Frames

Here is the essence of the frame theory: When one encounters a new situation (or makes a substantial change in one’s view of a problem) one selects from memory a structure called a “frame.” This is a remembered framework to be adapted to fit reality by changing details as necessary (Minsky 1975).

- Frames, like scripts, are used in stereotypical situations
  - When a new situation is encountered, a frame may be recalled from memory
  - The frame provides a complete framework
  - Details may vary from situation to situation
  - Frames can provide default values
  - Frames can be arranged in a hierarchy

Conceptual Graphs and Frames

![Diagram of conceptual graphs and frames]
Components of a Frame

1. *Frame identification information.*

2. *Relationship of this frame to other frames.* The "hotel phone" might be a specific instance of "phone," which in turn might be an instance of a "communication device."

3. *Descriptors of requirements for frame match.* A chair, for instance, has its seat between 20 and 40 cm from the floor, its back higher than 60 cm, etc. These requirements may be used to determine when new objects fit the stereotype defined by the frame.

4. *Procedural information on use of the structure described.* An important feature of frames is the ability to attach procedural code to a slot.

5. *Frame default information.* These are slot values that are taken to be true when no evidence to the contrary has been found. For instance, chairs have four legs; telephones are pushbutton, or hotel beds are made by the staff.

6. *New instance information.* Many frame slots may be left unspecified until a given value for a particular instance or when they are needed for some aspect of problem solving. For example, the color of the bedspread may be left unspecified if the definition of bed.

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### Frame for a Hotel Room

- **hotel room**
  - specialization of: room
  - location: hotel
  - contains: (hotel chair, hotel phone, hotel bed)
  - superclass: bed
  - use: sleeping
  - size: king
  - part: (mattress frame)

- **hotel chair**
  - specialization of: chair
  - height: 20–40 cm
  - legs: 4
  - use: sitting

- **hotel phone**
  - specialization of: phone
  - use: (calling, room service)
  - billing: through room

- **mattress**
  - superclass: cushion
  - firmness: firm
Application of Frames to Vision

• Spatial Frame for a Cube

A Summary of Frames

• Frames organize knowledge into structures
• Frames are recalled on an as needed basis
• Procedures can be attached to frames where the procedure may process one of the slots in the frame in some way, such as detecting changes
• Frames support class inheritance
• Frames can supply default knowledge
• In essence, frames extended semantic networks by providing organization and structure
Issues in Knowledge Representation

• We have examined several ways to represent knowledge
  – Predicate calculus
  – Procedural, as in an expert system
  – Network, as in semantic nets, conceptual dependency and conceptual graphs
  – Structured, as in frames and scripts

• Particular problems arise with each type, we examine problems with more recent types
  – Hierarchies and inheritance
  – Exceptions

Inheritance - 1

• A hierarchy for birds
Inheritance - 2

- Multiple inheritance for “Opus”

Inheritance - 3

- A new class to resolve ambiguity
Transitivity of Subclasses

- Fixing one problem
  - Penguins don’t fly
  - Introduce a flightless bird class
- Results in other problems
  - If subclasses are transitive, we infer a penguin is a bird
  - This adds an extra link that introduces problems with multiple inheritance

Logic Systems

1. **Multiple-valued logics.** These extend logic by adding new truth values such as unknown to the standard values of true and false. This can, for example, provide a vehicle for distinguishing between assertions that are known to be false and those that are simply not known to be true.
2. **Modal logics.** Modal logic adds operators that enable it to deal with problems of knowledge and belief, necessity and possibility.
3. **Temporal logics.** Temporal logics enable us to quantify expressions with regard to time, indicating, for example, that an expression is always true or will be true at some time in the future.
4. **Higher-order logics.** Many categories of knowledge involve higher-order concepts, where predicates, and not just variables, may be quantified. Do we really need higher-order logics to deal with this knowledge, or can it all be done in first-order logic? If higher-order logics are needed, how may they best be formulated?
5. **Logical formulations of definitions, prototypes, and exceptions.** As we illustrated in the discussion of inheritance, exceptions are a necessary feature of a definitional system. However, careless use of exceptions undermines the semantics of a representation. Another issue is the difference between a definition and a prototype, or representation of a typical individual. What is the exact difference between the properties of a class and the properties of a typical member? How should prototypical individuals be represented? When is a prototype more appropriate than a definition?