# Modeling the Complexity of Manual Annotation Tasks: a Grid of Analysis

**Karën Fort**, Adeline Nazarenko, Sophie Rosset

December 13th



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# Manual annotation: notoriously costly

**Penn Treebank** [Marcus et al., 1993]:

- 4.8 million tokens annotated with POS ⇒ learning phase of 1 month, to reach 3,000 words/h
- 3 million tokens annotated in syntax ⇒ learning phase of 2 months, to reach 475 words/h

**Prague Dependency Treebank** [Böhmová et al., 2001]:

- 1.8 million tokens annotated with POS and syntax

⇒ 5 years, 22 persons (max. 17 in parallel), 600,000 dollars

**GENIA** [Kim et al., 2008]:

- 9,372 sentences annotated in microbiology (proteins and gene names)

⇒ 5 part-time annotators, 1 senior coordinator and 1 junior for 1.5 year

# Some solutions...

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  - \+ simple to implement
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- active learning:
  - \+ gain in time [Cohn et al., 1995, Engelson and Dagan, 1996]
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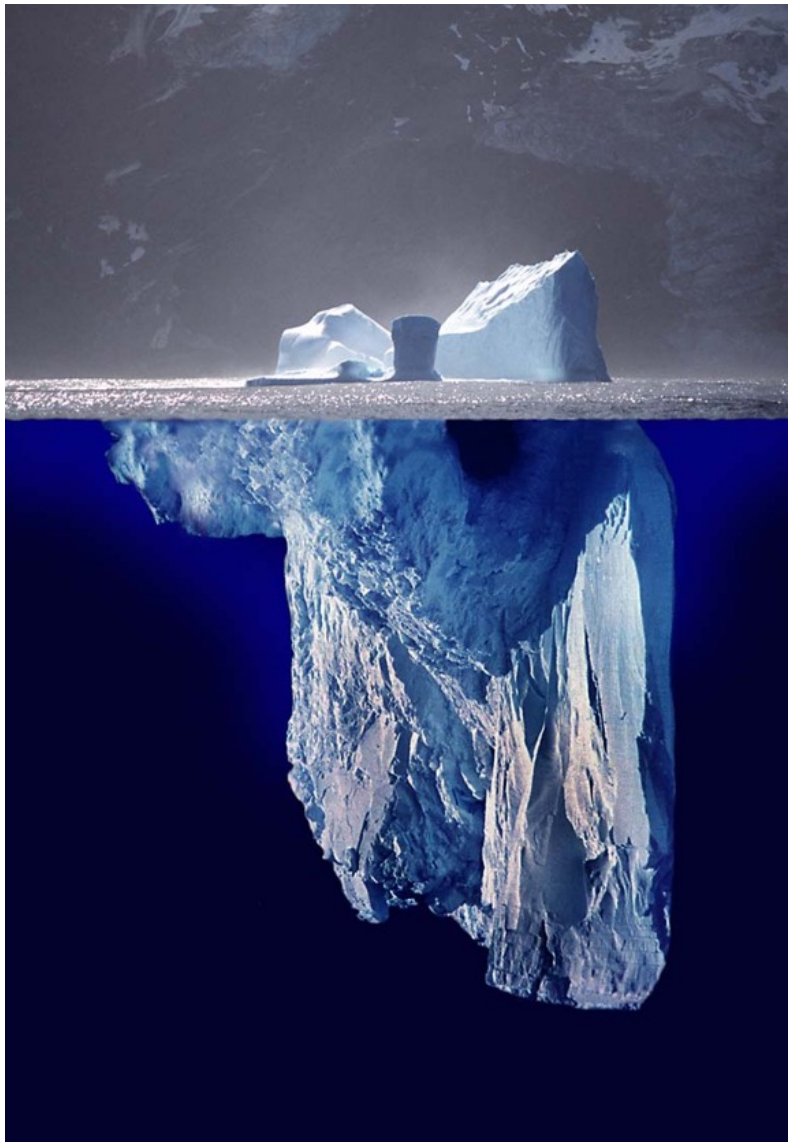
  - \- bias
- active learning:
  - \+ gain in time [Cohn et al., 1995, Engelson and Dagan, 1996]
  - \- bias and not so simple to implement
- crowdsourcing:
  - GWAPs: real cost rarely estimated [Chamberlain et al., 2013]
  - microworking (MTurk): quality and ethical issues [Fort et al., 2011]

# Some solutions...

# ... to a problem that is still little known



# Some traces

- Large-scale campaigns feedback
  [Marcus et al., 1993, Abeillé et al., 2003]
- Good practices:
  - formats [Ide and Romary, 2006]
  - organization [Bontcheva et al., 2010]
  - evaluation [Krippendorff, 2004]
- Partial methodologies: agile annotation
  [Bonneau-Maynard et al., 2005, Voormann and Gut, 2008]
- Some insights from cognitive science [Tomanek et al., 2010]

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# What is complex in manual annotation?

1 Introduction

2 Analysing the complexity of an annotation campaign

3 What to annotate?

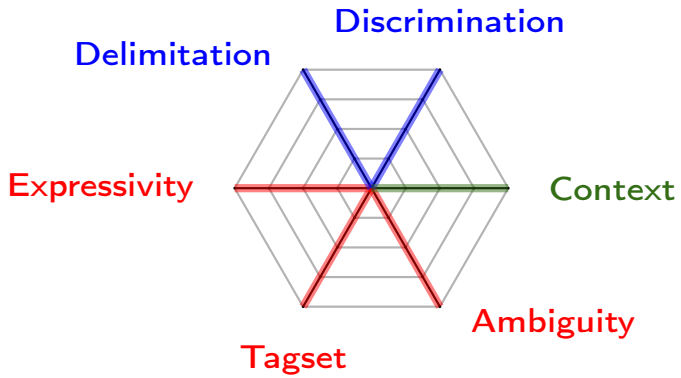
4 How to annotate?

5 Synthesis

6 Conclusion and prospects

# Complexity dimensions

- 5 independent dimensions:
  - 2 related to the localisation of annotations
  - 3 related to the characterisation of annotations
- 1 not independent: the context




- Scale from **0** (null complexity) to **1** (maximal complexity) to allow for the comparison between campaigns
- Independent from the volume to annotate and the number of annotators

# Elementary Annotation Task (EAT)

From a complex task, to several elementary tasks:

**Criteria**

An annotation task may be decomposed into at least two EATs if the used tagset can be decomposed into reduced and independent tagsets.

$\rightarrow$ may correspond to several successive annotation steps or not

# Example: gene renaming

1. Identification of gene names in the source signal:

   *The **yppB** gene complemented the defect of the recG40 strain. **yppB** and **ypbC** and their respective null alleles were termed "**recU**" and "**recU1**" (recU:cat) and "**recS**" and "**recS1**" (recS:cat), respectively.*

2. Identification of gene couples expressing a renaming relation:

   *The **yppB** gene complemented the defect of the recG40 strain. **yppB** and **ypbC** and their respective null alleles were termed **"recU"** and "**recU1**" (recU:cat) and **"recS"** and "**recS1**" (recS:cat), respectively.*

# Discrimination

Parts-of-speech [Marcus et al., 1993], pre-annotated :

*I/PRP do/VBP n't/RB feel/VB very/RB ferocious/JJ ./.*

Gene renaming[Fort et al., 2012], no pre-annotation:

*The yppB:cat and ypbC:cat null alleles rendered cells sensitive to DNA-damaging agents, impaired plasmid transformation (25- and 100-fold), and moderately affected chromosomal transformation when present in an otherwise Rec+ B. subtilis strain. The yppB gene complemented the defect of the recG40 strain. yppB and ypbC and their respective null alleles were termed recU and "recU1" (recU:cat) and recS and "recS1" (recS:cat), respectively. The recU and recS mutations were introduced into rec-deficient strains representative of the alpha (recF), beta (addA5 addB72), gamma (recH342), and epsilon (recG40) epistatic groups.*

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$\Rightarrow$ **more difficult** if the units to annotate are scattered, in particular if the segmentation is not obvious.

# Discrimination

The discrimination weight is all the more high as the proportion of what *should* be annotated as compared to what *could* be annotated is low.

## Definition

$$Discrimination(Flow) = 1 - \frac{|Annotations(Flow)|}{\sum_{i=1}^{LevelSeg} |UnitsObtainedBySeg_i(Flow)|}$$

$\Rightarrow$ Need for a reference segmentation

Parts-of-speech[Marcus et al., 1993] :

*I/PRP do/VBP n't/RB feel/VB very/RB ferocious/JJ ./.*

$$Discrimination_{PTB_{POS}} = 0$$

Gene renaming[Fort et al., 2012] :

*The yppB:cat and ypbC:cat null alleles rendered cells sensitive to DNA-damaging agents, impaired plasmid transformation (25- and 100-fold), and moderately affected chromosomal transformation when present in an otherwise Rec+ B. subtilis strain. The yppB gene complemented the defect of the recG40 strain. yppB and ypbC and their respective null alleles were termed recU and "recU1" (recU:cat) and recS and "recS1" (recS:cat), respectively. The recU and recS mutations were introduced into rec-deficient strains representative of the alpha (recF), beta (addA5 addB72), gamma (recH342), and epsilon (recG40) epistatic groups.*

$$Discrimination_{Identification} = 0,9$$
$$Discrimination_{Renaming} = 0,95$$

# Boundaries delimitation

- **extending** or **shrinking** the discriminated unit:
  *Madame Chirac* $\rightarrow$ *Monsieur et Madame Chirac*

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- **decompose** a discriminated unit into several elements:
  *le préfet Érignac* $\rightarrow$ *le préfet Érignac*

# Boundaries delimitation

- **extending** or **shrinking** the discriminated unit:
  *Madame Chirac* → *Monsieur et Madame Chirac*
- **decompose** a discriminated unit into several elements:
  *le préfet Érignac* → *le préfet Érignac*
- or **group** together several discriminated units into one unique annotation:
  *Sa Majesté*
  *le roi Mohamed VI* → *Sa Majesté le roi Mohamed VI*

# Boundaries delimitation

## Definition

$$Delimitation(Flow) = min\left(\frac{Substitutions + Additions + Deletions}{|Annotations(Flow)|}, 1\right)$$

$$Delimitation_{Identification} = 0$$
$$Delimitation_{Renaming} = 0$$

$$Delimitation_{PTB_{POS}} = 0$$

$$Délimitation_{EN_{TypesSubtypes}} = 1$$
$$Délimitation_{EN_{Components}} = 0,3$$

# Expressiveness of the annotation language

## Definition

The degrees of expressiveness of the annotation language are the following:

- 0.25: type languages
- 0.5: relational languages of arity 2
- 0.75: relational languages of arity higher than 2
- 1: higher-order languages

$$Expressiveness_{Identification} = 0.25$$
$$Expressiveness_{Renaming} = 0.25$$

# Dimension of the tagset

<table>
<tr><th colspan="3">Person</th><th colspan="3">Function</th></tr>
<tr><td colspan="2">pers.ind (individual person)</td><td>pers.coll (group of persons)</td><td colspan="2">func.ind (individual function)</td><td>func.coll (collectivity of functions)</td></tr>
<tr><th colspan="3">Location</th><th colspan="3">Production</th></tr>
<tr><td>administrative (loc.adm.town, loc.adm.reg, loc.adm.nat, loc.adm.sup)</td><td>physical (loc.phys.geo, loc.phys.hydro, loc.phys.astro)</td><td>facilities (loc.fac), oronyms (loc.oro), address (loc.add.phys, loc.add.elec)</td><td>prod.object (manufactured object)</td><td>prod.serv (transportation route)</td><td>prod.fin (financial products)</td></tr>
<tr><td colspan="3"></td><td>prod.doctr (doctrine)</td><td>prod.rule (law)</td><td>prod.soft (software)</td></tr>
<tr><td colspan="3"></td><td>prod.art</td><td>prod.media</td><td>prod.award</td></tr>
<tr><th colspan="3">Organization</th><th colspan="3" rowspan="3">Time</th></tr>
<tr><td colspan="2">org.adm (administration)</td><td>org.ent (services)</td></tr>
<tr><th colspan="3">Amount</th></tr>
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</table>

Types and sub-types used for structured NE annotation [Grouin et al., 2011]

# Dimension of the tagset

| **Person** | |
|---|---|
| *pers.ind* (individual person) | *pers.coll* (group of persons) |

| **Function** | |
|---|---|
| *func.ind* (individual function) | *func.coll* (collectivity of functions) |

| **Location** | | |
|---|---|---|
| administrative (*loc.adm.town*, *loc.adm.reg*, *loc.adm.nat*, *loc.adm.sup*) | physical (*loc.phys.geo*, *loc.phys.hydro*, *loc.phys.astro*) | facilities (*loc.fac*), oronyms (*loc.oro*), address (*loc.add.phys*, *loc.add.elec*) |

| **Production** | | |
|---|---|---|
| *prod.object* (manufactured object) | *prod.serv* (transportation route) | *prod.fin* (financial products) |
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| *prod.art* | *prod.media* | *prod.award* |

| **Organization** | |
|---|---|
| *org.adm* (administration) | *org.ent* (services) |

| **Time** | |
|---|---|
| *time.date.abs* (absolute date), *time.date.rel* (relative date) | *time.hour.abs* (absolute hour), *time.hour.rel* (relative hour) |

| **Amount** |
|---|
| *amount* (with unit or general object), including duration |

Level 1: *pers*, *func*, *loc*, *prod*, *org*, *time*, *amount* $\rightarrow$ 7 possibilities (degree of freedom = 6).

# Dimension of the tagset

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Level 1: *pers*, *func*, *loc*, *prod*, *org*, *time*, *amount* $\rightarrow$ 7 possibilities (degree of freedom = 6).
Level 2: *prod.object*, *prod.serv*, *prod.fin*, *prod.soft*, *prod.doctr*, *prod.rule*, *prod.art*, *prod.media*, *prod.award* $\rightarrow$ 9 possibilities (degree of freedom = 8).

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Level 3: *loc.adm.town*, *loc.adm.reg*, *loc.adm.nat*, *loc.adm.sup* $\rightarrow$ 4 possibilities (degree of freedom = 3).

# Dimension of the tagset

## Degree of freedom

$$\nu = \nu_1 + \nu_2 + \ldots + \nu_m$$

where $\nu_i$ is the maximal degree of freedom the annotator has when choosing the $i^{th}$ sub-type ($\nu_i = n_i - 1$).

## Dimension of the tagset

$$Dimension(Flow) = min(\frac{\nu}{\tau}, 1)$$

where $\tau$ is the threshold from which we consider the tagset to be very large (experimentally determined).

$$Dimension_{Identification} = 0$$
$$Dimension_{Renaming} = 0.04$$
$$Dimension_{NE_{TypesSubtypes}} = 0.34$$

# Degree of ambiguity: residual ambiguity

Using the traces left by the annotators:

*[...] <EukVirus>3CDproM</EukVirus> can process both structural and nonstructural precursors of the <EukVirus* ***uncertainty-type*** *= "too-generic"><taxon>poliovirus</taxon> polyprotein</EukVirus> [...].*

## Définition

$$AmbiguityRes(Flow) = \frac{|Annotations_{amb}|}{|Annotations|}$$

$$AmbiguityRes_{Identification} = 0.04$$
$$AmbiguityRes_{Renaming} = 0.02$$

# Degree of ambiguity: theoretical ambiguity

Proportion of the units to annotate that corresponds to ambiguous vocables.

## Definition

$$AmbiguityTh(Flow) = \frac{\sum_{voc_i=1}^{|Voc(Flow)|} (Ambig(voc_i) * freq(voc_i, Flow))}{|Units(Flow)|}$$

with

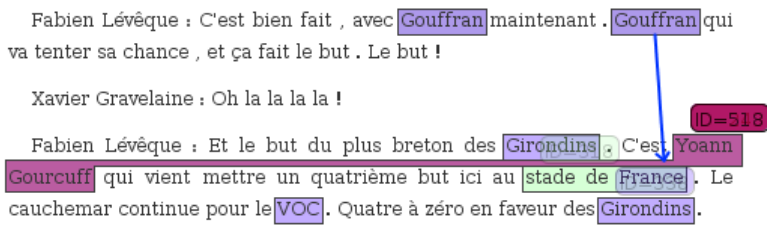
$$Ambig(voc_i) = \begin{cases} 1 & \text{if} \quad |Tags(voc_i)| > 1 \\ 0 & \text{else} \end{cases}$$

$$AmbiguityTh_{Identification} = 0.01$$

$\rightarrow$ Does not apply to renaming relations (2 EATs).

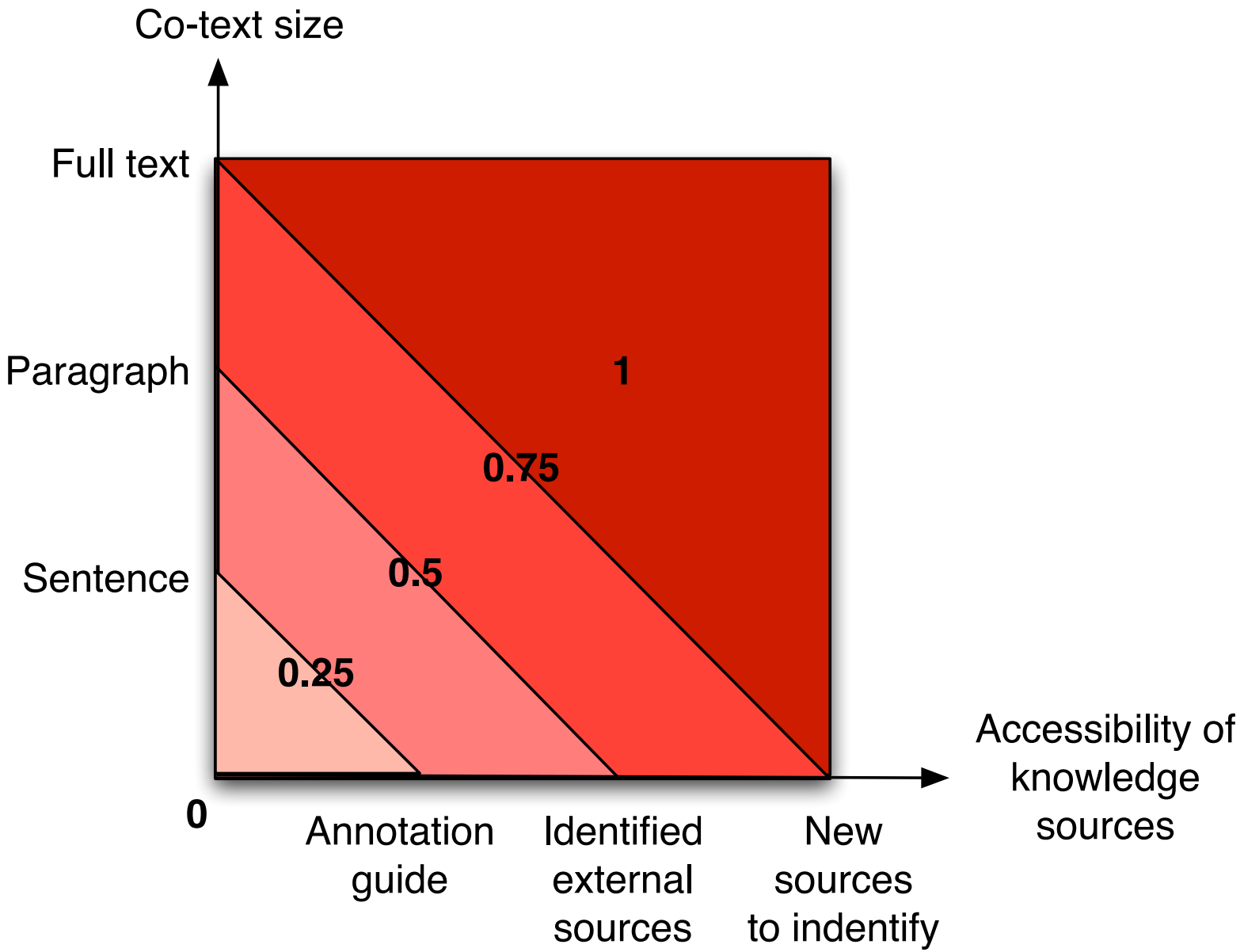
# Context to take into account

- **size of the window** to take into account in the source signal:
  - The sentence:
    *I/PRP do/VBP n't/RB feel/VB very/RB ferocious/JJ ./.*
  - ... or more:

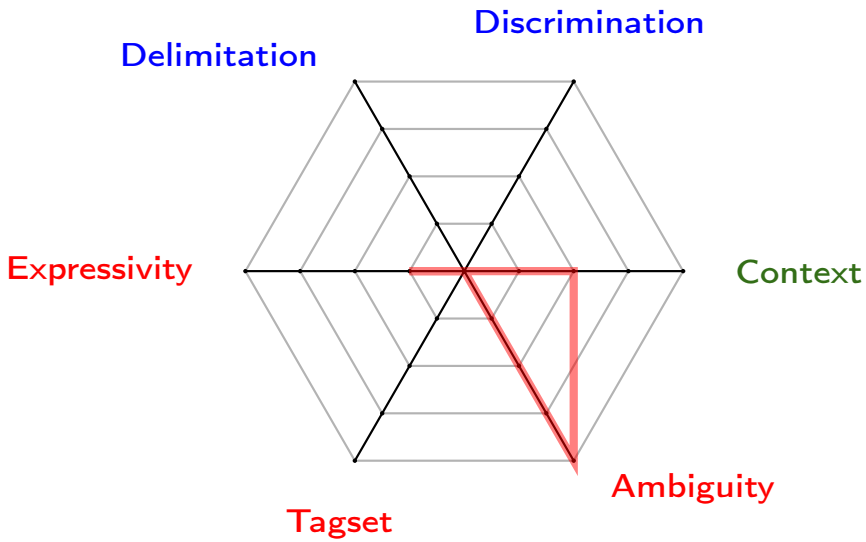



- number of **knowledge elements** to be rallied or degree of accessibility of the knowledge sources that are consulted:
  - annotation guidelines
  - nomenclatures (Swiss-Prot)
  - new sources to be found (Wikipedia, etc.)

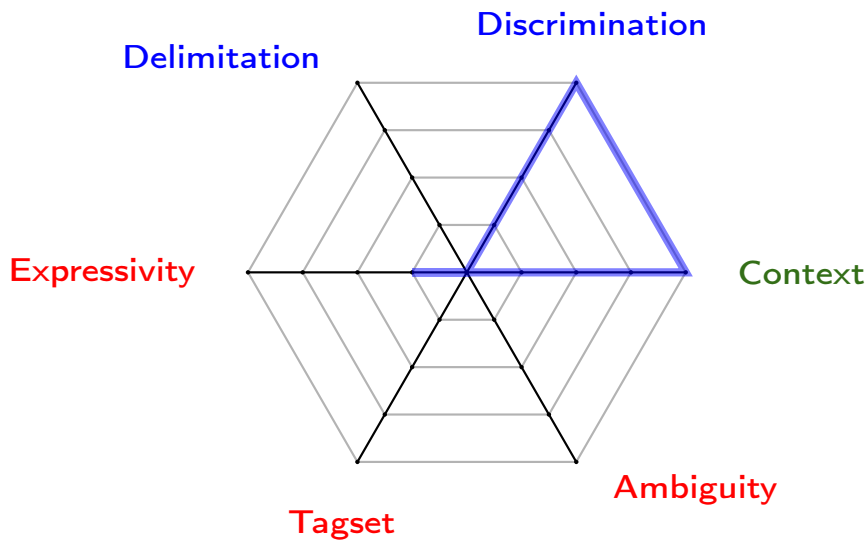
# Weight of the context



# Synthesis of the complexity dimensions

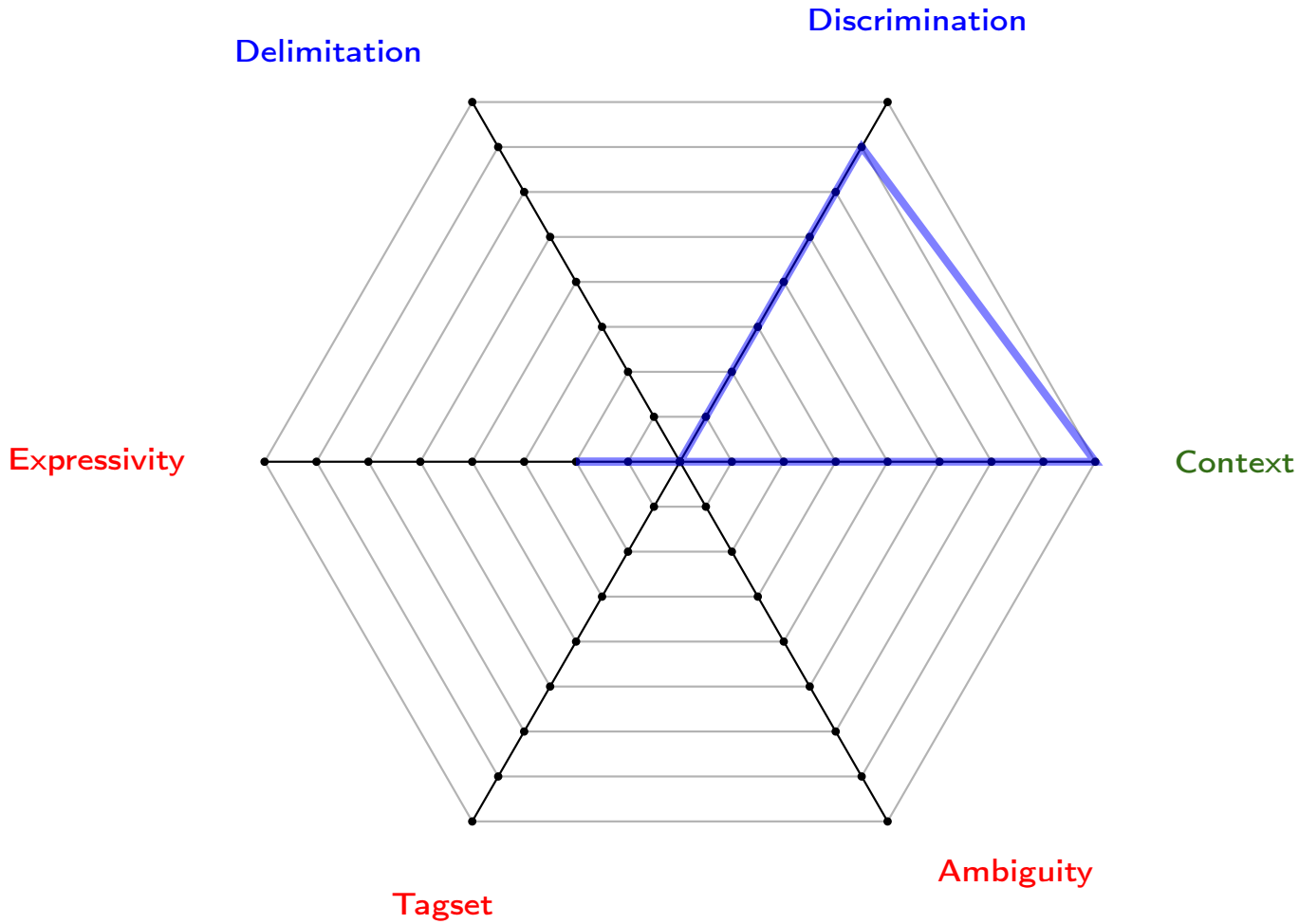



Classification of *it* pronouns as anaphoric or impersonal




Gene names identification

# Synthesis




Gene renaming campaign (2 EATs)

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# Conclusion and prospects

A grid of analysis:

- to use during preparatory work
- to help asking the right questions and finding the appropriate solutions

→ that should be computed more or less automatically

→ that should be integrated as part of annotation tools
[Kaplan et al., 2010, Bontcheva et al., 2010]

Thank you for your attention!


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