

MIT Java Wordnet Interface Series 2: User's Guide

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1. Purpose of the Software

This MIT Java Wordnet Interface (JWI) was designed to be an easy-to-use, easy-to-extend Java library for interfacing with the Wordnet electronic dictionary. It features API calls to retrieve index words, synsets, and morphological exceptions from the Wordnet data files. It also has calls that allow browsing by following lexical and semantic pointers, and contains classes that can perform simple morphological processing. The library includes no GUI elements.

The version 2 series of JWI supports Wordnet versions 1.6 through 3.0. It is not compatible with version 1.5, and support for version 1.6 does not include access to *cousin* files or the *index.gloss* file. No version of Wordnet is included with the JWI distribution; Wordnet must be downloaded separately from the Wordnet site at <http://wordnet.princeton.edu>.

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2. Getting Started

The main interface for accessing dictionary data is the *IDictionary* interface in the *edu.mit.jwi* package. The distribution comes with a single default implementation of this interface in the same package, the *Dictionary* class. In the simplest case, where you are using Wordnet with the data files on the same filesystem as your Java program, you can instantiate the *Dictionary* class with a single argument, a Java *URL* object that points to the directory where the Wordnet dictionary data files are located.

An example of this can be found in Figure 1, in the form of a Java method *testDictionary()*. In that method, the first block of three lines (4-6) deals with constructing a *URL* object that points to the Wordnet data files. In this particular example, the base Wordnet directory is assumed to be stored in a system environment variable called **WNHOME**; this may be different on your system. Note that the **WNHOME** variable points to the root of the Wordnet installation directory and the dictionary data directory "dict" must be appended to this path. Again, this may be different on your system depending on where your Wordnet files are located. The second block of code, two lines long (9-10), constructs an instance of the default *Dictionary* object, and opens it by calling the *open()* method. The final block of six lines (13-18) demonstrates searching the dictionary for the first sense of the noun "dog". Figure 2 shows the console output of the method.

```
1  public void testDictionary() throws IOException {
2
3      // construct the URL to the Wordnet dictionary directory
4      String wnhome = System.getenv("WNHOME");
5      String path = wnhome + File.separator + "dict";
6      URL url = new URL("file", null, path);
7
8      // construct the dictionary object and open it
9      IDictionary dict = new Dictionary(url);
10     dict.open();
11
12     // look up first sense of the word "dog"
13     IIndexWord idxWord = dict.getIndexWord("dog", POS.NOUN);
14     IWordID wordID = idxWord.getWordIDs().get(0);
15     IWord word = dict.getWord(wordID);
16     System.out.println("Id = " + wordID);
17     System.out.println("Lemma = " + word.getLemma());
18     System.out.println("Gloss = " + word.getSynset().getGloss());
19
20 }
```

Figure 1: Sample Dictionary code

```
1  Id = WID-2084071-n-?-dog
2  Lemma = dog
3  Gloss = a member of the genus Canis (probably descended from the
common wolf) that has been domesticated by man since prehistoric
times; occurs in many breeds; "the dog barked all night"
```

Figure 2: Sample Dictionary Code Output (for Wordnet 3.0)

3. Modifying and Extending the Software

One design goal of this software library was for it to be easy to extend. To that end, most classes are governed by a corresponding Java interface, and they are manipulated as such in the code. To add your own functionality, you must only find the proper insertion point for your code and implement the appropriate interfaces. Following the convention found in the code for the Eclipse project, every interface begins with the capital letter 'I'.

The main interface for customizing the default behavior of the *Dictionary* class is the *IDataProvider* interface, an instance of which can be passed to a *Dictionary* instance either via constructor or the *setDataProvider(IDataProvider)* method. This object controls the way the dictionary accesses the data in the Wordnet data files. For the more adventurous, the *IDictionary* interface can be re-implemented from scratch to provide whatever functionality you desire.

4. Major Changes in Version 2

There are significant changes in the JWI API for version 2. These will generally only be of interest to those who have reached deeply into the code. For most, the only change that needs to be made is the switch from arrays to unmodifiable lists. Other major improvements include:

1. Improved use of parameterized types
2. Use of the Java NIO packages for file access, with significant increases in speed
3. Use of direct binary access to .dat files, with significant increases in speed
4. Separation of the PERTAINYM and DERIVED_FROM_ADJECTIVE pointers
5. Exposure of lexical file name data through the ILexFile interface and LexFile class
6. Addition of support for sense keys through the ISenseKey interface and SenseKey class
7. Elimination of the IParserProvider interface
8. Numerous method and class name refactorings

For details, please see the change log included in the distribution.

5. Frequently Asked Questions

5.1 How do I retrieve the synonyms of a word?

Each meaning, or Synset, in Wordnet has multiple lexical forms or collocations associated with it. The meaning of the word *dog* implied in sentence "My dog Fido barks," has three: *dog*, *domestic_dog*, and *Canis_familiaris*. To obtain this list, we must first get a handle to the *ISynset* object for that meaning. Then, we can get the graphical forms by iterating over all the *IWord* objects associated with that synset. Java code that does this is shown in Figure 3.

```
1  public void getSynonyms(IDictionary dict){
2
3      // look up first sense of the word "dog"
4      IIndexWord idxWord = dict.getIndexWord("dog", POS.NOUN);
5      IWordID wordID = idxWord.getWordIDs().get(0); // 1st meaning
6      IWord word = dict.getWord(wordID);
7      ISynset synset = word.getSynset();
8
9      // iterate over words associated with the synset
10     for(IWord w : synset.getWords()) {
11         System.out.println(w.getLemma());
12     }
13 }
```

Figure 3: Java code for retrieving the synonyms of the first meaning of the word "dog".

```
1  dog
2  domestic_dog
3  Canis_familiaris
```

Figure 4: Output of the *getSynonyms()* method (for Wordnet 3.0)

5.2 How do I retrieve the hypernyms of a word?

Each Synset is connected to other Synsets by *semantic* pointers. One of the most prevalent of these is the *Hypernym* pointer, which points from a meaning to other meanings that are “more general” in some fashion; these are called *hypernyms*. The sense of dog used in the previous example has a two hypernyms: the subset of mammals that are closely related to dogs, such as wolves or jackals (this Synset has synonyms *canine*, *canid*), and the set of domesticated animals (with synonyms *domestic_animal* and *domesticated_animal*). To obtain these Synsets, we must first get a handle to the *ISynset* object for the meaning for dog. Then, we can retrieve the hypernym Synsets via the *getRelatedSynsets(IPointerType)* method. Java code that does this is shown in Figure 6.

```
1 public void getHypernyms(IDictionary dict){
2
3     // get the synset
4     IIndexWord idxWord = dict.getIndexWord("dog", POS.NOUN);
5     IWordID wordID = idxWord.getWordIDs().get(0); // 1st meaning
6     IWord word = dict.getWord(wordID);
7     ISynset synset = word.getSynset();
8
9     // get the hypernyms
10    List<ISynsetID> hypernyms =
11        synset.getRelatedSynsets(Pointer.HYPERNYM);
12
13    // print out each hypernym's id and synonyms
14    List<IWord> words;
15    for(ISynsetID sid : hypernyms){
16        words = dict.getSynset(sid).getWords();
17        System.out.print(sid + " {"");
18        for(Iterator<IWord> i = words.iterator(); i.hasNext();){
19            System.out.print(i.next().getLemma());
20            if(i.hasNext()) System.out.print(", ");
21        }
22        System.out.println("}");
23    }
24 }
```

Figure 5: Java code for retrieving the hypernyms of the first meaning of the word “dog”.

```
1 SID-2083346-n {canine, canid}
2 SID-1317541-n {domestic_animal, domesticated_animal}
```

Figure 6: Output of the *getHypernyms()* method (for Wordnet 3.0)

5.3 I'm trying to retrieve ISynsets linked by the DERIVED (or another) pointer by calling the ISynset .getRelatedSynsets(IPointer) method, or, I'm trying to retrieve IWords related by the HYPERNYM (or another) pointer by calling the IWord.getRelatedWords(IPointer) method, but JWI doesn't return anything. I know the relevant relationships exist in Wordnet, I looked it up using the Wordnet website. What gives?

The key conceptual error here is that there are two types of pointers in Wordnet, lexical and semantic. Semantic pointers are between synsets (i.e., meanings, such as the domesticated animal meaning captured in {dog, domestic_dog, canis_familiaris}), and lexical pointers are between word forms (e.g., the dog word form of the above meaning only). These two types of pointers are not well distinguished in the Wordnet documentation. Figure 7 diagrams the relationship. As can be seen, in JWI, lexical pointers are found only between IWord objects, and semantic pointers are found only between ISynset objects. There are no pointers that connect an IWord to an ISynset. Thus, you can only find Hypernyms of synsets, and you can only find Derived forms of words.

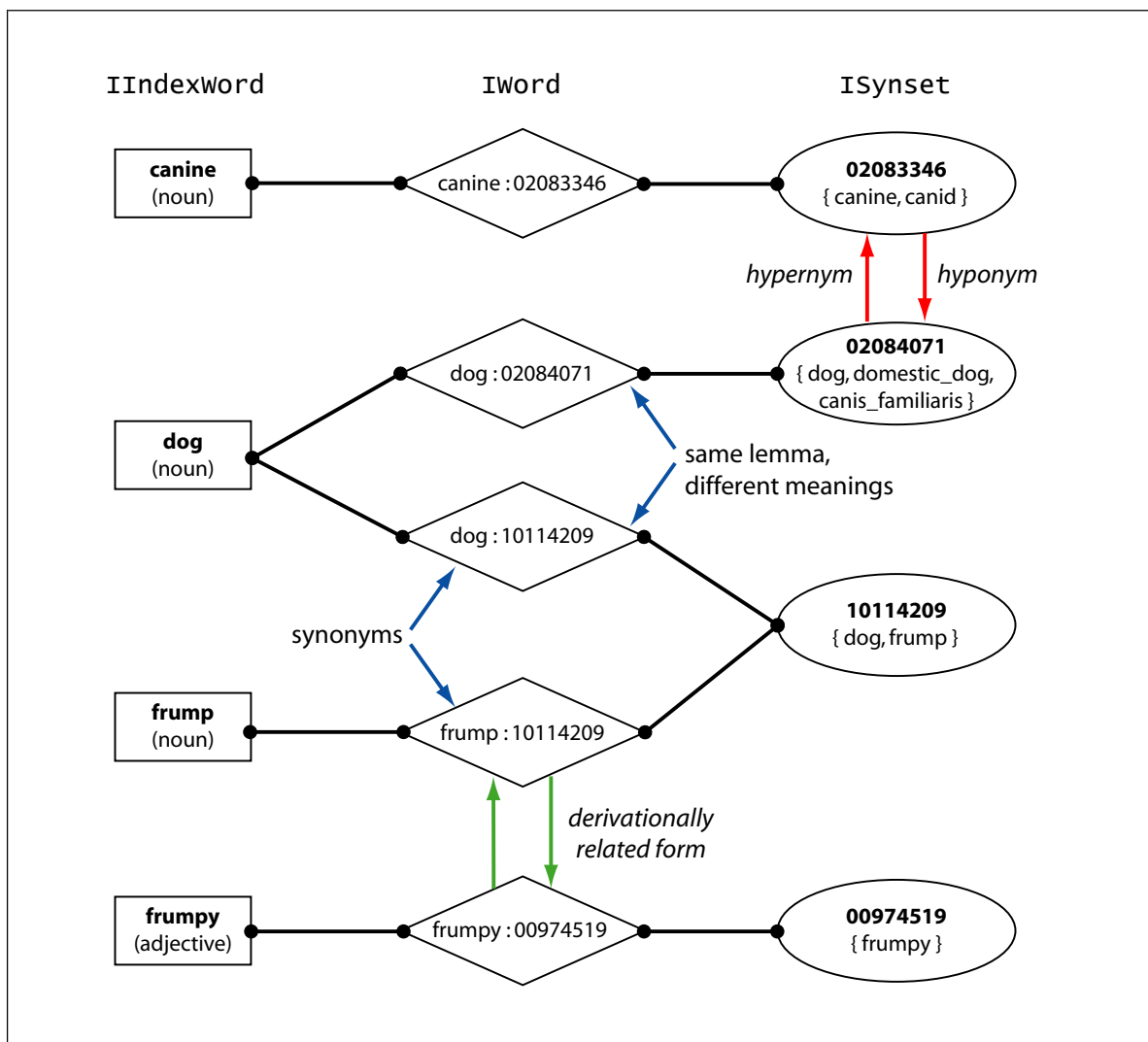


Figure 7: Illustration of the structure of Wordnet: index words, words, synsets, synonyms, lexical pointers (green arrows) and semantic pointers (red arrows) (for Wordnet 3.0).

5.5 How do I know which pointers are lexical and which are semantic?

Unfortunately, the Wordnet documentation doesn't give much hint about which pointers are used as lexical pointers, which are used as semantic pointers, and which as both. Fortunately for those seeking an answer to this question, I wrote some code that sifts through Wordnet and counts the instances of each. Those numbers for Wordnet 3.0 are found in Table 1. The counts for the Wordnet 2.0 and 2.1 are similar, and the separation of lexical and semantic pointers between lexical and semantic is exactly the same, with the exception that Wordnet 2.0 uses `REGION` and `REGION_MEMBER` types only as semantic pointers.

Pointer	Lexical	Semantic	Total	Both
also_see	580	2692	3272	Yes
antonym	7979	-	7979	-
attribute	-	1278	1278	-
cause	-	220	220	-
derived	74714	-	74714	-
derived_adj	3222	-	3222	-
entailment	-	408	408	-
holonym_mem	-	12293	12293	-
holonym_prt	-	9097	9097	-
holonym_sub	-	797	797	-
hypernym	-	89089	89089	-
hypernym_in	-	8577	8577	-
hyponym	-	89089	89089	-
hyponym_ins	-	8577	8577	-
meronym_mem	-	12293	12293	-
meronym_prt	-	9097	9097	-
meronym_sub	-	797	797	-
participle	73	-	73	-
pertainym	4799	-	4799	-
region	15	1345	1360	Yes
region_mem	15	1345	1360	Yes
similar_to	-	21386	21386	-
topic	11	6643	6654	Yes
topic_mem	11	6643	6654	Yes
usage	409	967	1376	Yes
usage_mem	409	967	1376	Yes
verb_group	2	1748	1750	Yes
Total	92239	285348	377587	

Table 1: Counts of Lexical and Semantic Pointers for Wordnet 3.0

5.4 I want to load Wordnet completely into memory; can JWI do this?

No, JWI currently does not have the ability to pre-load all of Wordnet into memory. The best you can do is make the cache extremely large. There also are currently no plans to make JWI load completely into memory. The API was not designed with this in mind, e.g., calls to the *getRelatedWord(IPointer)* or *getRelatedSynset(IPointer)* methods return ID objects, not the objects themselves. Nevertheless, this does not stop some enterprising coder from implementing a JWI Dictionary which does this, or prevent popular demand from forcing me to do the same.

5.5 I get messages similar to the following printed to *System.err*. What's up?

1229375196772 - Error on direct access in verb data file: check CR/LF endings

The Wordnet .data files (i.e., the four files that either start or end with *data*, e.g., *noun.data*, *verb.data*, etc.) are indexed by byte offset. The line endings in the files are indicated in the standard UNIX way, by a single linefeed (LF) character, often written as '\n'. In contrast, the standard linefeed on Windows systems is a carriage-return character followed by a linefeed (CR/LF), often written '\r\n'. Some archive extraction programs automatically convert LF linefeeds to CR/LF linefeeds, especially if you're on a Windows system. If this was done, the Wordnet data files will have an extra character at the end of each line, and the byte offsets will no longer index to the right places. As of JWI 2.1.5, there is a check for this, which causes the above error message to be printed and the dictionary to compensate. This causes a reduction in performance, but the dictionary will still work. I recommend you re-extract your data files from the Wordnet archive, making sure you have the option to automatically convert line endings unchecked. For example, in WinZip, there is an option under Configuration → Miscellaneous called "TAR smart CR/LF conversion". Make sure it is unchecked. This will probably solve the problem.

5.6 The dictionary opens fine, and I can retrieve *IndexWord* objects, but all my *ISynset* objects come back **null**. I know the synset I'm looking for is in the dictionary, I checked in using the Wordnet online API / I see it in the data file. What's going on?

See the answer to question 5.6. In versions of JWI before 2.1.5, there was no check for corrupted line endings in the data files, and the symptom is **null** synset objects.

5.7 I think I've found a bug / I need a particular feature / this software is really cool, I'd like to heap praise upon you. What do I do?

If you find a bug, have a feature request, or wish to send your praises, please contact me via my permanent email forwarding address markaf@alum.mit.edu.

5.8 I'm with XYZ Corporation and we think we could integrate JWI into our product and use it to make many Gazillions of dollars. We would like to obtain a commercial license for JWI. Whom should I contact?

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