Synthesizing Optimally Resilient Controllers

Joint work with Daniel Neider and Alexander Weinert

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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?
**Definition**

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

- starts in $v$,
- is consistent with $\sigma$, and
- has strictly less than $k$ disturbances

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

Theorem (DNT’16)

The resilience of the vertices of a safety game $G$ and a memoryless optimally resilient strategy for $G$ are computable in polynomial time.
Neider, Weinert, Z. ('17): What about (max-) parity games?

![Diagram of a parity game with states and transitions]
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Theorem (NWZ’18)

The resilience of the vertices of a parity game $G$ and a memoryless optimally resilient strategy for $G$ 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
Disturbances make games more interesting!

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.

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