# 2048 is NP-Complete

#### Ahmed Abdelkader, Aditya Acharya, Philip Dasler

**Department of Computer Science, University of Maryland** 

## Original game:

- 4x4 board
- $\bullet \quad \{\leftarrow,\rightarrow,\uparrow,\downarrow\}$
- New {2, 4} each turn
- $2^i + 2^i \Rightarrow 2^{i+1}$
- Goal: 2048

### Variant studied:

- Big board
- No new tiles
- Goal: ≥ 256
- ∈ NP (by Chris Chen)

		_			_	_	_	_	_	_		_	_		_	_	_	_	_	_	_		
2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2
2	4	2	4	2	4	2	4	2	4	2		16	4	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	4	32	64	2	4	2	4	2	4	2	4	2	4	2
2	4	2	4	2	4	2	4	2	4		4	2	16	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	32	2	4	64	4	2	4	2	4	2	4	2	4	2
2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2
2	4	2	i:	3	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2
2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	4	16	64	2	4	2	4	2	4	2	4	2	4	2
2	4			16	16	2	4	2	16	64	4	2	16	64	4	2	4			16	16	2	4
4	2	32	32	64	64	4	2	4		32	2	4		32	2	4	2	32	32	64	64	4	2
2	4	2	4	2	4	2	4	2	4	2	8	32	4	2	4	2	4	2	4	2	4	2	4
4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2
2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4

### **Result:**

∈ NP-hard ∈ ≥ 3SAT

**Building Block of Reduction**