Chair Data Science and Artificial Intelligence for Digitalized Industry and Services

Internship project

Subject

IRAC method for statutory reasoning

Possibility to continue as a PhD candidate

YES (Funding to be confirmed)

About the chair

The Chair Data Science and Artificial Intelligence for Digitalized Industry and Services (DSAIDIS), lead by Florence d'Alché-Buc, a Professor in the department Image, Data, Signal of Telecom Paris, unites five industrial partners: Airbus Defence & Space, Engie, Idemia, Safran et Valeo. It's general objective is to develop, in collaboration with the partners, teaching and research of the international level.

Its four principal research directions are:

1. Building predictive analytics on time series and data streams.
2. Exploiting large scale, heterogeneous, partially labeled data.
3. Machine Learning for trusted and robust decision.
4. Learning through interactions with environment.

Description of the internship

Supervision

Nils Holzenberger (https://perso.telecom-paristech.fr/holzenberger/)

Location and dates of the internship

Address : Télécom Paris, 19 Place Marguerite Perey, 91120 Palaiseau

Date of the beginning of the internship : 2024

Team where the thesis will be written

Department INFRES, Team Data, Intelligence and Graphs (DIG)

Keywords

Natural Language Processing, Reasoning, Neuro-Symbolic AI, Law

Detailed subject

Legal professionals routinely need to determine which laws apply to a specific legal case. *Statutory reasoning* is the task of determining whether a given legal rule applies to a case, both being expressed in natural language. Statutory reasoning is a basic skill for lawyers, and computational statutory reasoning is a fundamental task for legal AI. The core challenge is developing models with the ability to utilize prescriptive rules stated in natural language, and able to generalize to new rules. The SARA dataset is a benchmark dataset for statutory reasoning (Holzenberger et al., 2020).

Currently, Natural Language Processing (NLP) models for statutory reasoning try to perform statutory

reasoning in a single step. This is error-prone, especially if the reasoning clearly involves multiple steps, and the model's output is not interpretable for humans. To address these issues, this project aims to infuse NLP models with the IRAC method. The IRAC method — Issue, Rule, Application, Conclusion — is a guideline to write legal memos (https://en.wikipedia.org/wiki/IRAC). Its purpose is to clarify the writing and make it more understandable to the reader.

1. Issue: specify what the issue at hand is, e.g. *is Alice a head of household in 2017?*

2. Rule: specify the applicable rule, e.g. §2(b)

3. Application: apply the Rule to the case

4. Conclusion: answer the Issue using the Application of the Rule.

Responses from Large Language Models (LLMs) to legal NLP questions have been analyzed from the point of view of the IRAC framework (Katz et al., 2023). The plan for this project is to leverage Deep ProbLog (Manhaeve et al., 2021), a neuro-symbolic library. The IRAC method is encoded using symbols, specifying the general frame of the system, and a neural model is trained to fill in the gaps. For example, the IRAC method could be encoded similarly to a grammar:

S --> I, R, A, C

I --> generate_question

R --> retrieve_from_the_statutes

A --> C

A --> S

C --> generate_conclusion

where generate_question, retrieve_from_the_statutes and generate_conclusion are performed by neural models. Performing statutory reasoning is then a sequence of actions generated by the above grammar.

The milestones for this project are:

1. Use the existing Prolog solver for the SARA dataset to derive IRAC programs

2. Build a neuro-symbolic system with Deep ProbLog (Manhaeve et al., 2021)

3. Experiment with training on the SARA dataset, with and without the IRAC programs

Candidate profile

- M2 student, interested in research

- Coursework in statistical machine learning, probabilities

- Good level of programming in Python

- Good command of English

- Optional: familiarity with deep learning and NLP libraries

Application

To send to nils.holzenberger@telecom-paris.fr:

- Curriculum Vitae

- Personalized motivation letter that explains interest of the candidate in the subject (can be directly in the body of the email)

- Grade reports for recent years

- Contact of a person willing to give recommendation

Incomplete applications will not be considered.

References

Holzenberger, N., A. Blair-Stanek, and B. Van Durme, 2020: A dataset for statutory reasoning in tax law entailment and question answering. Natural Legal Language Processing Workshop 2020.

Katz, D. M., M. J. Bommarito, S. Gao, and P. Arredondo, 2023: Gpt-4 passes the bar exam. Available at SSRN 4389233.

Manhaeve, R., S. Dumancic, A. Kimmig, T. Demeester, and L. D. Raedt, 2021: Neural probabilistic logic programming in DeepProbLog. Artificial Intelligence, 298, 103504.