Extended Hierarchical Censored Production Rules (EHCPRs) System as Decision Support System

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ABSTRACT

Knowledge based systems that aim at mimicking human behavior should be able to reason with uncertain knowledge as well as insufficient data. To capture the uncertain and imprecise knowledge about the real world, a EHCPRs System has been presented, which exhibits both the variable certainty as well as the variable specificity. EHCPRs system is a knowledge representation and reasoning system in which an EHCPR is used as a unit of knowledge for representing any universal concept. There are a number of EHCPRs at various levels of hierarchy of knowledge structure in the EHCPRs system, which results in a tree of EHCPRs. This paper discusses how the EHCPRs system manages the trade-off between the precision of decisions and efforts needed to derive those decisions. EHCPRs system support professionals engaged in design, diagnosis, or evaluation of complex situations. It can be used either as interactive advisor or as automated tool for converting data into recommendations or other conclusions. It helps in automating decisions, hence improving efficiency or consistency and makes errors less likely.

Keywords: Decision Support System, Knowledge Based Systems, Extended Hierarchical Censored Production Rules (EHCPRs) System, Management

Introduction

Techniques of Artificial Intelligence (AI) are being used in a variety of ways to improve the decision support provided to managers and business professionals in many companies. AI-enabled applications are at work in information distribution and retrieval, data-base mining, product design, manufacturing, inspection, training, user support, surgical planning, resource scheduling, and complex resource management.

Leading companies in many different industries are using artificial intelligence technologies as a vital ingredient of many strategic business applications such as manufacturing, process control, biomedical research, fraud detection, data mining and market research. For example, financial analysts use a variety of artificial intelligence systems to manage assets, invest in the stock market, and perform other financial operations [Dunkin 1995]. In finance industry, neural networks are being used for detecting credit-card fraud. Insurance companies use artificial intelligence to spot fraudulent claims [Port 1995]. Hospitals use artificial intelligence in many capacities, from scheduling staff, to assigning beds to patients, to diagnosing and treating illness. Wal-Mart Stores Inc. (www.walmart.com) harnesses AI (data mining systems including neural nets, statistical analysis and expert systems) to uncover patterns and relationships in the huge amounts of data collected from its 3000 stores. Hence, Wal-Mart can predict sales of every product at each store accurately. Artificial Intelligence lends itself to tasks as diverse as airline ticket pricing, food preparation, oil exploration, and child protection. It is widely used in the insurance, meteorology, engineering, and aerospace industries and by the military. It was artificial Intelligence that guided cruise missiles during the Gulf War in 1991 [Williams 2001].

When building knowledge-based systems, one uses rules to represent definition, and common characteristic features as defaults with certain constraints on it, along with the other general commonsense knowledge. It uses exceptions to represent any particular, rarely possible special cases may be regarded as specific context with the rule when it is not applicable. The "rule + exception" models provide a realistic description of the real world [Yao et al 2005]. Whereas, hierarchies give comprehensible knowledge structure that allows managing the complexity of the large knowledge

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bases and to view the knowledge partitioned at different levels of details. Moreover, it provides direction to the inference engine of the system on the different important aspects [Liu et al 2000] based on the requirement at that particular instance of time or context. One of such knowledge representation scheme that combines rules, exceptions and hierarchy is Hierarchical Censored Production Rules (HCPRs) System [Bharadwaj and Jain 1992]. HCPRs system has numerous applications in situations where decision must be taken in real time with uncertain information and with incomplete data. Various extensions and generalizations of the HCPRs system have been discussed [Bharadwaj et al 1994, Bharadwaj and Varshneya 1995, Bharadwaj et al 1996, Neerja and Bharadwaj 1996, Hewahi and Bharadwaj 1996, Jain and Bharadwaj 1998, Hewahi 1998(a), Hewahi 1998(b), da Silva and Bharadwaj 1998, Ba-Alwi and Bharadwaj 2005(a), 2005(b), Bharadwaj and Al-Maqaleh 2005, 2006, Kandwal and Bharadwaj 2005, 2006, 2007, Bharadwaj and Kandwal 2005, 2008].

The obvious problem for AI is how to characterize, to represent, and to compute with prototypes in psychology, or to concepts like natural kinds in philosophy, where default assumptions play a prominent role [Rieter 1987]. In order to distinctly represent defining and characteristic features of a concept along with its instances, an Extended Hierarchical Censored Production Rules (EHCPRs) System is presented [Jain et al 1999], just as an attempt towards developing a generalized knowledge representation and reasoning system. The EHCPRs System employs a general representation having merits of all four formalisms: logic, semantic networks, frames, and production rules. Various extensions and generalizations of the EHCPRs system have been discussed [Jain et al 2007, 2008a, 2009a, 2009b, 2009c, 2010]. The EHCPRs system exhibits both the variable certainty as well as the variable specificity in decision making. Acting as a decision support system, the EHCPRs system is able to directly support the specific types of decisions and the personal decision making styles and needs of individual executives, managers and business professionals. The EHCPRs systems support professionals engaged in design, diagnosis, or evaluation of complex situations. They can be used either as interactive advisors or as automated tools for converting data into recommendations or other conclusions.

Expert Systems and Business

Expert Systems try to mimic the reasoning an expert would use and are often called **knowledge-based systems** because they represent knowledge in an explicit form so that it can be applied automatically. Many expert systems represent knowledge as **if-then rules** stated in the form: *if* certain conditions are true, *then* certain conclusions can be drawn. A hypothetical if-then rule that might be used to decide whether to grant a business loan is:

If: The applicant is current on all debts, and the applicant has been profitable
for two years, and the applicant has strong market position,
Then: The applicant is an excellent credit risk.

A rule-based expert system asks the user questions and, based on the answers, asks other questions until it has enough information to make a decision or recommendation. Expert Systems are being used in many different fields, including medicine, engineering, physical sciences, and business. They are good for diagnostic (what's wrong) and prescriptive (what to do) problems. Expert systems now help diagnose illness, search for minerals, analyze compounds, recommend repairs, and do financial planning. So from a strategic business standpoint, expert systems can and are being used to improve every step of the product cycle of a business, from finding customers to shipping products to providing customer service.

Fuzzy Logic Systems and Business

In spite of the funny name, fuzzy logic systems represent a small, but serious application of AI in business. Fuzzy logic is method of reasoning that resembles human reasoning since it allows for approximate values and inferences (fuzzy logic) and incomplete or ambiguous data (fuzzy data) instead of relying only on crisp data, such as binary (yes/no) choices. Here is given a partial set of rules (fuzzy rules) in a credit risk analysis application.

If debt-equity is very high

then risk is positively increased
If income is increasing
then risk is somewhat decreased
If cash reserves are low to very low
then risk is very increased
If PE ratio is good
then risk is generally decreased

Here is a SQL query for analyzing and extracting credit risk information on businesses that are being evaluated for selection as investments:

Select companies
from financials
where revenues are very large
and pe_ratio is acceptable
and profits are high to very high
and (income/employee_tot) is reasonable

The fuzzy logic queries of a database promise to improve the extraction of data from business databases [Cox 1995, Jablonowski 1994]. The use of the imprecise terminology, such as *very high, increasing, somewhat decreased, reasonable, and very low* enables fuzzy systems to process incomplete data and quickly provide approximate, but acceptable, solutions to problems that are difficult for other methods to solve. Thus fuzzy logic systems can solve unstructured problems with incomplete knowledge by developing approximate inferences and answers, as humans do.

The United States has tended to prefer using AI solutions like expert systems or neural networks in business. But Japan has implemented many fuzzy logic applications including auto focus cameras, energy-efficient air conditioners, self-adjusting washing machines, and automatic transmissions [Mc Neill et al 1994].

Neural Networks and Business

A neural network simulates the human ability to classify things without taking prescribed steps leading to the solution. It starts with a large set of coded examples that represents the range and frequency of possibilities in the situation being studied. Neural networks apply automated statistical 'learning' techniques to find the statistical parameters that best present correlations between groups of characteristics within the trading set. They have the ability to learn and adapt. As neural nets start to recognize patterns, they can begin to program themselves to solve such problems on their own.

Neural networks are widely used for visual pattern and speech recognition systems. A PDA uses a neural network to analyze the characters we write while deciphering one's handwriting [Kay 2001]. Neural networks are being used in a variety of applications. In business, neural networks are very popular for fraud detection, evaluating loan applications, and target marketing, to mention a few. MasterCard estimates that neural networks save them $50 million annually [Punch 1993].

Variable Precision Logic:

In the real world, both humans and computers have to reason and make decisions in the presence of uncertain, fuzzy and often changing knowledge. Moreover, both are subject to constraints of time or memory to be specific and resources in general. Classical logics are based on the concept of a proposition which is either true or false. This property does not map onto the real world. A representation which is constrained to truth or falsehood is not flexible enough to deal with much of the vagueness of the real world. Multivalued Logics [Lukasiewicz 1967] have been developed within first order logic [FOL] – changing semantics to allow values other than true and false in an interpretation. Fuzzy Logic [Zadeh 1974, 1979] and Schwarz [1995] attempts to contribute to the same problem.

Knowledge based systems that aim at mimicking human behavior should be able to reason with uncertain knowledge as well as insufficient data. Variable Precision Logic [Michalski and Winston 1983] is reasoning in automatic computer system or decision support system with constraints of time or memory to be specific and resources in general. It offers mechanisms for handling trade-offs between the precision of inferences and the computational efficiency of deriving them. As a vehicle to implement such logic based system exhibiting variable precision, we employ Extended Hierarchical Censored Production Rules (EHCPRs) which are production rules with exceptions, generality, specificity, characteristic attributes, and instances. An EHCPR is a form of representation which we believe is most natural and comprehensible than any other logically equivalent forms.

Extended Hierarchical Censored Production Rules (EHCPRs) System:

A EHCPRs System [Jain et al 1999, Jain et al 2007] is an attempt towards developing a generalized knowledge representation, learning and reasoning system. An EHCPR has already been shown as a general structure for representation [Jain et al 1999] exhibiting the merits of four most important representation formalisms viz., production rules, frames, semantic nets, and logic.

An EHCPR takes the following general form [Jain et al 2009a]:

A ***{decision/concept/object}*** ***/*As Head of rule*/***

If ***B[b1, b2, ..., bm]*** ***{preconditions (AND conditions)}***

Unless ***C[c1, c2, ..., cn]*** ***{censor conditions (OR conditions)}***

Generality ***G*** ***{general concept}***

Specificity ***S[a1,a2, ..., ak]*** ***{specific concepts} /* mutually exclusive set*/***

Has_Part [Part_Concept1: (Default),(Constraints), Part_Concept2: (Default), (Constraints), ..., Part_Conceptp: (Default),(Constraints)]

Has_Property [Property_Concept1: (Default), (Constraints), Property_Concept2: (Defau lt), (Constraints), ..., Property_Conceptq: (Default),(Constraints)]

Has_Instance [...] ***{instances}***

$: \gamma, \delta$ .... ***(1)***

Here 'A' is a concept, consequent or decision part in the EHCPR. 'B' is the antecedent or precondition part. It contains the defining features of concept A. When 'B' is satisfied, it leads to take the action or decision given by 'A'. 'C' is censor (or exception) part of the 'If-Then-Unless' rule. An exception to a rule is a low likelihood condition which when satisfied blocks the 'If-Then' rule. The specificity information 'S' in an EHCPR is the clue about the next set of more specific entities and may also be regarded as goals, decisions, consequences, or actions in a knowledge base which are the most relevant and are most likely to be satisfied after successful execution of that EHCPR under the given situation. The general information 'G' in an EHCPR is the clue about the next general entity related to the entity 'A' up in the hierarchy. The 'Has_Part' and the 'Has_Property' operators relegates the characteristic features, which normally holds true but also at the same time are allowed to be false for an item, or individual who is an instance of that particular concept, in an extraordinary situation. The 'Has_Instance' operator represents information about every individual, example, or instance, belonging to that specific concept distinctly.

Parameter 'γ' is a numeric measure of "If" relationship between 'A' and 'B'. 'γ' is referred to as the 0–level strength of implication. Every censor (c1, c2, ..., cn) is associated with an estimate of its likelihood (δ1,..., δn) also called the certainty factor of that censor.

$'\delta' = \gamma + \textit{summation of all } \delta\text{'s}$ ....***(2)***

and is referred to as the 1–level strength of implication. A detailed discussion of 'γ' and 'δ' is given in [Bharadwaj and Jain 1992]. Their value is constrained to be greater than 0.5 and less than 1 for a meaningful and hence useful implication.

Each concept represented as an EHCPR can have various instances. For example, Titu and Mithu are instances of concept Bird and instances of concept Parrot to be more specific. 'Green of a leaf', 'Green of grass', and 'Green of a mango' are different instances of the concept Green. All instances of EHCPRs are represented uniformly through the same general form given here:

Head/* particular instance of a concept/ name of individual object
    Instance_Of   (a general concept)
    Has_Part   (set of actual known parts)
    Has_Property (set of known true properties) .... (3)

Here, *Head* is the name of the instance. *Instance_of* is the name of the concept, of which it is an instance. The override or peculiar attributes of an instance are kept with its *Has_Part* and *Has_Property* operators. Other attributes might be inherited by it through *'Instance_Of'* and subsequently by the *'Generality'* operator.

Components of the EHCPRs System

The EHCPRs system may be regarded to have two major components as many of the other AI systems have:

1. *Declarative Knowledge*
2. *Procedural Knowledge*

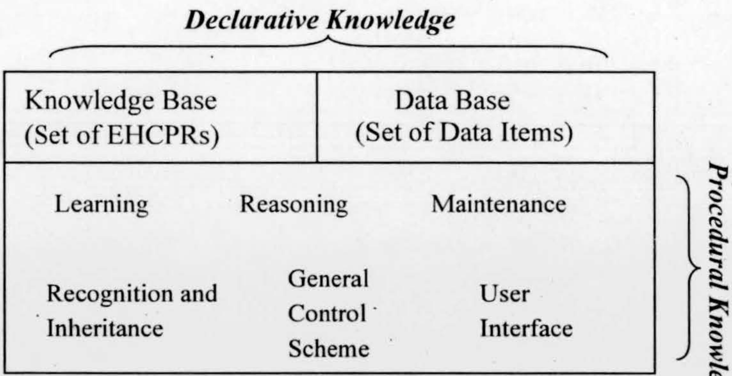


Figure 1 Components of EHCPRs System

The Declarative Knowledge part consists of:

1. The static knowledge base (KB) - Set of EHCPRs – consisting of all the EHCPRs representing rules, definitions, or structures which are independent of particular domain instances. It is similar to human long-term memory and consists of knowledge, which will be highly invariable with change in time.
2. The dynamic database (DB) - Set of Data Items – consisting of information or data derived by the system through its interaction with the outside world in relation to its permanent background knowledge. It is similar to the short-term memory of human beings, which is subject to major and frequent changes with change in time and location.

The Procedural Knowledge part consists of:

1. The EHCPRs Subsystem – consisting of the procedural knowledge imparting reasoning and learning power to the system. It includes programs for various learning strategies, knowledge maintenance techniques, general control scheme, procedures to impart semantic and pragmatic to various operators and symbols, inference rules, user interface, etc.

Various features of EHCPRs system are explored via its implementation in object oriented programming language Java [Jain et al 2008b, 2009a, 2009b, 2009b, 2010]. Recognition means matching and giving to an unknown input instance a suitable system entity name and is aptly regarded as its classification. Procedures for inheritance and recognition have already been shown to be successfully implemented in EHCPRs system [Jain et al 2009a]. Context-sensitive behavior is critical for any intelligent agent, whether biological or a machine. The EHCPRs system is already shown to behave differently by exhibiting variable precision in its decisions making and with amount of resources available [Jain et al 2009c]. A variable precision system is a system that exhibits either variable specificity or variable certainty or some trade-off between the two. A **mathematical simulation of the reasoning process constrained by employing a general control scheme (GCS), of variable precision logic, has already been explored in** [Jain et al 2008b]. The EHCPRs system exhibits the capability to acquire fresh knowledge through its regress interaction with the external world in a given working environment [Jain et al 2010].

In the following discussion, a set of related EHCPRs is called a cluster and is represented as a EHCPRs tree. An EHCPR in the EHCPRs tree is the smallest and simplest chunk of knowledge that may be created, modified, or removed without directly affecting the other EHCPRs in the EHCPRs tree (because of its declarative nature of representation). Here is an example set of related EHCPRs. The cluster formed by these EHCPRs is represented as EHCPRs tree below.

Animal {level 0}
If: {"Can move spontaneously and independently", "Can't manufacture its own food"}
Unless: Insect, Worm
Generality: Living Organism
Specificity: Bird, Fish, Reptile, Mammal, Amphibian
Has_Part: {Legs: 4, Teeth: Yes}
Has_Property: {Color: Brown, Voice: Shrill, Food Habit: Plants & meat}
Bird {level 1}
If: {"Bipedal", "Having a constant body temperature", "Lay eggs"}
Generality: Animal
Specificity: Crow, Ostrich, Parrot, Penguin, Sparrow, Kiwi, Eagle
Has_Part: {Legs: 2, Wings: Yes, Beak: 1, Teeth: No}
Has_Property: {Fly: Medium, Habitat: Nest, Voice: Sweet, Behavior: Active in day, Egg-size: Medium, Food Habit: Seed & insects}
Fish {level 1}
If: {"Lives in water", "Have gills and fins"}
Generality: Animal
Reptile {level 1}
If: {"Crawls", "Lay eggs"}
Generality: Animal
Mammal {level 1}
If: {"Their brain possess a neocortex", "Possess Sweet Glands"}
Generality: Animal
Specificity: Human, Aquatic, Hoofed, Marsupial, Carnivore, Rodent, Ape, Monkey
Has_Part: {Hair: Yes, Nipples: 2}
Has_Property: Habitat: Land
Amphibian {level 1}
If: {"Metamorphose"}
Generality: Animal
Crow {level 2}
If: {"Color is Black", "Voice is Harsh"}
Unless: Voice is sweet (Koel)
Generality: Bird
Specificity: Common Raven, Carrion Crow, Hooded Crow, Jackdaw, Rook
Has_Property: {Color: Black, Voice: Harsh}
Ostrich {level 2}
If: {"Large flightless bird", "Long neck & legs", "Run at speed about 65 km/hr", "Lays

the

known largest egg"}

Generality: Bird

Has_Property: {Fly: No, Egg-size: Large}

Parrot {level 2}

If: {"Found in most warm & tropical regions", "Most intelligent bird"}

Generality: Bird

Has_Part: {Beak: 1 and Sharp}

Has_Property: {Color: Green}

Has_Instance {Titu, Mithu}

Human {level 2}

If: {"Most Intelligent"}

Generality: Mammal

Specificity (Asian, African, Europe, America)

Has_Instance {John, Mary} .... ***(4)***

And a data item in the database for a particular instance of class Bird, say Titu:

Titu

Instance_Of (Bird)

Has_Part (Legs: 1)

Has_Property (Fly: No) .... ***(5)***

The EHCPRs System possesses the capabilities of an expert system, fuzzy logic system and a neural network system. The world knowledge is represented as a EHCPRs tree which is a systematic arrangement of various EHCPRs in a hierarchy. While acting as an **expert system**, the domain which is of interest is fetched from the knowledge base.

The root node in the EHCPRs tree represents the most general concept, and any child node is a more specific case of its parent node. As we move towards the leaf nodes, the concept becomes increasingly specific. Obviously, as the concept becomes more specific, the number of elements of its IF set increases. However, it is not required to list all such elements along with the EHCPR. This is because total inheritance is an inherent feature of the EHCPRs tree structure; each EHCPR in the hierarchy inherits the complete set of defining properties of its parent EHCPR and thus of all its ancestors. Each EHCPR has link to only those preconditions which are added at that EHCPR. Hence, in the tree representation, redundancy is minimized in the listing of defining properties. Also, each EHCPR in the hierarchy may or may not inherit all the characteristic attributes (parts and properties) of its parent node. The characteristic attributes can be overridden, or new characteristic attributes can be added at each EHCPR in the hierarchy. So, we may have a ***fuzzy inheritance***. Every EHCPR has link to only those characteristic attributes which are overridden or added.

To explain above points, consider the cluster (4). The defining properties of Animal (*Can move spontaneously and independently, Can't manufacture its own food*) are also inherited by all its descendants (Bird, Fish, Reptile, Mammal, Amphibian, Crow, Human), but are linked only with the EHCPR of Animal. The characteristic part Legs: 4 of Animal is inherited by Mammal, so it is not linked with Mammal. But the characteristic part Legs: 4 is overridden in Bird as Legs: 2. So Bird EHCPR has a link to Legs: 2. The Bird EHCPR also overrides the characteristic part Teeth: Yes to Teeth: No. The Bird EHCPR also has link to two added characteristic parts, Wings: Yes and Beak: 1.

As knowledge represented in human brain is independent at neuron level and related or connected to other neurons with the help of dendrites hence span **neural network**. Similarly here, an EHCPR is considered as an independent entity at rule level and it is related or connected to other EHCPRs via various operators or links and hence generate the networks of concepts. Each EHCPR like a neuron is smallest unit of knowledge in a EHCPRs system and has identical structure. An EHCPR is same as a node in a semantic network representation.

EHCPRs System as Decision Support System

EHCPRs systems support professionals engaged in design, diagnosis, or evaluation of complex situations. They can be used either as interactive advisors or as automated tools for converting data into recommendations or other conclusions. EHCPRs System helps in automating decisions if a great deal of information must be processed or if small time delays affect the outcome. By automating decisions, the EHCPRs system can improve efficiency or consistency and make errors less likely.

Bharadwaj and Jain [1992] suggested the following heuristic formula for the computation of the certainty factor of decision at the i^{th} level of specificity under forward chaining of reasoning:

$$CF(D_i) = min\ (CF(D_{i-1}), CF\ (premises\ for\ EHCPR_i)) * \delta \qquad \ldots (6)$$

$$\delta = \gamma_i + (\delta_1 + \delta_2 + \delta_3 \ldots \delta_n) \qquad \ldots (7)$$

Here, $EHCPR_i$ is an EHCPR at i^{th} level; D_i is the decision of $EHCPR_i$ at the i^{th} level ... and so on.

γ_i is 0 level strength of implication. It implies the certainty factor by which premises for $EHCPR_i$ alone determine D_i.

$\delta_1, \delta_2 \ldots \delta_n$ are estimates of the likelihood of exceptions c1, c2 ... cn.

δ is 1 level strength of implication. It implies the certainty factor by which premises for $EHCPR_i$ alone determine D_i, when C is known to be false.

Note that depending on the resource constraints and the user requirements on certainty / specificity, all censor conditions are evaluated, or some are evaluated, or censors are totally ignored. For details, see Bharadwaj and Jain [1992].

Example 1: As a special case, dropping the Has_Part, Has_Property, and Has_Instance operators of all EHCPRs as they do not play any role in the control scheme thus employed, here is a EHCPRs cluster displayed in EHCPRs tree form (figure 2).

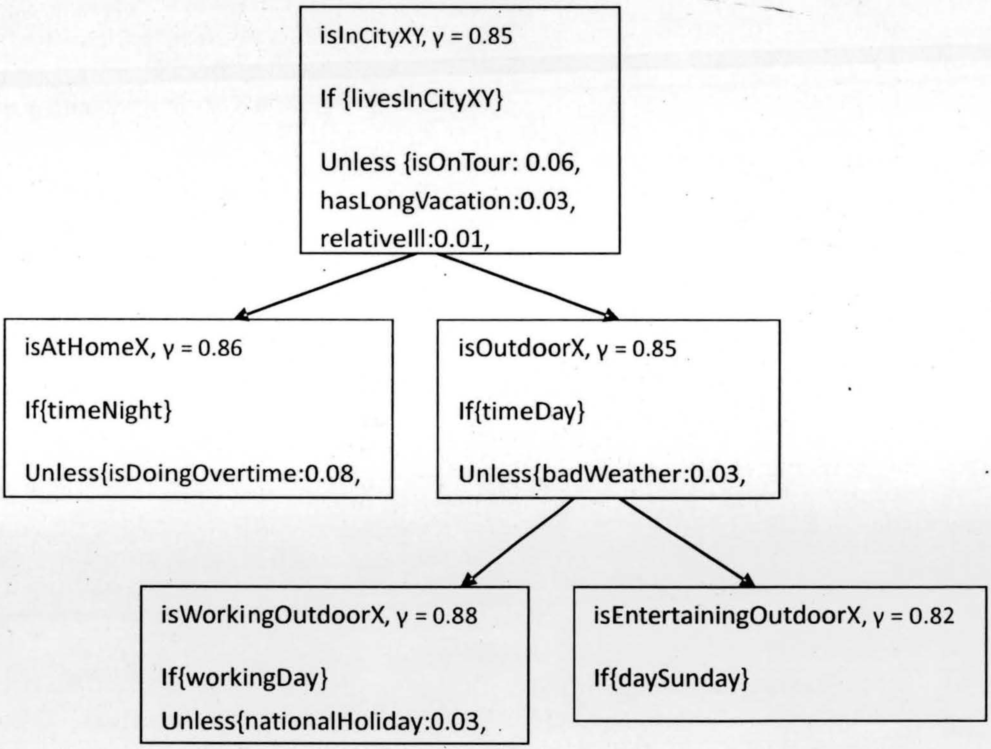


Figure 4.3 EHCPRs Tree for Daily Life Queries

This EHCPRs cluster is helpful for answering queries of the type:

"What is X doing"
"Is X Outdoor"
"Is X at Home"
"Is X Entertaining Outdoor"
"Is X Working Outdoor"

If an exception to an EHCPR at any level of specificity is found to be true then it would block all the decisions derived or derivable from the EHCPRs-tree with the blocked EHCPR as its root. In this way, the reasoning in the EHCPRs system is related to the non-monotonic reasoning.

Suppose that the certainty factor of premise livesInCityXY is 1, and

- if all censor conditions at level 0 are false,
  CF (isInCityXY) = 1.0 * (0.85+0.06+0.03+0.01+0.02+0.01) = 0.98
- isOnTour is Unknown, hasLongVacation is false, relativeIll is unknown, relativeMarriage is unknown, salesperson is false
  CF (isInCityXY) = 1.0 * (0.85+0.00+0.03+0.00+0.00+0.01) = 0.89
- Any one censor, say, hasLongVacation is True,
  CF(isInCityXY) = 1.0*(0.0)=0.0. Also, all certainty factors below level 1 will also be 0.0.

Further assuming, CF (isInCityXY) = 0.98 and the certainty factor of premise timeDay is 1,
CF (isOutdoorX) = min (0.98, 1) * (0.85 + (0.03 + 0.01 + 0.04)) = 0.9114

To see how a system based on EHCPRs system of representation concentrate on main line of reasoning, consider the above EHCPRs-tree for taking decisions of the type "*What is X doing right now?*" The reasoning system will first ask the query "*Which city does person X live in?*" from the user. Having got the reply that *X lives in city Y* (variable Y would be initialized to the name of the city) the system may conclude that *X is in the city Y* with variable 'YA' initialized to the computed value of certainty factor. In order to strengthen this decision further, the reasoning system may try to find *Is X on tour?* If it is found to be true, then the system will stop with the decision, '*X is on tour*'. Otherwise if this censor condition is found false, then 'YA' would be updated and system may proceed to get a more specific answer of type '*X is_at_home*' or '*X is_outside_home*' by asking or checking whether it is night or day time. Similarly, depending on the previously inferred general conclusion, say, *X is_outside_home*, the system could attempt for a more specific decision like '*X is_working_outdoor*' or '*X is_entertaining_outdoor*'.

A decision support system should avoid out-of-context rules to be tried by the reasoning system. Intelligent systems should be able to discard quickly most of the task irrelevant information and should concentrate on the main line of reasoning. For example consider the query "What is John doing?" Having found by reasoning process that "John is working in the yard", the next line of action by the system might be to get more specific answer if there are enough resources. At this state of the reasoning process the next set of rules selected by an intelligent reasoning system should give decisions of the following type:

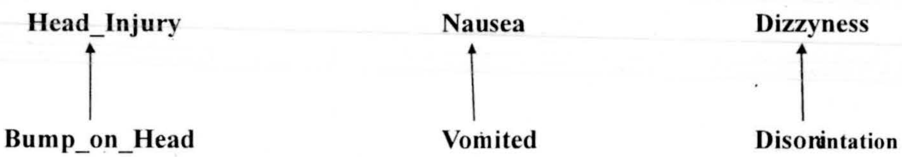
-- John is raking leaves, John is watering, and John is shaping plants.

Rather than the rules which give decisions of the type:

-- John is sleeping, John is out for a walk, and John is on tour.

These later decisions are totally unrelated to the previously inferred decision, i.e., "John is working in the yard". To a certain extent, HCPRs system is able to incorporate the above requirements on the reasoning system.

Example 2:



Brain_Hemorrhage

If(Head_Injury, Nausea, Dizzyness)

Perform_CATSCAN

If(Brain_Hemorrhage)

An emergency room EHCPRs system examines a 3 year's old injured in an automobile accident. The child has a bump on his head, has vomited, and seems disoriented. A EHCPRs system confronted with this information might search in the list of EHCPRs-tree for the facts/concepts bump on head, vomited, and disorientation. Find the most general concepts of the three given concepts to get Head Injury, Nausea, and Dizzyness. Search for a EHCPR with all these three general concepts in its If list. And the result is Brain Hemorrhage.

So the EHCPRs system suspects a brain hemorrhage. Using the fifth EHCPR, the EHCPR system performs the CATSCAN to rule out or confirm brain hemorrhage.

Inheritance is the form of reasoning that leads an agent to infer properties of a concept that is based upon the properties of its ancestors. For example, if the agent knows that birds fly, then given that "Sparrow is a bird" he may infer that "Chichi which is a sparrow flies". EHCPRs are assumed to be transitive with respect to **If, Specificity,** and **Generality** part of the rule, whereas they are non-transitive with respect to **Has_part** and **Has_property** operators. For example, consider the following two rules:
"Typically high school dropouts are adults"
"Typically adults are employed"

These statements might be converted into the following pair of EHCPRs.
High_school_dropouts

Generality (Dropouts)
If(Education : High School)
Has_property (Adult : Yes)

Adult

Generality (Human)
If(Age : >21)
Has_property (Employment Status : Employed, Marital Status : Married)

It may be inferred that "Typically high school dropouts are adults", but the **Has_property** operator cannot inherit any property from the EHCPR for Adult, such as whether they are employed or married.

In an EHCPR, the universal quantifier is implemented using the **If** and **Generality** operators, whereas, quantification like most, many, a large number of, typically, (or existential quantifier), and so on, are implemented trough the **Has_part** and **Has_property** operators. For example,
"All 21 years old are adults" and
"Typically adults are married"

would generally imply that typically 21 years old are married., which is normally false. But represented in the form of an EHCPR:
Adult

Generality (Human)
If(Age : >21)
Has_property (Marital Status : Married, Employment Status : Employed)

It is easily inferable that if 'John' is an instance of adult, then 'John is married and employed' is assumed, unless stated otherwise in the data item for the concept 'John'.

Conclusion

Artificial Intelligence Technologies have significantly strengthened the role that information systems play in supporting the decision making activities of every manager in business. AI is being applied to many applications in business operations and managerial decision making, as

Electronic voting

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ABSTRACT

Electronic voting is an application of cryptography. The automation should preserve the security of the traditional elections (especially the privacy of the votes). Mechanical voting booths and punch cards are already designed to replace paper ballots for faster counting. Fast, cheap and convenient voting process could have great impact on the contemporary democratic societies. Recent advances in communication networks and cryptographic techniques have made possible to consider online voting systems as a feasible alternative to conventional elections. Until today several protocols for electronic voting have been proposed, unfortunately only a few of them have been implemented in an end-to-end fully functional system. In this paper we present a secure electronic voting system for medium scale on-line elections in which, it accomplishes all the standard properties of conventional voting systems, namely, accuracy, democracy, privacy, verifiability, simplicity, flexibility and double voting detection.

Keywords : Electronic voting, Plurality/Majority Systems, Proportional Representation Systems, Semi proportional Systems, Voter Authentication, Online voting.

INTRODUCTION

Voting systems the procedures by which we cast votes and elect our public officials are a crucial part of the democratic election process. The decision to use one kind of voting system rather than another has far reaching political consequences. Among other things, voting systems help to determine which officials are elected to run our governments, the variety of parties that voters have to choose from at the polls, how many citizens will turnout to vote, which citizens will or will not be represented in our legislatures, and whether the majority will rule. Ultimately, the choice of voting system not only has a profound effect on the process of elections, but also on the degree to which a political system is fair, representative, and democratic.

A voting scheme must ensure not only that the voter can keep his vote private, but also that he must keep it private. In other words, the voter should not be able to prove to the third party that he has cast a particular vote. He must not be able to construct a receipt proving the content of his vote. This property is referred to as receipt-freeness. Only a few schemes guaranteeing receipt-freeness have been proposed **here.**

Types of electronic voting

Electronic voting refers to the use of computers or computerized equipment to cast votes in an election. Sometimes this term is used more specifically to refer to voting that takes place over the internet. Machine counting Machine-readable ballot systems require voters to mark their votes on a paper card with a pencil or marker, or remove divots from a perforated card with a stylus or mechanical hole puncher. The ballot cards may be scanned and tallied at a central computer centre or at each polling station.

There are three basic "families" of voting systems: plurality/majority, proportional representation, and semi proportional. All the voting systems within a particular family tend to produce the same kind of political results and tend to resemble each other in terms of their general political advantages and disadvantages. The main political differences are therefore between the families, not within them.

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