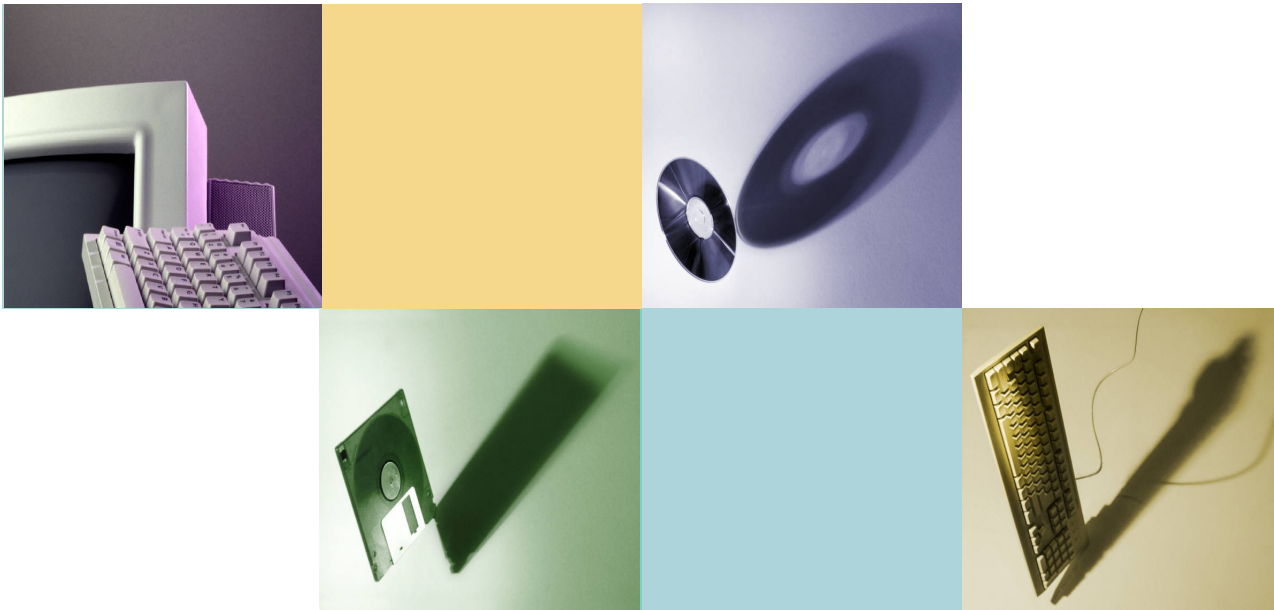


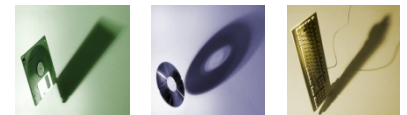
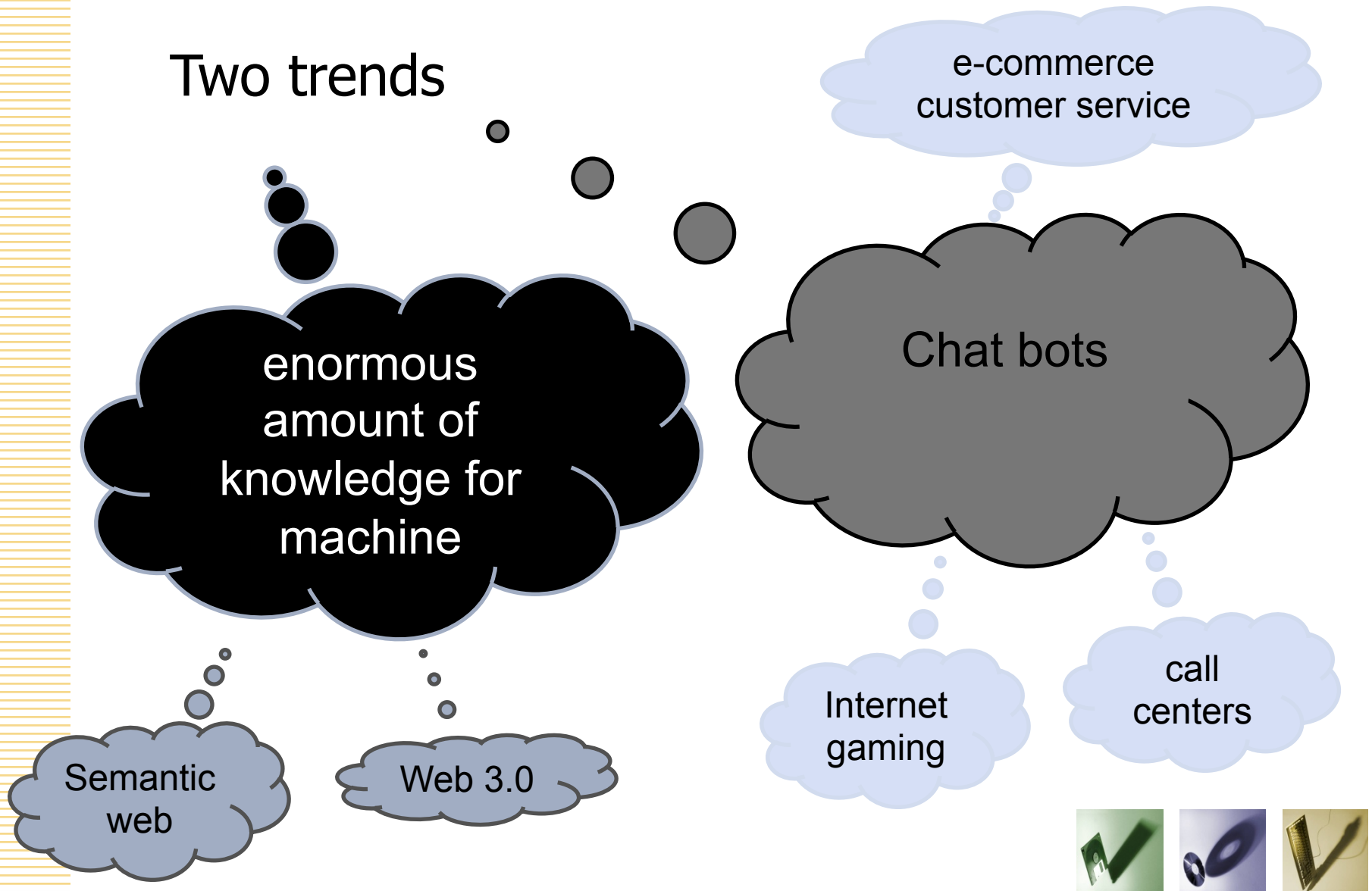
# BMCS2003 Artificial Intelligence



Natural Language Understanding

# Why NLP?

Two trends



# Search 3.0



## 1. Deep Blue Sea Maldives

Dreamt of hiding away from the World in the Maldives? You've found the right people. We are **Deep Blue Sea** Maldives.

<http://www.dbsmaldives.com/index.html>

## 2. Deep Blue Sea - Scrapbook - Smilebox

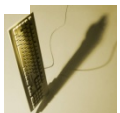
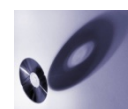
Dive in to this **sea** themed square format scrapbook and make a splash with your photos and videos.

<http://www.smilebox.com/templates/15162/Deep-Blue-Sea-Scra...>

## 3. Amalfi Holiday - an Balcony in Italy Overlooking a Deep Blue ...

Amalfi **Holiday** - an Balcony in Italy Overlooking a **Deep Blue Sea** Wall Tapestry Coastal Tropical Tapestries Go on **holiday** whenever you like when you

<http://www.walldecorandhomeaccents.com/balcony-in-italy-la...>



# Search 2.0



holiday at deep blue sea

Search

About 437,000 results (0.05 seconds)

[Advanced search](#)

 Everything

☐ More

Kuala Lumpur,  
Federal Territory of  
Kuala Lumpur

☐ [Change location](#)

The web

Pages from Malaysia

☐ [More search tools](#)

[PROVENCE - Mountains to deep blue sea - WorldWalks.com](#) ☆ 🔍

World Walks: tour operator for your hiking/ walking **holiday** to Provence. ... PROVENCE 2010  
– FROM THE MOUNTAINS TO THE DEEP BLUE SEA ...

[www.worldwalks.com/provence-mountains-to-deep-blue-sea.aspx](http://www.worldwalks.com/provence-mountains-to-deep-blue-sea.aspx) - [Cached](#)

[Lanzarote fishing holidays | Discover the deep blue sea ...](#) ☆ 🔍

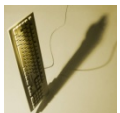
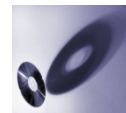
19 Feb 2010 ... Getaway on a fishing **holiday** to Lanzarote. Experience something new on  
your next Lanzarote **holiday**.

[blog.lowcostholidays.com/.../find-the-perfect-catch-on-lanzarote-holidays/](http://blog.lowcostholidays.com/.../find-the-perfect-catch-on-lanzarote-holidays/) - United Kingdom -  
[Cached](#)

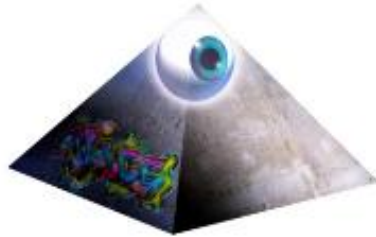
[Amazon.com: Greens and Grains on the Deep Blue Sea: Fabulous ...](#) ☆ 🔍

Amazon.com: Greens and Grains on the **Deep Blue Sea**: Fabulous Vegetarian Cuisine from  
the Holistic **Holiday** at Sea Cruises (9780757002878): Sandy Pukel: ...

[www.amazon.com](http://www.amazon.com) > ... > [Cooking, Food & Wine](#) > [Natural Foods](#) - [Cached](#) - [Similar](#)



# A.L.I.C.E the Chat Bot



## A. L. I. C. E. Artificial Intelligence Foundation

Promoting the development and adoption of **ALICE** and **AIML Free Software**

[A.L.I.C.E. Silver Edition](#)

[DAVE E.S.L. bot](#)

[C.L.A.U.D.I.O Personality Test](#)

[GET SITEPAL AVATARS](#)



*Human: May I know who is Captain Kirk?*

*ALICE: Not right now, maybe later.*

*Human: How old are you?*

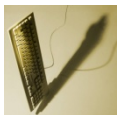
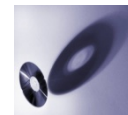
*ALICE: I'm Eighteen in computer years.*

*Human: who are you?*

*ALICE: I am ALICE. Who are you?*

You say:

Get **ALICE Silver Edition** with talking **Sitepal[tm]**, winner of the 2004 **Loebner Prize** competition sponsored by **Crown Industries, Inc.**





# Chatbot for Virtual Customer Service

Ask Lisa

Chat

Hi, my name is Lisa. I am a virtual chat assistant who can provide personal advice. I am also known as the LiveCom 5GChatbot, one of the many LiveCom applications available. You can ask me about the company and our solutions and I will be happy to answer your questions.

How can I be of assistance?

Michael: What are the benefits of LiveCom 5G?

Lisa: LiveCom 5G enables you to come into direct contact with your website visitors through various channels. No download or plug-in is required for visitors to make contact from any secure network. Your staff works with the revolutionary LiveCom Agent Workstation using a standard web browser. This takes place on demand, thereby eliminating ICT overhead costs.

Last message received on: 13:10

What are your contact details?

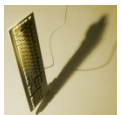
Send



Many people ask me about:  
the new possibilities of  
LiveCom 5G multichannel

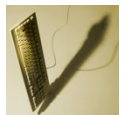
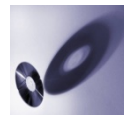
Other possibilities of  
contact:  
[Chat with an employee](#)  
[send an email](#)

powered by LiveCom.net - Live Customer Communication



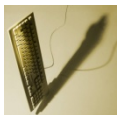
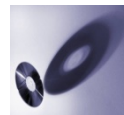
# Applications

- First, what makes an application a language processing application (as opposed to any other piece of software)?
  - An application that **requires** the use of knowledge about human languages
    - **Example: Is Words *word count* a language processing application?**



# Applications

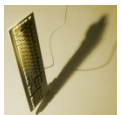
- Word count?
  - When it counts words: Yes
    - To count words you need to know what a word is. That's knowledge of language.
  - When it counts lines and bytes: No
    - Lines and bytes are computer artifacts, not linguistic entities



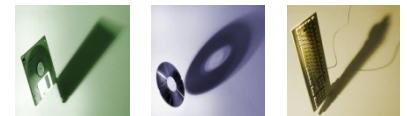
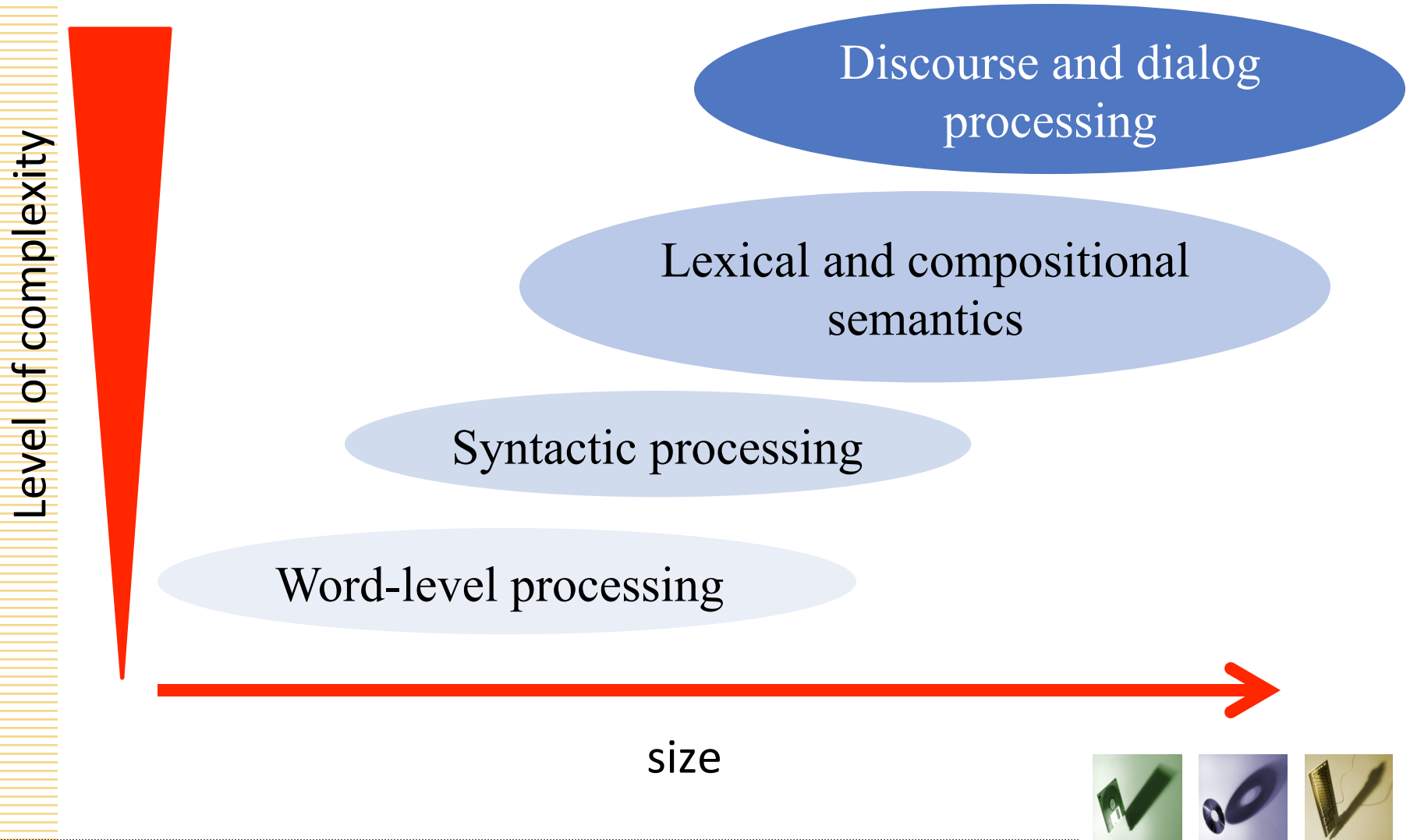


# Questions

- Spelling and grammar checking?
- Characters?

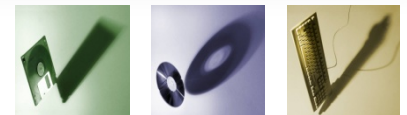
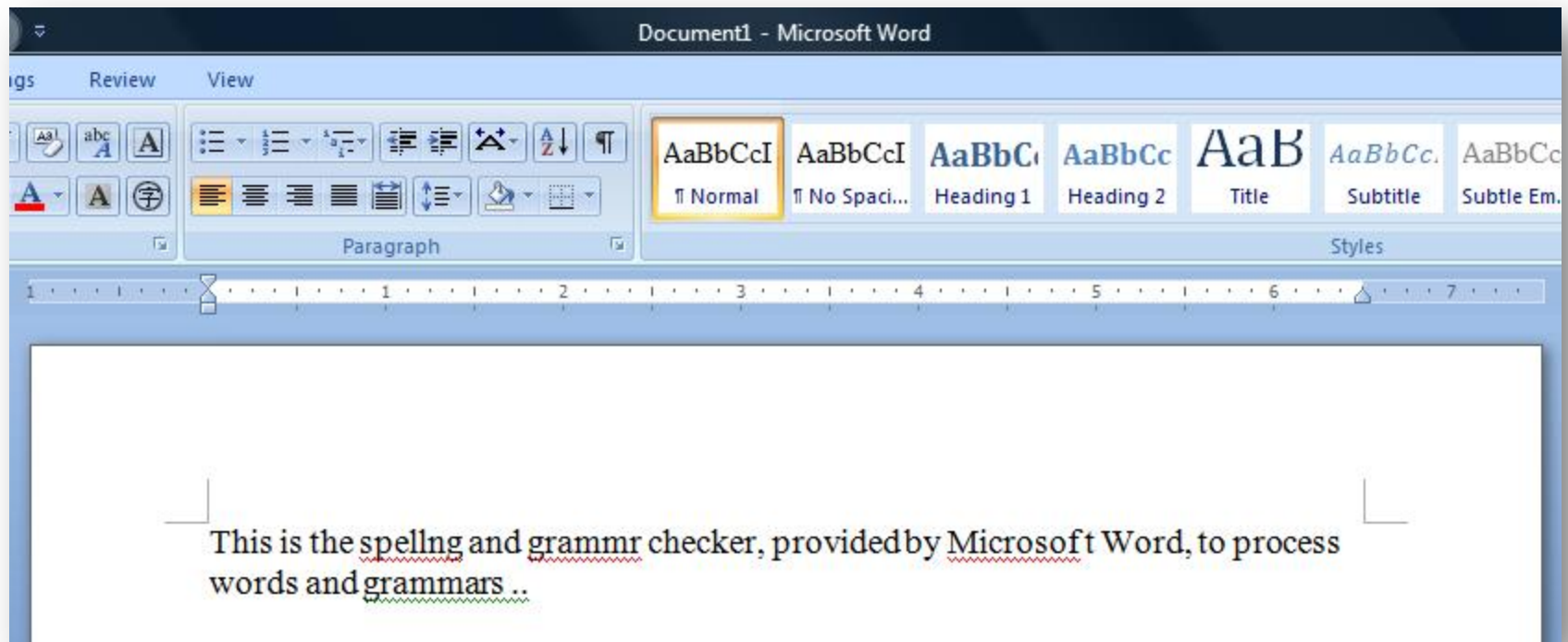


# Applications



# Applications

- Small
  - Spelling correction



# Applications (cont)

- Medium

Word-sense  
disambiguation

- **spring** cleaning



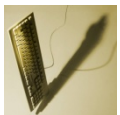
Named entity  
recognition

- Canon
- Lotus



Information  
retrieval

- search engine



# Applications (cont)

- Large

## Question Answering

- Story understanding
- [MSN Encarta](#)

## Conversational Agents

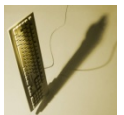
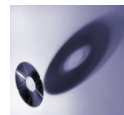
- Chat Bot
- Robot

## Summarization

- Auto summary in Microsoft Word

## Machine Translation

- WindowsLiveTranslator
- See next slide



# Machine Translation

- An inefficient translation could result in embarrassment to the users





# Machine Translation

A machine translation result could be like this



# What's needed?

Speech  
recognition  
and synthesis

- i.e. sound signal processing

Knowledge of  
the English  
words

- What they mean
- How they combine (sweet, vs. sweetheart)

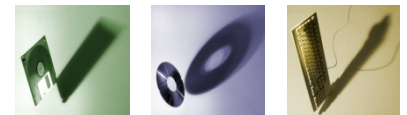
How groups  
of words  
clump

- What the clumps mean
- [expertsexchange.com](http://expertsexchange.com) to [experts-exchange.com](http://experts-exchange.com)



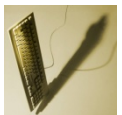
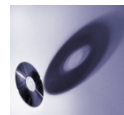
# Aims

- Natural language Understanding (NLU)
- Natural language Processing
  - NL analysis stages



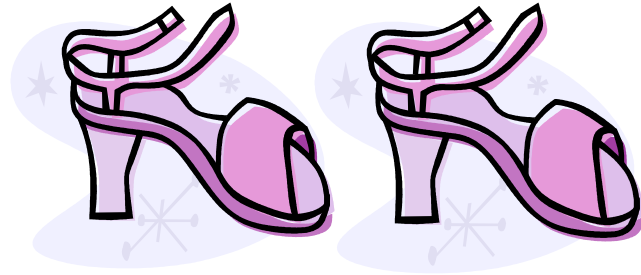
# NLU Problem

- Communication with natural language, whether text or as speech acts, depends heavily on our knowledge within the domain of discourse.
- It involves:
  - Transmission of words
  - Inferences about speaker's goals
  - Knowledge
  - Assumptions
  - The context of the interaction

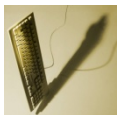
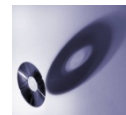


# Example

- She steals a pair of shoes

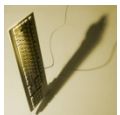


- She steals my heart



# Problems

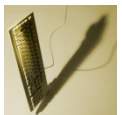
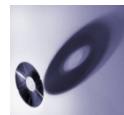
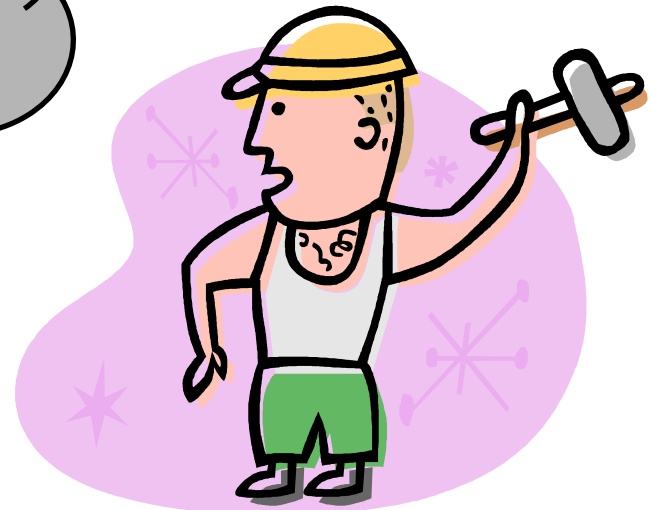
- We cannot merely chain together the dictionary meanings of “steal” to both of the sentences.
- Instead, we must employ a complex process of understanding the words, **parsing** the sentence, constructing a **representation** of the semantic meaning, and interpret the meaning of our **knowledge** of the problem domain.





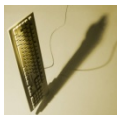
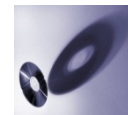
# Syntactic Problem

**“He hit the man with the hammer”**



# 3 issues in NLU

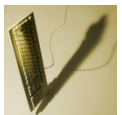
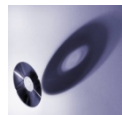
1. Large amount of human knowledge is assumed. Language acts describe relationships in complex world.
2. Language is pattern-based: communication is impossible without the rather constrained use of the components such as phoneme, word, and sentence orders.
3. Language acts are product of agent: human or computer. Agents are embedded in complex environments with both individual and sociological dimensions.



# Symbolic analysis in NLP

## Morphology

- components such as prefixes (un-, non-, anti-) and suffixes (-ing, -ly)
- meaning of root words may change



# Symbolic analysis in NLP

## Prosody

- rhythm and intonation of language
- relate to emotion

## Phonology

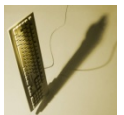
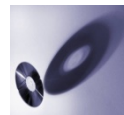
- combination of sounds to form language
- Pronunciation



# Questions: Prosody or Phonology?

- “He is a good student”
- A woman without her man is nothing
- My principle

After translation:  
My principal



# Symbolic analysis in NLP (cont)

## Syntax

- rules for combining words into legal phrases and sentences
- i.e. grammar

## Semantics

- the meaning of words, phrases, and sentences





# Syntactic vs Semantic Ambiguity

## syntactic ambiguity

the same sequence  
of words is  
interpreted as having  
different syntactic  
structures.

*“They are **hunting**  
**dogs**”*

## semantic ambiguity

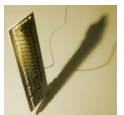
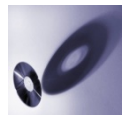
the structure remains  
the same, but the  
individual words are  
interpreted  
differently.

“Meet me at the  
**bank**”



# Question: Syntactic or Semantic?

- Rambo lifted the man with one hand
- She steals the patient's heart

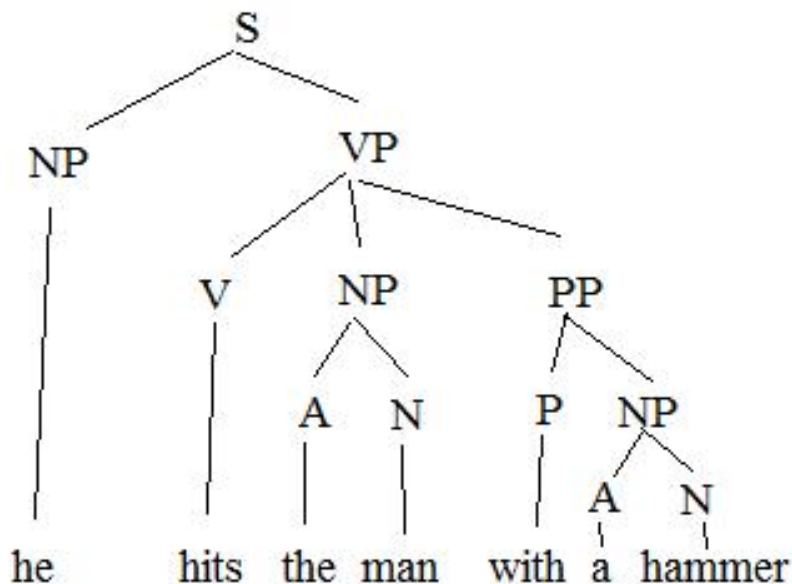


# Syntactic problem

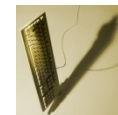
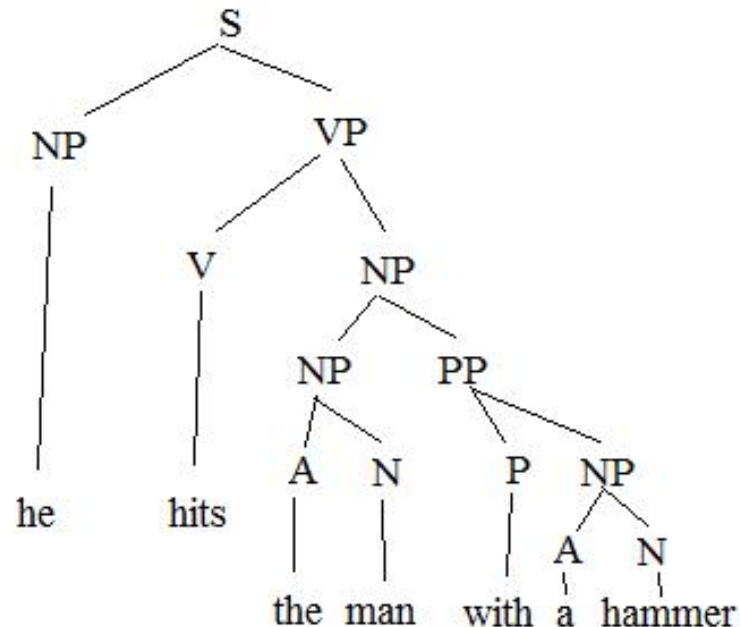
- Usually two different parse trees can be drawn

He hits the man with a hammer

Parse Tree 1



Parse Tree 2



# Symbolic analysis in NLP (cont)

## Pragmatics

- the study of the ways in which language is used and its effects on the listener
- Through experience
- e.g. telling a joke

## World knowledge

- knowledge of the physical world, human interaction, the role of goals and intentions in communication.
- Ontology



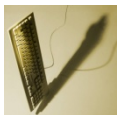
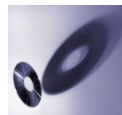
# Stages of language analysis

- Translate the original sentence into an internal representation of its meaning by the following stages:

Parsing

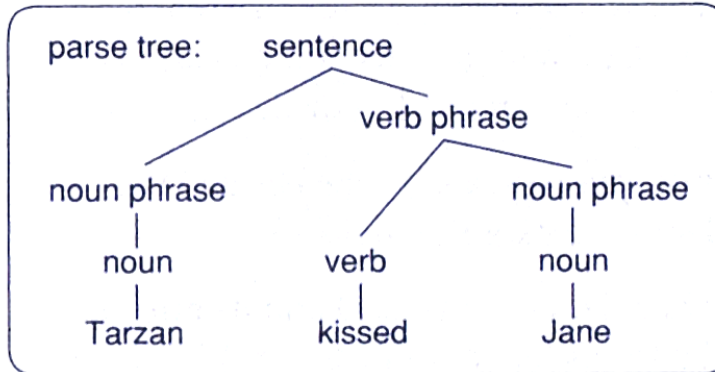
Semantic  
Interpretation

World  
knowledge  
representation

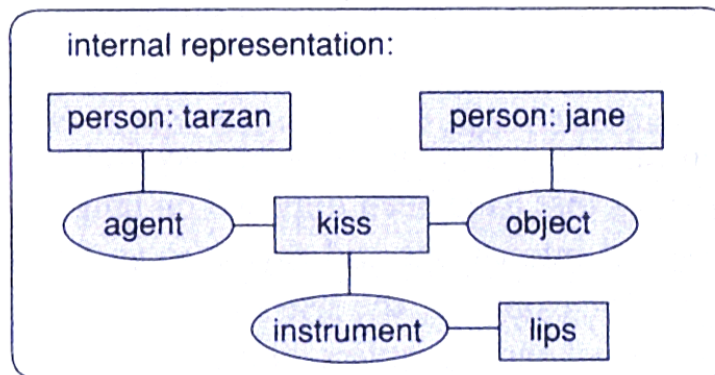


**Input:** Tarzan kissed Jane.

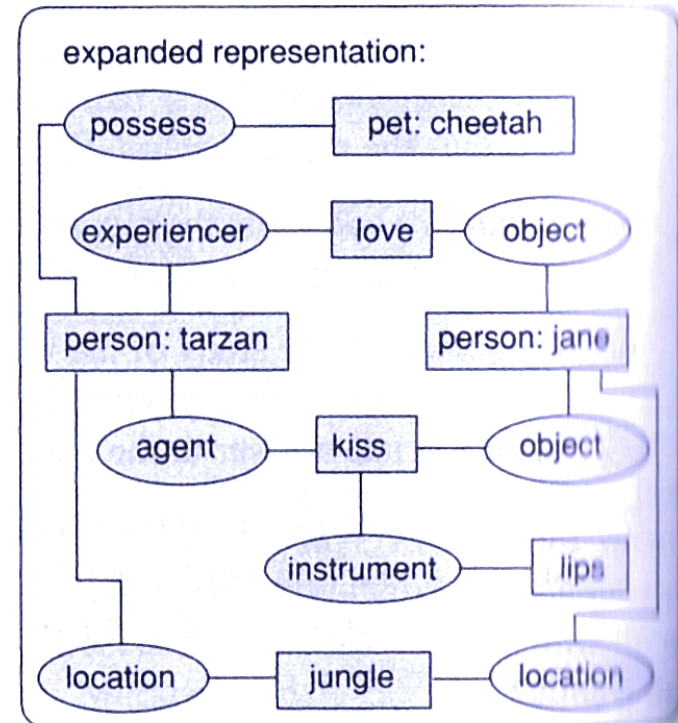
## Parsing



## Semantic Interpretation



## Contextual/World Knowledge Representation



**To:**  
question answerer,  
database query handler,  
translator, etc.

**NEXT**



# Parsing

- analyze the **syntactic** structure of sentences
- identifying the major relations such as subject-verb, verb-object, noun-modifier
- Often represented as **parse tree**
- employs knowledge of language **syntax**, morphology, and some semantics
  - i.e. GRAMMAR



# Semantic Interpretation

- **representation of the meaning**
- Use semantic network, conceptual graph, conceptual dependencies, frames, etc.
- Uses knowledge about the meaning of words and linguistic
  - e.g. “kiss” and “lips”
- Perform consistency checks and include constraints
  - E.g. “kiss” can be performed by person, but not tree.

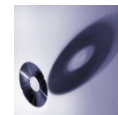
# World knowledge interpretation

- Produce **expanded representation** of the sentence's meaning and add to knowledge base.
- For complete understanding
  - E.g. Tarzan loves Jane, they live in jungle, Tarzan has pet Cheetah.
- Used for handling database query, answering questions, translating the meaning, etc.



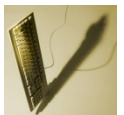
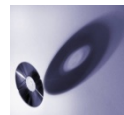
Now let's see how to do

# REPRESENTATIONS



First Stage

# **PARSING – PARSE TREE TRANSITION NETWORK PARSER**



# Syntax –Grammars

Rule below define a grammar for simple transitive sentence

Sentence  $\leftrightarrow$  noun-phrase verb\_phrase

Noun\_phrase  $\leftrightarrow$  noun

Noun\_phrase  $\leftrightarrow$  article noun

Verb\_phrase  $\leftrightarrow$  verb

Verb\_phrase  $\leftrightarrow$  verb noun\_phrase

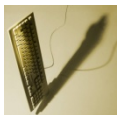
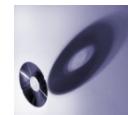
Article  $\leftrightarrow$  a

Article  $\leftrightarrow$  the

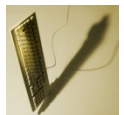
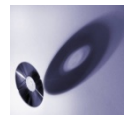
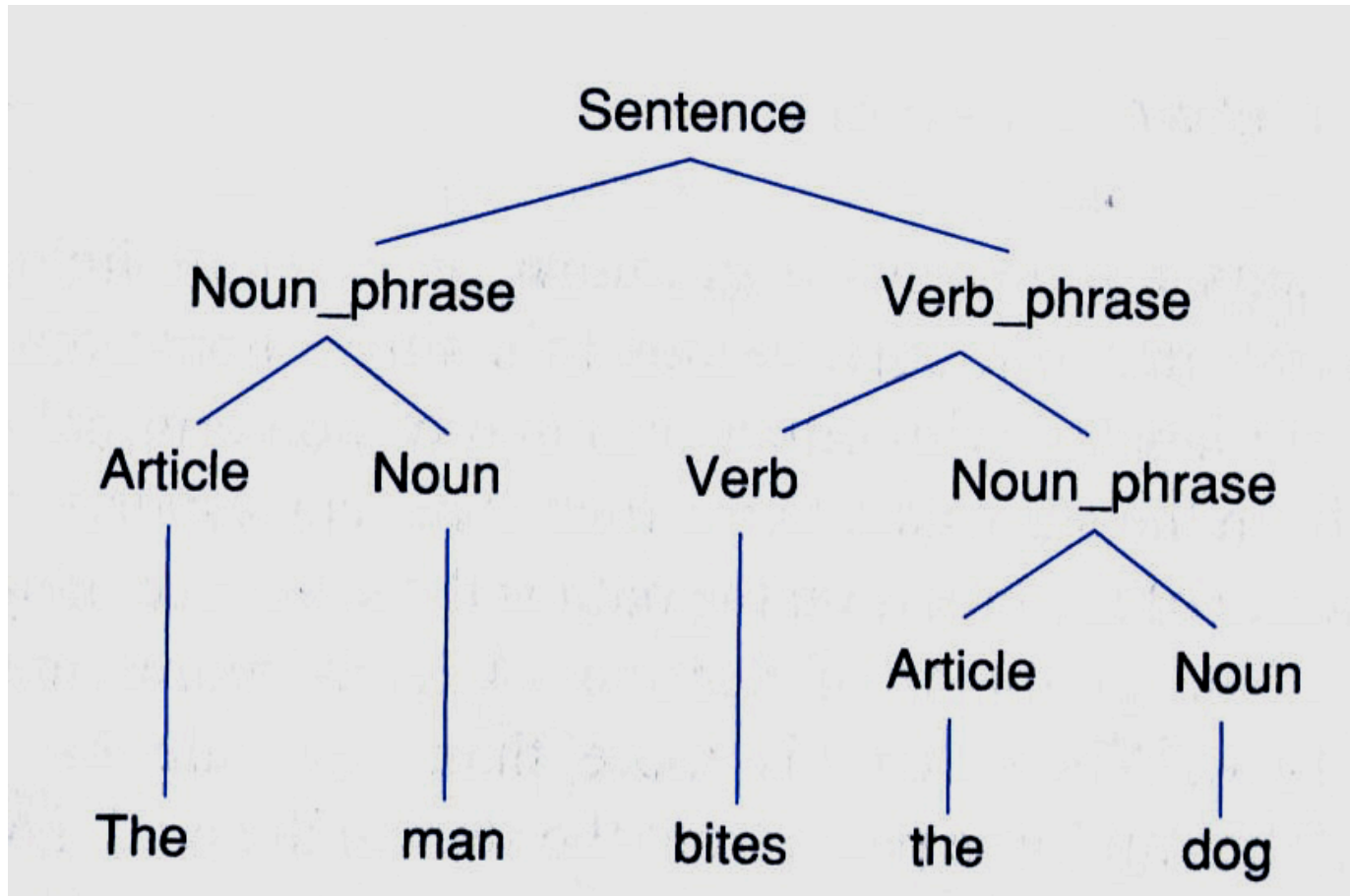
# Example

Sentence: **“The man bites the dog”**

1. Sentence  $\leftrightarrow$  noun\_phrase verb\_phrase
2. Noun\_phrase  $\leftrightarrow$  noun
3. Noun\_phrase  $\leftrightarrow$  article noun (the man, the dog)
4. Verb\_phrase  $\leftrightarrow$  verb
5. Verb\_phrase  $\leftrightarrow$  verb noun\_phrase (bites the dog)
6. Article  $\leftrightarrow$  a
7. Article  $\leftrightarrow$  the
8. Noun  $\leftrightarrow$  man
9. Noun  $\leftrightarrow$  dog
10. Verb  $\leftrightarrow$  bites



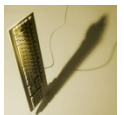
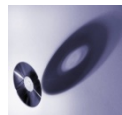
# Parse Tree





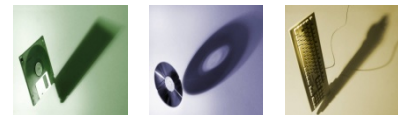
Second Stage

# **SEMANTIC INTERPRETATION– SEMANTIC NET/CONCEPTUAL GRAPH/ CONCEPTUAL DEPENDENCY**



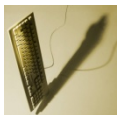
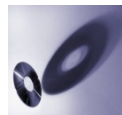
# Why semantic Representation?

- Semantic representation can solve canonical form of sentences



# Canonical Form

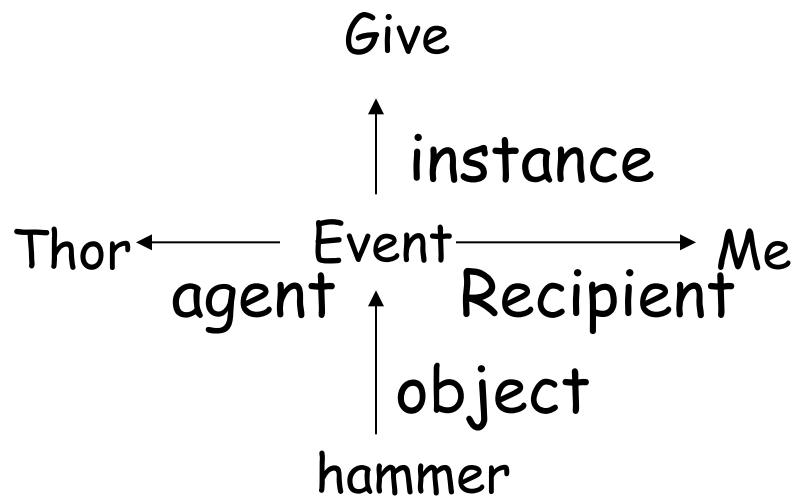
- “Canonical Form” – two different sentences with the same meaning
  - “I was given this hammer by Thor”
  - “Thor gave me this hammer”
- Representation allows canonical form sentences get transformed to the same “meaning representation”



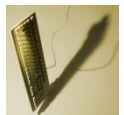
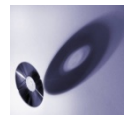
# Example of Canonical Form:

- “I was given this hammer by Thor”
- “Thor gave me this hammer”

## By using Semantic Net



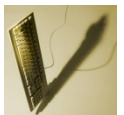
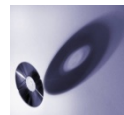
`gives(thor, me, hammer)`



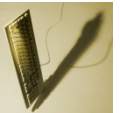
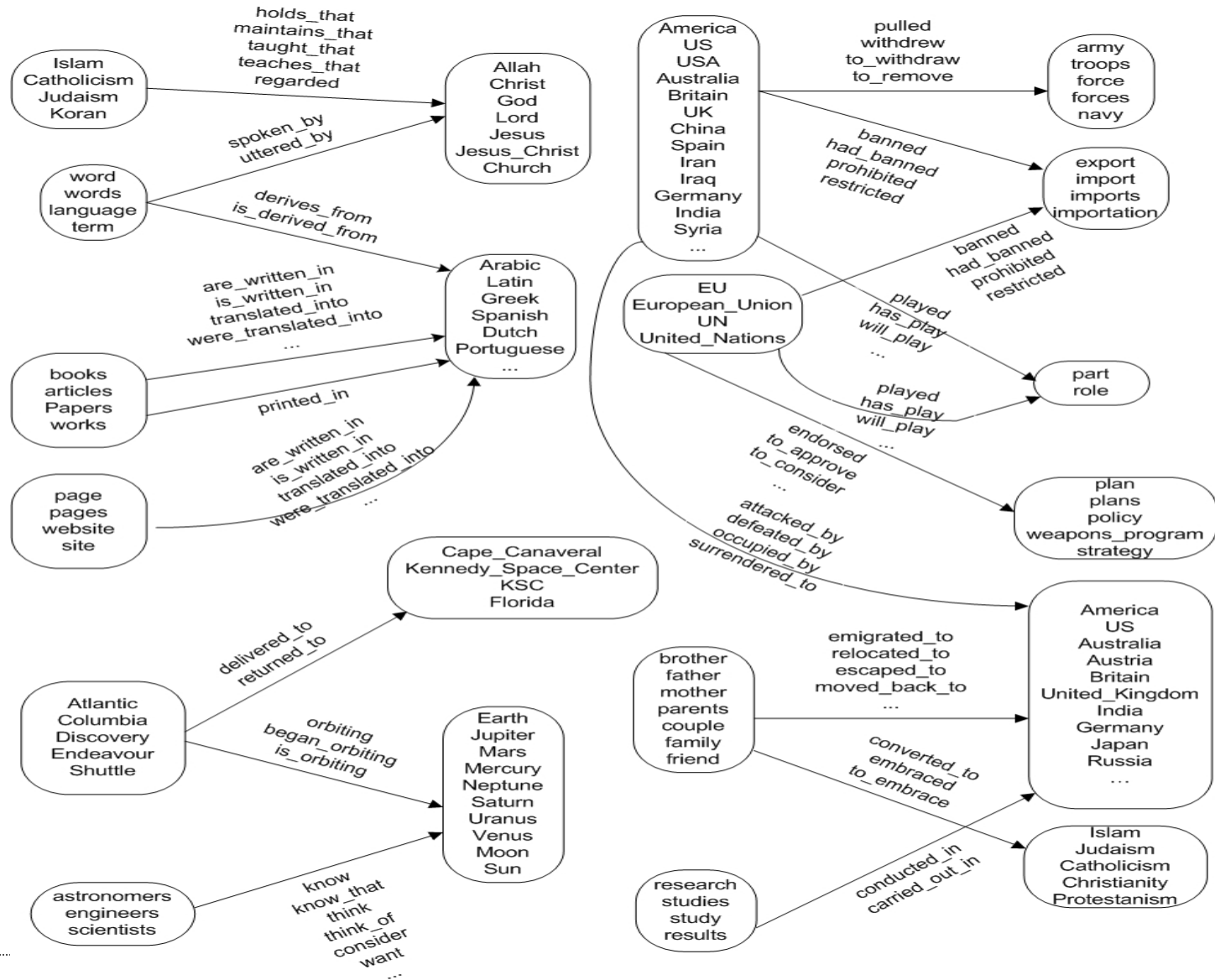
Stage 3

# **WORLD KNOWLEDGE REP –**

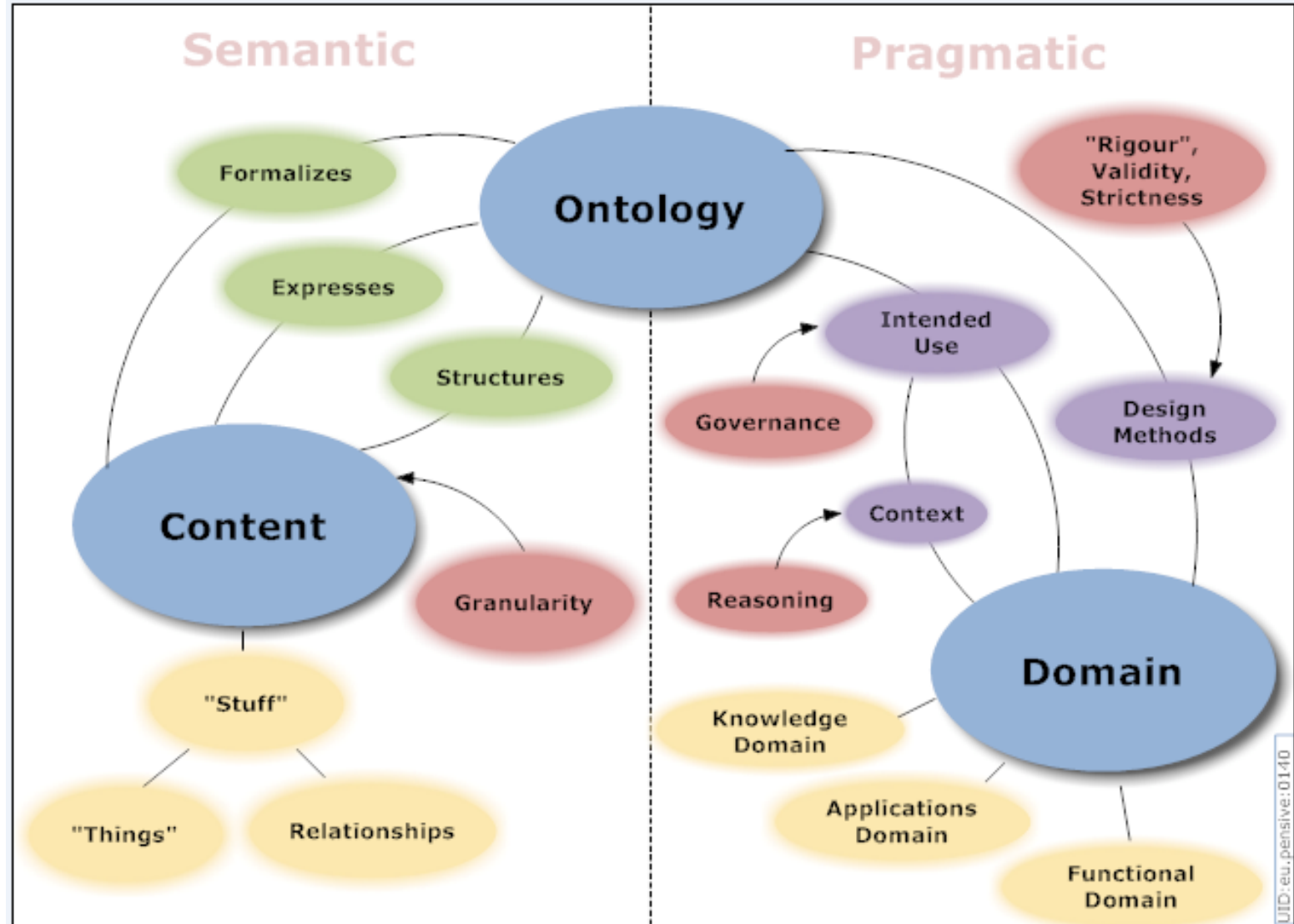
## **SEMANTIC NET/CONCEPTUAL GRAPH/ONTOLOGY/ CONCEPTUAL DEPENDENCY**



# Extended Semantic Network

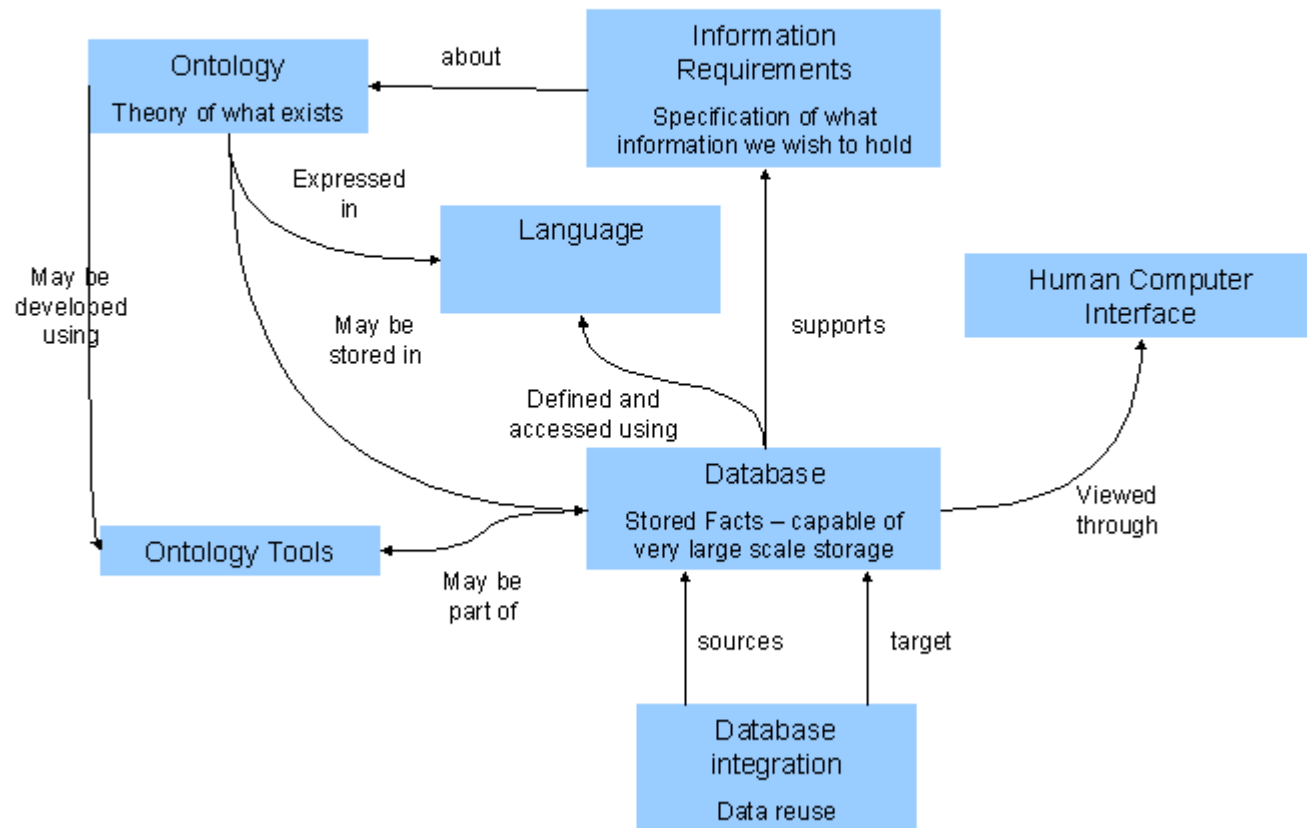


# Conceptual/World Knowledge Representation



# For Q & A Handling

## Ontology and Databases





# MSN Encarta

- **Keith says:**  
What is  $2 * 2 ^ 6 + 7$
- **Encarta® Instant Answers says:**  
9
- **Keith says:**  
Name the planets in the solar system?
- **Encarta® Instant Answers says:**  
There are 9 planets in the solar system:  
Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.
- **Keith says:**  
What is Encarta?
- **Encarta® Instant Answers says:**  
About MSN Encarta®.  
MSN Encarta® is an online Encyclopedia, Dictionary, Atlas, and Homework helper:  
it's your gateway for interactive learning on the Web.  
You can ask me questions, and I will automatically search Encarta for an answer.  
You can also explore Encarta by going to its website: <http://encarta.msn.com/>.
- Add this id in your MSN Instant Messenger **encarta@conversagent.com**, send a simple message to the Encarta Instant Answers like Hi or anything it will then ask you to choose the appropriate Encarta site.

