# Frame-Based Systems

6.871 Lecture 9

## Outline

- Minsky's original motivations, observations
- Details and use
- In the spirit: PIP and Internist-1
- Not in the spirit: FRL
- Frames summary
- Comparison of KR technologies



## A KR Should Tell You

- What to attend to:
  "A Frame …[represents] a stereotyped situation…"
- What inferences are recommended:
  "When one encounters a new situation …, one selects from memory a structure called a frame… a remembered framework to be adapted to fit reality by changing details as necessary."

Minsky "A Framework for Knowledge Representation"



## Motivations and Observations

- A model of human cognition; the structure of knowledge memory; "common sense" reasoning
- Explain why understanding is …
  - fast
  - anticipatory
  - persistent over changes in perspective
  - tenacious: "Colorless green ideas sleep furiously."
- Meaning is poorly approximated by dictionary defns.
- Memory is full of prototypical situations, richly interconnected.



## Use

- Frames are a useful representation when the task is to *understand [or explain, react to] a new situation.*

"When one *encounters a new situation* …, one selects from memory a structure called a *frame*… a remembered framework to be *adapted to fit reality* by changing details as necessary."



## Details

- Frames are networks
  - Top levels fixed
  - Lower levels hold specific instances of data
  - Terminals holding data have easily displaced defaults
- Inferencing is matching of data to prototype
  - Subjective, approximate
- Optional (in the original conception):
  - Hierarchy of frames, inheritance
  - Daemons: procedures triggered when needed

## Example

Birthday Party



## In The Spirit: PIP

- Motivated by data on clinical cognition:
  - Quick focus on little data
  - Not easily refocused
  - Ask discriminating questions
  - Answer is an ordered list of matches
- Wanted expert level performance



## In The Spirit: PIP

| NephroticSyndrome | | |
|---|---|---|
| IS-A | ClinicalState | |
| Finding | Low Serum Albumin | |
| Finding | Heavy Proteinuria | |
| Finding | … | |
| MustNotHave | Proteinuria Absent | |
| Sufficient | Pedal edema and proteinuria > 5gm/day | |
| MayBeCausedBy | Acute Glomerulonephritis | |
| MayBeCompBy | Hypovolemia | |
| Scoring | | |
| Edema: | Massive, symmetrical: | 1.0 |
| | Not massive, symm. | 0.5 |
| | Asymmetrical | -0.5 |
| | … | |

- 70 Disease frames, 500 findings
- Variety of interconnections: MustNotHave, ComplicatedBy…



## PIP's Machinery

- Hypothesis generation via data-driven triggering
  - Frame moves into short term memory
  - "Nearby" frames become semi-active
- Hypothesis testing via calibrating match of data & frame
  - Match of frame and data
    - » Sufficiency, exclusionary rules
    - » Scoring
  - Ability to explain the findings
- Additional data gathering to fill terminals
  - Asks questions



## In the Spirit: Internist-1

- Doctors move from more general to more specific disorders
  - Need hierarchy of frames

| ALCOHOLIC HEPATITIS | | |
|---|---|---|
| AKO | Hepatitis | |
| Findings | | |
| Age 16-25 | 0 | 1 |
| Age 26-55 | 0 | 3 |
| Age >55 | 0 | 2 |
| Alcohol History | 2 | 4 |
| Causes Hepatatic Encephalopathy | 2 | 2 |

- Hierarchy, rooted on organ systems
- The numbers: evoking strength and frequency
- 500 disease frames, 3500 findings



## Internist-1: Reasoning

- Begin with lots of data
- Evoking strength determines active hypotheses
  - increased/decreased for present/absent findings
- Matching controlled by "undershoot" and "overshoot"
- Reasoning strategies
  - pursue, rule out, discriminate

## Not in the Spirit: FRL

- Task: a scheduler constraint propagation + common sense
- Hierarchical frames; viewed as "property lists"
- Wide variety of explicit slot types, e.g.:
  - Comments (source of value)
  - Defaults
  - Value
  - Constraints on values
- Attached procedures
  - IfNeeded, IfAdded, IfRemoved
- Looks like?



## FRL

| | | |
|---|---|---|
| MEETING | | |
| AKO | VALUE | Activity |
| WHO | REQUIRE | EXIST x Chairman(x) |
| WHEN | | |
| RA-GROUP-MEETING | | |
| AKO | VALUE | MEETING |
| WHERE | DEFAULT | ConferenceRoom1 |
| WHEN | DEFAULT | Friday |
| | PREFER | Weekday |
| ACTIVITY | | |
| AKO | VALUE | THING |
| WHEN | IfAdded | AddToCalendar |



## Not in the Spirit: FRL

- Where is the theory of intelligent reasoning?
- Where are the "glasses"?
- Instead of knowledge representation we have…?
- A common mistake: focus on *mechanism* instead of *intent*.



## Frames Summary

- Inspired by human understanding and reasoning
- Prototypes and matching as key concepts
- Representations evolve: Originally a model of human memory and cognition, now at times used more mechanistically



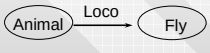
## Comparing the Technologies

Representation and reasoning using

Logic: bird(x) ➡ can-fly(x)

Rules: If class of animal is bird then animal can fly (.9)

SI-Nets:




Frames:

| | |
|---|---|
| Bird | |
| Class | Animal |
| Loco | Fly |



## Comparing the Technologies

Granularity of unit of meaning

- Logic
  - Axioms
- Rules
  - Centered around heuristic association
  - Individual inference step
- SI-Nets
  - Organized around "nouns"
  - Necessary and sufficient conditions
- Frames
  - Organized around prototypes
  - Meaning spread throughout the network.

## Comparing the Technologies

Reasoning

- Logic
  - Formal deduction
  - Results precisely determined
- Rules
  - Chains of heuristic associations
  - Uncertainties combined
- SI-Nets
  - Logic-based subsumption algorithm
  - Formal method and result
- Frames
  - Heuristic matching of instances to prototypes
  - Ranked by closeness

6.871 - Lecture 9 36