Fuzzy Logic

Lecture 1
Introduction To Fuzzy Logic

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Motivation

- The term "fuzzy logic" refers to a logic of approximation.

- Boolean logic assumes that every fact is either entirely true or false.

- Fuzzy logic allows for varying degrees of truth.

- Computers can apply this logic to represent vague and imprecise ideas, such as "hot", "tall" or "balding".

What is meant by fuzzy?

Fuzzy (technical meaning) is

- imprecise, uncertain or unreliable knowledge,

- uncertain/noisy/incomplete Information,

- ambiguity (vague)

- or partial truth

Difference between imprecision and uncertainty

Consider the following two situations :

1. John has at least two children and I am sure about it.

2. John has three children but I am not sure about it.

In case 1, the number of children is imprecise but certain.

In case 2, the number of children is precise but uncertain.

Uncertainty

- There is uncertainty that arises from ignorance, from various classes of randomness, from the inability to perform adequate measurements, from lack of knowledge, or from vagueness.
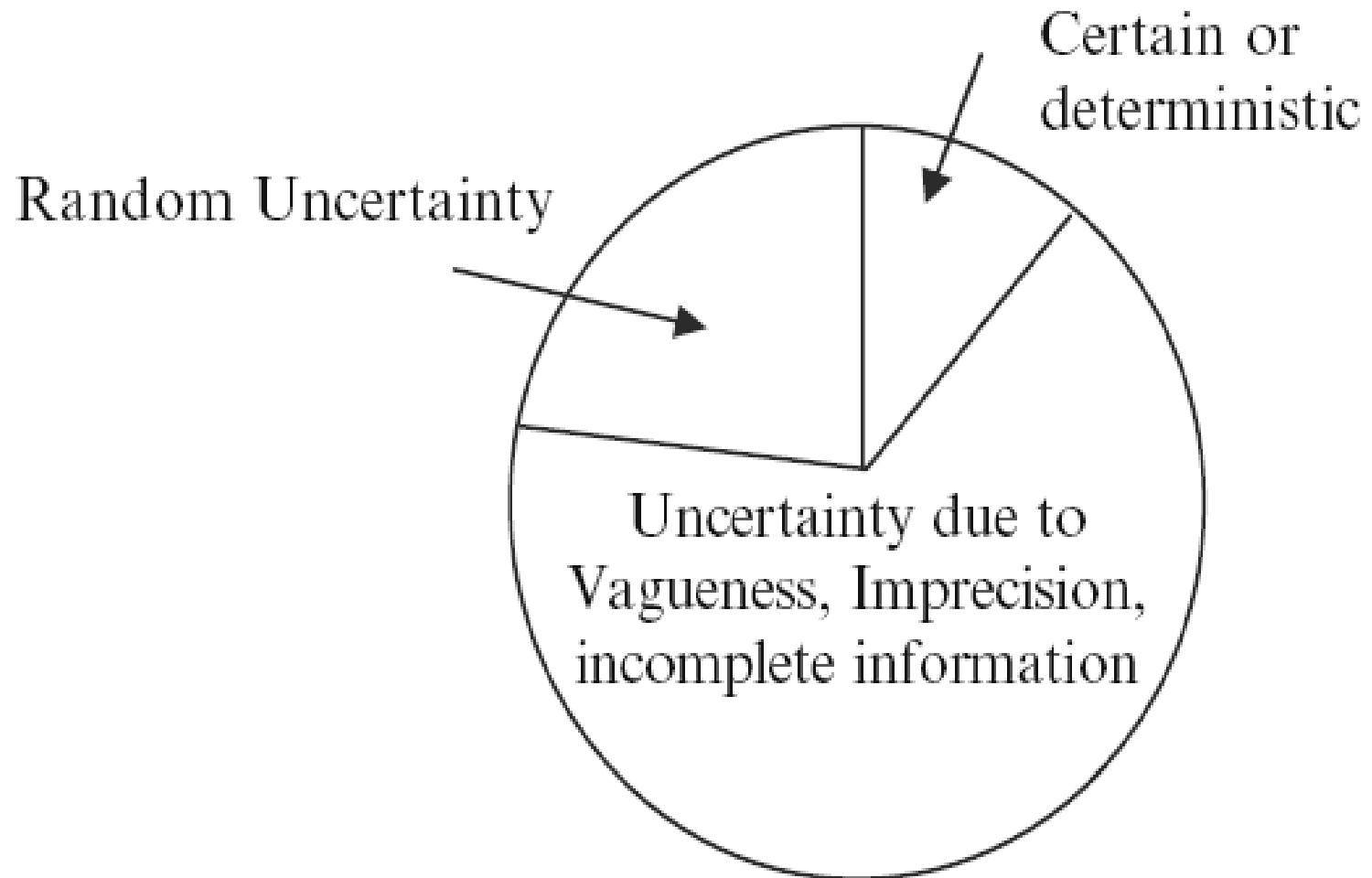
Types of Uncertainty

1. **Stochastic uncertainty**: It is the uncertainty towards the occurrence of a certain event.

2. **Lexical uncertainty**: It is the uncertainty lies in human languages like hot days, stable occurrence, a successful financial year and so on.

Ambiguity (vague)

- Food is hot.

- Here hot may be 'spicy' or 'warm'

World of information

Introduction

➢ Fuzzy Logic was initiated in 1965, by Dr. Lotfi A. Zadeh, professor for computer science at the university of California in Berkley.

➢ Fuzzy logic is a mathematical tool for dealing with uncertainty.

➢ It provides a technique to deal with imprecision and information granularity.

➢ The fuzzy theory provides a mechanism for representing linguistic constructs such as "many," "low," "medium,"

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Classical set

- Classical sets are also called **crisp set** or **nonfuzzy** set.

- The traditional binary set theory describes crisp events, events that either do or do not occur.

- The crisp sets are sets without ambiguity in their membership.

- Example 1, for the set of integers, either an integer is even or it is not (it is odd).

- Example 2, However, either you are in the USA or you are not.

Example

Lists: A = {apples, oranges, cherries, mangoes} A =

$\{a_1, a_2, a_3\}$

A = {2, 4, 6, 8, …}

Formulas: A = {x | x is an even natural number} A = {x | x
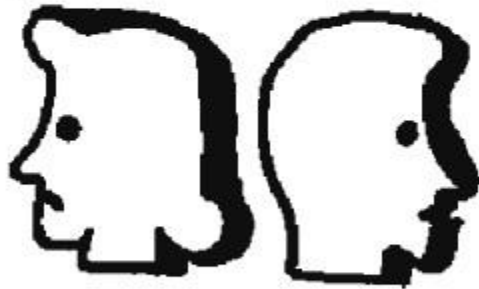
= 2n, n is a natural number}

Membership or characteristic function

$$X_A(x) = \begin{cases} 1 \text{ if } x \in A \\ 0 \text{ if } x \notin A \end{cases}$$

Can they see each other?
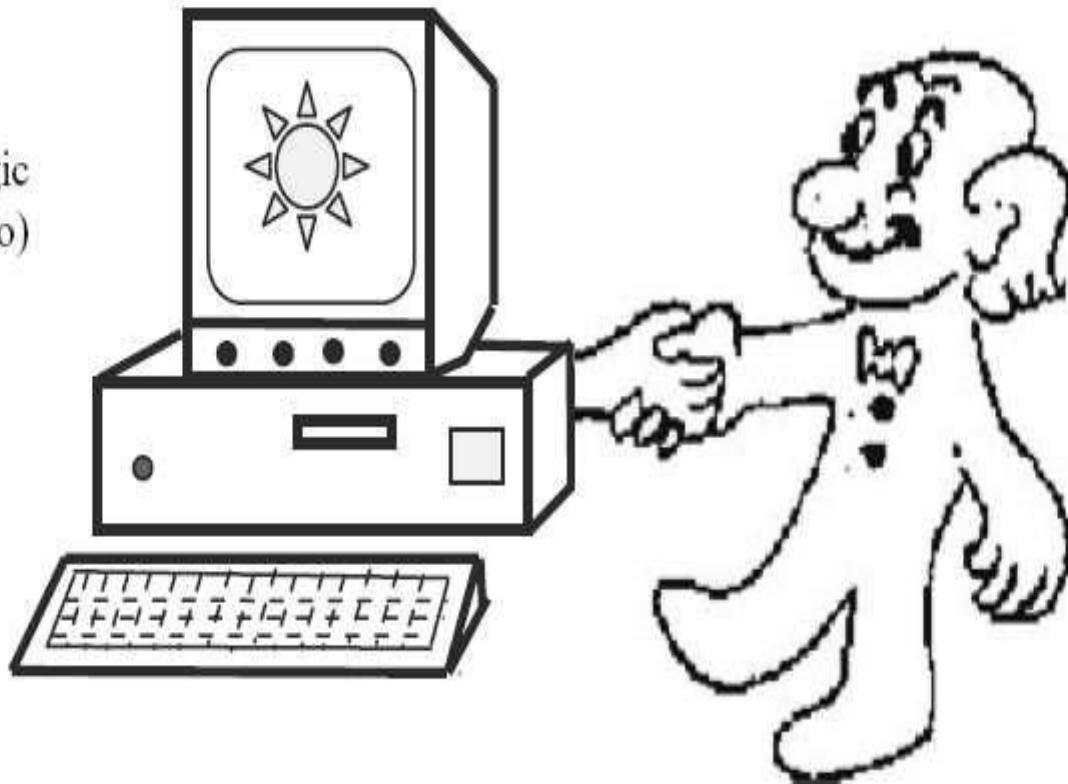

YES

NO

Binary logic

MAYBE

Fuzzy logic

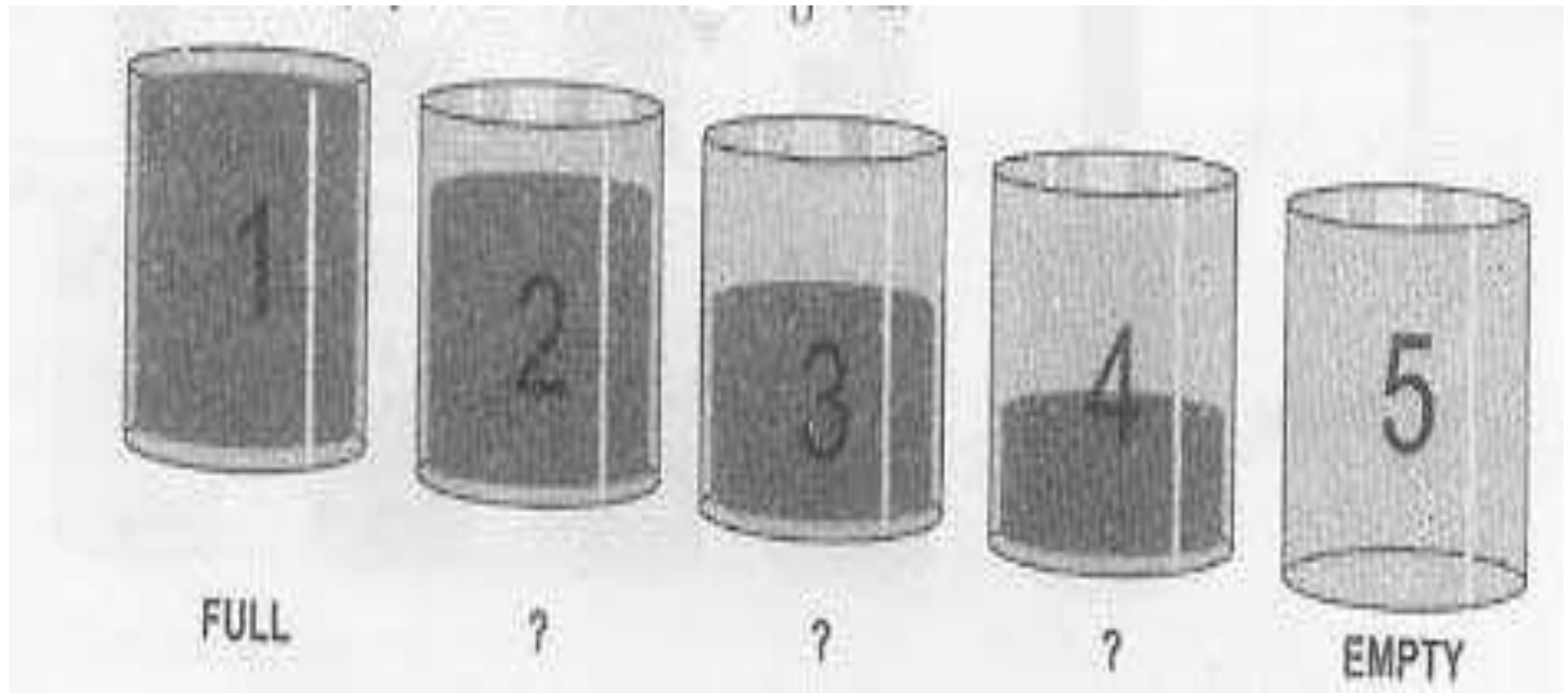# Binary logic Vs. Fuzzy logic

Binary logic (Yes or No)

Human Reasoning /Fuzzy logic (maybe, more or less, very hot, heavy etc.)

Fuzzy sets

- It has an ability to classify elements into a continuous set using the concept of degree of membership.

- Fuzzy set is defined as a set whose elements have degrees of membership.

- The characteristics function or membership function not only gives 0 or 1 but can also give values between 0 and 1.

- Value 0-> non-membership

- Value 1->complete membership

- Value between 0 and 1-> degree of membership

Example of tumblers
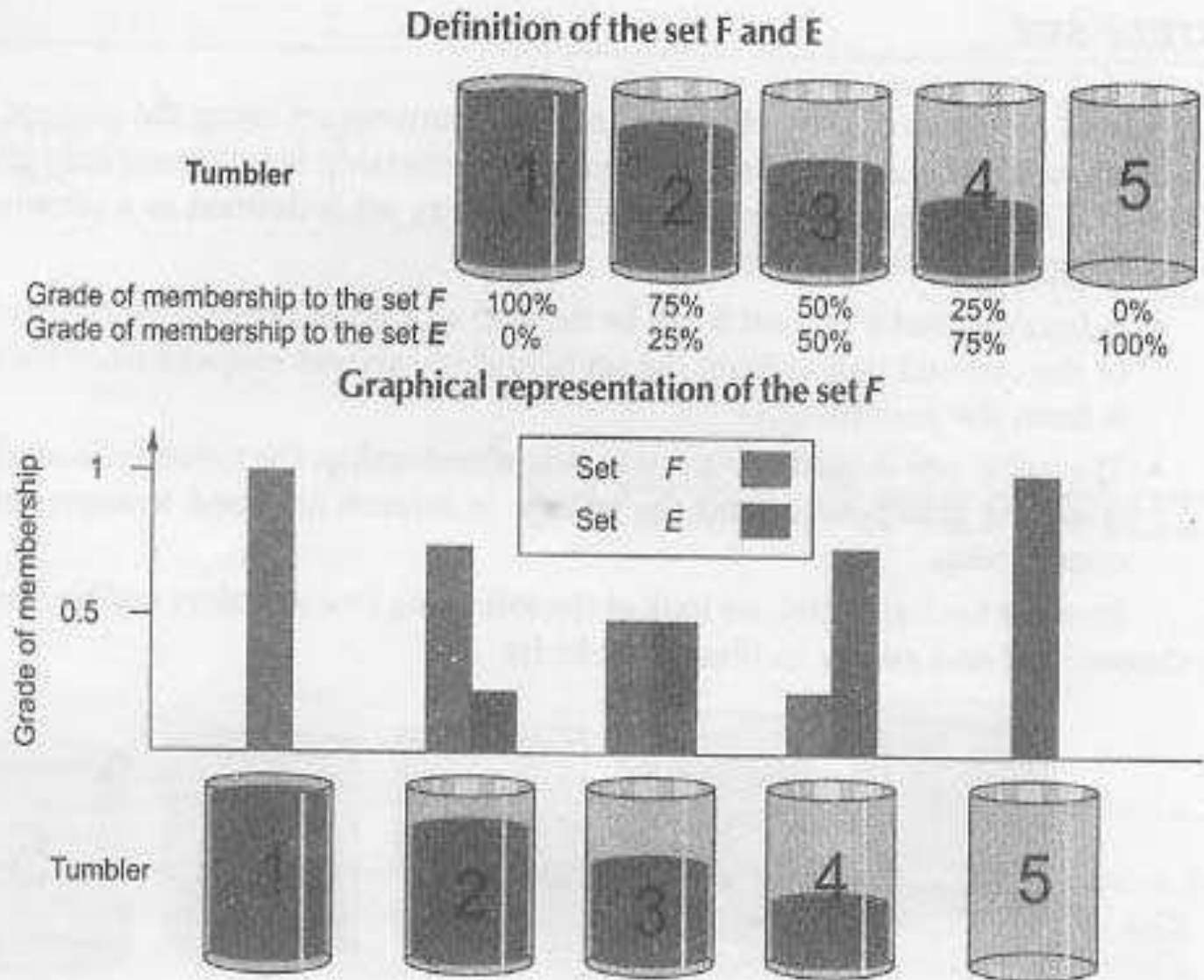

FULL   ?   ?   ?   EMPTY

Example

- There are following five tumblers, divided into two classes: **full and empty.**

- It is obvious: tumbler 1 belongs to the class full and tumbler 5 belongs to the class empty.

- Then tumblers 2, 3 and 4 belongs to which class?

- These tumblers are neither 100% full nor 100% empty.

- In other word we can say that tumbler 2 is 75% full, or 25% empty.

Example

- Now we define two sets: F and E.

- F is the set of all tumblers that belong to the class full.

- E is the set of all tumblers that belong to the class empty.

Graphical representation of sets

Definition of the set F and E

Tumbler

	1	2	3	4	5
Grade of membership to the set F	100%	75%	50%	25%	0%
Grade of membership to the set E	0%	25%	50%	75%	100%

Graphical representation of the set F

Set F
Set E

Fuzzy sets

- The sets F and E have some elements, which have not the full, but a partial membership. Such kind of **non-crisp sets are called fuzzy sets.**

- The set "all tumblers" that is here the basis of the fuzzy sets F and E, is called the **Base set or universe of Discourse.**
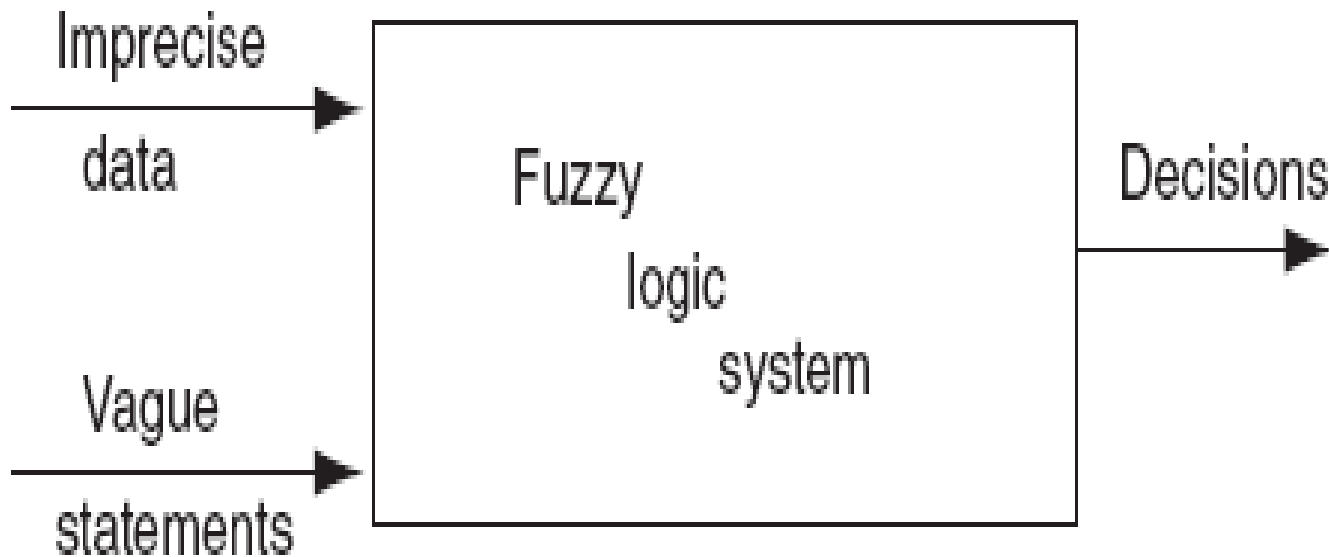
Fuzzy Logic

➤ Basically, Fuzzy Logic is a multivalued logic, that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, etc.

➤ Fuzzy Logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth, i.e. truth values between "completely true" and "completely false".

➤ Fuzzy Logic provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information.

Fuzzy Logic Systems

- A system becomes a fuzzy system when its operations are entirely or partially governed by fuzzy logic or are based on fuzzy sets.

- A fuzzy logic system which accepts imprecise data and vague statements such as low, medium, high and provides decisions.

Fuzzy Logic Systems

Thank you…

Any questions??

My google site