Modeling Nomic Using LKIF-Core Ontology

Abdallah El Ali, Marc Bron, Szymon Klarman and Xingrui Ji

Leibniz Center For Law

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Outline

Introduction

The Goal:

The primary aim of the project was to explore capabilities of the LKIF-Core ontology of legal terms in modeling a sample piece of legislation. The object of modeling was the Initial Set of rules of Peter Suber's Nomic game.

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Supplementary Goal:

To develop a suitable strategy for:

- representing changes in the terminological knowledge, which may take place during a game,
- reasoning about different stages of the game according to the knowledge applicable at those stages.

Scope of Model

The model is focused around the concept of rule and rule change, which are most characteristic for Nomic.

Apart from an action of a rule change the model encompasses knowledge about (some) necessary prerequisites for a rule change to take place:

- agents playing some roles in game
- rule change proposals
- voting on proposals
- status of voting

Representation Support of LKIF-Core

Two roles of LKIF-Core:

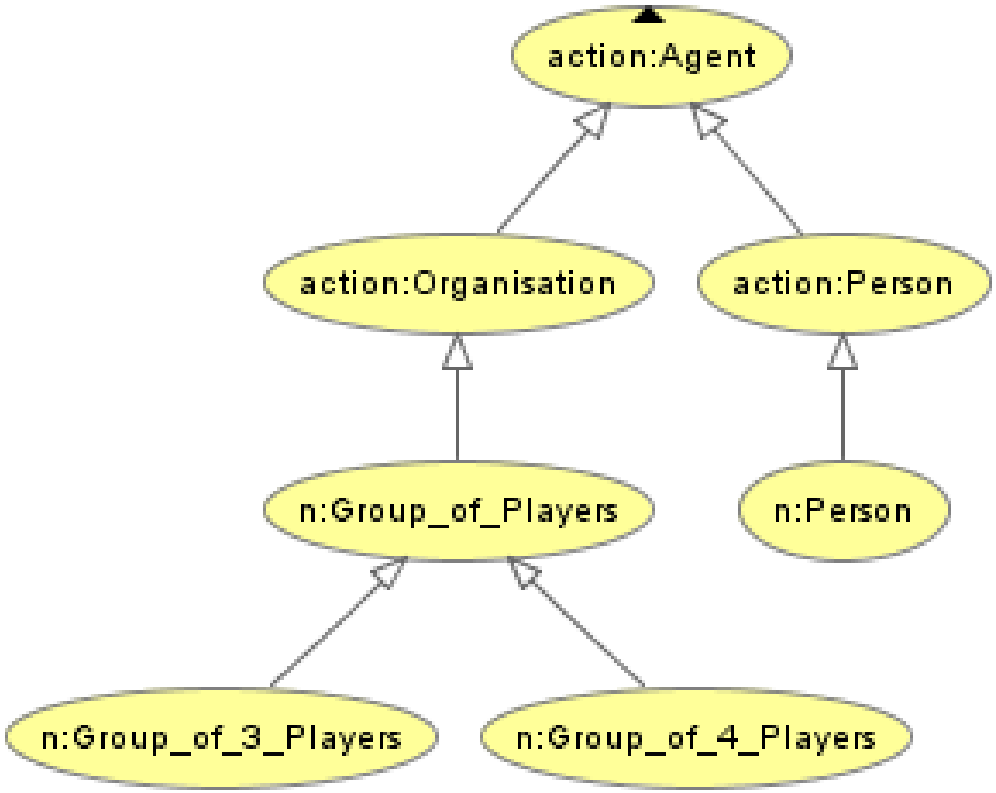
- a ready upper-level taxonomy allowing for faster and easier organization and structuring of terminological knowledge extracted from Nomic.

  e.g. there is no need to define what an action in general is. We can assert a game action as a subclass of LKIF action and thus inherit predefined restrictions.

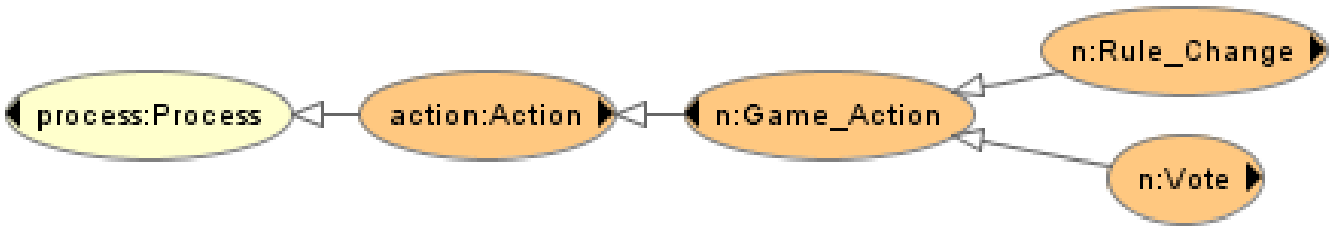
- a heuristic guide providing valuable hints on what concepts and relations should be searched for in the text of legislation.

  e.g. Qualification — Qualified, Norm — Normatively Qualified, Action — Actor

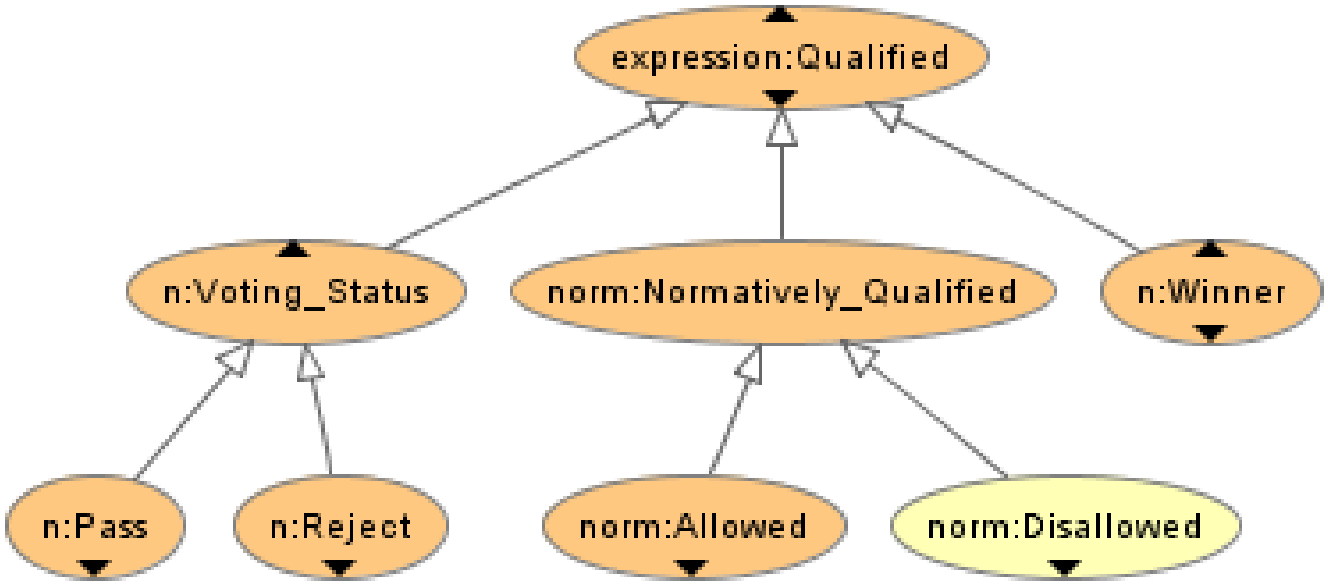
Agent


action:Agent
action:Organisation
action:Person
n:Group_of_Players
n:Person
n:Group_of_3_Players
n:Group_of_4_Players

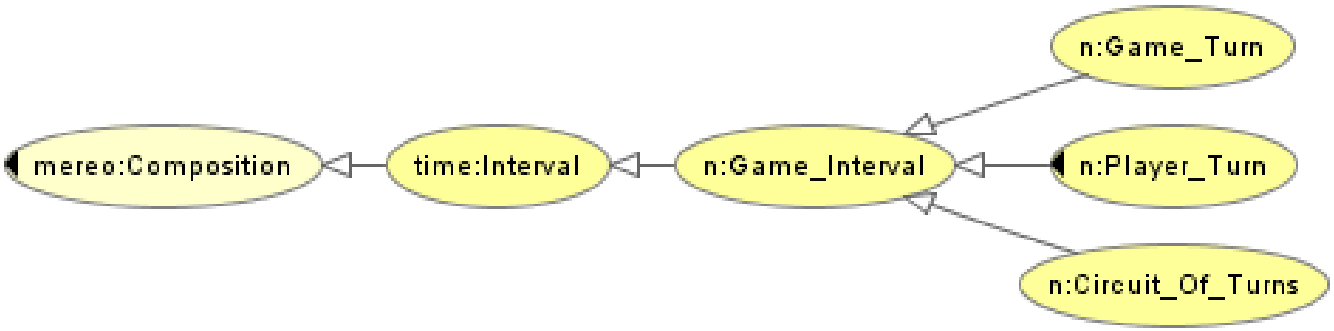
Change


process:Process
action:Action
n:Game_Action
n:Rule_Change
n:Vote

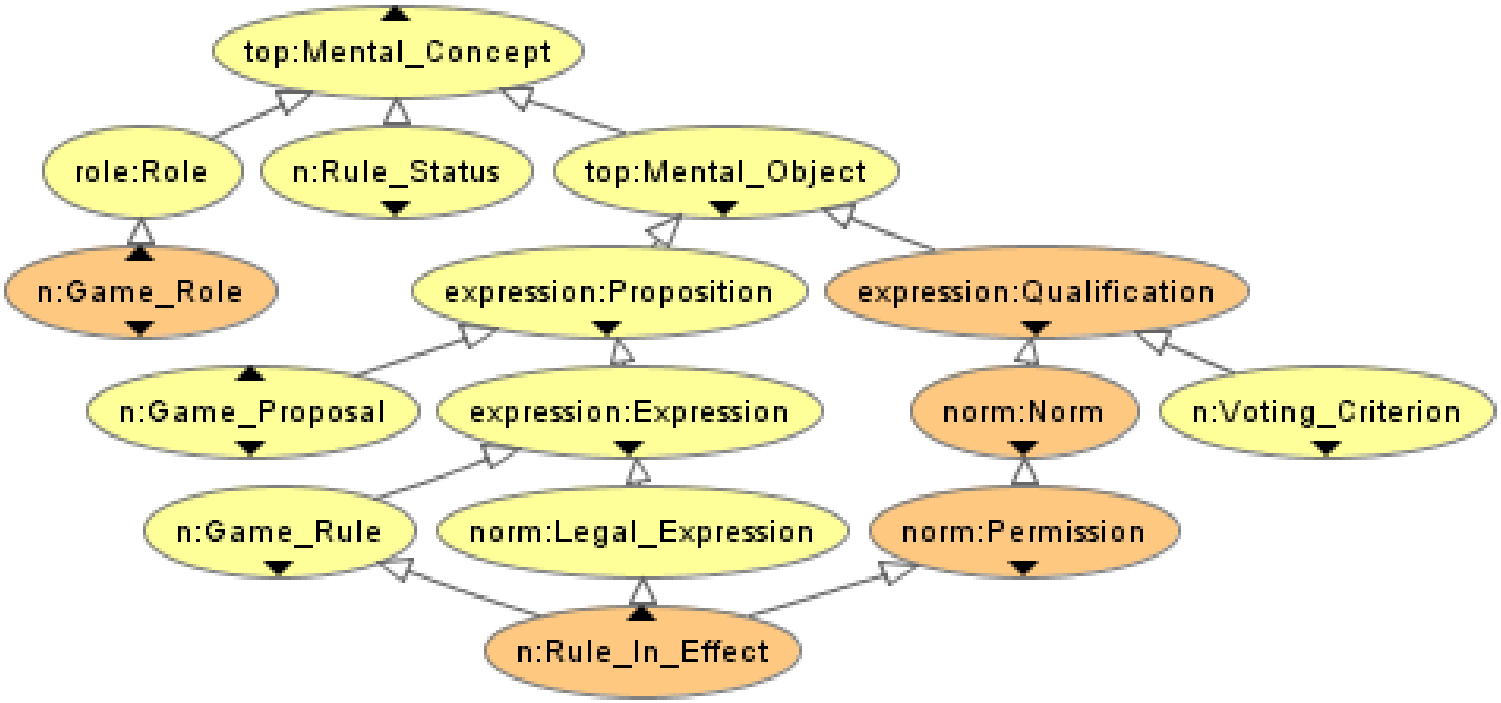
Qualified


expression:Qualified
n:Voting_Status
norm:Normatively_Qualified
n:Winner
n:Pass
n:Reject
norm:Allowed
norm:Disallowed

Abstract Concept



Mental Concept



Handling Dynamic Knowledge

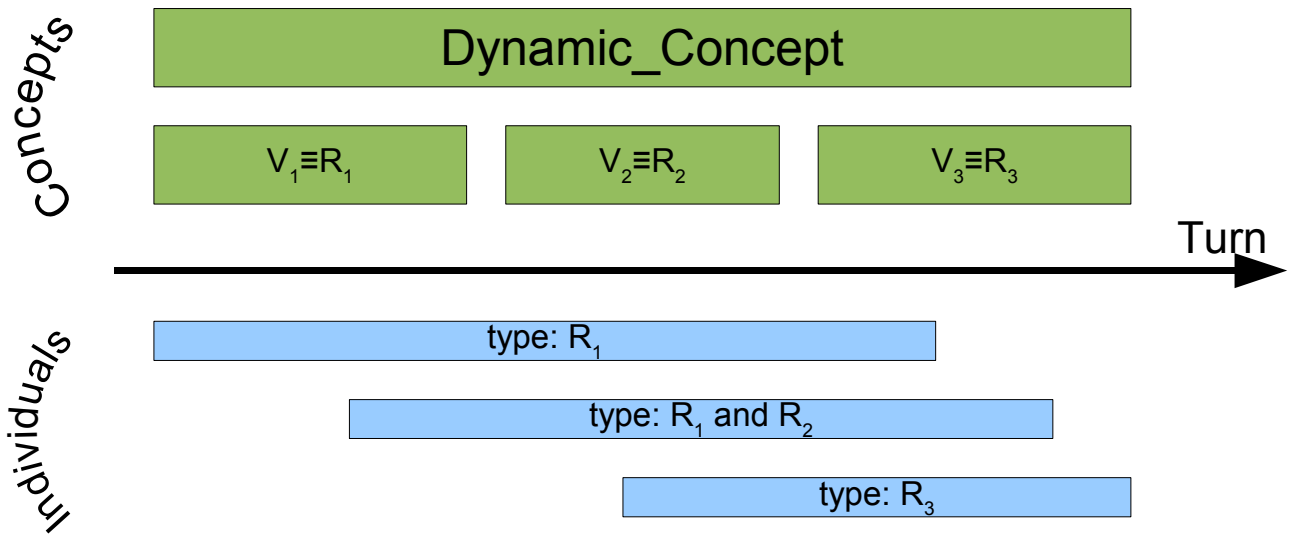
The model supports representation and reasoning over knowledge that changes over time.

- Each new concept variant is introduced as a new class defined by means of equivalence conditions.
- Most of the instances are originally stored under 'bin concepts'.
- Classification is left to the inference engine and is driven by the choice of the current turn.

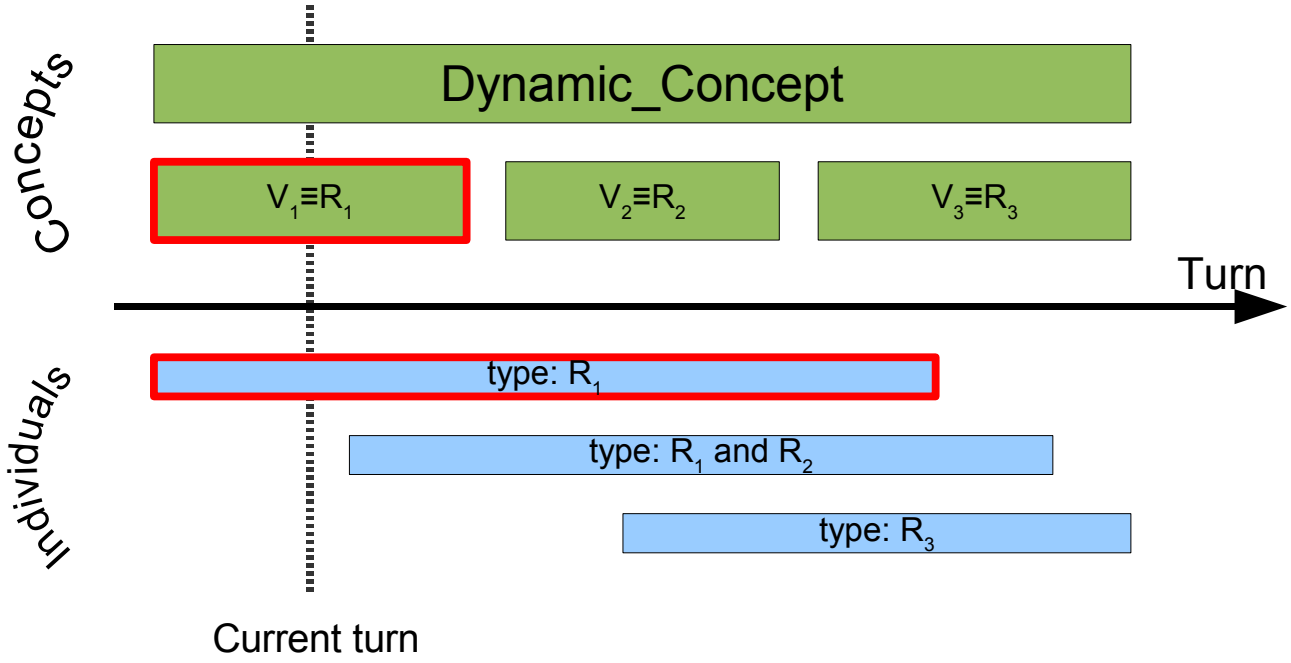
Example

The proper classification for the 2^{nd} turn is entailed by the assertion: `Current_Turn owl:sameAs Game_Turn_2`

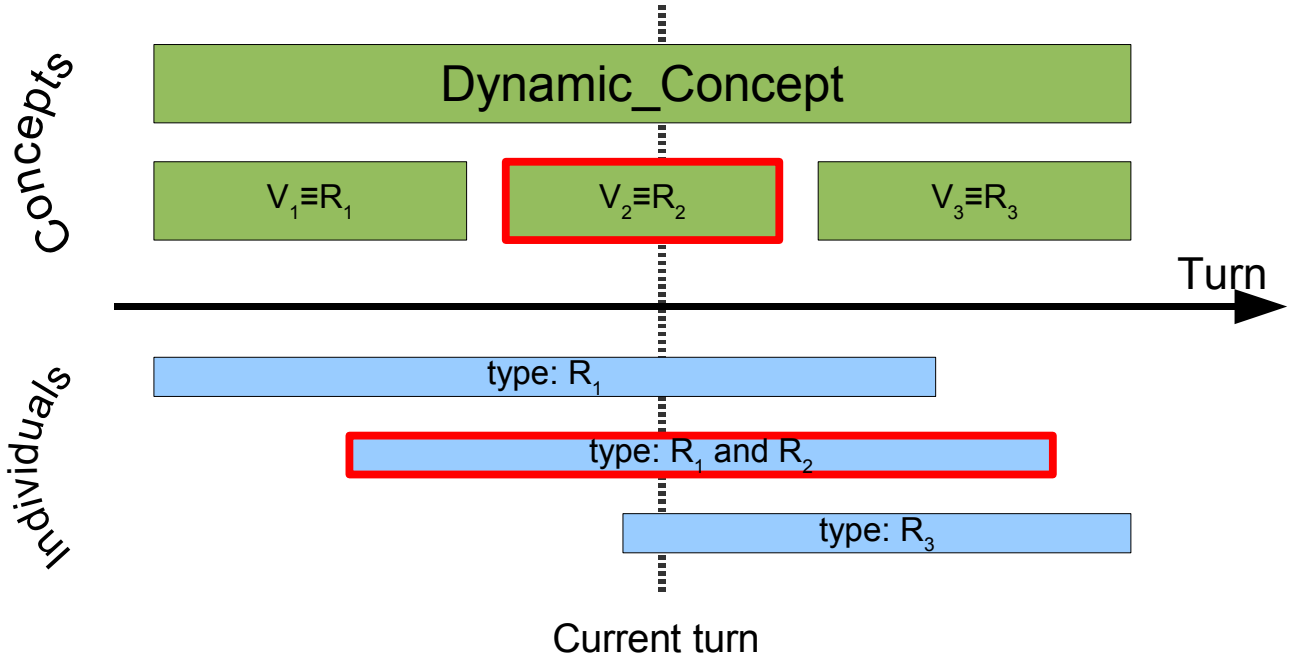
Classification of Instances



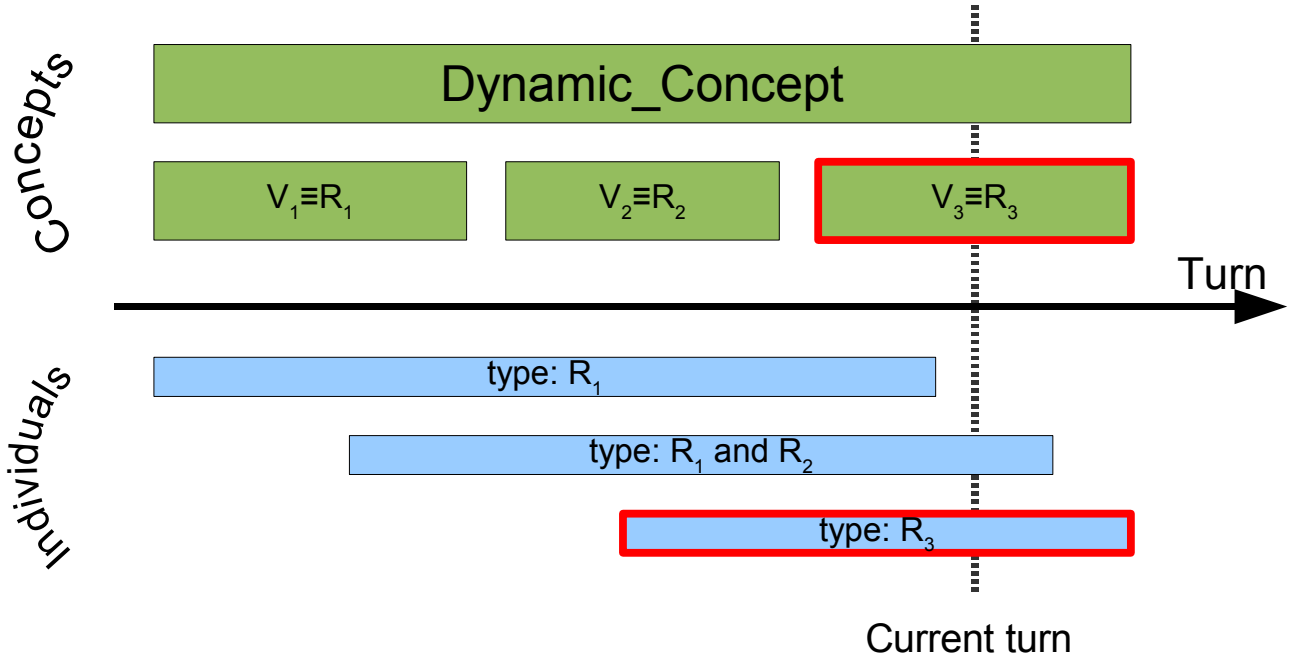
Classification of Instances



Classification of Instances



Classification of Instances



Handling Dynamic Knowledge

Two benefits of our representation:

- providing limited automated legal assessment services,
- allowing for convenient cross-referencing between different parts of knowledge in the epistemically dynamic setting.

Limitations

Nomic is in principle hard to model. One has to account for its specific features emerging on two levels:

- a multi-player game of a sequential character,
- a piece of a self-reflexive legislation.

The other sources of limitations:

- OWL/DL syntax, and OWA semantics,
- complexity of representation resulting in increased time of reasoning.

Semantic and Syntactic Limitations

Some concepts had to be left out or defined in a roundabout way because of semantic and syntactic limitations of OWL.

- The lack of variables (DL):

  e.g.: amendment should amend the rule given in some proposal and result in another rule specified by the same proposal.

- The limited use of negation (OWA):

  Every player is a voter unless it is his turn.

  If x is not allowed than it should be disallowed.

Complexity Limitations

The model strongly relies on the role of the reasoner (especially on the ability to assert types of individuals).

Attempt to build a highly detailed representation results in the increasing time of reasoning.

Reduction of the time of reasoning was a main challenge during the process of modeling. Three employed strategies:

- Proposing LKIF skeleton containing only required concepts and relations from LKIF-core.
- Imposing disjointness conditions on classes and owl:differentFrom properties on individuals.
- Experimenting with various representations and comparing gain in the reasoning time.

Demo

A sample scenario of a 4-player Nomic game has been implemented.

During 6 turns of the game, rules are being legally amended, transmuted, enacted or repealed, entailing respective changes in the knowledge.

Turn 2:

Player Ji proposes proposal 302, which states: amend rule 301 into: *A player is an eligible voter, if it is his turn or one of the two previous turns was his.* The proposal is unanimously accepted by all players. The amended rule receives the number 302.

Demo

Before the change:

- Rule 301 (status: mutable, in effect): *Every player is an eligible voter.*

Demo

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- Rule 301 (status: mutable, in effect): *Every player is an eligible voter.*

The change:

- Proposal 302 is stated by the current player (Ji).
- The proposal is voted on by all 4 players.
- The voting results in unanimous acceptance of the proposal.

Demo

Before the change:

- Rule 301 (status: mutable, in effect): *Every player is an eligible voter.*

The change:

- Proposal 302 is stated by the current player (Ji).
- The proposal is voted on by all 4 players.
- The voting results in unanimous acceptance of the proposal.

After the change (turn 3):

- Rule 301 is not in effect anymore. Instead there is Rule 302 (status: mutable, in effect): *A player is an eligible voter, if it is his turn or one of the two previous turns was his.*
- Currently valid definition of `Voter` is different than before.

Summary

- We have modeled a small but representative subset of the Initial Set of Nomic's rules.
- Nomic's concepts have been embedded into LKIF-core ontology, thus obtaining explicit legal semantics.
- It is possible to represent and reason about the terminological knowledge and instances in the epistemically dynamic setting.
- LKIF-core has been useful in structuring the representation and guiding the modeling process.

Summary

- The model is available in files:
  `nomic.owl` + `skeleton-lkif.owl`
- Report: *Modeling Nomic in LKIF-Core Ontology*.
- *Tutorial on Using LKIF-Core for Modeling Legislation*
  [in progress]