Corpus Linguistics for NLP

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2016
Outline

• Text Corpora in NLP
• Corpus Selection
• Corpus Annotation:
  – Purpose
  – Representation Issues
  – Linguistic Methods
  – Measuring Quality
• Role of Corpora & Annotation in Final Projects
Characters, Encodings, Etc.

- A Text Corpus is a set of texts
- Corpora can be derived in different ways
  - Text that was originally electronic (published, letters, etc.)
    - Does it include “non-standard” characters?
  - Transcripts of spoken language
    - No punctuation
    - Possible representation of pauses
    - Possibly including pauses and false starts
  - Optical Character Recognition (with errors)
- Encodings (mappings between bits and characters)
  - Old Standards (English): ASCII (less than 1 byte), ISO-8859 (2 bytes)
  - New standards UTF-8 (back-compat w/ASCII) and UTF-16
    - More characters/alphabets
    - UTF-8 encoded: 1st 128 chars use 1 byte, next 1920 char use 2 bytes, more chars use 3 or 4 bytes
    - UTF-16 encoded in 2-byte and 4-byte units
  - Other encodings: GB (e.g., Chinese), EUC (e.g., Japanese)
Types of Texts

• “Genre” divides text into types along several dimensions
  – Register? (socio-ling division by social setting): Fiction, News, Magazine, Scholarly Article, Legal Documents, Correspondence, Email, Discussion Groups, Twitter, Text Messages, Phone Calls, Instructions, Oral Narratives, Webpages
  – Topic: Sports, Games, Art, Natural Science, Social Science, Business, Fiction, Literary Criticism, …

• Spoken language transcripts have different properties from standard written text (published text, correspondence, etc.)
  – Differences in Basic Units
    • Pauses/intonation, but no punctuation/capitalization
      – If transcribed at all, encoding is not standard
  – Additional lexical items, syntactic phenomena
    • Disfluencies: false starts, stutters,..
    • “uh”, “um”, “like”, ....
Choosing a Corpus for a Project

• Specialize in a single type of corpus
  – Simplifies study of a language phenomenon
    • If noted, this is normal for academic studies
  – Particular corpus is appropriate for your project
    • A telephone Question Answer system → corpus of phone conversations

• A “Diverse” Corpus
  – For development of versatile system
  – To focus on common features of different genres
  – Keep corpora separate & focus on adaptability of system

• Your own corpus or an existing standard corpus
  – Own corpus requires preparation, but will be suitable for your needs
    • Removing unwanted fields (tables), formatting codes, …
  – Standard/Shared Corpus: Next Slide
Standard/Shared Corpora

• Why have shared or standard Corpora?
  – Opportunities for comparison and collaboration
  – Use other's expertise/avoid duplicate effort

• Brown Corpus (Kucera and Frances 1967)
  – 1 million words, sort of open source now
  – “balanced” (“diverse” is easier to define)
  – prose fiction, poetry, news, general interest, government documents, biography, ...

• Work using corpora flourished starting in the 1990s
  – Mostly government sponsored, mostly newspaper corpora
    • Wall Street Journal Corpus, incl Penn Treebank (1 million words)
      – Licensed by Linguistic Data Consortium
    – Depends on what was widely available
      • Hansard Corpus – Canadian French/English Parliamentary Proceedings

• Return to “diverse” corpora
  – British National Corpus (BNC) – 100 million words, 1994
  – American National Corpus, incl Open American National Corpus (OANC) 2004 & ongoing
    • 21 million words (and growing) including (15 million words in OANC)
Statistical Info Derivable from Corpora (without Annotation)

• Frequency:
  – words: eat, ate, cats, cat, Mary, because, ...
  – base forms: eat, cat, Mary, because, ...
  – characters: a, e, i, z, q, &, ., 5, 3, ?, @, ..

• Examples of Higher Level Statistics:
  – Frequency of bi-grams: ate the, the cat, house was, ...
    • tri-grams, 4-grams, 5-grams, … N-grams
  – TF-IDF: Term Freq × Inverse Document Freq
    • TF = Frequency of term in corpus
    • IDF = Num of Docs ÷ Num of Docs containing term
    • Examples: 100 documents, 100 instances of the word cat
      – If all in same document: 100 × 100/1 = 10,000
      – If each in a different document: 100 X 100/100 = 100
    • Used in Information Retrieval, Terminology Extraction, and other areas
Multi-lingual Corpora

• Parallel Corpora: bi-texts, tri-texts, etc.
  – 2 (or more corpora), such that corresponding segments are (literal) translations of each other
  – Useful for Machine Translation
  – Ex: Hansard Corpus

• Comparable Corpora
  – 2 (or more corpora) about similar/same topics, e.g., Wikipedia articles in multiple languages
Role of Manual Annotation in CL

• Together, annotation and specifications define a task
  – Can be used to “score” the output of any type of system

• For supervised machine learning, corpus is divided
  – A **Training** corpus is used to acquire statistical patterns
  – A **Test** corpus is used to measure system performance
  – A **Development** corpus is similar to a test corpus
    • Systems are “tuned” to get better results on the Dev corpus
    • Test corpora are used infrequently and system should not be tuned to get better results

• More annotated text often yield more effective patterns

• Different genres may have different properties
  – Systems can “train” separately on different genres
  – Systems can “train” on one diverse corpus
Annotation by Directly Marking Text

• Example: The Penn Treebank
• Input: This is a sentence.
• Output: (S (NP (DT This)) (VP (VBZ is) (NP (DT a) (NN sentence))) (. .))

• Can be difficult to align original text with the annotation
  – Spaces, newlines, etc. not explicitly represented
  – Words --> tokens not always obvious
    • cannot --> can/MD not/RB
    • 'Tis → T-/PRP is/VBZ
    • fearlast → fear/NN last/JJ
  – token standardization, typos and other accidental changes
Encoding Annotation with a Markup Language

• Input: *This is a sentence.*
• Output: `<S><NP><DT> This</DT></NP> <VP><VBZ>is</VBZ> <NP><DT> a</DT> <NN>sentence</NN></NP><VP><.> </.></S>`
  – (all on one line, preserving spaces)

• Markup language
  – Markup languages are designed to add information to text and typically distinguish beginning and ending tags `<X>` vs. `</X>`
  – Examples
    • HTML – language for website creation
    • XML, SGML – standards for more specific markup languages

• Programs often treat text and markup separately, e.g., turn markup into instructions (text color = red, bold, underline, italic, hyperlink, ...).
  – Example program: web browser treats html markup as instructions
Markup Annotation: Slide 2

- Annotation is usually designed so deleting the markup will remove all changes
  - `sed 's/<[^>]*>//' annotated_file > copy_of_original_file`
  - `diff original_file copy_of_original_file`
- Markup relies on assumption that certain characters will not appear in the original text (`<` and `>`)  
  - Suppose the corpus included the sentence: “I used an “<NP>” tag today”  
  - To handle this special characters are often substituted, e.g., html uses the following codes for ampersands and greater than signs
    - `&amp;`
    - `&gt;`
  - See for example [http://rabbit.eng.miami.edu/info/htmlchars.html](http://rabbit.eng.miami.edu/info/htmlchars.html)
  - Same/similar codes are often used in non-html text for NLP purposes
  - This adds a layer of complexity if one wants to compare (e.g., align) the annotated version with the original text.
Offset Annotation

• Many newer annotation frameworks use annotation that “points” to the original file
  – There is a file of plain text containing the words, sentences, etc. being classified.
  – 1 or more annotation files “point” to positions in the original file by means of character offsets from the beginning of the file.

• For example, a tag of the form:
  – `<S :start 0 end: 57>` could mean that there is a sentence beginning at the start of the file and ending 57 characters after the start of the file.
  – As in many programming environments, positions in strings are before and after characters and begin with 0, e.g.,
    • the python slice: `'This string'[0:4]` selects the substring between 0 and 4, assuming: `0 T h i s 1 s t r i n g 2 3 4 5 6 7 8 9 10 11`
Offset Annotation – Slide 2

• Overcomes the shortcomings of other methods
  – No special characters are needed
  – Relation to original text transparent
  – Multiple Annotations with the Same Scheme
    • Easy to Compare
  – Multiple Annotations with Different Schemes
    • Easier to compare, combine, etc.

• Difficult to read without programs (visualization tools, tools that write-out inline tag versions, etc.)
Annotation of Annotation

- Annotation Often Performed in Layers
  - One Project (or phase) Annotates Constituents
  - Another Project (or phase) Annotates Relationships Between Those Constituents

- Typical Cases:
  - Coreference:
    - Constituents X and Y are “mentions” of one Entity
  - Argument Structure
    - Predicate is in relation R with X as ARG1 and Y as ARG2

- 2 Layers of Annotation for: *John and Mary said that they were leaving.*
  - $NP_1 = [John and Mary], \text{verb}_1 = said, NP_2 = [they], S_1 = [that they were leaving]$
  - Coref($NP_1, NP_2$), ARG0($\text{verb}_1, NP_1$), ARG1($\text{verb}_1, S_1$)

- Examples of Projects: ACE, Penn Treebank + PropBank, NomBank and PDTB
Annotation Entry Tools

• Help humans create computationally viable annotation
  – simulate inline annotation, while creating offset annotation

• Well-formedness
  – Only legal labels are permitted
  – Other constraints can be hard-coded (e.g., distance)
  – Constraints can be automated
  – Warning statements can be included for “unusual” labelings

• Ease of Annotation
  – Specification help menus can be included
  – System can automatically propose next item
  – Common options can be automated, e.g., previous tags for particular strings can be proposed by system
The MAE annotation tool

- Original (Amber Stubbs at Brandeis):
  - http://code.google.com/p/mae-annotation/
- Alternative version (modified at NYU by Giancarlo Lee):
  - http://nlp.cs.nyu.edu/meyers/IE_TECH_NYU.html

- java -jar mae.jar
- Write dtd file: specifications for annotation
- Load txt file and create xml file
- Process
  - Mae separates the document into 2 XML fields:
    - Copy of original text between: “<TEXT> <![CDATA[“ and “ ]]></TEXT>”
    - Annotation between <TAGS> and </TAGS>
- Annotation of entities is offset annotation
- Annotation of relations: refers to entity annotation
AttributionTask Example

- Let's do a little bit of sample “AttributionTask”
  - Load dtd file
  - Load file

- Let's assume the following specifications:
  - The ATTRIBUTION relation links a COMMUNICATOR with a MESSAGE
  - A COMMUNICATOR is an NP that is capable of making a statement. Subcategories include
    - person: fictional or nonfictional human being or a set of people
    - government_entity: country or organization run by a government
    - nongov_organization: corporation, nonprofit, etc. group with a structure
    - Other: must be capable of having a message, e.g., a book/text, cartoon duck, etc.
  - A Message must be either quoted material or a complete sentence, subcategories include
    - direct_quote – a quoted sentence
    - indirect_quote – complement clause (e.g., with “that”)
    - mixed_quote – sentence, part of which is quoted
    - insinutated_attribution – sentence associated with communicator in some other way
    - other: must be a message; must be a sentence that someone communicates, but not covered by specs.
• Let's look at the output file in emacs (my preferred text editor)
• In this output, character positions begin at the end of [CDATA[
  – i.e., = 0
• Ctrl-U N – does following command N times
  – Ctrl-u N Ctrl-f – moves forward N spaces
• The relation (ATTRBIUTION) refer to the IDs of the entities: COMMUNICATOR and MESSAGE
• Each annotated tag has several feature=value pairs
  – Some are calculated by the program start/end
  – Others we added in explicitly (function/type/comment)
Now Let's Look at the Penn Treebank and NomBank

- **Penn Treebank: wsj_0003.mrg**
  - In emacs, Ctrl-Meta-B and Ctrl-Meta-N are useful for finding corresponding brackets particularly in lisp-mode

- **NomBank (and PropBank): wsj_0003.nombank**
  - Identifies nodes in Penn Treebank Trees
    - **Token:length-of-path-from-first-leaf**
    - **wsj/00/wsj_0003.mrg 10 13 amount 01 5:1*8:0-ARG1 7:0,9:0-Support 13:0-rel**
    - **File = wsj_0003**
    - **Tree = 10** (11th tree because count starts with 0)
    - **predicate amount(s) = token 11** (staring with 0)
    - **sense/roleset number 01** – see lexical entry
    - **ARG1 = (NP-SBJ-1 (NN asbestos)) as connected to its empty category**
    - **Support Chain = used + in** (tokens 7 and 9)
Designing Content Component of Annotation Task

- **Goals:**
  - Task must describe desired phenomena
  - Humans must be able to make distinctions consistently

- **Write detailed specs and test them on data**
  - Use multiple annotators
  - Do annotators agree N %
    - Easy task: N>90%
    - Medium Task: N>85%
    - Difficult Task: N>70%, ...
  - Annotator Agreement is Upper Bound for System Output Quality
    - Different levels of agreement may be required for different applications

- **If results are insufficient, revise specs and test new specs again**
  - Repeat until results are good enough for your purpose
Measuring Annotation Quality

- Popular, but imperfect measurement of agreement:

  \[ \text{Kappa} = \frac{\text{Percent (Actual Agreement)} - \text{Prob (Chance Agreement)}}{1 - \text{Prob (Chance Agreement)}} \]

  - Kappa works provided it is possible to estimate “chance agreement”

- For POS tagging each token gets exactly one tag. So estimates can be based on:
  - tags assigned to previous instances of token
  - tags assigned to tokens in general

- Multiply annotated data can be adjudicated and then each annotator can be scored against the corrected annotation. These same scores are often used for system evaluations:

  \[ \text{Recall} = \frac{|\text{Correct}|}{|\text{Answer Key}|} \quad \text{Precision} = \frac{|\text{Correct}|}{|\text{System Output}|} \quad \text{F - Score} = \frac{2}{\frac{1}{\text{Precision}} + \frac{1}{\text{Recall}}} \]
Annotation Tasks Vary in Difficulty

- Penn Treebank Part of Speech Tagging
  - Approximately 97% accuracy/agreement
  - Annotation = Fast process
- Penn Treebank Bracketing Annotation
  - Mid 90s? (a guess)
  - Now mostly by one experienced annotator (Ann Bies)
- PropBank – Approximately 93%
  - About 1 instance per minute
- NomBank – Approximately 85%
  - About 1 instance per 2 minutes
- Temporal Relations – (big variation, approx 75%)
- Sentiment Annotation (about 75%)
Who Should Annotate?

• Most Common for Difficult Annotation
  – Linguistics Academics: PostDocs and Students
  – Penn Treebank: Ann Bies
  – Other Experts: Classics students
  – Researchers (small projects)
  – Domain Experts (biology, physics, etc.)

• Crowd Sourcing
  – For easier annotation tasks
  – Some research breaking down hard tasks into sequences of easy ones
Crowd Sourcing

• Unknown annotators contribute via a web browser
• Tasks formulated so non-experts can do OK
  – break down decisions into multiple choice questions
  – use qualification tests
  – do more annotation and filter through consensus
• Amazon Turk: currently the most common conduit
  – Inexpensive (including Amazon's commission)
• Some People have set up their own sites, e.g.:
  – https://anawiki.essex.ac.uk/phrasdetectives/
• Limitation: difficult to formulate sophisticated tasks for crowd sourcing
URLs for Corpora w/English Bias

- Organizations that distribute corpora (and other resources) for fees
  - Linguistic Data Consortium: https://www.ldc.upenn.edu/
- The British National Corpus: http://www.natcorp.ox.ac.uk/
- American National Corpus (including OANC):
  - http://www.americannationalcorpus.org/
- The Brown Corpus (also through NLTK)
  - http://www.hit.uib.no/icame/brown/bcm.html
  - https://archive.org/details/BrownCorpus
- PubMed Corpus of Scientific Abstracts: http://www.americancorpus.org/
- Links to more links: http://www.americancorpus.org/
- Legal Cases: https://www.courtlistener.com/api/bulk-info/
  - requires registration
Annotation Project URLs w/ English Bias

- Examples of Shared Tasks with Associated Corpora & Annotation
  - Automatic Content Extraction: Coreference, Named Entities, Relations, Events, English, Arabic, Chinese, Spanish (little bit) – organized by US government
    - https://www.ldc.upenn.edu/collaborations/past-projects/ace
  - CONLL (yearly since 1997, diverse, internationally organized)
    - http://ifarm.nl/signll/conll/
    - I was on the committee for the 2008 & 2009 tasks
  - BIONLP (yearly IE task for biological texts)
- Penn Treebank: http://www.cis.upenn.edu/~treebank/
- PropBank: http://verbs.colorado.edu/~mpalmer/projects/ace.html
- NomBank: http://nlp.cs.nyu.edu/meyers/NomBank.html
- Penn Discourse Treebank: http://www.seas.upenn.edu/~pdtb/
- TimeML (incl TimeBank): http://www.timeml.org/site/index.html
- Pittsburgh Opinion Annotation: http://mpqa.cs.pitt.edu/
Role of Corpora & Annotation in Final Projects

• Programming projects usually require corpora
  – To run system on consistent, well-defined sets of data

• Annotated Data
  – Test Corpus = Answer Key
  – Training & Dev Sets – To develop system and/or train statistical systems

• Multi-Student Projects
  – 1 or 2 students can be responsible for annotation
    • Creating and Tuning Specifications
    • Annotating and Scoring (Measuring Annotation Quality)

• Corpus Creation and/or Annotation Can also be Main Topic of Project

• Crowd Sourcing – Another Possible Technique/Topic
  – Designing Tasks for Crowd Sourcing
  – Combining Crowd Sourced Results