NLP course 2023

Homework 2

Coarse-Grained WSD

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Word Sense Disambiguation

An introduction

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Word Sense Disambiguation
An Introduction

- **Word sense disambiguation** (WSD) is the "computational identification of the **meaning for words in context**" **(Navigli, 2009)**

A mouse takes much more space than a trackball.

Any of numerous small rodents

A hand-operated electronic device

Person who is quiet or timid

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Word Sense Disambiguation
An Introduction

- WSD is usually framed as a **multiclass classification problem** where the classes belong to a specific Sense Inventory

- **WordNet:** a lexical-semantic database containing structured knowledge for the English Language

  Mouse:

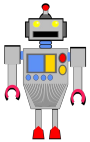
- *mouse%1:05:00::* *Any of numerous small rodents typically resembling diminutive rats*
- *mouse%1:18:00::* *Person who is quiet or timid*
- *mouse%1:06:00::* *A hand-operated electronic device that controls the coordinates of a cursor on your computer screen*

Word Sense Disambiguation
Task Challenges

Sense distributions follow the **Zipf distribution** making classes highly unbalanced

The number of possible **senses is in the hundreds of thousands**!

The **expertise to annotate sense tagged training data** makes it difficult to scale on different domains and languages



Polysemous words have senses with **similar meaning**, making the model struggle to classify them correctly

Word Sense Disambiguation

Even for a person, it is sometimes hard to choose between definitions that **have similar meanings**.

Let us consider the possible senses that the polysemous word *Italic* can assume:

> *I prefer **italic** to highlight important words*

WordNet
(Miller, 1995)

- **Italic.n.01:** a style of handwriting with the letters slanting to the right.
- **Italic.n.02:** a branch of the Indo-European languages of which Latin is the chief representative.
- **Italic.n.03:** a typeface with letters slanting upward to the right.

Polysemy vs Homonymy

Idea: cluster the similar senses of a polysemous word to obtain a list of **highly distinguishable, coarse grained candidates.**

Two or more words are **homonyms** when they have the same lexical form but different, **unrelated** meanings.

- **Italic.n.01:** a style of handwriting with the letters slanting to the right.
- **Italic.n.03:** a typeface with letters slanting upward to the right.

Homonymy

- **Italic.n.02:** a branch of the Indo-European languages of which Latin is the chief representative.

Coarse-Grained WSD

WSD with coarse-grained senses

Instead of using all the candidates, now we have classes that are highly distinguishable: we have clustered **candidates with similar meaning** in ***homonymy clusters***.

WordNet
(Miller, 1995)

- **Italic.n.h.01:** { a style of handwriting with the letters slanting to the right;
  a typeface with letters slanting upward to the right }.
- **Italic.n.h.02:** {a branch of the Indo-European languages of which Latin is the chief representative.}

In this way we have to disambiguate only between homonymy clusters, which is easier due to their **distant meanings**.

Coarse-Grained WSD

WSD with coarse-grained senses

WordNet
(Miller, 1995)

- **race.n.01**: any competition.
- **race.n.02**: a contest of speed.
- **race.n.03**: people who are believed to belong to the same genetic stock.
- **subspecies.n.01**: (biology) a taxonomic group that is a division of a species.
- **slipstream.n.01**: the flow of air that is driven backwards by an aircraft propeller.
- **raceway.n.01**: a canal for a current of water.

fine-to-coarse mapping to **Homonymy Clusters**

race.n.h.01

- **race.n.01**: any competition.
- **race.n.02**: a contest of speed.
- **slipstream.n.01**: the flow of air that is driven backwards by an aircraft propeller.
- **raceway.n.01**: a canal for a current of water.

race.n.h.02

- **race.n.03**: people who are believed to belong to the same genetic stock.
- **subspecies.n.01**: (biology) a taxonomic group that is a division of a species.

Dataset

The Dataset

Coarse-Grained WSD

- We will use WordNet *(Miller, 1995)*, the standard English source of word senses.
- In each dataset file, each sample is a tokenized sentence with information about the instances to disambiguate, such as lemmatization and part of speech tag.
- You will receive 2 dataset files:
    - A **coarse-grained** dataset, containing candidates and correct gold homonymy clusters. This is the official dataset for this homework and the submission will be evaluated on the performances on this data.
    - A **fine-grained** dataset, containing candidates and correct gold WordNet senses. This is a key resource for you to obtain **bonus** points by doing novel comparative analysis.
- You will receive an **additional file**, `"coarse_to_fine.json"` containing a mapping between each coarse grained candidate and its fine-grained sub-senses along with their definitions.

The Dataset

Coarse-grained dataset (mandatory usage)

- Each sample of the coarse-grained dataset is a sentence with annotations about words and their senses:
  - **idx**: document id and sentence id
  - **instance_ids**: mapping between token based offsets of each instance and its id
  - **words:** list of tokenized words
  - **lemmas**: list of tokenized and lemmatized words
  - **pos_tags**: list of part of speech tags
  - **senses**: mapping between token based offsets and gold homonymy clusters
  - **candidates**: list of possible homonymy clusters for each instance

The Dataset

Data Format: coarse-grained dataset

```
{
    “d000.s002”: {
        "instance_ids":{
            “1”: "d000.s002.t000"
            “5”: "d000.s002.t001"
        }
        “lemmas”: [“the”, “race”, “will”, “take”, “place”, “today”],
        “words”: [“The”, “races”, “will”, “take”, “place”, “today”]
        “pos_tags”: [“DT”, “NOUN”, “VB”, “VB”, “NOUN”, “ADP”]
        “senses”: {
            “1”: "race.n.h.01"
            “5”: "today.r.h.01"
        }
        “candidates”:[
            “1”: [“race.n.h.01”, “race.n.h.02”]
            “5”: [“today.r.h.01”]
        ]
    },
```

The Dataset

Fine-grained dataset (recommended for bonus points)

- Each sample of the fine-grained dataset is a sentence with annotations about words and their senses:
  - **idx**: document id and sentence id
  - **instance_ids**: mapping between token based offsets of each instance and its id
  - **words:** list of tokenized words
  - **lemmas**: list of tokenized and lemmatized words
  - **pos_tags**: list of part of speech tags
  - **senses**: mapping between token based offsets and gold WordNet synsets
  - **candidates**: list of possible WordNet synsets for each instance

The Dataset

Data Format:fine-grained dataset

```
{
     “d000.s002”: {
          "instance_ids":{
               “1”: "d000.s002.t000"
               “5”: "d000.s002.t001"
          }
          “lemmas”: [“the”, “race”, “will”, “take”, “place”, “today”],
          “words”: [“The”, “races”, “will”, “take”, “place”, “today”]
          “pos_tags”: [“DT”, “NOUN”, “VB”, “VB”, “NOUN”, “ADP”]
          “senses”: {
               “1”: "race.n.02"
               “5”: "today.r.01"
          }
          “candidates”:[
               “1”: [“race.n.01”, “race.n.02”, “race.n.03”,
     “subspecies.n.01”, “slipstream.n.01”, “raceway.n.01”]
               “5”:  [“today.r.01”, “today.r.02”]
          ]
     },
```

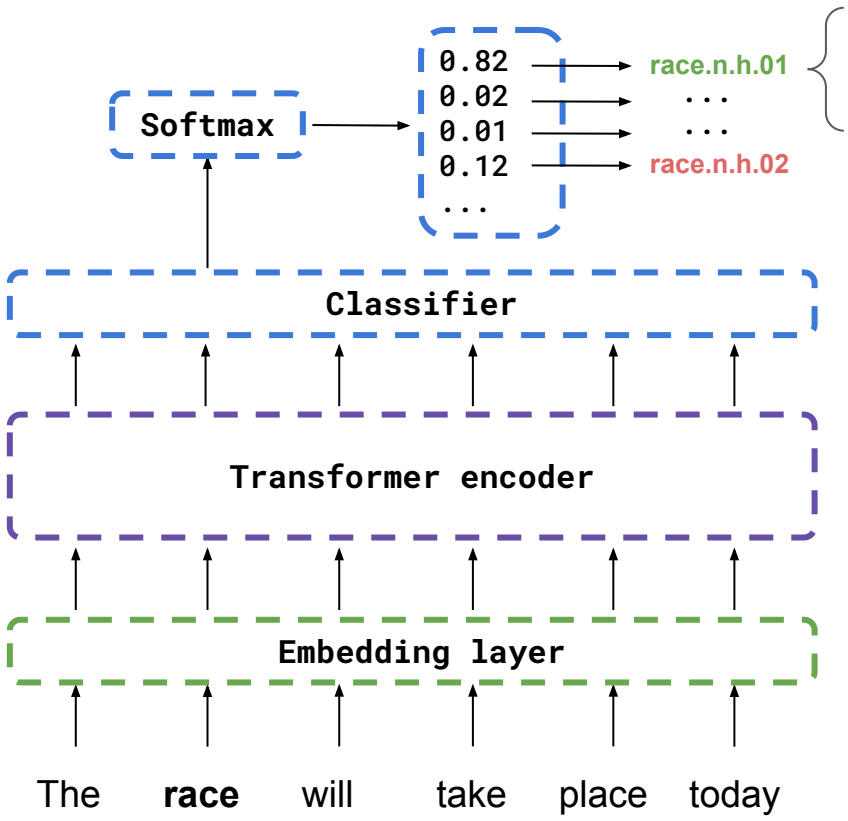
Additional data

Coarse-to-fine mapping

```
{“race.n.h.01”: [
     “race.n.01” : “any competition”,
     “race.n.02” : “a contest of speed”,
     “slipstream.n.01” : “the flow of air that is driven backwards by an aircraft
propeller”,
     “raceway.n.01” : “a canal for a current of water”
],
“race.n.h.02”: [
     “race.n.03” : “people who are believed to belong to the same genetic stock”,
     “subspecies.n.01” : “(biology) a taxonomic group that is a division of a
species”
],
“today.r.h.01”: [
     “today.r.01” : “in these times”
     ...
],
}
```

Possible Approach

Coarse-Grained WSD as Multiclass Token Classification



race.n.01 any competition
race.n.02 a contest of speed
slipstream.n.01 the flow of air that is driven backwards by an aircraft propeller
raceway.n.01 a canal for a current of water

The model computes softmax probabilities of each homonym cluster.

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Homework Extras

Increase the complexity of your model!

- Take inspiration from recent papers:
  - **GlossBERT**: BERT for word sense disambiguation with gloss knowledge (ACL 2019)
  - **EWISER,** Breaking Through the 80% Glass Ceiling: Raising the State of the Art in Word Sense Disambiguation by Incorporating Knowledge Graph Information(ACL 2020)
  - **BEM**, Moving Down the Long Tail of Word Sense Disambiguation with Gloss Informed Bi-encoders (ACL 2020)
  - **ESC**: Redesigning WSD with Extractive Sense Comprehension(NAACL 2021)
  - **ConSeC**: Word Sense Disambiguation as Continuous Sense Comprehension (EMNLP2021)

Fine- vs. coarse-grained WSD

- Using the **fine-grained** version of the dataset you can train a standard WSD model:
  - **Compare the results** of your architectures on the two tasks.
  - **Apply the coarse-to-fine mapping to the output** of the fine-grained wsd model to obtain coarse-grained disambiguations.
    - Is it better than the model trained on coarse-grained data? (If motivated on your report, you can submit this model!)
  - **Use both systems**: you can use the coarse grained system to filter out senses for the fine-grained wsd.
  - Use l**atent homonymy cluster embedding** to add useful information.
  - WSD coarse-grained by training a fine grained system that is rewarded positively for every synset in the correct homonym
  - Train a multiclass multilabel classifier (multilabel for each sense in a given homonymy cluster)
  - **Analyze qualitatively your results.**

Other extras

- Use sense definitions:
  - Find a way to employ senses definitions in your pipeline (it will improve your results!)
- Find new homonyms:
  - Find ways to detect new homonyms and validate their contribution
- Test on Multilingual Dataset:
  - Building on a multilingual homonym detector, you can train a Multilingual Model on coarse grained data, and test if the model is able to generalize well in other languages.
  - Possible Multilingual resources:
    - XL-WSD: An Extra-Large and Cross-Lingual Evaluation Framework for Word Sense Disambiguation.
- Extend coarse granularity to Entities:
  - Coarse Grained named entity recognition
  - Possible start of a thesis project with SapienzaNLP!

Submission

What you will receive

- We will provide you with a folder organized as follows (some files are omitted):

```
- nlp2023-hw2/
  - data/
  - hw1/
    - model.py
    - stud/
  - model/
  - requirements.txt
  - test.sh
```

- You are allowed to edit **only** the items in bold!

What you will receive

- We will evaluate your work using Docker
  - You should be fine even if you don't know anything about it
- If **`test.sh`** runs on your side, it will run on ours as well
  - Just keep in mind: do not change any file but those we marked in bold as editable in the previous slide
- Additionally, we wrote a **`README.md`** to get you everything up and running
- You can find the code repository here!

What we expect from you

- The zip folder we gave you (but populated :))
- Put your training code (if you used Colab, download the notebook `.ipynb` and place it) in **`hw2/stud/`**
- If you use any additional library, modify the **`requirements.txt`** file as needed (click here for info)
- Use the data (train, dev and test) in the data folder
  - use each file as defined in the **standard ML conventions** (*train for training*, *dev for model selection and test for final testing of the model*)

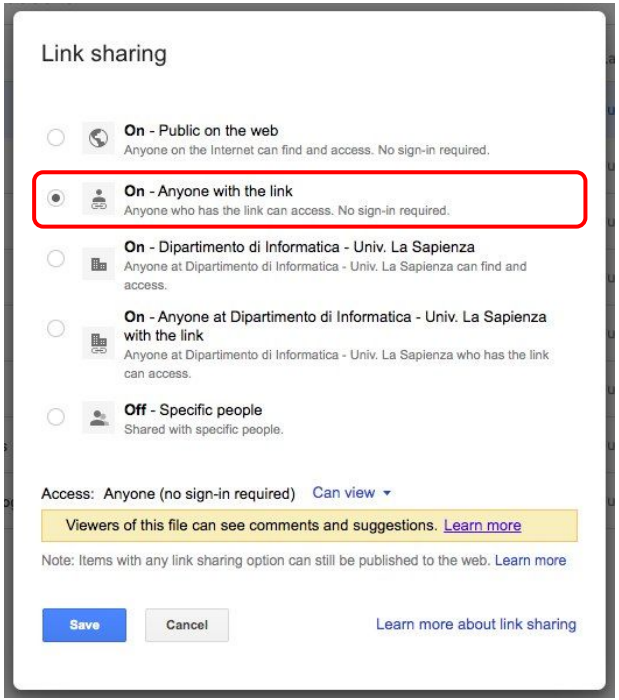
What we expect from you

- Put **everything** your model needs (vocabulary, weights, ...) inside the **`model/`** folder, and **be sure to properly load them** in your model
- In **`hw2/stud/implementation.py`** implement the **`StudentModel`** class
  - Load your model and use it in the **`predict`** method
  - You **must respect** the signature of the predict method!
  - You can add other methods (i.e. the constructor)
- In **`hw2/stud/implementation.py`** implement the **`build_model`** function
  - It should initialize your **`StudentModel`** class.

What we expect from you

- Use **`test.sh`** to check that everything works
- Add your **`report.pdf`** to the folder (yes, export it in PDF even if you are using Word!)
- Name the zip folder **`lastname_studentid_hw2.zip`**:
  - Ex: Luigi D'Andrea will submit a file named **`dandrea_1234567_hw2.zip`**
  - If you are unsure which name to put, use the one in your institutional email account

Submission Instructions



- Upload the zip on your **institutional** Drive and make it **link-shareable** and **public** to anyone (an automatic script will download it).
- Make sure it is accessible via an incognito page of your browser!
- Do **NOT modify** the folder structure
- You have to submit the homework through the submission form on Google Classroom. You will be asked to fill a form with the requested information and the **link** to the zip you uploaded on Drive.

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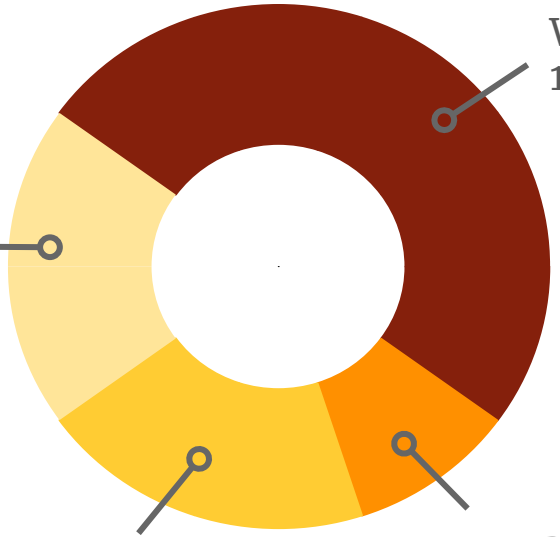
Evaluation

Evaluation

- Use the **validation split** to select the **best model/hyperparameters** configuration
- Use the **test split** to evaluate your model and **estimate its performance**
- The final evaluation will be conducted on a **SECRET** test set
- The evaluation metric will be the **F1-score** obtained comparing your model's predictions with our golden labels.

Evaluation

We will take into account the following criteria:



TOTAL: 36/30 POINTS

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Report: dos and don’ts

- **ACL 2023 paper template**
  - Freely available: LaTeX, Word or Overleaf
  - You can use either the LaTeX or the Word template, your choice
  - **DO NOT MODIFY** the template (margins, spacing, font size)
  - Use the non-anonymous flag, so you can enter your name
- **Max 3 pages**
  - For the report, including title, subtitles, etc.
  - This is a **STRICT RULE!**
- **Unlimited extra pages for images, tables and references**
  - Every image and table must have a caption (don’t abuse them please :))
  - Tables and images must be referenced in the report

Report: what you are expected to do

We expect a good report to be:

- **Readable** and **understandable**
  - We will not give penalties for English errors, but we expect the report to follow a clear flow. We don't want to read just a sequence of statements on what you did without showing the reasoning behind your choices
- **Well-structured** and **organized**
  - Take inspiration from the many papers available online and organize your report in well-defined sections (e.g. method, setup, experiments, results...)

Report: what you are not expected to do

We expect a good report **NOT** to include:

- Unnecessary **task** or **dataset descriptions**
  - just focus on your solution to the problem
- **Code** copy-paste
  - Your code should be self-explanatory, so no need to show it in the report. You can add **pseudocode** to show some particular algorithm, but **no code or screenshots,** please!

Report: what you are not expected to do

We expect a good report **NOT** to include:

- Unnecessary **low-level implementation details**
  - Avoid any **low-level implementation/technical details** like “I used a dictionary to store these values”, “I had to use configuration X to solve this exception”, “I could not use Y because there was a dependency issue with Z”, etc.
  - Instead, **we are interested in high-level abstractions/strategies** you decide to use to tackle the homework, as well as the **intuitions behind your choices**.

    E.g. use and description of a particular model, explanation of how and why an architecture works, etc.

Application: what you are expected to do

Your project should conform to the following rules:

- You **MUST** use PyTorch.
  - TensorFlow and other deep learning frameworks are **NOT** allowed.
  - PyTorch Lightning **is allowed** and suggested
- **Frameworks** that use PyTorch (e.g. AllenNLP, torchtext…) are allowed.
- Libraries (such as tqdm, sklearn, NLTK) are fine, but since the line between a framework and a library is sometimes blurred, please ask in the Google Classroom group before using any external library: **any other** library **MUST be agreed with the TAs**.

Application: what you are not expected to do

Your project should conform to the following rules:

- **You are not allowed** to use tools/architectures that have not been explained **yet** in the course, in particular:
  - word embeddings (Word2Vec, GloVe, etc.) **are allowed**,
  - contextualized word embeddings (ELMo, etc.) **are allowed**,
  - Transformer-based models (BERT, BART, RoBERTa, etc.) **are allowed and suggested**.
- For any doubt, please ask the TAs on Google Classroom.
- **Comment** your code, please!

Quantitative Results

We will evaluate the **accuracy of your model** on a SECRET test set.

You can get **from 0 to 6** points according to the following **thresholds**:

- `A < 0.70` => `FAIL`
- `0.70 < A < 0.75` => `0`
- `0.75 < A < T2` => `1`
- `T2 < A < T3` => `2`
- `T3 < A < T4` => `3`
- `T4 < A < T5` => `4`
- `T5 < A < T6` => `5`
- `A > T6` => `6`

Quantitative Results

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You can get **from 0 to 6** points according to the following **thresholds**:

- `A < 0.70` `=> FAIL`
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- `T2 < A < T3` `=> 2`
- `T3 < A < T4` `=> 3`
- `T4 < A < T5` `=> 4`
- `T5 < A < T6` `=> 5`
- `A > T6` `=> 6`

Thresholds will be defined based on an internal reference model and the **normalized distribution of YOUR scores**!

Extras

You can achieve **up to 6 points with some extras!**

See Homework Extras section for some suggestions about what we consider an extra.

Don’t forget to **explain your choices** in the report! Extras that are not explained in the report will not be considered for evaluation.

Evaluation

- `test.sh` is identical to what we will be using
- **If it does not run on your side, we will not correct your homework**
- Note that, if you use **any kind of hard-coded paths**, this script **won't work**
- Use **paths relative to the project root folder**, e.g.:
  - **NO:** `/home/pincopallino/my_folder/model/weights.pt`
  - **OK:** `model/weights.pt`

Warnings

Things you should be aware of

Please be aware that

This is an **individual exercise!** Collaboration among the students is **not** allowed.

We will check for **plagiarism** both manually and automatically.

It is **not allowed** to:

- Copy from other students.
- Share your code with other students.
- Use ChatGPT or similar systems for report writing.
- Copy from online resources (StackOverflow, GitHub, Medium, Kaggle and so on).

You are also allowed to use the **SOME** parts of the presented class notebooks. However, you **MUST** explicitly specify these parts in your code comments.

Data policy

- For your experiments, **use <u>ONLY</u> the provided and suggested data** (train, dev and test) in the data folder; use each file as defined in the standard ML conventions (train for training, dev for model selection and test for testing).
- If you train it on dev or test set, it will be a **FAIL**.

Tips

A few tips to organize your work:

- Start **as soon as possible**!
  - Training a neural network requires time, possibly hours, depending on your hardware
- Start **small**!
  - If you don't get decent results with a very simple neural network, there is a good chance that adding other things won't make your model perform better
- Leave some time for **hyperparameter** tuning!
  - Sometimes good hyperparameter combinations can do wonders for your neural network
- Use **Google** Colab (free GPUs!)

Deadline

When to deliver what

Deadline

The students **who passed the first homework** may deliver the second one in one of the four available deadlines (2022):

1. Early submission: May 31st (23:59 AoE) → <u>only this date allows **late submission!**</u>
   Late submission: June 2th (23:59 CEST)
   Presentation: 5th June, 8.30

2. Submission: June 28th (23:59 AoE)
   Presentation: July 5th, 8.30

3. If particularly well deserved (e.g. bonus and/or involvement),
   secret submission deadline: July 17-ish (23:59 AoE)
   Presentation: July 24-ish, 9.00

4. Submission: September 5th (23:59 AoE)
   Presentation: September 13th, 8.30

Deadline

The students **who passed the first homework** may deliver the second one in one of the four available deadlines (2022):

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   Presentation: September 13th, 8.30(up to 12 minutes)

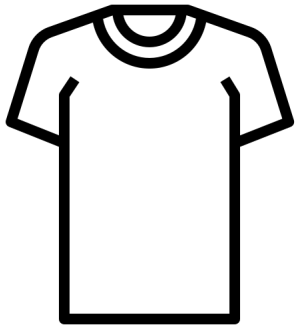
Awards

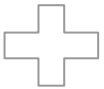
Get a **Sapienza NLP™** t-shirt

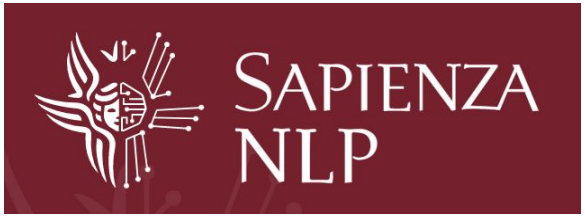
Win a Sapienza NLP t-shirt!

We will hand out amazing Sapienza NLP t-shirts to the **overall top-5** students!

The final ranking will be computed according to the scores on our **secret** test set.







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That’s not all

If your work is novel, interesting and original, we will gladly invite you to work together with us to extend on a fully-fledged paper for **TOP-TIER INTERNATIONAL CONFERENCE**!

Just over the last 12 months, the Sapienza NLP group published more than a dozen of papers!

Questions?

If you have a question that may interest your colleagues, **please ask it on Google Classroom.**

Otherwise, for personal or other questions, email **ALL** of us (but please, only reach for things that can't be asked on the Google Classroom).

Our emails are:

{bonomo, ghonim, martinelli, molfese, perrella,lproietti}@diag.uniroma1.it

Bonus 1: Language Recognition in Low-Resource Languages

- Low-resource languages:
  - Kazakh (Cyrillic script)
  - Khmer
  - Georgian
  - Burmese (Unicode encoding)
  - Albanian
  - Azerbaijani (Latin script)
  - Mongolian (Cyrillic script)
  - Armenian
  - Lao
  - Uzbek (Latin script)
  - Sinhala
  - Tibetan
  - Sorani Kurdish (Arabic script)
  - Swahili
  - Belarusian (Cyrillic script)
  - Uzbek (Cyrillic script)
  - Malayalam
  - Nepali
  - Kurmanji Kurdish (Latin script)
  - Welsh
  - Pashto (Arabic script)
  - Kyrgyz (Cyrillic script)
  - Kashmiri (Arabic script)
  - Māori
  - Tajik (Cyrillic script)
  - Maltese
  - Faroese
  - Dhivehi (Thaana script)
  - Turkmen (Latin script)
  - Malay (Arabic script)
- Transliteration in non-Latin languages
- Money+Babelscape tshirt prize from Babelscape: