



## 1 Safe Christmas!

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### Challenge

It is almost time to distribute the Christmas presents, but Santa Claus is nowhere to be found! All Christmas presents are stored in a safe, and Santa Claus appears to be the only person who knows how to open the safe. The safe is unique as it does not require a numerical code, but it opens once all lights are turned off or on. The elves are desperate and ask you to look and find a strategy to open the safe. You are the only one who can save Christmas! You decide to take a closer look at the safe. A large not rotatable disc with four light switches is on the door's exterior. Each switch can either be in an 'on' or 'off' position. Behind each switch is a light bulb that is either on or off, depending on the position of the switch controlling it. The bulbs are inside the safe; therefore, you cannot see them. The disc with the bulbs on the inside is rotatable.

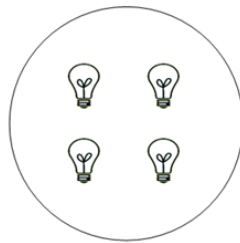


Figure 1: Interior of the lock of the safe.

The safe door opens once all lights are turned off, or all lights are turned on. You will use the switches on the safe door to open the safe. You can switch

1 or 2 switches at each try. After each try, the disc rotates an unknown number of quarter turns (given that the door did not open).

### Your task

It is up to you to design a strategy that always opens the safe, regardless of the current state of the lock. Give your strategy as a sequence of the actions you need to take in order to open the safe, where the possible actions are decoded in the following way:

- (1) : Pressing 1 button
- (D) : Pressing 2 diagonally adjacent buttons
- (A) : Pressing 2 horizontally or vertically adjacent buttons

If the safe is open once, by all lights being turned on or turned off, the game is over and Christmas is saved!

*Hint:* One way to start could be to write down all possible states where the lock can be. What happens when the disc with the bulbs rotates? Are there similar states? Consider how the given actions influence each state. Time to save Christmas!

*Note:* Explanation for understanding the switches: Each switch has two positions. When a switch is flipped, the state of the connected light bulb changes, regardless of the switch's previous position (i.e., it does not matter whether the switch is flipped from top to bottom or from bottom to top).

### Possible answers:

1. (1)  $\rightarrow$  (A)  $\rightarrow$  (D)
2. (D)  $\rightarrow$  (A)  $\rightarrow$  (1)  $\rightarrow$  (D)  $\rightarrow$  (A)
3. (A)  $\rightarrow$  (D)  $\rightarrow$  (1)  $\rightarrow$  (A)  $\rightarrow$  (D)
4. (D)  $\rightarrow$  (A)  $\rightarrow$  (A)  $\rightarrow$  (1)  $\rightarrow$  (D)  $\rightarrow$  (A)  $\rightarrow$  (A)
5. (D)  $\rightarrow$  (A)  $\rightarrow$  (1)
6. (D)  $\rightarrow$  (A)  $\rightarrow$  (D)  $\rightarrow$  (1)  $\rightarrow$  (D)  $\rightarrow$  (A)  $\rightarrow$  (D)
7. (1)  $\rightarrow$  (A)  $\rightarrow$  (D)  $\rightarrow$  (1)  $\rightarrow$  (A)  $\rightarrow$  (D)
8. (A)  $\rightarrow$  (1)  $\rightarrow$  (A)  $\rightarrow$  (D)

9.  $(1) \rightarrow (D) \rightarrow (A)$

10.  $(A) \rightarrow (1) \rightarrow (A) \rightarrow (D) \rightarrow (A) \rightarrow (1) \rightarrow (D)$