

## Researching other Logics + LLMs - Task 6

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### Probabilistic Soft logic

Probabilistic Soft logic is a framework for modelling complex logical relationships by constructing rules that follow a logical sequence. PSL produces grounded inferences by applying soft weights between  $[0,1]$  producing new outcomes. The PSL framework supports all basic arithmetic and logical operators while also supporting special operations such as Similarity function operators, weight based operators and prior negative allowing to model complex logical operations.

### Tutorial : Modelling Voter Behavior

PSL is a suitable framework for modelling voter behavior through social network influence. Unlike some machine learning approaches PSL predicts voting preferences based on social relationships and demographic similarities by utilizing probabilistic reasoning and first order logic.

```
Textproto
// Social influence rules
0.3: Friend(P1, P2) & VotesFor(P1, PARTY) -> VotesFor(P2, PARTY) ^2
0.8: Spouse(P1, P2) & VotesFor(P1, PARTY) -> VotesFor(P2, PARTY) ^2
5.0: AgeSimilar(P1, P2) & VotesFor(P1, PARTY) -> VotesFor(P2, PARTY) ^2

// Constraints
VotesFor(P, +PARTY) = 1.0 .
1.0: !VotesFor(P, PARTY)
```

The above code demonstrates a simple example of modelling voter behavior. Here we take three factors, and add weights accordingly. 0.3 for influence of friends, 0.8 for spouses and 5.0 if people voting are of similar age. We also enforce that one person can only vote for one party at a time. The negation operator enforces negative bias by enforcing non voting unless there is evidence.

To run a PSL simulation, we define a JSON in with the following fields

- **rules** - where all the rules of the PSL model are written

- **predicates** - with input types and path to the observation data.

We generate the inferred output probability from the learn and eval data and obtain the following output.

Textproto

```
Alice Republican 0.0
Alice Green 0.0
Bob Democrat 0.94710255
Bob Republican 0.027526164
Bob Green 0.028656185
Charlie Democrat 0.8932856
Charlie Republican 0.05020552
Charlie Green 0.056753688
Dave Democrat 0.6370932
Dave Republican 0.19213226
Dave Green 0.17359492
Eve Democrat 0.6085047
Eve Republican 0.208066
Eve Green 0.18499015
Frank Democrat 0.0
Frank Green 0.0
Grace Democrat 0.0
Grace Republican 2.8908253E-5
```

Shell

```
Evaluation results:
Evaluator: DiscreteEvaluator,
Predicate: VOTESFOR,
Results -- Accuracy: 0.722222, F1: 0.285714,
Positive Class Precision: 0.250000,
Positive Class Recall: 0.333333,
Negative Class Precision: 0.857143,
Negative Class Recall: 0.800000
```

AI Attribution :

Perplexity usage to generate sample input voter influence data.

```
Textproto
// age similiarity
Alice Bob    0.95
Charlie Dave 0.80
Eve   Frank  0.45

// friends
Alice Bob    1.0
Bob   Charlie 1.0
Dave  Eve     1.0

// observed votes
Alice Democrat 1.0
Frank Republican 1.0
Grace Green 1.0

// spouses
Dave  Eve     1.0
Frank Grace 1.0
```