SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution
Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF INFORMATION TECHNOLOGY

19CSE303 – ARTIFICIAL INTELLIGENCE

III YEAR IV SEM

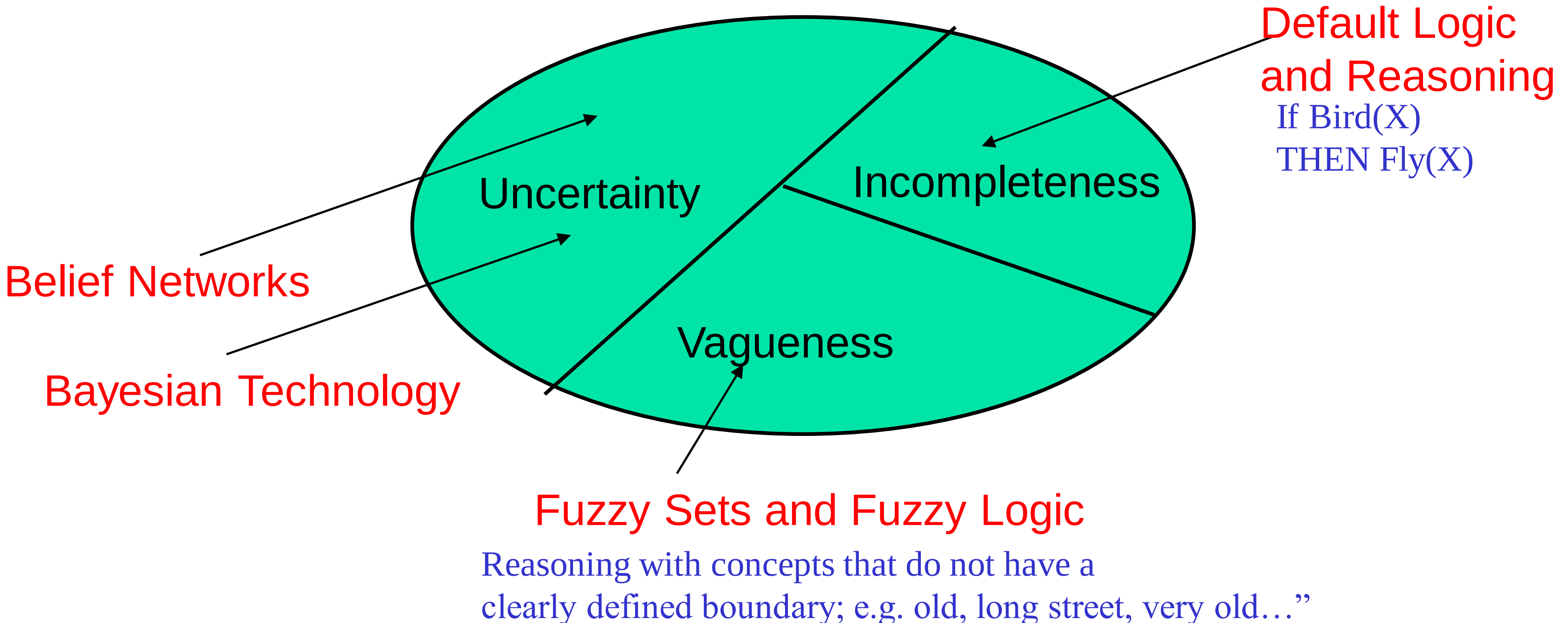
UNIT IV – **UNCERTAIN KOWLEDGE AND REASONING**

TOPIC – **Probability Uncertainty**

Reasoning and Decision Making Under Uncertainty

1. Quick Review Probability Theory
2. Bayes' Theorem and Naïve Bayesian Systems
3. Bayesian Belief Networks
   - Structure and Concepts
   - D-Separation
   - How do they compute probabilities?
   - How to design BBN using simple examples
   - Other capabilities of Belief Network short!
   - Netica Demo
   - Develop a BBN using Netica likely Task6
4. Hidden Markov Models (HMM)

Causes of not knowing things precisely



Random Variable

Definition: A variable that can take on several values, each value having a probability of occurrence.

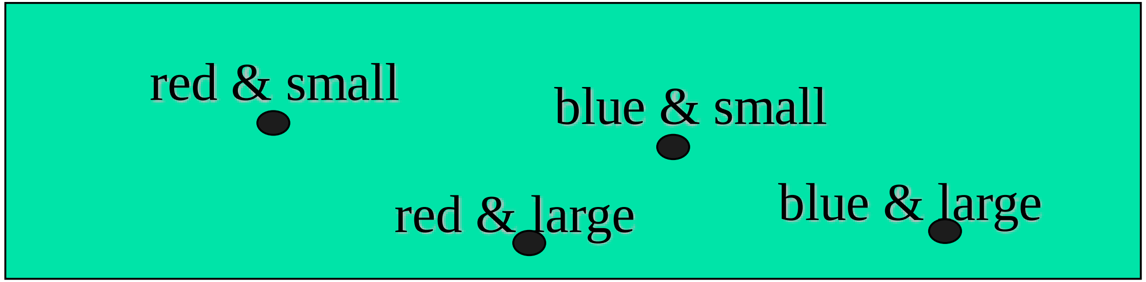
There are two types of random variables:

- Discrete. Take on a countable number of values.
- Continuous. Take on a range of values.

The Sample Space

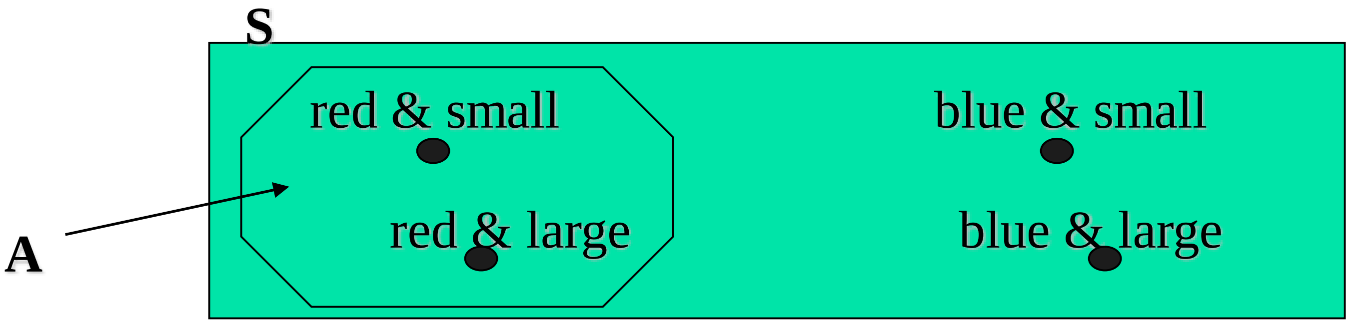
- The space of all possible outcomes of a given process or situation is called the sample space S.

S



An Event

- An event A is a subset of the sample space.



Atomic Event

An atomic event is a single point in S.

Properties:

- Atomic events are mutually exclusive
- The set of all atomic events is exhaustive
- A proposition is the disjunction of the atomic events it covers.

The Laws of Probability

- The probability of the sample space S is 1,
  $P(S) = 1$
- The probability of any event A is such that
  $0 <= P(A) <= 1$.
- Law of Addition

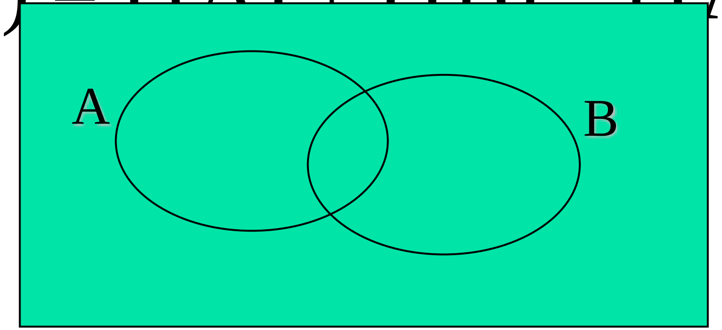
  If A and B are mutually exclusive events, then the probability that either one of them will occur is the sum of the individual probabilities:

  $P(A \text{ or } B) = P(A) + P(B)$

The Laws of Probability

If A and B are not mutually exclusive:

P(A or B) = P(A) + P(B) – P(A and B)



Statistical Independence Example Discussion

- Population of 1000 students
  - 600 students know how to swim (S)
  - 700 students know how to bike (B)
  - 420 students know how to swim and bike (S,B)
  - In general, between … and … can swim and bike
  - $P(S \wedge B) = 420/1000 = 0.42$
  - $P(S) \times P(B) = 0.6 \times 0.7 = 0.42$
  - In general: $P(S \wedge B)=P(S)*P(B|S)=P(B)*P(S|B)$

  - $P(S \wedge B) = P(S) \times P(B)$ => Statistical independence
  - $P(S \wedge B) > P(S) \times P(B)$ => Positively correlated
  - $P(S \wedge B) < P(S) \times P(B)$ => Negatively correlated
  - $\max(0, P(S)+P(B)-1) \leq P(S \wedge B) \leq \min(P(S),P(B))$

Conditional Probabilities and P(A,B)

- Given that A and B are events in sample space S, and P(B) is different of 0, then the conditional probability of A given B is

$$P(A|B) = P(A,B) / P(B)$$

- If A and B are independent then $P(A,B)=P(A)*P(B) \rightarrow P(A|B)=P(A)$
- In general:

$$\min(P(A),P(B)) \geq P(A)*P(B) \geq \max(0,1-P(A)-P(B))$$

For example, if P(A)=0.7 and P(B)=0.6 then P(A,B) has to be between 0.3 and 0.6, but not necessarily be 0.42!!

The Laws of Probability

- Law of Multiplication

  What is the probability that both A and B occur together?

$$P(A \text{ and } B) = P(A) \ P(B|A)$$

where $P(B|A)$ is the probability of B conditioned on A.

The Laws of Probability

If A and B are statistically independent:

$P(B|A) = P(B)$ and then

$P(A \text{ and } B) = P(A)\, P(B)$

Independence on Two Variables

$P(A,B|C) = P(A|C)\ P(B|A,C)$

If A and B are conditionally independent:

$P(A|B,C) = P(A|C)$ and

$P(B|A,C) = P(B|C)$

Multivariate Joint Distributions

$P(x,y) = P(X = x \text{ and } Y = y)$.

- $P'(x) = \text{Prob}(X = x) = \sum_y P(x,y)$
  It is called the marginal distribution of X
  The same can be done on Y to define
  the marginal distribution of Y, $P''(y)$.

- If X and Y are independent then
  $P(x,y) = P'(x)\, P''(y)$

Bayes' Theorem

P(A,B) = P(A|B) P(B)
P(B,A) = P(B|A) P(A)

The theorem:

$$\boxed{P(B|A) = P(A|B)*P(B) / P(A)}$$

Example: P(Disease|Symptom)= P(Symptom|Disease)*P(Disease)/P(Symptom)

THANK YOU