

A Survey of WordNet Annotated Corpora

Tommaso Petrolito^{⊕⊙} and Francis Bond[⊕]

[⊕]Linguistics and Multilingual Studies,
Nanyang Technological University, Singapore

[⊙] Informatica Umanistica,
University of Pisa, Italy

bond@ieee.org, tommasouni@gmail.com

Abstract

This paper surveys the current state of wordnet sense annotated corpora. We look at corpora in any language, and describe them in terms of accessibility and usefulness. We finally discuss possibilities in increasing the interoperability of the corpora, especially across languages.

1 Introduction

There are over 60 different wordnet projects for more than 60 languages.¹ The first wordnet was the Princeton WordNet of English (Fellbaum, 1998) describing over 150,000 concepts. Many others have followed, even if with different coverage rates in each continent (Africa and central Asia are less covered than the other geographical regions), all around the world. So today there are many wordnets all sharing a similar structure, some of them freely available, others restricted to license owners.

Bond and Paik (2012) surveyed the available wordnets and evaluated them on two axes: how **accessible** (legally OK to use) and how **usable** (of sufficient quality, size and with a documented interface) (Ishida, 2006). In this paper we do the same for sense-annotated corpora. We restrict ourselves to those that use a wordnet as the sense inventory.

Sense annotated corpora can be classified according to several criteria. Some obvious ones are the language used; the lexicon used to determine the senses; the size; the license. In addition, another useful distinction is that between those that annotate **all words** and those that only annotate **some words**, typically either a sample of a few frequent words, or of a single part-of-speech. We will also distinguish those corpora that align to SemCor (Langone et al., 2004) the first wordnet annotated corpus. We will first describe it in some detail, as it is the most typical corpus, and then note where other corpora differ from it.

We have found more than 20 WordNet Annotated Corpora in more than 10 different languages. We describe them in the following Section 2, discuss some of the issues they raise in Section 3 and then plans for future work in 4.

2 WordNet Annotated Corpora

We have tried to list all known corpora annotated with wordnet senses, in any language.² In most cases, information on size comes from the latest publication describing the corpus, or its web-page. Sometimes the data is from the corpus providers themselves, in which case we will note this. We have also put the information online as the Global Wordnet Association's *Wordnet Annotated Corpora* page (http://globalwordnet.org/?page_id=241). This will be kept up-to-date.

We divide the corpora into three groups: SemCor and its translations; non-English Corpora; and English Corpora. We summarize the corpora in Table 1, and then describe each one in more detail.

2.1 SemCor and Translations

2.1.1 Princeton SemCor

The English SemCor corpus is a sense-tagged corpus of English created at Princeton University by the WordNet Project research team (Landes et al., 1998). It was created very early in the WordNet project (Miller et al., 1994), and was one of the first sense-tagged corpora produced for any language. The corpus consists of a subset of the Brown Corpus (700,000 words, with more than 200,000 sense-annotated) (Francis and Kucera, 1979), and it has been part-of-speech-tagged and sense-tagged. It is distributed under the Princeton Wordnet License.

For each sentence, open class words (or multi-word expressions) and named entities are tagged. Not all expressions are tagged. We give a (constructed) example in Figure 1. Note that the tagged synsets do not have to be continuous (as in *get up*) and that there are some untagged elements (typically multi word expressions, such as *on one's feet*). Closed class words such as articles and prepositions are only tagged if they are part of a multi-word expression. The annotation is known to be imperfect: Bentivogli and Pianta (2005) estimate around 2.5% of the tags to be incorrect.

The Brown corpus has also been annotated with syntactic information by various other projects, including the Penn Treebank (Marcus et al., 1993); Susanne (Sampson, 1995) (also sense-annotated with the WordNet 1.6 senses in the SemiSusanne project by Powell (2005)) and Redwoods (Oepen et al., 2004; Flickinger,

¹http://globalwordnet.org/?page_id=38

²Although we may have missed some lexical sample corpora.

Name	# words	# taggable	# tagged	Ing	Wordnet	License	Semcor	Target
SemCor3.0-all	360k	n/a	193k	eng	WN 3.0	wordnet	+	all
SemCor3.0-verbs	317k	n/a	41k	eng	WN 3.0	wordnet	+	v
Jsemcor	380k	150k	58k	jpn	Jpn WN	wordnet	+	all
MultiSemCor ^a	269k	121k	93k	ita	MultiWN	CC BY 3.0	+	all
	258k	n/a	120k	eng	WN 1.6	CC BY 3.0		
SemCor EnRo	176k	89k	48k	rum	BalkaNet	MSC ...	+	all
	178k	n/a	n/a	eng	WN 2.0	BY-NC-ND		
BulSemCor ^b	101k	n/a	99k	bul	BulNet	web only	—	all+
Eusemcor	300k	n/a	n/a	baq	Basque WN	web only	—	all
spsemcor	850k	n/a	23k	spa	ESPWN1.6	web only	—	n, v
AnCora	500k	n/a	n/a	spa	EuroWN 1.6	research only	—	n
	500k	n/a	n/a	cat	EuroWN 1.6	research only		
DutchSemcor ^c	500,000k	n/a	283k	dut	Cornetto	n/a	—	all
TüBa-D/Z Treebank ^d	1,365k	n/a	18k	ger	GermaNet	none	—	some, v, n
WebCaGe	n/a	n/a	11k	eng	GermaNet	CC BY-SA 3.0	—	all
ISST	306k	n/a	81k	ita	ItalWN	research only	—	all
NTU-MC	116k	63k	51k	eng	PWN	CC BY	—	all
	106k	67k	36k	cmn	COW	CC BY		
	56k	37k	28k	ind	WN Bahasa	CC BY		
	49k	20k	15k	jpn	Jpn WN	CC BY		
AQMAR Arabic SST ^e	65k	n/a	32k	ara	WN	CC BY-SA 3.0	—	n, v
Jos100k ^f	100k	n/a	5k	slv	sloWNet	CC BY-NC 3.0	—	some n
Hungarian WSD corpus	16k	n/a	5k	hun	HuWN	none	—	n, v, adj
KPW ^r	438k	n/a	9k	pol	plwordnet	CC BY 3.0	—	some
Gloss Corpus	1,621k	656k	449k	eng	WN 3.0	wordnet	—	some
Groningen Meaning Bank	1,020k	n/a	n/a	eng	WN	none	—	all
MASC	504k	n/a	100k	eng	WN 3.0	none	—	v
DSO Corpus	n/a	n/a	193k	eng	WN 1.5	LDC	—	n, v
OntoNotes	1,500k	n/a	n/a	eng	Coarse WN	LDC	—	n, v
SemLink	78k	n/a	n/a	eng	Coarse WN	none	—	all
Senseval 3	5k	n/a	2k	eng	WN 1.7.1	none	—	all
SemEval-2013 Task 12 ^g	5k	n/a	n/a	eng	BabelNet	none	—	n
SemEval-2013 Task 13	141k	n/a	5k	eng	BabelNet	none	—	n, v, adj

Table 1: Corpora Tagged with Wordnet Senses

a According to Bentivogli and Pianta (2005) 23.4% of Italian words still need to be tagged, so we can estimate (given that 93k is the 76.6%) the content words at 121k.

b The annotations include both open-class and closed-class words.

c 282,503 tokens manually tagged by two annotators, anyway more than 400,000 have been manually tagged by at least one annotator and millions have been automatically tagged (information from the corpus providers themselves: Piek Vossen).

d The targets of the annotation are not all the nouns and verbs but only a selected set of 109 words (30 nouns and 79 verbs). The total number of annotations is 17,910 (information from the corpus providers themselves: Verena Henrich and Marie Hinrichs). The corpus is not currently available but it will be.

e According to Schneider et al. (2012) about half the tokens in the data are covered by a nominal supersense, so we can estimate (given that the tokens are 65k) the tagged tokens at 32k.

f Only the 100 most frequent nouns are annotated.

g The corpus is multilingual, in fact the same articles are available in other four languages: french, spanish, german and italian, respectively containing 3k tokens each, Frech, Spanish and German and 4k Italian)

*Kim_a got_b slowly_c up_b, the children_d
were_e already_f on_g their_g feet_g.*

ID	Lemma	Sense
a	Kim	org
b	get_up	get_up ₄
c	slowly	slowly ₁
d	child	child ₁
e	be	be ₃
f	already	already ₁
g	on_one's_feet	notag

Figure 1: SemCor Example

2011). The combination of syntactic and semantic information has been used in various parsing experiments (Bikel, 2000; Agirre et al., 2008). The corpus is divided into two parts: **semcor-all** in which 186 texts have all open-class words (such as nouns, verbs, adjectives and adverbs) semantically annotated. The SemCor component of all word types consists of 359,732 (Lupu et al., 2005) tokens of which 192,639 are semantically annotated. The second part, **semcor-verbs**, only has verbs senses annotated: 41,497 verbal occurrences from 316,814 tokens (Lupu et al., 2005).

2.1.2 MultiSemCor

MultiSemCor is an English/Italian parallel corpus created by translating the English SemCor corpus into Italian (Bentivogli and Pianta, 2005). In particular it consisted of the translation of 72% of the SemCor-all corpus. This sub-corpus was automatically word aligned and the semantic annotations were automatically projected from the English words to their Italian translation equivalents. The resulting corpus has texts aligned both at the sentence and word level, and annotated with part of speech, lemma and word sense (PWN 1.6). MultiSemCor version 1.1 contains 14,144 sentences and 261,283 tokens, 119,802 of which are annotated with senses. Words that did not project from English were not tagged: an estimated 23.4% of the concepts that should be tagged are not. The MultiSemCor project includes a MultiSemCor Web Interface (Ranieri et al., 2004). It provides for two distinct browsing modalities. In the *text-oriented* modality (*MSC Browser*), for each bi-text (109/116 aligned texts working actually³) the user has access to the alignment at the sentence and word level, and to the dictionary. "MultiSemCor+" (as defined by Lupu et al. (2005)) is a more recent extension that also contains the the Romanian SemCor (Section 2.1.3, Lupu et al., 2005). This new project represents a first test bed for multilingual semantic disambiguation experiments. We can browse the same aligned texts in Romanian and English on the MultiSemCor Browser. Currently the English-Romanian modality has only a subset of the Italian: 12/116 aligned texts.

2.1.3 SemCor En-Ro corpus and RoSemCor

Even if the monolingual Romanian corpus is not so clearly available while the multilingual one is distributed open and free under MS Commons-BY-NC-ND⁴. En-Ro SemCor contains a total of 178,499 words for English and 175,603 words for Romanian (Lupu et al., 2005; Ion, 2007). The English SemCor texts have been translated into Romanian and the sentence and paragraph annotations have been observed. The sense transfer from English to Romanian follows closely the WSDTool procedure (a wordsense disambiguation algorithm described by Ion (2007)). From a total of 88,874 occurrences of content words in Romanian, 54.54% received sense annotation by the transfer procedure.

2.1.4 Jsemcor

Japanese Sem-Cor (JSemCor: Bond et al., 2012) is a sense-tagged corpus for the Japanese Wordnet (Isahara et al., 2008), based on translation of the subset of English SemCor used in MultiSemCor (Section refsec:multisemcor) with senses projected across from

English. In this case, of the 150,555 content words only 58,265 are sense tagged. Jsemcor is a SemCor corpus: the texts are aligned to the correspondent English SemCor texts both at the sentence and word level. The transfer process left 39% of the senses untagged because of the fundamental differences between Japanese and English. A major cause of lexical gaps is part-of-speech mismatches. The license is similar to the Princeton WordNet License, so the data is freely available.

2.2 Independent Corpora for other languages

Most projects sense-tag existing annotated corpora for their languages. This means that they can take advantage of the work that has gone into pre-processing them, and also be used with other annotations.

2.2.1 BulSemCor

The Bulgarian Semantically Annotated Corpus (Koeva et al., 2010) is part of the Bulgarian Brown Corpus (balanced but not aligned to the English Brown Corpus, so BullSemCor is a NonSemCor corpus). It consists of 811 excerpts each containing 100+ words: the total size of the source corpus is 101,062 tokens.⁵ Each lexical item (simple or compound word) which occurs in the particular context in BulSemCor is assigned manually the unique semantic or grammatical meaning from the Bulgarian wordnet. The result is a lemmatised POS and sense-annotated corpus of units of running text. Unlike most wordnet corpora, the annotation includes both open-class and closed-class words. Sense distinctions in the closed word classes have been drawn primarily from corpus evidence. The sense-annotated corpus consists of 99,480 lexical units annotated with the most appropriate synset from the Bulgarian wordnet (BulNet). The corpus excerpts are offered under MS NoRedistribution NonCommercial license⁶ for free, it is also possible to query the corpus online. The restrictions on use and redistribution mean that corpus is not considered open source.

2.2.2 Eusemcor and spsemcor

The University of the Basque Country and the Department of Software, Technical University of Catalonia have produced two browsing-online-only corpora: Eusemcor (Basque Semcor) and spsemcor (Spanish Semcor) (Agirre et al., 2006). Eusemcor was compiled with samples from a balanced corpus and a newspaper corpus. It comprises 300,000 words in total. Agirre et al. (2006) point out that as Basque is an agglutinative language, it has a higher lemma/word rate than English, so in parallel corpora it would allow to think that 300,000 words in Basque are comparable to 500,000 words in English. The process of tagging the new corpus was

³multisemcor.fbk.eu/frameset1.php

⁴http://meta-net.eu/meta-share/meta-share-licenses/META-SHARE=%20COMMONS_BYNCND%20v1.0.pdf

⁵dcl.bas.bg/en/corpora_en.html#SemC

⁶<http://www.meta-net.eu/meta-share/meta-share-licenses/META-SHARE%20NonCommercial%20NoRedistribution%20NoDerivatives%20For-a-fee-v%201.0.pdf>

used in this case mainly to extend the Basque WordNet adding the eventual missing needed senses. Spsemcor is a part of SenSem, a databank of Spanish which maps a corpus and a verbal database. The SenSem corpus consists of 25,000 sentences, 100 for each of the 250 most frequent verbs of Spanish (Davies, 2002). Sentences are tagged at both syntactic and semantic levels: verb sense, phrase and construction types, aspect, argument functions and semantic roles. In the Spsemcor part of SenSem the noun heads were tagged with the Spanish WordNet 1.6: 23,307 forms for 3,693 noun lemmas of the SenSem corpus have been semantically annotated (Climent et al., 2012). This corresponds to the 82.6% of the total amount of verbal arguments in the corpus. Both Eusemcor and Spsemcor are only available for online browsing.

2.2.3 AnCora

AnCora (Martí et al., 2007) are two multilingual corpora of 500,000 words each: a Catalan corpus (AnCora-CAT) and a Spanish (AnCora-ESP) one, built in an incrementally way from the previous 3LB corpora.⁷ In this way, 400,000 words were added to each corpus coming from different press sources (mainly newspapers). The AnCora corpora were annotated at different levels of linguistic description: the whole Catalan corpus is annotated with morphological, syntactic, and semantic information; as for Spanish, the morphological and syntactic levels are already completed, while the semantic annotation covers 40% of the corpus (200,000 words). The lexical semantic annotation consists in assigning each noun in the corpora its sense. This process was carried out manually and the senses repository is WordNet. Each noun was assigned either a WordNet sense or a label indicating a special circumstance.

2.2.4 DutchSemCor

DutchSemCor is a sense-tagged corpus with senses and domain tags from the Cornetto lexical database (Vossen et al., 2011). In DutchSemCor about 282,503 tokens for 2,870 nouns, verbs and adjectives (11,982 senses) have been manually tagged by two annotators, resulting in 25 examples on average per sense (anyway more than 400,000 have been manually tagged by at least one annotator and millions have been automatically tagged). The examples mainly come from existing corpora collected in the projects CGN (9 millions words: Van Eerten, 2007), D-Coi, and SoNaR (500 millions words: Oostdijk, 2008), but also additional examples from the Dutch websites have been added. DutchSemCor is not available, but excerpts and statistics are freely downloadable.

⁷Read Civit and Martí (2004) for 3LB-ESP and Civit et al. (2004) for 3LB-CAT

2.2.5 TüBa-D/Z Treebank

Henrich and Hinrichs (2013) have manually annotated the TüBa-D/Z Treebank⁸ with GermaNet senses with the goal of providing a gold standard for word sense disambiguation. The underlying resource is a German newspaper corpus manually annotated at various levels of grammar. The sense inventory used for tagging word senses is taken from GermaNet. With the sense annotation for a selected set of 109 words (30 nouns and 79 verbs) occurring 17,910 times in the TüBa-D/Z, the treebank currently represents the largest manually sense-annotated corpus available for GermaNet. The corpus is not currently available but it will be made freely available in a future release at the TüBa-D/Z Sense Annotations webpage.⁹

2.2.6 WebCaGe

WebCaGe is a web-harvested corpus annotated with GermaNet senses, the largest sense-annotated corpus available for German (Henrich et al., 2012). WebCaGe includes example sentences from the German Wiktionary (46,457 German words) and additional material collected by following the links to Wikipedia, the Gutenberg archive, and other web-based materials. Wiktionary (7,644 tagged word tokens) and Wikipedia (1,732) contribute by far the largest subsets of the total number of tagged word tokens (10,750) compared with the external webpages (589) and the Gutenberg texts (785). These tokens belong to 2,607 distinct polysemous words contained in GermaNet, among which there are 211 adjectives, 1,499 nouns, and 897 verbs. On average, these words have 2.9 senses in GermaNet (2.4 for adjectives, 2.6 for nouns, and 3.6 for verbs). WebCaGe is distributed under the Creative Commons Attribution-ShareAlike 3.0 Unported License (CC BY-SA 3.0)¹⁰

2.2.7 ISST

ISST is the Italian Syntactic-Semantic Treebank (Montemagni et al., 2003) a multi-layered annotated corpus of Italian. ISST has a five-level structure covering orthographic, morpho-syntactic, syntactic and semantic levels of linguistic description. The fifth level deals with lexico-semantic annotation, which is carried out in terms of sense tagging of lexical heads (nouns, verbs and adjectives) augmented with other types of semantic information: ItalWordNet (Italian part of the EuroWordNet Project) is the reference lexical resource used for the sense tagging task. The ISST corpus consists of 305,547 word tokens (composing a balanced corpus for a total of 215,606 tokens and a specialized

⁸www.sfs.uni-tuebingen.de/en/ascl/resources/corpora/tueba-dz.html

⁹<http://www.sfs.uni-tuebingen.de/en/ascl/resources/corpora/sense-annotated-tueba-dz.html>

¹⁰<http://creativecommons.org/licenses/by-sa/3.0/>

corpus, amounting to 89,941 tokens, with texts belonging to the financial domain) of which 81,236 content words are sense annotated. ISST was made available for research purposes in 2010 (Dei Rossi et al., 2011).

2.2.8 NTU-MC

The NTU-Multilingual Corpus is a corpus designed to be multilingual from the start. It contains parallel text in eight languages: English (eng), Mandarin Chinese (cmn), Japanese (cpn), Indonesian (ind), Korean (kor), Arabic (arb), Vietnamese (vie) and Thai (tha) (Tan and Bond, 2012). Text is in three genres: short stories, essays and tourism. All the text is translated from English. The text is being sense annotated (Open Multilingual Wordnet¹¹ senses) in Chinese, English, Japanese and Indonesian (tourist data only; Bond et al., 2013). Tagging is still underway, snapshots are available from compling.hss.ntu.edu.sg/ntumc. The sizes of the different subcorpora are given in Table 1. There is more data for Chinese and English, with less for Indonesian and Japanese.

2.2.9 AQMAR Arabic SST

This is a 65,000-token corpus¹² of 28 Arabic Wikipedia articles (selected from the topical domains of history, sports, science, and technology) hand-annotated for nominal supersenses (40 coarse lexical semantic classes, 25 for nouns, 15 for verbs, originating in WordNet). It extends the Named Entity Corpus¹³ and was developed by Nathan Schneider, Behrang Mohit, Kemal Oflazer, and Noah Smith (Schneider et al., 2012) as part of the AQMAR project.¹⁴ This dataset is released under the Creative Commons Attribution-ShareAlike 3.0 Unported license (CC BY-SA 3.0).

2.2.10 Jos100k

The Jos100k corpus of Slovene contains 100,000 words of sampled paragraphs from the FidaPLUS corpus.¹⁵ It is meant to serve as a reference annotated corpus of Slovene: its manually-validated annotations cover three level of linguistic description (morphosyntactic, syntactic and semantic). All the occurrences of 100 most frequent nouns are annotated with their concept (synset id) from the Slovene WordNet sloWNet. The corpus is now at the version 2.0 and is freely available (CC BY-NC 3.0¹⁶) for browsing and downloading at the project webpage: n1.ijs.si/jos/jos100k-en.html. An online browser for concordances is available here n1.ijs.si/jos/cqp/ and a lot of documenting information is available as TEI corpus.¹⁷

¹¹compling.hss.ntu.edu.sg/omw

¹²www.ark.cs.cmu.edu/ArabicSST/

¹³www.ark.cs.cmu.edu/ArabicNER/

¹⁴www.ark.cs.cmu.edu/AQMAR/

¹⁵www.fidaplus.net/

¹⁶<http://creativecommons.org/licenses/by-nc/3.0/deed.en>

¹⁷<http://www.tei-c.org/release/doc/tei-p5-doc/en/html/ref-teiCorpus.html>

2.2.11 Hungarian word sense disambiguated corpus

The Hungarian WSD corpus (Vincze et al., 2008), contains 39 suitable word form samples selected (the most frequent words with more than one well-defined senses) for the purpose of word sense disambiguation. There are 300-500 samples for each word (so more or less 16,000 thousands samples). The Hungarian National Corpus and its *Heti Világgazdaság* (HVG) subcorpus provided the basis for corpus text selection and senses are from the Hungarian WordNet (HuWN)¹⁸. This corpus is a fine-grained lexical sample corpus. The corpus follows the SemEval XML format (not valid-able XML).

2.2.12 KPWr Polish Corpus of Wroclaw University

The Polish Corpus of Wroclaw University (Broda et al., 2012) represents written and spoken Polish. All the documents are freely available under the Creative Commons Attribution 3.0 Unported Licence¹⁹. The texts are organized in 14 categories (blogs, science, stenographic recordings, dialogue, contemporary prose, past prose, law, long press articles, short press articles, popular science and textbooks, wikipedia, religion, official texts and technical texts). The annotations are on the level of chunks and selected predicate-argument relations, named entities, relations between named entities, anaphora relations and word senses (plwordnet²⁰ senses). The corpus contains totally 438,327 words with 9157 tagged (for selected lexemes) and has been developed by The WrocUT Language Technology Group G4.19, Artificial Intelligence Department at the Institute of Informatics, Wroclaw University of Technology.

2.3 Other English Corpora

As is common for language resources, there are more for English than for any other language.

2.3.1 WordNet Gloss Corpus

In the Princeton WordNet Gloss Corpus Word, the definitions (or glosses) of WordNet's synsets are manually linked to the context-appropriate sense in WordNet. The corpus contains 1,621,129²¹ tokens with 449,355 sense tagged (330,499 manually + 118,856 automatically) on 656,066 taggable words and globs (the tagged ones + 206,711 untagged). The wordnet definitions have been translated into many languages, including Albanian (Ruci, 2008), Japanese (Bond et al., 2010), Korean (Yoon et al., 2009) and Spanish (Fernández-Montraveta et al., 2008). Further, the glosses are useful for unsupervised sense disambiguation techniques such

¹⁸<http://www.inf.u-szeged.hu/rgai/HuWN>

¹⁹<http://creativecommons.org/licenses/by/3.0/legalcode>

²⁰plwordnet.pwr.wroc.pl/wordnet

²¹wordnet.princeton.edu/glossstag.shtml

as LESK (Lesk, 1986): and it has been shown for another resource that having the glosses disambiguated improves the accuracy of extended LESK (Baldwin et al., 2008).

2.3.2 Groningen Meaning Bank

The Groningen Meaning Bank (GMB), is a free corpus of English (1,020,367 tokens) developed at the University of Groningen, comprises thousands of texts in raw and tokenised format, tags for part of speech, named entities and lexical categories (word senses from WordNet, among other things), and discourse representation structures compatible with first-order logic (Basile et al., 2012). The senses are mostly automatically annotated, though part of them are manually corrected through the GMB wiki-like interface: gmb.let.rug.nl/explorer. The current (development) version of the GMB is accessible via the GMB Explorer: everybody is explicitly invited to contribute to the GMB by providing corrections to existing linguistic annotations with the simplicity made possible by such a wiki-like environment. Anyone can register via the GMB Explorer and check, improve, or discuss linguistic annotations. Stable releases are made available periodically and are freely available from the downloads webpage. Data from the Wordrobe²² platform is also used to correct word senses in the GMB, applying the very innovative crowdsourcing technique “Game with a Purpose” (GWAP): rewarding contributors with entertainment rather than money. The design and the first results of Wordrobe are presented in Venhuizen et al. (2013).

2.3.3 MASC

MASC (Manually Annotated Sub-Corpus) is a part of the American National Corpus (Ide, 2012) with multiple layers of annotations in a common format that can be used either individually or together, and (unlike, for example, OntoNotes) to which others can add annotations. MASC currently contains nineteen genres of spoken and written language data in roughly equal amounts, covers a wide range of written genres, including emerging social media genres (tweets, blogs). The entire MASC is annotated for logical structure, token and sentence boundaries, part of speech and lemma, shallow parse (noun and verb chunks), named entities (person, location, organization, date), and Penn Treebank syntax. Portions of MASC are also annotated for additional phenomena, including 40,000 of full-text FrameNet frame element annotations and PropBank, TimeML, and opinion annotations over a roughly 50,000 subset of the data. MASC also includes sense-tags for 1,000 occurrences of each of 100 words chosen by the WordNet and FrameNet teams (100,000 annotated occurrences), described in (Ide, 2012). The sense-tagged data are distributed as a separate sentence corpus with links to the original documents in which

they appear. Where MASC does not contain 1000 occurrences of a given word, additional sentences were drawn from the OANC. All annotations have either been manually produced or automatically produced and hand-validated. MASC is distributed without license or other restrictions.

2.3.4 DSO Corpus of Sense-Tagged English

This sense tagged corpus was provided by Ng and Lee (1996) of the Defence Science Organisation (DSO) of Singapore and has been hand tagged by 12 undergraduates from the Linguistics Program of the National University of Singapore. It contains sense-tagged word occurrences for 121 nouns and 70 verbs which are among the most frequently occurring and ambiguous words in English. These sentences are taken from the Brown corpus and the Wall Street Journal corpus. About 192,800 word occurrences have been hand tagged with WordNet 1.5 senses. It is distributed on the Linguistic Data Consortium Catalogue²³ (LDC) under different licences for LDC Members (free for 1997 members) and Non-Members.

2.3.5 OntoNotes

OntoNotes Release 5.0²⁴ is the final release of the OntoNotes project,²⁵ a collaborative effort between BBN Technologies, the University of Colorado, the University of Pennsylvania and the University of Southern Californias Information Sciences Institute. The goal of the project was to annotate a large corpus comprising various genres of text (news, conversational telephone speech, weblogs, usenet newsgroups, broadcast, talk shows) in three languages (English, Chinese, and Arabic) with structural information (syntax and predicate argument structure) and shallow semantics (word sense linked to an ontology and coreference). OntoNotes Release 5.0 contains the content of earlier releases and adds source data from and/or additional annotations for, newswire (News), broadcast news (BN), broadcast conversation (BC), telephone conversation (Tele) and web data (Web) in English and Chinese and newswire data in Arabic. Also contained is English pivot text (Old Testament and New Testament text). This cumulative publication consists of 2.9 million words. Its semantic representation includes word sense disambiguation for nouns and verbs. The sense annotation is done on coarse grained clusters of wordnet senses (OntoNotes Sense Groups) for 1.5 million words of English.

2.3.6 SemLink

SemLink is a project whose aim is to link together different lexical resources via set of mappings. These mappings could make it possible to combine the different information provided by these different lexical

²²gmb.let.rug.nl/wordrobe.php

²³catalog.ldc.upenn.edu/LDC97T12

²⁴catalog.ldc.upenn.edu/LDC2013T19

²⁵www.bbn.com/ontonotes/

resources for tasks such as inferencing. Currently SemLink contains mappings between PropBank,²⁶ VerbNet,²⁷ FrameNet²⁸ and WordNet²⁹ (which is again represented by the OntoNotes Sense Groups). The content of all four of these resources can be browsed on-line using the Unified Verb Index.³⁰ The SemLink corpus is the WSJ portion of the Penn TreeBank, currently at Version 1.2.2c with approximately 78,000 tokens. The corpus is freely downloadable and browsable on the SemLink project webpage.³¹

2.4 Senseval and SemEval tasks and lexical samples

SemEval (Semantic Evaluation) is an ongoing series of evaluations of computational semantic analysis systems. The first three evaluations, Senseval-1 through Senseval-3, were focused on word sense disambiguation, then Senseval evolved from the Senseval word sense evaluation series to the new SemEval series. In fact during the fourth workshop, SemEval-2007 (SemEval-1), the nature of the tasks evolved to include semantic analysis tasks outside of word sense disambiguation. Each of these evaluations provided some lexical samples or little corpora. Here we list the most recent and relevant.

2.4.1 Senseval 1-3

The first SENSEVAL took place in 1998, for English, French and Italian, culminating in a workshop. Senseval 1³² provided a corpus containing 12,000+ instances of 35 words, and a practice run corpus distributed prior to Senseval 1, containing 20,000+ instances of 38 words. In 2001 Senseval 2 provided a corpus containing 12,000+ instances of 73 words. For the "English all-words task" at the Senseval-3, Snyder and Palmer (2005) prepared a sense-tagged corpus: 5,000 words from two Wall Street Journal articles (editorial domain the first, news story the second one) and one excerpt from the Brown Corpus (fiction). All verbs, nouns and adjectives have been double annotated with WordNet 1.7.1 senses, and then adjudicated and corrected by a third person. The total tagged words are 2,212 (given that some of these are multiwords the total number of tags is 2,081). All the data (ill-formed XML) produced for Senseval are freely available at the Senseval web page, but are also available at the Pedersen's webpage³³ in a partially corrected but still ill-formed XML version.

²⁶verbs.colorado.edu/~mpalmer/projects/ace.html

²⁷verbs.colorado.edu/~mpalmer/projects/verbnet.html

²⁸framenet.icsi.berkeley.edu/fndrupal/

²⁹wordnet.princeton.edu/

³⁰verbs.colorado.edu/verb-index/

³¹verbs.colorado.edu/semlink/

³²www.senseval.org/

³³www.d.umn.edu/~tpederse/data.html

2.4.2 Line, Hard, Serve and Interest Corpora

Pedersen has also collected and converted to the Senseval 2 format the corpora for *line*, *hard* and *serve*, each with 4,000+ noun instances, tagged with 6, 3 and 4 wordnet senses respectively Leacock et al. (1993), along with the *interest* corpus (2,369 instances from the ACL/DCI Treebank tagged with 6 LDOCE senses described by Bruce and Wiebe (1994)). All these resources are freely available at the Ted Pedersen's webpage³⁴.

2.4.3 SemEval07-13

Many other resources are available at the SemEval2007³⁵, SemEval2010³⁶, SemEval2012³⁷ and SemEval2013³⁸ websites. In particular we have to mention Semeval-2013 Task 12 (all nouns tagged with WordNet 3.0 senses) and SemEval-2013 Task 13. The Task 12 test set consisted of 13 articles (Navigli et al., 2013) obtained from the datasets available from the 2010, 2011 and 2012 editions of the workshop on Statistical Machine Translation (WSMT). The articles cover different domains, ranging from sports to financial news. The same article was available in 4 different languages (English, French, German and Spanish). In order to cover Italian, an Italian native speaker manually translated each article from English into Italian, with the support of an English mother tongue advisor. In Table 1 we show for each language the number of words of running text, together with the number of multiword expressions and named entities annotated, from the 13 articles. The Task 13 (Jurgens and Klapftis, 2013) has a lexical sample corpus for 20 nouns, 20 verbs, and 10 adjectives, tagged with WordNet 3.1 senses. In the dataset there are 4664 instances (on 141k tokens) and will soon be available on its task website³⁹. Task 13's dataset (Jurgens and Klapftis, 2013) covers multiple genres of text (spoken, newswire, fiction, etc.) and has annotations when multiple senses apply, with around 11% annotated with at least two senses that are weighted by applicability.

3 Discussion

Currently, there is no widely adopted format for wordnet annotated corpora (even if the ISO TC37/SC4 group⁴⁰ is working on the principles of semantic annotation⁴¹): every institution uses its own format, and very little sharing of tools to manipulate the data. This is despite much work on corpus standards. With the

³⁴www.d.umn.edu/~tpederse/data.html

³⁵www.senseval.org/

³⁶semeval2.fbk.eu/semeval2.php?location=data

³⁷www.cs.york.ac.uk/semeval-2012/

³⁸www.cs.york.ac.uk/semeval-2013/

³⁹www.aclweb.org/anthology/S/S13/S13-2049.pdf

⁴⁰www.tc37sc4.org/index.php

⁴¹www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=60581

exception of the MultiWordNet, the corpora are not linked with the wordnets in an online interface. For those languages with sense tagged corpora, there are generally between 10–100 thousand tagged entries: far fewer than the number of senses in the wordnets. This means that most wordnet entries have no example in the corpus. Kilgarriff and Rosenzweig (2000) argued that tagging all words was not useful from the lexicographers point of view: it is better to have 50-100 examples for each word, than 1 or 2 for many. However, for research into lexical semantics and the distribution of words, as well as the use of semantic classes as back-off in other processing, it is necessary to tag all words. This is the most common form of annotation. Most projects point out that the much of the time spent in annotation is in fact in adding new word senses — this is still a very hard problem.

English has the most sense tagged data, followed by Dutch, then Italian, Japanese and Romanian (assuming that much of the Bulgarian is closed class words). The last three are all tagging through projection — this is an efficient way to bootstrap sense annotation.

There are two projects that have created multilingual corpora. The first is the MultiSemCor project, which grew out of the MultiWordNet. Construction of multiple wordnets and corpora went hand in hand. They inspired a similar approach for Japanese. Their MultiSemCor Browser (Ranieri et al., 2004) is probably the best and most useful tool for researchers interested in studying multilingual information. Even so, there is still much to do. There are only two non-English corpora currently available and the browser works only with English-Italian/Romanian: there are no links between Italian and Romanian.

Building a new translated semcor is difficult for at least three reasons. The first problem is that the wordnet annotated corpora don't update their sense tagging system (based on a precise wordnet version) when the English WordNet and SemCor do. If your wordnet is linked to a different version, in order to combine them into a single multilingual structure, we have to map to a common version.

The second problem is the variety of formats used. So sometimes even if a corpus is legally available, there could be still a technical hurdle before it becomes easily accessible. Conversion to a common format is the obvious solution. Finally, translating SemCor is in itself expensive, even though it may be worth it due to the richness of the existing annotation that can be projected across.

The second multi-lingual project is the NTU Multilingual Corpus. Instead of translating an existing sense tagged corpus, they chose to choose texts already freely available in multiple languages, and use the translations to guide the annotation. This was more expensive to annotate at first, but has the potential to cheaply expand to more languages: projecting from the existing annotations.

One possible explanation for the lack of coordination in tools and formats is that many of the large corpora are not open-source (Dutch, DSO, Romanian, Spanish, Basque, WebCaGe, ISST). It is therefore not legally possible for people to reformat and redistribute the corpora. In contrast, the open English corpora have been mapped to the latest version of Wordnet and the same format and made available.⁴² As more corpora are released under open licenses, we expect this state to improve.

4 Future Work

We would like to further the usefulness of the multilingual corpora in several ways. The first is to align the English, Italian, Romanian and Japanese translations of SemCor. We will then use English as a pivot to link Italian, Romanian and Japanese. When all four languages are aligned, we can use the translations to disambiguate and check the senses, as well as trying to make the projection more robust. The second is to do this with the NTU-multilingual corpus: make it compatible with MultiSemCor, align through English and refine. This will make it easier to add other languages: the Sherlock Holmes short stories and the Cathedral and the Bazaar have many translations. The third is to do this with the Wordnet Gloss Corpus: linking definitions in other languages to make a multilingual gloss corpus. It would also be interesting to use definitions from other sources (such as Wiktionary) to make an aligned sense-tagged paraphrase corpus. Finally (or in parallel) we would like to make these corpora all searchable, and linked to the Wordnet Grid (Pease et al., 2008; Bond and Foster, 2013).

5 Conclusions

All these observations about the compatibility troubles in the construction process of multilingual wordnet annotated corpora point at a clear fact: the more we standardize our data formats, and the more we open and share freely our resources and tools the easier and the faster will be the development of new resources all over the world.

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⁴²You can find SemCor, Senseval 2 and 3 here, www.cse.unt.edu/~rada/downloads.html#semcor

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