

On the Complexity of Slide-and-Merge Games

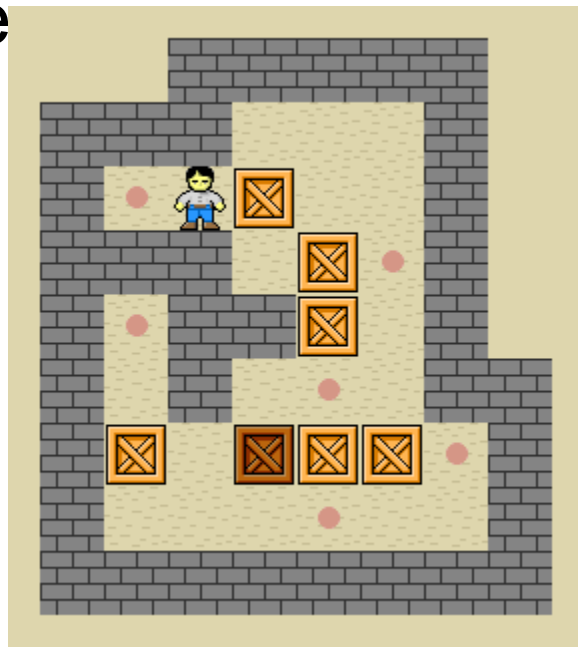
Ahmed Abdelkader, Aditya Acharya, Philip Dasler

Slide and Merge Games

- Slide tiles in a $N \times N$ grid
- Equal valued tiles merge
- Objective: To produce a tile of a given target value

Related Work

- Push-1: A block pushing puzzle
- Move to the target location by pushing blocks
- PushPush: Blocks slide all the way
- Shown to be NP-Hard [Demaine et al. 2000]



Related Work

- Bejeweled and Candy Crush:
- Match three similar three tiles to make them disappear
- Objective: to create as many matching as possible
- Shown to be NP-Hard [Guala et al. 2014]



2048

- Like tiles merge
- All pieces slide as far as possible
- All single merges that can happen, will
- New tiles $\in \{2,4\}$ are added randomly
- Objective: Obtaining a tile of value 2048

Reduction Approaches

- Bejeweled, Candy Crush shown to be NP-Hard: reduction from 1-in-3 Positive SAT
- Clauses encoded by a pattern of tiles, satisfied by clearing those tiles
- Assignments of variables encoded by the choice of tiles to merge

Reduction Approaches

- Push is NP-Hard in 3D [Rourke 1999] by a reduction from SAT
- Push in 2D:
- Similar approach to reduction in 3D
- Extra gadgets to take care of path intersection