Perfect Observability is a Myth: Restraining Bolts in the Real World

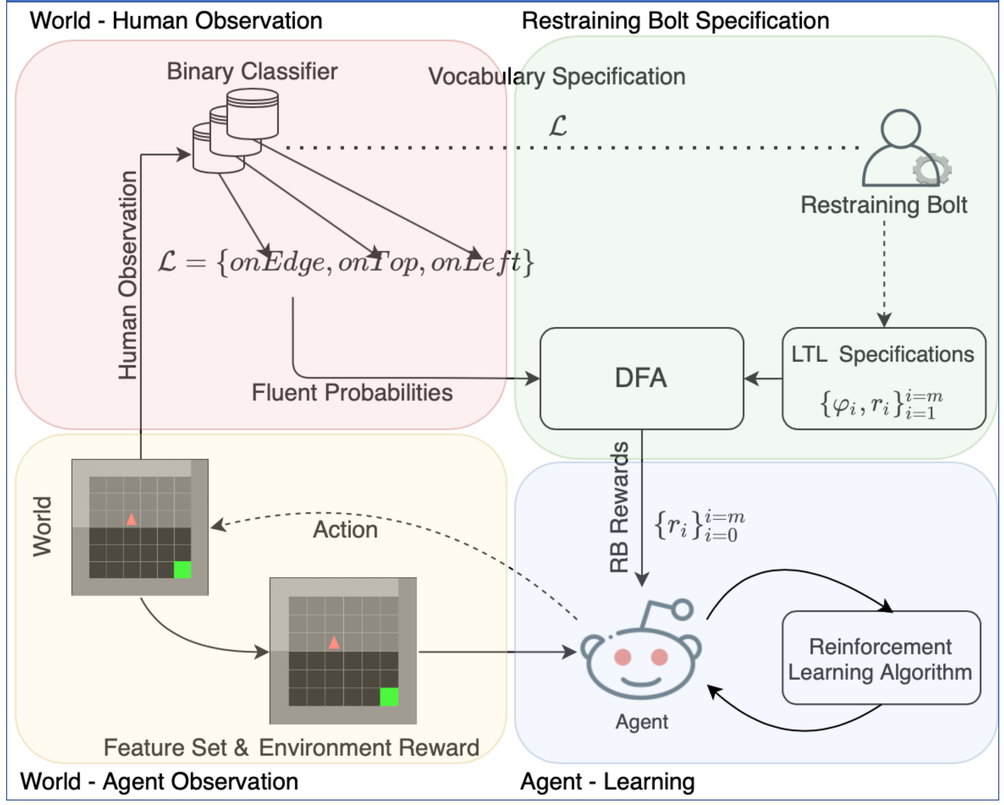
Robonauts: Akkamahadevi Hanni, Rashmeet Kaur Nayyar, Naman Shah, and Mudit Verma

CSE 574: Planning and Learning in Artificial Intelligence

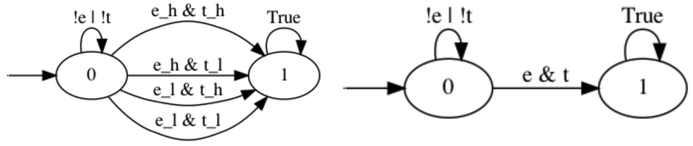
Introduction

- A restraining bolt often assumes a fully observable setting where it models aspects of the world distinct from an agent's observations.
- We disentangle observations from inference of symbols over those observations which can be noisy.
- Contributions:
  - Impose constraints on an agent in a world with noisy observations.
  - Allow for image observations for the agent as well as the bolt.
  - Flexible Codebase that works for different LTL configurations & openAI gym envs.

Overall Flow



Approach



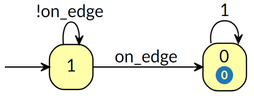
Algorithm 1: Transitioning over augmented DFA

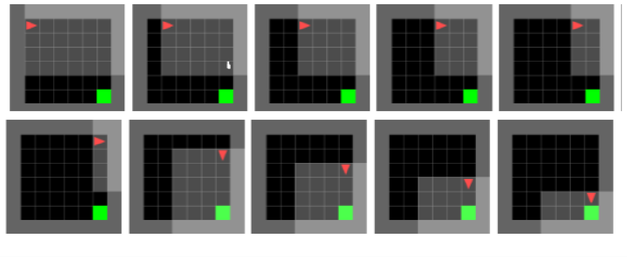
Result: Reward, Next state over augmented DFA
Input: Original DFA D, Current DFA state q, Probabilities of Fluents C ;
if $C(e) \geq 0.5$ **then**
  $Truth(e) = T$
else
  $Truth(e) = F$
end
E_list = D.get_edges(q) ;
E = e in E_list s.t. $\delta(q, Truth, e) = 1$;
initialize $r = 0$;
for *symbols in e* **do**
  if $0.5 \leq C(symbol) \leq 0.9$ **then**
    r = r - d.LowConfidenceCost ;
  end
end
if *e is a terminal state* **then**
  r = r + d.TerminalReward
end
return r, e ;

Results

- Domains : Gridworld, breakout
- DRL Algorithms : PPO, A2C, DQN.
- 5 restraint specifications

LTL: F(on_edge)





LTL specification	Algorithm	R^c_{max}	R_π	N_{steps}	N_{frames}	Constraint followed
G(o)	PPO	94	79.48	90	25k	✓
	A2C	94	63.64	75	80k	✓
	DQN	92	74.42	82	4k	✓
!F(t)	A2C	82	80.71	60	50k	✓
	DQN	82	79	59	4k	✓
F(t and X(!(F(t))))	PPO	92	77.78	87.13	133k	✓
	A2C	92	74.54	104.2	165k	✓
(F(t and X(!(F(t)))) and !F(b)) or (F(b and X(!(F(b)))) and !F(t))	A2C	92	78.42	78	20k	✓
F(c)	DQN	—	-240	2900	2.8m	×

Table 1: Results for Gridworld domain where e = on_edge, t = top_right_corner, b = bottom_left_corner, and u = facing_upwards, and Breakout domain where c = brick_clear_left. Here, e, t, b, u, and c are fluents used to specify the LTL specifications.