Introduction to Natural Language Processing
This week:
More QA
Lexical Semantics
Any questions from last week
Final: Via Ecommons

- Strike possibility => can take it from anywhere via computer
- Still timed: open book, honor pledge
- Will prepare some review questions
- Aim to not be any harder/longer than the midterm
Homework 8: Final QA system

- Homework 6: got all the points if you got something that ran.

- Homework 7: Worth 20 points. Grading will be stricter.

- HW7 and HW8: **Can work with a partner, can start now if you like**

- Extra/Replacement office hours this week!

- Last Phase: Continue testing techniques so far, add in enhancement based on noun and verb synsets.

- **Last Day: Presentations and Competition:** see who can get the best accuracy on the test set.
Lexical Resources

• A lexicon, or lexical resource, is a collection of words and/or phrases along with associated information such as part of speech and sense definitions.

• A vocabulary (list of words in a text) is the simplest lexical resource

• Lexical entry
  • A **lexical entry** typically consists of a **headword** (also known as a **lemma**) along with additional information such as the part of speech and the sense definition.
Different types of Lexical Dictionaries

- **LIWC: Linguistic Inquiry and Word Count**: categorizes words into a hierarchical set of lexical categories.
- **Sentiment Lexicons**: Classify words into positive and negative polarity, either binary or scalar.
- **Wordnet**:
  - classifies words hierarchically according to an ontology of things in the world, e.g. cup ISA container.
  - Tells you the different senses of a word and groups words with their synonyms “service”.
- **Verbnet**:
  - groups verbs by their meaning into an ontology.
  - Tells you how verbs ‘subcategorize’ for their arguments.
Wordnet and Verbnet
In the nltk data download
WordNet

- **WordNet** is a large lexicon of English. Nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept*. 

- Synsets are interlinked by means of conceptual-semantic and lexical relations. The resulting network of meaningfully related words and concepts can be navigated with the browser. 

- NLTK includes the English WordNet, with 155,287 words and 117,659 synonym sets. 

- **Senses and Synonyms**
  - Consider the 2 sentences: 
    - *Benz is credited with the invention of the motorcar*
    - *Benz is credited with the invention of the automobile.*
  - *motorcar* and *automobile* have the same meaning, i.e. they are **synonyms**.
The WordNet Hierarchy

- WordNet synsets correspond to abstract concepts, and they don't always have corresponding words in English.

- These concepts are linked together in a hierarchy. Some concepts are very general, such as *Entity, State, Event* — these are called unique beginners or root synsets.
WordNet (Synsets)

- *motorcar* has just one possible meaning and it is identified as car.n.01, the first noun sense of *car*.
- The entity car.n.01 is called a **synset**, or "synonym set", a collection of synonymous words (or "lemmas"):

```
Word to search for: motorcar  Search WordNet
Display Options:  (Select option to change)  Change
Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: (gloss) "an example sentence"
Display options for word: word#sense number

Noun

- S: (n) car#1, auto#1, automobile#1, machine#6, motorcar#1 (a motor vehicle with four wheels; usually propelled by an internal combustion engine) "he needs a car to get to work"
```
Words in our Stories

Verb

- [35] S: (v) crop#4 (crop%2:35:10::), graze#3 (graze%2:35:10::), pasture#1 (pasture%2:35:10::) (let feed in a field or pasture or meadow)
  - direct hypernym | inherited hypernym | sister term
  - derivationally related form
  - sentence frame

- [35] S: (v) graze#2 (graze%2:35:02::) (break the skin (of a body part) by scraping) "She was grazed by the stray bullet"
- [35] S: (v) crop#4 (crop%2:35:10::), graze#3 (graze%2:35:10::), pasture#1 (pasture%2:35:10::) (let feed in a field or pasture or meadow)
- [35] S: (v) graze#4 (graze%2:35:00::), crease#3 (crease%2:35:02::), rake#6 (rake%2:35:02::) (scrape gently) "graze the skin"
- [34] S: (v) browse#4 (browse%2:34:00::), graze#5 (graze%2:34:02::) (eat

Synset
WordNet (Gloss)

- Each entry has a short definition or gloss
- E.g., "A motor vehicle with four wheels; usually propelled by an internal combustion engine"

Gloss

- S: (n) car#1, auto#1, automobile#1, machine#6, motorcar#1 (a motor vehicle with four wheels; usually propelled by an internal combustion engine) "he needs a car to get to work"
Words in our Stories

Verb

- [35] S: (v) crop#4 (crop%2:35:10::), graze#3 (graze%2:35:10::), pasture#1 (pasture%2:35:10::) (let feed in a field or pasture or meadow)
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- [34] S: (v) browse#4 (browse%2:34:00::), graze#5 (graze%2:34:02::) (eat...
WordNet

• Each entry usually has at least one example use from a corpus.
• E.g., "A motor vehicle with four wheels; usually propelled by an internal combustion engine"

Example

Word to search for: motorcar

Display Options: (Select option to change) Change

Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: (gloss) "an example sentence"
Display options for word: word#sense number

Noun

• S: (n) car#1, auto#1, automobile#1, machine#6, motorcar#1 (a motor vehicle with four wheels; usually propelled by an internal combustion engine) "he needs a car to get to work"
Word Sense Disambiguation

- An area of NLP which focuses on automatically finding the word senses for words in text or dialogue
- Not yet a solved problem
- Classic Example:
  - I took the money to the bank.
  - I went fishing at the bank.
- “Words go in Herds”: Money would rarely co-occur with fishing
Word Sense Disambiguation

Classic Example:

- I took the money to the bank.
- I went fishing at the bank.

WordNet Search - 3.1
- WordNet home page - Glossary - Help

Word to search for: bank  Search WordNet

Display Options: [Select option to change]  Change

Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: "an example sentence"

Noun

- S: (n) bank "they pulled the canoe up on the bank"; "he sat on the bank of the river and watched the currents"
- S: (n) depository financial institution, bank, banking concern, banking company "he cashed a check at the bank"; "that bank holds the mortgage on my home"
- S: (n) bank "a huge bank of earth"
- S: (n) bank "he operated a bank of switches"
Word Sense: A Sense Key

WordNet Search - 3.1
- WordNet home page - Glossary - Help

Word to search for: bank

Display Options: (Select option to change) Change
Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: "an example sentence"
Display options for word: word (sense key)

Noun

- S: (n) bank (bank%1:17:01::) "they pulled the canoe up on the bank"; "he sat on the bank of the river and watched the currents"
- S: (n) depository financial institution (depository_financial_institution%1:14:00::), bank (bank%1:14:00::), banking concern (banking_concern%1:14:00::), banking company (banking_company%1:14:00::) "he cashed a check at the bank"; "that bank holds the mortgage on my home"
- S: (n) bank (bank%1:17:00::) "a huge bank of earth"
The WordNet Hierarchy

- \textbf{S: (n) car\#1, auto\#1, automobile\#1, machine\#6, motorcar\#1} (a motor vehicle with four wheels; usually propelled by an internal combustion engine) "he needs a car to get to work"
  - *direct hyponym* / *full hyponym*
    - \textbf{S: (n) ambulance\#1} (a vehicle that takes people to and from hospitals)
      - \textbf{S: (n) funny wagon\#1} (an ambulance used to transport patients to a mental hospital)
    - \textbf{S: (n) beach wagon\#1, station wagon\#1, wagon\#5, estate car\#1, beach waggon\#1, station waggon\#1, waggon\#2} (a car that has a long body and rear door with space behind rear seat)
      - \textbf{S: (n) shooting brake\#1} (another name for a station wagon)
    - \textbf{S: (n) bus\#4, jalopy\#1, heap\#3} (a car that is old and unreliable)
      - "the fenders had fallen off that old bus"
It's very easy to navigate between concepts. For example, given a concept like *motorcar*, we can look at the concepts that are more specific; the (immediate) hyponyms.
The WordNet Hierarchy in NLTK

- Hypernyms and hyponyms are called **lexical relations** because they relate one synset to another. These two relations navigate up and down the "is-a" hierarchy.
Uses the SENSE KEY

- It’s very easy to navigate between concepts. For example, given a concept like *motorcar*, we can look at the concepts that are more specific; the (immediate) **hyponyms**.

```python
>>> motorcar = wn.synset('car.n.01')
>>> types_of_motorcar = motorcar.hyponyms()
>>> types_of_motorcar[26]
Synset('/ambulance.n.01')
>>> sorted([synset.lemma.name for synset in types_of_motorcar for lemma in synset.lemmas()])
['Model T', 'S.U.V.', 'SUV', 'Stanley Steamer', 'ambulance', 'beach_wagon', 'beach_wagon', 'bus', 'cab', 'compact', 'compact_car', 'convertible',
 'coupe', 'cruiser', 'electrical', 'electrical_automobile', 'electrical_car',
 'estate_car', 'gas_guzzler', 'hack', 'hardtop', 'hatchback', 'hemp',
 'horseless_carriage', 'hot-rod', 'hot_rod', 'jalopy', 'jeep', 'landrover',
 'limo', 'limousine', 'loaner', 'minicar', 'minivan', 'pace_car', 'patrol_car',
 'phaeton', 'police_car', 'police_cruiser', 'prowl_car', 'race_car', 'racer',
 'racing_car', 'roadster', 'runabout', 'saloon', 'secondhand_car', 'sedan',
 'sport_car', 'sport_utility', 'sport_utility_vehicle', 'sports_car', 'squad_car',
 'station_wagon', 'station_wagon', 'stock_car', 'subcompact', 'subcompact_car',
 'taxi', 'taxicab', 'tourer', 'touring_car', 'two-seater', 'used-car', 'wagon',
 'wagon']
```
We can also navigate up the hierarchy by visiting hypernyms. Some words have multiple paths, because they can be classified in more than one way. There are two paths between car.n.01 and entity.n.01 because wheeled_vehicle.n.01 can be classified as both a vehicle and a container.

- **direct hypernym / inherited hypernym / sister term**
  - \( S: (n) \) motor vehicle#1, automotive vehicle#1
  - \( S: (n) \) self-propelled vehicle#1
  - \( S: (n) \) wheeled vehicle#1
  - \( S: (n) \) vehicle#1
    - \( S: (n) \) conveyance#3, transport#1
    - \( S: (n) \) instrumentality#3, instrumentation#1
    - \( S: (n) \) artifact#1, artefact#1
    - \( S: (n) \) whole#2, unit#6
      - \( S: (n) \) object#1, physical object#1
      - \( S: (n) \) physical entity#1
    - \( S: (n) \) container#1
    - \( S: (n) \) instrumentality#3, instrumentation#1
      - \( S: (n) \) artifact#1, artefact#1
      - \( S: (n) \) whole#2, unit#6
      - \( S: (n) \) object#1, physical object#1
      - \( S: (n) \) physical entity#1
  - \( S: (n) \) entity#1
A Lion watched a fat Bull feeding in a meadow, and his mouth watered when he thought of the royal feast he would make, but he did not dare to attack him, for he was afraid of his sharp horns.

There once was a fat bull. The bull was grazing in a meadow. A lion watched the bull and salivated because the lion wanted to eat the bull. The lion didn't attack the bull because the lion feared sharp every horn of the bull.
Using Synonyms, Hyponyms, Hypernyms

- Where was the lion feeding?
- Where was the lion cropping?
- Where was the lion pasturing?
- Where was the lion eating?
## Words in our Stories

**Verb**

- **[04]** S: (n) graze\#2 (graze\%1:04:00::), grazing\#1 (grazing\%1:04:01::) (the act of grazing)

### Verb Group

- **[35]** S: (v) crop\#5 (crop\%2:35:01::), browse\#2 (browse\%2:35:01::), graze\#1 (graze\%2:35:01::), range\#6 (range\%2:35:02::), pasture\#2 (pasture\%2:35:00::) (feed as in a meadow or pasture) "the herd was grazing"
  - direct hypernym / inherited hypernym / sister term
  - derivationally related form
  - sentence frame

- **[35]** S: (v) graze\#2 (graze\%2:35:02::) (break the skin (of a body part) by scraping) "She was grazed by the stray bullet"
- **[35]** S: (v) crop\#4 (crop\%2:35:10::), graze\#3 (graze\%2:35:10::), pasture\#1 (pasture\%2:35:10::) (let feed in a field or pasture or meadow)
- **[35]** S: (v) graze\#4 (graze\%2:35:00::), crease\#3 (crease\%2:35:02::), rake\#6 (rake\%2:35:02::) (scrape gently) "graze the skin"
- **[34]** S: (v) browse\#4 (browse\%2:34:00::), graze\#5 (graze\%2:34:02::) (eat..."
Eagle and the Serpent

- In revenge the Serpent spat some of his poison into the man's drinking-horn. Heated with his exertions, the man was about to slake his thirst with a draught from the horn, when the Eagle knocked it out of his hand, and spilled its contents upon the ground.

- The serpent spat some poison in the drinking vessel. The countryman decided to sip from the drinking vessel. The eagle spilled the drinking vessel.
Some highly ambiguous Words: Horn

Noun

- (7){03542265} <noun.artifact>[06] S: (n) horn#1 (horn%1:06:06::) (a noisemaker (as at parties or games) that makes a loud noise when you blow through it)
- (3){01328058} <noun.animal>[05] S: (n) horn#2 (horn%1:05:01::) (one of the bony outgrowths on the heads of certain ungulates)
- (1){07280214} <noun.communication>[10] S: (n) horn#3 (horn%1:10:02::) (a noise made by the driver of an automobile to give warning)
- (1){03542111} <noun.artifact>[06] S: (n) horn#4 (horn%1:06:04::), saddle horn#1 (saddle_horn%1:06:00::) (a high pommel of a Western saddle (usually metal covered with leather))
- (1){03115320} <noun.artifact>[06] S: (n) cornet#1 (cornet%1:06:00::), horn#5 (horn%1:06:01::), trumpet#1 (trumpet%1:06:00::), trumpet#3 (trumpet%1:06:01::) (a brass musical instrument with a brilliant tone; has a narrow tube and a flared bell and is played by means of valves)
- (1){01328494} <noun.animal>[05] S: (n) horn#6 (horn%1:05:02::) (any hard protuberance from the head of an organism that is similar to or suggestive of a horn)
- {14782206} <noun.substance>[27] S: (n) horn#7 (horn%1:27:00::) (the material (mostly keratin) that covers the horns of ungulates and forms hooves and claws and nails)
- {03542421} <noun.artifact>[06] S: (n) horn#8 (horn%1:06:07::) (a device
What were we doing with words when we annotated
A Lion watched a fat Bull
feeding
in a meadow,
and his mouth watered
when he thought of the royal feast he would make,
but he did not dare to attack him,
for he was afraid of his sharp horns.
presently compelled him to do something:

the lion is watching the bull
the bull is eating
in the meadow
the lion salivates
because the lion believed that the bull is tasty
the lion doesn't dare himself to attack the bull
because the lion fears the horn of the bull
the lion decides to pursue the bull
the bull is tasty
Words in our Stories

Verb

- [35] S: (v) crop#5 (crop%2:35:01::), browse#2 (browse%2:35:01::), graze#2 (graze%2:35:01::), range#6 (range%2:35:02::), pasture#2 (pasture%2:35:00::) (feed as in a meadow or pasture) "the herd was grazing"
  - verb group
    - [34] S: (v) range#7 (range%2:34:00::) (let eat) "range the animals in the prairie"
    - [35] S: (v) crop#4 (crop%2:35:10::), graze#3 (graze%2:35:10::), pasture#1 (pasture%2:35:10::) (let feed in a field or pasture or meadow)
  - direct hypernym / inherited hypernym / sister term
  - derivationally related form
  - sentence frame
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- [34] S: (v) browse#4 (browse%2:34:00::), graze#5 (graze%2:34:02::) (eat
Annotating with Scheherezade

- Remember DramaBank has all the Aesop’s Fables already annotated.
- Often annotated more than once.
- Available for Download.

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Using Synonyms, Hyponyms, Hypernyms

- Where was the lion feeding?
- Where was the lion cropping?
- Where was the lion pasturing?
- Where was the lion eating?
How will we do Word Sense Disambiguation?
Use the Sch files to produce a Dict

```
word,synset_id,synset_offset,lemmas
drinking_vessel,drinking_vessel.n.01.3241496,"[Lemma('drinking_vessel.n.01.drinking_vessel')]"
cheese,cheese.n.01.7850329,"[Lemma('cheese.n.01.cheese')]"
eyeball,eyeball.n.01.5316025,"[Lemma('eyeball.n.01.eyeball'), Lemma('eyeball.n.01.orb')]"
distress,distress.n.02.14476852,"[Lemma('distress.n.02.distress')]"
cruiser,cruiser.n.01.3141065,"[Lemma('cruiser.n.01.cruiser'), Lemma('cruiser.n.01.police_cruiser'), Lemma('cruiser.n.01.police_car'), Lemma('cruiser.n.01.prowl_car'), Lemma('cruiser.n.01.prowl_car')]"
people,people.n.03.7971141,"[Lemma('people.n.03.people')]"
crow,crow.n.01.1579028,"[Lemma('crow.n.01.crow')]"
broth,broth.n.01.7585208,"[Lemma('broth.n.01.broth'), Lemma('broth.n.01.stock')]"
scene,scene.n.08.4144782,"[Lemma('scene.n.08.scene'), Lemma('scene.n.08.view')]"
```
Verb Lemmas (from WordNet)

- Word, Synset ID, Synset offset, Lemmas

- Lemmas are the Word roots for the synonyms

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<thead>
<tr>
<th>Word</th>
<th>Synset ID</th>
<th>Lemmas</th>
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<td>burn</td>
<td>burn.v.03,377002</td>
<td>Lemma('burn.v.03.burn'), Lemma('burn.v.03.combust')</td>
</tr>
<tr>
<td>free</td>
<td>free.v.01,2421374</td>
<td>Lemma('free.v.01.free'), Lemma('free.v.01.liberate')</td>
</tr>
<tr>
<td>ase</td>
<td>free.v.01.unloose</td>
<td>Lemma('free.v.01.unloose'), Lemma('free.v.01.unloosen')</td>
</tr>
<tr>
<td>graze</td>
<td>graze.v.02,1608508</td>
<td>Lemma('graze.v.02.graze')</td>
</tr>
<tr>
<td>devour</td>
<td>devour.v.02,1820798</td>
<td>Lemma('devour.v.02.devour')</td>
</tr>
<tr>
<td>rebel</td>
<td>rebel.v.01,2583139</td>
<td>Lemma('rebel.v.01.rebel'), Lemma('rebel.v.01.arise')</td>
</tr>
<tr>
<td>rise_up</td>
<td>rebel.v.01.rise_up</td>
<td>Lemma('rebel.v.01.rise_up')</td>
</tr>
<tr>
<td>put</td>
<td>put.v.01,1494310</td>
<td>Lemma('put.v.01.put'), Lemma('put.v.01.set'), Lemma('put.v.01.put')</td>
</tr>
</tbody>
</table>

A Lion watched a fat Bull feeding in a meadow, and his mouth watered...

There once was a fat bull. The bull was grazing in a meadow.

There once was a fat bull. The bull was pasturing in a meadow.
Eagle and the Serpent

- In revenge the Serpent spat some of his poison into the man's drinking-horn. Heated with his exertions, the man was about to slake his thirst with a draught from the horn, when the Eagle knocked it out of his hand, and spilled its contents upon the ground.

- The serpent spat some poison in the drinking vessel. The countryman decided to sip from the drinking vessel. The eagle spilled the drinking vessel.
Some highly ambiguous Words: Horn

Noun

- (7){03542265} <noun.artifact>[06] S: (n) horn#1 (horn%1:06:06::) (a noisemaker (as at parties or games) that makes a loud noise when you blow through it)
- (3){01328058} <noun.animal>[05] S: (n) horn#2 (horn%1:05:01::) (one of the bony outgrowths on the heads of certain ungulates)
- (1){07280214} <noun.communication>[10] S: (n) horn#3 (horn%1:10:02::) (a noise made by the driver of an automobile to give warning)
- (1){03542111} <noun.artifact>[06] S: (n) horn#4 (horn%1:06:04::), saddle horn#1 (saddle_horn%1:06:00::) (a high pommel of a Western saddle (usually metal covered with leather))
- (1){03115320} <noun.artifact>[06] S: (n) cornet#1 (cornet%1:06:00::), horn#5 (horn%1:06:01::), trumpet#1 (trumpet%1:06:00::), trump#3 (trump%1:06:01::) (a brass musical instrument with a brilliant tone; has a narrow tube and a flared bell and is played by means of valves)
- (1){01328494} <noun.animal>[05] S: (n) horn#6 (horn%1:05:02::) (any hard protuberance from the head of an organism that is similar to or suggestive of a horn)
- {14782206} <noun.substance>[27] S: (n) horn#7 (horn%1:27:00::) (the material (mostly keratin) that covers the horns of ungulates and forms hooves and claws and nails)
- {03542421} <noun.artifact>[06] S: (n) horn#8 (horn%1:06:07::) (a device
The serpent spat some poison in the drinking vessel. The countryman decided to sip from the drinking vessel. The eagle spilled the drinking vessel.
Word to search for: drinking vessel

Display Options: (Select option to change) Change

Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: (frequency) {offset} <lexical filename> [lexical file number] (gloss) "an example sentence"
Display options for word: word#sense number (sense key)

Noun

- {03246199} <noun.artifact>[06] S: (n) drinking vessel#1
  (drinking_vessel%1:06:00::) (a vessel intended for drinking)
    - direct hyponym / full hyponym
      - {03699033} <noun.artifact>[06] S: (n) loving cup#1
        (loving_cup%1:06:01::) (a large drinking vessel (usually with two handles) that people drink out of in turn at a banquet)
      - {03802912} <noun.artifact>[06] S: (n) mug#4 (mug%1:06:00::) (with handle and usually cylindrical)
      - {04337327} <noun.artifact>[06] S: (n) stoup#1 (stoup%1:06:02::) (an archaic drinking vessel)
      - {04396517} <noun.artifact>[06] S: (n) tankard#1
        (tankard%1:06:00::) (large drinking vessel with one handle)
Verb Lemmas (from WordNet)

- Word, Synset ID, Synset offset, Lemmas
- Lemmas are the Word roots for the synonyms

There was a protest that happened along the street where I work and at first it looked peaceful until a bunch of people started rebelling and creating a riot. Police cars were burned and things were thrown at cops.
Hyponyms and Hypernyms from WordNet

A Lion watched a fat Bull feeding in a meadow, and his mouth watered...

There once was a fat bull. The bull was grazing in a meadow.

Verb

- [35] $S$: (v) crop#5 (crop%2:35:01::), browse#2 (browse%2:35:01::), graze#1 (graze%2:35:01::), range#6 (range%2:35:02::), pasture#2 (pasture%2:35:00::)
  (feed as in a meadow or pasture) "the herd was grazing"
  - verb group
    - [34] $S$: (v) range#7 (range%2:34:00::) (let eat) "range the animals in the prairie"
    - [35] $S$: (v) crop#4 (crop%2:35:10::), graze#3 (graze%2:35:10::), pasture#1 (pasture%2:35:10::) (let feed in a field or pasture or meadow)
  - direct hypernym / inherited hypernym / sister term
    - [34] $S$: (v) feed#6 (feed%2:34:00::), eat#3 (eat%2:34:02::) (take in food; used of animals only) "This dog doesn't eat certain kinds of meat"; "What do whales eat?"
A Lion watched a fat Bull feeding in a meadow, and his mouth watered...

There once was a fat bull. The bull was grazing in a meadow.
Other Kinds of Links

Word to search for: mellow  Search WordNet

Display Options: (Select option to change)  Change

Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations
Display options for sense: (gloss) "an example sentence"

Verb

- **S:** (v) mellow (soften, make mellow) "Age and experience mellowed him over the years"
- **S:** (v) mellow, melt, mellow out (become more relaxed, easygoing, or genial) "With age, he mellowed"
- **S:** (v) mellow (make or grow (more) mellow) "These apples need to mellow a bit more"; "The sun mellowed the fruit"

Adjective

- **S:** (adj) laid-back, mellow (unhurried and relaxed) "a mellow conversation"
  - similar to
  - **S:** (adj) relaxed (without strain or anxiety) "gave the impression of being quite relaxed"; "a relaxed and informal discussion"
  - derivationally related form
    - **W:** (n) mellowness [Related to: mellow] (geniality, as through the effects of alcohol or marijuana)
    - antonym
      - **W:** (adj) tense [Indirect via relaxed] (in or of a state of physical or nervous tension)
Some lexical relationships hold between lemmas, e.g., *antonymy*:

**Noun**
- S: (n) supply#1
- S: (n) supply#2
  - direct hypernym / inherited hypernym / sister term
  - antonym
- W: (n) demand#2 [Opposed to: supply]

There are also relationships between verbs. For example, the act of *walking* involves the act of *stepping*, so walking **entails** stepping. Some verbs have multiple entailments:

**Verb**
- S: (v) walk#1 (use one's feet to advance; advance by steps)
  - direct troponym / full troponym
  - verb group
  - direct hypernym / inherited hypernym / sister term
  - entailment
    - S: (v) step#1 (shift or move by taking a step)
VerbNet: A Verb Lexicon

- VerbNet, a hierarchical verb lexicon linked to WordNet. It can be accessed with nltk.corpus.verbnet.
- VerbNet is the largest on-line verb lexicon currently available for English.
- It is a hierarchical domain-independent, broad-coverage verb lexicon with mappings to other lexical resources such as WordNet and FrameNet.
- **NLTK only has a subset of VerbNet.**
- We are only giving you Verb WSDs when they are in NLTK verbnet
VerbNet: A Verb Lexicon

Each VerbNet class contains a set of syntactic descriptions, depicting the possible surface realizations of the argument structure for constructions such as transitive, intransitive, prepositional phrases, etc.

Semantic restrictions (such as animate, human, organization) are used to constrain the types of thematic roles allowed by the arguments.

Syntactic frames may also be constrained in terms of which prepositions are allowed.

Each frame is associated with explicit semantic information.

---

<table>
<thead>
<tr>
<th>Name</th>
<th>Example</th>
<th>Syntax</th>
<th>Semantics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Transitive</td>
<td>Paula hit the ball</td>
<td>Agent V Patient</td>
<td>cause(Agent, E) manner(during(E), directedmotion, Agent)!contact(during(E), Agent, Patient) manner(end(E), forceful, Agent) contact(end(E), Agent, Patient)</td>
</tr>
</tbody>
</table>
VerbNet: A Verb Lexicon

- Each verb argument is assigned one (usually unique) thematic role within the class.

<table>
<thead>
<tr>
<th>Thematic Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Actor</strong></td>
<td>used for some communication classes (e.g., Chitchat-37.6, Marry-36.2, Meet-36.2) when both arguments can be considered symmetrical (pseudo-agents).</td>
</tr>
<tr>
<td><strong>Agent</strong></td>
<td>generally a human or an animate subject. Used mostly as a volitional agent, but also used in VerbNet for internally controlled subjects such as forces and machines.</td>
</tr>
<tr>
<td><strong>Asset</strong></td>
<td>used for the Sum of Money Alternation, present in classes such as Build-26.1, Get-13.5.1, and Obtain-13.5.2 with 'currency' as a selectional restriction.</td>
</tr>
<tr>
<td><strong>Attribute</strong></td>
<td>attribute of Patient/Theme refers to a quality of something that is being changed, as in (The price) at of oil soared. At the moment, we have only one class using this role Calibratable cos-45.6 to capture the Possessor Subject Possessor-Attribute Factoring Alternation. The selectional restriction 'scalar' (defined as a quantity, such as mass, length, time, or temperature, which is completely specified by a number on an appropriate scale) ensures the nature of Attribute.</td>
</tr>
<tr>
<td><strong>Beneficiary</strong></td>
<td>the entity that benefits from some action. Used by such classes as Build-26.1, Get-13.5.1, Performance-26.7, Preparing-26.3, and Steal-10.5. Generally introduced by the preposition 'for', or double object variant in the benefactive alternation.</td>
</tr>
<tr>
<td><strong>Cause</strong></td>
<td>used mostly by classes involving Psychological Verbs and Verbs Involving the Body.</td>
</tr>
<tr>
<td><strong>Location, Destination, Source</strong></td>
<td>used for spatial locations.</td>
</tr>
<tr>
<td><strong>Destination</strong></td>
<td>end point of the motion, or direction towards which the motion is directed. Used with a 'to' prepositional phrase by classes of change of location, such as Banish-10.2, and Verbs of Sending and Carrying. Also used as location direct objects in classes where the concept of destination is implicit (and location could not be Source), such as Butter-9.9, or Image impression-25.1.</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>start point of the motion. Usually introduced by a source prepositional phrase (mostly headed by 'from' or 'out of'). It is also used as a direct object in such classes as Clear-10.3, Leave-51.2, and Wipeinstr-10.4.2.</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>underspecified destination, source, or place, in general introduced by a locative or path prepositional phrase.</td>
</tr>
</tbody>
</table>
http://www.nltk.org/howto/corpus.html - verbnet-corpus-reader
Because Verbnet is subset
Will prepare a Verbnet Dict for Thursday
Thursday

- New test/dev set
- New easy, medium questions released, SAME Type
- New Question types: using subset of lexical relations in wordnet and verbnet
- Verbnet subset issue: are preparing a verbnet dict file that will only have entries in it from NLTK
- Will provide WSD for verbs as well as nouns
- Nouns available now for dev/test to date.