Don’t Take Shortcuts!
Computational Lexical Semantics and the Turing Test
Roberto Navigli

http://lcl.uniroma1.it
Turing Test (1950)

- A test of a machine’s ability to demonstrate intelligence
- Inspired by a party game, known as the “imitation game" (a man vs. a woman)

“I propose to consider the question, *Can machines think?* [Since "thinking" is difficult to define, let’s] replace the question by another, which is closely related to it and is expressed in relatively unambiguous words. [...] Are there imaginable digital computers which would do well in the *imitation game*?”

-Alan Turing, “Computing Machinery and Intelligence” (1950)
Turing Test (1950)

- A test of a machine’s ability to demonstrate intelligence
Why a language-driven test?

- Because intelligence is manifested through the ability to converse (as a sufficient (?) condition)
Why a language-driven test?

• Because intelligence is manifested through the ability to converse (as a sufficient but not necessary condition)

• Because Natural Language Understanding (NLU) is often thought of as an AI-complete problem

• NLU requires extensive knowledge about the world and the ability to interact with it
ELIZA (Weizenbaum, 1964-66)

- Simulates a Rogerian psychotherapist (Person-Centered Therapy)

E> Hi, I’m Eliza. What problem do you want to talk about?
U> Let’s talk about the SOFSEM conference
E> What is your problem with the SOFSEM conference?
U> No problem, really
E> Why not?
U> I just wanted to chat about the conference
E> Is that the real reason?
U> Yes
E> I understand
**ELIZA (Weizenbaum, 1964-66)**

- Simulates a Rogerian psychotherapist (Person-Centered Therapy)

**U**> So what

**E**> Have you asked such questions before?

**U**> About a zillion times

**E**> Can you elaborate on that?

**U**> Ok, let’s talk about the Turing session of the conference

**E**> Does that question interest you?

**U**> Yes, tremendously, I’m here for giving an invited talk!

**E**> Are you sure?
ELIZA (Weizenbaum, 1964-66)

• An early example of computer program performing primitive natural language processing
• Processes human replies to questions
• Uses simple template matching by inserting keywords into template phrases
• No semantics, really!
Shortcut #1:
Flatter the user
(AKA: Template Matching)
Mgonz (Humphrys, 1989)

- Memoryless is good in a random conversation!

U> finger
M> cut this cryptic s**t speak in full sentences
U> well hello
M> ok thats it im not talking to you any more
U> mark?
M> mark isnt here and has left me to deal with cretins like you
U> hello mark are you there?
U> I can't tell if this thing is working.
M> ah type something interesting or shut up
Shortcut #2:
Insult the user
(AKA: “type something interesting or shut up”)

You’re Stoopid.
Implementing the Turing Test: the Loebner Prize

- Annual competition in Artificial Intelligence
- **Round**: a judge converses with a human and a machine and decides which is which
- **Time limit**: 5-20+ minutes
- **Risk**: a winning system might aim at trickery rather than plausible intelligence
These systems do not really UNDERSTAND!

- JUDGE> I liked "Betty Blue" very much. I like movies about crazy people.
- PROGRAM> Like wow. I'm so flattered. I saw "The City of Lost Children" recently. Have you heard of it?
- You just need a database of movies…
These systems do not really UNDERSTAND!

• JUDGE> Yes, but I haven't seen it. Why did you say you were "so flattered"?

• PROGRAM> OK. That's good... Does there have to be a reason?

• Reminiscent of ELIZA, maybe?
These systems do not really UNDERSTAND!

- JUDGE> Oh, I suppose not. Say anything which will convince me you are not a machine
- PROGRAM> Wow - you suppose not? Me too! Listen. I don't know which convince you I am a machine will not, and I don't wish to be told either! So, have you ever visited Australia?

- Alright, better than ELIZA at changing the subject when on a difficult topic
- But linguistically challenged!
These systems do not really UNDERSTAND!

• JUDGE> are you from australia?
• PROGRAM> It's cool being from Australia I guess. Gives you something to chat about when talking with a Yank!
• JUDGE> I am unsure of that reply--are you from australia?
• PROGRAM> It's cool being from Australia I guess. Gives you something to chat about when talking with a Yank!

• Oooops, a little crack in the system?
Let’s get SERIOUS!

• JUDGE> I bought pens for my cattle in Perth, Australia. What do you think about that?

• PROGRAM1> Check back later and see if I learn the answer to that one.

• Oooops, a larger crack in the system?
Let’s get SERIOUS!

- JUDGE> I bought pens for my cattle in Perth, Australia. What do you think about that?
- PROGRAM2> Hey, are they writing the next best seller?

- Nope, it doesn’t work…
Shortcut #3 (generalizes shortcuts #1 and #2):

Keep away from Natural Language Processing (AKA: “the intelligent parrot approach to the Turing Test”)
What knowledge does HAL 9000 need?

- **HAL** (Heuristically programmed ALgorithmic computer)

**Dave Bowman**: Hello, HAL. Do you read me, HAL?

**HAL**: Affirmative, Dave. I read you.

**Dave Bowman**: Open the pod bay doors, HAL.

**HAL**: I'm sorry, Dave. I'm afraid I can't do that.

**Dave Bowman**: What's the problem?

**HAL**: I think you know what the problem is just as well as I do.

**Dave Bowman**: What are you talking about, HAL?

**HAL**: This mission is too important for me to allow you to jeopardize it.

**Dave Bowman**: I don't know what you're talking about, HAL.
So what can we (researchers?) do about automatic text understanding?
"Let’s say you want to write an award-winning short story—you just push this key, here..."

© 1997 Mick Stevens from The Cartoon Bank. All rights reserved.
The (Commercial) State of the Art

- **How to translate**: “I like chocolate, so I bought a bar in a supermarket”?
- **Google Translate**: “Mi piace il cioccolato, così ho comprato un bar in un supermercato”!

Don’t Take Shortcuts! Computational Lexical Semantics and the Turing Test
Roberto Navigli

14/02/2014
Shortcut #4:
Just use statistics
(AKA: “tons of data will tell you”)
It’s not that the “big data” approach is bad, it’s just that mere statistics is not enough
Symbol vs. Concept

Source: Little Britain.

Don’t Take Shortcuts! Computational Lexical Semantics and the Turing Test

Roberto Navigli
Symbol vs. Concept

Source: Little Britain.
Word Sense Disambiguation (WSD)

- The task of computationally determining the senses (meanings) for words in context

- “Spring water can be found at different altitudes”
Word Sense Disambiguation (WSD)

• The task of computationally determining the senses (meanings) for words in context

• “Spring water can be found at different altitudes”
**Word Sense Disambiguation (WSD)**

- It is basically a *classification* task
  - The objective is to learn how to associate word senses with words in context
  - This task is strongly linked to Machine Learning

*I like chocolate, so I bought a **bar** in a supermarket*

\[
\text{bar} = \{\text{chocolate}, \text{food}, \text{item}, \ldots\}
\]
Word Sense Disambiguation (WSD)

bar
(target word)

“I like chocolate, so I bought a bar in a supermarket”
(context)

Corpora
Lexical
Knowledge
Resources

resources

WSD
system

at the bar?

bar/counter

bar/law

bar/block

output sense
Lexical sample vs. All words

• Lexical sample
  – A system is asked to disambiguate a restricted set of words (typically one word per sentence):
    • We are fond of fruit such as kiwi and banana.
    • The kiwi is the national bird of New Zealand.
    • ... a perspective from a native kiwi speaker (NZ).

• All words
  – A system is asked to disambiguate all content words in a data set:
    • The kiwi is the national bird of New Zealand.
    • ... a perspective from a native kiwi speaker (NZ).
But… is WSD any good?
But... is WSD any good?

- Back in 2004 (Senseval-3, ACL):

<table>
<thead>
<tr>
<th>Lexical sample</th>
<th>Accuracy</th>
<th>System</th>
<th>U/S</th>
<th>All words</th>
<th>Accuracy</th>
<th>System</th>
<th>U/S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>72.9</td>
<td>hata3</td>
<td>S</td>
<td></td>
<td>65.1</td>
<td>GAMEP-AW</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>72.6</td>
<td>IRST-TKernels</td>
<td>S</td>
<td></td>
<td>65.1/64.2</td>
<td>SenseParner</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>72.4</td>
<td>nites</td>
<td>S</td>
<td></td>
<td>56.6/58.2</td>
<td>IRS-EMDD-00</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>72.3</td>
<td>BCG-Word</td>
<td>S</td>
<td></td>
<td>52.4</td>
<td>BL</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>55.2</td>
<td>MinLP</td>
<td>S</td>
<td></td>
<td>62.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many instances of just a few words

State of the art: 65% accuracy

Few instances of many words
What does “65% accuracy” mean?

- You understand 65 (content) words out of 100 in a text:

______    ______    ______    ______  
______    ______    ______    ______  
______    ______    ______    ______  
______    ______    ______    ______  
______    ______    ______    ______  
______    ______    ______    ______  
______    ______    ______    ______  
______    ______    ______    ______  

- You might behave the wrong way!
- For instance:

I used to be a banker, but lost interest in the work

I was arrested after my therapist suggested I take something for my kleptomania
And you need a lot of training data!

- Dozens (hundreds?) of person-years, at a throughput of one word instance per minute [Edmonds, 2000]
- For each language of interest!

Source: [Iraolak, 2004]
Why is WSD so difficult?

“For three days and nights she danced in the streets with the crowd.”

WordNet [Miller et al. 1990; Fellbaum, 1998]:

- **street**¹ - a thoroughfare (usually including sidewalks) that is lined with buildings
- **street**² - the part of a thoroughfare between the sidewalks; the part of the thoroughfare on which vehicles travel
- **street**³ - the streets of a city viewed as a depressed environment in which there is poverty and crime and prostitution and dereliction
- **street**⁵ - people living or working on the same street
Inter-Tagger Agreement using WordNet

• On average human sense taggers agree on their annotations 67-72% of the time

• **Question 1**: So why should we expect an automatic system to be able to do any better than us?!

• **Question 2**: What can we do to improve this frustrating scenario?
From Fine-Grained to Coarse-Grained Word Senses

- We need to remove unnecessarily fine-grained sense distinctions
Coarser sense inventories can be created manually [Hovy et al., NAACL 2006]:
- Start with the WordNet sense inventory of a target word
- Iteratively partition its senses
- Until 90% agreement is reached among human annotators in a sense annotation task
Coarser sense inventories can be created automatically using WSD [Navigli, ACL 2006]:

- Flat list of senses
- Hierarchy of senses
- Homonyms
- Polysemous senses
- Subsenses

<table>
<thead>
<tr>
<th>race#n (WordNet)</th>
<th>race#n (ODP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any competition (→ contest).</td>
<td>Core: SPORT A competition between runners, horses, vehicles, etc.</td>
</tr>
<tr>
<td>People who are believed to belong to the same genetic stock (→ group).</td>
<td>• RACING A series of such competitions for horses or dogs • A situation in which individuals or groups compete (→ contest) • Astronomy The course of the sun or moon through the heavens (→ trajectory).</td>
</tr>
<tr>
<td>A contest of speed (→ contest).</td>
<td>Core: NAUTICAL A strong or rapid current (→ flow).</td>
</tr>
<tr>
<td>The flow of air that is driven backwards by an aircraft propeller (→ flow).</td>
<td>Core: A groove, channel, or passage.</td>
</tr>
<tr>
<td>A taxonomic group that is a division of a species; usually arises as a consequence of geographical isolation within a species (→ taxonomic group).</td>
<td>• MECHANICS A water channel • Smooth groove or guide for balls (→ indentation, conduit) • FARMING Fenced passage way in a stockyard (→ route) • TEXTILES The channel along which the shuttle moves.</td>
</tr>
<tr>
<td>A canal for a current of water (→ canal).</td>
<td>Core: ANTHROPOLOGY Division of mankind (→ ethnic group).</td>
</tr>
<tr>
<td></td>
<td>• The condition of belonging to a racial division or group • A group of people sharing the same culture, history, language • BIOLOGY A group of people descended from a common ancestor.</td>
</tr>
<tr>
<td></td>
<td>Core: BOTANY, FOOD A ginger root (→ plant party).</td>
</tr>
</tbody>
</table>
Is coarse-grained better than fine-grained?

- Let’s move forward to 2007 (Semeval-2007, ACL):

<table>
<thead>
<tr>
<th>Coarse-grained Lexical sample</th>
<th>Coarse-grained All words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>System</td>
</tr>
<tr>
<td>88.7</td>
<td>NUS-ML</td>
</tr>
<tr>
<td>86.9</td>
<td>UBC-ALM</td>
</tr>
<tr>
<td>86.4</td>
<td>I2R</td>
</tr>
<tr>
<td>85.4</td>
<td>USP-IBM2</td>
</tr>
<tr>
<td>85.1</td>
<td>USP-IBM1</td>
</tr>
<tr>
<td>78.0</td>
<td>MFS BL</td>
</tr>
</tbody>
</table>

training data

Most Frequent Sense Baseline
The Most Frequent Sense (MFS) Baseline

• Given an ambiguous word, simply *always* choose the most common (i.e., most frequently occurring) sense within a *sense-annotated corpus*

1. (8) *pen* -- (a writing implement with a point from which ink flows)
2. (1) *pen* -- (an enclosure for confining livestock)
3. *playpen*, *pen* -- (a portable enclosure in which babies may be left to play)
4. *penitentiary*, *pen* -- (a correctional institution for those convicted of major crimes)
5. *pen* -- (female swan)
The Most Frequent Sense (MFS) Baseline

• Given an ambiguous word, simply always choose the most common (i.e., most frequently occurring) sense within a sense-annotated corpus

• High performance on open text (the predominant sense is most likely to be correct)

• Looks like a pretty lazy way to tackle ambiguity!
But, hey, just think of the Web!

There are at least 8 billion Web pages out there! On average each page contains ~500 words (2006)
MFS on 8G * 500 words = 4T words...

- At 78.9% performance, it makes 21.1% of errors
- So it chooses the wrong sense for 844G words (out of 4T)
- Can we afford that?
- So what’s the output on:
  - JUDGE> I bought pens for my cattle in Perth, Australia. What do you think about that?
  - PROGRAM2> Hey, are they writing the next best seller?

Sense 1
pen -- (a writing implement with a point from which ink flows)
=> writing implement -- (an implement that is used to write)

Sense 2
pen -- (an enclosure for confining livestock)
=> enclosure -- (a structure consisting of an area that has been enclosed for some purpose)
Shortcut #5:
Most Frequent Sense
(AKA: “lazy about senses”)
Coarse-grained Word Sense Disambiguation
[Navigli et al. 2007; Pradhan et al. 2007]

- Semeval-2007, ACL:

<table>
<thead>
<tr>
<th>Coarse-grained Lexical sample</th>
<th>Coarse-grained All words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td><strong>System</strong></td>
</tr>
<tr>
<td>88.7</td>
<td>NUS-ML</td>
</tr>
<tr>
<td>86.9</td>
<td>UBC-ALM</td>
</tr>
<tr>
<td>86.4</td>
<td>I2R</td>
</tr>
<tr>
<td>85.4</td>
<td>USP-IBM2</td>
</tr>
<tr>
<td>85.1</td>
<td>USP-IBM1</td>
</tr>
</tbody>
</table>

State of the art: 82-83%!

- Training data
- Large knowledge base
Knowledge-based WSD: the core idea

• We view WordNet (or any other knowledge base) as a graph

• We exploit the relational structure (i.e., edges) of the graph to perform WSD
WordNet (Miller et al. 1990; Fellbaum, 1998)
Knowledge-based WSD: the main idea

The waiter served white port
Two Knowledge-Based WSD Algorithms which Exploit Semantic Structure

• Graph connectivity measures [Navigli & Lapata, 2007; 2010]
• Structural Semantic Interconnections [Navigli & Velardi, 2005]

• Both based on a graph construction phase
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]

• Transform the input sentence (e.g. “She drank some milk”) into a bag of content words:

\[ \{ \text{drink}_v, \text{milk}_n \} \]

• Build a disambiguation graph that includes all nodes in paths of length \( \leq L \) connecting pairs of senses of words in context

• The disambiguation graph contains the possible semantic interpretations for the sentence
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Graph Construction
[Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]
Knowledge-based WSD with Connectivity Measures [Navigli & Lapata, IJCAI 2007; IEEE TPAMI 2010]

- Measures from different areas of computer science (graph theory, social network analysis, link analysis, etc.) tested within a single framework
  - Degree
  - Betweenness [Freeman, 1977]
  - Key Player Problem [Borgatti, 2003]
  - Maximum Flow
  - PageRank [Brin and Page, 1998]
  - HITS [Kleinberg, 1998]
  - Compactness [Botafogo et al., 1992]
  - Graph Entropy
  - Edge Density

Local measures

Global measures

Don’t Take Shortcuts! Computational Lexical Semantics and the Turing Test
Roberto Navigli
Degree Centrality for WSD
[Navigli & Lapata, IEEE TPAMI 2010]

• Calculate the normalized number of edges terminating in a given vertex

\[\text{deg}(v) = \frac{|\{u, v\} \in E : u \in V|}{|V| - 1}\]

• Choose the highest-ranking sense(s) for each target word
Structural Semantic Interconnections (SSI) [Navigli & Velardi, IEEE TPAMI 2005]

• Key idea: “good” edge sequences (semantic interconnections) encoded with an edge grammar
• Examples of good and bad semantic interconnections according to the SSI grammar:

<table>
<thead>
<tr>
<th>Semantic interconnection</th>
<th>Good?</th>
</tr>
</thead>
<tbody>
<tr>
<td>eat #v#1 cause, feed #v#2 related, food #n#2</td>
<td>✓</td>
</tr>
<tr>
<td>drive #v#1 related, vehicle #n#1 related, fender #n#1 part-of, car #n#1</td>
<td>✓</td>
</tr>
<tr>
<td>cup #n#2 related, milk #n#1 related, beverage #n#1 has-kind, coffee #n#1</td>
<td>✓</td>
</tr>
<tr>
<td>shivery #a#1 similar-to, cold #a#1 attribute, temperature #n#1</td>
<td>✓</td>
</tr>
<tr>
<td>computer #1 related, user #1 kind-of, consumer #1 has-kind, drinker #2</td>
<td>×</td>
</tr>
</tbody>
</table>

• Exploit good edge sequences only for WSD
The SSI Algorithm

• It takes as input a set of words in context
• It consists of two phases:
  1. graph construction
     • A graph, induced from WordNet, is associated with the input words
  2. interpretation
     • For each word the highest-ranking node (i.e. word sense) in the graph is selected according to a path-based measure
Structural Semantic Interconnections (SSI) [Navigli & Velardi, IEEE TPAMI 2005]

- Available online:
  - http://lcl.uniroma1.it/ssi

- Example:
  - “We drank a cup of chocolate”
Lesson Learned (1): Horizontal vs. Vertical Relations

- WordNet provides mostly paradigmatic (i.e. vertical) relations

  bunga bunga -is-a-> sex party

- We need syntagmatic (i.e. horizontal) relations for high-quality WSD

  bunga bunga -related-to-> Silvio Berlusconi

beware: hot information!
Lesson Learned (2): The Richer, The Better

- Highly-interconnected semantic networks have a great impact on knowledge-based WSD [Navigli & Lapata, IEEE TPAMI 2010] even in a fine-grained setting.
The knowledge acquisition bottleneck

- So why don’t we “simply” enrich 100k concepts with 100 semantic relations each?
- Again it would require dozens of person-years of annotation work!

FEASIBLE... BUT SUSCEPTIBLE TO LAZINESS FACTOR

- A task which then has to be repeated for each new language!
**Key Idea 1:** create **knowledge** for **all languages**
Key Idea 2: use many languages to disambiguate one language
The BabelNet solution [Navigli & Ponzetto, ACL 2010]

- A wide-coverage multilingual semantic network containing concepts, named entities and semantic relations, obtained from the automatic integration of:
  - Wikipedia (encyclopedic)
  - WordNet (lexicographic)
BabelNet [Navigli & Ponzetto, ACL 2010]

- From a heterogeneous set of monolingual resources…

- to a new unified multilingual language resource
- containing millions of ready-made semantic relations harvested from Wikipedia
- First version available at: http://lcl.uniroma1.it/babelnet
State-of-the-art Monolingual WSD
(Navigli & Ponzetto, AIJ 2012?, pending revision)

<table>
<thead>
<tr>
<th>Resource</th>
<th>Algorithm</th>
<th>Nouns only P/R/F₁</th>
<th>All words P/R/F₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>WordNet</td>
<td>Degree</td>
<td>80.0</td>
<td>79.4</td>
</tr>
<tr>
<td></td>
<td>PLength</td>
<td>79.8</td>
<td>79.8</td>
</tr>
<tr>
<td></td>
<td>SProbability</td>
<td>79.7</td>
<td>79.7</td>
</tr>
<tr>
<td></td>
<td>PageRank</td>
<td>79.2</td>
<td>79.3</td>
</tr>
<tr>
<td>BabelNet</td>
<td>Degree</td>
<td>85.1</td>
<td>82.5</td>
</tr>
<tr>
<td></td>
<td>PLength</td>
<td>85.4</td>
<td>82.6</td>
</tr>
<tr>
<td></td>
<td>SProbability</td>
<td>85.1</td>
<td>82.0</td>
</tr>
<tr>
<td></td>
<td>PageRank</td>
<td>81.0</td>
<td>81.0</td>
</tr>
<tr>
<td></td>
<td>SUSSX-FR</td>
<td>81.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TreeMatch</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NUS-PT</td>
<td>82.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SSI</td>
<td>84.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MFS BL</td>
<td>77.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random BL</td>
<td>63.5</td>
<td></td>
</tr>
</tbody>
</table>

Ok, so now we have ~85% performance with non-naive WSD!
What for?

- **JUDGE**> I bought **pens** for my **cattle** in Perth, Australia. What do you think about that?
- **PROGRAM3**> Hey, do you like raising **livestock**?

Sense 1

**pen** -- (a writing implement with a point from which ink flows)

=> writing implement -- (an implement that is used to write)

Sense 2

**pen** -- (an enclosure for confining livestock)

=> enclosure -- (a structure consisting of an area that has been enclosed for some purpose)
Keep cool, we have not solved the problem yet!

- What about *pragmatics* without tricks?
- And *discourse*? (Maybe not so relevant for a 5-minute chat?)
- Also, we just dealt with *(some)* computational *lexical semantics*
- Much more can be done!

Don’t take shortcuts!
The next level: our current work in Rome

- Multilingual WSD & semantic relatedness
  Simone Ponzetto

- Word Sense Induction & Ontology-based Query Suggestion
  Antonio Di Marco

- Large-scale WSD & Statistical Machine Translation
  Taher Pilehvar

- Ontologized semantic relations, really
  Andrea Moro

- Domain WSD & Ontology Learning from Scratch
  Stefano Faralli

- That’s me!!

- Ontologized Selectional Preferences
  Tiziano Flati

Don’t Take Shortcuts! Computational Lexical Semantics and the Turing Test
Roberto Navigli
Thanks or...

merci
(grazie)
Roberto Navigli
Linguistic Computing Laboratory
http://lcl.uniroma1.it

Joint work with: Mirella Lapata, Simone Ponzetto, Paola Velardi