Modeling regular polysemy: A study in the semantic classification of Catalan adjectives

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Overview

Automatic acquisition of **semantic classes for adjectives**
[Boleda et al., 2007, Boleda et al., prep]

**Given:** classification, set of adjectives, corpus

**Task:** infer the class for each adjective in the set
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- no established semantic classification or dataset
- we have to build these as we go along
  → exploratory nature of the experiments
- two classifications tested
  - experiments 1 and 2
Challenges

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- some adjectives are **polysemous** → have more than one sense → belong to more than one class
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Hypotheses and contribution

**Lexical Acquisition**

1. There is a stable relationship between semantic properties and other linguistic properties
   - Distributional Hypothesis [Harris, 1968]

2. Linguistic properties can be modeled using observable cues in corpora

3. Observable cues can be used to induce semantic properties
This study

1. it is possible to use observable cues to
   - induce semantic classes for adjectives
   - identify polysemous adjectives

2. computational methodology can give feedback to theoretical questions
This study

1. it is possible to use observable cues to
   - induce semantic classes for adjectives
     - most work on lexical acquisition on verbs (vs. adjectives)
     - and English (vs. Catalan)
   - identify polysemous adjectives

2. computational methodology can give feedback to theoretical questions
Hypotheses and contribution

This study

1. it is possible to use observable cues to
   - induce semantic classes for adjectives
   - identify polysemous adjectives
     - polysemy largely ignored in related work on lexical acquisition
     - regular polysemy: studied on a theoretical level, not in empirical approaches to computational semantics

2. computational methodology can give feedback to theoretical questions
This study

1. It is possible to use observable cues to
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   - Identify polysemous adjectives

2. Computational methodology can give feedback to theoretical questions
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Computational methodology can give feedback to theoretical questions
Outline

1. Introduction
2. Semantic classes and polysemy
3. Experiment 1: independent classes
4. Experiment 2: multi-label classification
5. Discussion
6. Research agenda
Semantic classification

- insights from descriptive grammar and formal semantics

Qualitative adjectives denote attributes or properties of objects.
Examples: ample, autònòm ‘wide’, ‘autonomous’

Intensional adjectives denote second order properties.
Examples: presume, antic ‘alleged’, ‘former’

Relational adjectives denote a relationship to an object.
Examples: pulmonar, botànic ‘pulmonary’, ‘botanical’

- semantic classes
- correlate with other linguistic properties
Semantic classification

- insights from descriptive grammar and formal semantics

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Example property: predicativity

qualitative (1)  intensional (2)  relational (3)
predicative       non-predicative       marginally predicative

(1) el carrer és ample
    the street is wide

(2) #l’ assassí és presumpte
    the murderer is alleged

(3) ?la malaltia és pulmonar
    the disease is pulmonary
Polysemy cutting across two classes: relational (4a) and qualitative (4b):

(4) a. la recuperació econòmica
   the recovery economic
   ‘the economic recovery’

b. els pantalons econòmics
   the trousers economic
   ‘the cheap trousers’

(5) a. ¿la recuperació és econòmica
   ‘the recovery is economic’

b. els pantalons són econòmics
   ‘the trousers are cheap’

in each sense, the adjective’s behaviour corresponds to that of the relevant class
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In each sense, the adjective’s behaviour corresponds to that of the relevant class.
Regular polysemy [Apresjan, 1974, Copestake and Briscoe, 1995]

- same type of polysemy for a range of adjectives

(6) a. reunió familiar / cara familiar
    meeting familiar / face familiar
    ‘family meeting / familiar face’

b. problema amorós / noi amorós
    problem love<sub>SUFFIX</sub> / boy love<sub>SUFFIX</sub>
    ‘love problem / lovely boy’

- in general:
  relation to **object** $\rightarrow$ salient property of the **object**

- we only consider class-related polysemy
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Experiment 1: Motivation

- classification based on linguistic literature
- does it account for the semantics of a broad range of adjectives?
- polysemous adjectives should exhibit a different profile than monosemous adjectives
- is this behaviour distinct enough to identify polysemous classes?
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Material and method (I)

- CTILC corpus (Institut d’Estudis Catalans):
  - 14.5 million words, written, formal texts
  - manually lemmatised and POS-tagged
  - automatically shallow-parsed (noise)

- adjective database [Sanromà and Boleda, 2010]:
  - almost 2,300 lemmata from CTILC corpus
  - morphological information manually coded
Gold Standard: 101 lemmata, random choice except for intensional class
- 4 judges, $\kappa$ 0.54-0.64
- for each adjective, choose semantic class
- target classes:
  - basic classes: qualitative (Q), relational (R)
  - polysemous “class”: qualitative-relational (QR)

- technique: clustering, $k$-means
- 3,521 objects (freq $> 10$)

- features:
  - theoretically motivated: predicativity, ... (6)
  - POS: POS unigrams; 2 words left and right of target (36)
Feature example: value distribution across classes

Predicativity

- I = intensional
- IQ = int−qual
- Q = qualitative
- QR = qual−rel
- R = relational

Box plot showing the distribution of values across different predicativity categories.
Theoretical features, 3 clusters
Results

A: 3 clusters
B: 5 clusters
Discussion: polysemy

- approach to polysemy is clearly wrong
Discussion: polysemy

- approach to polysemy is clearly wrong
polysemous adjectives do not have a homogeneous, differentiated profile

most adjectives are used predominantly in one of their senses, corresponding to one of the classes

- irònic (‘ironic’): qualitative-relational.
  - mainly used as qualitative in the corpus
  - systematically assigned to the qualitative cluster

- militar (‘military’): qualitative-relational.
  - mainly used as relational in the corpus
  - systematically assigned to the relational cluster
Discussion: classification

- “mixed” cluster: group of problematic adjectives identified in error analysis:
  - indicador, parlant, protector, salvador, …
- these adjectives do not fit into the classification
  - create new class
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Modified classification

Qualitative adjectives

Relational adjectives

Event-related adjectives denote a relationship to an event.

Examples:
- protector, variable
- ‘protecting’, ‘variable’

- relationship with morphology
- qualitative event relational
- non-derived deverbal denominal

- supported by Ontological Semantics
  [Raskin and Nirenburg, 1998]
Modified classification

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  non-derived deverbal denominal

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  [Raskin and Nirenburg, 1998]
Experiment 2: Motivation

Experiment 1 shows that

- polysemous adjectives do exhibit a different profile from monosemous adjectives
- ...but it is not distinct enough to identify polysemous classes
- polysemy = membership in more than one class

→ multi-label classification

- a lemma can belong to more than one target class
- look for properties of each of the classes
Material: Gold Standard

- same corpus and database as in Experiment 1
- Gold Standard: 210 lemmata
- stratified sampling approach
  - frequency, morphology
- large-scale manual annotation experiment
  - task: choose one or more pseudo-dictionary definitions
  - administered via Web
  - 322 naive subjects
  - does not yield reliable classification ($\kappa 0.31-0.45$)
- Gold Standard classification: committee of 3 experts
  - agreement subjects-experts: $\rho_0 0.68$, $\kappa 0.55$
Method

- classifiers: Decision Trees (flat), ensemble classifiers
- features:

<table>
<thead>
<tr>
<th>Type</th>
<th>Explanation</th>
<th># F.</th>
</tr>
</thead>
</table>
| morph | morphological properties  
  ex.: *suffix* | 2 |
| func | syntactic function  
  ex.: *predicate in copular sentence* | 4 |
| uni | uni-gram distribution  
  ex.: *-1noun* | 24 |
| bi | bi-gram distribution  
  ex.: *-1noun+1adj* | 50 |
| theor | distributional cues of theoretical properties  
  ex.: *gradable* | 18 |

Table: Experiment 2: features.
Procedure

Standard procedure for multi-label classification

1. binary decision
2. merge classifications
   - **economic:**
     - qualitative: yes
     - relational: yes
     - event: no
   - rationale: if an adjective is polysemous, it will exhibit properties of each class it belongs to

Evaluation

- 10 run, 10-fold cross-validation
- baseline: most frequent class
Procedure

Standard procedure for multi-label classification

1. binary decision
2. merge classifications

- **econòmic:**
  - qualitative: yes
  - relational: yes
  - event: no
  - merged: qualitative-relational (QR)

- rationale: if an adjective is polysemous, it will exhibit properties of each class it belongs to

Evaluation

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Procedure

Standard procedure for multi-label classification

1. binary decision
2. merge classifications
   - **econòmic:** qualitative relational event merged
     yes yes no qualitative-relational (QR)
   - rationale: if an adjective is polysemous, it will exhibit properties of each class it belongs to

Evaluation

- 10 run, 10-fold cross-validation
- baseline: most frequent class
## Results

<table>
<thead>
<tr>
<th>Classifier</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>baseline</em></td>
<td>51.0 ± 0.0</td>
</tr>
<tr>
<td>best flat</td>
<td>62.5 ± 2.5</td>
</tr>
<tr>
<td>Att. Bagg. (_{FS,bin,i=100})</td>
<td>69.1 ± 1.0</td>
</tr>
</tbody>
</table>

*Human agreement* 68

**Table:** Experiment 2: summary of results.
### Error analysis

<table>
<thead>
<tr>
<th>Experts</th>
<th>Q</th>
<th>E</th>
<th>R</th>
<th>QR</th>
<th>QE</th>
<th>ER</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>90</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>107</td>
</tr>
<tr>
<td>E</td>
<td>10</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>37</td>
</tr>
<tr>
<td>R</td>
<td>4</td>
<td>0</td>
<td>20</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>QR</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>QE</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>ER</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>22</td>
<td>28</td>
<td>22</td>
<td>19</td>
<td>9</td>
<td>210</td>
</tr>
</tbody>
</table>

- overgenerated polysemous adjectives: 26
- undergenerated polysemous adjectives: 13
Outline

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Discussion: Two models for regular polysemy

Model 1

Monosemous$_A$

Monosemous$_B$

Polysemous$_{AB}$

Model 2
Conclusion

This study

1. it is possible to use observable cues to
   - induce semantic classes for adjectives
   - identify polysemous adjectives

2. computational methodology can give feedback to theoretical questions
Conclusion

This study

1. it is possible to use observable cues to
   - induce semantic classes for adjectives
     - relationship between observable cues and semantic properties
     - explored morphology-semantics and syntax-semantics interfaces
     - roadblock: human agreement → need to improve theory
   - identify polysemous adjectives

2. computational methodology can give feedback to theoretical questions
This study

1. it is possible to use observable cues to
   - induce semantic classes for adjectives
   - identify polysemous adjectives
     - polysemous adjectives exhibit “hybrid” behaviour
     - tested two models of regular polysemy
     - need to model both similarities and differences with respect to basic classes

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   - random sampling: emergence of “nonprototypically nonprototypical” adjectives
     - Gold Standards: medium-sized datasets
   - feature representation: empirical properties
   - Machine Learning: evaluation of different models
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Overall research question

How do languages encode meaning?
Overall research question

How do words and word combinations encode meaning?
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How do words and word combinations encode meaning?

→ empirical computational lexical semantics
Approach: computational lexical semantics

**Method**
- Computational, quantitative:
  - Machine Learning
  - Statistical analysis

**Word meaning and composition**

**Data**
- Empirical: large scale, corpora, ling. resources

**Perspective**
- Cognitive: concepts, conceptual combination
Current research

**Goal**

*computationally model* the interpretation processes that take place in *semantic composition*

→ distributional/vector-space models
Question 1

While words may have different meanings, when used in a given context not all of them are relevant.

Question 1: How does combining two words affect the interpretation of each word?

- colour adjectives: *red dress* vs. *red wine*.
  → the modifier is altered depending on the head noun.

- can distributional models account for the different meanings of the modifiers depending on the head noun?
Question 1

- While words may have different meanings, when used in a given context not all of them are relevant.

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  - colour adjectives: *red dress* vs. *red wine*.
  - → the modifier is altered depending on the head noun.

- can distributional models account for the different meanings of the modifiers depending on the head noun?
Often, the interpretation of a complex expression is richer than what can be inferred from the meaning of its parts alone.

Question 2: How does combining two words yield the interpretation of a complex expression?

- noun-noun compounds: *dog magazine* [Murphy, 2002]
  → magazine ABOUT dogs – and more!
- can distributional models account for the relation between a head and its modifier?
Question 2

- Often, the interpretation of a complex expression is richer than what can be inferred from the meaning of its parts alone.

**Question 2: How does combining two words yield the interpretation of a complex expression?**

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Regular polysemy.
*Linguistics*, 142:5–32.

Modelling adjective polysemy as multi-label classification.
In *Proceedings of the Joint Meeting of the Conference on Empirical Methods in Natural Language Processing and the Conference on Computational Natural Language Learning (EMNLP-CoNLL 2007)*.

Boleda, G., Schulte im Walde, S., and Badia, T. (prep.).
Modeling regular polysemy: A study in the semantic classification of catalan adjectives.

Semi-productive polysemy and sense extension.

Harris, Z. (1968).
*Mathematical Structures of Language*.

Murphy, G. L. (2002).
*The Big Book of Concepts*.
MIT Press, Cambridge, MA.

An applied ontological semantic microtheory of adjective meaning for natural language processing.

# Material for Experiment 2: Gold Standard

<table>
<thead>
<tr>
<th>class</th>
<th>#adjs.</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>qualitative</td>
<td>107</td>
<td>ample ‘wide’</td>
</tr>
<tr>
<td>event</td>
<td>37</td>
<td>revelador ‘revealing’</td>
</tr>
<tr>
<td>relational</td>
<td>30</td>
<td>pulmonar, ‘pulmonary’</td>
</tr>
<tr>
<td>qual-ev</td>
<td>7</td>
<td>cridaner ‘vociferous/loud-coloured’</td>
</tr>
<tr>
<td>qual-rel</td>
<td>23</td>
<td>amorós ‘affectionate/related to love’</td>
</tr>
<tr>
<td>ev-rel</td>
<td>6</td>
<td>docent ‘teaching/related to teachers or the teaching task’</td>
</tr>
</tbody>
</table>
## Results for Experiment 2: linguistically principled EC

<table>
<thead>
<tr>
<th></th>
<th>Qualit.</th>
<th>Event</th>
<th>Relat.</th>
<th>Full</th>
<th>Partial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>best flat (all)</strong></td>
<td>75.5±9.0</td>
<td>86.5±6.4</td>
<td>86.0±6.5</td>
<td>62.5±2.5</td>
<td>87.6±2.5</td>
</tr>
<tr>
<td>3 best feat. sets</td>
<td>72.9±1.4</td>
<td>88.2±1.3</td>
<td>85.4±0.6</td>
<td>61.8±1.7</td>
<td>86.7±0.8</td>
</tr>
<tr>
<td>4 best feat. sets</td>
<td>74.6±2.0</td>
<td>86.5±1.5</td>
<td>88.1±1.2</td>
<td>63.0±2.4</td>
<td>87.4±1.8</td>
</tr>
<tr>
<td>5 best feat. sets</td>
<td>75.2±2.7</td>
<td>86.4±1.4</td>
<td><strong>90.8±1.2</strong></td>
<td>64.8*±2.6</td>
<td><em><em>89.5</em>±1.5</em>*</td>
</tr>
<tr>
<td>7 best feat. sets</td>
<td>75.3±2.3</td>
<td>82.7±1.8</td>
<td><strong>90.8±1.1</strong></td>
<td><strong>64.0±1.5</strong></td>
<td>85.9±1.3</td>
</tr>
<tr>
<td>all 9 feat. sets</td>
<td><strong>75.4±1.7</strong></td>
<td>80.9±2.1</td>
<td>90.1±1.2</td>
<td>62.4±2.2</td>
<td>84.4±1.3</td>
</tr>
</tbody>
</table>
## Results for Experiment 2: other ensemble classifiers

<table>
<thead>
<tr>
<th>Method</th>
<th>Qualit.</th>
<th>Event</th>
<th>Relat.</th>
<th>Full</th>
<th>Partial</th>
</tr>
</thead>
<tbody>
<tr>
<td>best flat (all)</td>
<td>75.5±9.0</td>
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<td>87.6±2.5</td>
</tr>
<tr>
<td>best ling. EC (*)</td>
<td>75.2±2.7</td>
<td>86.4±1.4</td>
<td>90.8±1.2</td>
<td>64.8*±2.6</td>
<td>89.5*±1.5</td>
</tr>
<tr>
<td>adaboost</td>
<td>82.0*±8.6</td>
<td>85.6±7.1</td>
<td>88.0±6.7</td>
<td>66.0*±1.9</td>
<td>89.9*±1.3</td>
</tr>
<tr>
<td>A. B. FS, bin, i=3</td>
<td>76.0±9.4</td>
<td>84.0±7.0</td>
<td>88.3±7.2</td>
<td>64.0±2.5</td>
<td>86.7±2.0</td>
</tr>
<tr>
<td>A. B. FS, bin, i=4</td>
<td>75.9±9.2</td>
<td>84.7±7.3</td>
<td>89.1±6.9</td>
<td>64.5±1.5</td>
<td>86.6±1.1</td>
</tr>
<tr>
<td>A. B. FS, bin, i=5</td>
<td>77.0±8.7</td>
<td>85.8±7.1</td>
<td>89.0±6.5</td>
<td>66.3*±1.1</td>
<td>87.0±1.5</td>
</tr>
<tr>
<td>A. B. FS, bin, i=100</td>
<td>81.0±8.8</td>
<td>86.1±6.9</td>
<td>90.1*±5.3</td>
<td>69.1***±1.0</td>
<td>89.0±1.0</td>
</tr>
<tr>
<td>Human agreement</td>
<td></td>
<td></td>
<td></td>
<td>68</td>
<td>85</td>
</tr>
</tbody>
</table>
Variation in object-object modification

(7) a. world war  
b. John’s book  
c. agreement by France  
d. psychological evidence