91258 - Natural Language Processing

Lesson 1. Introduction

Alberto Barrón-Cedeño

Alma Mater Studiorum-Università di Bologna
a.barron@unibo.it @_albarron_

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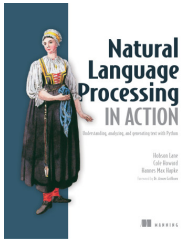
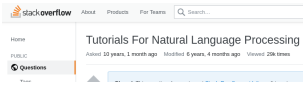
Materials

Core Bibliography

1. Lane et al. (2019)'s **Natural Language Processing in Action**[1]
2. Numerous **Wikipedia articles** on relevant topics
3. Multiple online forums





[1] https://www.manning.com/books/natural-language-processing-in-action

Complementary Bibliography

1. Intro to computing for text
   K.W. Church's **Unix for poets**[2]
2. For social media analysis
   Hovy (2021)'s **Text Analysis in Python for Social Scientists***[3]
3. A basic intro in Italian
   Nissim and Pannitto (2022)'s **Che cos'è la linguistica computazionale**
4. From linguistics
   Bender (2013)'s **Linguistic fundamentals for natural language processing: 100 essentials from morphology and syntax**[4]
5. Advanced
   Goldberg (2017)'s **Neural Network Methods for NLP**[5]

[2] https://web.stanford.edu/class/cs124/kwc-unix-for-poets.pdf
[3] https://doi.org/10.1017/9781108873352
[4] https://doi.org/10.2200/S00493ED1V01Y201303HLT020
[5] https://doi.org/10.2200/S00762ED1V01Y201703HLT037

Lesson coordinates

Slides, code, and more are all available at:

albarron.github.io/teaching/natural-language-processing

Tools

Essential

Python 3 development framework on any modern OS

1. Command line **or**
2. Integrated development Environment; e.g., Pycharm[6], Eclipse[7] **or**
3. Jupyter notebook; e.g., Google's colab[8], local Jupyter[9]

Desirable[10]

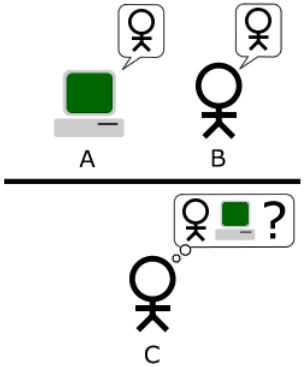
1. Git Version control system; e.g., Gitlab[11] **or** Github[12]
2. LaTeX system for document preparation

[6] https://www.jetbrains.com/pycharm/
[7] https://www.eclipse.org/
[8] https://colab.research.google.com/
[9] https://jupyter.org/
[10] Could be part of "Advanced Research Skills Lab"
[11] https://gitlab.com
[12] https://github.com

Introduction

Introduction

Natural language as a measure of intelligence



Turing (1950). "Computing machinery and intelligence". Mind. 59(236)

upload.wikimedia.org/wikipedia/commons/e/e4/Turing_Test_version_3.png

Introduction

CL vs NLP

Computational linguistics[13]

- **Interdisciplinary** field concerned with the **computational** (it used to say "statistical or rule-based"!) **modeling of natural language**
- Study of appropriate computational approaches to **linguistic questions**

Natural Language Processing[14]

- Subfield of **computer science** and **linguistics** [...] concerned with giving computers the ability to support and manipulate speech
- Processing natural language datasets, such as text corpora or speech corpora, using either rule-based or probabilistic machine learning approaches

[13] https://en.wikipedia.org/wiki/Computational_linguistics
[14] https://en.wikipedia.org/wiki/Natural_language_processing

Introduction

CL vs NLP

Natural Language Processing (Lane et al., 2019, p. 4)

- Area of research in computer science and artificial intelligence concerned with **processing natural languages**
- This processing generally involves **translating natural language into data** (numbers) that a computer can use to learn about the world

The term **natural language processing** is nowadays considered to be a near-synonym of **computational linguistics** and (human) **language technology**.[15]

[15] https://en.wikipedia.org/wiki/Computational_linguistics

Introduction

Rule-based vs Statistical NLP

Introduction

Rule-based NLP

Models are based on a number of hand-crafted rules or grammars

Diagram borrowed from L. Moroney's Introduction to TensorFlow for Artificial Intelligence, Machine Learning, and Deep Learning

Introduction

Rule-based NLP

Models are based on a number of hand-crafted rules or grammars

```
greeting_inputs = ("hey", "morning", "evening", "hi",
                   "whatsup", "hello")
greeting_responses = ["hey", "hey hows you?", "*nods*",
                   "hello, how you doing", "hello",
                   "Welcome, I am good and you"]

def generate_greeting_response(input):
    for token in input.split():
        if token.lower() in greeting_inputs:
            return random.choice(greeting_responses)
```

Derived from `https://stackabuse.com/python-for-nlp-creating-a-rule-based-chatbot/`

Introduction

Statistical NLP

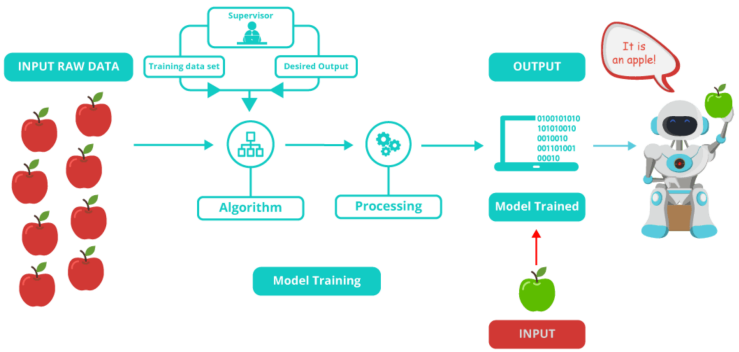
Models are tuned on *annotated* data

Diagram borrowed from L. Moroney's Introduction to TensorFlow for Artificial Intelligence, Machine Learning, and Deep Learning

Introduction

Statistical NLP

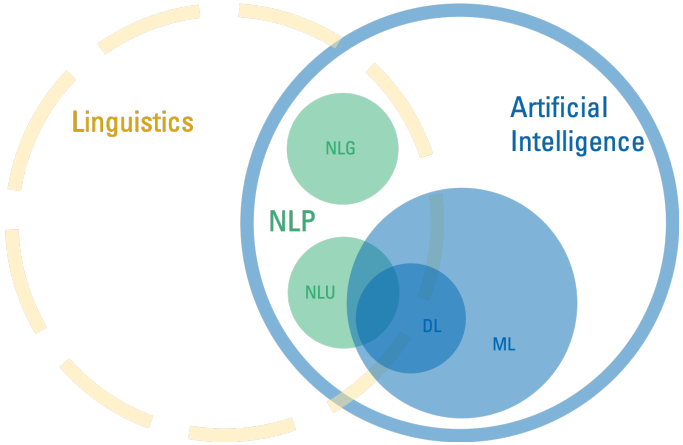
Models are tuned on annotated data



Borrowed from `https://www.edureka.co/blog/machine-learning-tutorial`

Introduction

The NLP neighborhood



Borrowed from `https://www.retresco.de/en/how-to-ai-natural-language-processing/`

Introduction

Non-exhaustive list of NLP applications with examples

Search	web search engines · text autocompletion
Editing	grammar issues identification
Dialogue	chatbot creation
Email	spam filtering · message classification
Text mining	(multi-)document summarisation
News analysis	event identification · fact checking
Forensics	plagiarism detection · authorship attribution
Sentiment analysis	product review ranking · opinion mining
Creative writing	text generation with a narrative and style
Translation	translation · quality estimation

Partially derived from (Lane et al., 2019, p. 8)

Requirements & Evaluation

Requirements

Necessary

- Linguistics
- Algebra
- Programming in **Python**

Desirable

- Intermediate programming (e.g., object-oriented, testing)
- High-performance computing (e.g., slurm)[16]

[16] Could be part of "Advanced Research Skills Lab"

Evaluation: **One final project**

You will address a relevant problem...

- within the range of your own (research) interests
- participating (formally) in a shared task
- proposed by me, if you prefer

Evaluation: **One final project**

Typical pipeline

1. You propose a topic/problem. We assess if it is reasonable, doable...
2. You compile data, study the problem, design experiments, code...
   IF you plan for a publication[17]
   - We meet regularly to see the advances and shape the experiments, submissions, and/or paper towards the submission deadline

   ELSE
   - We could meet sporadically, if you need it
3. You submit a written report ($\sim$ 7 pages) **1 week before the appello**
4. We meet on the date of the appello to discuss about your project, in the context of the lecture

[17] Talk to me well in advance; it would require my heavy involvement to target a high quality

Evaluation: **Final mark**

Combination of the quality of the experiments, report, code, and oral discussion

Targetting 30L?
If I let you submit a paper, it is very likely. But it is not the only way...

$$p(30L \mid \text{paper submited} == \textit{True}) \approx 0.85 \quad (1)$$
$$p(30L \mid \text{paper submited} == \textit{False}) \approx 0.15 \quad (2)$$

Evaluation: Previous final projects

2022–2023

- Sentiment analysis of video game reviews
- Authorship attribution: machine vs human

2021–2022

- Hate Speech Detection in Incel Online Spaces *•♠
- Fishing for catfishes: predicting the author gender in Reddit

* student with previous programming skills

• turned into (part of a) thesis ♠ turned into a publication

Evaluation: Previous final projects

2020–2021

- Semantic similarity between originals and machine translations •
- Definition extraction on food-related Wikipedia articles •
- Identifying Characters' Lines in Original and Translated Plays •
- Classifying an Imbalanced Dataset with CNN, RNN, and LSTM

2019–2020

- AriEmozione: Identifying Emotions in Opera Verses *•♠
- UniBO@AMI: A Multi-Class Approach to Misogyny and Aggressiveness Identification on Twitter Posts Using AlBERTo *•♠

* students with previous programming skills

• turned into (part of a) thesis ♠ turned into a publication

Visit the **projects section** of the class website for details, reports and papers

References

Bender, E. M.
2013. *Linguistic Fundamentals for Natural Language Processing: 100 Essentials from Morphology and Syntax*. Morgan & Claypool Publishers.

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