

STV: Model Checking for Strategies under Imperfect Information

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LAMAS, 09/05/2020



Outline



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ATL: What Agents Can Achieve

- ATL: Alternating-time Temporal Logic [Alur et al. 1997-2002]
- Temporal logic meets game theory
- Main idea: cooperation modalities

$\langle\langle A \rangle\rangle\Phi$: coalition A has a collective strategy to enforce Φ

\rightsquigarrow Φ can include temporal operators: X (next), F (sometime in the future), G (always in the future), U (strong until)



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 $q \sim_a q' \implies s_a(q) = s_a(q')$



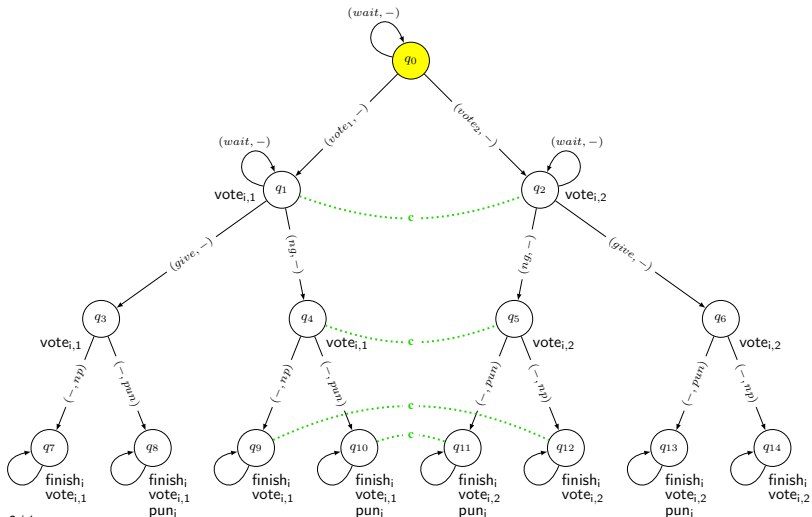
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- Fixpoint equivalences **do not hold** anymore
- Model checking **ATL_{ir}** is Δ_2^P -complete

Example - Simple Model of Voting and Coercion





Example Formulae

- $\langle\langle \textit{coercer} \rangle\rangle F(\neg \textit{pun}_1 \vee \textit{vote}_{1,1})$:
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Approximate Verification of Strategic Ability

$M \models_{ir} \varphi$: **DIFFICULT!**



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↑
our contribution

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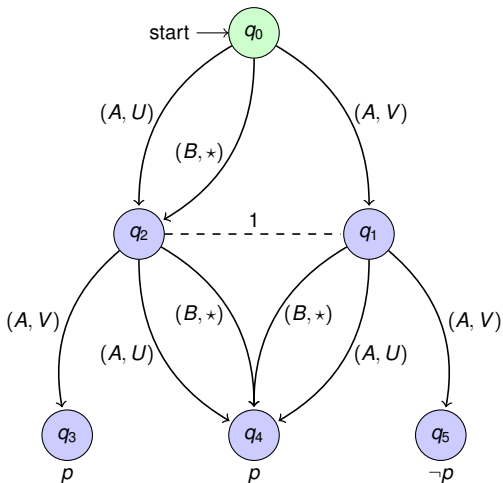
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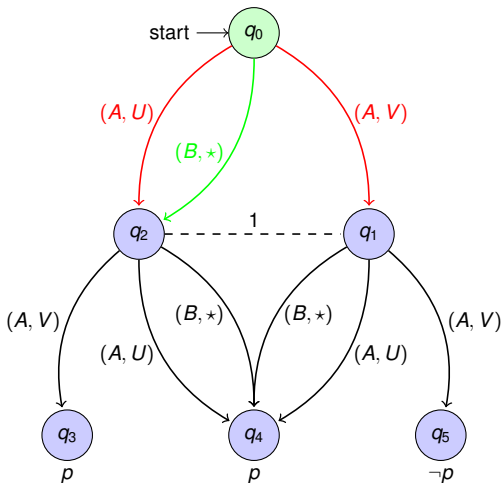
our contribution

perfect information

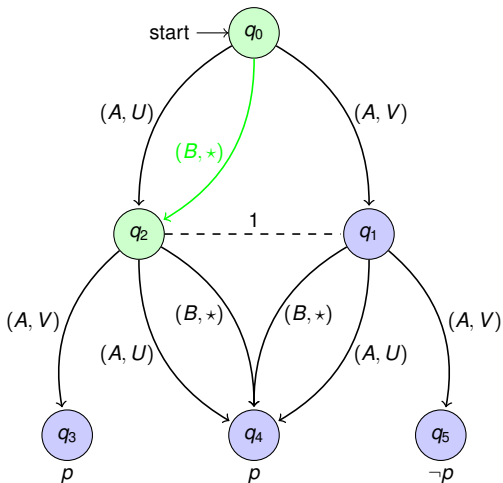
Domino DFS



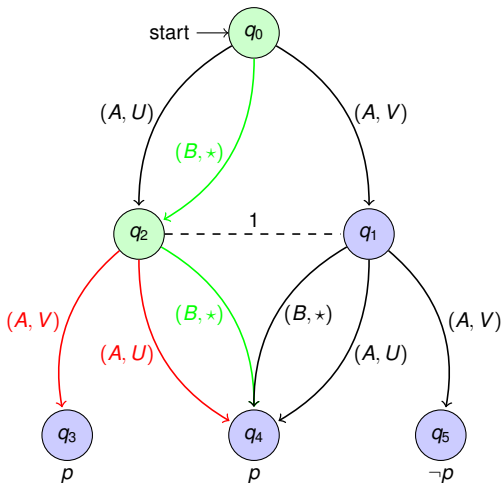
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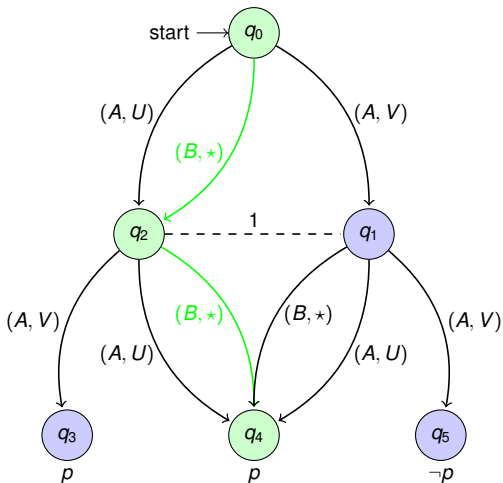
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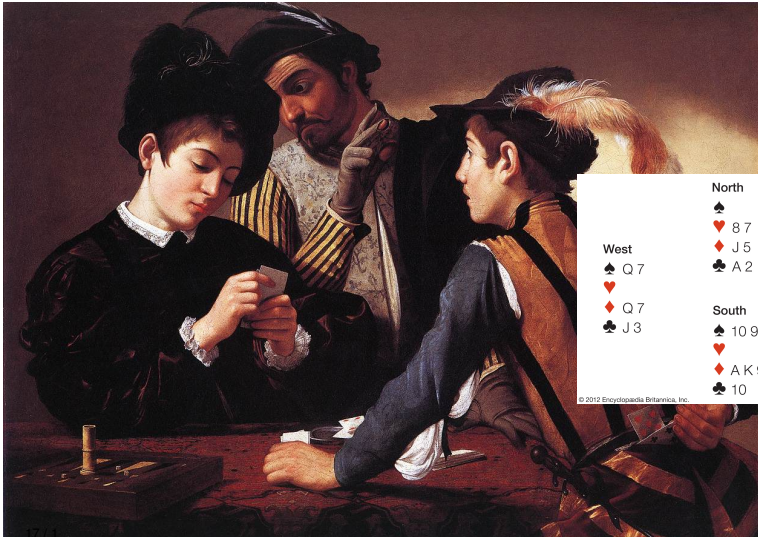
Outline



Implemented models

- Bridge scenario
- Castles
- TianJi
- Drones
- Simple Voting

Bridge scenario



	North			
	♠			
	♥	8 7		
	♦	J 5		
	♣	A 2		
West			East	
♠	Q 7		♠	J 6
♥			♥	
♦	Q 7		♦	10 8 6
♣	J 3		♣	8
		South		
		♠	10 9	
		♥		
		♦	A K 9	
		♣	10	

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Bridge scenario

- Typical bridge play scenario, modified by two variables: **n, k**
- Each player holds **k cards in hand**
- Deck consists of **4n cards in total**
- We consider only **endplay**
- Random deal
- Four players - S, W, N, E
- Declarer (S) handles his own cards and the ones of the dummy (N)
- Players **remember already played cards**
- Everyone see dummy cards
- NoTrump contract



DEMO

Experimental results - Bridge scenario

Conf.	DominoDFS	MCMAS	Approx.	Approx. opt.
(1, 1)	0.0006	0.12	0.0008	< 0.0001
(2, 2)	0.01	8712*	0.01	< 0.0001
(3, 3)	0.8	timeout	0.8	0.06
(4, 4)	160	timeout	384	5.5
(5, 5)*	1373	timeout	8951	39
(5, 5)	memout	timeout	memout	138
(6, 6)*	memout	timeout	memout	4524

Experimental results - Castles

Conf.	DominoDFS	MCMAS	SMC
(1, 1, 1)	0.3	65	63
(2, 1, 1)	1.5	12898	184
(3, 1, 1)	25	timeout	6731
(2, 2, 1)	25	timeout	4923
(2, 2, 2)	160	timeout	timeout
(3, 2, 2)	2688	timeout	timeout
(3, 3, 2)	timeout	timeout	timeout



THANK YOU