Chapter 5

Fuzzy Sets and Fuzzification

5.1 Introduction

-Crisp sets
-Fuzzy sets
-Fuzzy membership functions
-Fuzzification
-Fuzzy logic

5.2 Crisp Sets

-Everything is either true or false
-No uncertainty is allowed
-An item either is
–entirely within a set, or
–entirely not in a set
-The Law of the Excluded Middle
–X must be either in set A or in set not-A
–no middle ground is allowed
-Opposite sets (A and not-A) must between them contain everything
–Venn diagrams

5.3 Fuzzy Sets

-Items can belong to a fuzzy set to different degrees
–degrees of membership
-Completely within a set is a membership degree of 1
-Completely outside a set is a membership degree of 0
-Degrees of membership must sum to 1
-An item can be both A and not-A to different degrees
–e.g. A to a degree of 0.8, not-A 0.2
-Degrees of membership are expressed with membership functions

-Range of values a variable can take is called the universe of discourse

5.4   Membership Functions

-A membership function describes the degree of membership of a value in a fuzzy set
-Referred to as MF
–Also $\mu(x)$
—where x is the value being fuzzified
-here are many different types of MF
-Which one to use depends on the problem

5.4.1   Singleton MF

5.4.2   Rectangular MF

5.4.3   Triangular MF

5.4.4   Gaussian MF

5.4.5   Other Representations of MF

5.5   Fuzzification

-The process of determining the degree to which a value belongs in a fuzzy set
-The value returned by a fuzzy MF
-Most variables in a fuzzy system have multiple MF attached to them
-Fuzzifying that variable involves passing the crisp value through each MF attached to
that value

5.6   Fuzzy Logic

-Same operations and function as in crisp logic
-Must deal with degrees of truth rather than absolute truths
-Fuzzy logic is a superset of crisp (Boolean) logic
A-ND, OR, NOT
-Crisp logical functions
–AND true is both parameters are true
–OR true if either parameter is true
–NOT reverses truth of argument
-AND function - crisp version
-AND function - fuzzy version
–take the minimum of the two arguments
-OR function - crisp version
-OR function - fuzzy version
–take the maximum of the two arguments
-NOT function - crisp version

-NOT function - fuzzy version
–subtract the truth value from one
-Output of fuzzy logical functions are the same as crisp functions
–just calculated differently
–handle degrees of truth, rather than absolute truths
-The basis of fuzzy rule based systems

5.7   Summary

-Fuzzy logic deals with uncertainty
-Allows degrees of truth
-Allows partial membership in sets
-Fuzzy membership functions describe degrees of membership in fuzzy sets
-Many different types of MF exist
-Fuzzification = determining degree of membership
–uses fuzzy MF to do so
-Fuzzy logic extends Boolean operators to handle partial truths
–the basis of fuzzy rules