

Bridging Text and Knowledge with Frames

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Talk Outline

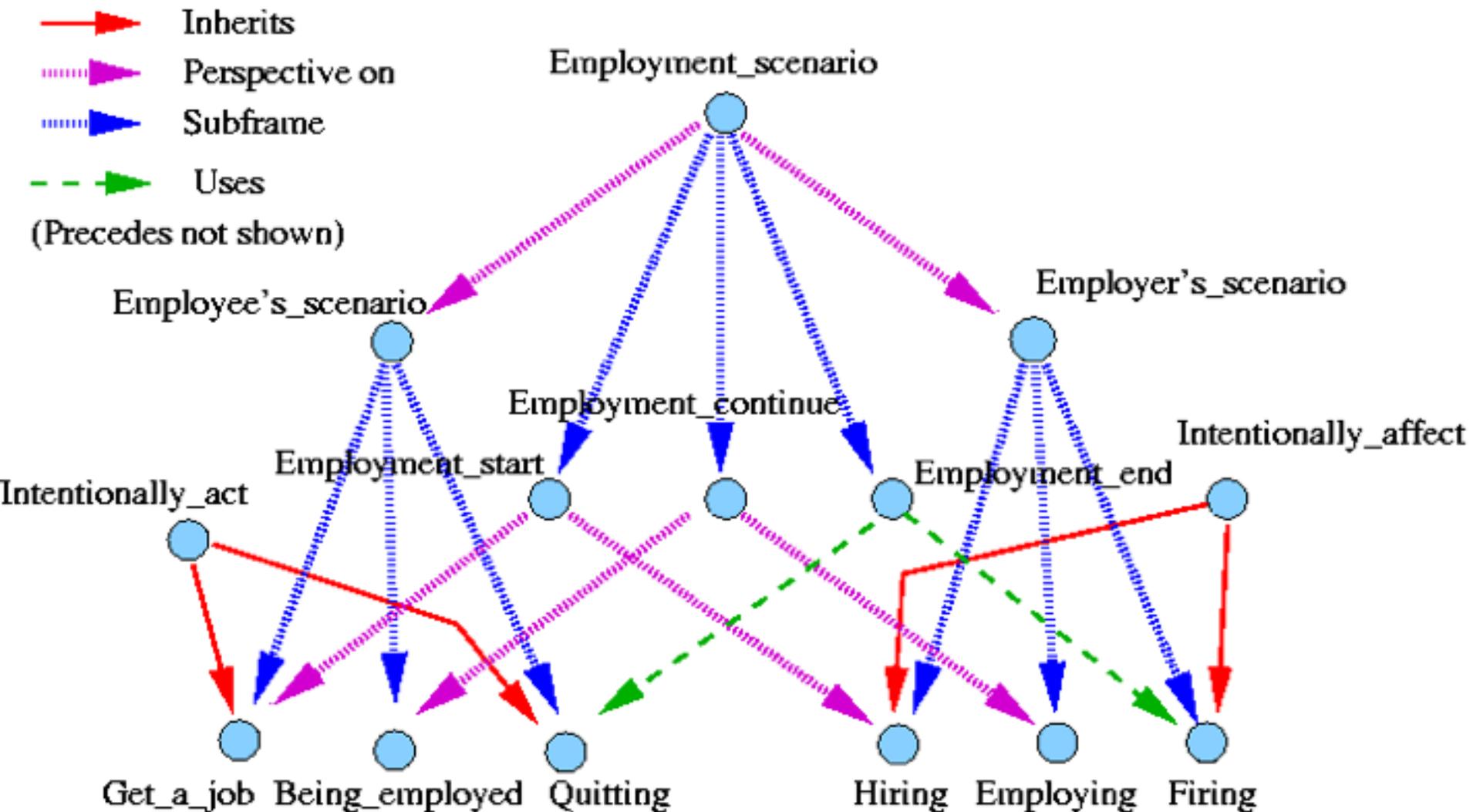
- Introduction
- FrameNet and Inference
- Applications
 - Question Answering
 - Metaphor
- Evidence for Framing
- Conclusions

The FrameNet Project

- FrameNet is a lexical resource organized around Semantic frames:
 - events, relations, and states which are the basis for understanding groups of word senses,
 - e.g. the Being_employed frame contains *work.v*, *position.n*, *employed.a*, *jobless.a*, etc.
- Frames are distinguished by the set of roles involved, known as **frame elements**, in this case, **Employee**, **Employer**, **Field**, **Place of employment**, etc.
- Sentences are annotated to exemplify these FEs, e.g.
[Employee She] [Time recently] *accepted* [Contract_basis part-time] work [Employer at ICSI].
- FN currently contains > 1,100 frames and 170,000 annotations



The FrameNet Project



“Two arraigned on heroin charges”

Arraignment

[Lexical Unit Index](#)

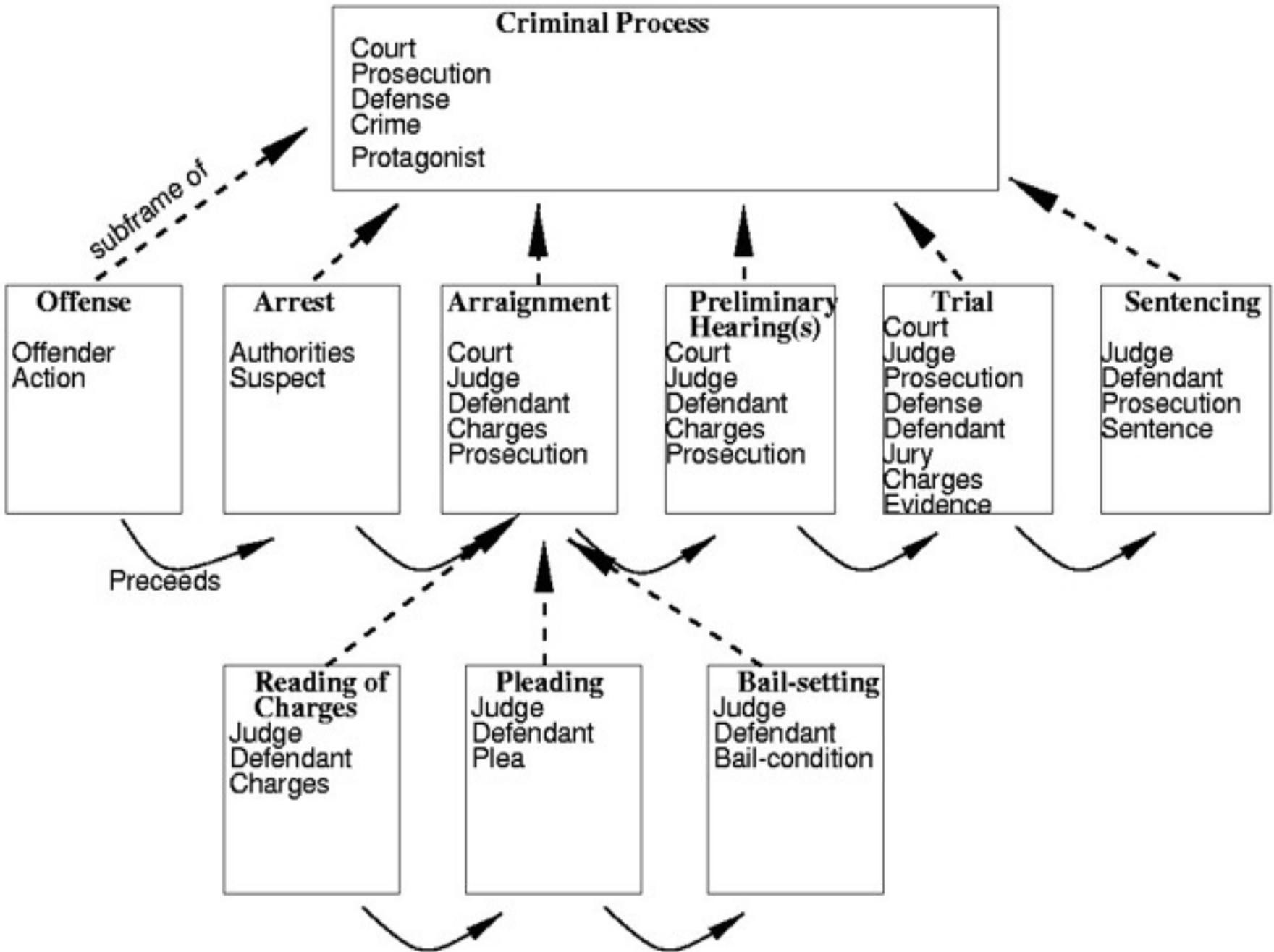
Definition:

At a court hearing, a **Defendant** is informed of the **Charges** against him or her, (usually) enters a plea, and a decision is made by a **Judge** as to the amount of bail, if any.

Mortimer and Isabella were hurried off and **ARRAIGNED** **before parliament** **in November**.

If the court rejects the appeal, **the 19 young men** face **ARRAIGNMENT** **on murder charges** **before the tribunal** **in the southern city of Port Harcourt**.

Frame descriptions are **textual** guides for annotation...
... and do not support (much) **inference**.



FrameNet and IE

- Mohit and Narayanan (2003) “Semantic Extraction with Wide-Coverage Lexical Resources”
 - Frames --> IE templates
 - LUs expanded via WordNet
 - News stories Extraction (P = .71, R = .65)

LU	Distribution	Frame 1	Frame 2	Prec
Charge	65-35	Commerce	Crime	90%
Find	80-20	Verdict	Becoming aware	85%
Head	50-50	Leadership	Self Motion	70%

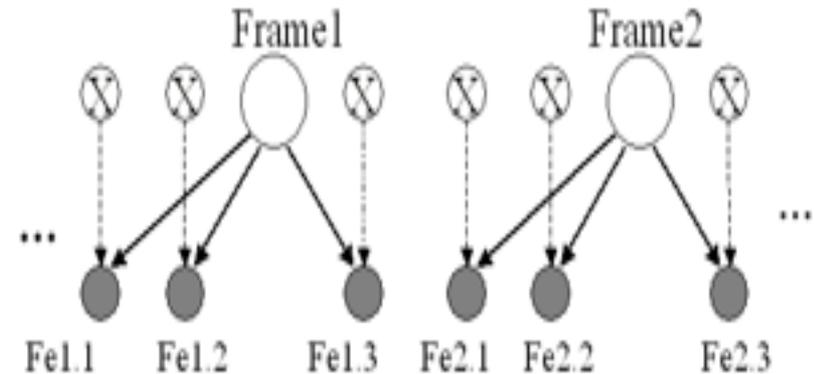
Frame Assignment

- **General Garner heads Iraq's reconstruction plan.**
- **General Garner heads to Iraq for reconstruction plan.**

- Question: Which frame gains the
- highest posterior probability from
- the combination of semantic roles?

$$MAP = \arg \max_{fr} p(fr | (fe1, fe2, \dots))$$

$$\arg \max_{fr} \frac{p(fr) \prod_{i=1}^n P(fe_i | fr)}{\sum_{fr} P(fe1 | fr) P(fe2 | fr) \dots}$$



⊗ Words subsumed by highest relevance WN Node

Some Results

- A corpus of 848 NYTimes News stories
 - Worked on ambiguous lexical units
 - Automatically tagged 24000 sentences.
- Low incremental cost of frames for new domain, LUs for a new language.
 - Use existing term bases, NER.
- FN has many general verbs, can add domain-specific ones in new frames with nouns--> deeper semantics than word-based

Frame-based inference

event structure / aspectual inference

e.g. *buy* vs. *buying*

perspectival inference

e.g. *buy* vs. *sell*, *buy* vs. *pay*

resources

e.g. *spend*, *cost*, *worth*

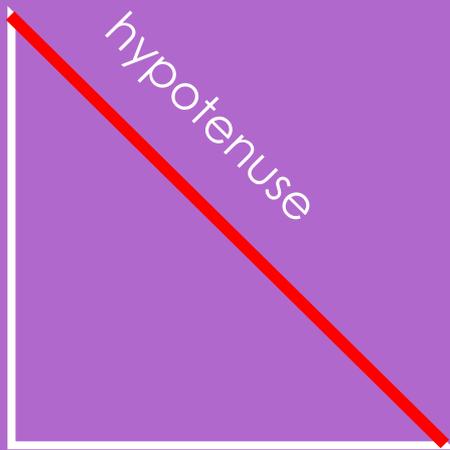
planning (goals, preconditions, effects)

How can these inferences be **unpacked**?

Frame semantics and perspective



buying and selling



Chuck bought a car from Jerry for \$1000.

Jerry **sold** a car to Chuck for \$1000.

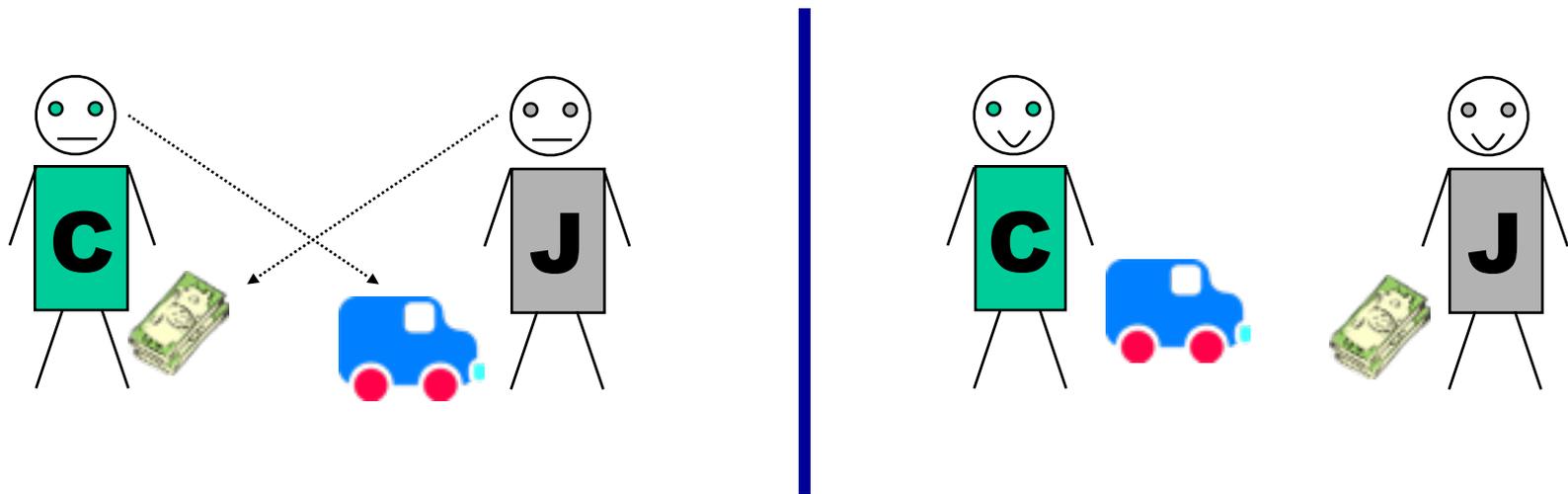
Chuck **paid** Jerry \$1000 for a car.

Chuck **spent** \$1000 on a car.

The car **cost** Chuck \$1000.

Chuck **is buying** a car from Jerry for \$1000.

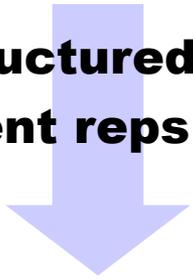
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Chuck bought a car from Jerry for \$1000.

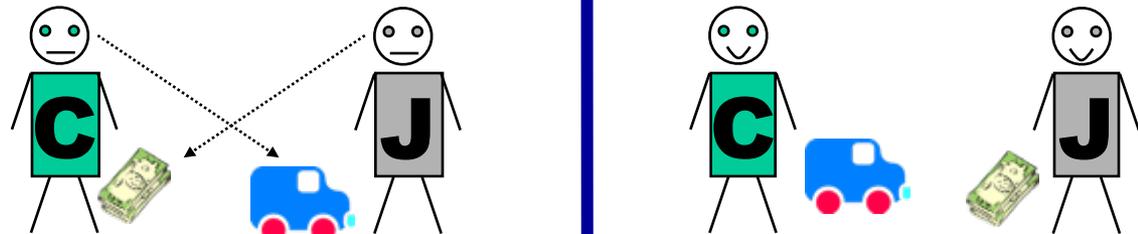
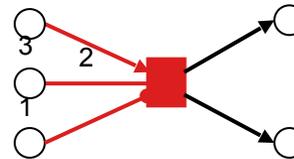
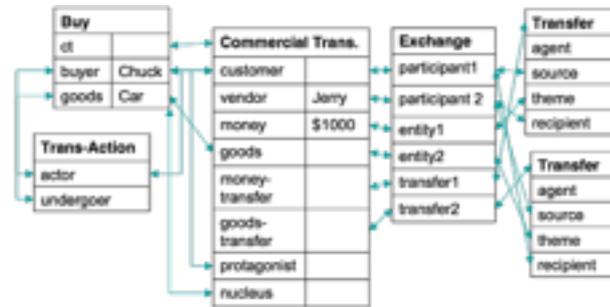
FrameNet

Structured
event reps

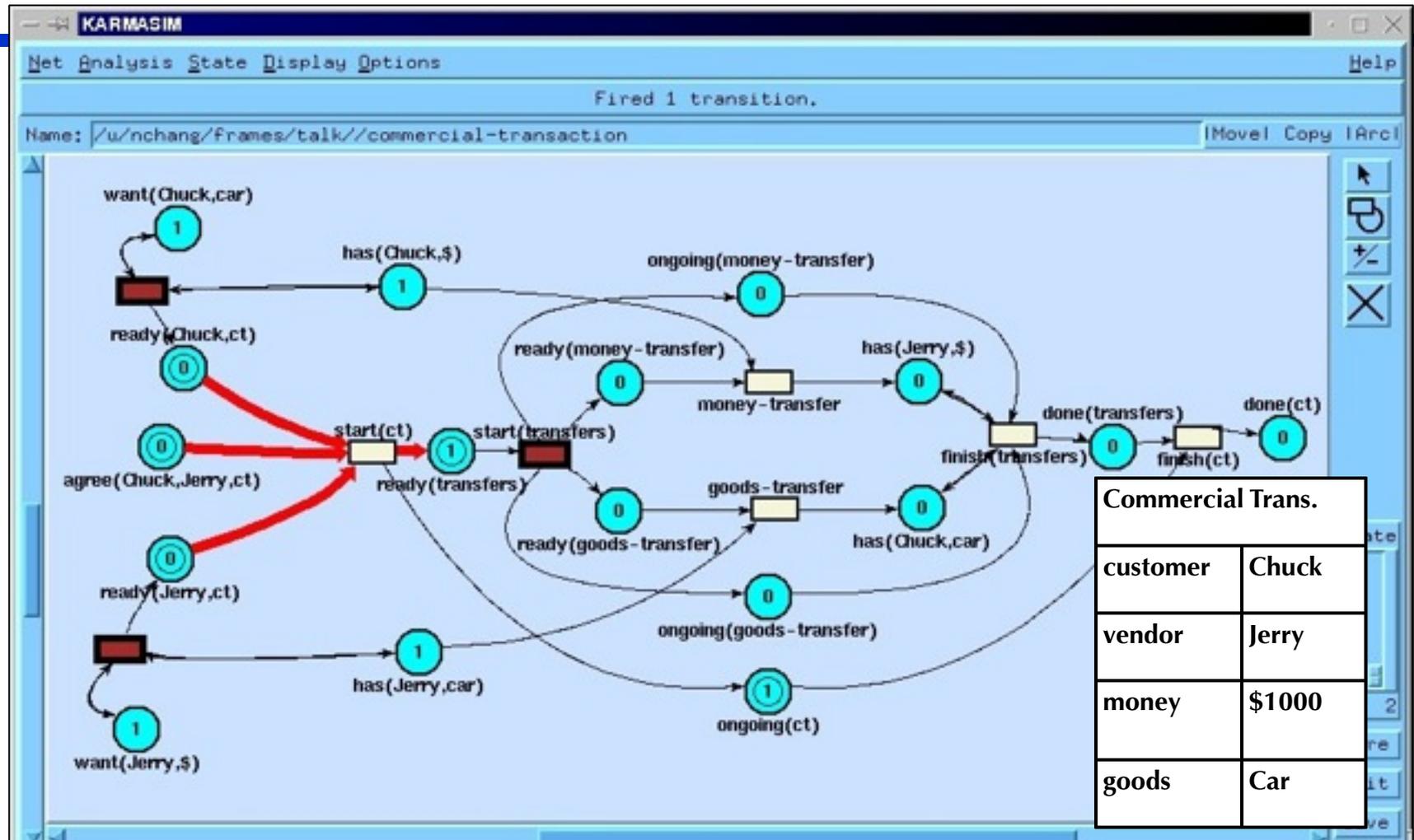


Simulation
semantics

Chuck bought a car from Jerry for \$1000.
Buyer **Goods** **Seller** **Payment**

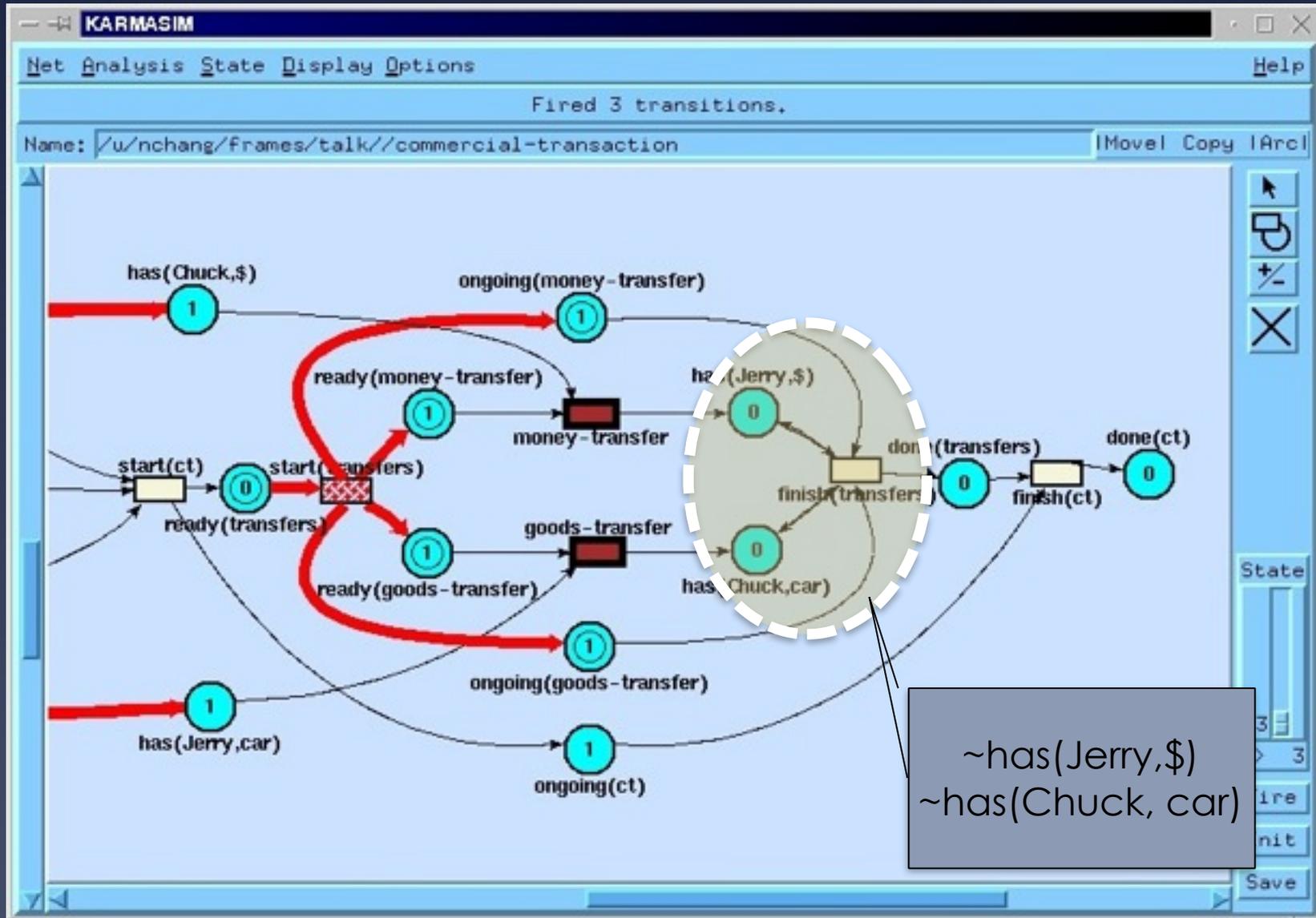


Active simulation engine

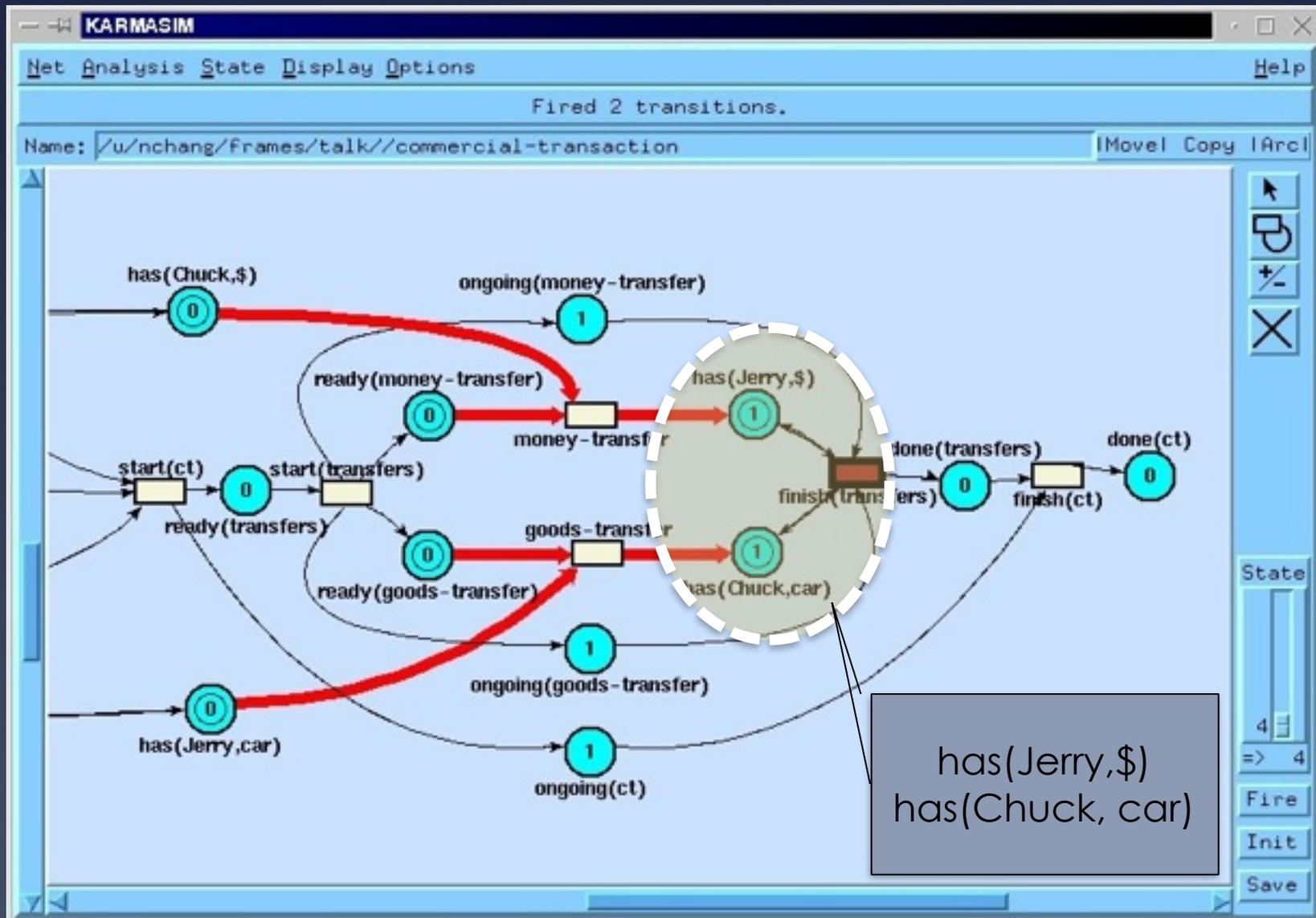


Chuck bought a car from Jerry. (*start*)

Chuck bought a car from Jerry (ongoing)



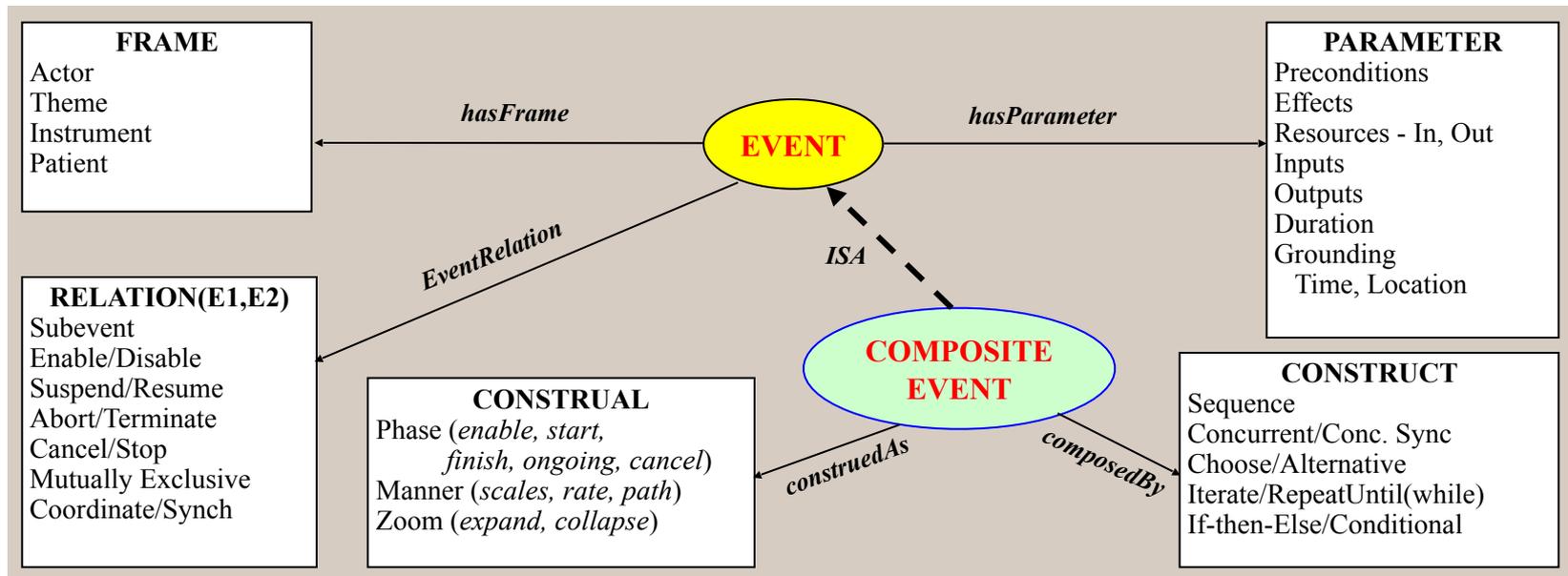
Chuck bought a car from Jerry. (*finish*)



How do we specify an event?

Formalized event schema

- Key elements
 - preconditions, resources, effects, sub-events
 - evoked by frames (alternatively: predicates, words)
- Contrast with Event Recognition/Extraction, other NLP work
 - [Bethard '07], [Chambers '07]



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Answering Questions about Complex Events (Sinha 2008)

Many questions they have to answer with the data are, implicitly or explicitly, about event interactions



Event Models for Question Answering

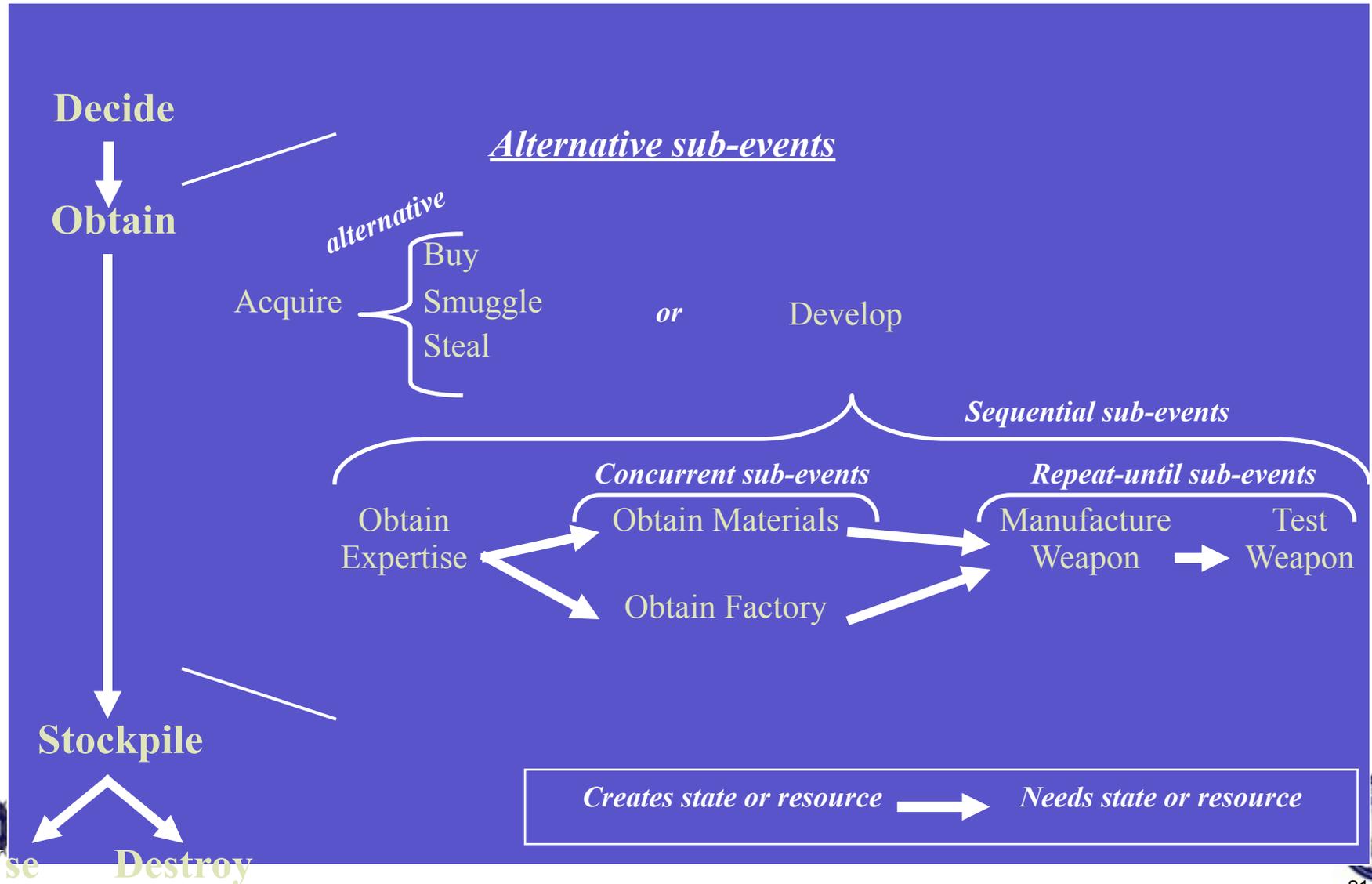
Steve Sinha (PhD Thesis 2008)

Tackle prominent question types. Assumes question and **frame analysis** (UTD, Stanford)

Justification	Is Iran a signatory to the Chemical Weapons Convention?
Temporal Projection/ Prediction	What were the possible ramifications of India's launch of the Prithvi missile?
Ability	Is Syria capable of producing nuclear weapons?
"What-if" Hypothetical	If Canada has Highly Enriched Uranium, is it capable of producing nuclear weapons?
System Identification	How does a management action reveal the possibility of legal or illegal programs?
System Control	What action is necessary to force management to follow a different trajectory?



Compose complex scenarios: Obtain WMD model



Basic System: find the exact same frame

PASSAGE: The continued willingness of the Democratic People's Republic of Korea (DPRK), the People's Republic of China (PRC), and Russia to *provide* Iran with both missiles and missile-related technology that at the very least exceed the intentions of the Missile Technology Control Regime (MTCR). This has been complemented, to a lesser extent, by the willingness of other nations (e.g., Libya and Syria) to cooperate within the realm of ballistic missile development.

Question: What countries have *provided* Iran with ballistic missiles and missile-related technology? (lcch 9)

Q Frame: Supply

Supplier: <?Country> What countries

Recipient: <Iran> Iran

Theme: <Ballistic_missile> with ballistic missiles and missile-related technology

Ans Frame: Supply

Supplier: <North_Korea, China, Russia> the Democratic People's Republic of Korea (DPRK), the People's Republic of China (PRC), and Russia

Recipient: <Iran> Iran

Theme: <Missile> with both missiles and missile-related technology ...

The question drives the match

Event model extends matching capability

Question

Does Egypt possess BW stockpiles?

Possession [Own:Egypt, Pos:BW]

Index into event models

↓

Getting [Rec:Egypt, Thm:BW]
Theft [Perp:Egypt, Gds:BW]
Commerce_buy [Byr:Egypt, Gds:BW]
Manufacturing [Man:Egypt, Pro:BW]
Storing [Agt:Egypt, Thm:BW]
...

Answer Candidate #4

“... Egypt bought BW.”

Commerce_buy [Byr:Egypt, Gds:BW]

MATCH!

Evaluated on Complex Process and Pathway Models

- More than a dozen complex models
 - Funded and Evaluations by IARPA under AQUAINT and PAINT (COLING 2004, AAI 2006, Sinha 2008)
 - Treaty Process
 - Obtaining WMDs (general)
 - Biological WMD Production
 - Israel-Lebanon Conflict
 - Biological Pathway models
 - Technology Development Pathways/Probes

Complete Pathway simulations with 100s of processes, 3 pathways, >15K dynamically generated PDFs runs in 3 secs. on a std. laptop

Simulator software downloadable from

<http://www.icsi.berkeley.edu/~snarayan/PAINT/software/api/index.html>

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MetaNet

Goal: to build a system that extracts metaphors from text in four different languages

English, Persian, Spanish, Russian

Purpose: To understand the role metaphor plays in how people from different cultural backgrounds make judgments and decisions



Conceptual Metaphor

- Many abstract concepts have conventional metaphorical conceptualizations: normal everyday ways of using concrete concepts to reason systematically about abstract concepts.
- Most abstract reasoning uses embodied reasoning via *metaphorical mappings from concrete (source frames) to abstract domains (target frames)*

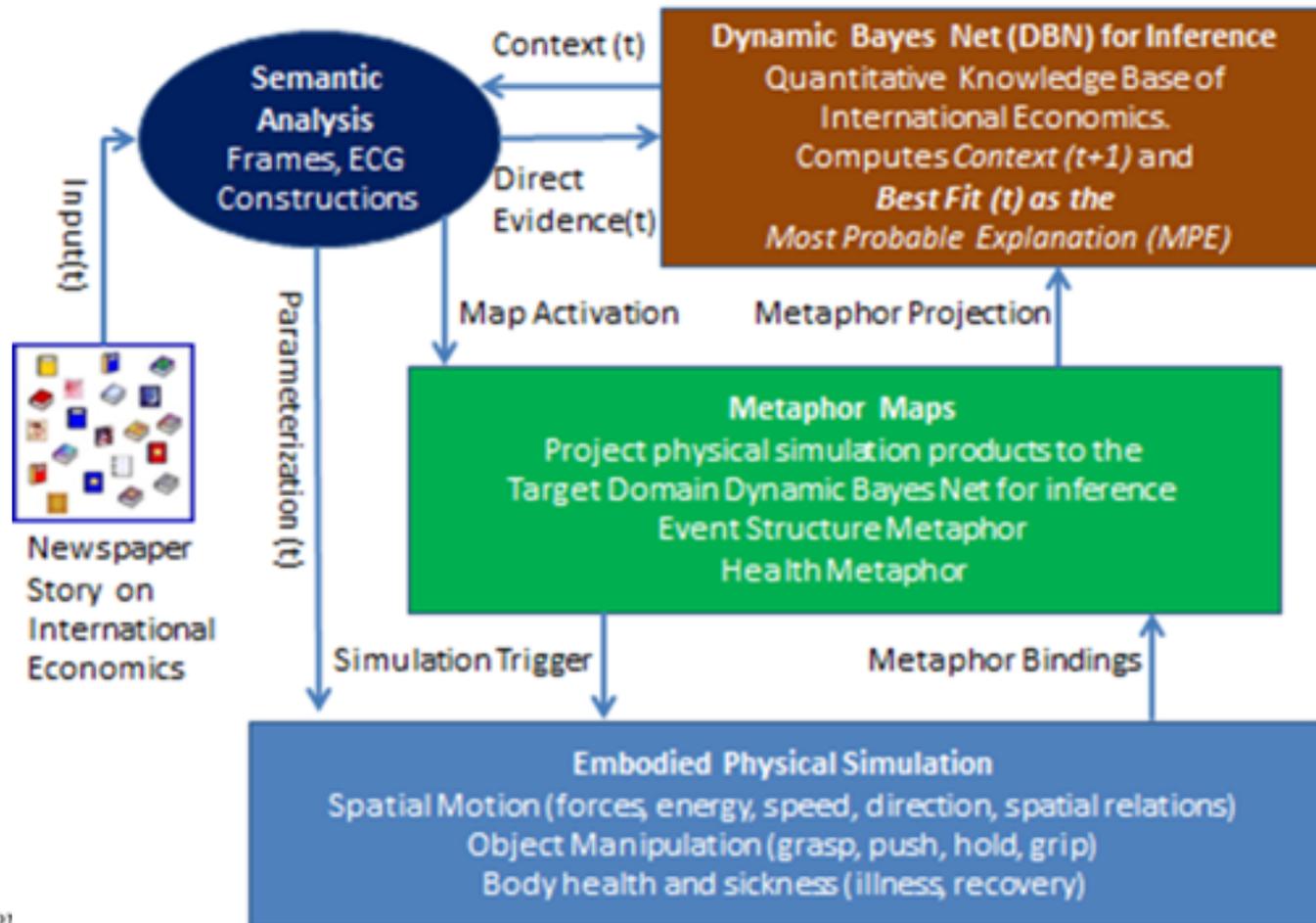


A Pilot Task: Interpret simple newspaper stories

- France **fell into** recession. **Pulled out** by Germany.
- US Economy on **the verge of falling back** into recession after **moving forward** on an **anemic recovery**.
- One year ago, the American economy was **teetering on the verge of total collapse**.
- Indian Government **stumbling** in implementing Liberalization plan.
- **Moving forward** on all fronts, we are going to be **ongoing** and **relentless** as we **tighten the net** of justice.
- The Government is **taking bold new steps**. We are **loosening** the stranglehold on business, **slashing** tariffs and **removing obstacles** to international trade.

Technical Details: A Pilot System

(Narayanan 1997, 2010, 2012)



Previous Results

- Model was implemented and tested on discourse fragments from a database of 50 newspaper stories in international economics from standard sources such as WSJ, NYT, and the Economist.
- Results show that motion inferences are often the most effective method to provide the following types of information about abstract plans and actions.
 - Information about **uncertain events and dynamic changes in goals and resources**. (sluggish, fall, off-track, no steam)
 - Information about **evaluations of policies and economic actors and communicative intent** (strangle-hold, bleed). *Affect is transferred from the source to the target domain.*
 - Communicating **complex, context-sensitive and dynamic economic scenarios** (stumble, slide, slippery slope).
 - Communicating complex **event structure and aspectual information** (on the verge of, sidestep, giant leap, small steps, ready, set out, back on track).
- Papers at (<http://www.icsi.berkeley.edu/~snarayan/publications.html>)

Scaling Up: Combining Multiple Systems

- Dual systems
 - Conceptual Semantics:
 - Construction based system for LM detection
 - Mapping to Sources through Schemas and Frames
 - Affect identification with source and target frames
 - Distributional Semantics
 - Seed based semi-supervised system for LM detection
 - Mapping to sources through subcategorization and distributional information

Conceptual Semantics

- Based on over three decades of the *science of metaphor*
- Integrate results of metaphor science into the engineering systems
- Use construction analysis to identify and analyze metaphoric constructions
- Use automatic mapping to Metaphor schemas and frames

Distributional Approach (Shutova)

- Data-driven, statistical approach
- Distributional and subcategorization information to assign the corresponding conceptual metaphors (CMs) and source dimensions
- Linguistic annotation experiments and supervised learning to model affect of LMs.
- Multilingual topic modeling experiments to detect cross-cultural differences
- (NAACL 2013, CL 2013, COLING 2013)

LM Detection Performance

- m4detect on internally developed Gold Standard:
 - Tuned to favor precision
 - EN Recall=0.836 (153/183) Precision=0.793 (153/193)
 - ES Recall=0.804 (115/143) Precision=0.891 (115/129)
 - FA Recall=0.484 (44/91) Precision=0.423 (44/104)
 - RU Recall=0.545 (67/123) Precision=0.971 (67/69)
 - Tuned to favor recall
 - EN Recall=0.847 (155/183) Precision=0.718 (155/216)
 - ES Recall=0.846 (121/143) Precision=0.691 (121/175)
 - FA Recall=0.527 (48/91) Precision=0.358 (48/134)
 - RU Recall=0.626 (77/123) Precision=0.846 (77/91)

LM/CM Mapping Performance

- On internally developed Gold Standard
- m4mapping
 - EN Recall=0.760 (139/183) Precision=0.777 (139/179)
 - ES Recall=0.748 (107/143) Precision=0.775 (107/138)
 - FA Recall=0.407 (37/91) Precision=0.536 (37/69)
 - RU Recall=0.675 (83/123) Precision=0.748 (83/111)
- m4source
 - EN Recall=0.710 (130/183) Precision=0.710 (130/183)
 - ES Recall=0.622 (89/143) Precision=0.627 (89/142)
 - FA Recall=0.308 (28/91) Precision=0.406 (28/69)
 - RU Recall=0.504 (62/123) Precision=0.525 (62/118)

State of the Repository

- Implemented for all four languages:
 - RDF triplestore repository, Semantic MediaWiki environment, LM extraction, SQL export
 - Automatically Extracted Mappings
 - 1200 Vetted Conceptual Mappings (Frame to Frame)
 - 10000 Linguistic metaphors (lexicalized mappings)
 - ~150000 example annotations
- Connection to inference
 - Probabilistic Network Analysis
 - Inference through simulation
- Initial results in several ICLC 2013 papers, NAACL 2013 (Shutova)



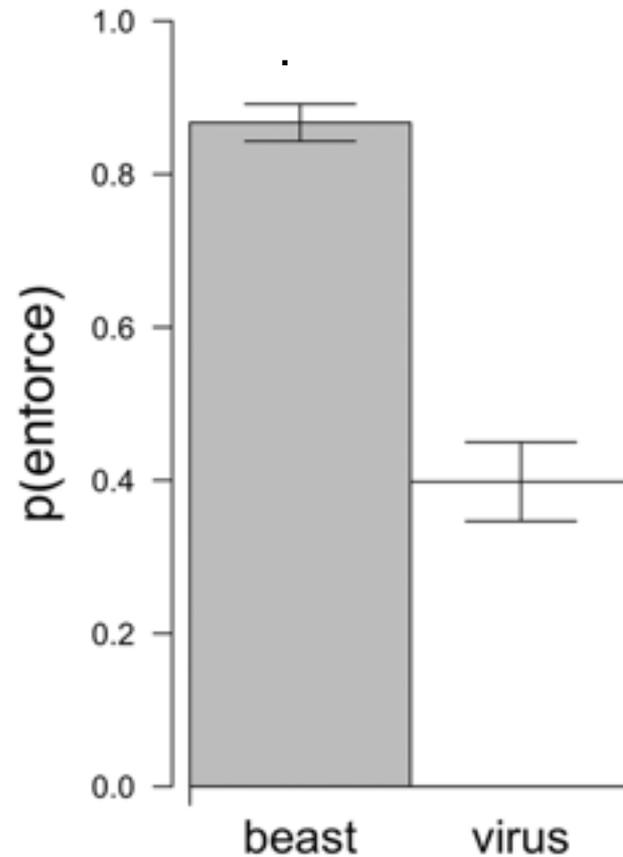
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Validation of the cognitive aspects of metaphor

- Corpus Methods
- Basic Scalar measures
 - familiarity, accessibility, acceptability, imageability, well-formedness, conventionality, metaphoricity, informativeness, and productivity
- Behavioral Tests
 - lexical and conceptual priming, inference. measures of memorability, paraphrasing and explication, gesture, eye, body tracking
- Affective Aspects
 - Behavioral (IAT, Psychological measures)
 - Imaging
 - Metaphoric activation of emotional circuits
 - » anterior insula, and the fear and reward circuits of the amygdala and the nucleus accumbens.

Crime: Beast or Disease



Thibodeau PH, Boroditsky L (2013) Natural Language Metaphors Covertly Influence Reasoning. PLoS ONE 8(1): e52961. doi:10.1371/journal.pone.0052961

<http://www.plosone.org/article/info:doi/10.1371/journal.pone.0052961>

Elections (Teenie Matlock)

Focus: POLITICAL CAMPAIGNS ARE RACES

Manner	slow vs. fast “motion”
	<i>Candidate A <u>is racing/inching</u> ahead of Candidate B</i>
Aspect	perfective vs. imperfective
	<i>Candidate A <u>raced/inched</u> ahead of Candidate B</i>
Viewpoint	ahead vs. behind
	<i>Candidate A moved <u>ahead of</u> Candidate B vs. Candidate B moved <u>behind</u> Candidate A</i>

American political messages are replete with such language in an election year

Used by journalists, politicians, campaign managers, and just about everybody in predicting and discussing election outcomes

In other languages/cultures, this may be less entrenched (e.g., Russian, not bi-partisan)

Main question: How do motion metaphors influence our reasoning about elections and is their power enhanced/diminished by other information?

Why important → (1) Affects who gets into office and governs; (2) provides new insights into how metaphor interacts with other dimensions of language

Results

We found that manner of motion (e.g., *race*, *inch*) influenced

- (1) confidence about whether a political candidate would win an election
- (2) margin of victory (how many more votes)

We also found that

- (3) aspectual form (*was* VERB+ing vs. VERB+ed) influenced confidence
- (4) manner of motion interacted with viewpoint (Candidate A ahead, Candidate B behind) for margin of victory: People are sensitive to manner of motion in the ahead perspective, but not in the behind perspective.

Economic inequality metaphors (Ben Bergen, Lisa Aziz-Zadeh)

- Gap, canyon, chasm

There is a widening gap, growing chasm between the rich and the poor

- Barrier, obstacle, hurdle

People face insurmountable obstacles, countless barriers, daily hurdles

- Race

unable to keep up, lagging behind, getting ahead

Are frames and metaphors psychologically real?

- Do these competing framings make people reason differently about economic inequality?
- Can exposure to metaphors change...
 - What people think is the cause of inequality
 - What people think should be done about it
 - How people feel about the rich and the poor

Conclusion

- Natural language understanding requires
 - semantic representations that support dynamic, uncertain, event based inference.
- We now understand the extraction algorithms and inference techniques that bridge multiple levels
 - NE and Extraction-based
 - Framing and Inference
 - Mappings and Metaphor
 - Narratives and stories

Frame Semantics is crucial for the bridge!

- Ongoing work
 - Frame Induction
 - Metaphor Learning (Neural Computation 2013)
 - Event Synthesis



THANKS FOR THE PRIVILEGE

