Network Management

Lecture 10

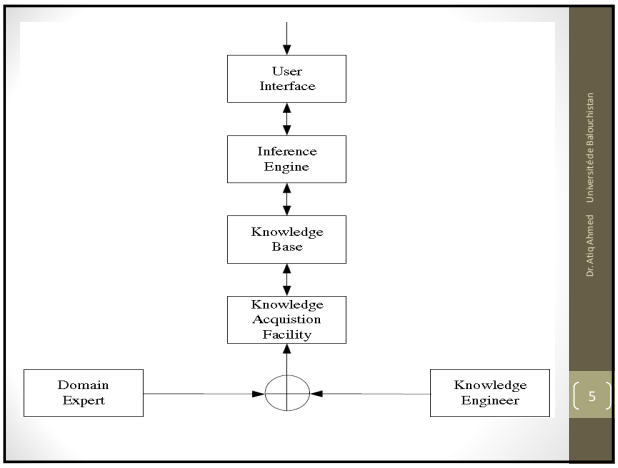
ARTIFICIAL INTELLIGENCE TECHNIQUES FOR NETWORK MANAGEMENT

Introduction

- Difficult to find a network manager for each management center who
  - Has entire knowledge of the network
  - Is available round the clock to handle the network
  - Makes sure that it runs in a healthy condition
- Artificial Intelligence (AI) technologies help in
  - Fault management
  - Performance analysis
  - Traffic management

Expert Systems Techniques

- Refers to a system that
  - Uses modern technology to store and interpret the knowledge
  - Experience of a human expert, sometimes several experts, in a specific area of interest
- Tries to reflect actions of a human expert when solving problems in a particular domain



Rule-based systems

- General knowledge of a certain area is contained in a set of rules
- Specific knowledge, relevant for a particular situation, is constituted of facts, expressed through assertions
- Stored in a database

Rule-based systems

- **Forward Mode**
  - Departs from an initial state and constructs a sequence of steps that leads to the solution of the problem ("goal")
  - In a fault diagnosis system, the rules would be applied to a database containing all the alarms received, until a termination condition involving one fault is reached

Rule-based systems

- **Backward Mode**
  - Starts from a configuration corresponding to the solution of the problem
  - Constructs a sequence of steps that leads to a configuration corresponding to the initial state
- The same set of rules may be used for the two operation modes

Rule-based systems

- **Fault Localization**
  - Inference engine usually uses a forward-chaining inference mechanism
  - Operates in a sequence of rule-firing cycles
  - In each cycle the system chooses rules for execution whose conditions match the content of the working memory
- Systems that rely on surface knowledge do not require deep understanding of the underlying system architectural and operational principles

Examples of RBS

- **ANSWER (Automatic Network Surveillance with Expert Rules)**
  - Expert system used in monitoring and maintaining the 4ESS switches in the AT&T long distance network
  - Knowledge base is constructed with C++
- Knowledge base interacts with the actual switch in two ways:
  - It receives events as input;
  - It issues commands (e.g., to request diagnostics to be run) as output

Examples of RBS

- **HP OpenView Event Correlation Service (ECS)**
- **ECS Designer**
  - A GUI where rules can be developed interactively by selecting, connecting, and configuring nodes
  - The process of combining different nodes creates a correlation circuit where events flow from a source node through the path(s) of the defined circuit and exit through a sink node
- **ECS engine**
  - A run-time correlation engine
  - Executes a set of download correlation rules that control the processing of event streams

Case-based systems

- Cases contain registers with the most relevant characteristics of past episodes
- Stored, retrieved, adapted, and utilized in the solution of new problems
- Experience obtained constitutes new cases, which are added to the database for future use
- System is able to acquire knowledge through its own means, and do not need a human expert
- Ability to modify their future behavior according to the current mistakes
- May build solutions to the unheard-of problems through the adaptation of past cases to the new situations

Model-based systems

- **Structural Model**
  - Includes a description of the network elements and of the topology
- **Functional Model**
  - Describes the processes of event propagation and event correlation
- Rules are based on observed associations in traditional rule-based systems
- Model is usually defined by an object-oriented paradigm

Limitations of AI based Methods

- Expert Systems (ESs) cannot handle new and changing data
- Rules are brittle and not robust when faced with unforeseen situations
- They cannot learn from experience (i.e., they cannot use analogy to reason from past experiences or remember past successes and failures in the context of a current problem)

Limitations of AI based Methods

- They do not scale well to large dynamic real-world domains
- It is difficult to add new rules without a comprehensive understanding of what the current rule base is and how a new rule may impact the rule base
- The rules that are incorporated at development time cannot easily adapt as the network evolves

Limitations of AI based Methods

- Require extensive maintenance when the domain knowledge changes; new rules have to be added and old rules adapted or deleted
- Not good at handling probability or uncertainty
- Difficulty in analyzing large amounts of uncorrelated, ambiguous, and incomplete data
- The domain must be well understood and thought out
- This is not entirely possible in domains such as fault management