Création rapide et efficace d'un système de désambiguïsation lexicale pour des langues peu-dotées

(Rapid construction of a supervised Word Sense Disambiguation system for under-resourced languages)

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Outline

Introduction

Objective

Quickly build a supervised Word Sense Disambiguation (WSD) system for an under-resourced language U

Condition

Availability of

1. sense-annotated corpus from a well-resourced language W
2. Statistical Machine Translation (SMT) system $W \rightarrow U$

Proposal

Contribution

1. Script
   - to translate SemCor to language L;
     if SMT available, English $\rightarrow L$
2. Translating SemCor
   - to Bengali
   - to French
3. Building and evaluating a supervised WSD system
   - for French

Word Sense Disambiguation – 1/4

Definition

- Automatically identifying the meaning of a word from context
- A kind of classification task

Example

The mouse	is eating	cheese	.
animal	use	food	
furtively	take	flower	
manipulate	nosh	wind into	
timid person	cause	get away	
swollen bruise	worry		
electronic device	swallow		
	consume		

from Princeton WordNet 3.0

The mouse$_{\text{animal}}$ is eating$_{\text{swallow}}$ cheese$_{\text{food}}$.

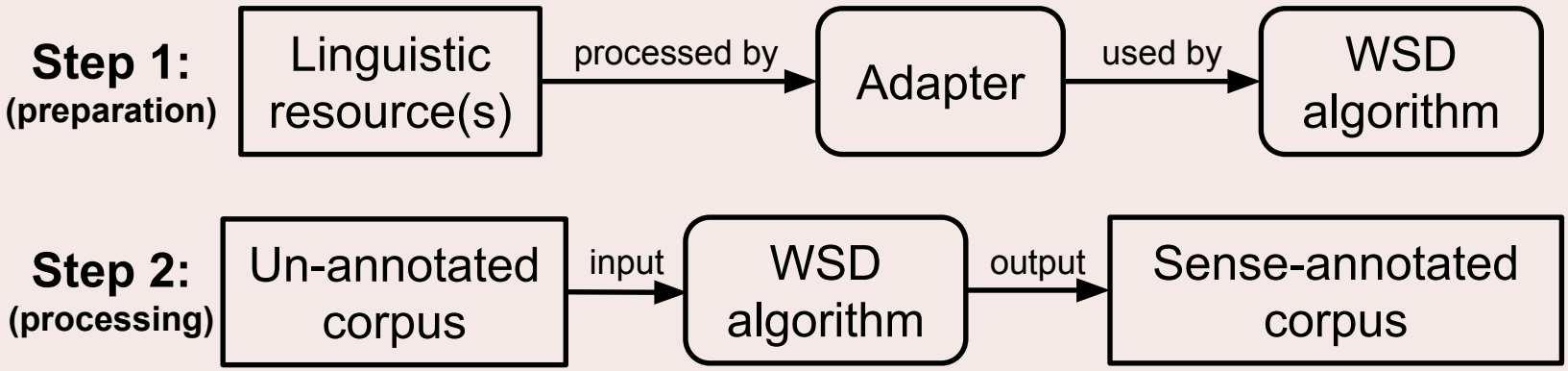
Word Sense Disambiguation – 2/4

Description

Given a context $C = w_1, ..., w_m$, to assign the correct sense(s) s_i from the set of possible senses $s_1, ..., s_n$ to some (target-words) or all words in C,

$$w_1, ..., w_m \subseteq s_1, ..., s_n$$

WSD process



Word Sense Disambiguation – 3/4

Linguistic resources exploited for WSD

1. Corpus:
   i. un-annotated – e.g.
      - Brown Corpus [Francis and Kučera, 1979]
      - British National Corpus [Burnard, 1998]
   ii. sense-annotated – e.g.
      - SemCor [Miller et al., 1993]
      - Defence Science Organization (DSO) corpus [Ng and Lee, 1996]
2. Sense inventory:
   i. less-elaborated – e.g.
      - Collins English Dictionary [Dictionary, 1979]
   ii. more-elaborated – e.g.
      - WordNet [Miller, 1995]
      - BabelNet [Navigli and Ponzetto, 2010]
      - DBnary [Sérasset, 2012]

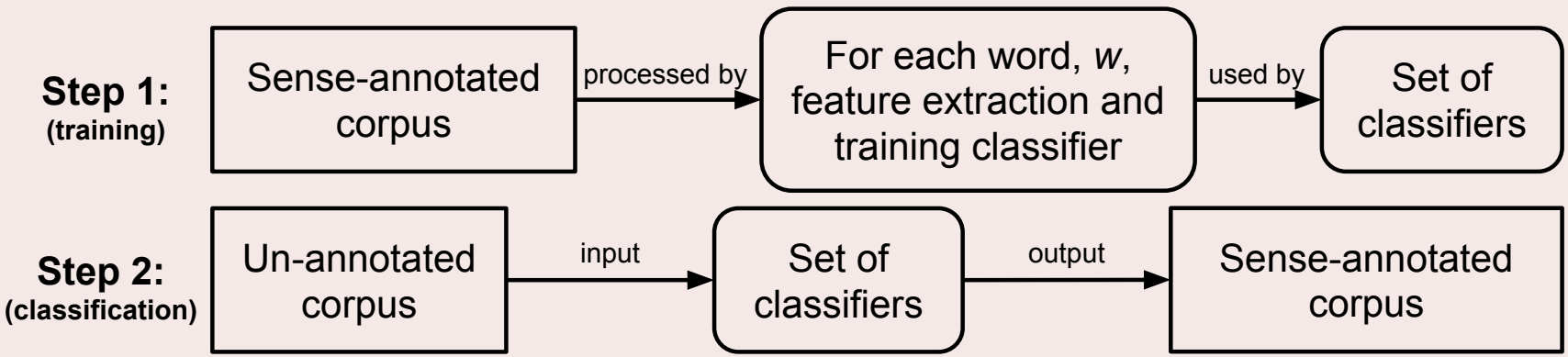
Word Sense Disambiguation – 4/4

WSD in probabilistic view

Given a context $C = w_{-m}, ..., w_{-1}[w]w_1, ..., w_n$, to assign the correct sense(s) s_i from the set of possible senses $s_1, ..., s_o$ to a word w in C,

$$\arg\max_{s_i} P(s_i|C) = \arg\max_{s_i} \frac{P(s_i)P(C|s_i)}{P(C)} = \arg\max_{s_i} P(s_i)P(C|s_i)$$

Supervised WSD process



Characterization of a language

Berment's classification [Berment, 2004]

- Measure the digitization of a language to its application – e.g
  - language script representation into memory
  - localization of different tools (e.g. word processing tool)
  - machine translation

Language named	**Score (0 – 20)**	**Resource level**	**Example**
π (Pi)	0 – 9.99	Low	Bengali, Somali, ...
μ (Mu)	10 – 14.99	Medium	Norwegian, Malay, ...
τ (Tau)	14 – 20	High	English, French, ...

✓ Considering different linguistic resources required to perform WSD and MT, Bengali is still under-resourced.

Machine Translation – 1/2

Machine Translation

A process of translating from one language to another

source language $S \rightarrow$ **MT Engine** $\rightarrow$ **target language** T

Statistical Machine Translation

- Data-driven (parallel corpus) probabilistic statistical approach
- Given a source language text S, to determine the most probable translation T in the target language,

$$\arg\max_T P(T|S) = \arg\max_T \frac{P(T)P(S|T)}{P(S)} = \arg\max_T P(T)P(S|T)$$

- Decoder
  - contains – translation model, language model, ...

Machine Translation – 2/2

Our SMT systems used for translation

1. English→French

System	Decoder	Dataset	BLEU
EN-FR [Besacier et al., 2012]	Moses	Europarl, UN, ...	24.85

2. English→Bengali

System	Decoder	*Dataset	BLEU
EN-BN	Moses	EMILLE, OPUS, INDIC, ...	27.21

***Figures**:

- Parallel corpus: 679,019 sentences – 85% for training, 10% tuning, 5% testing
- Monolingual corpus: 1,107,776 sentences (IRSTLM toolkit for Language Model)

Translating sense-annotated corpus – 1/3

State of the art of annotation transfer

Author	Application	Languages
[Brown et al., 1991]	WSD	En-Fr
[Yarowsky and Ngai, 2001]	POS-tags	En-Fr
[Yarowsky et al., 2001]	Chunks	En-Fr
[Diab and Resnik, 2002]	WSD	Fr-En
[Hwa et al., 2005]	SD	En-Cn
[Padó and Lapata, 2009]	SRL	En-De
[van der Plas and Apidianaki, 2014]	SRL	En-Fr
[Wang and Manning, 2013]	SRL	En-Fr

SD : Syntactic Dependency
SRL: Semantic Role Labeling

Translating sense-annotated corpus – 2/3

Algorithm

- *SemCor sentences (surface form, stripped SGML tags)* → Moses (shell invokation) → Translated sentences + Word alignments
  - Word alignments in an array
    - position = source word index
    - value = translated word index
  - for each instances $I_j[lemma, pos, lexsn, surfaceForm]$ indexed by j, I_j[lemma] replaced with its translation though alignment link
- Obtain a Translated SemCor

Translating sense-annotated corpus – 3/3

SemCor 3.0

```
<contextfile concordance=brown>
 <context filename=br-a01 paras=yes>
  <p pnum=1>
   <s snum=1>
    <wf cmd=ignore pos=DT>The</wf>
          <wf cmd=done rdf=group pos=NNP
lemma=group wnsn=1 lexsn=1:03:00:: pn=group>
Fulton_County_Grand_Jury</wf>
        <wf cmd=done pos=VB lemma=say wnsn=1
lexsn=2:32:00::>said</wf>
    [...]
     <punc>‘‘</punc>
    <wf cmd=ignore pos=DT>no</wf>
      <wf cmd=done pos=NN lemma=evidence wnsn=1
lexsn=1:09:00::>evidence</wf>
     <punc>’’</punc>
    [...]
     <wf cmd=done pos=VB lemma=take_place wnsn=1
lexsn=2:30:00::>took_place</wf>
     <punc>.</punc>
   </s>
  </p>
  [...]
 </context>
</contextfile>
```

Translated SemCor (Bengali)

```
<contextfile concordance=brown>
 <context filename=br-a01 paras=yes>
  <p pnum=1>
   <s snum=1>
    <wf cmd=ignore pos=DT>আর</wf>
          <wf cmd=done rdf=group pos=NNP
lemma=group wnsn=1 lexsn=1:03:00:: pn=group>
Fulton_County_Grand_Jury</wf>
        <wf cmd=done pos=VB lemma=say wnsn=1
lexsn=2:32:00::>বলেছিলেন</wf>
    [...]
     <punc>‘‘</punc>
    <wf cmd=ignore pos=DT>কোনো</wf>
      <wf cmd=done pos=NN lemma=evidence wnsn=1
lexsn=1:09:00::>প্রমাণ</wf>
     <punc>’’</punc>
    [...]
     <wf cmd=done pos=VB lemma=take_place wnsn=1
lexsn=2:30:00::>took_place</wf>
     <punc>।</punc>
   </s>
  </p>
  [...]
 </context>
</contextfile>
```

Supervised WSD – 1/3

Naïve Bayes classifier [Rish, 2001]

- Given a context $C = w_{-m}, ..., w_{-1}[w]w_1, ..., w_n$, from the previously training data (sense-tagged corpus) D a Baysian classifier assigns the most probable classification (sense(s)) s_i to each new instance (context) w in C.
- Naïve Bayes classifier assumes, attributes of the instance w are independent of each other,

$$\arg\max_{s_i} P(s_i)P(C|s_i) = \arg\max_{s_i} P(s_i) \prod_{w_j \in C} P(w_j|s_i)$$

Supervised WSD – 2/3

Feature set (NUS-PT system for SemEval 2007 task 7) [Chan et al., 2007]

Feature type	Number	Feature
Local collocation	11	$C_{-1,-3}$, $C_{-2,-2}$, $C_{-1,-2}$, $C_{-1,-1}$, $C_{-1,1}$, $C_{1,1}$, $C_{-1,2}$, $C_{-2,1}$, $C_{1,2}$, $C_{2,2}$, $C_{1,3}$
POS-tags	7	t_{-3}, t_{-2}, t_{-1}, t_0, t_1, t_2, t_3
Context words	depends	w_{-m}, ..., w_{-1}, w_0, w_1, ..., w_n

Example

The Fulton_County_Grand_Jury said **Friday** an investigation of Atlanta 's recent primary_election produced [...]

t_{-3}	t_{-2}	t_{-1}	t_0	t_1	t_2	t_3						
w_{-3}	w_{-2}	w_{-1}	w_0	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	[...]

$c_{-1,-3}$: The Fulton_County_Grand_Jury said
$c_{-2,-2}$: Fulton_County_Grand_Jury
$c_{-1,-2}$: Fulton_County_Grand_Jury said
$c_{-1,-1}$: said
$c_{-1,1}$: said an
$c_{1,1}$: an
$c_{-1,2}$: said an investigation
$c_{-2,1}$: Fulton_County_Grand_Jury said an
$c_{1,2}$: an investigation
$c_{2,2}$: investigation
$c_{1,3}$: an investigation of

Supervised WSD – 3/3

Three systems

1. **For English**
   - directly trained with SemCor 3.0
2. **For Bengali**
   - trained with translated SemCor 3.0 with transferred annotations (Bengali)
3. **For French**
   - trained with translated SemCor 3.0 with transferred annotations (French)

Evaluation – 1/4

Evaluation corpus (SemEval 2013 task 12 multilingual WSD)[Navigli et al., 2013]

- **5 languages** : de, en, es, fr, it
- **Corpus** : 13 articles/language (different domains)
- **WSD task** : all-nouns
- **Sense inventory**: BabelNet 1.1.1 (WordNet 3.0 + Wikipedia)

Challenge

- Sense inventory for SemCor 3.0 – Princeton WordNet 3.0
- Sense mapping between – Princeton WordNet 3.0 and BabelNet 1.1.1
- Mapping coverage: **96.10%**

Evaluation – 2/4

Evaluation measures

1. *Precision P*
   - number of correct senses among the number of senses returned by the system
2. *Recall R*
   - number of correct senses among the number of expected senses from the system
3. *F1-score*
   - harmonic mean of *Precision* and *Recall*, $\frac{2.P.R}{P+R}$

Evaluation – 3/4

Result

Trained on	*System*	*P*	*R*	*F1*
SemCor	SUP-EN	64.80%	64.70%	64.75%
	MFS-EN	66.90%	66.60%	66.64%
	difference	*-2.10%*	*-1.90%*	*-1.89%*
Translated SemCor*	SUP-FR	51.60%	51.50%	51.55%
	MFS-FR	45.60%	45.10%	45.34%
	difference	**+6.00%**	**+6.40%**	**+6.21%**

*Transferred annotations

SUP-EN: English supervised WSD system
MFS-EN: English Most Frequence Sense baseline
SUP-FR: French supervised WSD system
MFS-FR: French Most Frequence Sense baseline

Evaluation – 4/4

Comparison

Language	*System*	*P*	*R*	*F1*
EN	UMCC-DLSI**	68.50%	68.50%	68.50%
	GETALP-SUP	**64.80%**	**64.70%**	**64.75%**
	DAEBAK!**	60.40%	60.40%	60.40%
	GETALP-UNS*	58.30%	58.30%	58.30%
FR	UMCC-DLSI**	60.50%	60.50%	60.50%
	DAEBAK!**	53.80%	53.80%	53.80%
	GETALP-SUP	**51.60%**	**51.50%**	**51.55%**
	GETALP-UNS*	48.30%	48.20%	48.30%

*[Schwab et al., 2013]
**[Navigli et al., 2013]

GETALP-SUP: GETALP supervised WSD system
GETALP-UNS: GETALP unsupervised WSD system
DAEBAK! : DAEBAK! unsupervised WSD system
UMCC-DLSI : UMCC-DLSI unsupervised WSD system

Conclusion and perspective

Conclusion

- Translating a sense-annotated corpora and transferring sense-annotations though SMT word alignments
- Quickly built a supervised WSD system for any language
- Acceptable disambiguation performance with no tuning and little training data

Perspective

- Training the system with more annotated data (e.g. DSO)
- Compare different supervised algorithms and classifier fusion techniques (e.g. Boosting [Zhou, 2012])
- Combine supervised and unsupervised approaches

https://getalp.imag.fr/wsd/

Thank you!

Questions?

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