

# **Frames and Commonsense**

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## **Winston, Chapter 10**

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# Representations

**powerful ideas** — the representation principle:  
*once a problem is described using an appropriate  
representation,  
the problem is almost solved.*

## four fundamental parts of a representation

- **lexical part:** determines which symbols are allowed in the representation's vocabulary
- **structural part:** describes how the symbols can be arranged
- **procedural part:** specifies access procedures (for creation, modification and questions)
- **semantic part:** establishes a way of associating meaning with the descriptions

# Commonsense and Expert Knowledge

To be considered an “**expert**,” one needs a large amount of knowledge of only a relatively few varieties.

An ordinary person’s “**common sense**” involves a much larger variety of different types of knowledge — and this requires more complicated management systems.

**Frank Lloyd Wright:** “An expert is one who does not have to think. He knows.”

**Herbert Simon:** “The smartest people in the world do not generally look very intelligent when you give them a problem that is outside the domain of their vast experience.”

# Defaults

- **default assumptions fill our frames to represent what's typical**
  - birds fly, unless .....
  - basketball players are tall, unless .....
  - dwarfs are small, unless .....
  - bathrooms have sinks, toilets, shower, mirrors ,  
..... (but no sofas, .....
- **question:**
  - why use default assumptions, instead of seeing what's really there?
  - unless we make assumptions, the world would simply make no sense
- **Minsky:**

The secret is that sight is intertwined with memory. When face to face with someone you've just met, you seem to react almost instantly — but not as much to what you see as to what that sight "reminds" you of. The moment you sense the presence of a person, a whole world of assumptions are aroused that are usually true about people in general. At the same time, certain superficial cues remind you of particular people you've already met. Unconsciously, then, you will assume that this stranger must also resemble them, not only in appearance but in other traits as well. No amount of self-discipline can keep those superficial similarities from provoking assumptions that may then affect your judgments and decisions.

# Context and Ambiguity (in Language, in Vision)

- The astronomer married the star.
- John shot two bucks
  - shot:
    - shooting a gun
    - making a bet
  - buck:
    - a dollar
    - a male deer
- implausible interpretations: people rarely shoot bullets at dollars  
bet deer
- possible interpretations:
  - people do bet dollars
  - shoot at deer
- further context: money & gambling <----> hunting, forestry, outdoor life

# Thematic-Roles Frames

- verbs specify actions
- noun phrases identify the objects that participate in the action
- reminder:
  - procedural semantics: <verb> <noun>, e.g.,  
“forward turtle 100”
  - object-oriented semantics: <noun> < verb>, e.g.,  
“turtle forward 100”
- example: “Robbie hit a ball with a racket”  
“hit” <-----> Robbie (agent) , ball (thematic object) ,  
racket (instrument)
- sentence analysis:
  - what thematic roles are to be filled by a sentence?
  - how is it possible to determine the thematic roles of the noun phrases in a sentence?

# An Example World

**Agent.** The agent causes the action to occur. Volition is generally implied, as in "Robbie hit the ball," but there are exceptions: "The moon eclipsed the sun." The agent is often the surface subject, but in a passive sentence, the agent also may appear in a prepositional phrase: "The ball was hit by Robbie."

**Coagent.** The word with may introduce a noun phrase that serves as a partner to the principal agent. The two carry out the action together: "Robbie played tennis with Suzie."

**Beneficiary.** The beneficiary is the person for whom an action is performed: "Robbie bought the balls for Suzie."

**Thematic object.** The thematic object is the object the sentence is really all about-typically the object undergoing a change. Often, the thematic object is the same as the syntactic direct object, as in "Robbie hit the ball." On the other hand, in a passive sentence, the thematic object appears as the syntactic subject as in "The ball was hit by Robbie."

**Instrument.** The instrument is a tool used by the agent. The preposition with typically introduces instrument noun phrases: "Robbie hit a ball with a racket."

**Source and destination.** Changes are often simple changes in physical position. The source is the initial position, and the destination is the final position: "Robbie went from the dining room to the kitchen."

# An Example World - Continued

**Old surroundings and new surroundings.** The old surroundings is the location out of which something comes, and the new surroundings is the location in which it goes: "Robbie took the cereal out of the box and put it into the bowl."

**Conveyance.** The conveyance is something in which or on which one travels: "Robbie always goes by train."

**Trajectory.** Motion from source to destination takes place over a trajectory. In contrast to the other role possibilities, several prepositions can serve to introduce trajectory noun phrases: "Robbie and Suzie went in through the front door; he carried her over the threshold."

**Location.** The location is where an action occurs. As in the trajectory role, several prepositions are possible, each of which conveys meaning in addition to serving as a signal that a location noun phrase is coming: "Robbie and Suzie studied in the library, at a desk, by the wall, under a picture, near the door."

**Time.** Time specifies when an action occurs. Prepositions such as at, before, and after introduce noun phrases serving as time role fillers, "Robbie and Susie left before noon."

**Duration.** Duration specifies how long an action takes. Prepositions such as for indicate duration. "Robbie and Susie jogged for an hour."



# Thematic-Role System

A thematic-role system is a representation that is a frame system in which

- The slots are, typically, verb, agent, coagent, beneficiary, thematic object, instrument, source, destination, old surroundings, new surroundings, conveyance, trajectory, time, location, and duration.
- Each frame describes an action. The verb slot identifies the action. Other slots identify objects that play various roles with respect to the action.

# Thematic-Role in Question Answering

## example sentence:

*Robbie made coffee for Suzie with a percolator.*

## questions which can be answered:

- |                          |                 |              |
|--------------------------|-----------------|--------------|
| • What was made?         | thematic object | coffee       |
| • Who made it?           | agent           | Robbie       |
| • With what was it made? | instrument      | a percolator |
| • For whom was it made?  | beneficiary     | Suzie        |

## example sentence:

*Robbie went to the theater with Suzy by car.*

## questions which can be answered:

- |                                  |             |             |
|----------------------------------|-------------|-------------|
| • Who went?                      | agent       | Robbie      |
| • With whom did he go?           | coagent     | Suzie       |
| • To where did he go?            | destination | the theater |
| • By what means did they travel? | conveyance  | car         |

# Constraints Establish Thematic Roles

## prepositions

by  
location  
with  
for  
from  
to

## allowable thematic roles

agent or conveyance or  
coagent or instrument  
beneficiary or duration  
source  
destination

example:

“Robbie ate with a fork with a gazerle”

“Robbie ate with a fork and a gazerle”

# Constraints Help Establish Verb Meanings

## use of particles:

he threw some food  
he threw away some food  
he threw up some food

## use of worlds:

physical world  
mental world  
ownership world

## To Determine Thematic Roles

- Obtain possible verb meanings from the dictionary. Throw away those verb meanings that are inconsistent with the verb's particle, if there are any.
- Find the thematic object among the preposition-free noun phrases.
- Throw away the verb meanings that the dictionary says are inconsistent with the thematic object.
- For each remaining noun phrase, determine the thematic role.
- Throw away the verb meanings that the dictionary says are inconsistent with the observed thematic roles.

## “Take” — Different Meanings

- **Take1** means transport. Either a source or a destination or both should appear.
- **Take2** means swindle. The source and destination roles are absent when this meaning is intended. Only people can be swindled.
- **Take3** means to swallow medicine. The available medicines include aspirin. The beneficiary is the same as the agent.
- **Take4** means to steal. People are not stolen.
- **Take5** means to initiate and execute a social event with another person. The particle “out” is always used.
- **Take6** means to remove. The particle “out” is always used. People cannot be removed.
- **Take7** means to assume control. The particle “over” signals this meaning.
- **Take8** means to remove from the body. The particle “off” is always used.

# Constraints

Thematic role class	Preposition	Allowed
agent	by	person
coagent	with	person
beneficiary	for	person
thematic object		
instrument	with	
source	inanimate	
destination	from	
old surroundings	to	
	out of	
new surroundings	inanimate	
	into	
conveyance	inanimate	
	by	
duration	inanimate	
	for	a time

# SUMMARY

- A thematic-role frame is an action-oriented representation focused on identifying the roles played by various objects.
- Primitive-action frames and state-change frames constitute an action-oriented representation focused on using background knowledge to identify primitive actions and infer subactions and state changes.
- Various constraints establish thematic roles and verb meanings. Once a thematic-role frame is instantiated, it can be used to answer questions about who or what played what role in an action.
- Instantiated primitive-action frames and state-change frames can be used to answer questions about what probably was done or what probably happened next.