

# 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] ...”
- What inferences are recommended:

Minsky “A Framework for Knowledge Representation”

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  - *tenacious*: “Colorless green ideas sleep furiously.”  
Chomsky

# 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 ...

# 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	Hepatitis	
AKO		
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:       $\text{bird}(x) \rightarrow \text{can-fly}(x)$

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



Frames:

<u>Bird</u>	
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