Natural Language Processing

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CS 365 Artificial Intelligence

Two views of Grammar

The question "How can you construct a grammar with no appeal to meaning" is wrongly put, since the implication that obviously one can construct a grammar with appeal to meaning is totally unsupported.

- Chomsky, Syntactic Structures 1957, p.93

[Cognitive grammar] takes the radical position that grammar reduces to the structuring and symbolization of conceptual content and thus has no autonomous existence at all.

- Langacker, Grammar and Conceptualization, 2000 ,p.3

Autonomy of Syntax

1. Colorless green ideas sleep furiously.
2. Furiously sleep ideas green colorless.

Both are meaningless yet we can judge 1 as grammatical and 2 as ungrammatical.

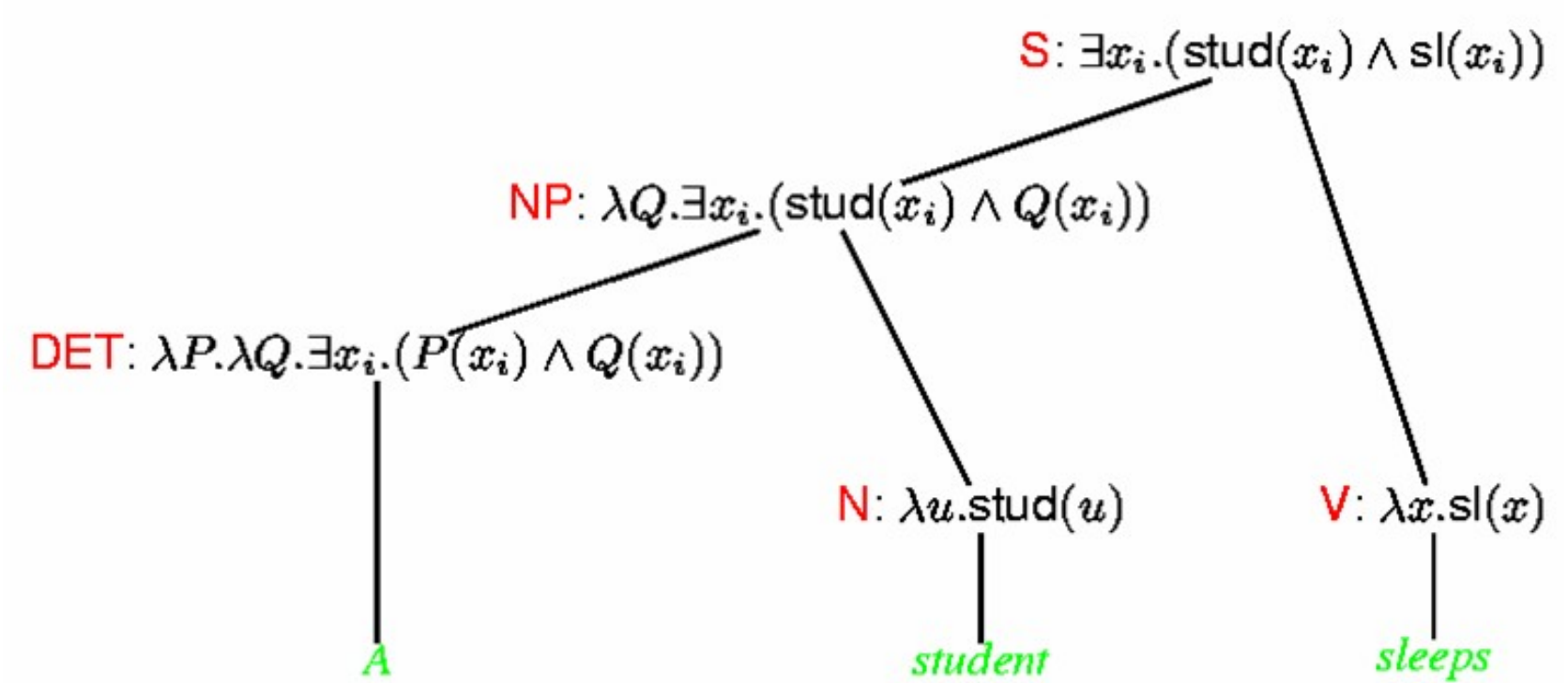
Hence syntax is independent of meaning.

Probabilistic Grammar

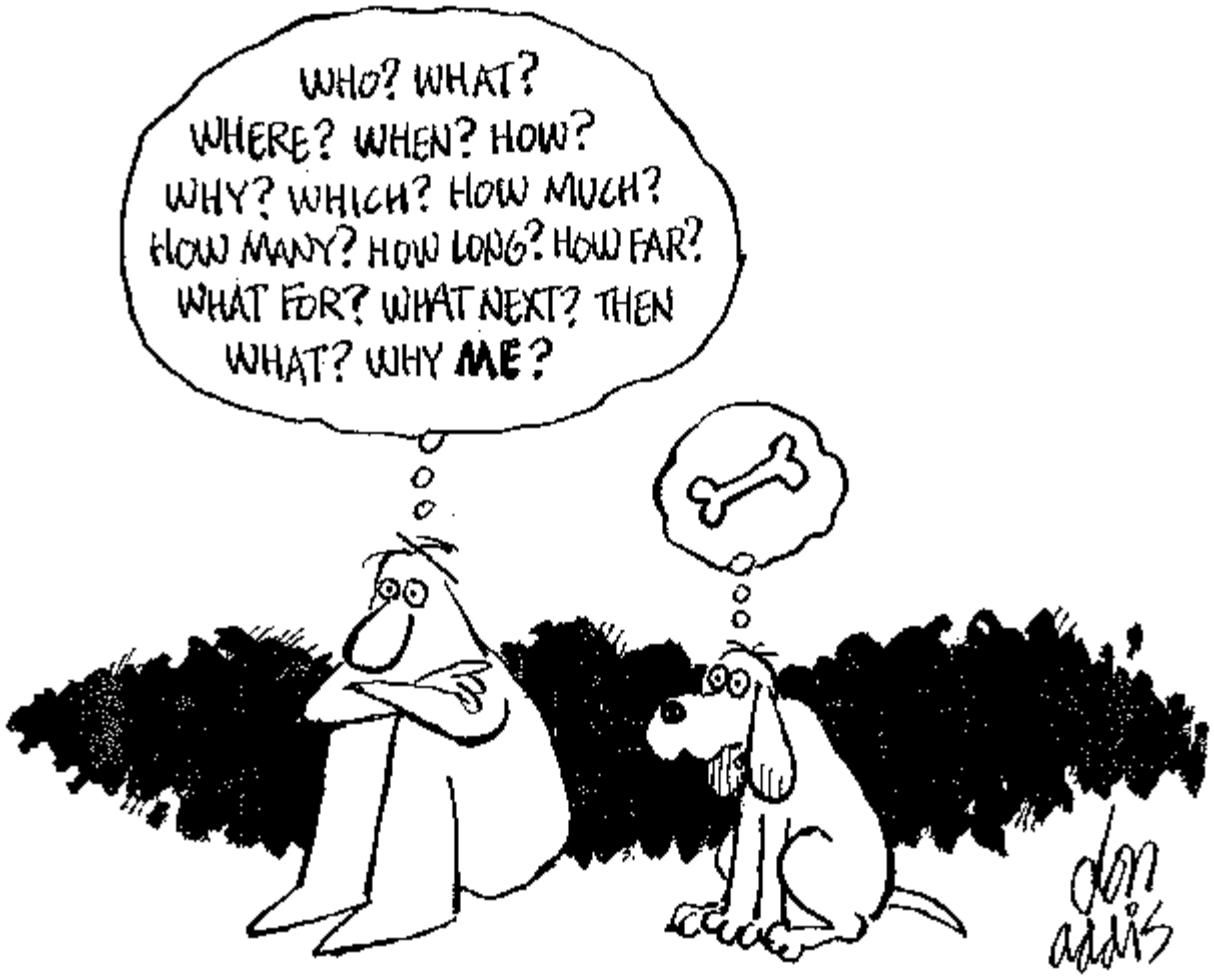
$$
\begin{array}{lcl}
S & \rightarrow & NP\ VP\ [1.00] \\
\\
NP & \rightarrow & Pronoun\ [0.10] \\
 & | & Name\ [0.10] \\
 & | & Noun\ [0.20] \\
 & | & Article\ Noun\ [0.50] \\
 & | & NP\ PP\ [0.10] \\
\\
VP & \rightarrow & Verb\ [0.60] \\
 & | & VP\ NP\ [0.20] \\
 & | & VP\ PP\ [0.20] \\
\\
PP & \rightarrow & Preposition\ NP\ [1.00]
\end{array}
$$

Semantics

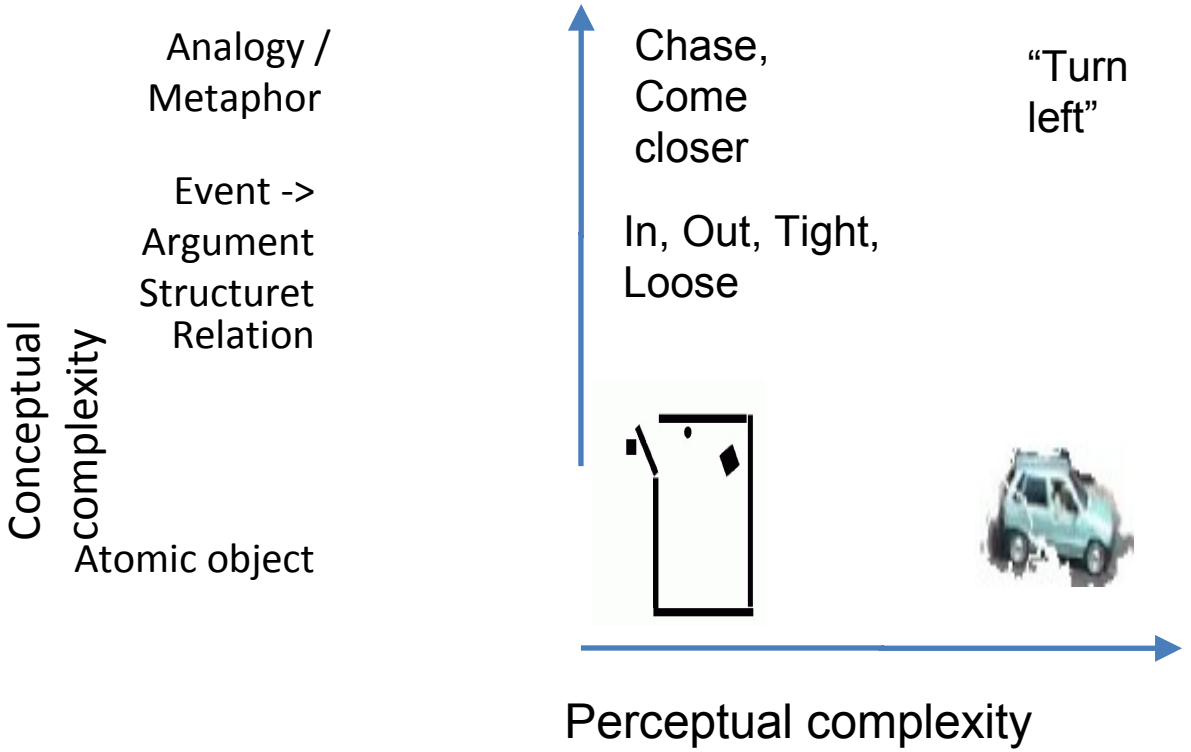
Montagovian Semantics [1973]



From [Kohlhase]


WHO? WHAT?
WHERE? WHEN? HOW?
WHY? WHICH? HOW MUCH?
HOW MANY? HOW LONG? HOW FAR?
WHAT FOR? WHAT NEXT? THEN
WHAT? WHY ME?

Semantics First:
A pathway to Cognition



Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's?

If this were then subjected to an appropriate course of education one would obtain the adult brain.

- Alan Turing

Framenet: Semantic Roles

Familiar notion in NLP

- Restaurant Frame:
  - "John ate chicken tandoori with his fingers."
- Framenet = Comprehensive Lexicon of Frames

- Roger C. Schank. 1972. Conceptual dependency: A theory of natural language processing. Cognitive Psychology,
- Robert F. Simmons. 1973. Semantic networks: Their computation and use for understanding English sentences.

Semantic Roles

- The underlying relationship that a constituent has with the target word in a clause.
- Eg : *John hit Bill.*
  Agent : John
  Victim : Bill
- Apt for capturing semantic information -:
  - systematic method for capturing the event structure
  - the value that a role takes is independent of the syntactic structure of the sentence

Framenet

The Frame is the basic lexical structure that links:

- individual word senses,
- relationships between the senses of polysemous words,
- relationships among semantically related words

Example

Frame : Ingestion

Frame Elements:

Core: Eater Eaten

Peripheral: Place Implement Manner Time

John [EATER]
ate [lexical unit]
chicken tandoori [EATEN]
at *the Indian Restaurant* [PLACE]
with *his fingers* [IMPLEMENT]

Participant semantics

The locals (Ingestor) EAT mainly fish and fruits (Ingestibles).

As the house dosen`t have a dining room the family(Ingestor) eats in the large kitchen(Place).

She(Ingestor) took the ice-cream(ingestible) out of the fridge (source) and ate it.

Degree Ingestibles Ingestor Instrument Manner Means Place Source Time

Frame : Ingestion

Lexical Units for Ingestion

English	Hindi	Bangla
breakfast.v	नाश्ता	prAtarAsh v
Consume.v	भोग करना	bhog k.v
drink.v	पी	khA.v
eat.v	खा	khA.v
feast.v	भोज करना	bhoj k .v
feed.v	खिला	khAoyA.v
gulp.v	निगल	gelA.v
have.v	ले	Neo.v
munch.v	चबा	chebA.v
nibble.v	कुतर	ThokrA.v
sip.n	घूँट	chumuk.n
sip.v	घूँट लेना	Chumuk de.v

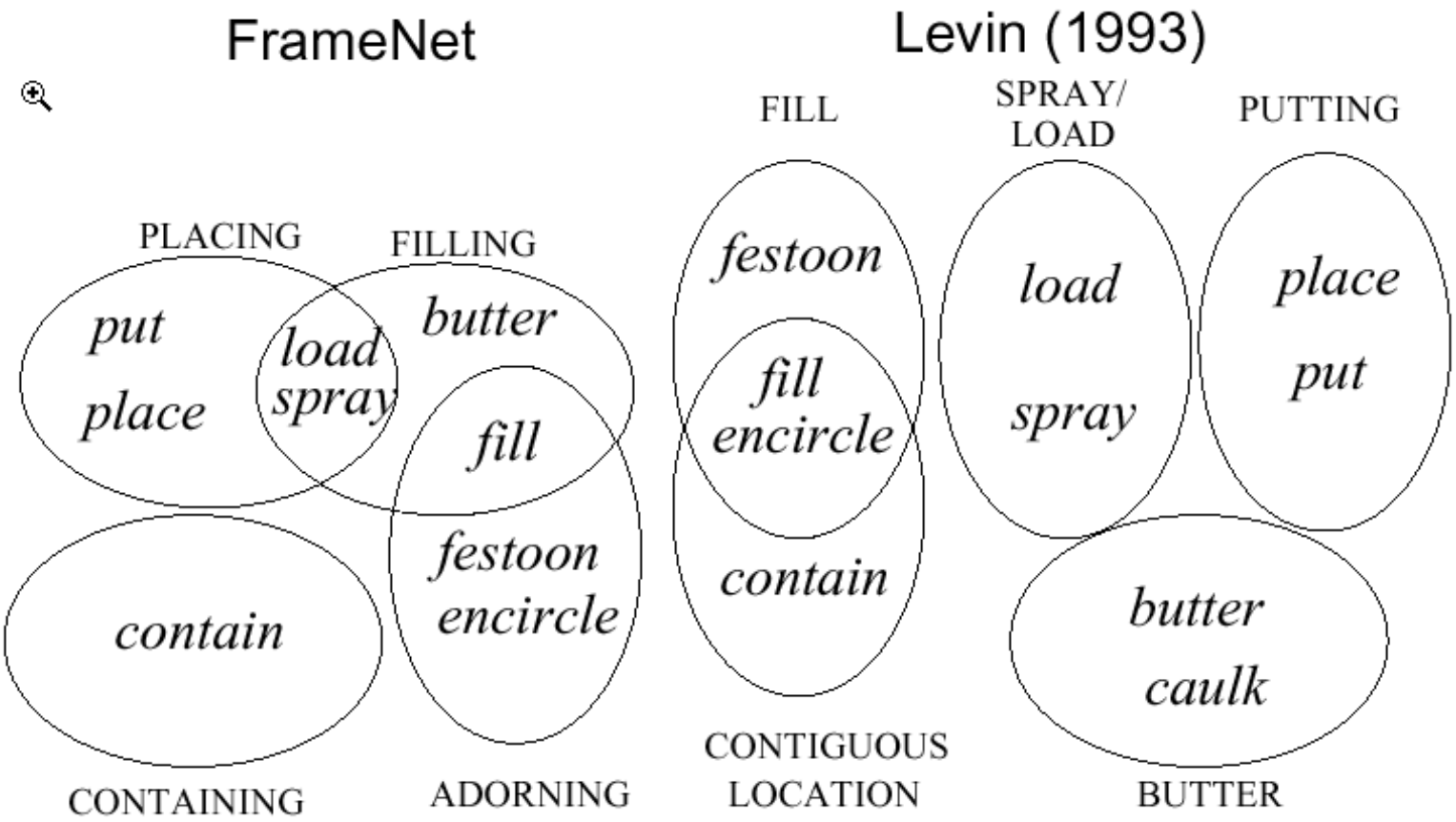
Parallel Sentence Analysis

As the house doesn't have a dining room, *the family* [EATER] *eat* [Lexical Unit] *in the large kitchen* [PLACE].

क्योंकि घर में भोजन क़क्ष नहीं है , *परिवार के लोग* [EATER] बडे *रसोयी* [PLACE] मे *खाते हैं* [LU]

bARite bhojan kakSha nei tAi *paribArer sabAi* [EATER] *baRa rAnnAghare* [PLACE] *khAy* [LU].

Other Semantic Categorization Schemes :



Communication Verbs

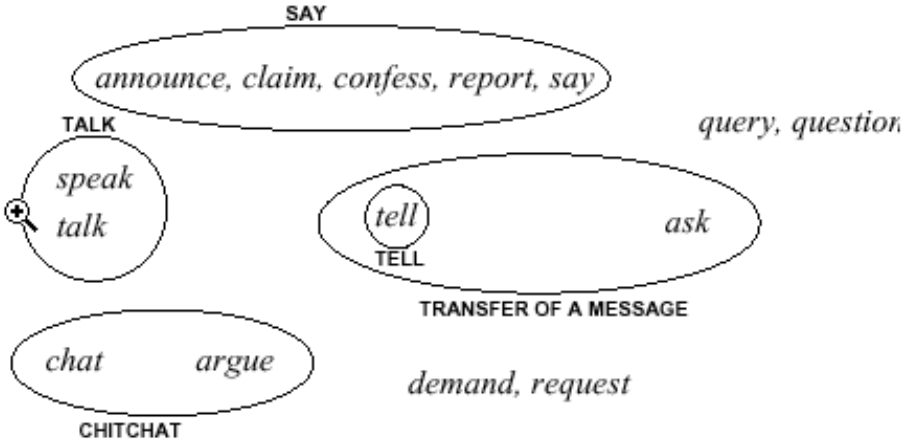


Figure 2Communication verbs in Levin

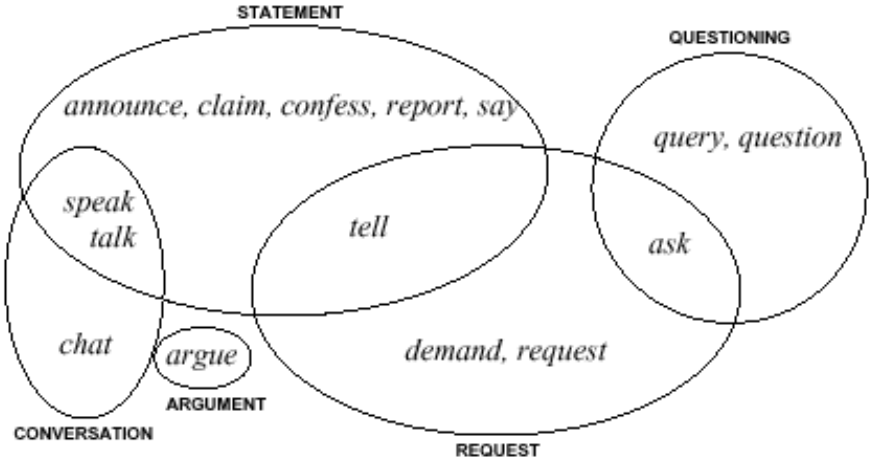


Figure 3 Communication verbs in FrameNet

PropBank / VerbNet

eat-39.1

Members

- [drink(1 2), eat(1 2 3)]

Thematic Roles

- Agent[+animate]
- Patient[+comestible]
- Instrument[+concrete]

Frames

Basic Transitive ()
"Cynthia ate the peach"
Agent V Patient

Unspecified Object Alternation ()
"Cynthia ate"
Agent V

Conative ()
"Cynthia ate at the peach"
Agent V Prep(at) Patient

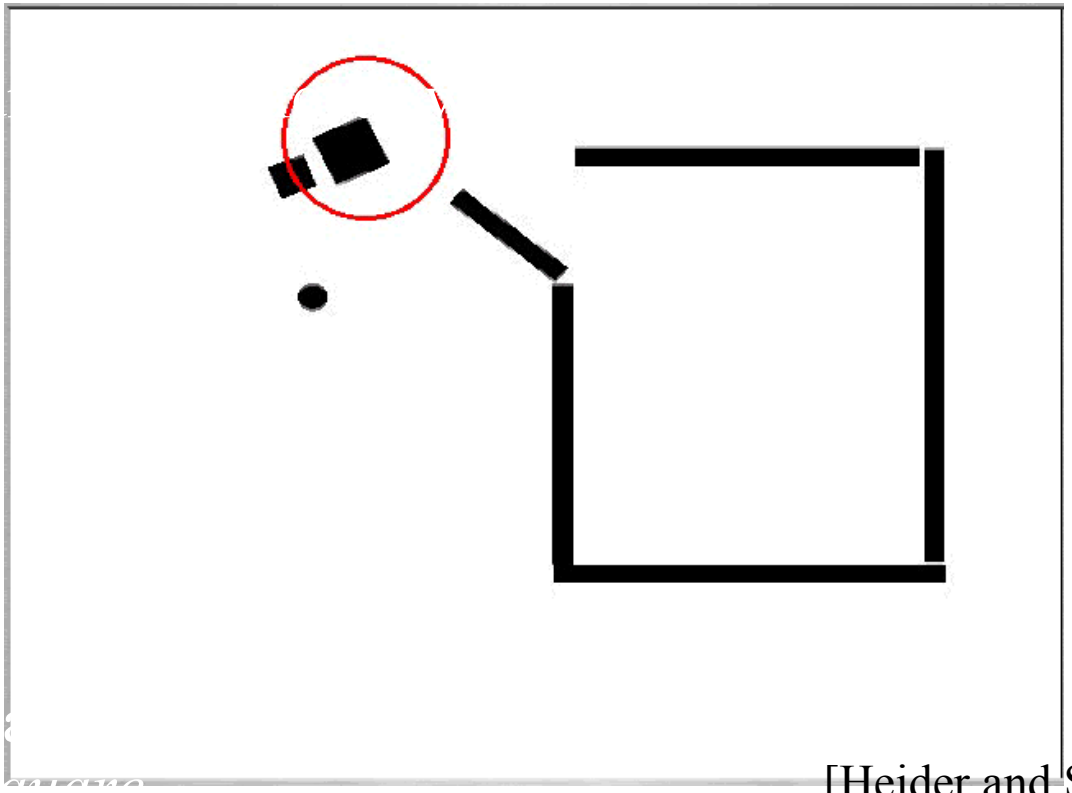
Resultative ()
"Cynthia ate herself sick"
Agent V Oblique Adj

Semantic Tagging

- Probabilistic Role Assignment based on FrameNet Corpus [Gildea, 2002]
- **Linking Theory** : "*There is a unique relationship between the syntactic and semantic structure of a sentence*"
- Based on features extracted from parse tree, and probability (A statistical approach)

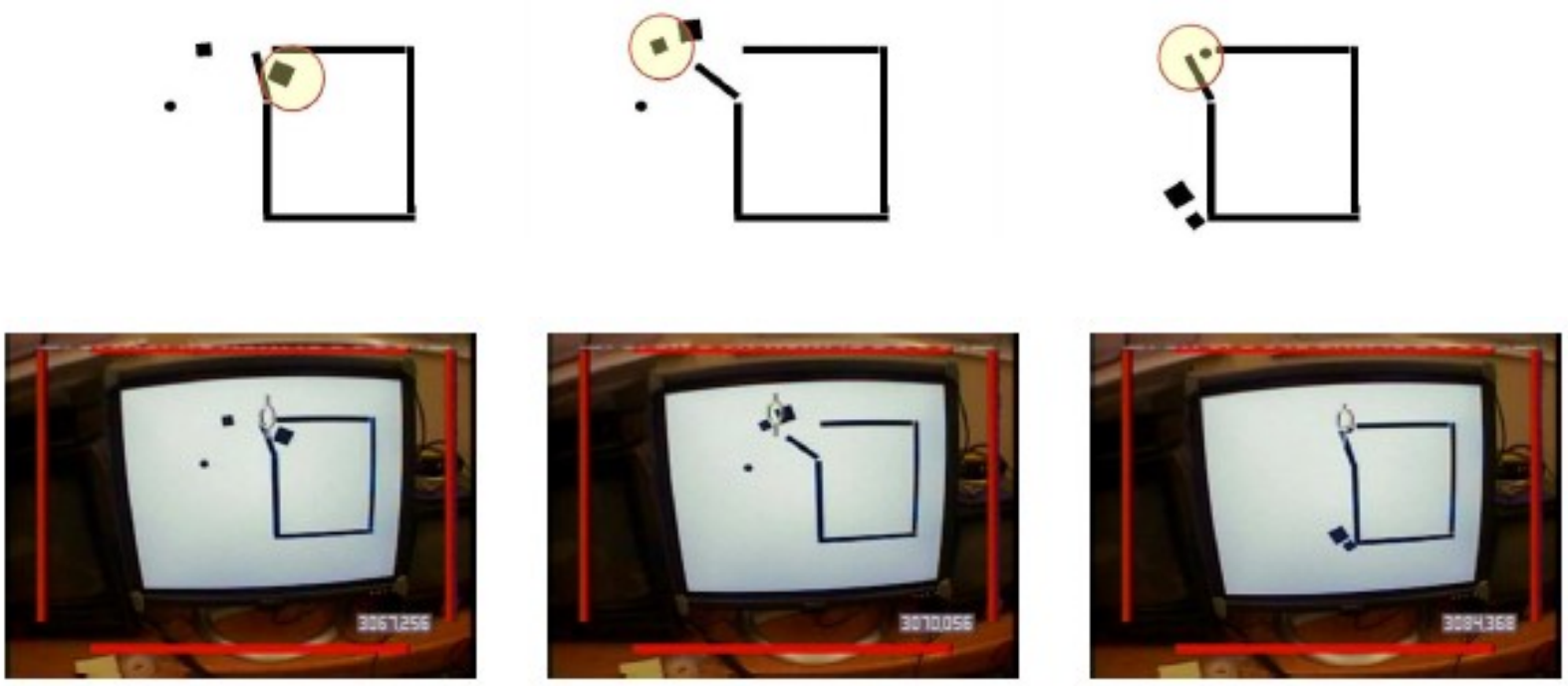
Grounded Language Learning

Heider/Simmel video



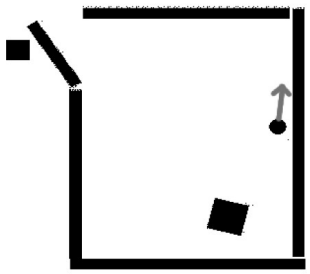
[Heider and Simmel 1944]
video recreated by Bridgette Hard
at Barbara Tversky lab, Stanford U

Visual attention model



Maji, Singh and Mukerjee 2005

Narratives: "Chase" Video



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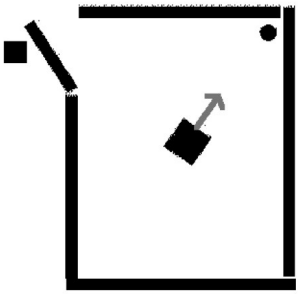

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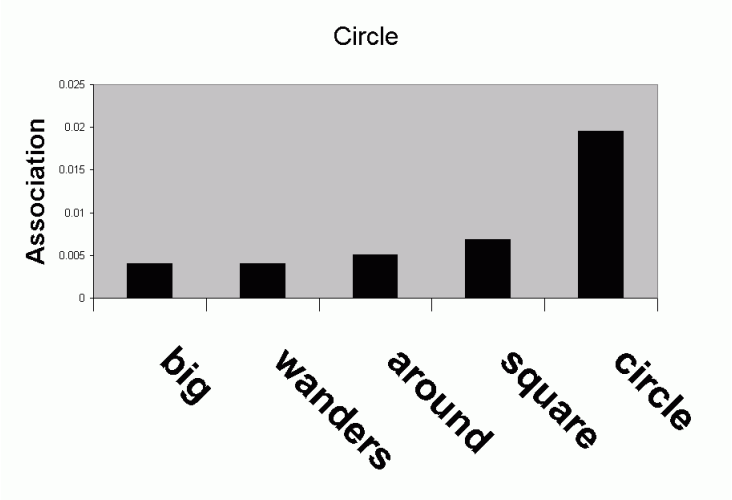
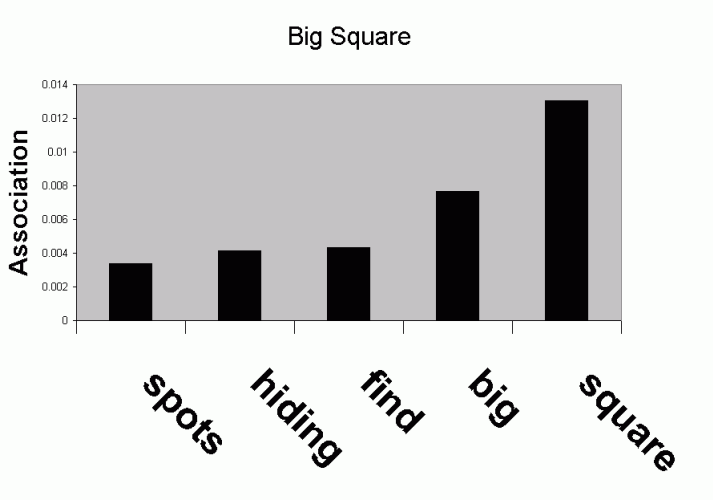
Wide variation in Narratives :

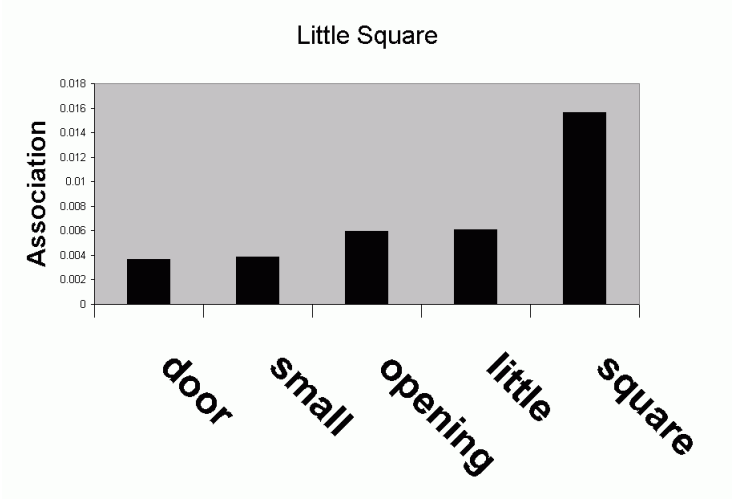
1. Large square corners the little circle
2. Big square approaches little circle
3. Little square is moving away from the big square; and objects inside are moving closer together
4. Big block tries to go after little circle

Video and commentaries from Tversky Group, Stanford University

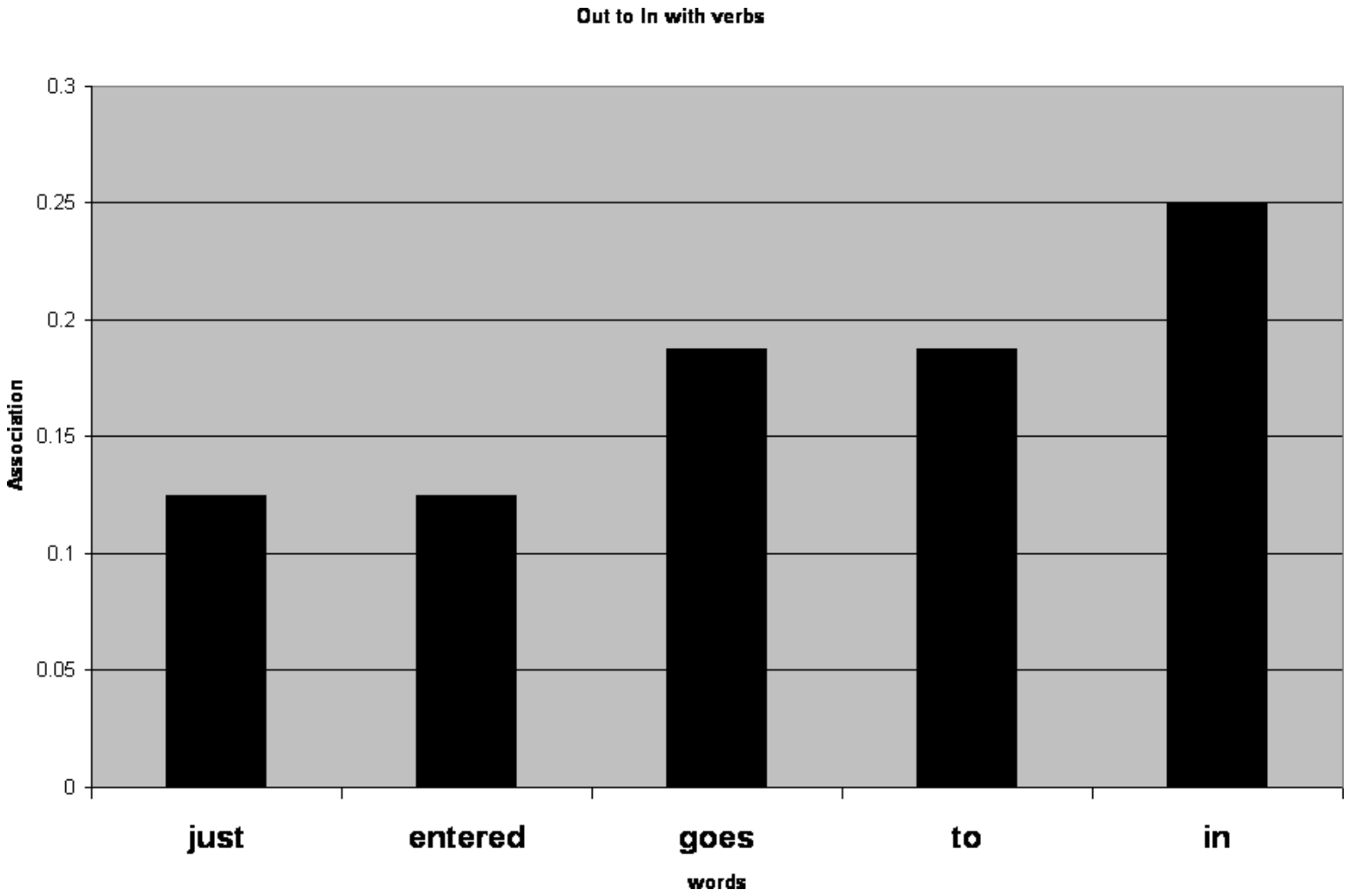
Noun Learning





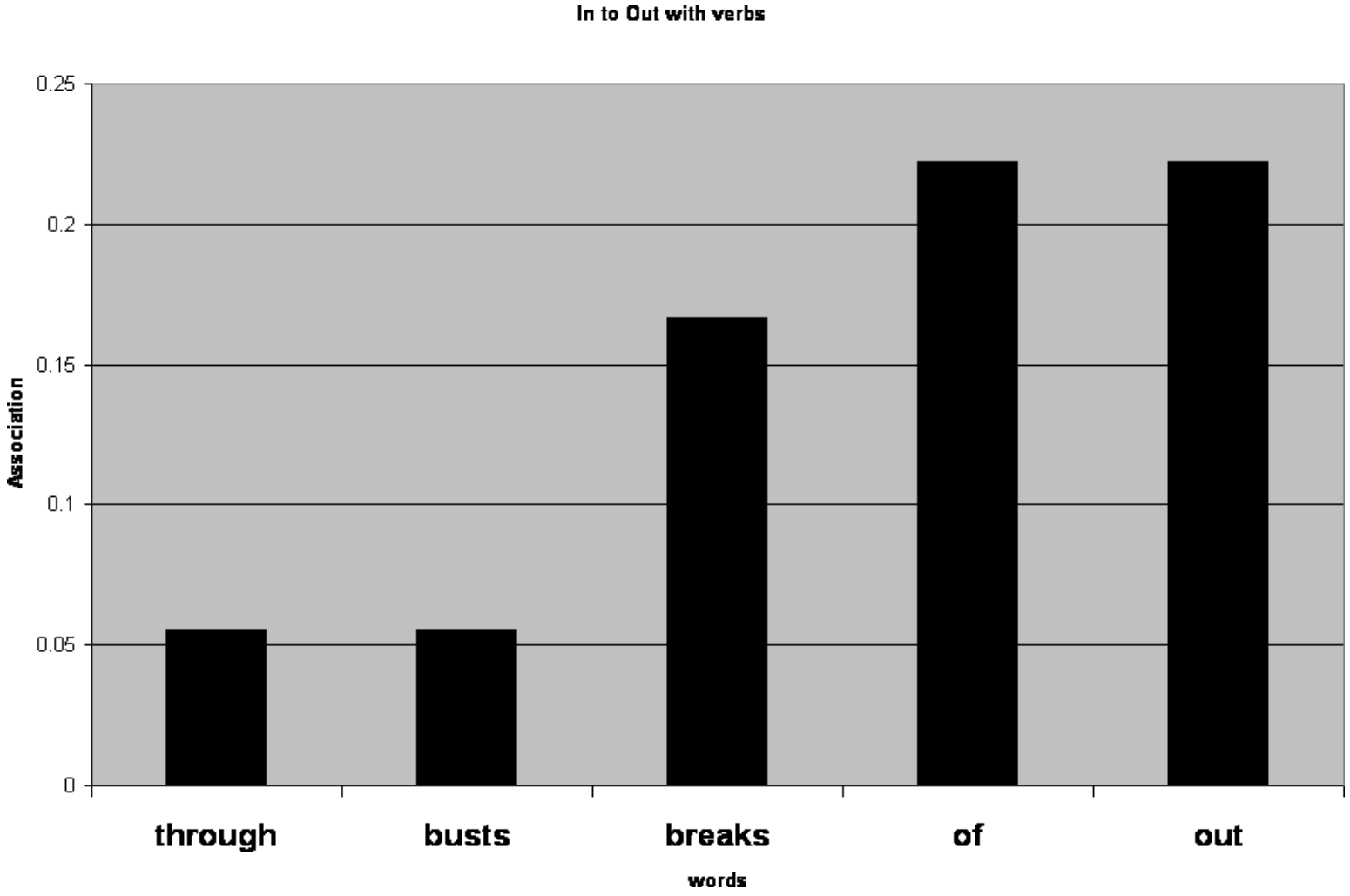


Trajectories ending inside (“in”)



Based on intervals where the attended agent is ending “in” the box

Trajectories ending Outside

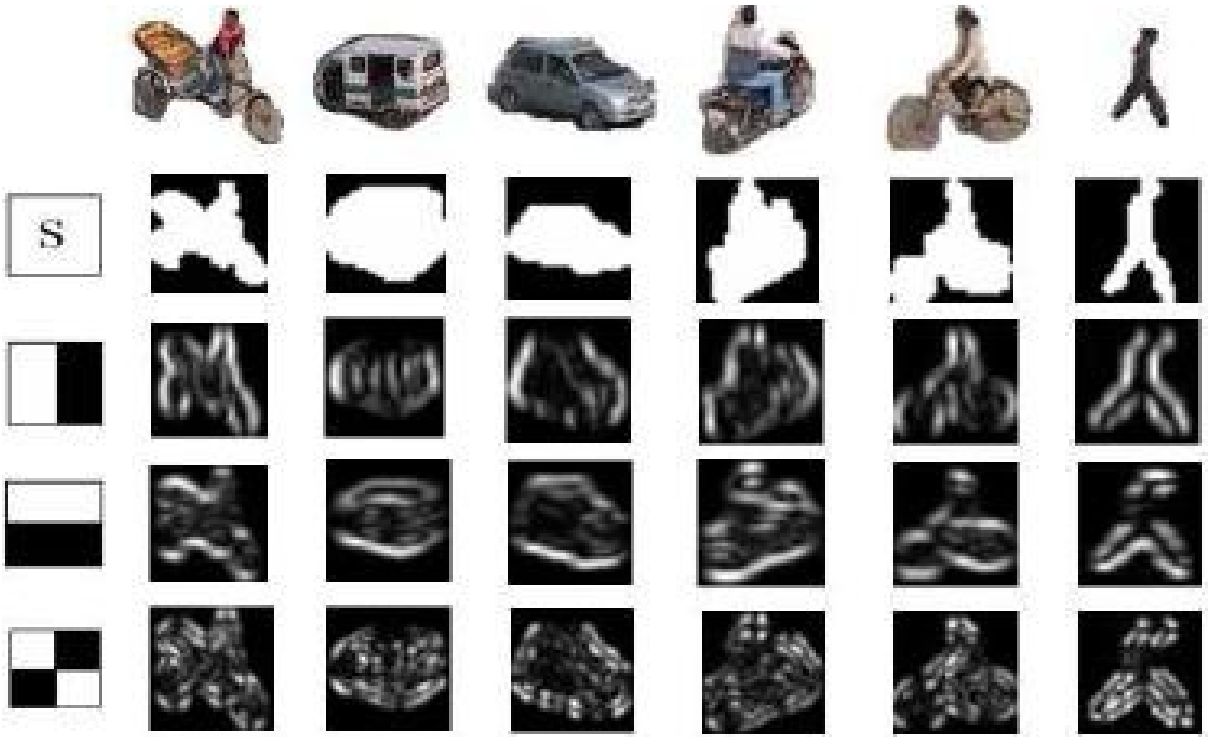


Learning Containment Spatial Descriptors

Recognition from real video

Learning Agent Appearances

Shape + Haar clusters



Guha and Nandi 09 model

PHOW clusters

C16

C19

C21

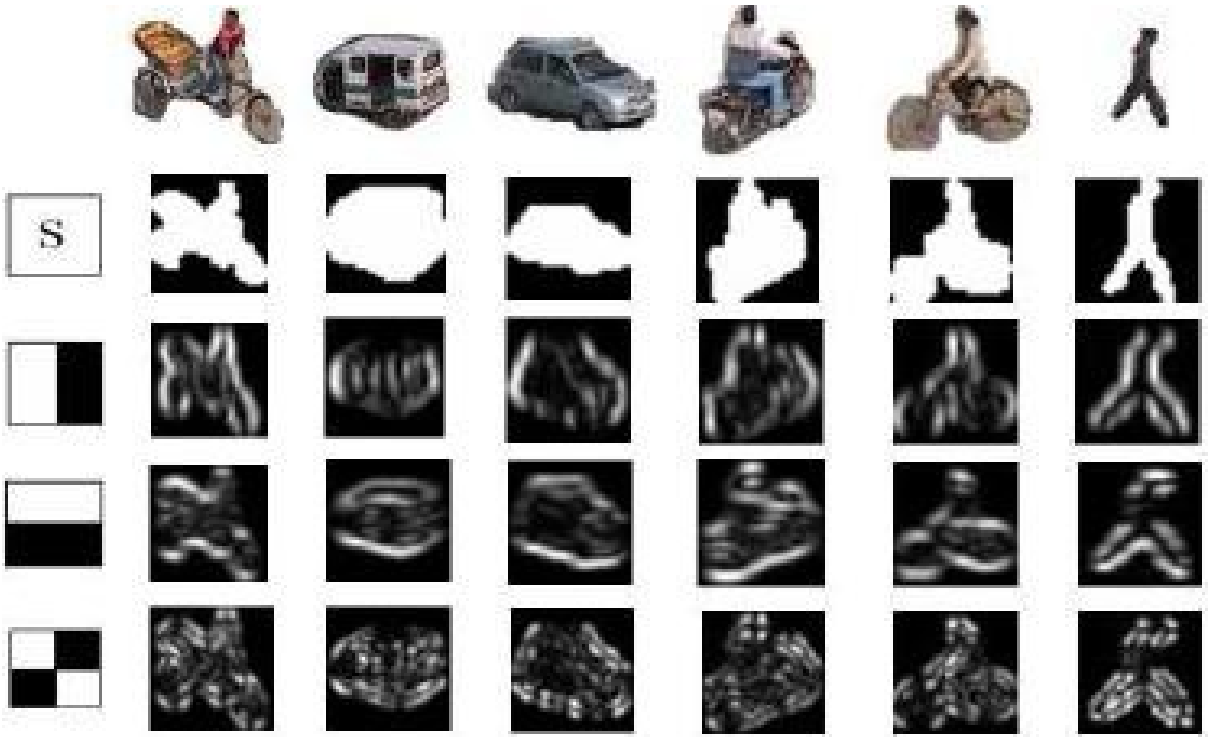
C23

C26

C27

C29

Shape + Haar clusters



Guha and Nandi 09 model

Unsupervised clustering results

H:52	C1	12/13	12H,1X
	C2	7/8	7H,1N
	C4	8/9	8H,1C
	C10	7/9	7H,2N
	C11	4/6	4H,1X,1N
	C13	5/8	5H,1X,1B,1N
	C14	2/4	2H,1T,1M
	C21	6/6	6H
M:36	C3	3/3	3M
	C8	8/9	8M,1X
	C9	11/15	11M,2T,1X,1B
	C22	6/6	6M
	C23	3/5	3M,2B
	C24	2/2	2M
	C26	2/8	2M,2B,1X,1T,1R,1C

B:32	C5	5/5	5B
	C6	1/2	1B,1X
	C7	2/3	2B,1X
	C15	2/2	2B
	C20	5/5	5B
	C28	7/8	7B,1T
T:21	C0	8/16	8T,4X,2C,1L,1R
	C16	1/1	1T
	C17	1/2	1T,1B
	C18	1/1	1T
	C25	4/7	4T,2C,1N
L:12	C12	4/5	4L,1C
	C29	7/8	7L,1T
C:16	C19	9/10	9C,1X
N:8	C27	2/4	2N,1B,1H

Guha and Nandi 09 model

Sample Commentaries

	Sentence	Interval
S1	एक बाइक गयी अभी	1158 - 1224
	ek bAik gayI abhI	
	One bike go+past now.	
	A bike went just now.	
S2	साइड में एक साइकल रिक्शा पे एक आदमी चढ़ा	1216 - 1382
	sAiD meN sAikal rikshA pe ek ADamI chaDhA	
	Side [on] one cycle rickshaw [on] one man climb+past	
	A man climbed on a cycle rickshaw on the side (of the scene).	
S3	*साइकल बाइक आये जा रहे हैं	1239 - 1354
	sAikal bAik Aye jA rahe haiN.	
	Bicycles bikes come+pp go+pp are.	
	Bicycles, bikes are coming and going.	

Word-Object Associations

Hindi phrase(l)	Trans literation	Gloss	$P(l\|\gamma)$
γ=HUMAN			
जा	jA	going	0.0391
टैम्पो	Tempo	tempo	0.0204
सड़क	saDak	road	0.0187
γ=MOTORCYCLE			
जा	jA	going	0.0295
लोग	log	people	0.0202
फिर	phir	again	0.0191
γ=BICYCLE			
साइकल	sAikal	bicycle	0.0699
जा	jA	going	0.0553
लोग	log	people	0.0444
γ=TEMPO			
जा	jA	going	0.0425
लोग	log	people	0.0208
ट्रक	Trak	truck	0.0182
γ=TRUCK (Lorry)			
ट्रक	Trak	truck	0.0374
लोग	log	people	0.0228
फिर	phir	again	0.0216
γ=CAR			
कार	kAr	car	0.0402
जा	jA	going	0.0342
ट्रक	Trak	truck	0.0254