

Understanding Initial work

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Context

- Is it possible to extract information from a text without *understanding* it ?
- Initial works in AI were towards the development of intelligent agents
- Text were an *application*
- Recent works are more application oriented but it is interesting to look at this aspect in order to gain a better perspective

Understanding criteria

- Finding answers to questions
- Paraphrase
- Make inferences
- Translate
- Reference resolving
- Pass the Turing test

Levels of understanding

- Utilitarian
- Linguistic - Logic
- Semantic

Utilitarian understanding

- Person-machine communication oriented

- Programming languages

- rigid syntax
- no ambiguity

$f[] = []$

$f(p:r) = f[y|y \leftarrow r, y < p] ++ [p] ++ f[y|y \leftarrow r, y \geq p]$

- data base query

```
SELECT * FROM clients WHERE age >18 and age <49
```

Linguistic - Logic Understanding

- Formal properties of languages
 - defined with rules
 - Type 1: context dependant
 - Type 2: context free
 - Type 3: regular
- Montague proposed a strict parallelism between grammar and semantic computation

Simple Grammar

$S \rightarrow NP VP$

$DET \rightarrow a \mid the$

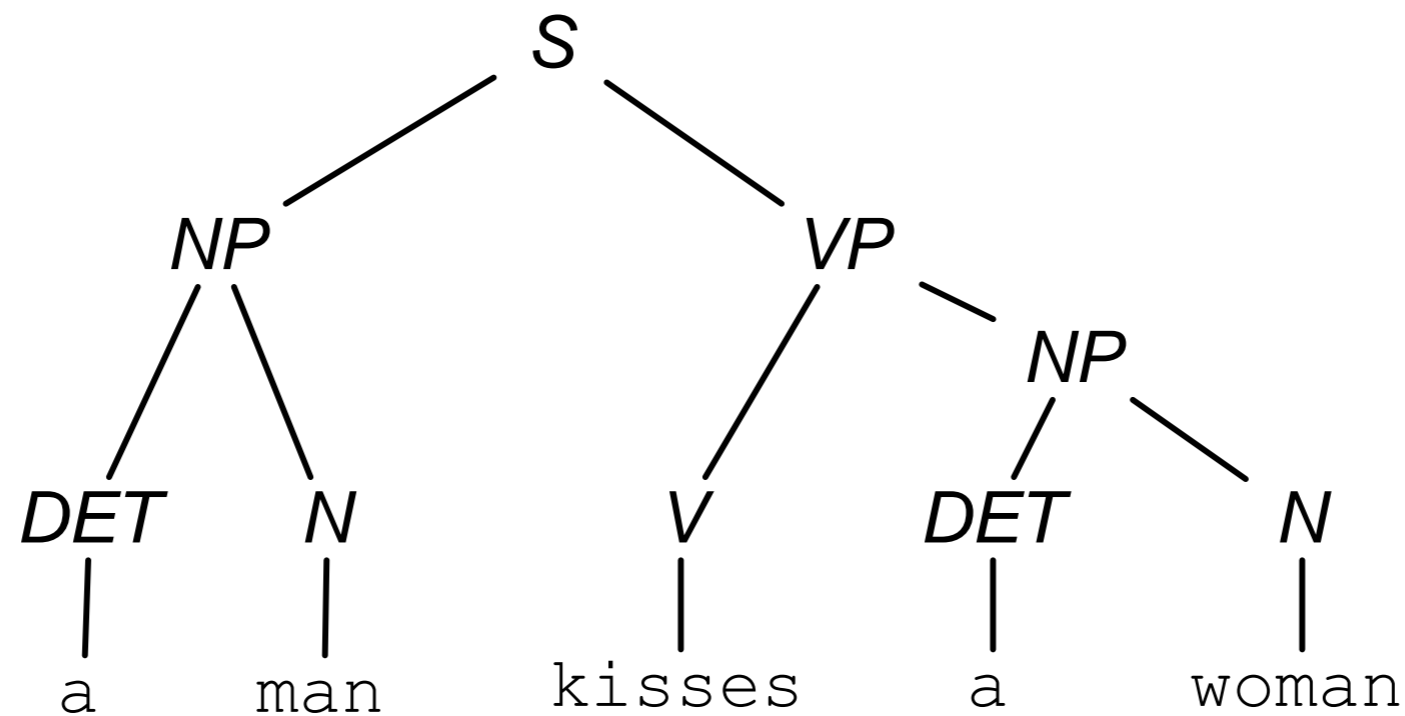
$NP \rightarrow DET N$

$N \rightarrow man \mid woman$

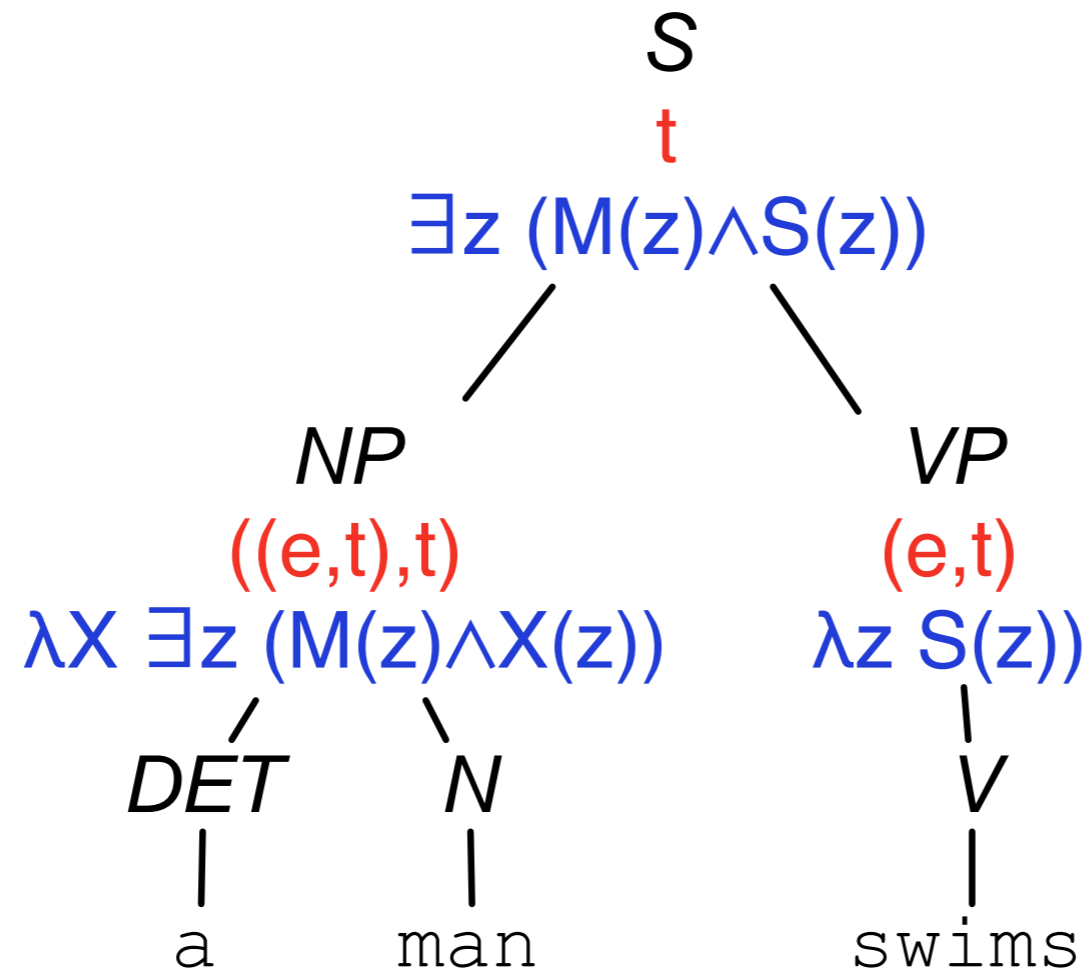
$VP \rightarrow V NP$

$V \rightarrow swims \mid kisses$

$VP \rightarrow V$

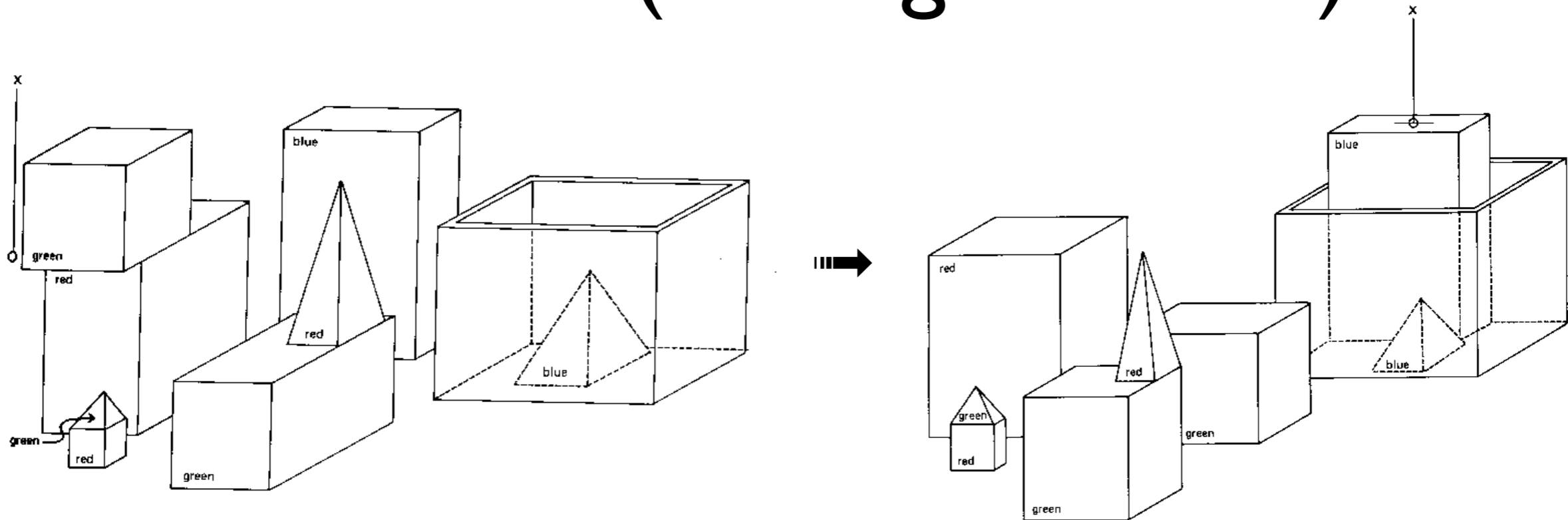


Montague Semantics



Terminal	Type	Semantics
a	$(e,t), ((e,t),t)$	$\lambda Y \lambda X \exists z (Y(z) \wedge X(z))$
man	(e,t)	$\lambda x M(x)$
swims	(e,t)	$\lambda x S(x)$

Shrdlu (Winograd 1970)



- Pick up the red block
- OK
- Grasp the pyramid
- I don't understand which pyramid you mean
- Find a block which is taller than the one you are holding and put it into the box.
- By "it", I assume that you mean the block which is taller than the one I am holding

Lunar (Woods 1977)

- ATNs application

- DO MY SAMPLES HAVE GREATER THAN 13 PERCENT ALUMINIUM?

⇒

```
(TEST (FOR SOME X1 / (SEQ SAMPLES) : T ;  
(CONTAIN X1 NPR* X2 / 'AL2O3) (GREATER THAN 13 PCT)))
```

- WHAT IS THE AVERAGE CONCENTRATION OF ALUMINUM IN HIGH ALKALI ROCKS?
- WHAT SAMPLES CONTAIN P200?
- GIVE ME THE MODAL ANALYSES OF P200 IN THOSE SAMPLES
- GIVE ME EU DETERMINATIONS IN SAMPLES WHICH CONTAIN ILM

Semantics

- non two-way relation between the surface form and meaning representing form
- text understanding is the same as the understanding of a *thing*
- syntax plays an important role but not necessarily fundamental one
- a great advocate: Roger Schank who proposes *Contextual Dependencies*

Conceptual Dependencies

- Two sentences with the same meaning should have the same representation
- Any implicit information in a sentence should be explicit in the representation
- A sentence is represented by a diagram showing the relations between *actions* and *agents*

Conceptual Dependencies - 2

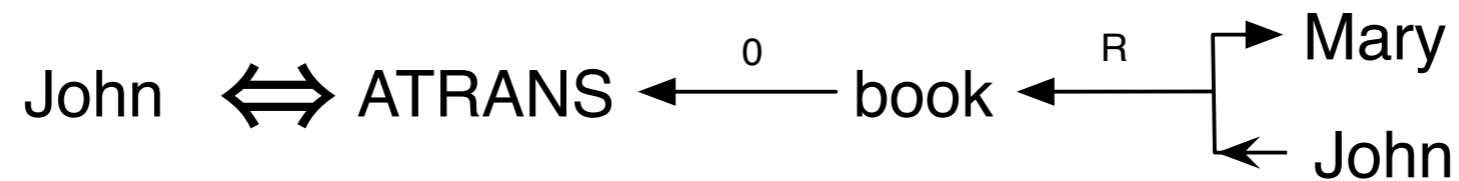
- Category (node)
 - PP (Picture production) \approx noun
 - ACT (Action) \approx verb
 - PA (Picture Aider) PP modifier \approx adjective
 - AA (Action Aider) ACT modifier \approx adverb
 - T (Times)
 - LOC (Locations)

Conceptual Dependencies - 3

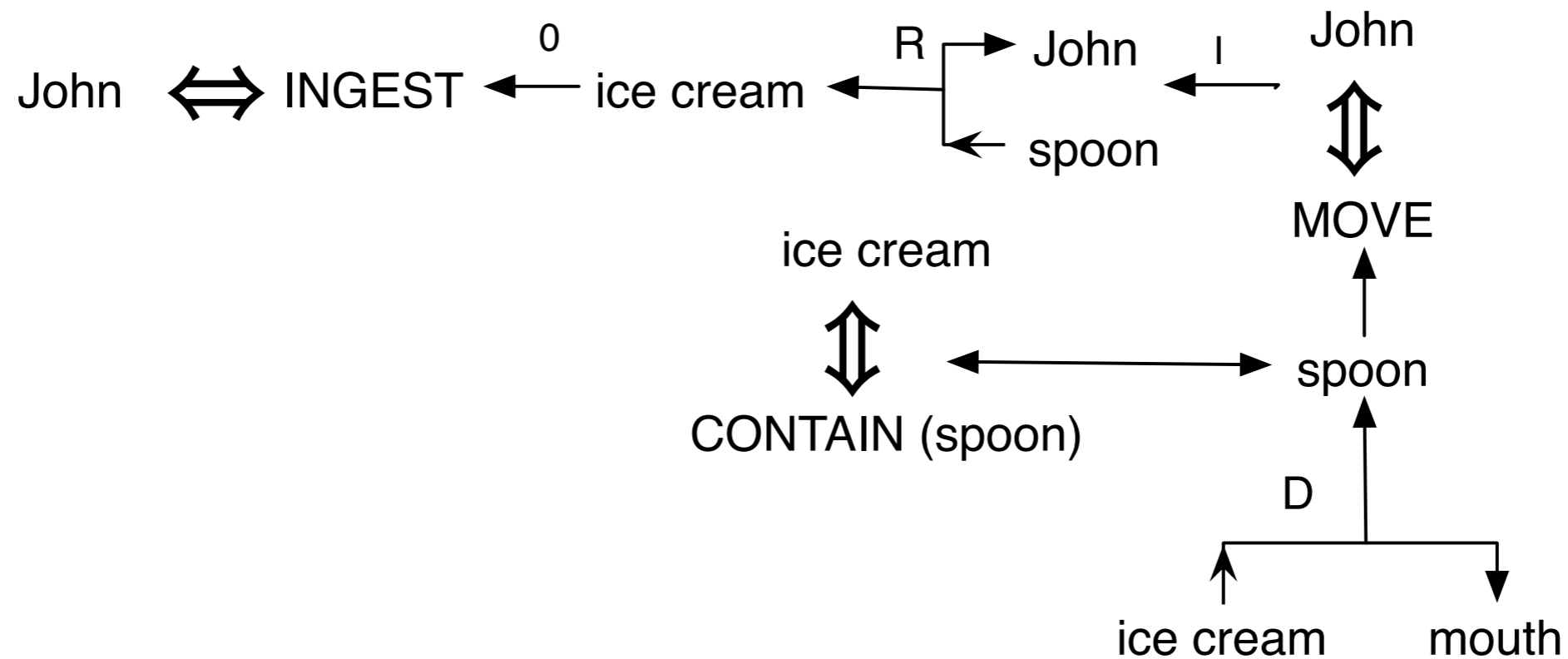
- Some primitive actions
 - ATRANS : abstract transfer *give*
 - PTRANS : physical transfer *go*
 - MTRANS : mental transfer *say*
 - PROPEL : physical force application *push*
- Types of dependance (arcs)
 - ⇔ each concept is necessary
 - ← one-way dependency between ACT and PP or between PP et PA
 - ⇐ one-way dependency between two PP

Conceptual Dependencies

Examples



John gives Mary a book



John eats the ice cream with a spoon

MARGIE (Riesbeck 1973)

Memory, Analysis, Response Generation, Inference in English

- Transforms a sentence into a conceptual dependency representation
- Paraphrase or inference modes
- Tries to guess
 - possible uses of interesting objects
 - goals or motivations of actors

Paraphrase Mode of Margie

- John killed Mary by choking Mary
 - John strangled Mary
 - John choked Mary and she died because she could not breathe
 - Mary died because she was unable to inhale some air and she was unable to inhale some air because John grabbed her neck

Inference Mode of Margie

- John told Mary that Bill wants a book
 - a book about what ?
 - Mary knows that Bill wants a book
 - Bill wants to come to have a book
 - Bill wants someone to cease to have a book
 - Bill wants to read a book

Text understanding Script (restaurant)

- *Accessories*: tables, menu, meals, money ...
- *Roles*: clients, server, boss, cook ...
- *Conditions*: client is hungry and has money
- *Results* :
 - client has less money
 - client is no more hungry
 - client is happy (optional)
 - boss has more money

Understanding with scripts

SAM (Schank 1978)

Friday evening a car swerved off Route 69. The vehicle struck a tree. The passenger, a New Jersey man, was killed. David Hall, 27, was pronounced dead at the scene by Dr. Dana Blanchard, medical examiner. Frank Miller, 32, of 593 Foxon Rd., the driver, was taken to Milford Hospital by Flanagan Ambulance. He was treated and released. No charges were made. Patrolman Robert Onofrio investigated the accident.

English summary with the *accident* script

AN AUTOMOBILE HIT A TREE HEAR HIGHWAY 69 FOUR DAYS AGO.
DAVID HALL, AGE 27, RESIDENCE IN NEW JERSEY, THE PASSENGER,
DIED. FRANK MILLER, AGE 32, RESIDENCE AT 593 FOXON ROAD IN
NEW HAVEN, CONNECTICUT, THE DRIVER, WAS SLIGHTLY INJURED.
THE POLICE DEPARTMENT DID NOT FILE CHARGES.

Questions answered with the *accident* script

Q1: Was anyone killed?

A1: YES, DAVID HALL DIED.

Q2: Was anyone hurt?

A2: YES, FRANK MILLER WAS SLIGHTLY INJURED.

Q3: Why was Miller hurt?

A3: BECAUSE THE AUTOMOBILE HIT THE TREE.

Text understanding with Plans

PAM (Wilensky 1978)

Juliette was hungry. She then took the guide Michelin

- *understandable only if one gets the plan motivating this action*

John loved Mary but she didn't want to marry him. One day, a dragon stole Mary from the castle. John got on top of his horse and killed the dragon. Mary agreed to marry him. They lived happily ever after.

- Why did John get on his horse?
- **BECAUSE HE WANTED TO BE NEAR MARY.**
- Why did Mary agree to marry John?
- **BECAUSE SHE WAS INDEBTED TO HIM.**
- Why did John kill the dragon?
- **BECAUSE HE WANTED MARY TO NOT DIE.**

Conclusion

- Initial work on understanding were dealing with ad-hoc and limited situations
- Nice demos but hard to apply in real contexts
- Recent approaches are more *bottom-up*
- Approaches based on more elementary processing on bigger corpora and with more restricted goals
 - named entities
 - newspaper types



References

- *The Handbook of Artificial Intelligence, Vol 1, 1981*
- Erik T. Mueller, *Story understanding resources*,
<http://xenia.media.mit.edu/~mueller/storyund/storyres.html>
- A. Gal, G. Lapalme, P. St-Dizier, H. Sommers, *Prolog for Natural Language Processing*, Wiley, 1991