Lights Out!

Math Circle Advanced Group

October 11th, 2025

Lights Out Introduction

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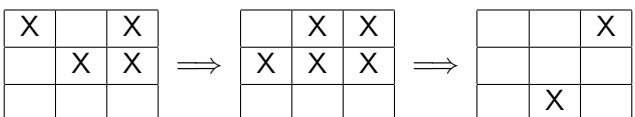
The catch: turning on or off a light *also changes all adjacent lights.*

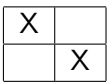
Example

Let X represent a light that is on and a blank space represent a light that is off. Then, as an example for a 3×3 grid, if we turn off the first light and then turn on the center light:



Try it

Which of these light grids can be solved (have all of their lights turned off)?



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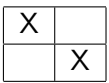

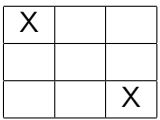

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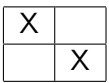

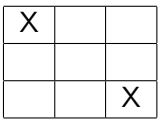

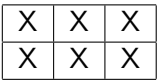

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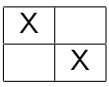

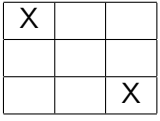

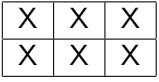

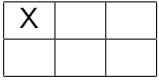

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- How about 2×3 boards?

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- Can you encode the graph information in a better way? (Perhaps with a system of equations...)
- How would you check solvability of this game on a computer?
- What if instead of a grid, you played this game on a torus?