FUZZY LOGIC

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A TIMES GROUP INITIATIVE

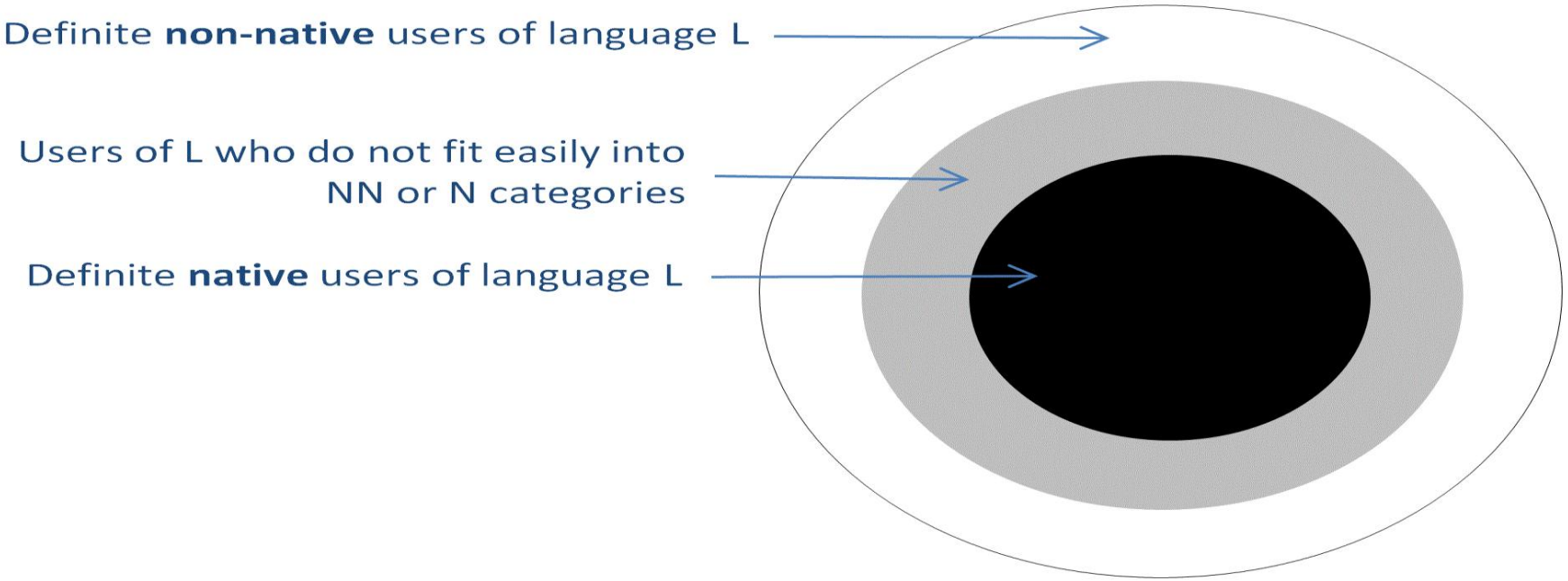
OVERVIEW

- What is Fuzzy Logic?
- Where did it begin?
- Membership Functions
- Fuzzy Logic vs. Neural Networks
- Fuzzy Logic in Control Systems
- Fuzzy Logic in Real Time Example
- Future

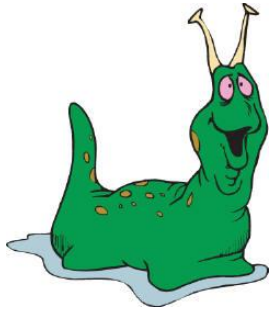

YES-NO
YES-NO
YES-NO
YES-NO
FUZZY LOGIC
more or less, rather, not very many

WHAT IS FUZZY LOGIC?

- Definition of fuzzy
  - Fuzzy – “not clear, distinct, or precise; blurred”
- Definition of fuzzy logic
  - A form of knowledge representation suitable for notions that cannot be defined precisely, but which depend upon their contexts.


Definite **non-native** users of language L
Users of L who do not fit easily into NN or N categories
Definite **native** users of language L

TRADITIONAL REPRESENTATION OF LOGIC



Slow

Speed = 0

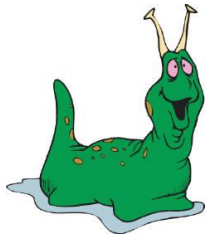
Fast

Speed = 1

```
bool speed;
get the speed
if ( speed == 0) {
//  speed is slow
}
else {
//  speed is fast
}
```

FUZZY LOGIC REPRESENTATION

- For every problem must represent in terms of fuzzy sets.
- What are fuzzy sets?



Slowest

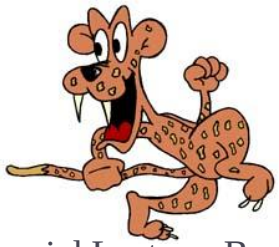
[0.0 – 0.25]

Slow

[0.25 – 0.50]

Fast

[0.50 – 0.75]



Fastest

[0.75 – 1.00]

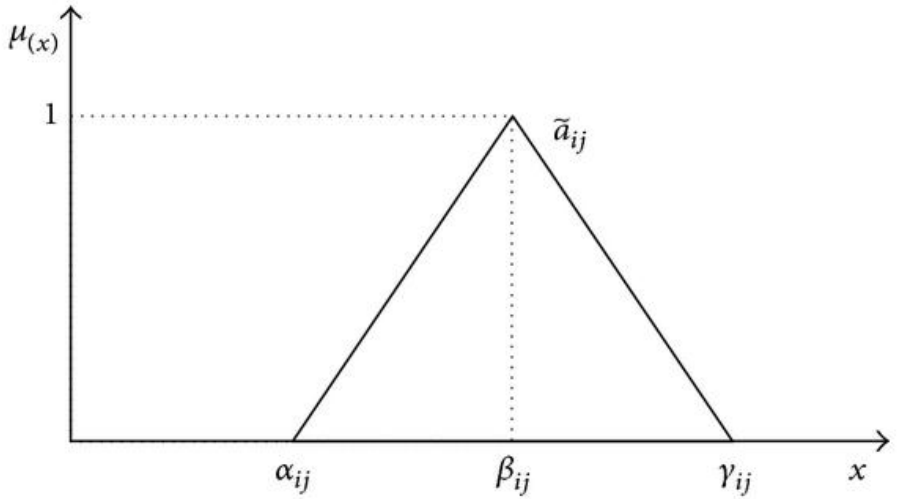
FUZZY LOGIC REPRESENTATION CONT.

Slowest Slow Fast Fastest

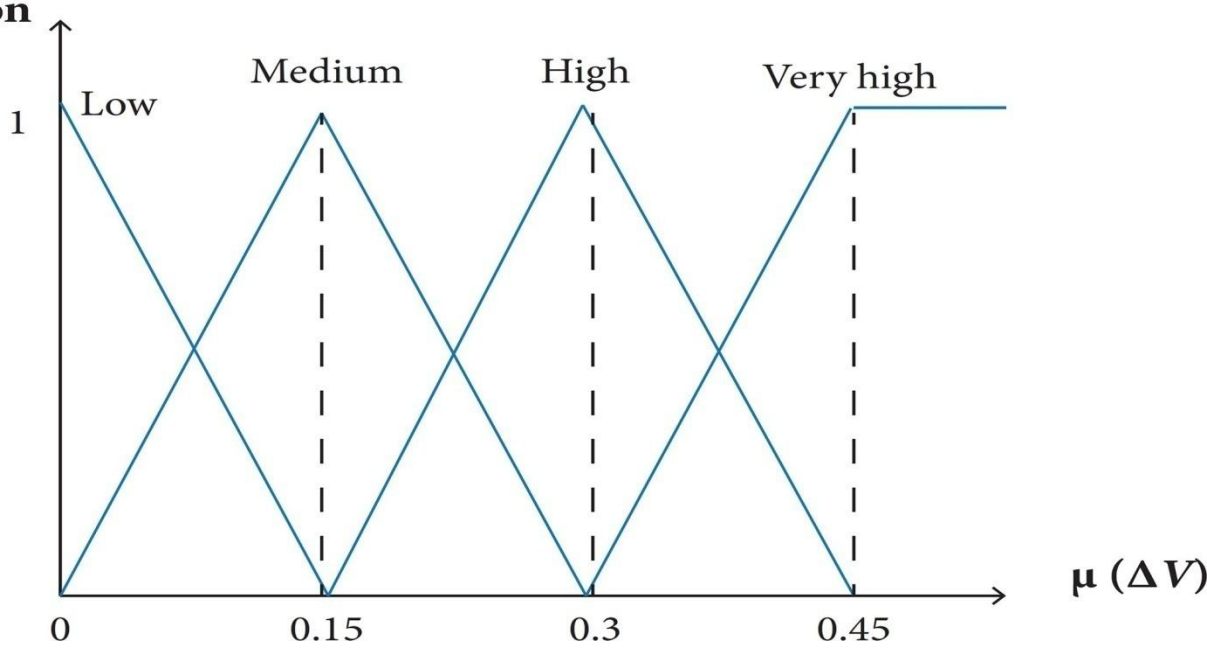
```
float speed;
get the speed
if ((speed >= 0.0)&&(speed < 0.25)) {
//  speed is slowest
}
else if ((speed >= 0.25)&&(speed < 0.5))
{
//  speed is slow
}
else if ((speed >= 0.5)&&(speed < 0.75))
{
//  speed is fast
}
else // speed >= 0.75 && speed < 1.0
{
//  speed is fastest
}
```

ORIGINS OF FUZZY LOGIC

- Traces back to Ancient Greece
- Lotfi Asker Zadeh (1965)
  - First to publish ideas of fuzzy logic.
- Professor Toshire Terano (1972)
  - Organized the world's first working group on fuzzy systems.
- F.L. Smidth & Co. (1980)
  - First to market fuzzy expert systems.



Membership function



FUZZY LOGIC VS. NEURAL NETWORKS

- How does a Neural Network work?
- Both model the human brain.
  - Fuzzy Logic
  - Neural Networks
- Both used to create behavioral systems.

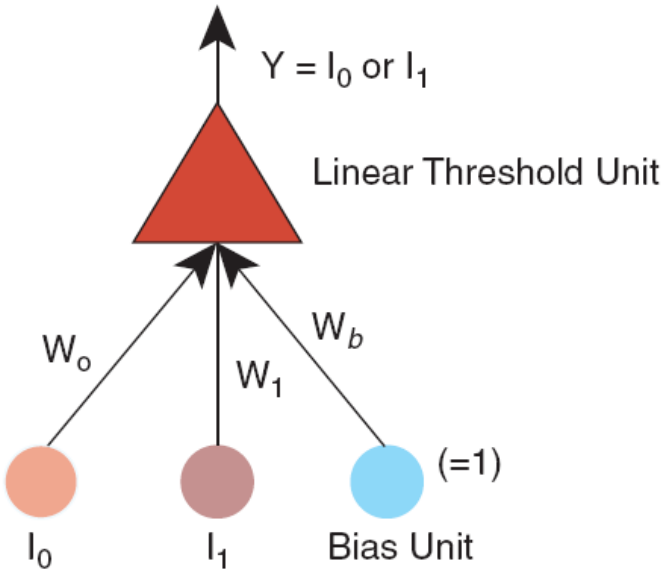


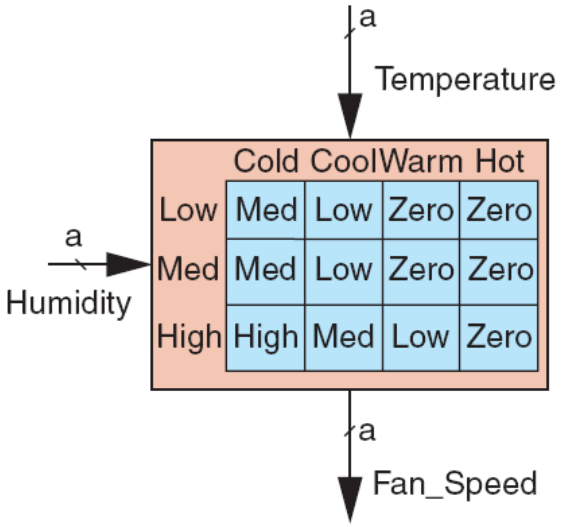
Fig. 2 A simple, single-unit adaptive network

FUZZY LOGIC IN CONTROL SYSTEMS

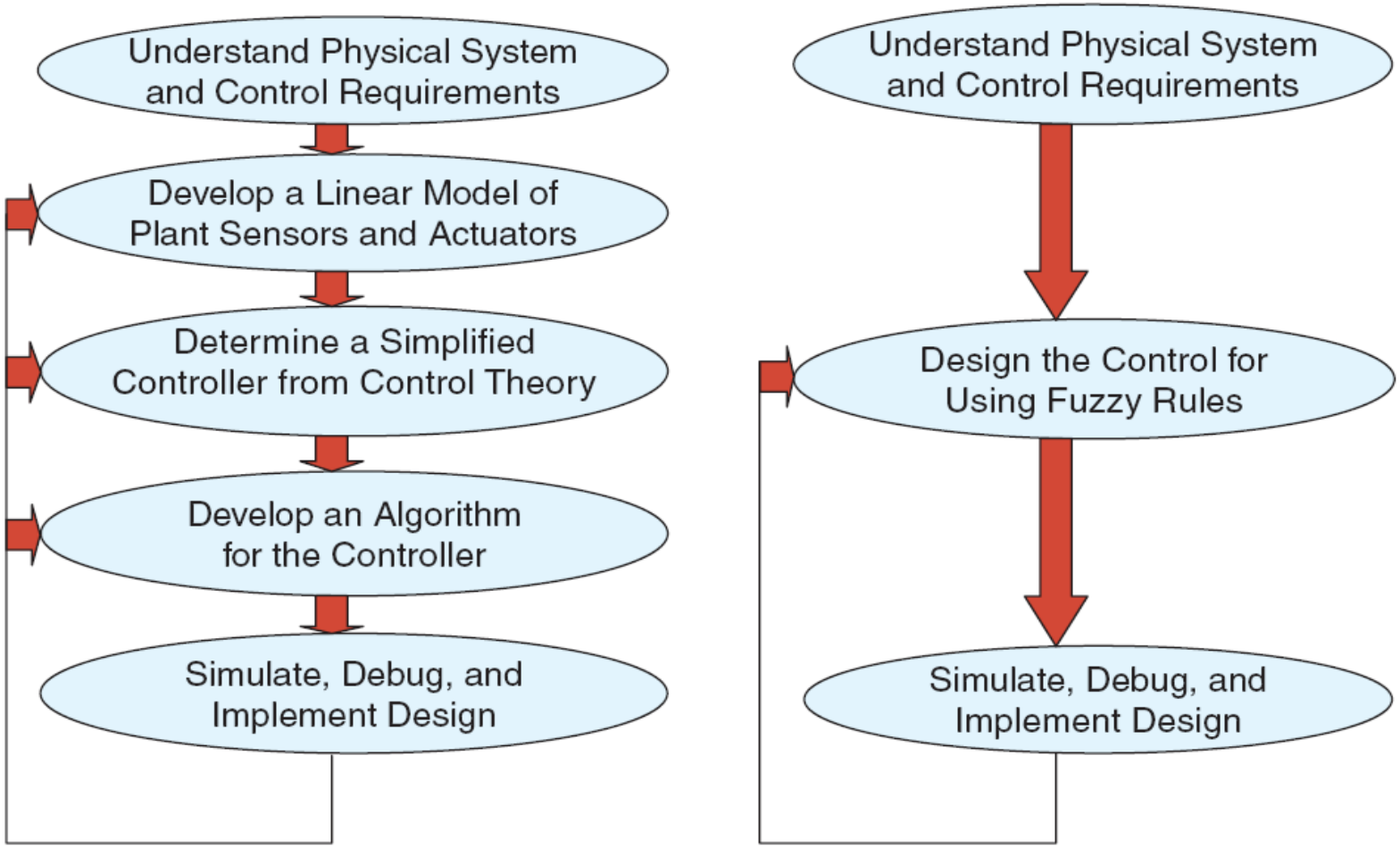
- Fuzzy Logic provides a more efficient and resourceful way to solve Control Systems.
- Some Examples
  - Temperature Controller
  - Anti – Lock Break System (ABS)

TEMPERATURE CONTROLLER

- The problem
  - Change the speed of a heater fan, based off the room temperature and humidity.
- A temperature control system has four settings
  - Cold, Cool, Warm, and Hot
- Humidity can be defined by:
  - Low, Medium, and High
- Using this we can define the fuzzy set.



BENEFITS OF USING FUZZY LOGIC



ANTI LOCK BREAK SYSTEM (ABS)

- Nonlinear and dynamic in nature
- Inputs for Intel Fuzzy ABS are derived from
  - Brake
  - 4 WD
  - Feedback
  - Wheel speed
  - Ignition
- Outputs
  - Pulsewidth
  - Error lamp

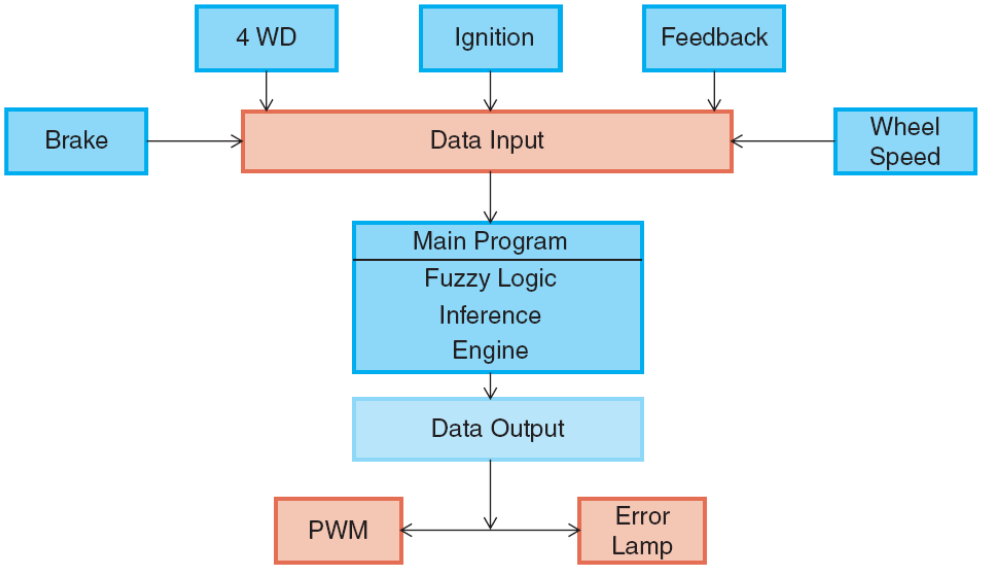


Fig. 6 ABS block diagram

FUZZY LOGIC IN OTHER FIELDS

- Business
- Hybrid Modeling
- Expert Systems

Clone Project:

https://github.com/arunpandianj/bennett_fuzzy_example

Self Assessments:

- Traditional set theory is also known as Crisp Set theory. (True / False)
- Fuzzy logic is extension of Crisp set with an extension of handling the concept of Partial Truth. (True / False)
- Japanese were the first to utilize fuzzy logic practically on high-speed trains in Sendai. (True / False)
- Fuzzy logic is a form of _____.
- The values of the set membership is represented by_____.

CONCLUSION

- Fuzzy logic provides an alternative way to represent linguistic and subjective attributes of the real world in computing.
- It is able to be applied to control systems and other applications in order to improve the efficiency and simplicity of the design process.

Next Session:

- Challenges in Fuzzy Logics
- More Membership Functions
- Fuzzy Set representation
- Neuro - Fuzzy systems
- Case study: Fuzzy @ MATLAB

QUESTIONS?