ML for SS: Linguistic analysis

Session 5

Dr. Richard M. Crowley
rcrowley@smu.edu.sg
http://rmc.link/

Overview

Papers

Jurafsky et al. (2014)

- A fairly simple paper examining linguistic patterns in consumer reviews of restaurants

Hope, Hu and Lu (2016)

- A use of Named Entity Recognition (NER) in a fairly simple way.
  - Names of persons, locations, or organizations
  - Percentages and monetary values
  - Times and dates

Garimella et al. (2019)

- Examines how social factors (gender) influence a common class of algorithms (tagging/parsing)

Technical Discussion: Linguistics

Python

- NLTK for standard/statistical approaches
- SpaCy for machine learning pipelines
- Stanza for Standford NLP methods
  - They have some interesting models for narrower uses
- BeautifulSoup for HTML parsing

R

- Call python's SpaCy package from R using `spacyr`
- `rvest` for HTML parsing

> Python is generally a bit stronger for these topics, unless your data is clean and fairly small.

> There is a fully worked out solution for using python, data and dictionaries are on eLearn.

Main application: Analyzing Wall Street Journal articles

- On eLearn you will find a full issue of the WSJ in text format

> Linguistic models using NLTK and SpaCy

- Tokenization and break documents into smaller chunks
- Part of speech tagging (grammar)
- Dependency parsing
- Named Entity Recognition (NER)
- Lemmatization

Using NLP parsers

NLTK

- `NLTK` stands for Natural Language Toolkit
- It provides a bunch of handy things for text analytics
  1. Corpora that are used in research and algorithm development
     - Tagged corpora are particularly valuable
  2. Models for things like dependency parsing
  3. Useful functions for working with text

Setting up NLTK

- When using a resource from `NLTK`, we will often have install needed datasets

> Useful parts to download using `nltk.download()`

- `'punkt'`: Used for tokenizing words (splitting apart words in a document)
- `'brown'`: A corpus that contains part of speech information based on news articles
  - Can be used to train a part of speech tagger
- `'averaged_perceptron_tagger'`“: An ML model for applying part of speech tags
- `'universal_tagset'`: If you only need simple part of speech labels, this is easier to work with
- `'treebank'`: Like `'brown'` above, but based on WSJ

Tokenizing

```python
text = 'A U.S. appeals court will hear oral arguments today in a suit by Verizon challenging FCC "net-neutrality" rules.'
tokens = nltk.tokenize.word_tokenize(text)
print(tokens)
```

```
## ['A', 'U.S.', 'appeals', 'court', 'will', 'hear', 'oral', 'arguments', 'today', 'in', 'a', 'suit', 'by', 'Verizon', 'challe
```

Part of Speech tagging

```python
text = 'A U.S. appeals court will hear oral arguments today in a suit by Verizon challenging FCC "net-neutrality" rules.'
tokens = nltk.tokenize.word_tokenize(text)

# Requires: nltk.download('brown')
brown_news_tagged = nltk.corpus.brown.tagged_sents(categories='news', tagset='brown')
pos_tagger = nltk.UnigramTagger(brown_news_tagged)

tagged = pos_tagger.tag(tokens)
print(tagged)
```

```
## [('A', 'AT'), ('U.S.', 'NP'), ('appeals', 'NNS'), ('court', 'NN'), ('will', 'MD'), ('hear', 'VB'), ('oral', None), ('argume
```

More details included in the Python file

- Using other PoS taggers (perceptron and Bigram)
- Extracting parts of speech from a full corpus
- Building a multi-level PoS tagger

SpaCy

- SpaCy provides a machine-learning based approach to many of the things NLTK does
- SpaCy is also perhaps a bit more user-friendly

```python
import spacy

# python -m spacy download en_core_web_sm
nlp = spacy.load("en_core_web_sm")
# pipes enabled by default: tok2vec, tagger, parser, ner, attribute_ruler, lemmatizer]

doc = nlp(text)
```

Parse trees in SpaCy

- SpaCy has a visualization module called displaCy
- With this, we can quickly see how a sentence is structured
- To run it in a Jupyter notebook, use the below code:

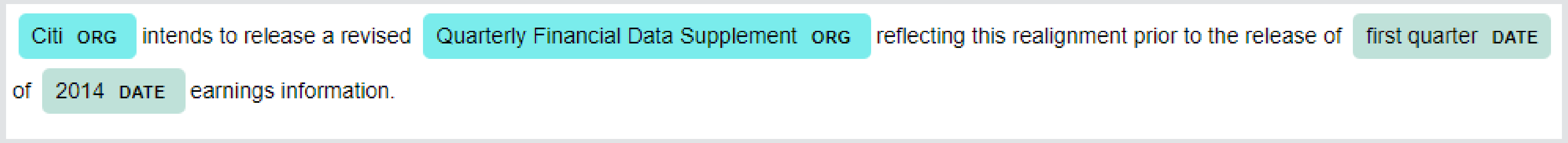
```python
sent = nlp("""Citi intends to release a revised Quarterly Financial Data
Supplement reflecting this realignment prior to the release of first quarter of
2014 earnings information.""")
spacy.displacy.render(sent, style="dep", jupyter=True, options={'compact':True})
```

Take a look at the code file to see the output

NER: Named Entity Recognition

- During the `nlp()` call earlier, spaCy automatically did named entity recognition’
- Using an ML algorithm + the dependency tree, it tries to determine any proper nouns in the document
  - It also tries to label them
- You can visualize these as well with displayCy

```python
spacy.displacy.render(sent, style="ent", jupyter=True)
```



Citi ORG intends to release a revised Quarterly Financial Data Supplement ORG reflecting this realignment prior to the release of first quarter DATE of 2014 DATE earnings information.

More details included in the Python file

- Using `nlp.pipe()` instead of `nlp()`
  - Allows you to apply a process to a corpus all at once (as a generator)
- Sentence boundary detection
- PoS tagging in SpaCy
- Lemmatization
- Extracting all entities from a corpus

Parsing HTML

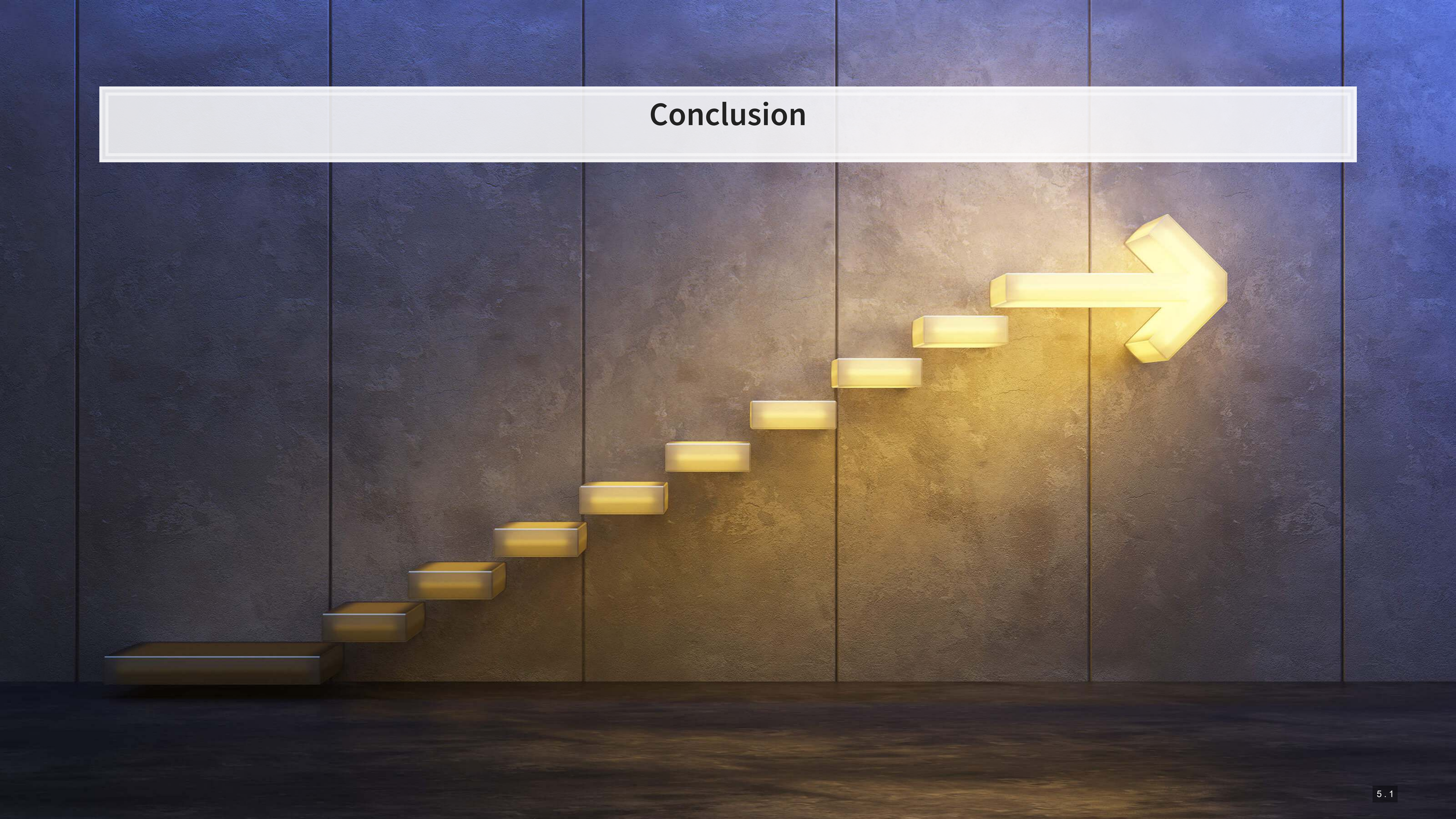
Overview

- As this part is code-heavy, we will do it in Jupyter
- The main idea is:
  1. Grab the main page of the website using `requests`
  2. Structure it with `beautifulsoup4` so we can traverse the page
  3. Grab the links to and names of standards, along with the publication years
  4. Traverse the links
  5. Extract the pdf locations from the traversed pages
  6. Grab the pdf files

Addendum: Using R

- HTML files
  - You can load from a URL using `httr` or `RCurl`
  - You can use `XML` or `rvest` to parse out specific pieces of html files
- JSON files
  - You can process JSON data using `jsonlite`
- PDF files
  - Use `pdftools` to extract text into a vector of pages of text
  - Use `tabulizer` to extract tables straight from PDF files!
    - This is very painful to code by hand without this package
    - The package itself is a bit difficult to install, requiring Java and `rJava`, though

Conclusion



Wrap-up

Linguistics is largely handled by importing specialized libraries

- NLTK for traditional measures
- SpaCy for more powerful, ML-based measures
- Stanza for Stanford NLP measures

Easy to calculate many different measures, such as grammar/parts of speech or entities (NER)

Packages used for these slides

Python

- bs4
- nltk
- numpy
- requests
- spacy

R

- knitr
- reticulate
- revealjs

References

- Garimella, Aparna, Carmen Banea, Dirk Hovy, and Rada Mihalcea. “Women’s syntactic resilience and men’s grammatical luck: Gender-bias in part-of-speech tagging and dependency parsing.” In Association for Computational Linguistics. 2019.
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