PROLEG:
Practical Legal Reasoning System

Ken Satoh

1. Self Introduction
2. PROLEG
3. Application of PROLEG to Legal Domain
4. Possible Extensions
5. Conclusion

大学共同利用機関法人 情報・システム研究機構
国立情報学研究所
National Institute of Informatics

Self Introduction

- I have been working on logic programming and logical foundations of AI for 30 years.
- To seek the application of my work, I entered the law school in University of Tokyo and learned law in 2006-2009.
- Based on the findings at the law school, I developed a programming language called PROLEG (PROlog based LEGal reasoning support system).
- As a by-product of the research, I passed the bar exam in Japan in 2017.

PROLEG

- PROLEG consists of rule base and fact base.
- A rule base consists of rules and exceptions.
- Rules consists of general rules of the form:

$$H \Leftarrow C1, C2, \cdots, Cn.$$

and exceptions of the form:

exception(H,E).

where H and E are heads of some rules.

- The facts in a case (represented by atoms) are described in a fact base to reason about specific judgements.
- This representation fits nicely to lawyer's reasoning.

The Semantics of PROLEG

- PROLEG has an equivalent representation power with PROLOG since we can easily translate PROLEG into PROLOG with NAF (and vice versa)
- Translation

  Suppose we have the following PROLEG rule:

  $H \Leftarrow C1, C2, \cdots, Cn.$

  and exceptions of the form:

  exception(H,E1).

  exception(H,E2).

  Then, we can translated into PROLOG

  H :- C1, C2, …, Cn, not E1, not E2.

Application of PROLEG to Legal Reasoning

- Reasoning Steps in Civil Code Litigation
  - Fact Finding Phase

    Deciding the truth value of real-world facts using evidential reasoning
  - Subsumption Phase

    Corresponding the real-worlds facts with legal facts
  - **Judgement Phase**

    Applying legal rules to legal facts to get judgements

→PROLEG supports the judgement phase.

Demonstration

alice bought this real estate from bob at the price of 200000 dollars by contract0 on 1/January/2018.

But alice rescinded contract0 on 1/March/2018 because alice is a minor.

However, this rescission was made because bob threatened alice on 1/February/2018.

It is because bob would like to sell this_real_estate to charlie in the higher price.

Legal Question: **Can alice ask bob to give the real estate to alice according to the contract0?**

PROLEG Rulebase (rules)

```
right_to_handing_over_the_goods(
    Buyer,Seller,Object,ContractID)<=
        valid_purchase_contract(
            Buyer,Seller,Object,Price,Tcontract,ContractID).

valid_purchase_contract(
    Buyer,Seller,Object,Price,Tcontract,ContractID)<=
        agreement_of_purchase_contract(
            Buyer,Seller,Object,Price,Tcontract,ContractID).
```

PROLEG Rulebase (exceptions)

```
exception(
  valid_purchase_contract(
    Buyer,Seller,Object,Price,
    Tcontract,ContractID),
  rescission_by_minor_buyer(
    Buyer,Seller,ContractID,
    Tcontract,Trescission)).

rescission_by_minor_buyer(
  Buyer,Seller,ContractID,
  Tcontract,Trescission)<=
    minor(Buyer),
    manifestation(
    rescission(ContractID),Buyer,Seller,Trescission),
    before_the_day(Tcontract,Trescission).
```

PROLEG Rulebase (exceptions of exceptions)

```
exception(
  manifestation(
    Action,Maniester,Mnifestee,Taction),
  minifestation_by_duress(Threater,Manifester,
    Manifestee,Action,Taction,Tduress,Trecission)).

minifestation_by_duress(
  Threater,Manifester,Manifestee,Action,
  Taction,Tduress,Trecission)<=
    fact_of_duress(Threater,Manifester,Action,Tduress),
    before_the_day(Tduress,Taction).
```

PROLEG Factbase

```
agreement_of_purchase_contract(
  alice,bob,this_real_estate,200000,
  2018 year 1 month 1 day,contract0).

minor(alice).

manifestation_fact(
  rescission(contract0),alice,bob,
  2018 year 3 month 1 day).

fact_of_duress(bob,alice,rescission(contract0),
  2018 year 2 month 1 day).
```

Demonstration

- Combining with deep neural network based NLP and logical reasoning
- Given a case description in NL, we translate it into PROLEG facts.
- Then using manually encoded PROLEG rules, we produce legal explanation of judgement.

The current status of PROLEG

- Implemented 2,500 rules (mainly contract law), including civil code and supreme court cases
- We checked the correctness of the rulebase to solve the multiple choice part of Japanese bar exams for 2009-2022 by the law school graduates from University of Tokyo

Possible Applications

- Educational support to understand judgement reasoning
- Legal support for novice lawyers to avoid to miss some applications of legal rules
- Support for judgements for newly created law (if it is written in PROLEG).

Extension of PROLEG

- We develop a system to arrange issues in civil litigation as an interactive system
- We can use PROLEG to check compliance for AI system with the legal rules.
- We can use PROLEG to define a new legislation in a more rigorous way.

Summary

- I believe that legal reasoning is one of the promising domain for symbolic AI and logic programming since it is very difficult for neural network to produce legal explanation for judgement.
- I also believe that PROLEG is a supporting system for legal reasoning and wish that every lawyer uses PROLEG (At least I will use it when I become a lawyer).

Acknowledgement

- My research carrier with logic programing had not started if the Japanese fifth generation computer project had not started.
- So, I feel this nomination is not only for me but also all the Japanese people who worked for the fifth generation computer project.
- I appreciate very much that the PROLOG community still remembers Japanese contribution to the community.