FOND4LTL$_f$: FOND Planning for LTL$_f$/PLTL$_f$ Goals as a Service

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Abstract

Planning is a central area in Artificial Intelligence (AI) concerned with the decision making performed by autonomous agents with the aim of achieving some goals. In the last decades, extensive literature has been produced in Fully Observable Non-Deterministic (FOND) planning for temporally extended goals when the specification is expressed using one of the several finite trace variants of LTL. Numerous applications have been developed to solve the problem, but most of them require special knowledge. In this demonstration, we present FOND4LTL$_f$, a web service tool that allows solving FOND planning for LTL$_f$/PLTL$_f$ goals as an integrated tool with editor, planners and policy visualizer. Video: `https://bit.ly/3ilX7JR`.

Context

Planning for *temporally extended goals* in *deterministic* and *non-deterministic* domain settings has been of increasing interest over the past decades, starting with the pioneering work on planning for temporally extended goals [1] and on planning via model checking [2]; then, with the work on integrating LTL goals into standard planning tools [3], and, more recently, with the work relating planning in non-deterministic domains to synthesis, often focused on the *finite trace* variants of LTL [4, 5, 6].

Two techniques have been mainly exploited to solve *Fully Observable Non-Deterministic* (FOND) Planning for temporally extended goals. One uses automata-theoretic approaches; whereas, the second one integrates the automaton dynamics directly within the compactly represented FOND domain model. Although some of these techniques have already been implemented, such an implementations involve several steps and, in general, do not conform on input/output formats. Thus, on the one hand non-expert users usually find challenging to understand the whole process pipeline and might encounter several difficulties for the correct usage of such tools. On the other hand, experienced users cannot check or debug solutions with ease.

FOND Planning for LTL$_f$/PLTL$_f$ Goals

Given a FOND planning domain model $\mathcal{P}$ with initial state s_0 (both represented in PDDL), and an LTL$_f$/PLTL$_f$ goal formula φ, the approaches work as follows:

1. Transform the goal formula φ into the corresponding (DFA) using off-the-shelf translators;
2. Build a new domain model $\mathcal{P}'$, by augmenting $\mathcal{P}$ with the automaton dynamics and states;
3. Solve $\mathcal{P}$ with any off-the-shelf FOND planner;
4. Extract from $\mathcal{P}'$ a solution to $\mathcal{P}$.

In this way, FOND planning for temporally extended goals is reduced to standard FOND planning. The main advantage of this solution is that any off-the-shelf FOND planner can be leveraged. Our application allows only LTL$_f$ and PLTL$_f$ as formalism to specify the goal, but the system can be easily adapted to accommodate others as well.

The FOND4LTL$_f$ Service

The web service comes with a graphical user interface and exposes RESTful APIs. A capture of the user interface is shown in Figure 1. At the beginning, the application requires the user to provide the PDDL domain and problem specifications along with an LTL$_f$/PLTL$_f$ goal. Users can either directly write their own models using the given editor or they can choose a preloaded working example.

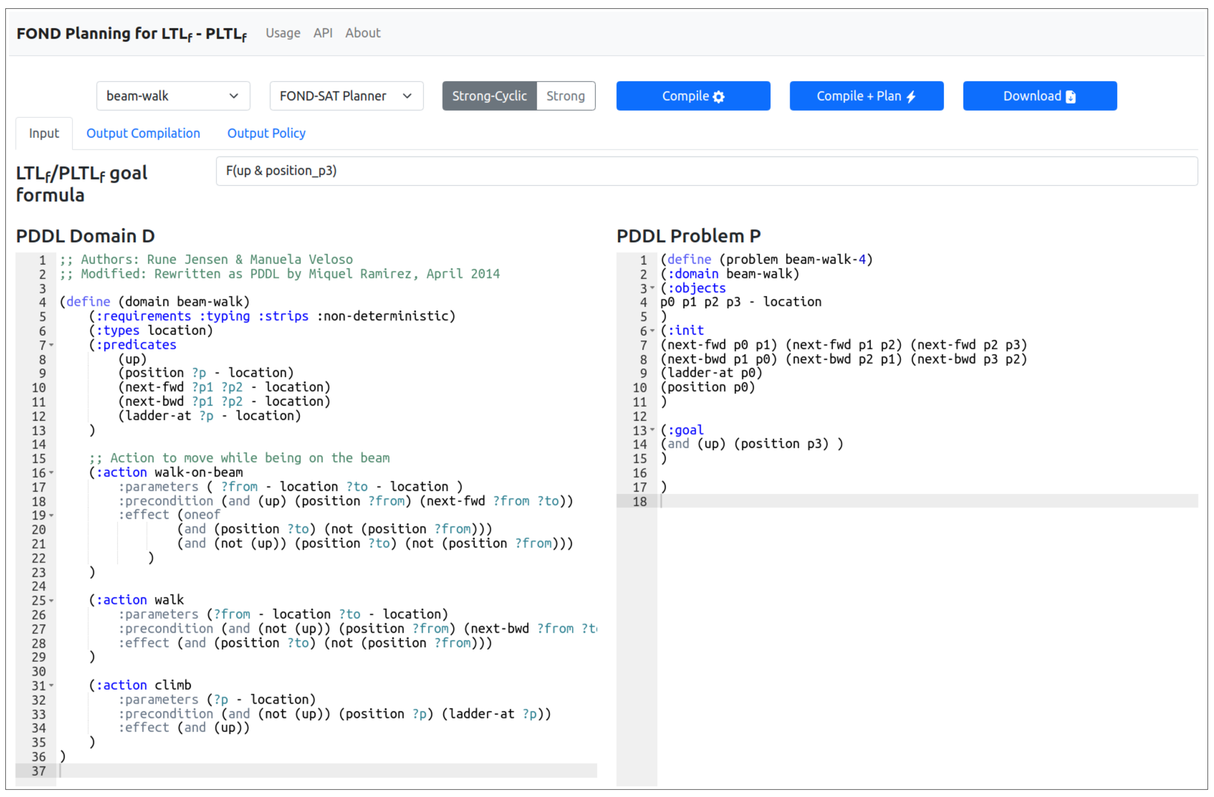

Figure 1: FOND4LTL$_f$ input section.

Once the input is given, the web service allows two main options: *Compile* or *Compile + Plan*. The former computes the DFA for the goal formula with the LTL$_f$2DFA [7] tool and integrates its dynamics within the PDDL domain model, returning a new domain and a new problem. The latter, instead, first performs the compilation just described and then calls an off-the-shelf FOND Planner to find a policy for the planning problem. The user can choose among the three main state-of-the-art planners, i.e., FOND-SAT, MyND and PRP. Moreover, based on the chosen planner, the user can also decide to ask for *strong-cyclic* or *strong* policies. A capture of a policy output is shown in Figure 2.

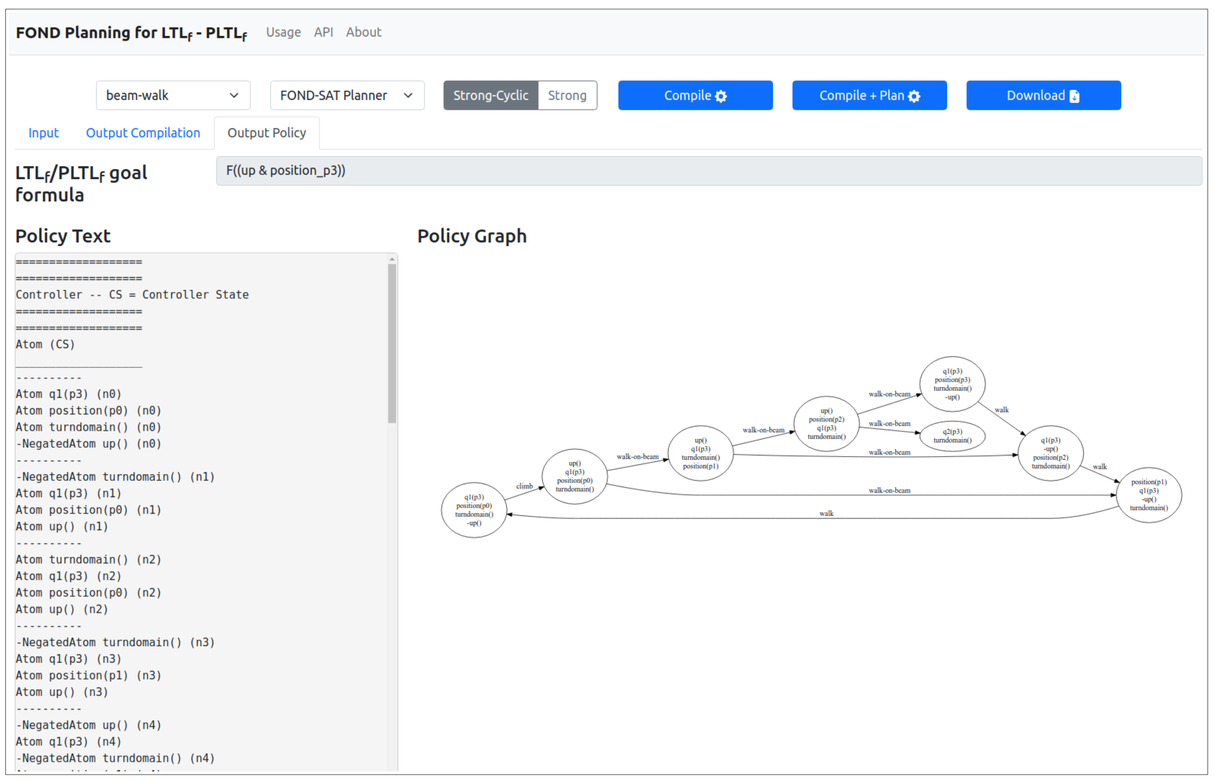

Figure 2: FOND4LTL$_f$ output policy section.

Conclusion

FOND4LTL$_f$, an easy-to-use web service tool that compiles FOND domain models for LTL$_f$/PLTL$_f$ goals into standard FOND planning problems and computes the policy with publicly available FOND planners.
The web service exposes:

1. Graphical user interface;
2. RESTful APIs;

Finally, FOND4LTL$_f$ is also available online at `https://fond4ltlf.herokuapp.com/`.

Acknowledgements

Work partially supported by the European Research Council under the European Union's Horizon 2020 Programme through the ERC Advanced Grant WhiteMech (No. 834228) and the EU ICT-48 2020 TAILOR (No. 952215).

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