Fuzzy

Fuzzy and Crisp

- Crisp Set
  - Has only 0 and 1 values
  - clear boundary
- Fuzzy Set
  - Has values b/w 0 and 1
  - no clear boundary

Membership Function

- Tells about the degree of belonging in the fuzzy set ### Features of Membership function
- Boundry Part
- Core Part
- Support Part

Operation and Properites

Operations and Properties of a classical set

- Operation on a classical set
  - Union
  - Intersection
  - Compliment
  - Set Difference
- Properties of a classical Set
  - Commutavity
    - AUB = BUA
  - Associativity
    - (AUB)UC = AU(BUC)
  - Distrubitivity
    - AdisBUC = (AdisB) U (AdisC)
  - Idempotency
    - AUA = A
  - Cardinality
    - It is the number of elements in a set nx
    - **Cardinality of the power set of a set with nx elements in** $2^n x$

Operations and Properties of Fuzzy Set

- Operation on Fuzzy Set
  - Compliment
    - 1 - (element value)
  - Union
    - max of both the values
  - Intersection
    - min of both the values

Relations

Crisp Relations

- The crisp relations are defined in 0 and 1
- Relation matrix b/w 2 crisp sets can be represented as 0 is there is no relation b/w the row and the col
- 1 if there is a relationship b/w the row and the column
- The relationship matrix b/w the crisp relations is obtained by cartesian product itself

Cardinality of Crisp Relations

- If the cardinality of the set1 is n_x and the cardinality of set2 is n_y
- Then the cardinality of the relation R b/w these 2 universes is nxy = nx * ny
- The cardinality of the power set describing the relation is $2^(nxny)$

Fuzzy Relations

- In real life the relations can be represented by fuzzy values
- Fuzzy Relation are one kind of fuzzy set

Operations on Fuzzy Relations

- Therefore you can apply operation on those fuzzy relation
- Union
- Intersection
- Complement
- Containment (FLAG101)

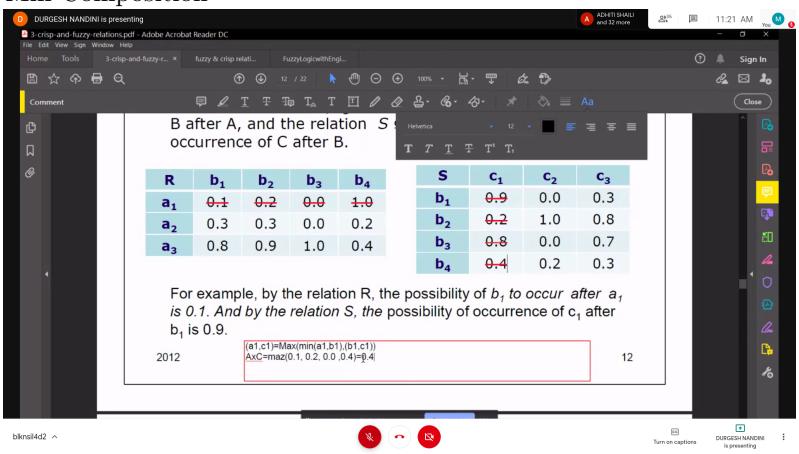
- Extra Properties (Other than Fuzzy Sets)
  - Sum
    - A + B = Max[aij,bij]
  - Max Product
    - A.B = AB = Max[Min(aik,bjk)]
  - Scalar Product
    - lambda * a

To form relation from two fuzzy sets

- Cartesian Product
  - Multiply the two sets and min of the values in the set
  - P[x][y] = min(u_a(x),u_b(x))

Composition of fuzzy relations

- Max Min Composition



- Max Product Composition
  - Instead of finding the min of the values , we will multiply them

Properties of Relation Matrices

- Reflexitivity
  - xr(xi,xi) = 1
- Symmetry
  - xr(yi,xi) = xr(xi,yi)
- Transitivity (Crisp)
  - xr(xi,xj) and xr(xj,xk) = 1 -> xr(xi,xk) = 1
- Transitivity (Fuzzy)

  - x2,x5 >= min((x2,x1) and (x1,x5))

Types of fuzzy Relations

- Check in the relation Matrices for these properties
- Equivalence
  - All three relations will hold
- Tolerance
  - Reflexivity
  - Symmetry

/alpha **cuts for fuzzy relations**

- **Basically saying that if 2 elements are highly related then they are connected**
- like defuzzification of fuzzy relations
- certain value below which the value of the fuzzy is approximated to zero
- above values are approximated to 1
- thus the fuzzy set is approximated to a crisp set

Similarity Methods in Matrices

- Cosine Methods
  - rij = $/sumk = 1mx_ikx_jk$
  - $(/sumk = 1m(x_ik)^2/sumk = 1m(x_ik)^2)^(1/2)$
- Max-Min Methods
  - $/sumk = 1mmin(x_ik, x_jk)$
  - $/sumk = 1mmax(x_ik, x_jk)$
    - where i,j = 1,2 . . . . . ,n

Convex Fuzzy Set

- Whose values are strictly monotically increasing or monotically descreasing

Arithemetic Operation

Fuzzy Sets

- Addition
- Subtraction
- Multiplication
- Division

Cont Fuzzy Sets

Fuzzy Number

- A fuzzy number is a fuzzy set
- It should be convex
- If it's normalized
- It's MF is peicewise continous

Arithemetic Operation of Fuzzy No.

Defuzzification

- It is the conversion of a fuzzy quantity to a precise quantity
- Methods
  - Max Membersip Function
    - Simply Replace the set with the max value
  - Centroid Average Method
    - Integral uc(x).x.dx/Intergral uc(x).dx
  - Weighted Average Method
    - Find the peak value in the set and where is the peak
    - weighted avg = (pk1*v1 + pk2*v2 + pk3*v3)/(v1+v2+v3)