Expert Systems

(Semantic Networks and Frames)
Lecture 004

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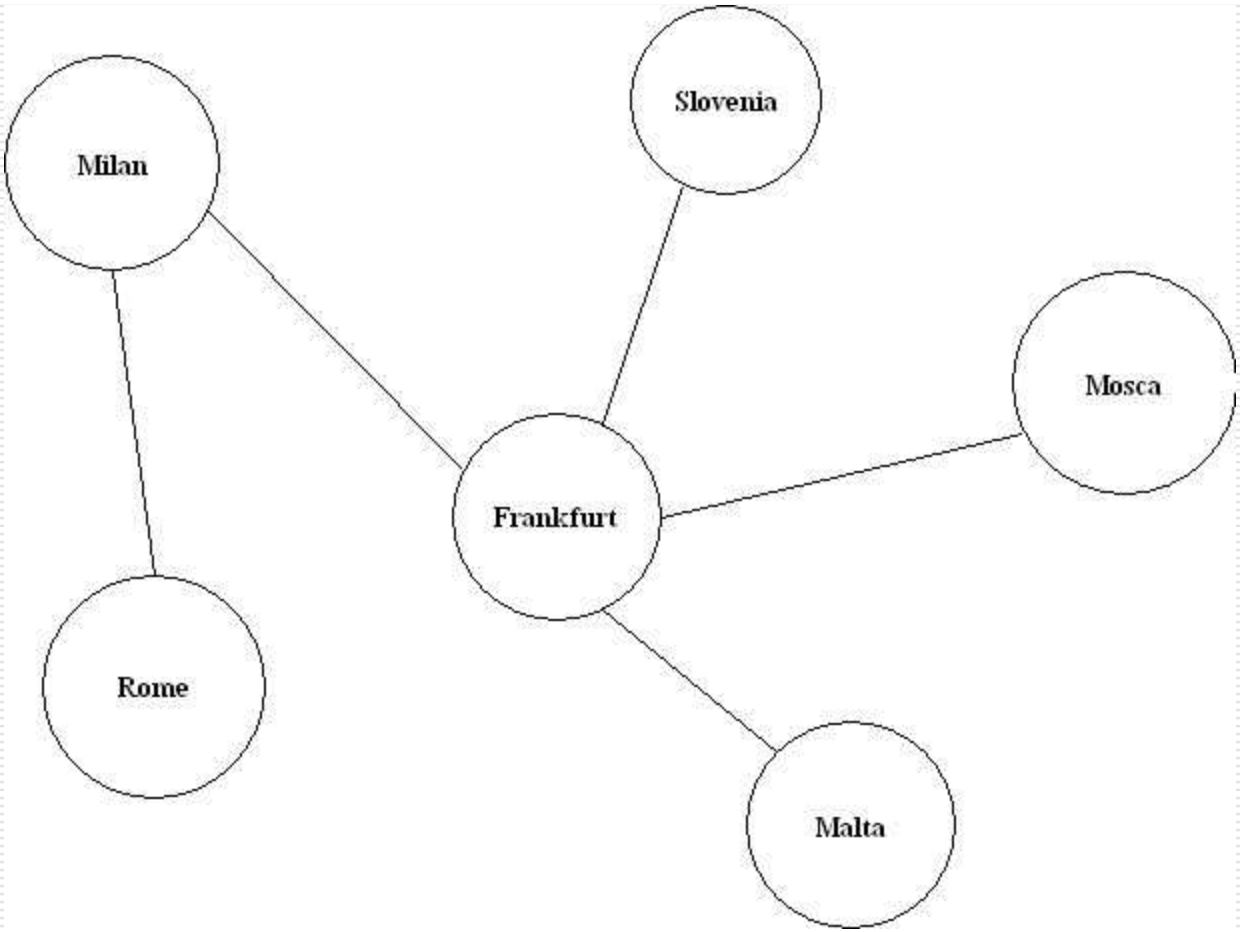
Semantic Nets

- A *Semantic Network, or net,* is a classic AI representation technique used for propositional information. (a.k.a. a propositional net).
- More formally, a semantic net is a labeled, directed graph.
- Semantic nets were first developed for AI as a way of representing human memory and language understanding by Quillian in 1968
- He used semantic nets to analyse the meanings of words in sentences. Note that the meaning of a sentence is not the same as parsing it into its tokens and lexical structure !!
- Semantic nets have been widely applied to many problems involving knowledge representation.

Semantic Nets Nodes and Arcs

- The structure of a semantic web is shown graphically in terms of nodes and the arcs connecting them.
- Nodes are sometimes referred to as *objects* and the arcs as *links* or *edges*.
  - The *links* of a semantic net are used to express *relationships.*
  - The *nodes* usually represent physical objects, concepts or situations.
- Next slide shows an example of a semantic net were the nodes represent cities and the links represent the directions in which planes can fly. Note that this is a directed graph.
- Note that relationships are of primary importance here, because they provide the basic structure for organizing knowledge. With relationships, knowledge is a cohesive structure about which other knowledge can be inferred. Ex. Transitivity of relations.

Semantic (Generic) Nets Example



Different Types of Semantic Networks (J.Sowa)

- Definitional Network
  - Emphasize the subtype or is-a relation between concept types and newly defined subtypes. The resulting network, also called a *generalization* or *subsumption* hierarchy, supports the rule of inheritance for copying properties defined for a supertype to all of its subtypes. Since definitions are true by definition, the information in these networks is often assumed to be necessarily true.

- Assertional Networks
  - are designed to assert propositions. Unlike definitional networks, the information in an *assertional* network is assumed to be contingently true, unless it is explicitly marked with a modal operator. Some assertional netwoks have been proposed as models of the *conceptual structures* underlying natural language semantics.

- Implicational networks
  - use implication as the primary relation for connecting nodes. They may be used to represent patterns of beliefs, causality, or inferences.

Different Types of Semantic Networks (J.Sowa)

- Executable networks
  - include some mechanism, such as marker passing or attached procedures, which can perform inferences, pass messages, or search for patterns and associations.
- Learning networks
  - build or extend their representations by acquiring knowledge from examples. The new knowledge may change the old network by adding and deleting nodes and arcs or by modifying numerical values, called *weights*, associated with the nodes and arcs.
- Hybrid networks
  - combine two or more of the previous techniques, either in a single network or in separate, but closely interacting networks.

The IS-A and A-KIND-OF relations

- Two types of commonly used links are the IS-A and AKO relations. They are very general relations between objects.

- Ex. Bronze is a kind of metal

Definitional Networks

- Check TrailerTruck example on handouts.

Assertional Networks

- Check the farmer owns donkey on notes (p.5)

Problems with Semantic Networks

- Although semantic networks can be very useful in representing knowledge, they have limitations such as the lack of link name standards. This makes it difficult to understand exactly for what the net is designed for. Ex.

- Suppose a node is labeled ‘chair’. Does it represent:
  - A specific chair
  - The class of all chairs
  - The concept chair
  - The person who is the chair of a meeting

- So, the binding of semantics to syntax is usually very difficult to decide.

- For a semantic net to represent definitive knowledge, that is, knowledge that can be defined, the link and node names must be rigorously defined. Of course the same occurs with programming languages and that’s why we study the semantics of programming languages.

Schemata (and Frames)

- A conceptual schema is an abstraction in which specific objects are classified by their general properties.
- For example: the conceptual schema of a real apple will include general properties of apples such as sizes, colours, tastes, uses and so forth. The schema will not include details of exactly where the apple was picked because this is not important to the properties that comprise your abstract concept of an apple.
- Schemas have some internal structure to their nodes while semantic nets usually don't. The label os a semantic net is all the knowledge about the node.
- In schemas nodes contain records.

Frames

- One type of schema used in many AI applications is the frame (Minsky 75)
- A frame is analogous to a record in a high-level programming language.
- A frame is basically a group of slots and fillers that define a stereotypical object. For example a frame of a car is given below.

Slots	Fillers
Manunfacturer	GM
Model	Chevrolet
Year	1979
Transmission	automatic
Tires	4
Etc…	

- The utility of frames lies in hierarchical frame systems and inheritance. The object oriented paradigm is very similar.

More complex frames

- This frame represents property:

Slots	Fillers
Name	property
Specialization_of	a_kind_of object
Types	(car,boat,house) if-added: Proc ADD_PROERTY
Owner	Government if-needed: Proc FIND_OWNER
Location	(home, work, mobile)
Status	(missing, good, poor