,人类接近控制。对于一个人类，如果阵雨水太温暖,那么就准备稍微使温度下降下去。对于一部计算机，"如果 - 然后" 计画的陈述会开始以一个被提供的人类为基础的温度降低人 “如果-然后”规则,藉由操作一个活瓣的指令输出。

为了要产生一部被建立模糊逻辑控制系统的个人计算机，我们：

1)决定输入。

2)用 "描述因素和效果系统的行动模糊规则"在简单的英文字中陈述。

3)写一个电脑程式给对输入有所反应而且决定输出,分开的考虑每个输入。规

则变成“如果-然后”计划的陈述。(当将会在下面被见到之时，回应使控制成环哪里被牵涉,图解式三角形的使用能帮助看得见而且计算这个输入- 输出的行动)。

4)在计划中，使用被重量的平均合并进入不同的输出在受约束的系统方面的演戏之内被个别的输入要求的各种不同的行动(在事件中只有输出，然后合并不是必需的,当作需要的唯一计数输出)。

模糊逻辑方式概念化并实现控制系统是比较容易。程序被转为一系列 visualizable 步骤。这是非常重要的一点。实际上实现一个控制系统，甚至一个简单的控制系统，出现也很困难。料想不到的越轨和实际的反常事物不可避免发生。得到正确地工作的程序最后作为一个削减和尝试努力。

在工业中读关于模糊逻辑控制应用的有关方面，突出的重要点之一是: 因为它弄短工程发展的时间，所以模糊逻辑被用。模糊逻辑使工程师能够不需要广泛的实验就很快地配置系统并且利用来自用手已经表演工作的专家人类的操作员的数据。也许超过飞的直升飞机或流动的地下铁更下来对地球你的控制需要是某事很多。也许全部你想要做是生计你的平滑地跑的小生意锯木厂，藉由木材变更和变更的刀锋锐利。也许你操作一个天然气压缩物，因为一些工具总是涌出那受到在之上的影响而且爆炸,而且你需要有压缩物自动地为了要低下地停留在线上而且保存吸强迫拿最适宜的制造,调整。也许你梦到一辆会自动地调整的比赛汽车到变更情况,像上述的直升飞机对没有转子刀锋的存在调整一样的有效地的保持最适宜的装备。

那有一个百万个故事，而且我们不能够猜测什么是你的故事，但是机会是，如果那里是某种你想要控制的，而且你不是富有经验的专业人士和有数百万元供给经费的公司工程师，然后模糊逻辑可能为你做到那些。如果你真的处于这种情况，它仍然可能适用于你。在技术的世界中一些最好的思想家试着解释模糊逻辑为什么工作。对我们这些平常的人,事实是模糊逻辑确实工作，似乎更有效率于许多贵的和复杂的系统并且是可以理解的和能负担的。