Synthesizing Optimally Resilient Controllers

Joint work with Daniel Neider and Alexander Weinert

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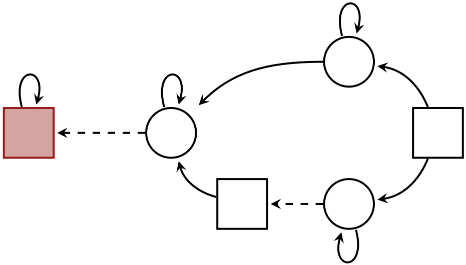
Dallal, Neider, Tabuada: Safety games with “unmodeled intermittent disturbances”



- Add disturbance edges (dashed) to classical safety game
  - Only from Player 0 vertices
  - Not under control of Player 1 nor equipped with fault model
  - Instead: assumed to be “rare” events
- **Question:** how many disturbances can Player 0 deal with?

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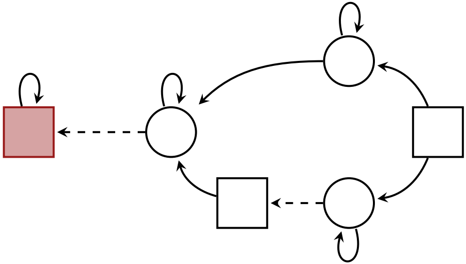

Definition

The resilience of a vertex v is the largest k such that Player 0 has a strategy σ such that every play that

- starts in v,
- is consistent with σ, and
- has strictly less than k disturbances

is winning for Player 0.

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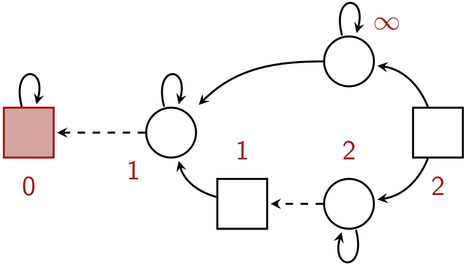

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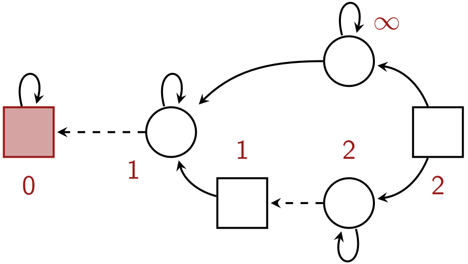
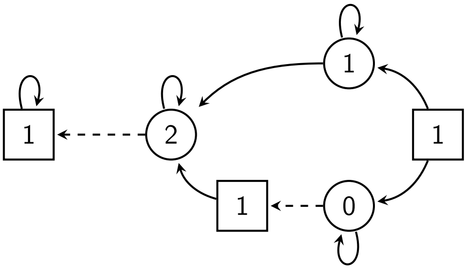


Theorem (DNT’16)

The resilience of the vertices of a safety game $\mathcal{G}$ and a memoryless optimally resilient strategy for $\mathcal{G}$ are computable in polynomial time.

Neider, Weinert, Z. ('17): What about (max-) parity games?



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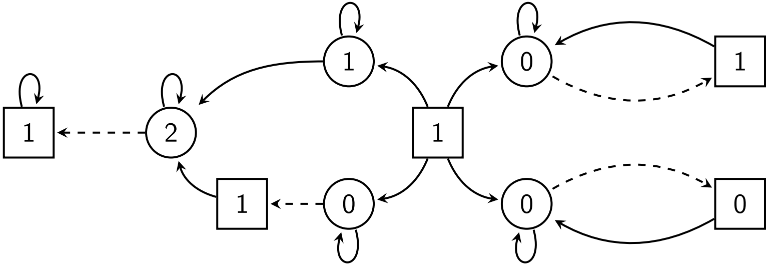

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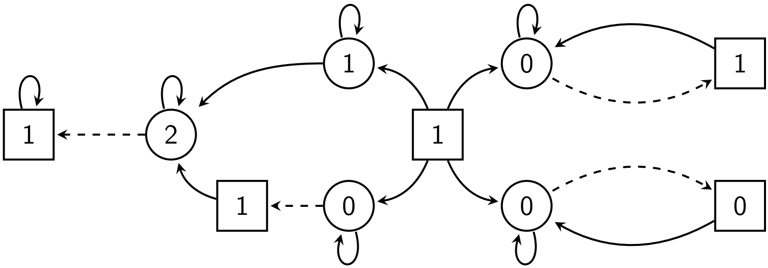

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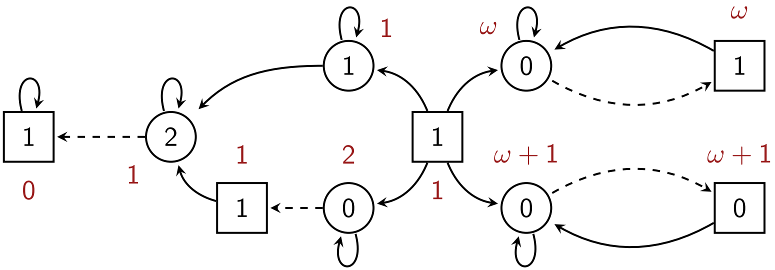

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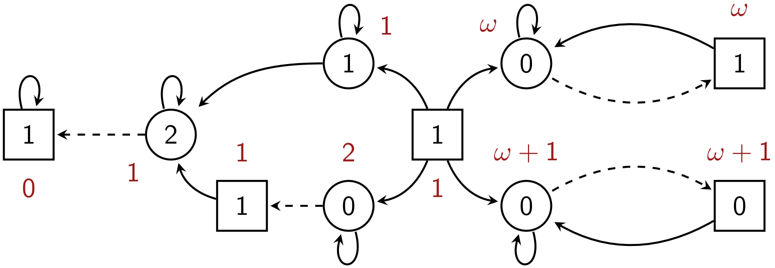
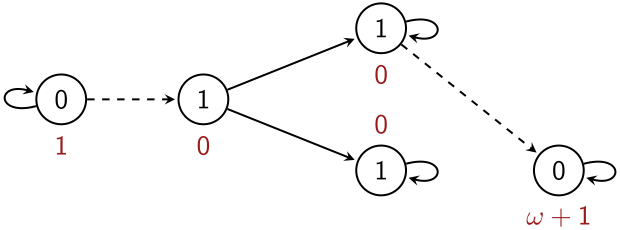


Theorem (NWZ'18)

The resilience of the vertices of a parity game $\mathcal{G}$ and a memoryless optimally resilient strategy for $\mathcal{G}$ are computable in quasi-polynomial time.

Disturbances make games more interesting!



Disturbances can be desirable:

- From upper vertex, one disturbance takes Player 0 from her opponent's winning region to her own
- From the lower vertex, there is no such chance for recovery

Note that both vertices have resilience 0

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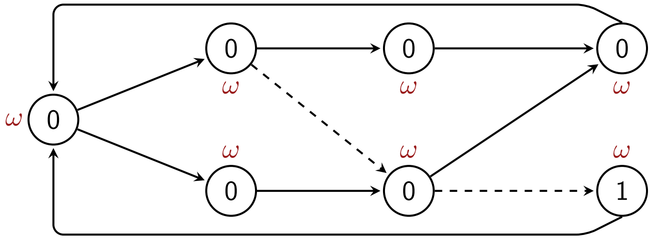
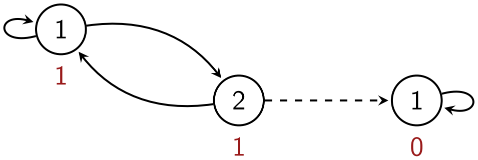


Tradeoff: disturbances vs. winning condition

- If odd colors are to be avoided, then the upper route is preferable (it takes two consecutive disturbances to reach 1)
- If disturbances are to be avoided, then the lower route is preferable (only one disturbance possible)

Note that both strategies witness all vertices having resilience ω

Disturbances make games more interesting!



Tradeoff: disturbances vs. memory

- The more memory Player 0 uses, the more she can avoid the risk of a fatal disturbance,
- but she has to take the risk infinitely often to satisfy the parity condition.