

Hybrid Intelligent Systems

Lecture 8

Hybrid Expert Systems

What is expert system? (Wikipedia)

- A [computer application](#) that performs a task that would otherwise be performed by a human expert. For example, there are expert [systems](#) that can diagnose human illnesses, make financial forecasts, and schedule routes for delivery vehicles. Some expert systems are designed to take the place of human experts, while others are designed to aid them. Expert systems are part of a general category of computer applications known as [artificial intelligence](#) .
- To design an expert system, one needs a *knowledge engineer*, an individual who studies how human experts make decisions and translates the rules into terms that a [computer](#) can understand

Experts systems.

Tasks solved by ES and areas of using

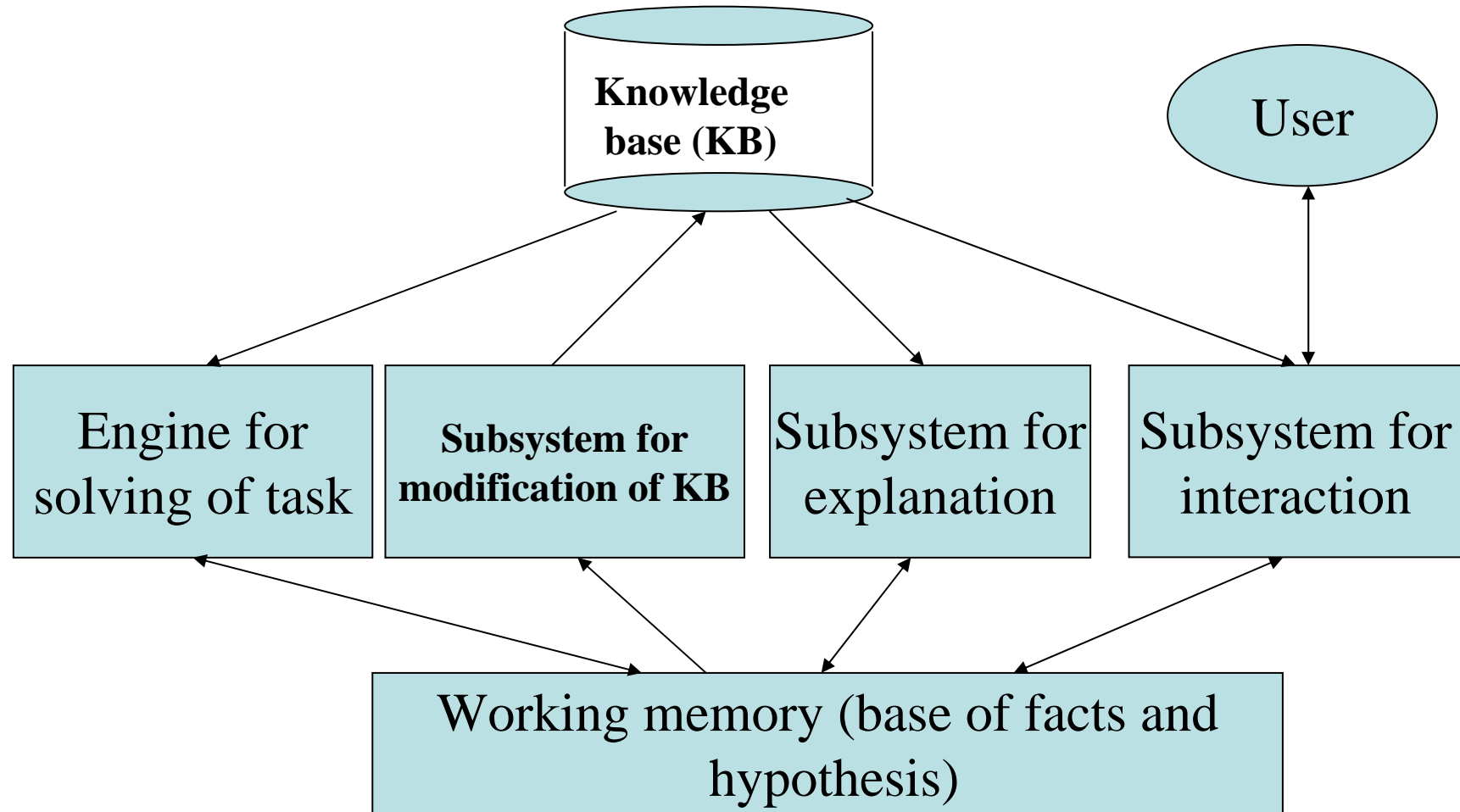
Tasks:

- Diagnostics
- Monitoring
- Control
- Identification
- Planning
- Forecasting
- Simulation
- Training
- Projecting (configuring)

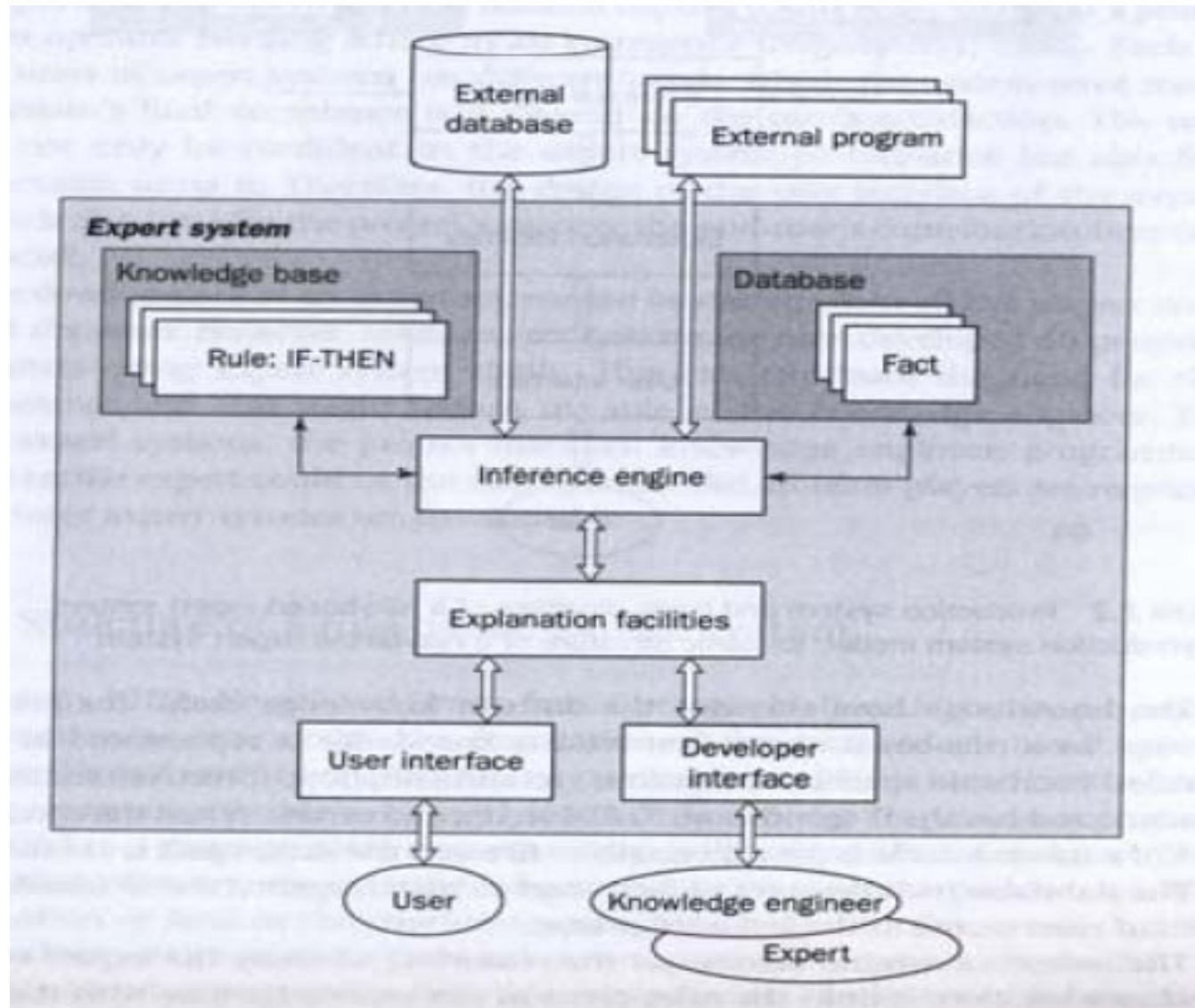
Areas:

- Business
- Medicine
- Manufacturing
- Computers
- Communications
- Science (mathematics, physics, chemistry)
- Transport
- Space
- Defense
- Education

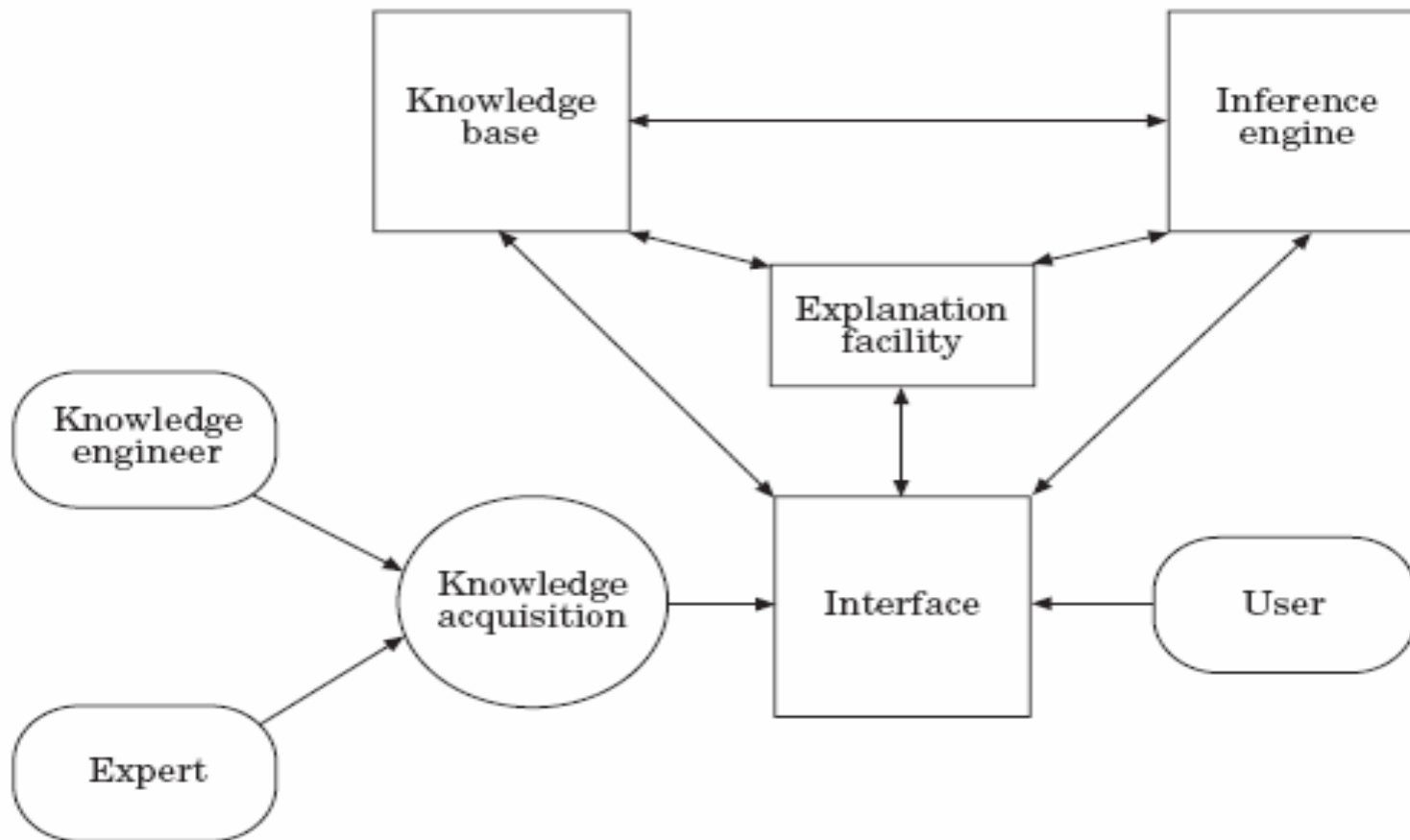
Structure of classic ES (in logical approach)



Structure of ES (2)



Structure of ES (3)



Example. Expert system for diagnosing car problems.

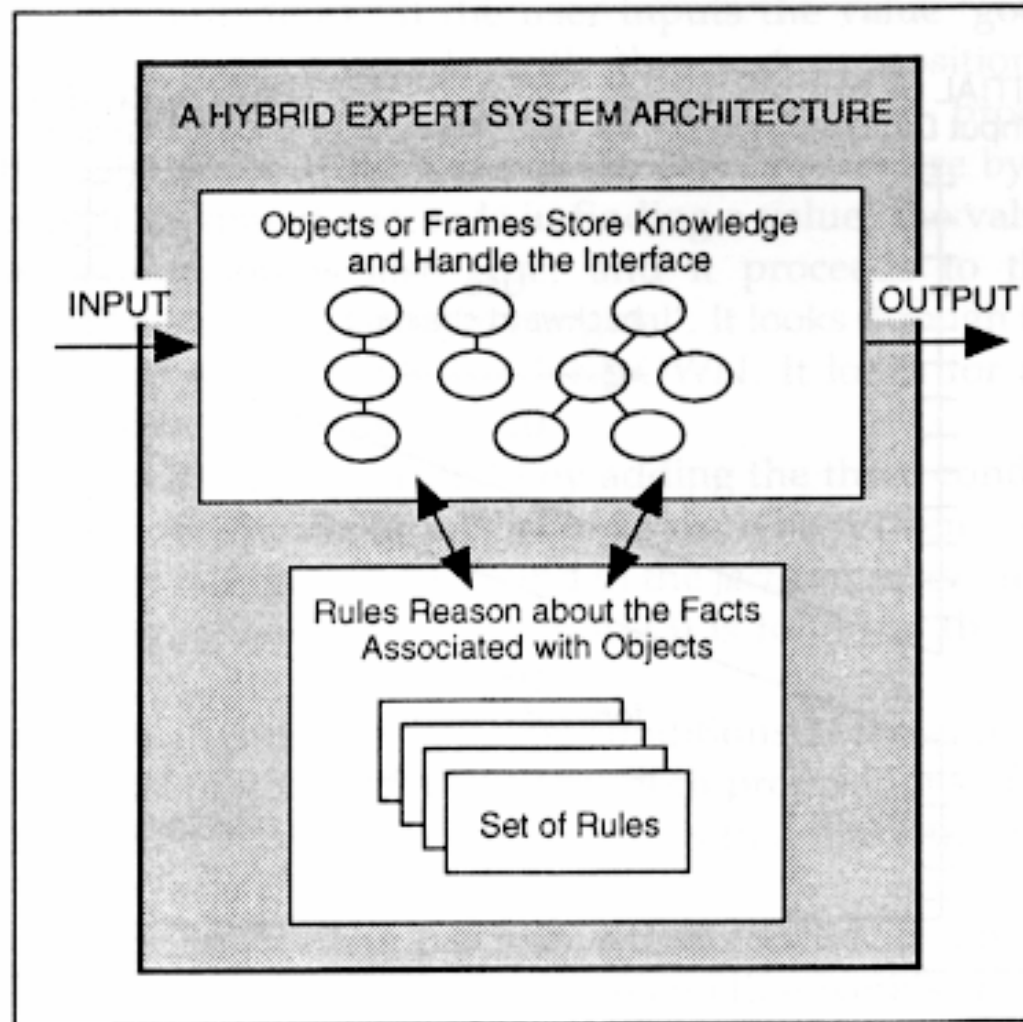
Rule 1: IF the engine is getting gas
 AND the engine will turn over
 THEN the problem is spark plugs

Rule 2: IF the engine does not turn over
 AND the lights do not come on
 THEN the problem is battery or cables.

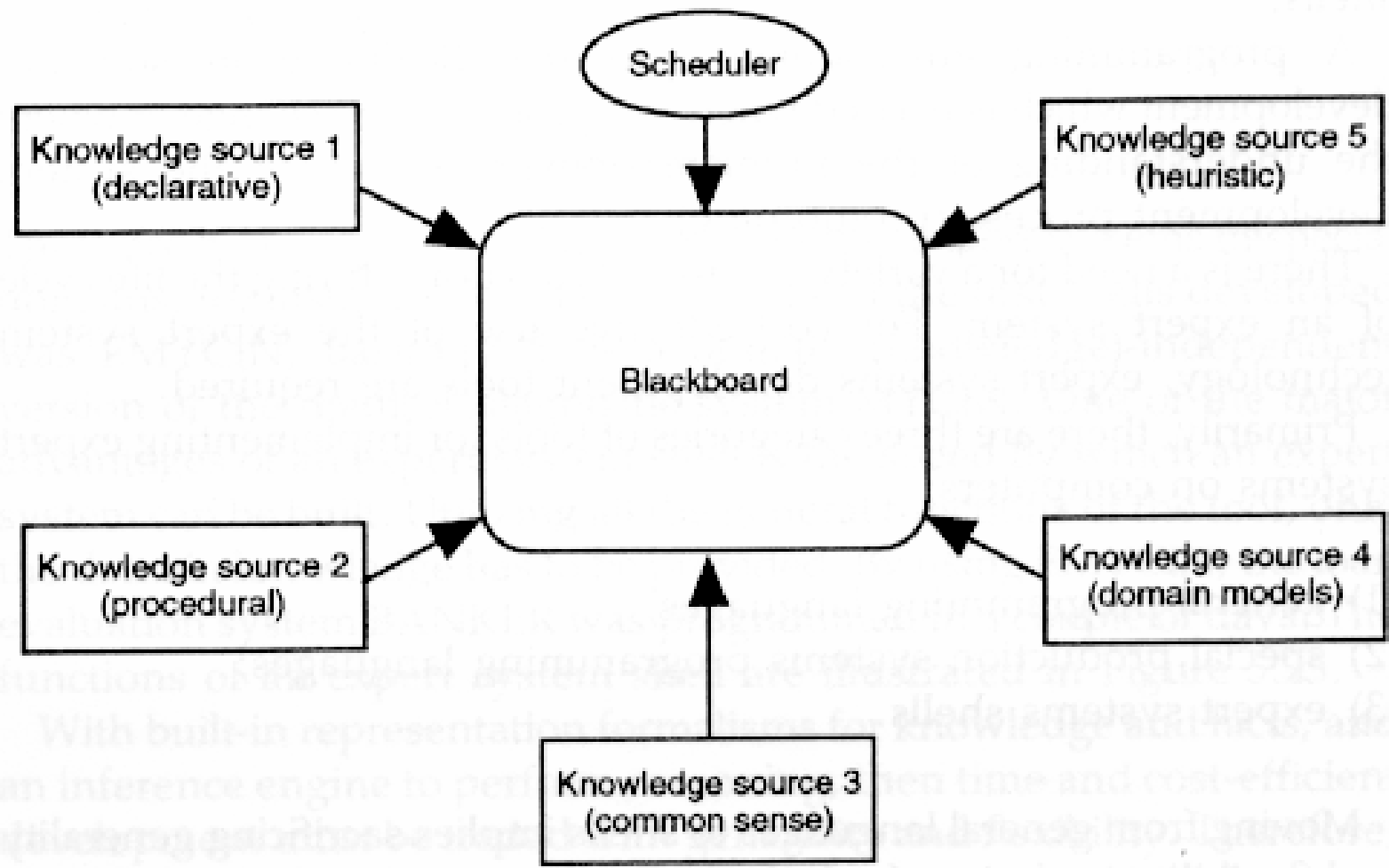
Rule 3: IF the engine does not turn over
 AND the lights do come on
 THEN the problem is the starter motor.

Rule 4: IF there is gas in the fuel tank
 AND there is gas in the carburettor
 THEN the engine is getting gas

Hybrid Expert System Architecture (different knowledge representation)



Blackboard Architecture



Blackboard Architecture (2)

- Blackboard - holds the problems solving data in a global data store.
- Knowledge sources - contain the knowledge required to solve the problem.
- Scheduler determines which knowledge source can contribute to the solution in the blackboard next.

Some of the applications:

- Hearsay II - speech understanding
(L.Erman, F.Lesser, F.Hayes-Roth, 1975)
- HASP - ocean surveillance task
(E.Feigenbaum, P.Nii, D.Reddy, 1978)

Kinds of interpretation of rules

- Logical
 - A – logical function with $\&$, \vee , not
 - If one is true then rule are executing
- Probabilistic
 - A – logical function with $\&$, \vee , not
 - Rule are executing with any probability
- Threshold (Hybrid)
 - A - set of features, which are adding with weights and rule are executing if addition is more then any threshold (as in model of neuron)

Kinds of inference

- Backward chaining
 - From goal to facts (as in Prolog or as in top-down method of grammatical analyzing),
 - Is used in dialog expert systems
- Forward chaining
 - From facts to goal (as in bottom-up method of grammatical analyzing),
 - Is used in real time and monitoring expert systems

HYBRID DIAGNOSTIC SYSTEM

for the condition monitoring of rotating machinery

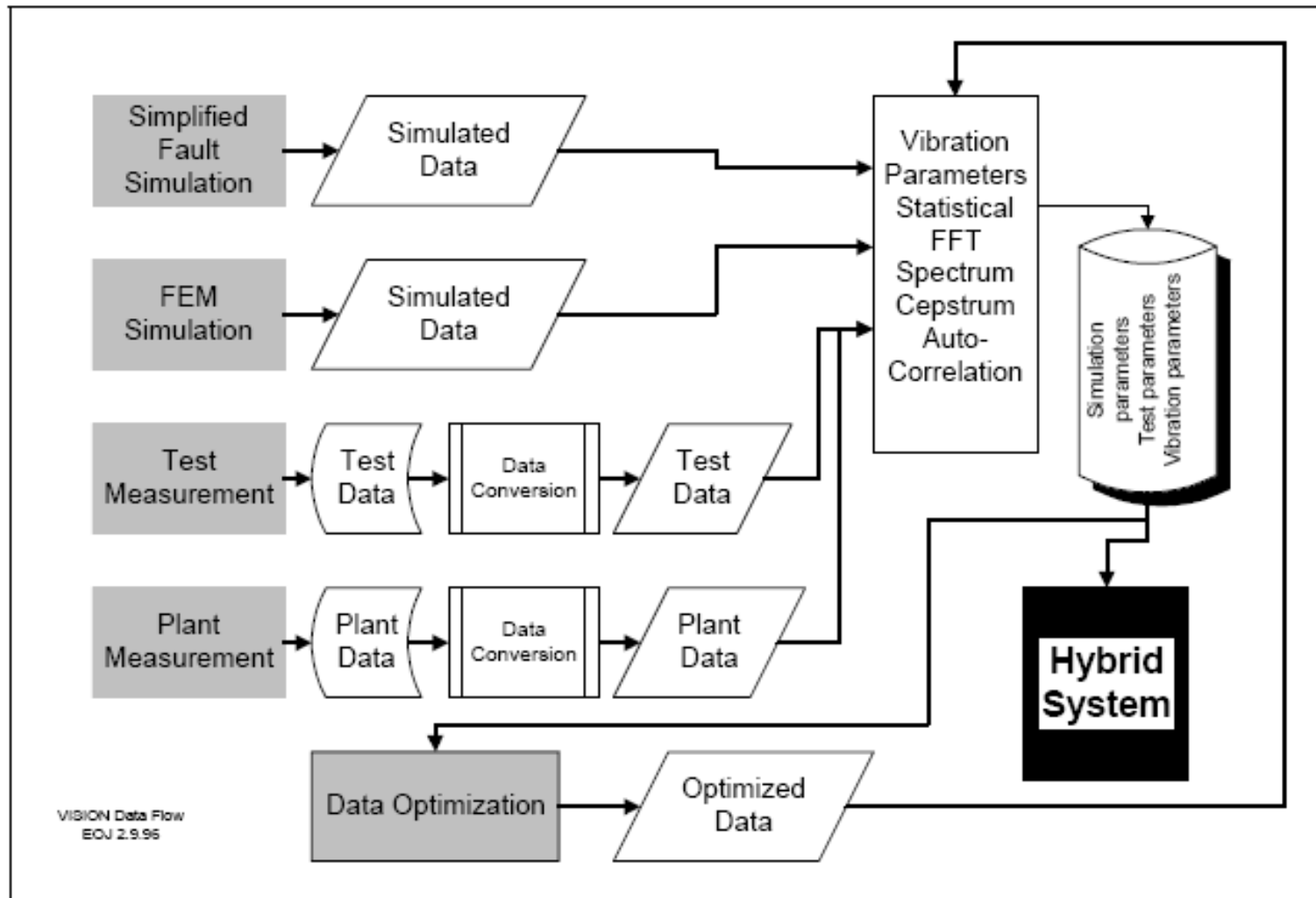


Figure 1 - Data flow during the development process.

HYBRID DIAGNOSTIC SYSTEM

for the condition monitoring of rotating machinery

(2)

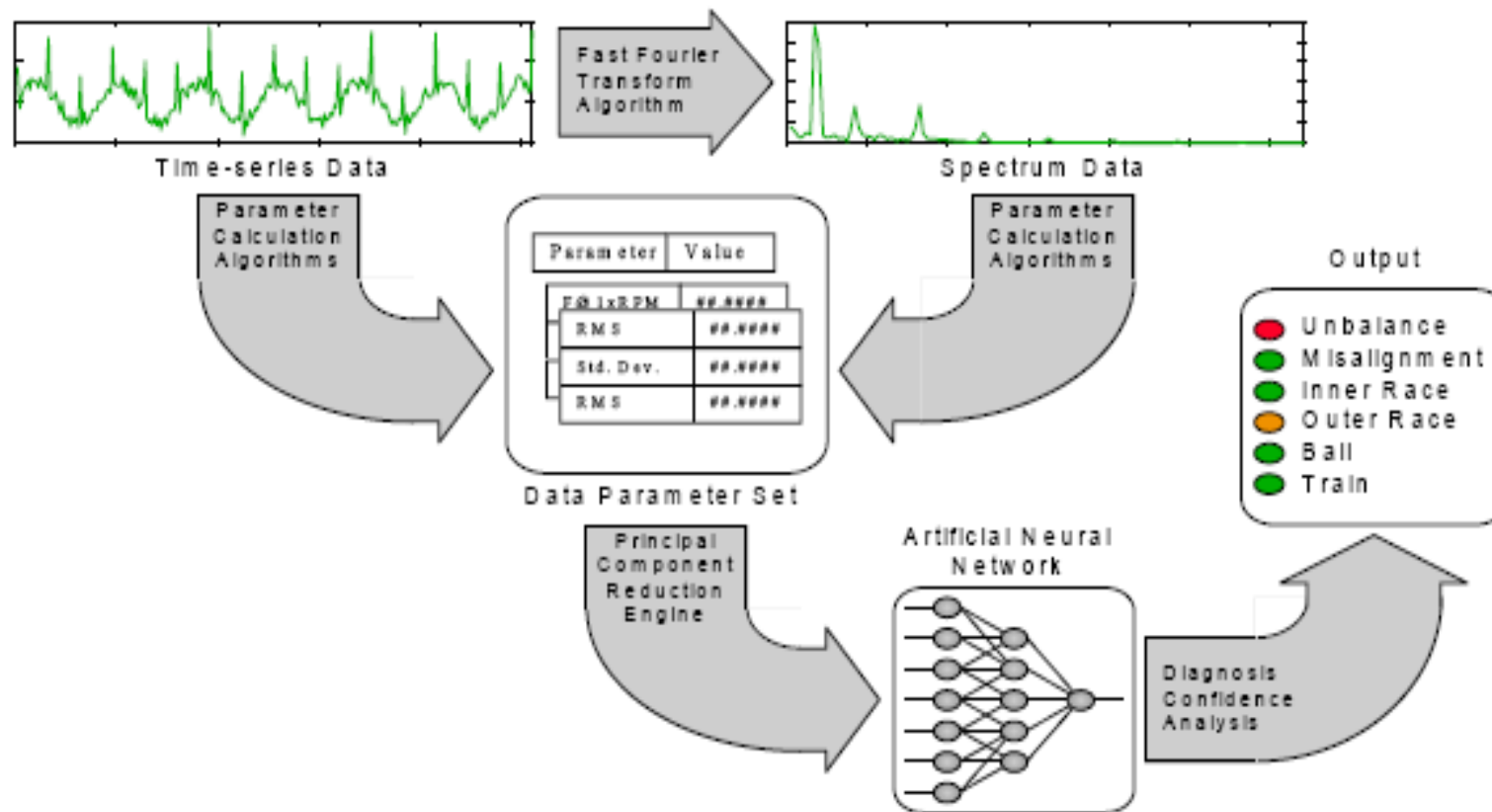


Figure 2. Neural network diagnosis module.

HYBRID DIAGNOSTIC SYSTEM for the condition monitoring of rotating machinery (3)

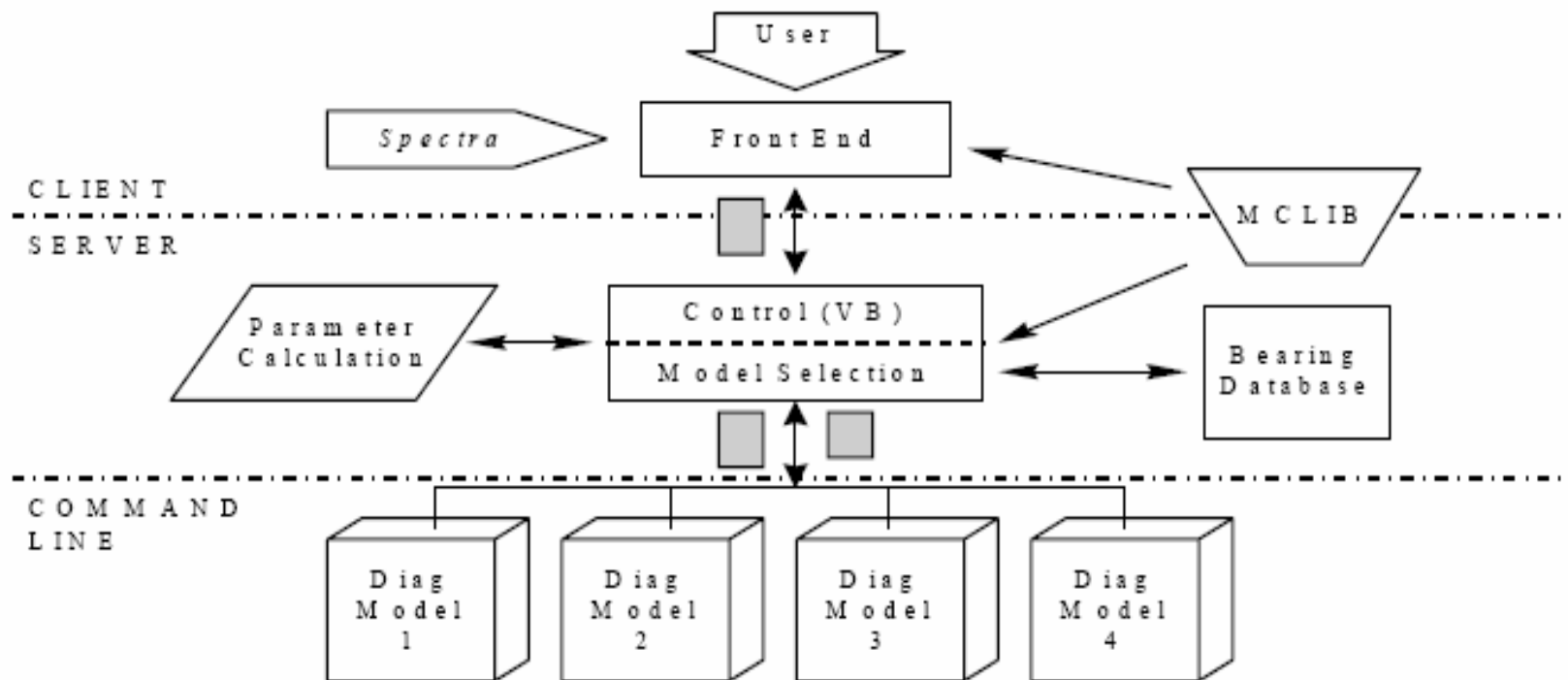


Figure 3. Diagnostic system integration.

HYBRID DIAGNOSTIC SYSTEM

for the condition monitoring of rotating machinery

(4)

- The hybrid diagnostic system integrates the powerful mathematical techniques of simulation and artificial intelligence
- The simulation model enables typical data from a base level machine to be synthesised for the training of neural networks. The simulation model was compared with the test rig data and modified to account for the actual machine characteristics.
- The hybrid system consists of several different AI techniques:
 - neural networks,
 - fuzzy logic,
 - rule-based components

A Hybrid Expert System for Error Message Classification

- A hybrid intelligent classifier is built for pattern classification. It consists of a classification and regression tree CART, a genetic algorithm GA and a neural network
- NN CART extracts features of the patterns by setting up decision rules
- Rule improvement by GA is explored
- The rules act as a preprocessing layer of NN a multiclass neural classifier through which the most probable class is determined

A Hybrid Expert System for Error Message Classification (2)

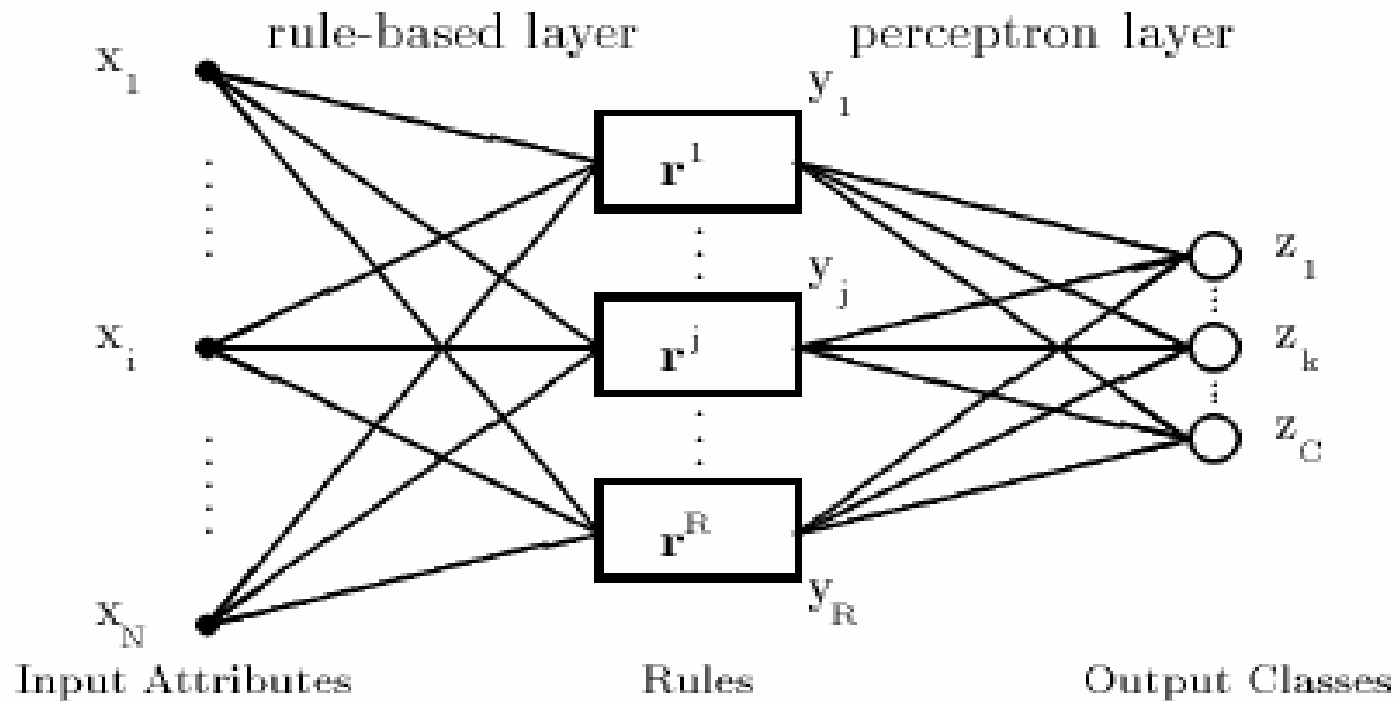
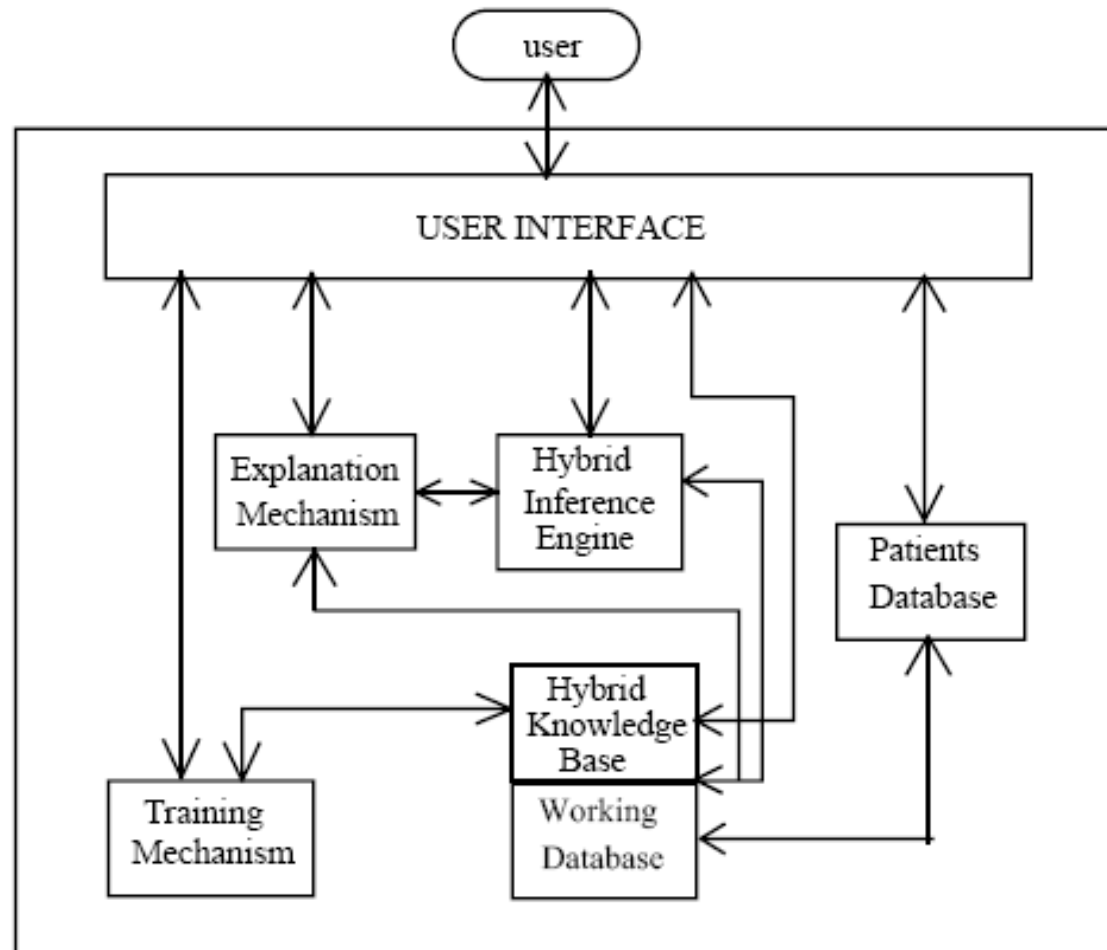


Figure 1: Hybrid Classifier Network Architecture

XBONE: A Hybrid Expert System Supporting Diagnosis of Bone Diseases.

(I. Hatzilvaeroudis. P. J. Vassilakos. A. Tsakalidis, 1997)



XBONE: A Hybrid Expert System Supporting Diagnosis of Bone Diseases (2)

Rule is implemented as neuron:

C_i – conditions (0, 1 or 0.5),

sf_i – confidence factor

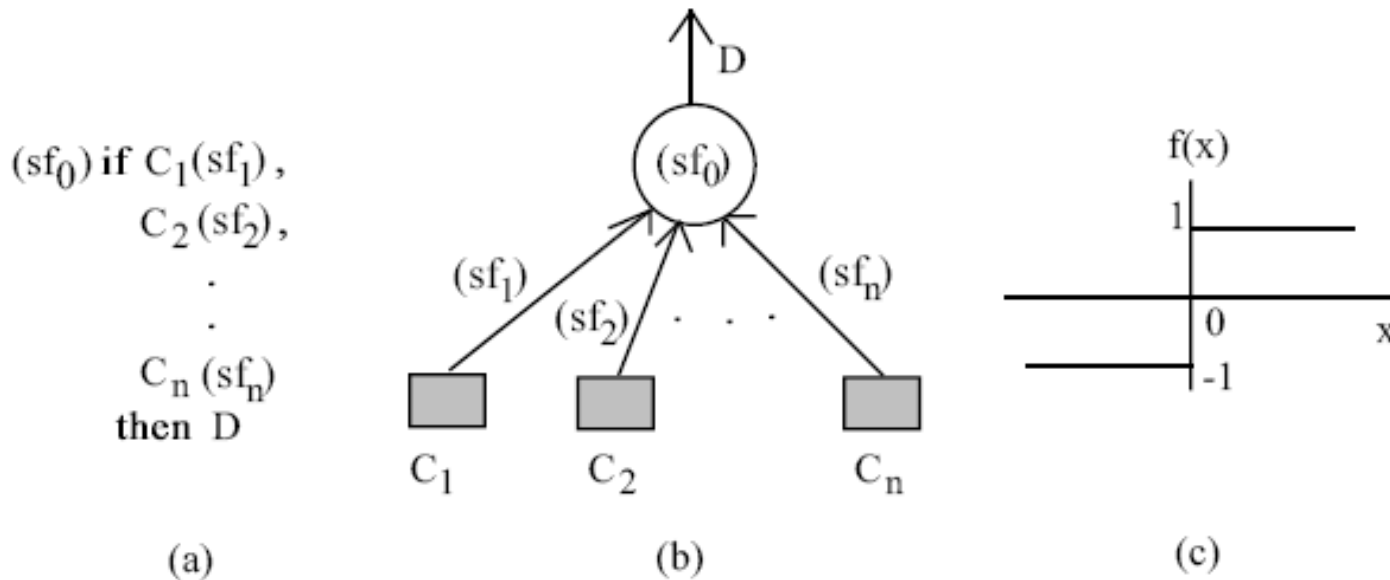


Fig.2 (a) A neurule (b) Corresponding adaline unit (c) Activation function

Examples of rules (neurons)

R1:
if sex is man ,
 age \geq 20 ,
 age < 35
then patient_class is man_20_35

R2:
(-8) if pain is continuous (5) ,
 patient_class is man_20_35 (2.5) ,
 fever is medium (2) ,
 fever is high (2)
then disease_type is inflammation

NEULA: A hybrid neural-symbolic expert system shell

(P. Floreen, P. Myllymaki, P. Orponen, H. Tirri, 1992)

```
concept animal (100) is basic with  
  offspring : [ living (20), eggs (80) ];  
  can       : { swim (70), fly (29), walk (49) };  
concept mammal (20) is animal with  
  offspring : [ living (20) ];  
  can       : { swim (10), fly (1), walk (19) };  
concept bird (30) is animal with  
  offspring : [ eggs (30) ];  
  can       : { swim (10), fly (29), walk (30) };  
concept fish (50) is animal with  
  offspring : [ eggs (50) ];  
  can       : { swim (50), fly (0), walk (0) };  
concept dolphin (2) is mammal with  
  can       : { swim (2), walk (0) };  
concept penguin (6) is bird with  
  can       : { swim (6), fly (0), walk (6) }.
```

Here, a description of a concept consists of a reference to its immediate ancestor (if any) together with a list of attributes and their value distribution for objects belonging to this conceptual class

The shell provides probabilistic inference