Introduction to Artificial Intelligence

Jaderick P. Pabico
Institute of Computer Science, College of Arts and Sciences
University of the Philippines Los Baños, College 4031, Laguna

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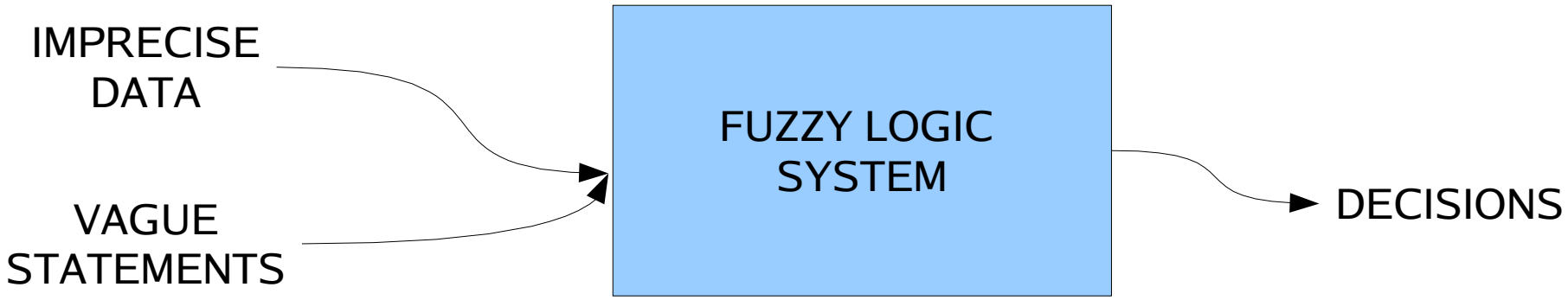
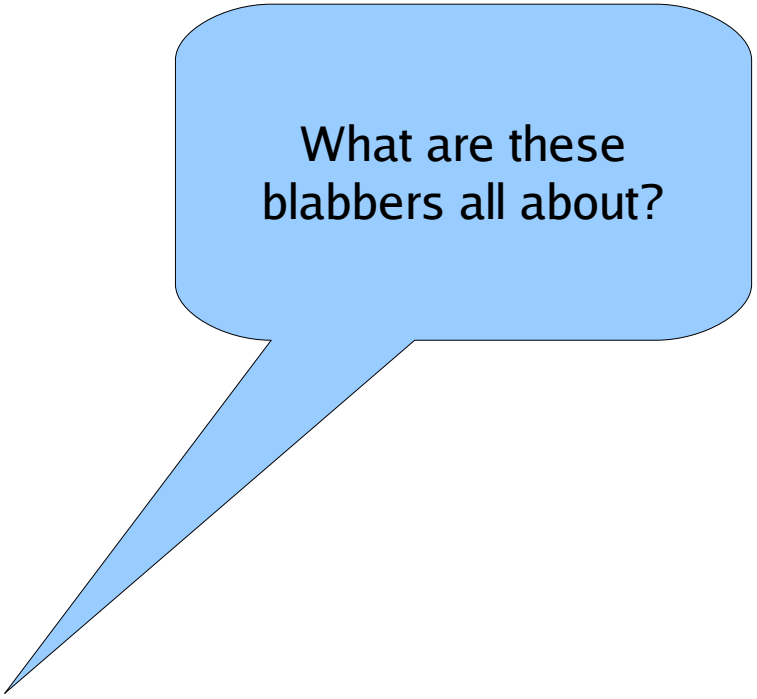
Fuzzy Logic System

- Fuzzy sets provide means to model the uncertainty associated with vagueness, imprecision and lack of information regading a problem



Fuzzy Operations

- How do we do operations in classical sets?
- Example X = {1, 2, 3, 4}
- What are X's
  - cardinal number?
  - power set?
  - cardinality of power set?



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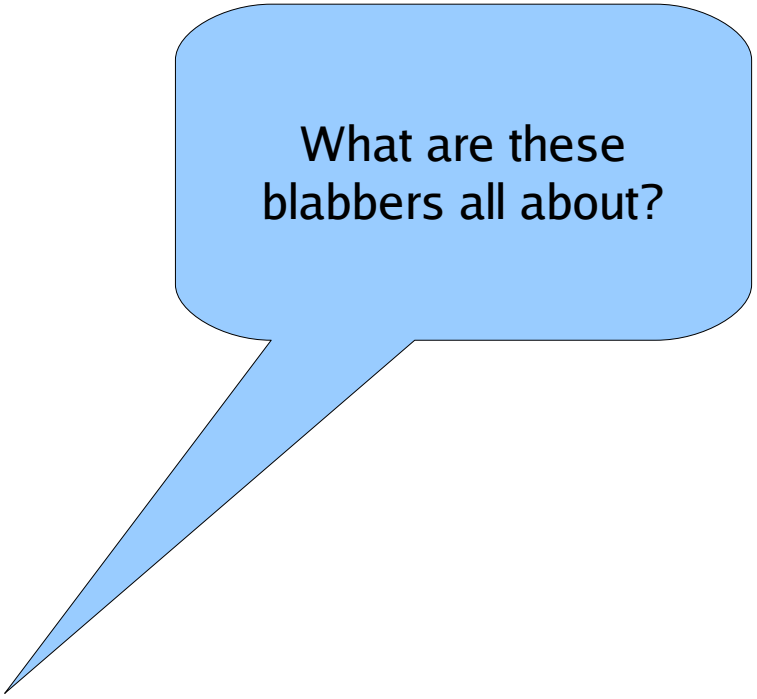


Fuzzy Operations

- cardinal number?
  - Number of elements in X
  - The number of elements in X = {1, 2, 3, 4} is 4
  - Thus the cardinality N_X of X is 4

Cardinal is just one step below a Pope!

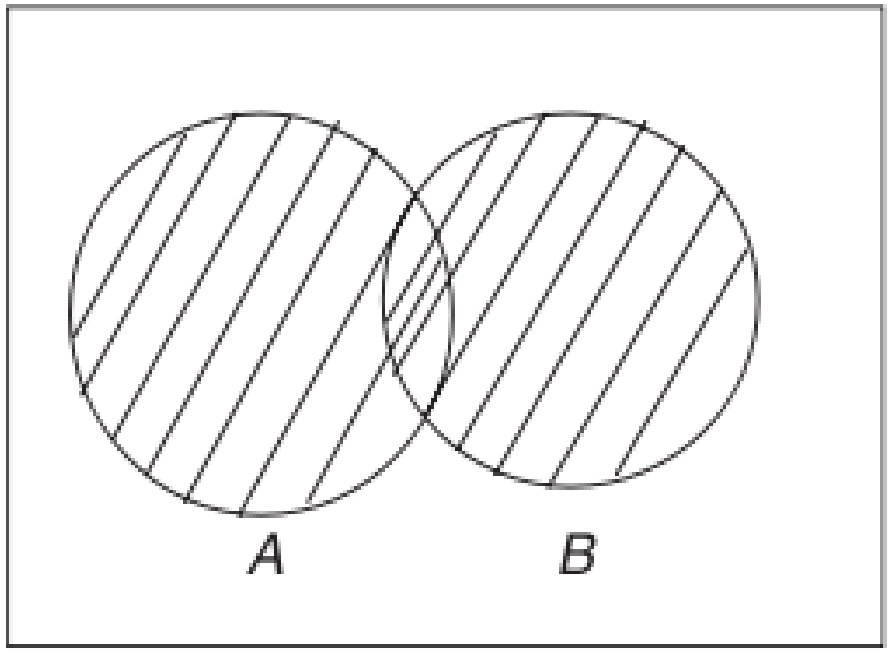
The cardinality of the set of cardinals in the picture is three!

Fuzzy Operations

- Power set?
  - All possible sets of X
  - {}, {1}, {2}, {3}, {4}, {1,2}, {1,3}, {1,4}, {2,3}, {2,4}, {3,4}, {1,2,3}, {1,2,4}, {1,3,4}, {2,3,4}, {1,2,3,4}
- Cardinality of Power Set of X?
  - 2 raised to N_X
  - Thus, $2^4 = 16$

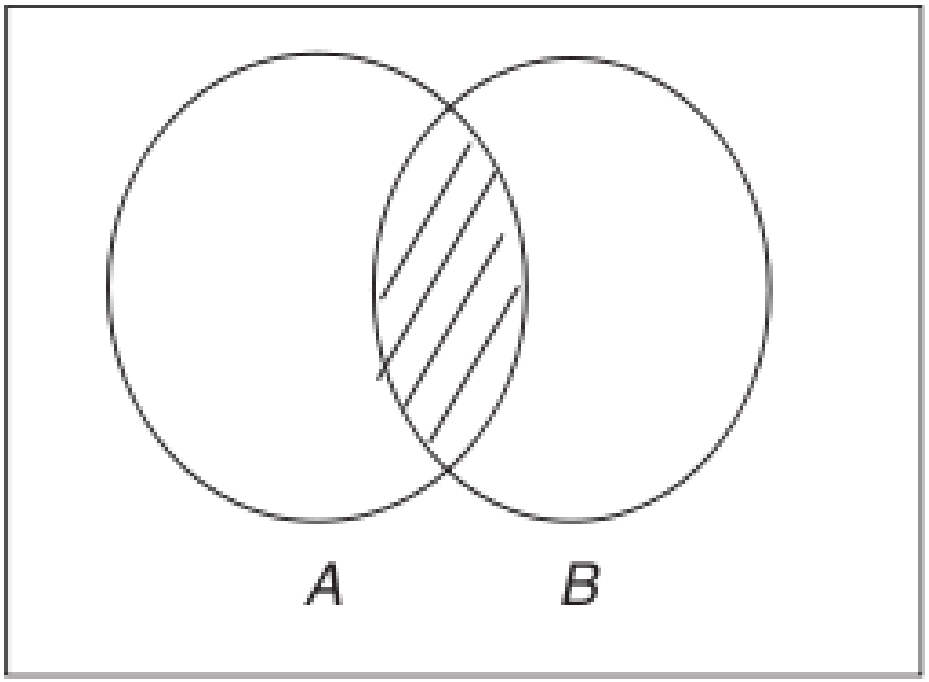
Fuzzy Operations

- Classical set operation: Union
  - $\boldsymbol{A} \cup \boldsymbol{B}$
  - Similar to Logical Or



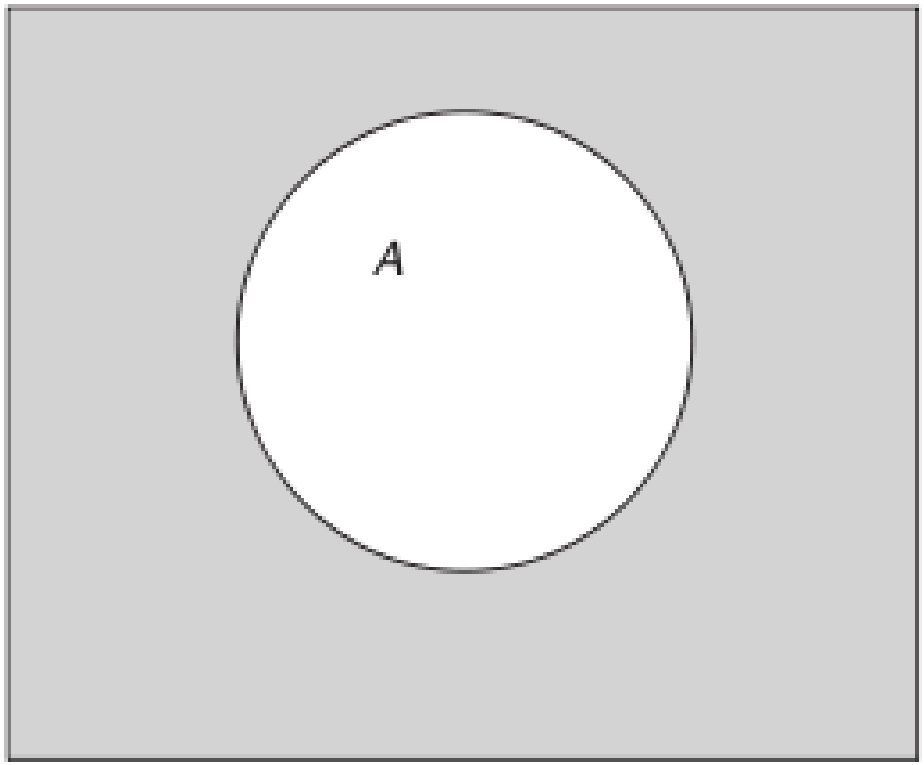
Fuzzy Operations

- Classical set operation: Intersection
  - $\boldsymbol{A \cap B}$
  - Similar to Logical And



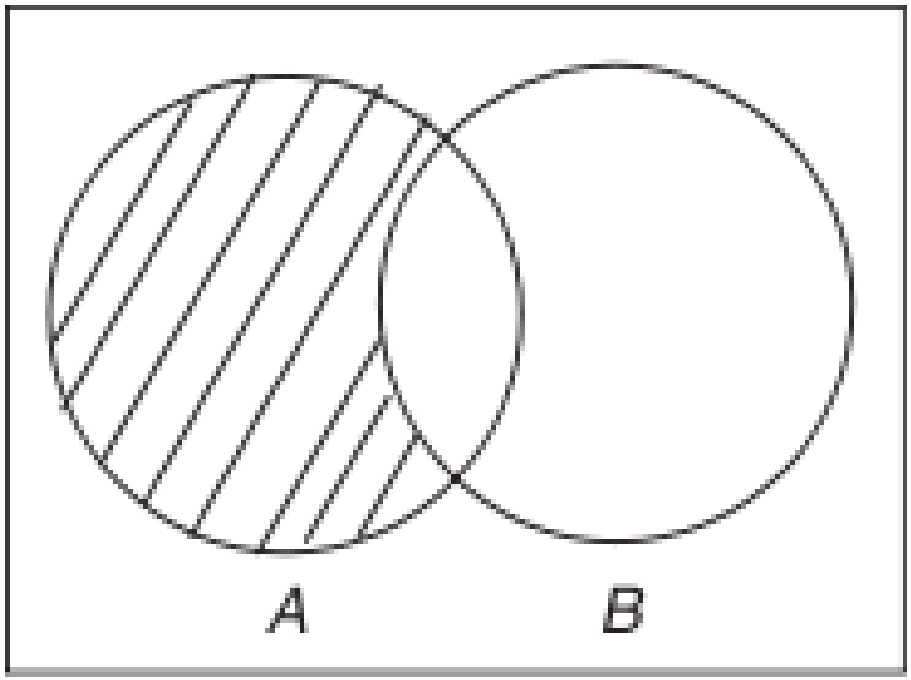
Fuzzy Operations

- Classical set operation: Complement
  - $\neg A$
  - Similar to Logical Not



Fuzzy Operations

- Classical set operation: Difference
  - ***A*** | ***B***
  - Elements that are simultaneously in ***A*** but not in ***B***

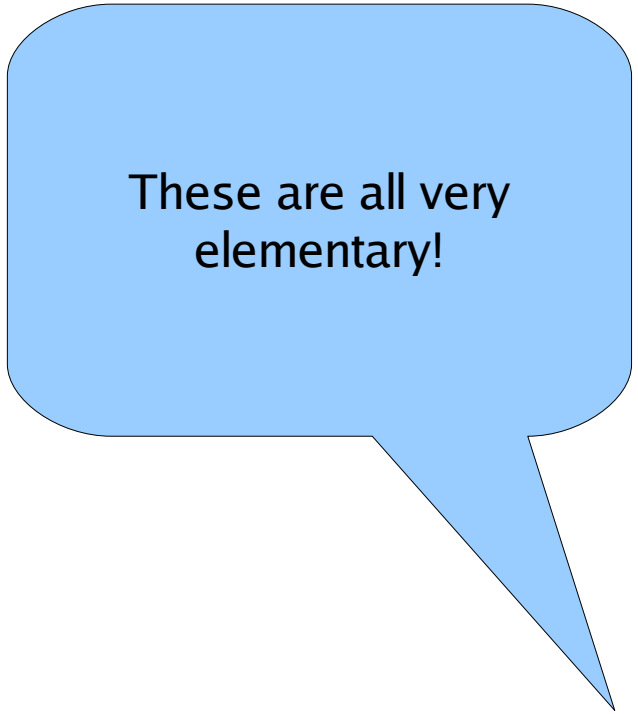


Fuzzy Operations

- Classical set property:
  - Commutativity
    - $A \cup B = B \cup A$
    - $A \cap B = B \cap A$
  - Associativity
    - $A \cup (B \cup C) = (A \cup B) \cup C$
    - $A \cap (B \cap C) = (A \cap B) \cap C$
  - Distributivity
    - $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$
    - $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$

Fuzzy Operations

- Classical set property:
  - Idempotency
    - $A \cup A = A$
    - $A \cap A = A$
  - Identity
    - $A \cup \{\} = A$
    - $A \cap U = A$
    - $A \cap \{\} = \{\}$
    - $A \cup U = U$
  - Transitivity
    - If $A \subseteq B \subseteq C$, then $A \subseteq C$



Fuzzy Operations

- Classical set property:
  - Excluded Middle Law
    - $A \cup \neg A = U$
  - Contradiction Law
    - $A \cap \neg A = \{\}$
  - De Morgan's Law
    - $\neg(A \cap B) = \neg A \cup \neg B$
    - $\neg(A \cup B) = \neg A \cap \neg B$

Don't need to go to law school do learn this!