

Lecture 28

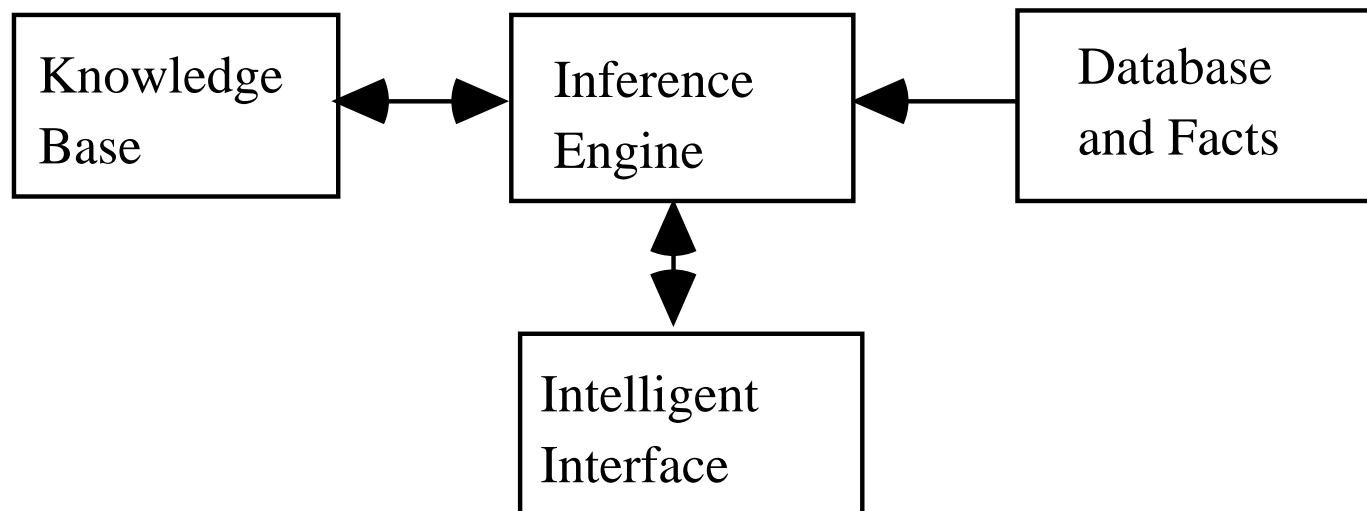
Modeling (3): Expert System and Reinforcement Learning

Outline

- ANN and Knowledge Based Expert System (KBES)
 - A Brief Introduction to rule-based KBES
 - Integrating KBES and ANN

Knowledge Based Expert System

- A Knowledge Based Expert System (KBES) is a Computer Program which solves a specific type of problems by codifying human experts knowledge in a knowledge base, and by mimicking the human problem solving process.



KBES (Cont'd)

- An KBES consists of a database which stores problem dependent facts, a human interface to communicate with user, and two special modules:

Knowledge Base – a special data base where human experts' knowledge is codified.

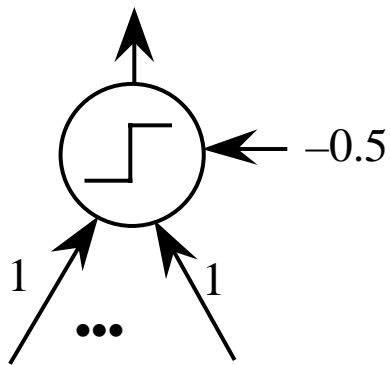
Inference Engine – a mechanism which enables the utilization of knowledge and facts to solve a given problem.

KBES Structure

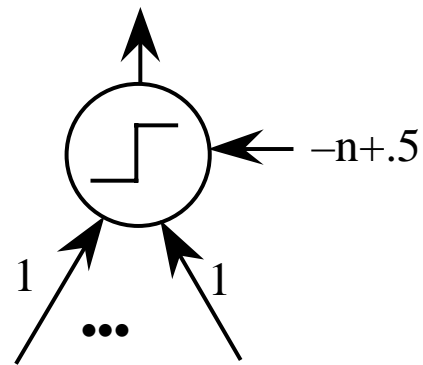
- The Knowledge base consists of "RULES" :
Rule 0021: IF (1) QRS \geq .11sec.on any two limb leads AND
 (2) Sd. \geq .04sec. on lead I or aVL AND
 (3) terminal R present lead VI
 THEN (a) QRS .11 seconds; AND
 (b) terminal QRS rightward and anterior; AND
 (c) incomplete right bundle branch block
- Rules are elicited from human experts' knowledge.
- Inference engine provides search and binding mechanism to perform "logic reasoning" – A process in which a chain of rules are invoked (fired) based on given facts.

ANN and KBES

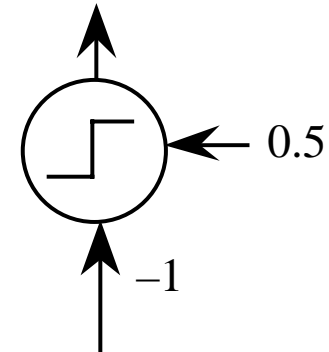
Any rule based expert system can be realized with a MLP network with threshold activation function to implement AND, OR, and NOT logic operations:



OR operation



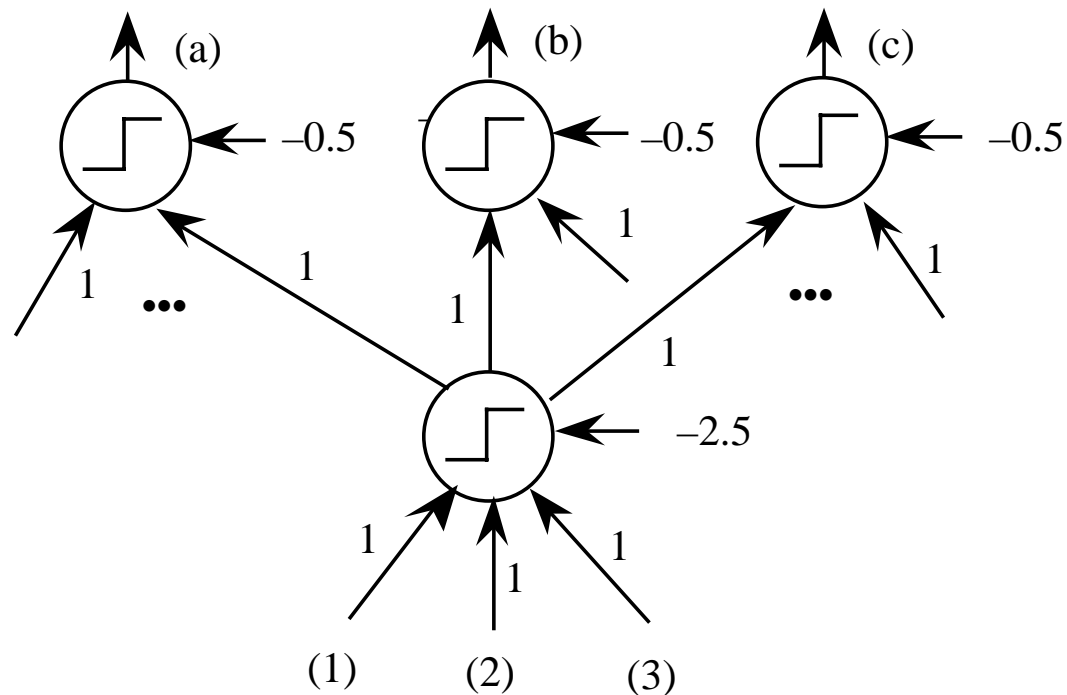
AND operation
n: # of inputs



NOT operation

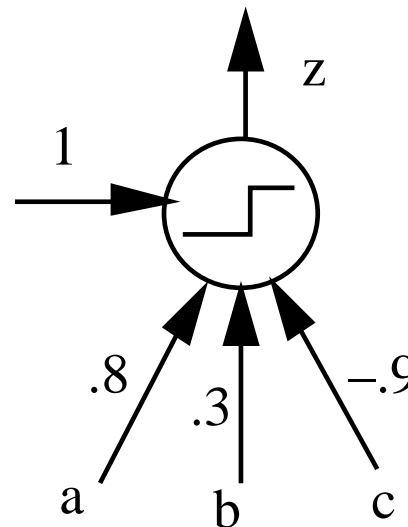
ANN and Rules

MLP implementation of Rule 0021. The hidden layer performs AND operation, the output layer performs OR operation.



EXtract KBES from An ANN

- KBNN (Knowledge Based Neural Network) – A rule based KBES can be used to initialize a MLP. Then its performance can be fine-tuned using learning. For example, if a trained MLP has the following form:



What will be the corresponding rules?

Extracting Rules

- One possible rule derived directly from the hyperplane:
If $0.8 \cdot a + 0.3 \cdot b - 0.9 \cdot c + 1 > 0$, then z is TRUE
Not quite a comprehensible rule!
- Rule Extraction Approaches:
Eliminating weights with small magnitude (pruning)
Training network with quantized weights ($-1, 0, +1$)
N_of_M rule extraction – Determine whether an OR gate or an AND gate should be used.