8-16-1996

The NuCINS(Nuclear Capability Identification of a Nation System) ---An Expert System for Political Intelligence Analysis

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1. Introduction.

Social science tends to deal with symbolic data rather than numeric one. Natural science could utilize information systems for manipulating numerical data easily while social science has been slow to adopt information systems largely due to the symbolic nature of data. The advancement of technique of manipulating symbolic representation of data, or knowledge in information systems such as expert system technology made the door open for social scientists. This paper presents a political intelligence analysis information system which processes symbolic data such as how democratic a nation is and produces a conclusion on the nuclear capability of a given nation. In political science area, the issue of politics of nuclear weapon has been researched extensively, i.e., there are human experts who can make an authoritative judgment on the nuclear capability of a nation by examining relevant data on the nation such as the existence of heavy-water nuclear reactor. The NuCINS(Nuclear Capability Identification of a Nation System) was developed as an expert system which can perform the intelligence analysis as the human expert.

Figure 3-1

2. System Development.

We had a series of interview sessions with a human expert who had an extensive knowledge on nuclear weaponry. We also relied on published material in [1], [2], [3], [4], [5], and [6]. We chose to follow rapid prototyping technique in developing the system, i.e., we first designed a prototype and incrementally improved it based on feedback from the human expert. We used C++ on a IBM PC-compatible machine. For knowledge representation method, we chose rules. In other words, the knowledge of the human expert was represented as "IF conditions THEN actions" format. For inference mechanism, we used forward chaining. In other words, rules on the leaves of a decision tree were first fired and then went forward up to the goal status. For data base implementation, we inserted names of all nations and their characteristics into a data base which was checked by the inference engine. The NuCINS was composed of a rule base, a data base, and an inference engine.

3. System Description.

When a user start the NuCINS, the following screen will be shown(see Figure 3-1).

This is a KBS for Identification of Nuclear Arms Capability of Nations.

The knowledge used in this system reflects the political situation of

the world up to 1995.

Enter current year. e.g.) 1995

1995

Enter the name of a nation:North Korea

The NuCINS was developed in 1995 using the knowledge reflecting the political situation in 1995. Since the knowledge on the political situation can change over time, we made it explicit that the system should be used for the current year, otherwise the conclusion from the system might be unreliable. When the user types the name of a nation which he wants to know about nuclear capability. The following screen will be shown(see figure 3-2).

Figure 3-2

NORTH KOREA has heavy-water nuclear reactors

NORTH KOREA has no nuclear fuel reprocessing plants

NORTH KOREA has no uranium enrichment plants

NORTH KOREA has no aircraft carriers

NORTH KOREA has less than one million soldiers in active duty

NORTH KOREA has a several-decade-long feud with an enemy

NORTH KOREA has enemies with much larger conventional weaponry

NORTH KOREA has experiences of war with other states since 1945

NORTH KOREA has totalitarian regime

NORTH KOREA has internationally recognized 'irrational' leadership

NORTH KOREA has no military-controlled government

NORTH KOREA has leadership who has a 'siege' mentality

NORTH KOREA has GNP per capita less than $10,000

NORTH KOREA has population less than 40 million

<NORTH KOREA has strong potential of having nuclear weapon> weight=7.800000

The NuCINS produces not only the conclusion that North Korea has strong potential of having nuclear weapon but also the facts that were used for inference. In addition, the weight of the conclusion is given which represents the degree of trustworthiness of the conclusion(the calculation of the weight is done in a

similar fashion as in MYCIN's probabilistic inference mechanism); the bigger the weight is, the more trustworthy the conclusion is. The conclusion can be one of "the nation has nuclear weapon", "the nation has strong potential of having nuclear weapon", "the nation has some potential of having nuclear weapon", and "the nation has no potential of having nuclear weapon".

Here is an example of the NuCINS output when typed with "Israel" as the nation of interest(see figure 3-3).

Figure 3-3

ISRAEL has heavy-water nuclear reactors

ISRAEL has nuclear fuel reprocessing plants

ISRAEL has no uranium enrichment plants

ISRAEL has no aircraft carriers

ISRAEL has less than one million soldiers in active duty

ISRAEL has a several-decade-long feud with an enemy

ISRAEL has enemies with much larger conventional weaponry

ISRAEL has experiences of war with other states since 1945

ISRAEL has no totalitarian regime

ISRAEL has no internationally recognized 'irrational' leadership

ISRAEL has no military-controlled government

ISRAEL has leadership who has a 'siege' mentality

ISRAEL has GNP per capita greater than $10,000

ISRAEL has population less than 40 million

<ISRAEL has nuclear weapon> weight=23.000000

Here is an example of the NuCINS output when typed with "Fiji" as the nation of interest(see figure 3-4).

Figure 3-4

FIJI has no heavy-water nuclear reactors

FIJI has no nuclear fuel reprocessing plants

FIJI has no uranium enrichment plants

FIJI has no aircraft carriers

FIJI has less than one million soldiers in active duty

FIJI has no several-decade-long feud with an enemy

FIJI has no enemies with much larger conventional weaponry

FIJI has no experiences of war with other states since 1945

FIJI has no totalitarian regime

FIJI has no internationally recognized 'irrational' leadership

FIJI has a military-controlled government

FIJI has no leadership who has a 'siege' mentality

FIJI has GNP per capita less than $10,000

FIJI has population less than 40 million

<FIJI has no potential of having nuclear weapon> weight=0.000000

Here is an example of the NuCINS output when typed with "South Korea" as the nation of interest(see figure 3-5).

Figure 3-5

SOUTH KOREA has no heavy-water nuclear reactors

SOUTH KOREA has no nuclear fuel reprocessing plants

SOUTH KOREA has no uranium enrichment plants

SOUTH KOREA has no aircraft carriers

SOUTH KOREA has less than one million soldiers in active duty

SOUTH KOREA has a several-decade-long feud with an enemy

SOUTH KOREA has no enemies with much larger conventional weaponry

SOUTH KOREA has experiences of war with other states since 1945

SOUTH KOREA has no totalitarian regime

SOUTH KOREA has no internationally recognized 'irrational' leadership

SOUTH KOREA has no military-controlled government

SOUTH KOREA has no leadership who has a 'siege' mentality

SOUTH KOREA has GNP per capita greater than $10,000

SOUTH KOREA has population greater than 40 million

<SOUTH KOREA has some potential of having nuclear weapon> weight=1.600000

4. Rule Examples.

Rules are formulated by the heuristic knowledge of the human expert. Following are the examples of rules.

a) IF a nation has no powerful enemy and experienced no battles in recent history

THEN the possibility of the nation's intention to have a nuclear weapon decreases

e.g.) Fiji, Austria, Tonga

b) IF a nation has a heavy-water nuclear reactor(or attempted to get it) and a history of conflict

THEN the possibility of the nation's intention to have a nuclear weapon increases.

e.g.) North Korea, Iran, Iraq

c) IF a nation has either a nuclear fuel reprocessing plant or an Uranium enrichment plant

THEN the possibility of the nation's intention to have a nuclear weapon increases

e.g.) United States, United Kingdom, France

d) IF a nation has leadership who has a "siege" mentality(believing being surrounded by enemies)

THEN the possibility of the nation 's intention to have a nuclear weapon increases

e.g.) Israel, South Africa(before the abolition of white rule)

e) IF a nation has a military-controlled and totalitarian government

THEN the possibility of the nation 's intention to have a nuclear weapon increases

e.g.) North Korea, Libya, Iraq

5. Conclusion.

The NuCINS is an example that demonstrates the viability of expert system technology in social science area. The human expert in social sciences can be used as the source of knowledge for various expert systems. For example, there can be an expert system to assess the degree of political stability of a regime; a human expert can produce heuristic knowledge on this matter which could be a valuable resource, if coded. The processing of symbolic data is now easy to implement due to advancement of artificial intelligence discipline. Social scientists can take advantage of this technique by developing expert systems, which will lead to jump-start information systems research in a school of social sciences.

6. References.

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