Easy to Win, Hard to Master:
Playing Infinite Games Optimally

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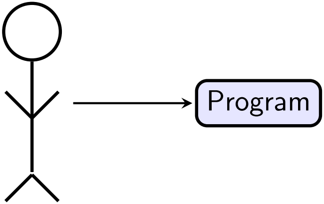
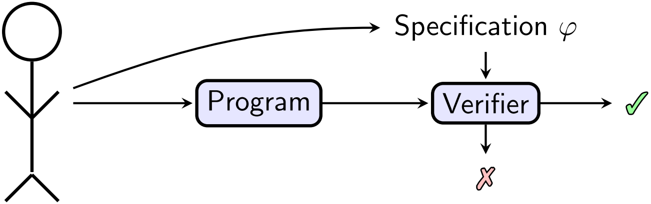
Thesis Proposal Talk

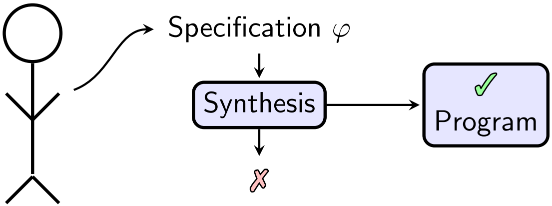
Programming



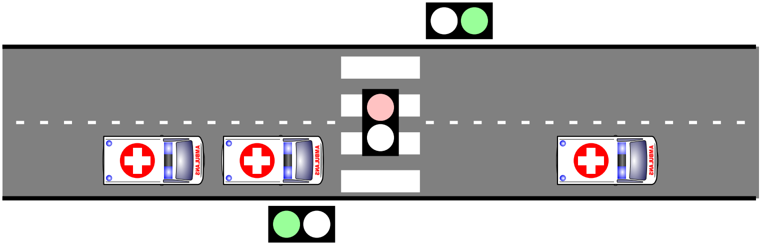
Program Verification



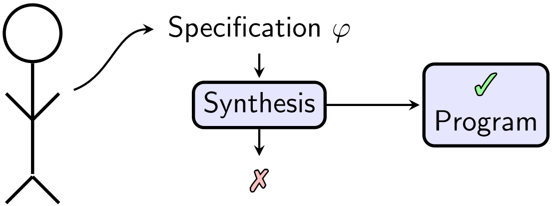
Program Synthesis



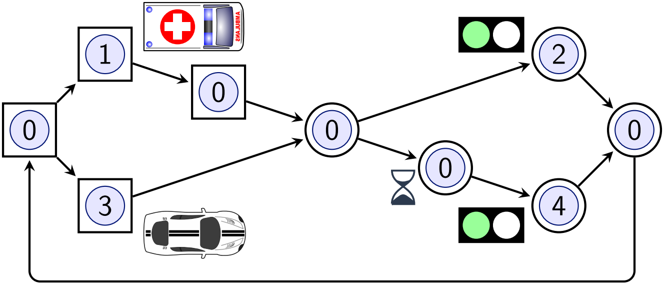
Example

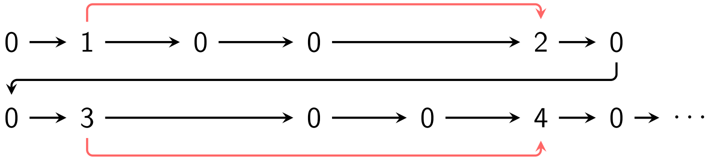


Program Synthesis



Parity Games

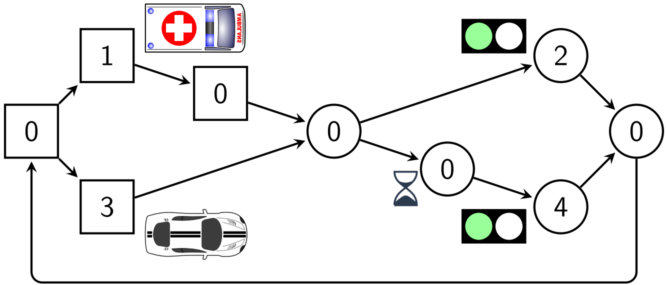


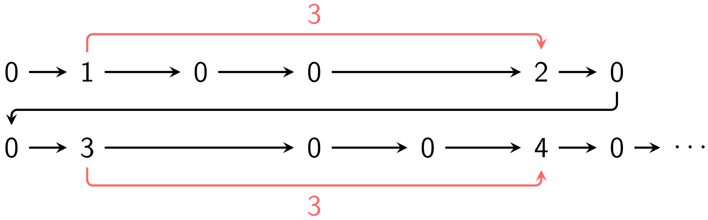


Example due to (Fijalkow and Chatterjee, Infinite-state games, 2013)

- Deciding winner in $\mathrm{NP} \cap \mathrm{co}\text{-}\mathrm{NP}$
- Positional Strategies

Finitary Parity Games





Goal for Player 0: Bound response times

Decision Problem

Theorem (Chatterjee, Henzinger, Horn, 2009)

The following decision problem is in $\mathrm{PT{\scriptsize IME}}$*:*

Input: *Finitary parity game* $\mathcal{G}$

Question: *Does there exist a strategy* σ *with* $\mathrm{Cst}(\sigma) < \infty$*?*

Theorem (W., Zimmermann, 2016)

The following decision problem is $\mathrm{PS{\scriptsize PACE}}$*-complete:*

Input: *Finitary parity game* $\mathcal{G}$*, bound* $b \in \mathbb{N}$

Question: *Does there exist a strategy* σ *with* $\mathrm{Cst}(\sigma) \leq b$*?*

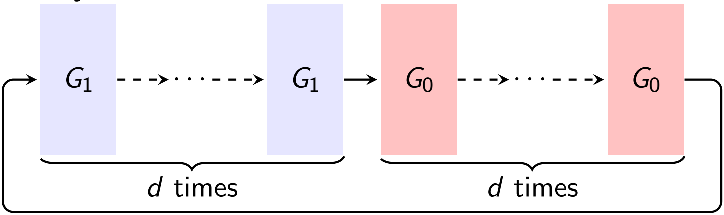
Memory Requirements (for Player 0)

Theorem (W., Zimmermann, 2016)

Optimal strategies for finitary parity games need exponential memory

Sufficiency: Corollary of proof of PSPACE-membership

Necessity:



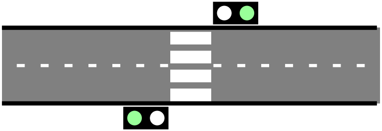
Player 0 needs to recall d positions with d possible values
$\Rightarrow$ Player 0 requires $\approx 2^d$ many memory states

Results so far

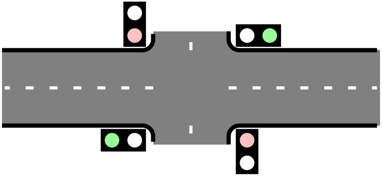
	Parity	Finitary Parity	
		Winning	Optimal
Complexity	NP ∩ co-NP	PTime	PSpace-comp.
Strategy Size	1	1	Exp.

Outlook

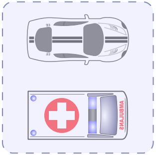
So far



Multi-Dimensional Games



Imperfect Information



Conclusion

Results so far: Forcing Player 0 to answer quickly in (finitary) parity games makes it harder

- to decide whether she can satisfy the bound
- for her to play the game

Guiding Question: What costs does playing games optimally incur

- in terms of computing a strategy?
- in terms of the complexity of strategies?