Introduction to Artificial Intelligence

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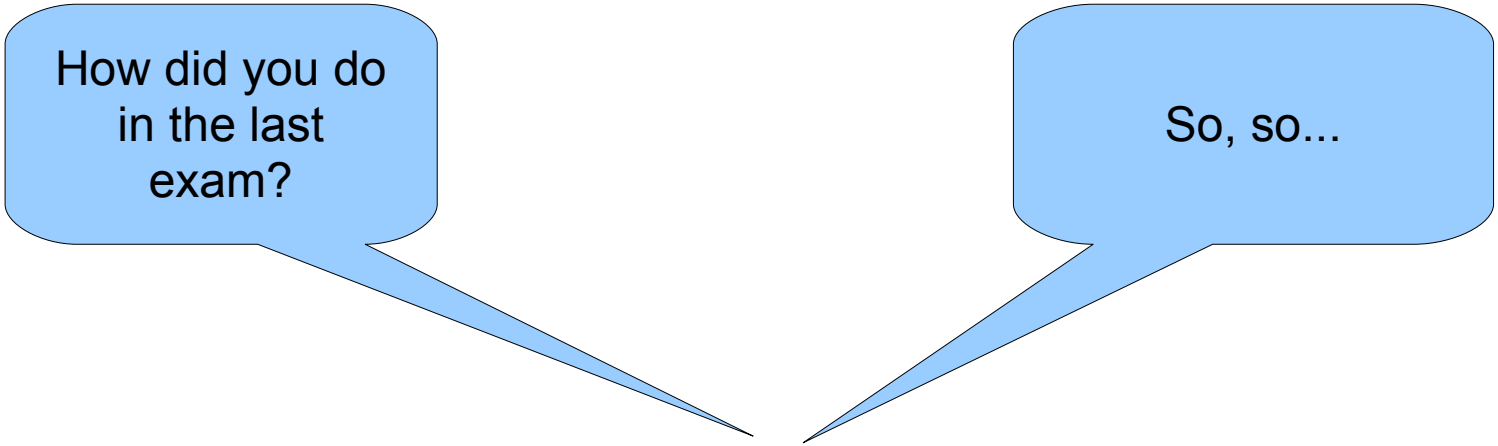
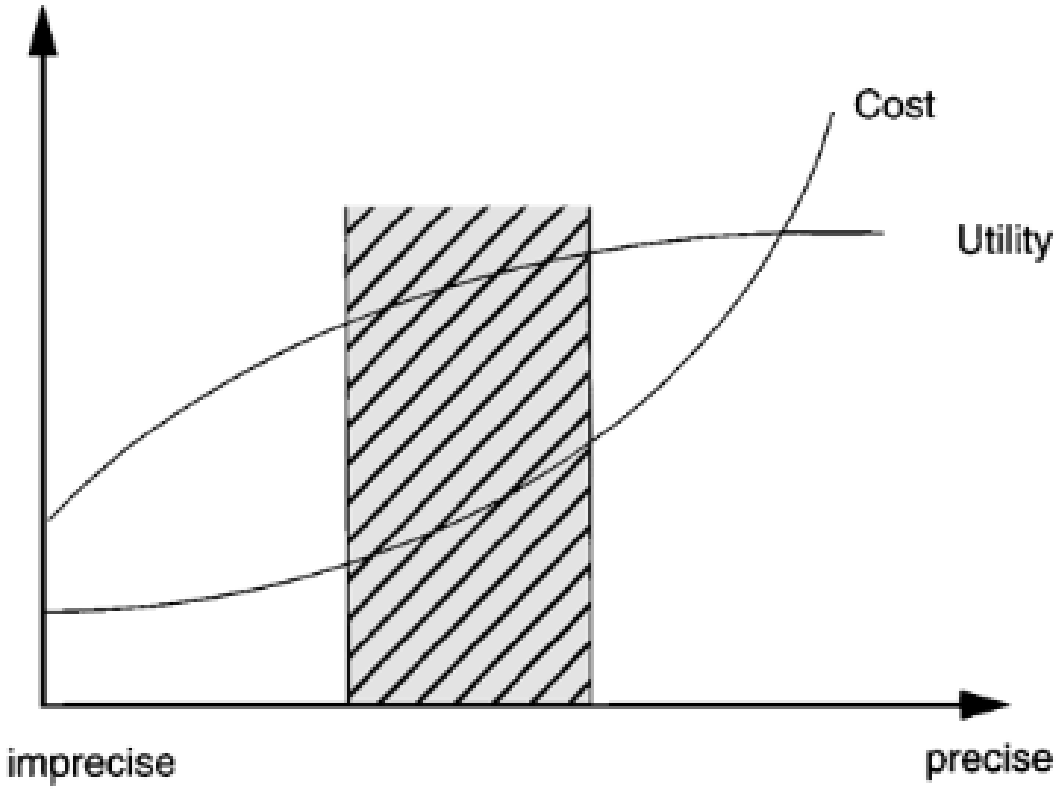
CMSC 170 – Introduction to AI
2nd Semester 2009-2010

Fuzzy Logic Motivation

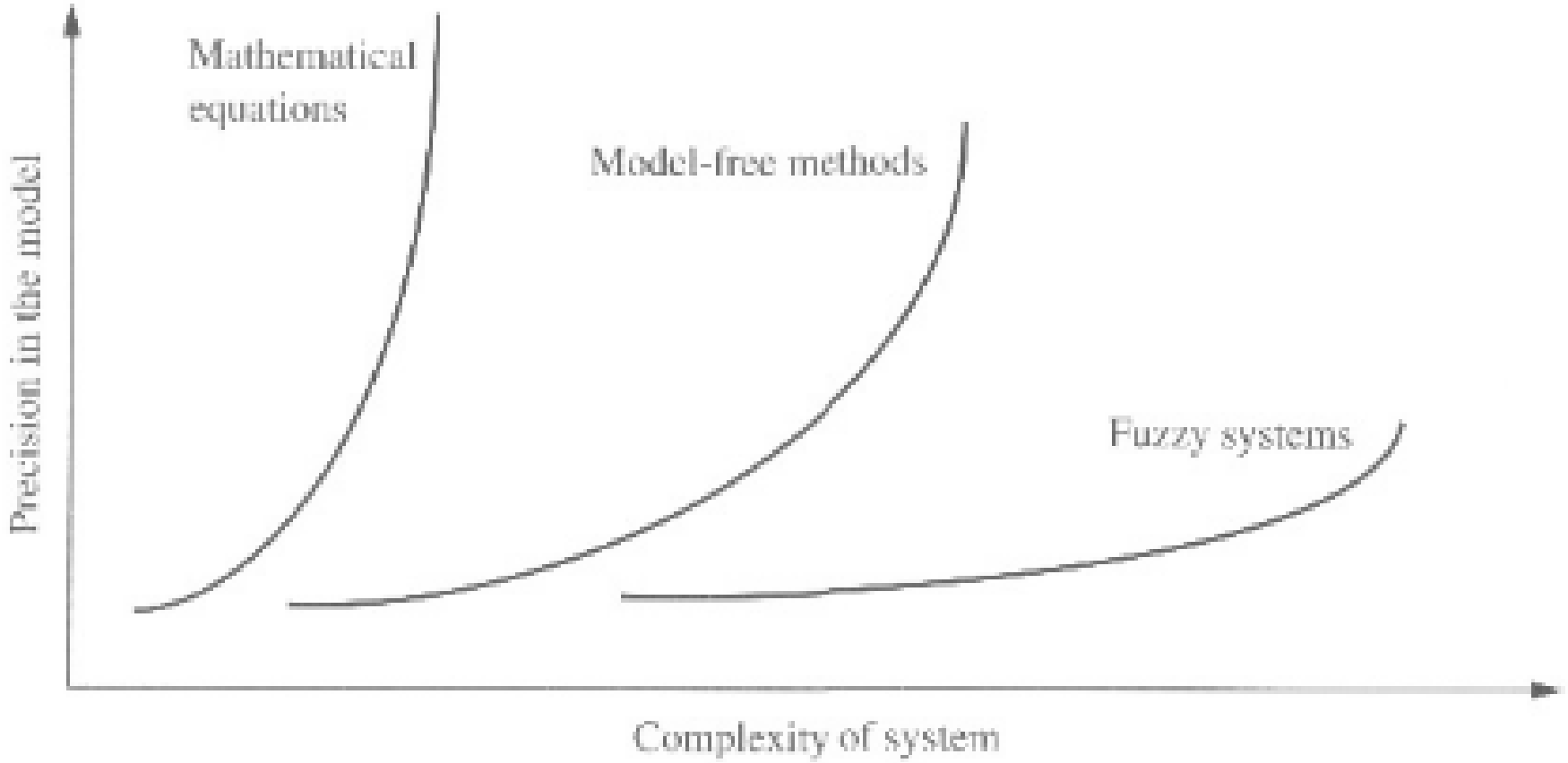
- Alleviate difficulties in developing and analyzing complex systems encountered by conventional mathematical tools
- Observing that human reasoning can utilize concepts and knowledge that do not have well-defined, sharp boundaries



Fuzzy Logic Motivation



Fuzzy Logic Motivation



Fuzzy Logic Motivation

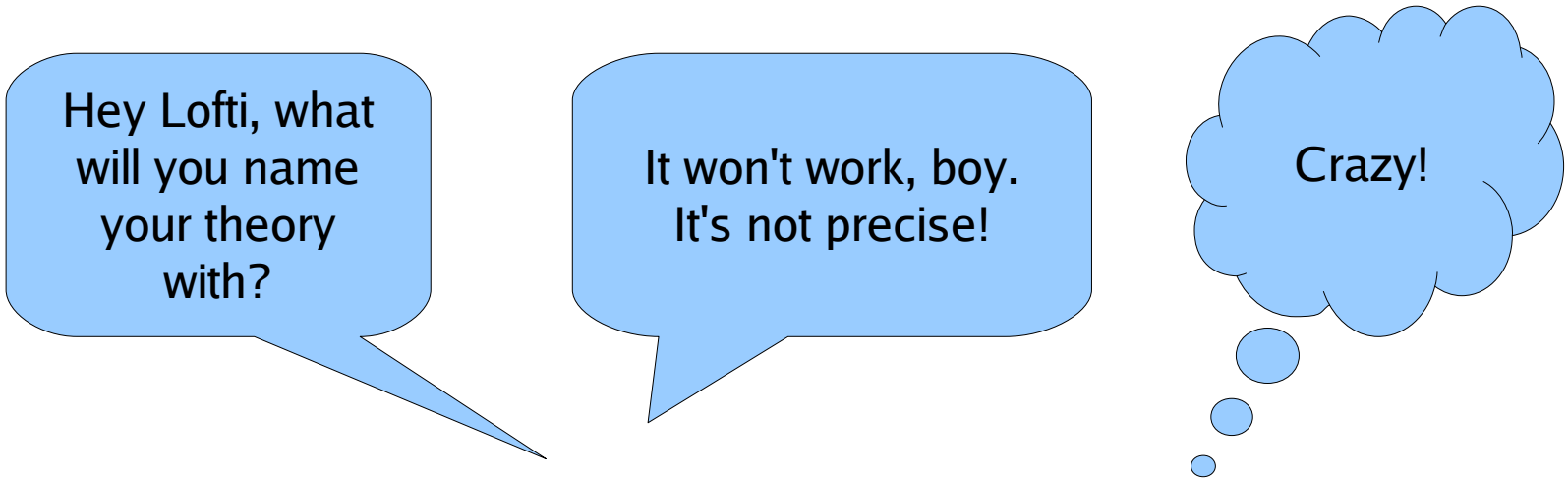
Fuzziness is beneficial for:

- Complex systems that are difficult or impossible to model
- Systems controlled bu human experts or systems that use human observations as inputs
- Systems that are naturally vague
  - Behavioral Science
  - Social Science

History of Fuzzy Logic

1964: Lofti A. Zadeh, UC Berkeley

- Idea of grade of membership was born
- Sharp criticism from academic community
  - Name!
  - Theory's emphasis on imprecision
- Waste of money!



History of Fuzzy Logic

1966-1975: Zadeh continued to broaden the foundation of fuzzy set theory

- Fuzzy multistage decision-making
- Fuzzy similarity relations
- Fuzzy restirctions
- Linguistic hedges

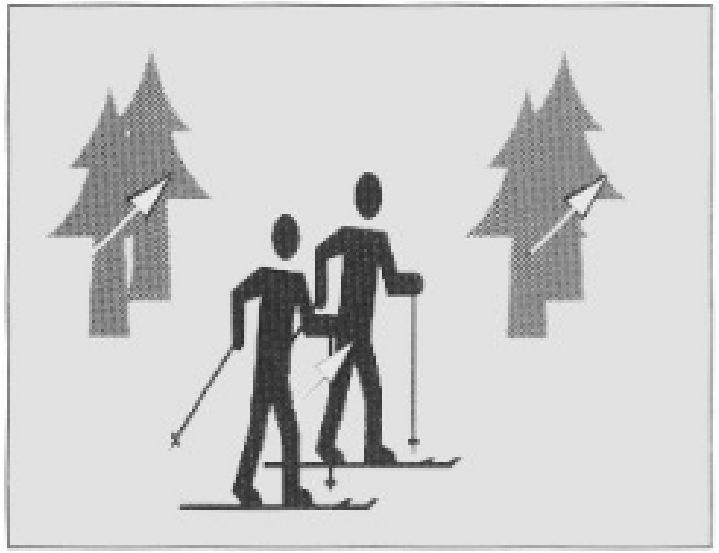
1970s: research groups were formed in Japan

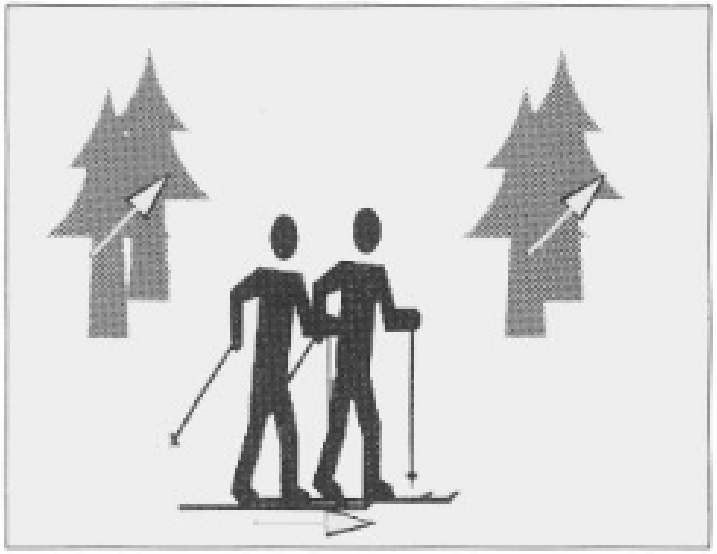
History of Fuzzy Logic

- 1974: Mamdani, UK, developed the first fuzzy logic controller (steam engine control)
- 1982: First commercial control system using fuzzy logic
  - Cement kiln, Holmblad and Ostergaard
- 1976-1987: Industrial application of fuzzy logic in Japan and Europe
- 1987-Present: Fuzzy Boom

Fuzzy Logic Application

- Image Stabilization





If all motion vectors are almost parallel and their time differential is small, then the hand jittering is detected and the direction of the hand movement is in the direction of the moving vectors.

Fuzzy Logic Application

- Aerospace
  - Altitude control of spacecraft
  - Satellite altitude control
  - Flow and mixture regulation in aircraft deicing vehicles

Fuzzy Logic Application

- Automotive
  - Trainable fuzzy systems for idle speed control
  - Shift scheduling for automatic transmission
  - Intelligent highway systems
  - Traffic control
  - Improving efficiency of automatic transmissions

Fuzzy Logic Application

- Business
  - Decision-making support systems
  - Personnel evaluation in a large company
  - Data mining systems

Fuzzy Logic Application

- Chemical industry
  - Control of pH
  - Drying
  - Chemical distillation processes
  - Polymer extrusion production
  - Coke oven gas cooling plant

Fuzzy Logic Application

- Defense
  - Underwater target recognition
  - Automatic target recognition of thermal infrared images
  - Naval decision support aids
  - Control of a hypervelocity interceptor
  - Fuzzy modeling of infantry decision making (war games)

Fuzzy Logic Application

- Electronics
  - Control of automatic exposure in video cameras
  - Humidity in a clean room
  - Air conditioning systems
  - Washing machine timing
  - Microwave ovens
  - Vacuum cleaners

Fuzzy Logic Application

- Finance
  - Banknote transfer control
  - Fund management
  - Stock market predictions

Fuzzy Logic Application

- Industrial
  - Cement kiln controls
  - Heat exchanger control
  - Activate sludge wastewater treatment process control
  - Water purification plant control
  - Control of water purification plants

Fuzzy Logic Application

- Marine
  - Autopilot for ships
  - Optimal route selection
  - Control of autonomous underwater vehicles
  - Ship steering

Fuzzy Logic Application

- Medical
  - Medical diagnostic support system
  - Control of arterial pressure during anesthesia
  - Multivariable control of anesthesia
  - Modeling of neuropathological findings in Alzheimer's patients
  - Radiology diagnosis
  - Fuzzy inference diagnosis of diabetes and prostate cancer

Fuzzy Logic Application

- Mining and Metal Processing
  - Sinter plant control
  - Decision making in metal forming
- Robotics
  - Fuzzy control for flexible-link manipulators
  - Robot arm control
- Securities
  - Decision systems for securities trading

Fuzzy Logic Application

- Signal Processing and Telecommunications
  - Adaptive filter for nonlinear channel equalization control of broadband noise
- Transportation
  - Automatic underground train operation
  - Train schedule control
  - Railway acceleration
  - Braking and stopping