SYSTEMS ANALYSIS LECTURE 9 – GENETIC CODE, FUZZY LOGIC

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Genetic code

- In the system there are some processes functioning more efficiently than the others (system has dispostion („genetic“ dispositions) for these processes
- When activating these kind of processes (according genetic code), strong functions are activated
- Typical processes – can be found in most of partial behaviour
- Typical behaviour (containing typical processes) – genetic code

Genetic code identification

- F_T can be found as intersection of partial behaviours using e.g. standard behaviour matrixes SDi

  $\mathbf{F_T = \cap_{\forall i} F_i}$

- Often there is no intersection of all partial behaviours, solution:
  - Decrease of the condition – not looking for the same process in all partial behaviours, but only e.g. in 90% of behaviours, 80%, etc.
  - Include process frequencies, weight of processes
  - Or to declare the GC process with the highes number of strong functions

Behaviour types in relation to the genetic code

- Ideal
- Normal
- Adaptive
- Mutative
- Degenerative

Analysis of variations from the genetic code (in general distance of processes)

- Structural analysis – how the processes differ
- Dynamic analysis – number of necessary steps to change the process to the genetic code
- Goal analysis

Other tasks

- Aging
- Depriciation

Further tools for systems description

Fuzzy sets

Fuzzy logic vs. standard logic

Standard logic

– two states

- true/false
- 1/0
- ...

In real world cannot be used all the times

Fuzzy logic

- How much system belongs

Fuzzy logic history

Aristotle x Platon

19. century – George Boole – two-value logic (0-no, 1-yes) – standard logic

Beginning of 20. century – Jan Lukasiewicz – three-value logic (was not used)

1965 – Lofti A. Zadeh – fuzzy sets

Origin of fuzzy logic

- Traditional computer logic has difficulties to process data represented by subjective and vague terms
- Fuzzy logic should bring the computers near the typical human thinking
- At the beginning fuzzy logic was meant for usage in humanities, although finally the most important usage is in control theory
- First fuzzy logic was accepted in Japan and other asian countries, Europe and Amarica accepted it afterwards
- Nowadays fuzzy logic is widely used in many kinds of electric and electronic devices

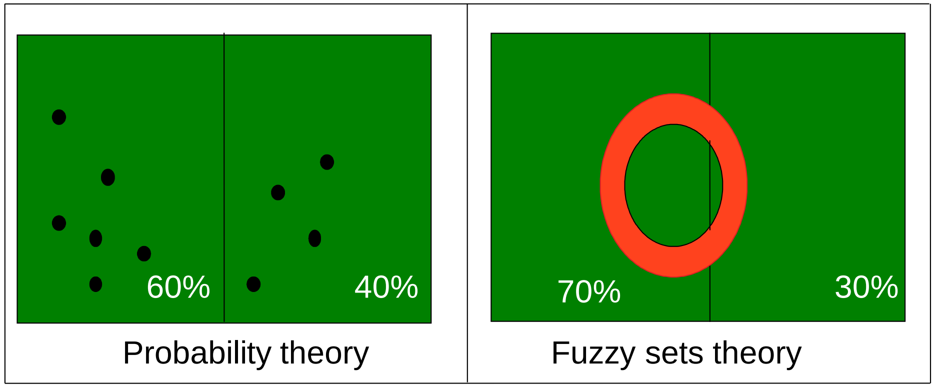
Fuzzy logic

Fuzzy set definition

$A=\{(x,\mu_A(x)):x\in X\}$

- x is element from set X
- $\mu_A(x)$ is grade of membership
- membership function has values in [0, 1] ($\mu \in$ <0,1> (0- definitely not belongs, 1 – definitely belongs)

Fuzzy logic vs. Probability theory



- Probability – results of many experiments
- Fuzzy – result of one attempt with ambiguous result

Fuzzy operations

In standard logic – complement, intersection, union

Standard fuzzy set operations:

Standard complement $\mu_{A'}(x) = 1 - \mu_A(x)$

Standard intersection $\mu_{(A \cap B)}(x) = \min[\mu_A(x), \mu_B(x)]$

Standard union $\mu_{(A \cup B)}(x) = \max[\mu_A(x), \mu_B(x)]$

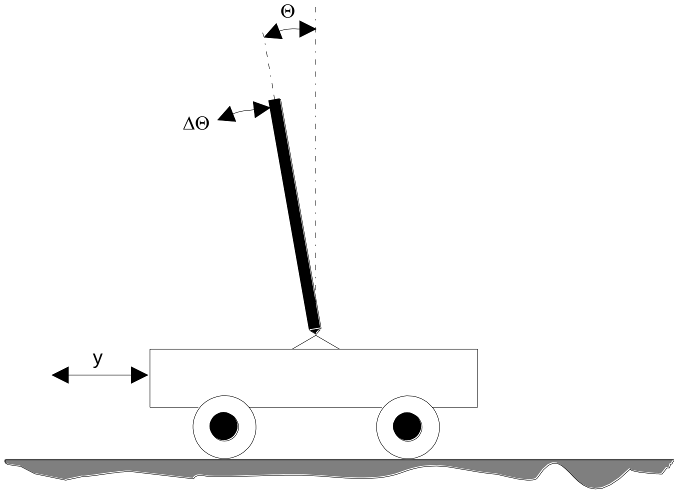
In fuzzy logic these are not the only possibilities.

There can be more functions (so called s-norm and t-norm) that have similar usage.

They have to fulfil several axioms

Typical example

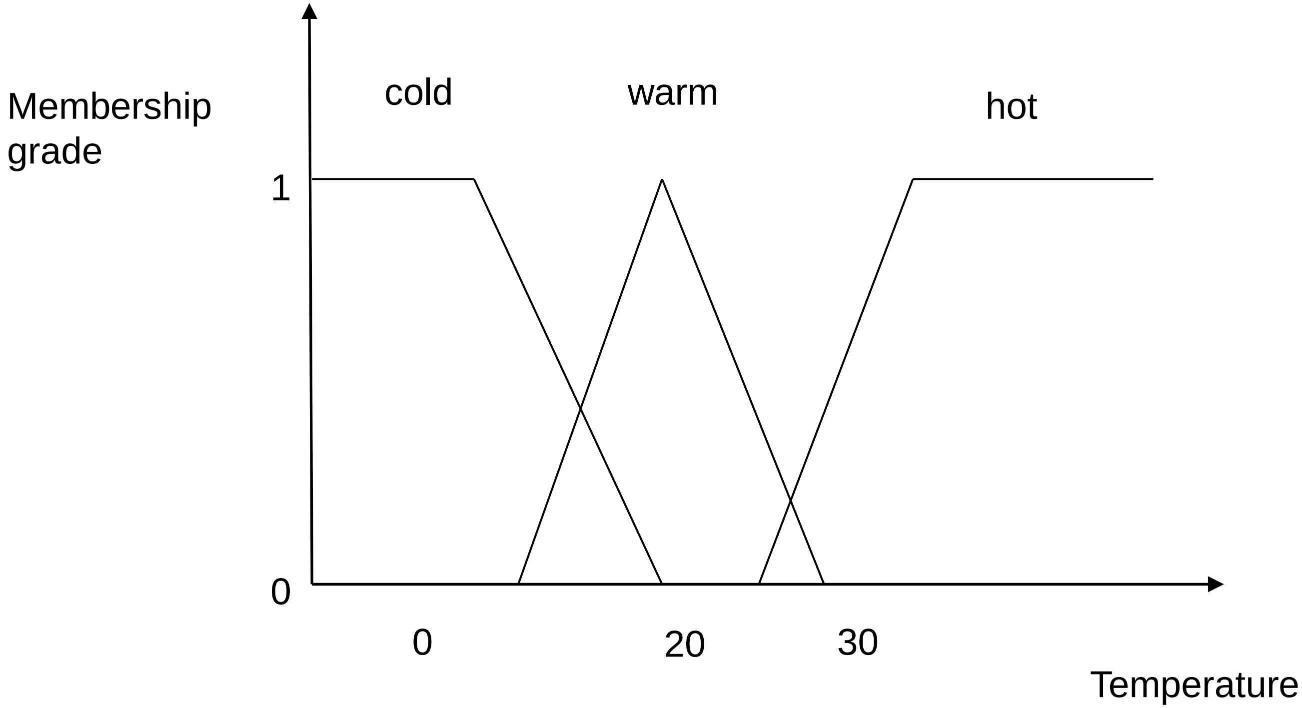
- Mathematical description is complicated
- Man can operate such system easily



Fuzzy linguistic variable

- Variable that contain values from language (either natural of artificial)
- Definition (L,T, X, G, M)
  - L label of the variable
  - T – set of possible terms (linguistic values – e.g. positive, negative)
  - X – universum, where the terms are defined (e.g. 0 – 100)
  - G – syntactic rules
  - M – semantic rules - meaning

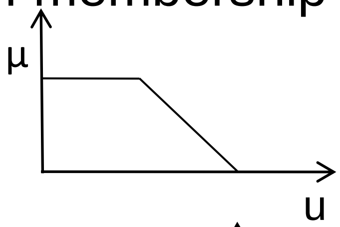
Fuzzy linguistic variable - example



Fuzzy sets – theory

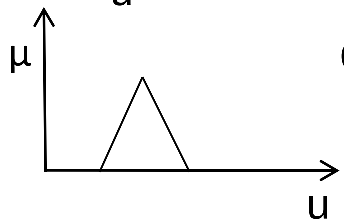
Different shapes of membership functions

- L-function



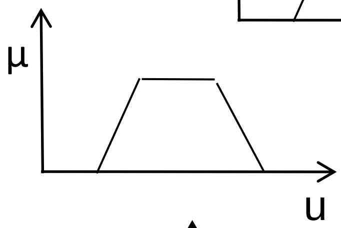
e.g. less and little larger than X

- Λ-function (lambda)



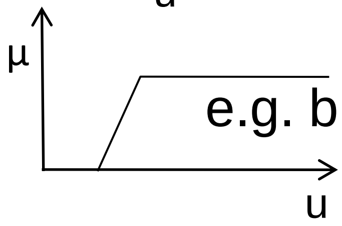
e.g. around X

- Π-function



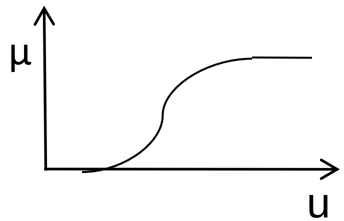
e.g. approximately in 1960s

- Γ-function (gamma)



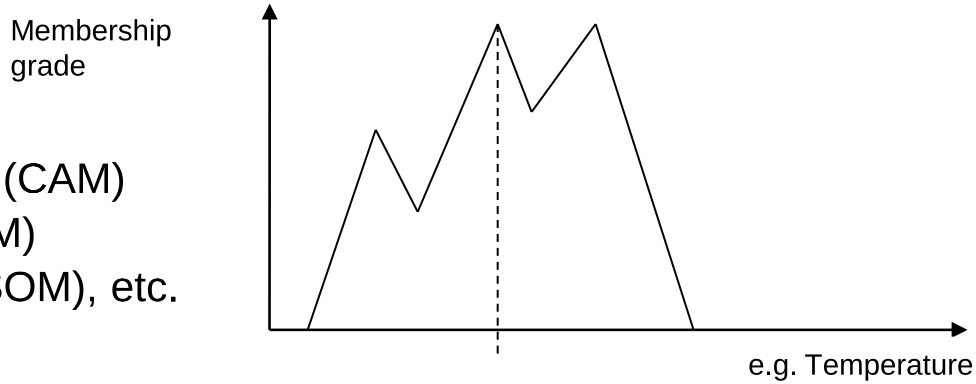
e.g. bigger or a little less than X

- S-function



Fuzzyfication and defuzzyfication

- Defuzzyfication
  - method for transforming fuzzy values to exact values
  - Several possibilities
    - Centroid Average (CA)
    - Center of Sum (COS)
    - Center Average Method (CAM)
    - Mean of Maximum (MOM)
    - Smallest of Maximum (SOM), etc.



- Fuzzyfication
  - Tranferring verbal values (e.g. high temperature) into quantificated scale
  - Basics for covering universum with fuzzy sets
  - Choose odd number of sets covering the universum (usually 3,5,7 or 9)
  - Or creating sets form data – e.g. using cluster analysis