LING 581: Advanced Computational Linguistics

Lecture Notes

March 23rd
Today's Topic

1. Installation of WordNet: Issues
2. Searching WordNet programmatically
3. Simple Homework Exercise
WordNet Compile on OSX

[Communicated by Damian Yukio Romero Diaz]

• replacement (on website) of `stub.c`

• Fix for compile errors is here:

```c
int wn_glosses (ClientData clientData, Tcl_Interp *interp,
               int argc, char *argv[]) {
    if (argc != 2) {
        // interp -> result = "usage: glosses [1 | 0]";
        Tcl_SetResult(interp, "usage: glosses [1 | 0]", TCL_DYNAMIC);
        return TCL_ERROR;
    }
    dflag = atoi (argv[1]);
    return TCL_OK;
}
```
Compile

1. $ ls WordNet-QueryData-1.49
2. WordNet-QueryData-1.49/ WordNet-QueryData-1.49.tar
3. $ cd WordNet-QueryData-1.49
4. $ which make
5. /usr/bin/make
6. $ /usr/bin/perl Makefile.PL
7. Writing Makefile for WordNet::QueryData
8. Writing MYMETA.yml and MYMETA.json
9. $ make
10. Skip blib/lib/WordNet/QueryData.pm (unchanged)
11. Manifying blib/man3/WordNet::QueryData.3pm
Test

make test  ok 100
PERL_DL_NONLAZY=1 /usr/bin/perl "-Iblib/lib" "-Iblib/arch" test.pl  ok 101
ok 1  ok 102
ok 2  ok 103
ok 3  ok 104
ok 4  ok 105
ok 5  ok 106
ok 6  ok 107
ok 7  ok 108
ok 8  ok 109
ok 9
...


Install

$ sudo make install
Password:
Installing /Library/Perl/5.18/WordNet/QueryData.pm
Installing /usr/local/share/man/man3/WordNet::QueryData.3pm
Appending installation info to /Library/Perl/Updates/5.18.2/darwin-thread-multi-2level/perllocal.pod

ls /Library/Perl/5.18/WordNet/QueryData.pm
Use

/usr/bin/perl bfs.perl minibike#n#1 convertible#n#1
Found at distance 4 (74 nodes explored)

Can't locate WordNet/QueryData.pm in @INC
(you may need to install the WordNet::QueryData module)
(@INC contains: /Library/Perl/5.18/darwin-thread-multi-2level
/Library/Perl/5.18
/Network/Library/Perl/5.18/darwin-thread-multi-2level
/Network/Library/Perl/5.18
/Library/Perl/Updates/5.18.2/darwin-thread-multi-2level
/Library/Perl/Updates/5.18.2
/System/Library/Perl/5.18/darwin-thread-multi-2level
/System/Library/Perl/5.18
/System/Library/Perl/Extras/5.18/darwin-thread-multi-2level
/System/Library/Perl/Extras/5.18 ) at bfs.perl line 17.
BEGIN failed--compilation aborted at bfs.perl line 17.
## Programmed search

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<td>6 querySense, 4 queryWord</td>
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**CMDLINE PARAMETERS**
1. word#pos#sense
2. word#pos#sense

**OPTIONAL**
$\text{max}$ can be set using a 3rd cmdline parameter for bfs3.perl and bfs4.perl
Programmed search

• We can write a program to find the minimum distance between word senses: bfs.perl (on website)

```perl
1 # Example of breadth-first search of WordNet relations in Perl
2 # Sandiway Fong, University of Arizona
3 #
4 # usage: bfs word#pos#sense word#pos#sense
5 # synopsis: finds the semantic distance in links between the two word senses
6 if ($#ARGV != 1) {
7   print "usage: perl bfs.perl word#pos#sense word#pos#sense\n";
8   exit
9 }
10 my $start = $ARGV[0]; # e.g. minibike#n#1
11 my $end = $ARGV[1];  # e.g. convertible#n#1
12```
Programmed search

```perl
13 # USER-SETTABLE PARAMETERS
14 my $max = 20000; # max number of nodes to be explored
15 my @relations = ("hype", "hypo", "mero", "holo"); # semantic relations
16
17 use WordNet::QueryData;
18 my $wn = WordNet::QueryData->new( noload => 0);
19 my @queue = ($start, 'mark');
20 my %seen = {};  # mark is used to count the depth of breadth-first search
21 my $found = 0;
22 my $n = 0;
23 my $distance = 0;
24
hash %seen holds already visited nodes so we don’t loop
semantic distance = depth of breadth-first search when $end is matched
```
Programmed search

```perl
24 sub found {
25   my $node = shift;
26   foreach $syn ($wn->querySense($node, "syns")) {
27     if ($end eq $syn) {
28       return 1
29     }
30   }
31 }
32 return 0
33 }
```

Example
**Synset**: minibike#n1 motorbike#n1
Programmed search

```plaintext
35 if (found($start)) {
36   $found = 1;
37 } else {
38     FOUND: while ($n < $max) {
39       my $node = pop @queue;
40       if ($node eq 'mark') {
41         $distance++;
42         unshift @queue, 'mark';
43         $node = pop @queue;
44       }
45     } $seen{$node} = 1;
46 }
```

get node to expand

bookkeeping for depth of search

record node as seen

Recall array: end (push/pop), beginning (shift/unshift)
Programmed search

```php
foreach ($rel as $relations) {
    foreach ($newnode as $wn->querySense($node, $rel)) {
        $n++;
        if (found($newnode)) {
            $found = 1;
            last FOUND;
        } else {
            if (!$seen[$newnode]) {
                unshift @queue, $newnode;
            }
        }
    }
}
```
only two ways to get to the end of the program, either we found our target node $end or $n is no longer < $max

63 if ($found) {
64 print "Found at distance $distance ($n nodes explored)\n";
65} else {
66 print "Not found (distance $distance and $n nodes explored)\n";
67}
Programmed search

• Exercise revisited:
  – find the relationship between *minibike* and *convertible*

  `perl bfs.perl minibike#n#1 convertible#n#1`
  – Found at distance 4 (74 nodes explored)

  `perl bfs.perl convertible#n#1 car#n#1`
  – Found at distance 1 (1 nodes explored)

Note:
  `perl bfs.perl convertible#n#1 minibike#n#1`
  – Found at distance 4 (255 nodes explored)

Semantic relatedness
can we compare concept distances?
Programmed search

• A more informative search
  – we can modify the program to make each node keep a path, i.e. history, of the relations and nodes
  – **website**: bfs2.perl *(quick and dirty implementation)*

Example:
– perl bfs2.perl *minibike#n#1 convertible#n#1*
– Found at distance 4 (74 nodes explored)
– *convertible#n#1 hypo car#n#1 hypo motor_vehicle#n#1 hype motorcycle#n#1 hype minibike#n#1*

https://wordnet.princeton.edu/wordnet/man/wngloss.7WN.html

**hypernym**
The generic term used to designate a whole class of specific instances. 
*Y* is a hypernym of *X* if *X* is a (kind of) *Y*.

**hyponym**
The specific term used to designate a member of a class. 
*X* is a hyponym of *Y* if *X* is a (kind of) *Y*. 
Programmed search

• Code changes:
  (uses Perl references to implement each node becoming a list itself)
  – my @queue = ([${start}], ['mark']);

```
41  FOUND: while ($n < $max) {
42      $node_ref = pop @queue;
43      if (@{$node_ref}[0] eq 'mark') {
44          $distance++;
45          unshift @queue, ['mark'];
46          $node_ref = pop @queue;
47      }
48      $seen[@{$node_ref}[0]] = 1;
```

- square brackets builds a reference to a list containing $start, another for ‘mark’
- picks out first element of the list
Programmed search

• Code changes (main loop):

```bash
foreach $rel (@relations) {
    foreach $newnode ($wn->querySense(@{$node_ref}[0], $rel)) {
        $n++;
        if (found($newnode)) {
            $found = 1;
            unshift @{$node_ref}, ($newnode, $rel);
            last FOUND;
        } else {
            if (!$seen[$newnode]) {
                my @new = @{$node_ref};
                unshift @new, ($newnode, $rel);
                unshift @queue, @new;
            }
        }
    }
}
```

puts $newnode $rel onto front of the list referenced by $node_ref

same thing here except it makes a fresh copy of the list called @new

(not the most space-efficient implementation... but simple)
Programmed search

• Code changes (print out at the end):

```perl
69 if ($found) {
70    print "Found at distance $distance ($n nodes explored)\n";
71    print "@{${node_ref}}", "\n";
72} else {
73    print "Not found (distance $distance and $n nodes explored)\n";
74}
```

because we’ve been adding relations and new nodes
@{${node_ref}} is a list that contains the entire history of how we got there
Programmed search

- Other examples:
  perl bfs2.perl minibike#n#1 roof#n#1
    – Found at distance 5 (509 nodes explored)
    – roof#n#1 hype sunroof#n#1 mero car#n#1 hypo
      motor_vehicle#n#1 hype motorcycle#n#1 hype
      minibike#n#1

  perl bfs2.perl convertible#n#1 roof#n#1
    – Found at distance 3 (222 nodes explored)
    – roof#n#1 hype sunroof#n#1 mero car#n#1 hype
      convertible#n#1
Programmed search

- Not everything seems related:
  (even when search limit is upped to 80000)
  - perl bfs.perl chair#n#1 table#n#1
    - Not found (distance 8 and 80008 nodes explored)
  - perl bfs.perl table#n#1 chair#n#1
    - Not found (distance 9 and 80215 nodes explored)

perl bfs.perl table#n#1 chair#n#1
Found at distance 9 (140548 nodes explored)

perl bfs2.perl table#n#1 chair#n#1
Found at distance 9 (140548 nodes explored)
chair#n#1 hypo seat#n#3 holo upholstery#n#1 hypo covering#n#2 hypo artifact#n#1 hype
decoration#n#1 hype flower_arrangement#n#1 hypo arrangement#n#2 hype array#n#1 hype table#n#1

does the long chain still have meaning?
Programmed search

### Noun

- **S: (n) table#1, tabular array#1** (a set of data arranged in rows and columns) "see table 1"
- **S: (n) table#2** (a piece of furniture having a smooth flat top that is usually supported by one or more vertical legs) "it was a sturdy table"
- **S: (n) table#3** (a piece of furniture with tableware for a meal laid out on it) "I reserved a table at my favorite restaurant"
- **S: (n) mesa#1, table#4** (flat tableland with steep edges) "the tribe was relatively safe on the mesa but they had to descend into the valley for water"
- **S: (n) table#5** (a company of people assembled at a table for a meal or game) "he entertained the whole table with his witty remarks"
- **S: (n) board#4, table#6** (food or meals in general) "she sets a fine table"; "room and board"

### Verb

- **S: (v) postpone#1, prorogue#1, hold over#5, put over#2, table#1, shelve#1, set back#1, defer#1, remit#2, put off#1** (hold back to a later time) "let’s postpone the exam"
- **S: (v) table#2, tabularize#1, tabularise#1, tabulate#1** (arrange or enter in tabular form)
Programmed search

• Note:
Programmed search

Noun

- **S: (n)** chair\#1 (a seat for one person, with a support for the back) "he put his coat over the back of the chair and sat down"
- **S: (n)** professorship\#1, chair\#2 (the position of professor) "he was awarded an endowed chair in economics"
- **S: (n)** president\#4, chairman\#1, chairwoman\#1, chair\#3, chairperson\#1 (the officer who presides at the meetings of an organization) "address your remarks to the chairperson"
- **S: (n)** electric chair\#1, chair\#4, death chair\#1, hot seat\#1 (an instrument of execution by electrocution; resembles an ordinary seat for one person) "the murderer was sentenced to die in the chair"
- **S: (n)** chair\#5 (a particular seat in an orchestra) "he is second chair violin"

Verb

- **S: (v)** chair\#1, chairman\#1 (act or preside as chair, as of an academic department in a university) "She chaired the department for many years"
- **S: (v)** moderate\#1, chair\#2, lead\#14 (preside over) "John moderated the discussion"
Programmed search

• What do you think is the common link between *table* and *chair*?
Programmed search

```perl
perl bfs.perl chair#n#1 table#n#2
Found at distance 2 (78 nodes explored)
perl bfs2.perl chair#n#1 table#n#2
Found at distance 2 (78 nodes explored)
table#n#2 holo leg#n#3 mero chair#n#1
```

[Definition of Holonym from WordNet](https://wordnet.princeton.edu/wordnet/man/wngloss.7WN.html)

**Holonym**
The name of the whole of which the meronym names a part.

Y is a holonym of X if X is a part of Y.

**Meronym**
The name of a constituent part of, the substance of, or a member of something.

X is a meronym of Y if X is a part of Y.
Programmed search

• So far..
  – explored used querySense with relations hypo/
    hype/mero/holo

• More complete search:
  – add more relations and queryWord

```perl
15 # USER-SETTABLE PARAMETERS
16 my $max = 100000; # max number of nodes to be explored
17 my @relations = ("hype", "hypo", "mero", "holo", "enta", "caus"); # for querySense
18 my @relations2 = ("ants", "also", "deri", "pert"); # for queryWord

– Website: bfs3.perl
```
Programmed search

• Example:
  – John mended the torn dress
  – what can be deduced about the state of the world (situation) after the event of “mending”?
  – find the semantic relationship between mend and tear

bfs3.perl mend#v#1 tear#v#1
Found at distance 6 (58492 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants
repair#v#1 hypo better#v#2 hype mend#v#1

perl bfs3.perl tear#v#1 mend#v#1
Found at distance 6 (33606 nodes explored)
mend#v#1 deri mender#n#1 hypo skilled_worker#n#1 hype cutter#n#3 deri
cut#v#1 hypo separate#v#2 hype tear#v#1
Programmed search

• Find all minimal length solutions.
• Website: bfs4.perl
• Example:

```perl
perl bfs4.perl mend#v#1 tear#v#1
Found at distance 6 (58492 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also
break#v#4 ants repair#v#1 hypo better#v#2 hype mend#v#1
Found at distance 6 (58552 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri
break#v#4 ants repair#v#1 hypo better#v#2 hype mend#v#1
Found at distance 6 (67147 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also
break#v#4 ants repair#v#1 hype tinker#v#3 hypo mend#v#1
Found at distance 6 (67207 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri
break#v#4 ants repair#v#1 hype tinker#v#3 hypo mend#v#1
```
Programmed search

Found at distance 6 (67429 nodes explored)
 tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype fill#v#9 hypo mend#v#1

Found at distance 6 (67489 nodes explored)
 rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype fill#v#9 hypo mend#v#1

Found at distance 6 (71190 nodes explored)
 tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype piece#v#5 hypo mend#v#1

Found at distance 6 (71250 nodes explored)
 rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype piece#v#5 hypo mend#v#1

Found at distance 6 (74452 nodes explored)
 tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype cobble#v#2 hypo mend#v#1
Programmed search

Found at distance 6 (74512 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype cobble#v#2 hypo mend#v#1

Found at distance 6 (75039 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype point#v#14 hypo mend#v#1

Found at distance 6 (75099 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype point#v#14 hypo mend#v#1

Found at distance 6 (75321 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype trouble-shoot#v#1 hypo mend#v#1

Found at distance 6 (75381 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype trouble-shoot#v#1 hypo mend#v#1
Programmed search

Found at distance 6 (75603 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype patch#v#3 hypo mend#v#1

Found at distance 6 (75663 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype patch#v#3 hypo mend#v#1

Found at distance 6 (76859 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype sole#v#1 hypo mend#v#1

Found at distance 6 (76919 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype vamp#v#4 hypo mend#v#1

Found at distance 6 (78287 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype vamp#v#4 hypo mend#v#1

Found at distance 6 (78347 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype vamp#v#4 hypo mend#v#1
Programmed search

Found at distance 6 (78722 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype heel#v#5 hypo mend#v#1

Found at distance 6 (78782 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype heel#v#5 hypo mend#v#1

Found at distance 6 (79004 nodes explored)
tear#v#1 hypo separate#v#2 hype break_up#v#10 also break#v#4 ants repair#v#1 hype darn#v#1 hypo mend#v#1

Found at distance 6 (79064 nodes explored)
rupture#v#1 deri rupture#n#3 hypo breakage#n#3 deri break#v#4 ants repair#v#1 hype darn#v#1 hypo mend#v#1

Found at distance 6 (86457 nodes explored)
tear#v#1 hypo separate#v#2 hype cut#v#1 deri cutter#n#3 hypo skilled_worker#n#1 hype mender#n#1 deri mend#v#1

All minimal solutions found
Programmed search

```perl
bfs4.perl chair#n#1 table#n#2
Found at distance 2 (82 nodes explored)
table#n#2 holo leg#n#3 mero chair#n#1
All minimal solutions found
```

- Take out `holo` and `mero` from `@relations`

```perl
bfs4.perl table#n#2 chair#n#1
Found at distance 3 (139 nodes explored)
chair#n#1 hypo seat#n#3 hypo `furniture#n#1` hype
table#n#2
All minimal solutions found
```

Noun

- `furniture#1`, `piece of furniture#1`, `article of furniture#1` (furnishings that make a room or other area ready for occupancy) "they had too much furniture for the small apartment"; "there was only one piece of furniture in the room"
Homework Exercise

• Question 1:
  – Find the shortest distance links between star and telescope
  – (Make sure you have the right word sense)
  – How many are there?

• Question 2:
  – Draw the graph of semantic relations found

• Question 3:
  – Are any of the chains of semantic relations what you expect?

• Question 4:
  – Is the chain useful? Why or why not?

• Question 5:
  – What do you think the shortest connection linking star and telescope should look like?