

**COMP6207 ALGORITHMIC GAME THEORY, SPRING 2022**

# **RESPONSIBILITY**

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# STRATEGIC GAMES

|    | b1                                                                                 | b2                                                                                  | b3                                                                                    |
|----|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| a1 |   |   |                                                                                       |
| a2 |  |  |   |
| a3 |                                                                                    |                                                                                     |  |

# STRATEGIC GAMES

|    | b1 | b2 | b3 | $S_a (\text{☀})$ |
|----|----|----|----|------------------|
| a1 | ☀  | ☀  |    |                  |
| a2 | ☀  | ☀  | ☀  |                  |
| a3 |    |    | ☀  |                  |

# STRATEGIC GAMES

|    | b1 | b2 | b3 |                       |
|----|----|----|----|-----------------------|
| a1 | ☀  | ☀  |    | $S_a (\text{☀})$      |
| a2 | ☀  | ☀  | ☀  | $\neg S_b (\text{☀})$ |
| a3 |    |    | ☀  |                       |

# STRATEGIC GAMES

|    | b1  | b2  | b3  |
|----|-----|-----|-----|
| a1 | ☀️🌷 | ☀️  | 🌷   |
| a2 | ☀️🌷 | ☀️🌷 | ☀️  |
| a3 | 🌷   |     | ☀️🌷 |

# STRATEGIC GAMES

|    | b1                                                                                  | b2                                                                                   | b3                                                                                    | $S_a (\text{☀})$ |
|----|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------------|
| a1 |    |   |    |                  |
| a2 |  |  |  |                  |
| a3 |  |                                                                                      |  |                  |

# STRATEGIC GAMES

|    | b1                                                                                  | b2                                                                                   | b3                                                                                    |
|----|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| a1 |    |    |    |
| a2 |  |  |  |
| a3 |  |                                                                                      |  |

$S_a (\text{☀})$

$\neg S_b (\text{☀})$

# STRATEGIC GAMES

|    | b1                                                                                  | b2                                                                                   | b3                                                                                    |
|----|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| a1 |    |    |    |
| a2 |  |  |  |
| a3 |  |                                                                                      |  |

$S_a (\text{☀})$

$\neg S_b (\text{☀})$

$\neg S_a (\text{🌸})$

# STRATEGIC GAMES

|    | b1                                                                                  | b2                                                                                   | b3                                                                                    |
|----|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| a1 |    |    |    |
| a2 |  |  |  |
| a3 |  |                                                                                      |  |

$S_a (\text{☀})$

$\neg S_b (\text{☀})$

$\neg S_a (\text{🌸})$

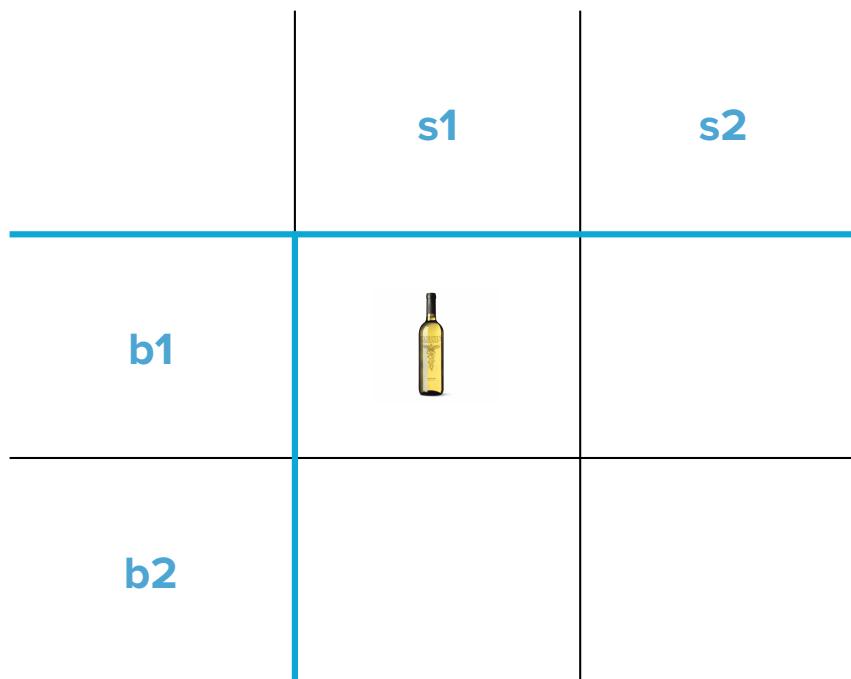
$S_b (\text{🌸})$

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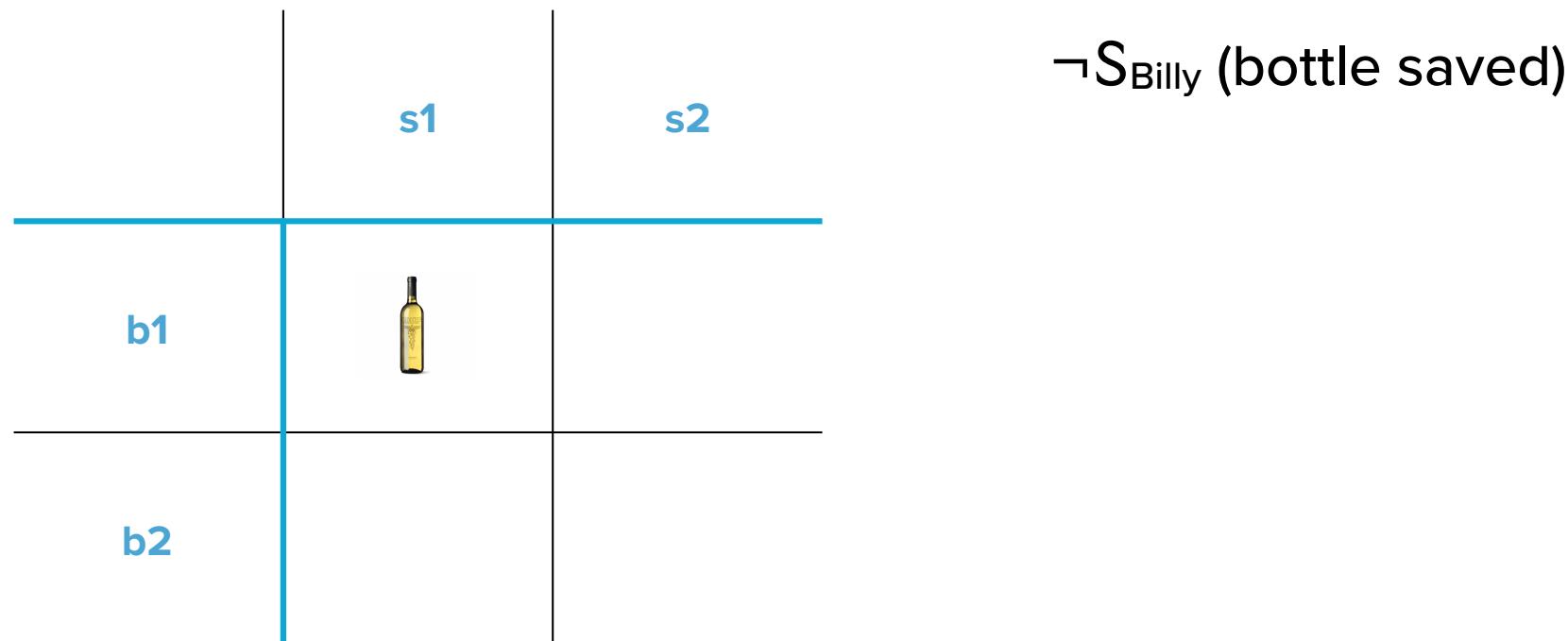
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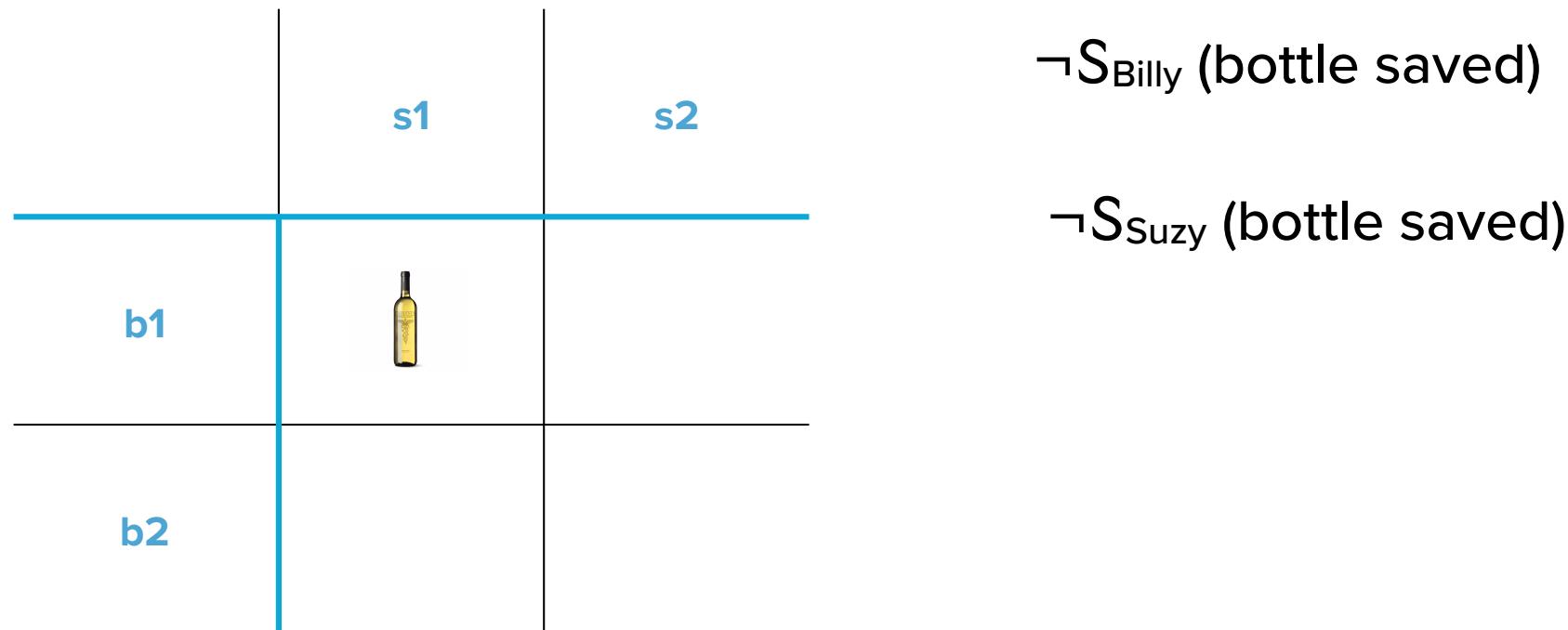
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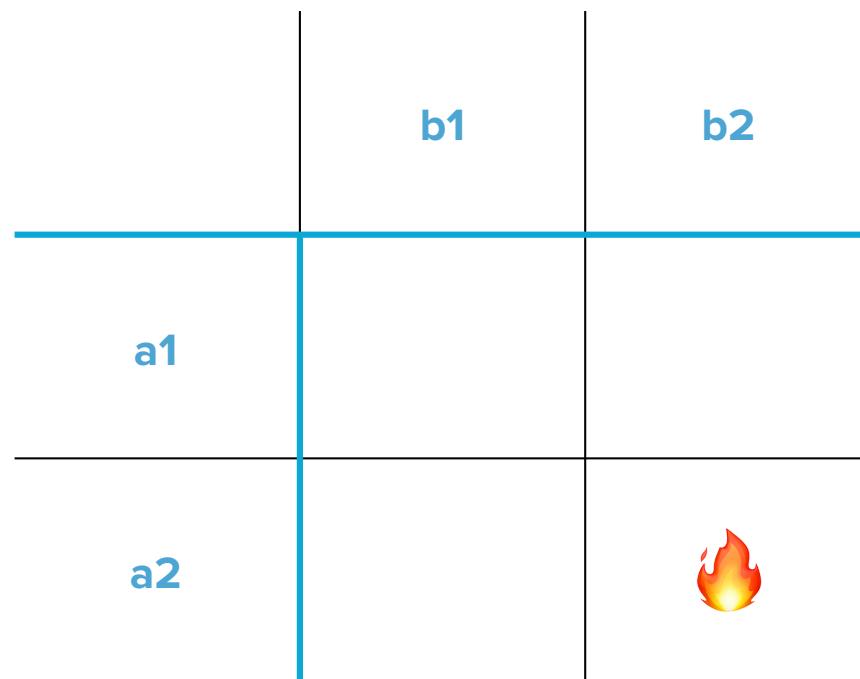


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Anne negligently spills gasoline, and Bob carelessly throws a cigarette into the spilled gasoline, then Anne's action is a cause of the fire. — J. Halpern, 2016

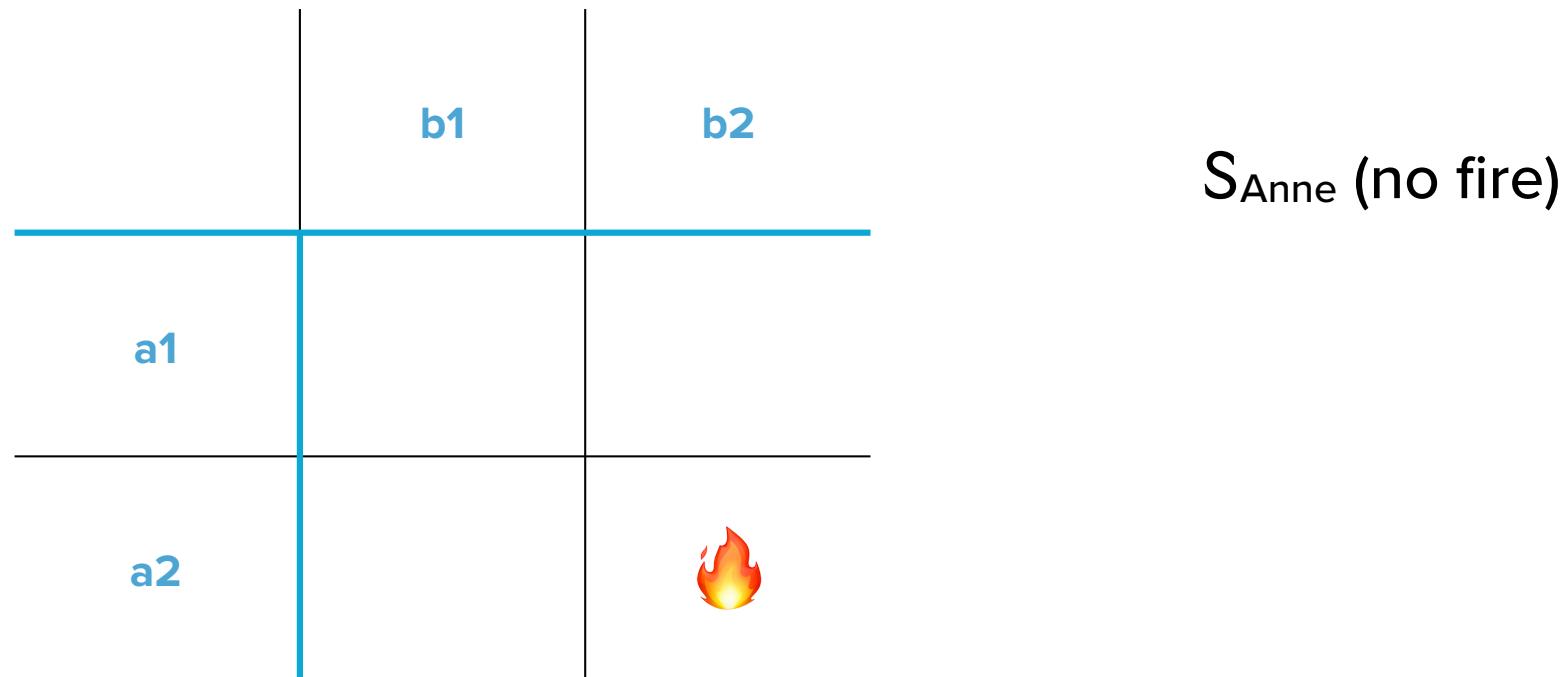
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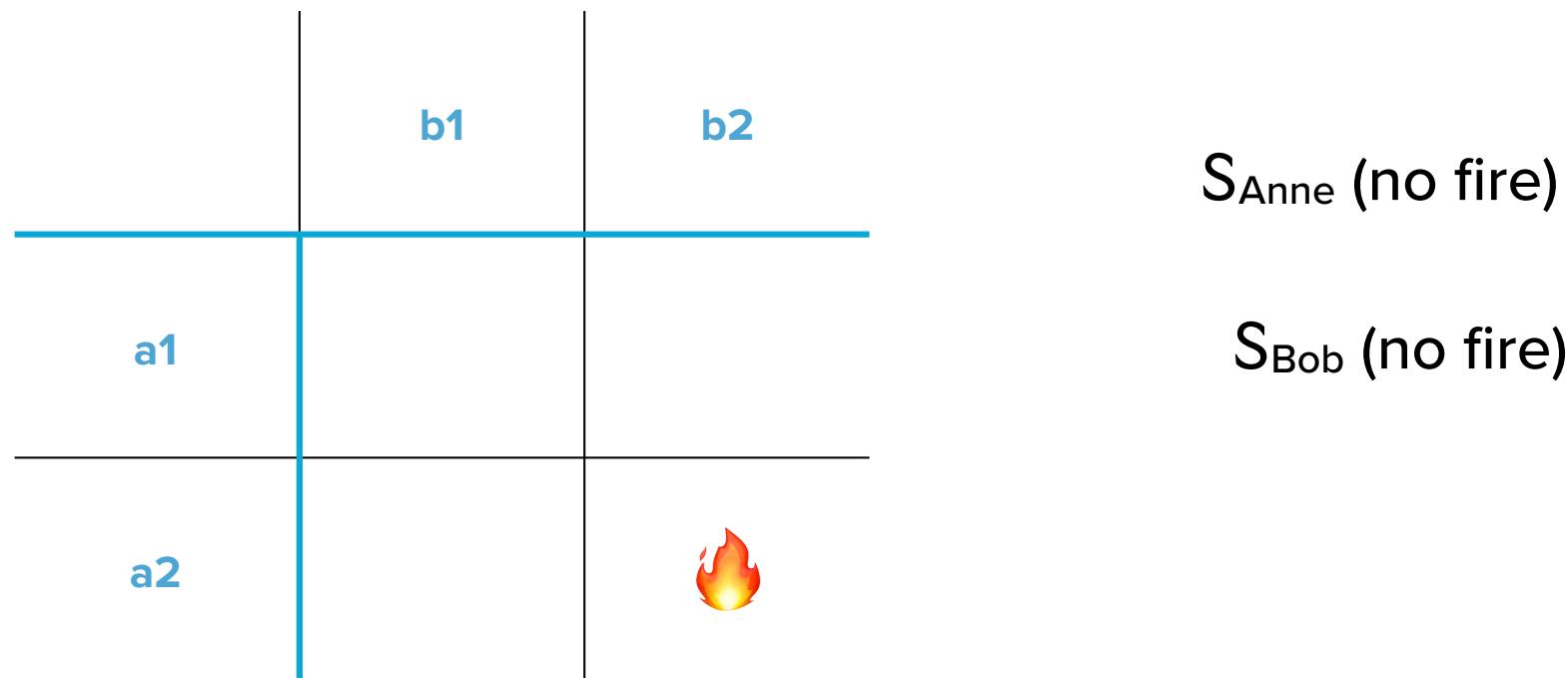
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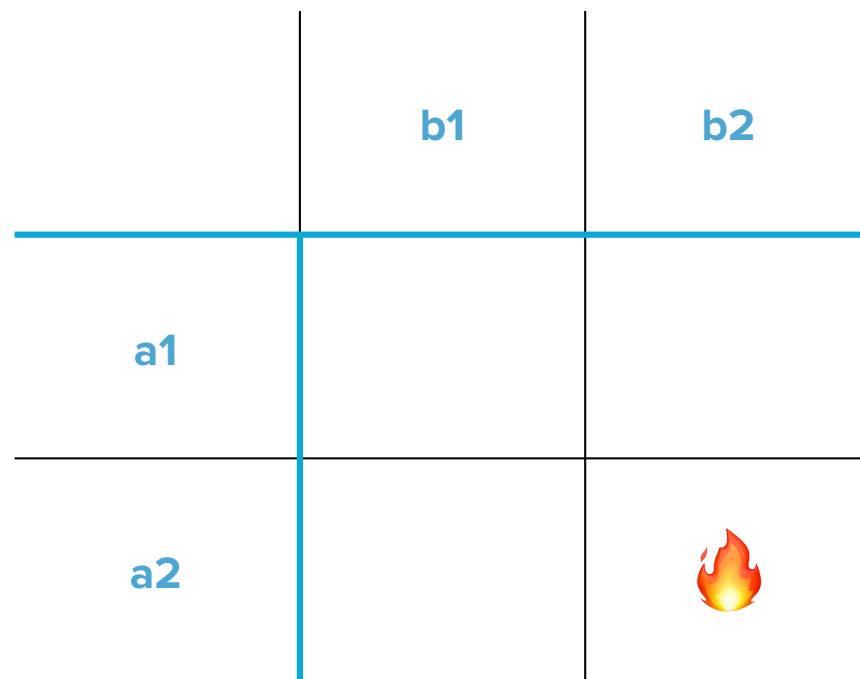


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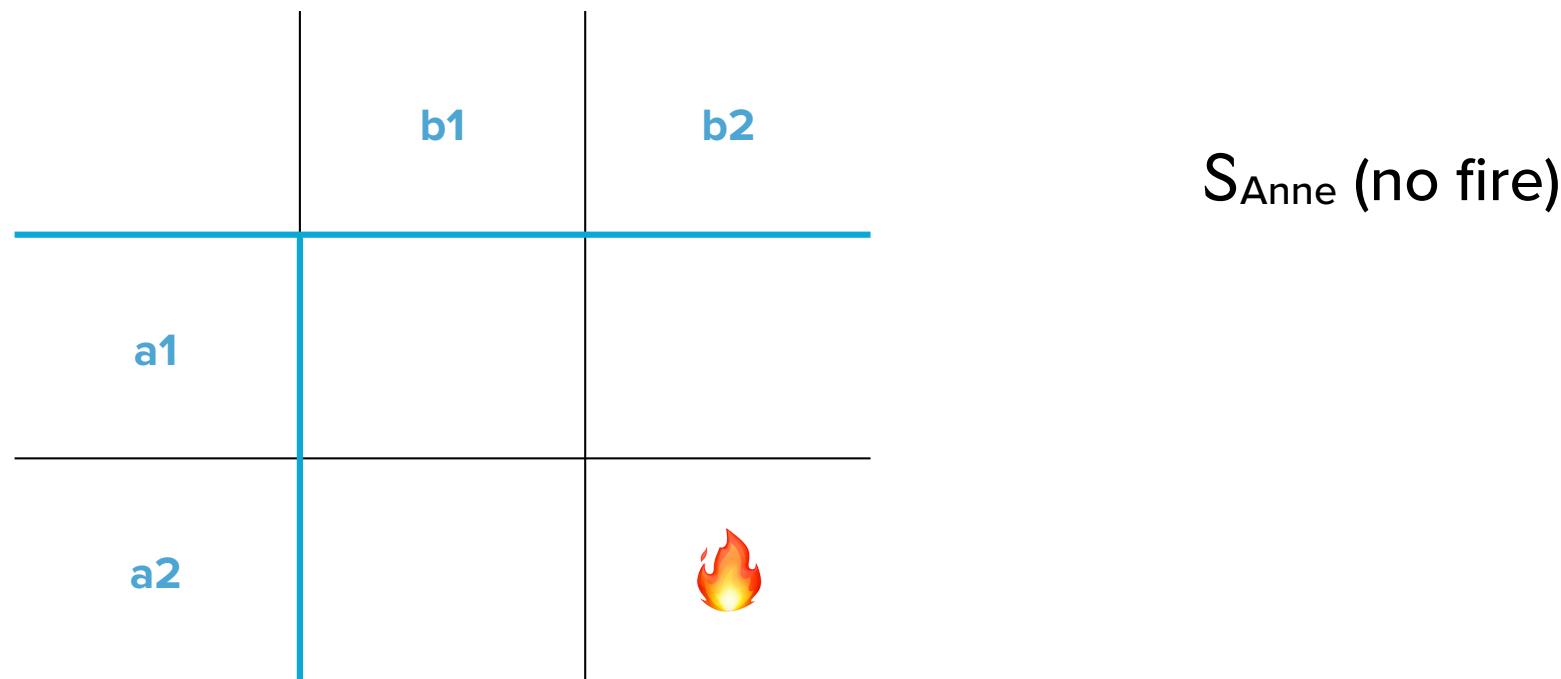
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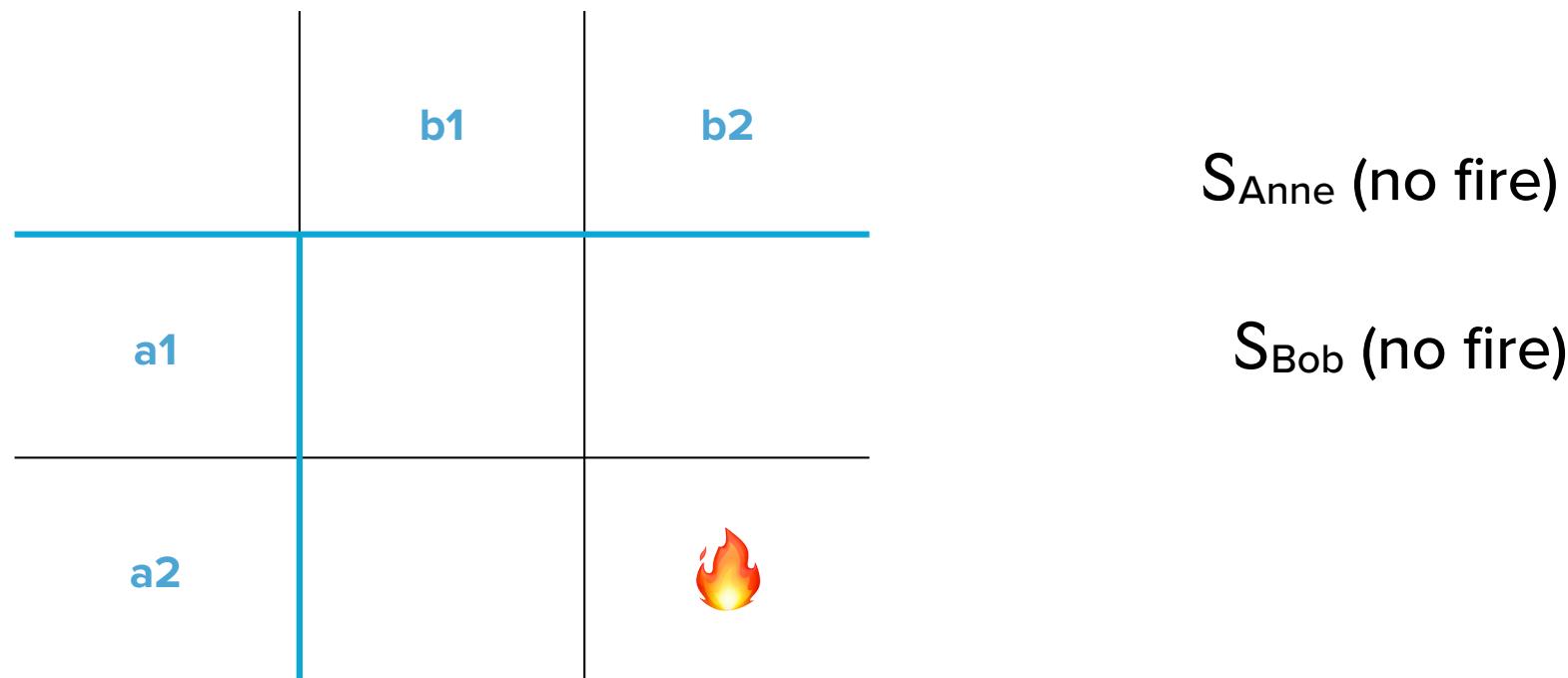
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# RIVER POLLUTION

Suppose that two companies both dump pollutant into the river. Company A dumps 100 kilograms of pollutant; company B dumps 60 kilograms. The fish in the river die. Biologists determine that  $k$  kilograms of pollutant suffice for the fish to die. Which company is the cause of the fish dying if  $k = 120$ , if  $k = 80$ , and if  $k = 50$ ? J. Halpern, 2015

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$$k=50$$

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$$k=50$$

$\neg S_A$  (fish alive)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$$k=50$$

$\neg S_A$  (fish alive)

$\neg S_B$  (fish alive)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$\neg S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$\neg S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

$S_A$  (fish alive)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$\neg S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

$S_A$  (fish alive)  
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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

$S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

$S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

$S_A$  (fish alive)  
 $\neg S_B$  (fish alive)

$S_A$  (fish alive)  
 $S_A$  (fish alive)

# INTERNATIONAL SALSA COMPETITION

You are the manager of your home country's team in the International Salsa Competition. Your team consists of Alice, Bob, Chuck, and Dan. In order to compete in the tournament, Alice will need to show up and at least one of her partners. You instruct all of them to come to the tournament. However, as it turns out, none of them show up on the day of the competition — Zultan, Gerstenberg, and Lagnado, 2012



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$\neg S_{\text{Alice}}$  (team competes)

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$S_{\text{Alice}, \text{Bob}}$  (team competes)

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$S_{\text{Alice}, \text{Bob}}$  (team competes)

$\neg S_{\text{Bob}, \text{Chuck}}$  (team competes)

# BLAMEWORTHINESS

A PERSON IS MORALLY RESPONSIBLE  
FOR WHAT HE HAS DONE ONLY IF HE  
COULD HAVE DONE OTHERWISE

FRANKFURT, 1969

# BLAMABLE

|    | b1 | b2 | b3 |
|----|----|----|----|
| a1 |    |    |    |
| a2 |    |    | 🔥  |
| a3 | 🔥  | 🔥  |    |

A is blamable

|    | b1 | b2 | b3 |
|----|----|----|----|
| a1 |    |    |    |
| a2 | 🔥  | 🔥  | 🔥  |
| a3 | 🔥  |    |    |

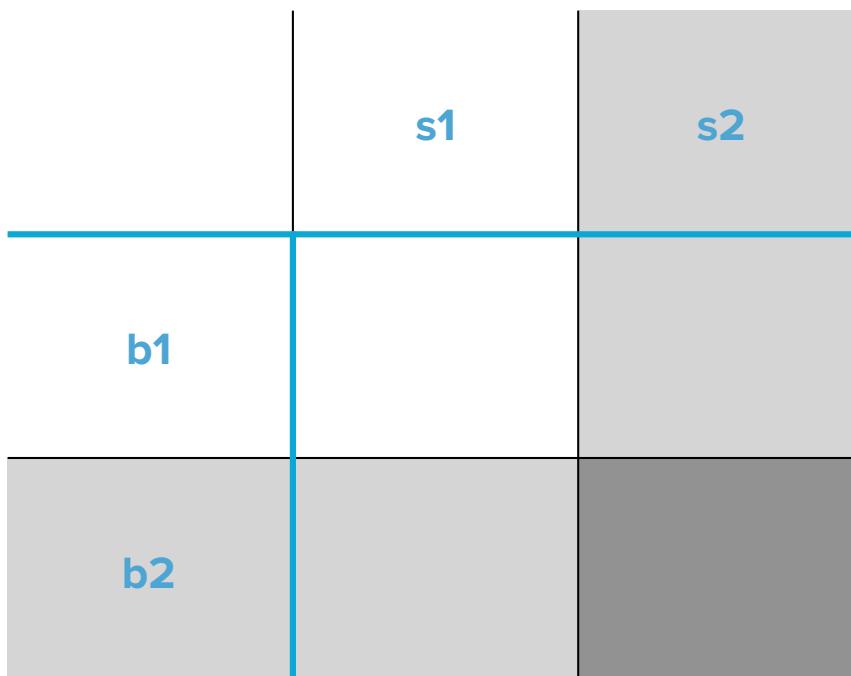
A is not blamable

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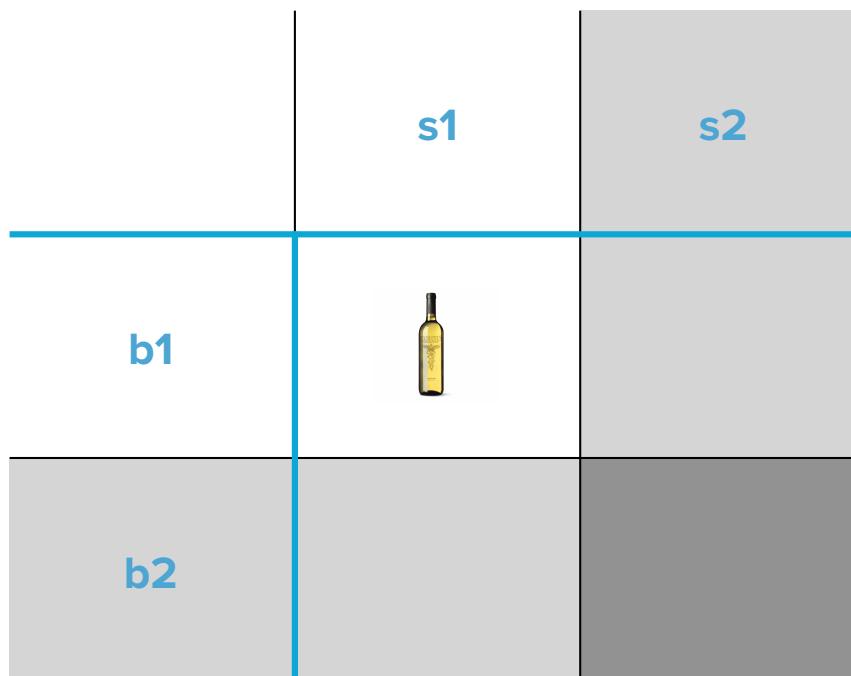
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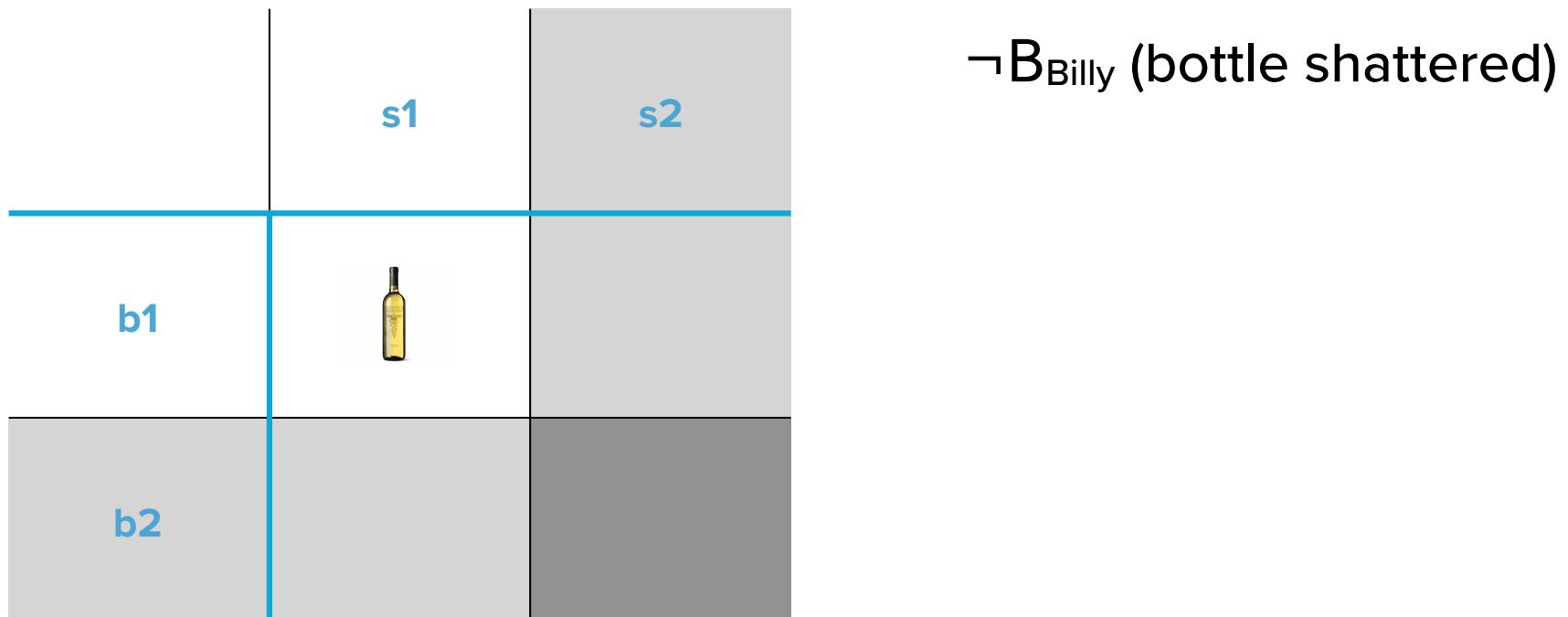
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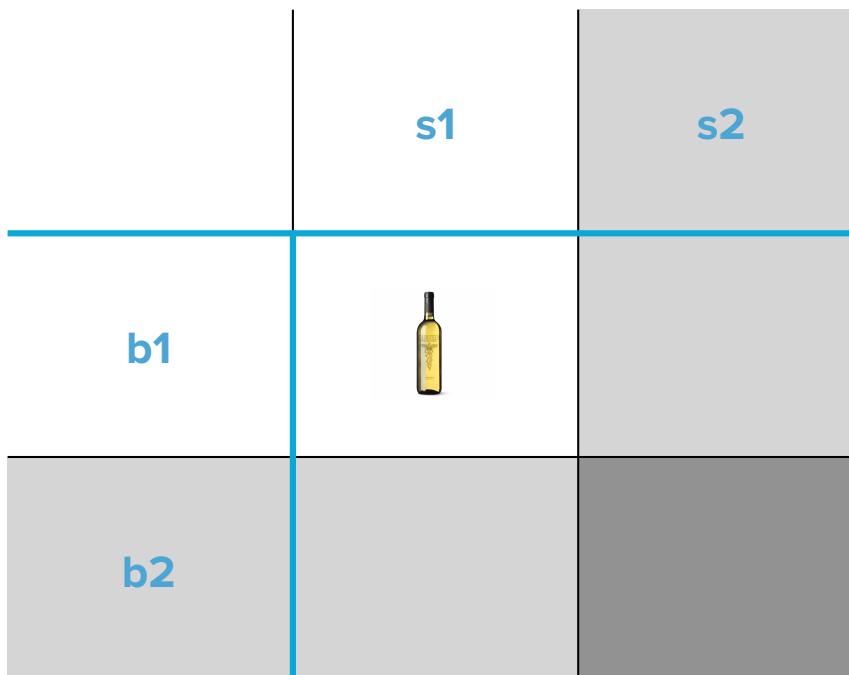
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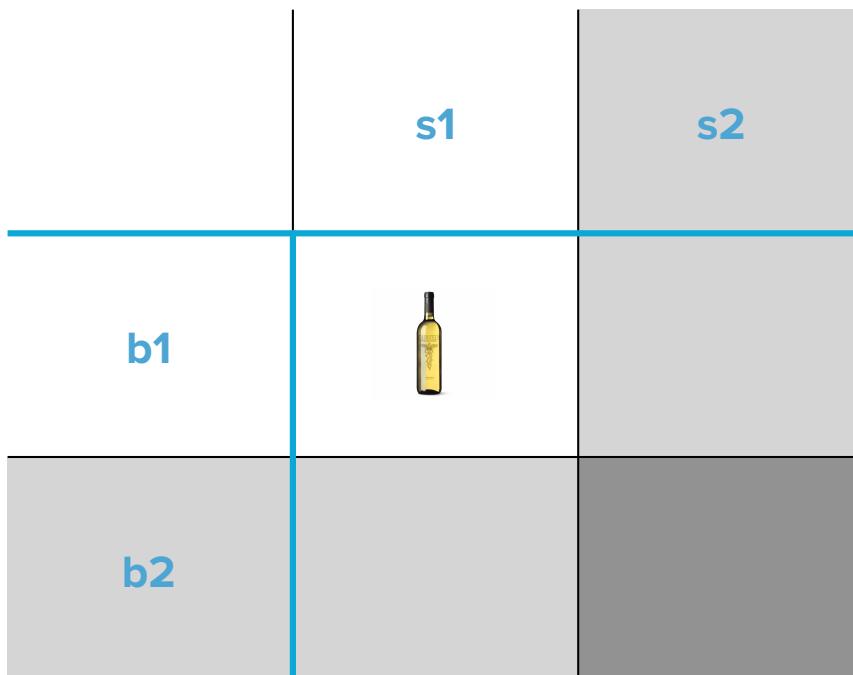


$\neg B_{\text{Billy}}$  (bottle shattered)

$\neg B_{\text{Suzy}}$  (bottle shattered)

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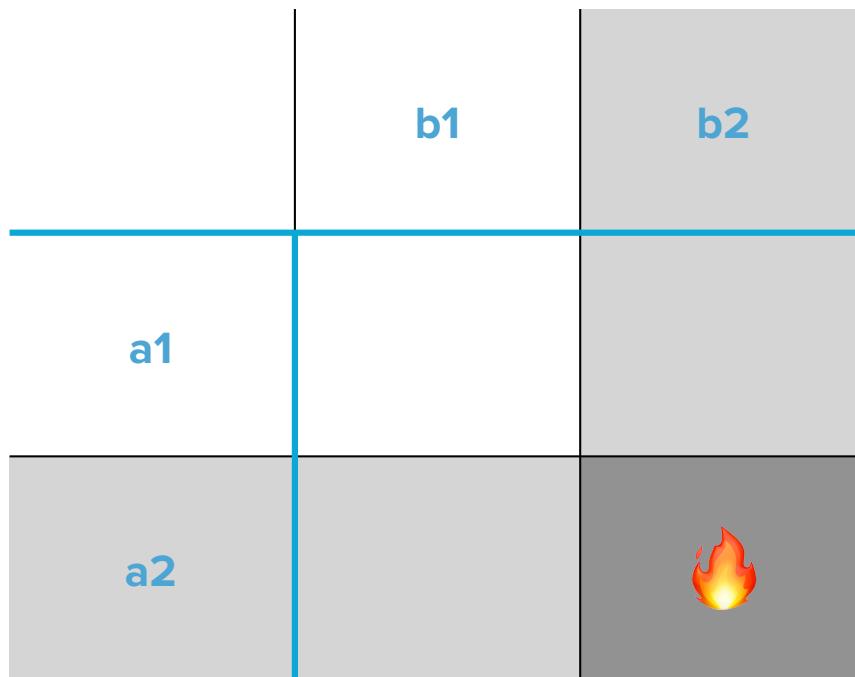
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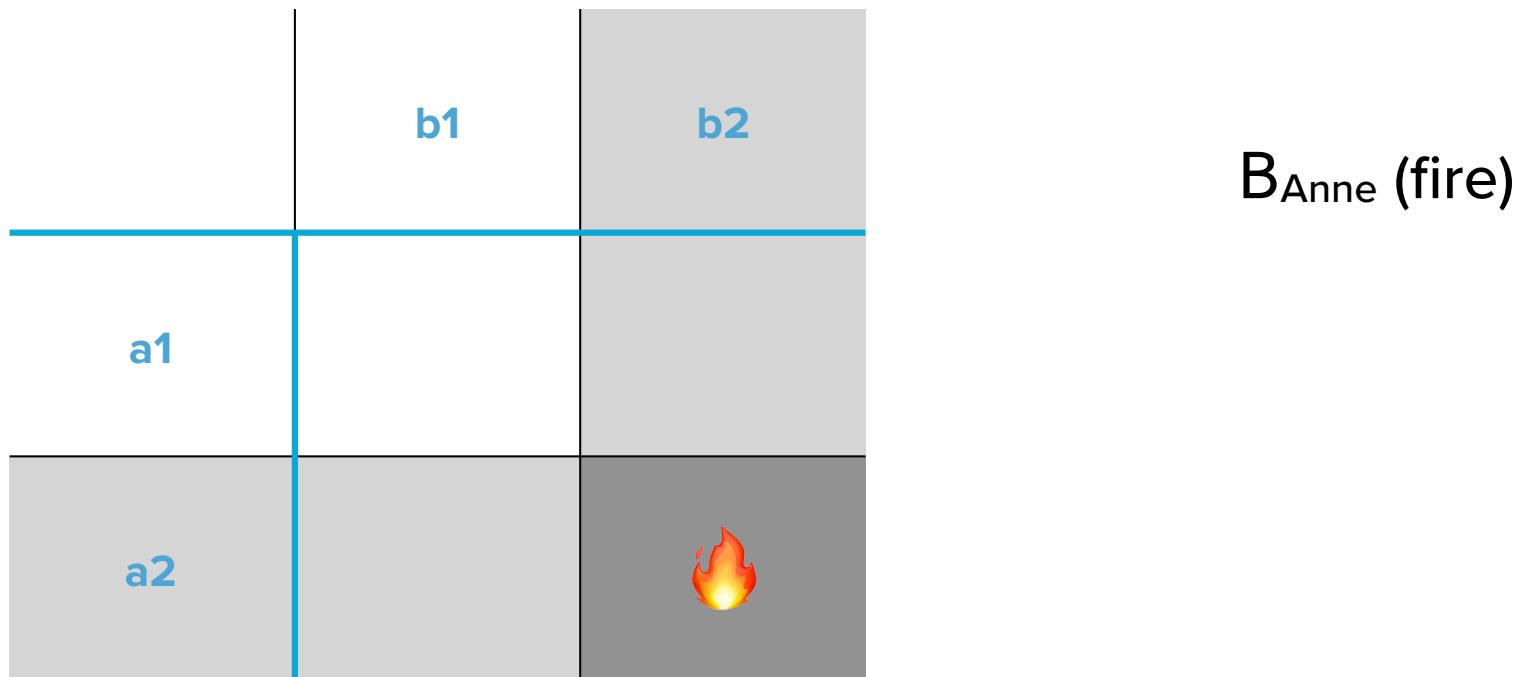
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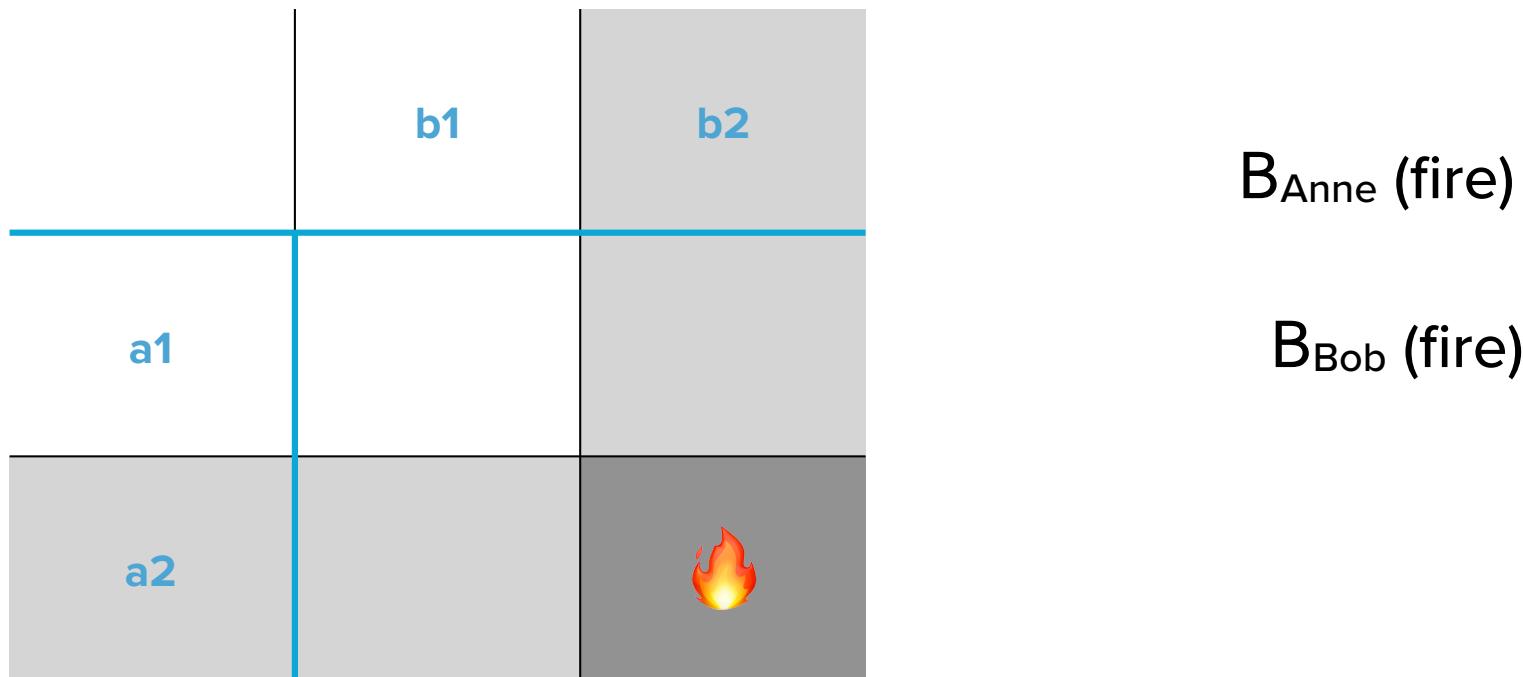
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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

$\neg B_A$  (fish dead)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

$\neg B_A$  (fish dead)

$\neg B_B$  (fish dead)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=50$

$\neg B_A$  (fish dead)

$\neg B_B$  (fish dead)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$\neg B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$\neg B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

$B_A$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

- $\neg B_A$  (fish dead)
- $\neg B_B$  (fish dead)

- $B_A$  (fish dead)
- $\neg B_B$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$\neg B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

$B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

$B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

$B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

$B_A$  (fish dead)  
 $\neg B_B$  (fish dead)

$B_A$  (fish dead)  
 $B_A$  (fish dead)

# INTERNATIONAL SALSA COMPETITION

You are the manager of your home country's team in the International Salsa Competition. Your team consists of Alice, Bob, Chuck, and Dan. In order to compete in the tournament, Alice will need to show up and at least one of her partners. You instruct all of them to come to the tournament. However, as it turns out, none of them show up on the day of the competition — Zultan, Gerstenberg, and Lagnado, 2012



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$\neg B_{Alice}$  (team did not compete)



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$\neg B_{Alice}$  (team did not compete)

$\neg B_{Bob}$  (team did not compete)

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- $\neg B_{\text{Alice}}$  (team did not compete)
- $\neg B_{\text{Bob}}$  (team did not compete)
- $\neg B_{\text{Chuck}}$  (team did not compete)
- $\neg B_{\text{Dan}}$  (team did not compete)

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- $\neg B_{Alice}$  (team did not compete)
- $\neg B_{Bob}$  (team did not compete)
- $\neg B_{Chuck}$  (team did not compete)
- $\neg B_{Dan}$  (team did not compete)
- $B_{Alice, Bob}$  (team did not compete)

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- $\neg B_{Alice}$  (team did not compete)
- $\neg B_{Bob}$  (team did not compete)
- $\neg B_{Chuck}$  (team did not compete)
- $\neg B_{Dan}$  (team did not compete)
- $B_{Alice,Bob}$  (team did not compete)
- $B_{Alice,Chuck}$  (team did not compete)
- $B_{Alice,Dan}$  (team did not compete)

**SEEING TO IT THAT**

# BLAMABLE VS. SEEING TO IT

|    | b1 | b2 | b3 |
|----|----|----|----|
| a1 |    |    |    |
| a2 |    |    | 🔥  |
| a3 | 🔥  | 🔥  |    |

A is blamable, but is not seeing to fire

|    | b1 | b2 | b3 |
|----|----|----|----|
| a1 |    |    |    |
| a2 | 🔥  | 🔥  | 🔥  |
| a3 | 🔥  |    |    |

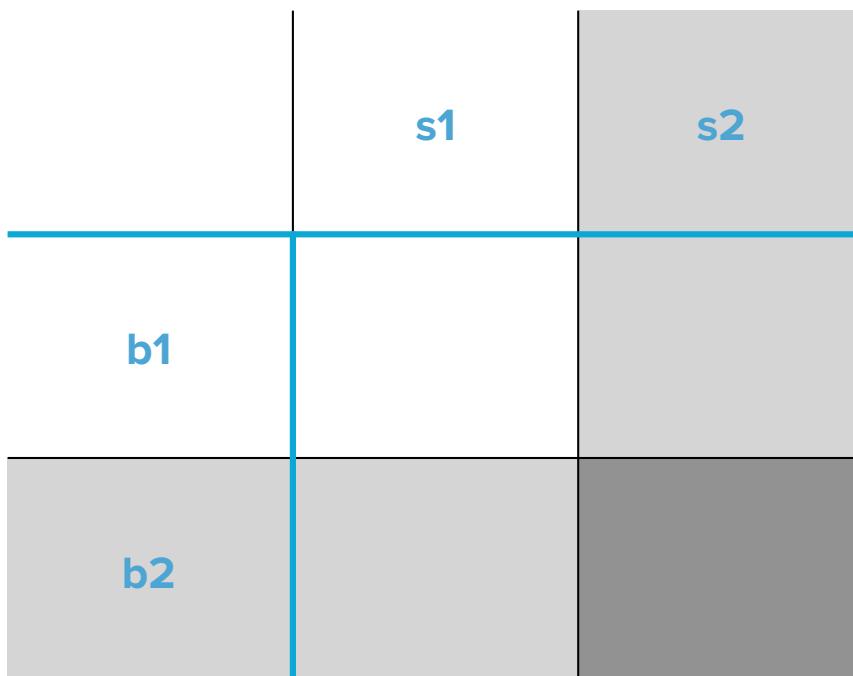
A is seeing to fire, but is not blamable

# THROWING ROCKS

Billy and Suzy throw rocks at a bottle. Suzy throws first, or maybe she throws harder. Her rock arrives first. The bottle shatters. When Billy's rock gets to where the bottle used to be, there is nothing there but flying shards of glass. Without Suzy's throw, the impact of Billy's rock on the intact bottle would have been one of the final steps in the causal chain from Billy's throw to the shattering of the bottle. But, thanks to Suzy's preempting throw, that impact never happens. — D. Lewis, 2000

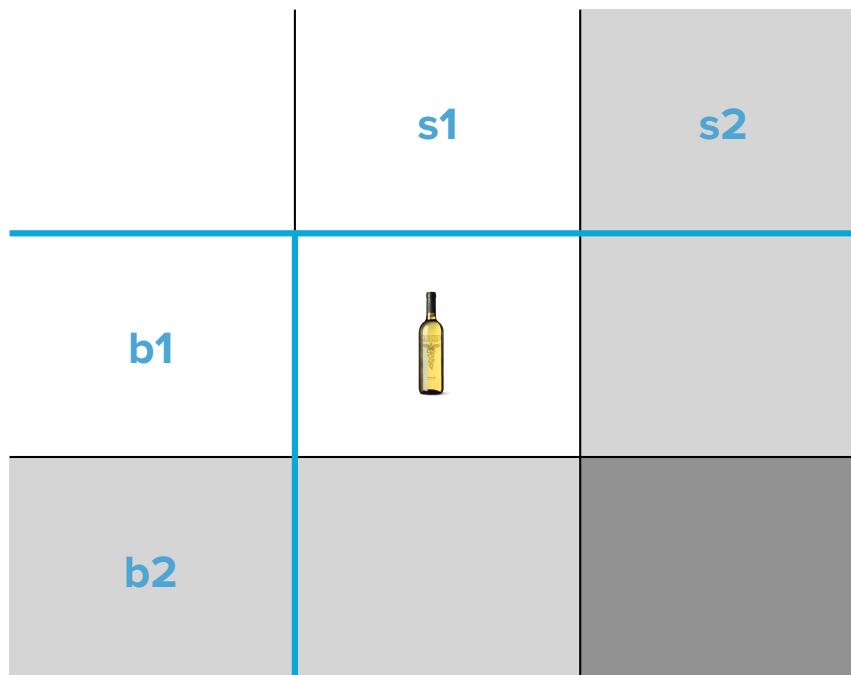
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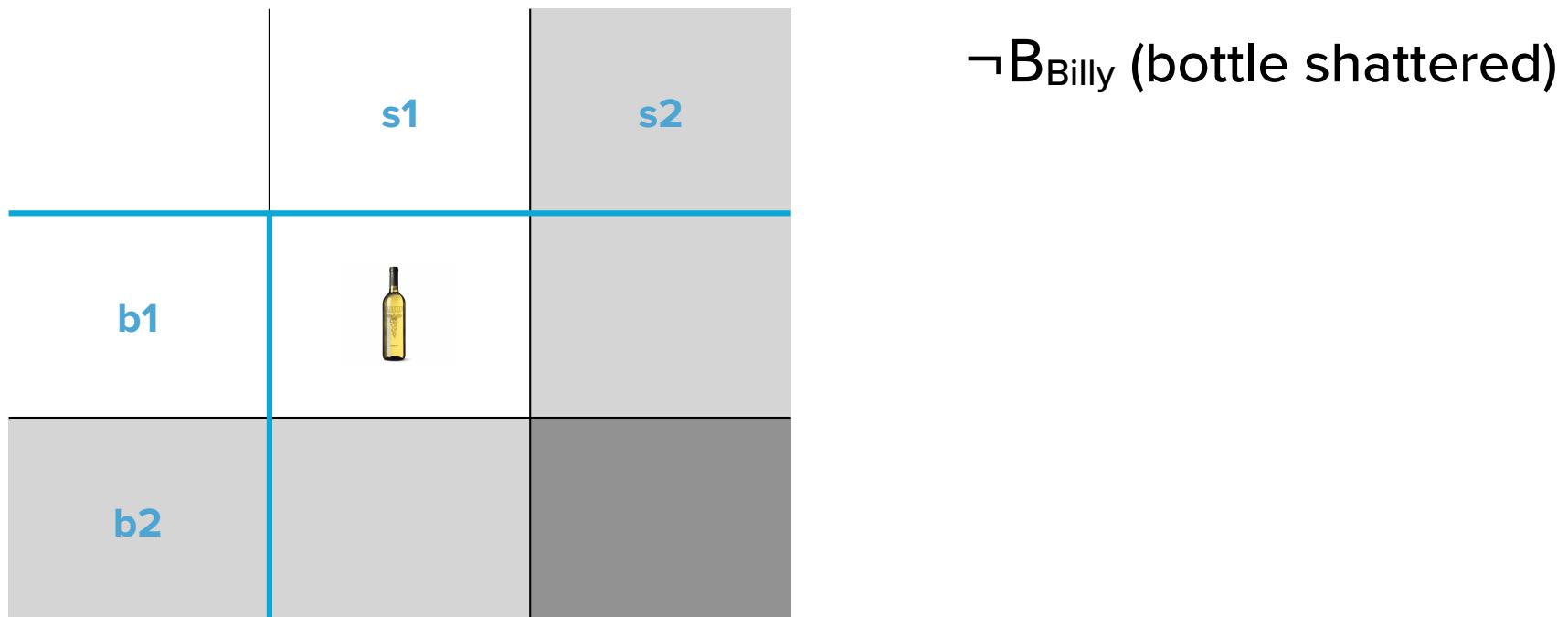
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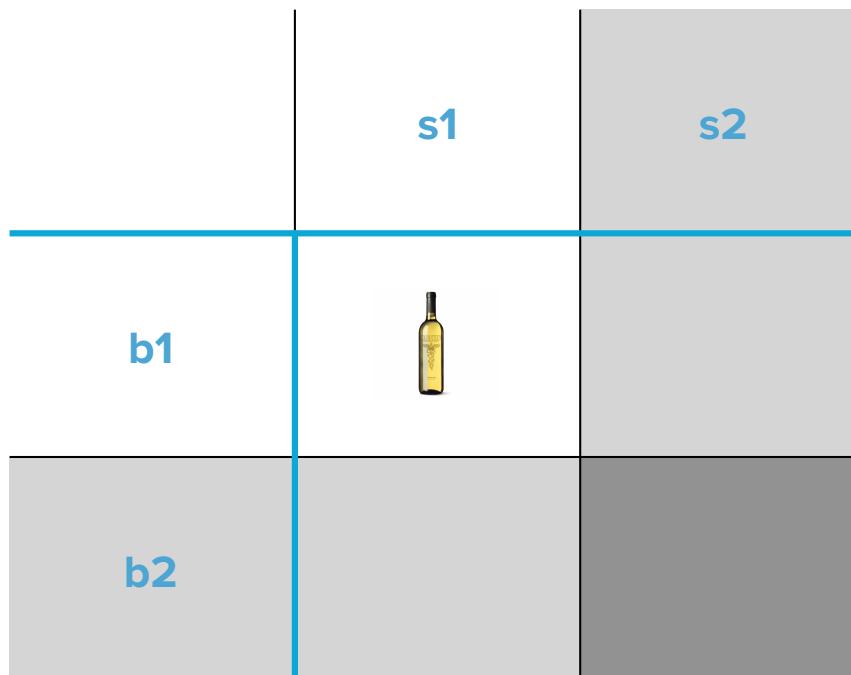
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$\neg B_{\text{Billy}}$  (bottle shattered)

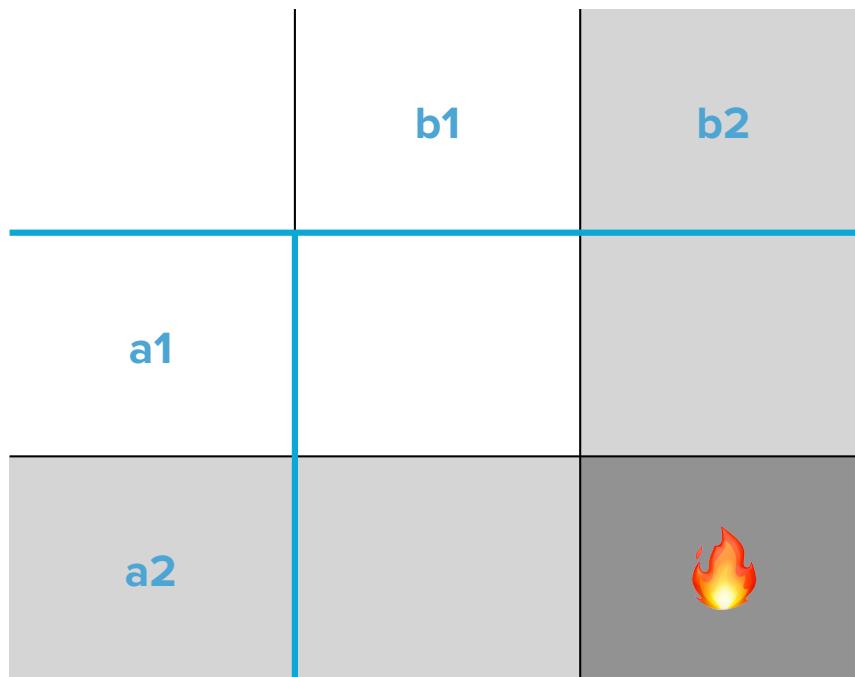
$ST_{\text{Billy}}$  (bottle shattered)

# STARTING A FIRE

Anne negligently spills gasoline, and Bob carelessly throws a cigarette into the spilled gasoline, then Anne's action is a cause of the fire. — J. Halpern, 2016

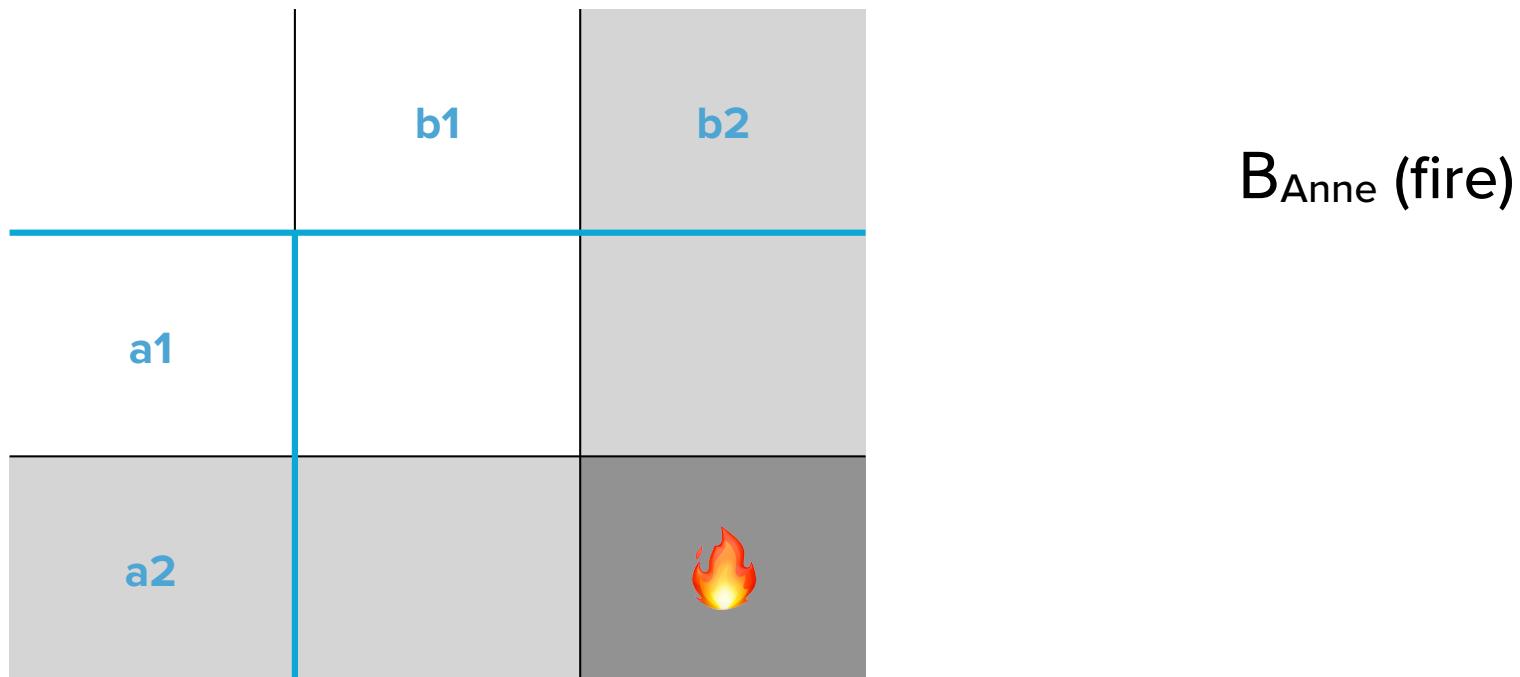
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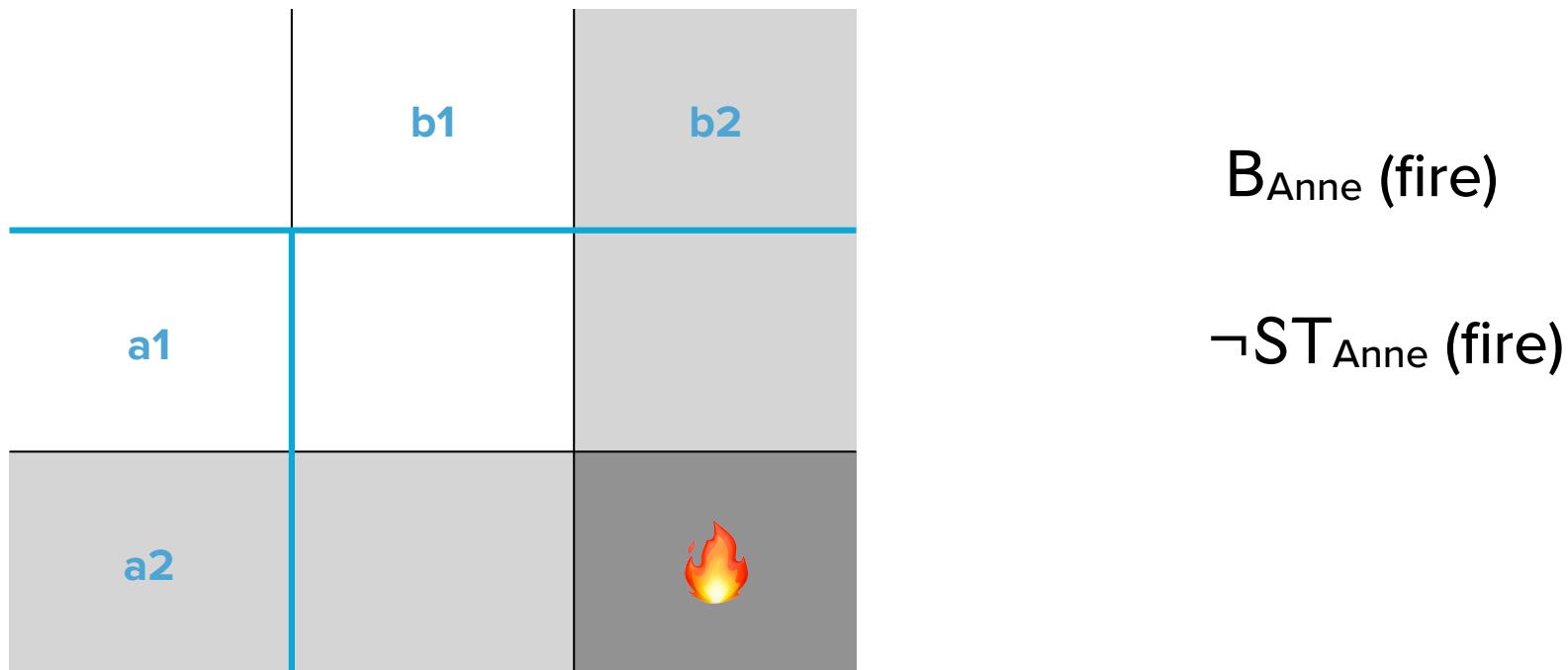
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Suppose that two companies both dump pollutant into the river. Company A dumps 100 kilograms of pollutant; company B dumps 60 kilograms. The fish in the river die. Biologists determine that  $k$  kilograms of pollutant suffice for the fish to die. Which company is the cause of the fish dying if  $k = 120$ , if  $k = 80$ , and if  $k = 50$ ? J. Halpern, 2015

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

$ST_A$  (fish dead)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

$ST_A$  (fish dead)

$ST_B$  (fish dead)

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$ST_A$  (fish dead)

$ST_B$  (fish dead)

# RIVER POLLUTION

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

$ST_A$  (fish dead)  
 $ST_B$  (fish dead)

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

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|    | b1                                                                                | b2 |
|----|-----------------------------------------------------------------------------------|----|
| a1 |  |    |
| a2 |                                                                                   |    |

$k=50$

|    | b1                                                                                  | b2                                                                                  |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| a1 |  |  |
| a2 |                                                                                     |                                                                                     |

$k=80$

$ST_A$  (fish dead)  
 $ST_B$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

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 $ST_B$  (fish dead)

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 $\neg ST_B$  (fish dead)

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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

$ST_A$  (fish dead)  
 $ST_B$  (fish dead)

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

$ST_A$  (fish dead)  
 $\neg ST_B$  (fish dead)

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

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|----|----|----|
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| a2 |    |    |

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 $ST_B$  (fish dead)

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

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 $\neg ST_B$  (fish dead)

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg ST_A$  (fish dead)  
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|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=50$

$ST_A$  (fish dead)  
 $ST_B$  (fish dead)

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=80$

$ST_A$  (fish dead)  
 $\neg ST_B$  (fish dead)

|    | b1 | b2 |
|----|----|----|
| a1 |    |    |
| a2 |    |    |

$k=120$

$\neg ST_A$  (fish dead)  
 $\neg ST_B$  (fish dead)

# INTERNATIONAL SALSA COMPETITION

You are the manager of your home country's team in the International Salsa Competition. Your team consists of Alice, Bob, Chuck, and Dan. In order to compete in the tournament, Alice will need to show up and at least one of her partners. You instruct all of them to come to the tournament. However, as it turns out, none of them show up on the day of the competition — Zultan, Gerstenberg, and Lagnado, 2012



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AN AGENT, ON A GIVEN OCCASION,  
FORBEARS THE DOING OF A CERTAIN  
THING IF, AND ONLY IF, HE CAN DO THIS  
THING, BUT DOES IN FACT NOT DO IT.

VON WRIGHT, 1965

# FORBEARING/REFRAINING

$$\text{ST}_a \neg \text{ST}_a \varphi$$

**Theorem**  $B_a \varphi \equiv \varphi \wedge \text{ST}_a \neg \text{ST}_a \neg \varphi$

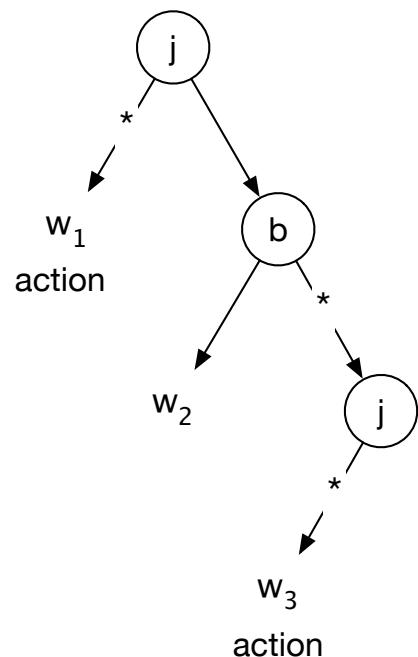
P. Naumov, J. Tao, Two Forms of Responsibility in Strategic Games,  
30th International Joint Conference on Artificial Intelligence (IJCAI 21), August 21-26, 2021

# EXTENSIVE FORM GAMES

# BLACK AND JONES

Suppose someone—Black, let us say—wants Jones to perform a certain action. Black is prepared to go to considerable lengths to get his way, but he prefers to avoid showing his hand unnecessarily. So he waits until Jones is about to make up his mind what to do, and he does nothing unless it is clear to him (Black is an excellent judge of such things) that Jones is going to decide to do something other than what he wants him to do. If it does become clear that Jones is going to decide to do something else, Black takes effective steps to ensure that Jones decides to do, and that he does do, what he wants him to do. Whatever Jones's initial preferences and inclinations, then, Black will have his way.

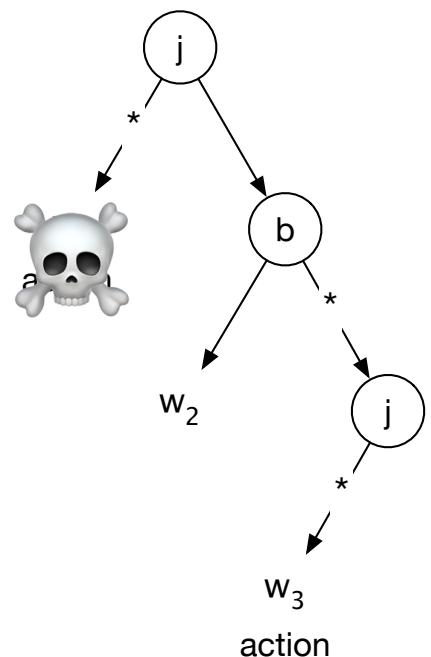
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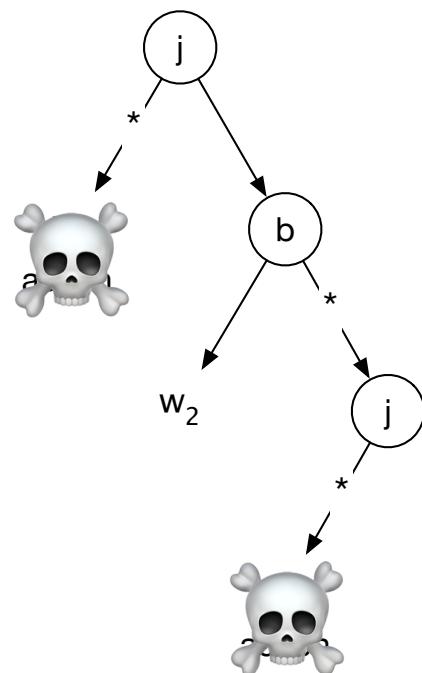
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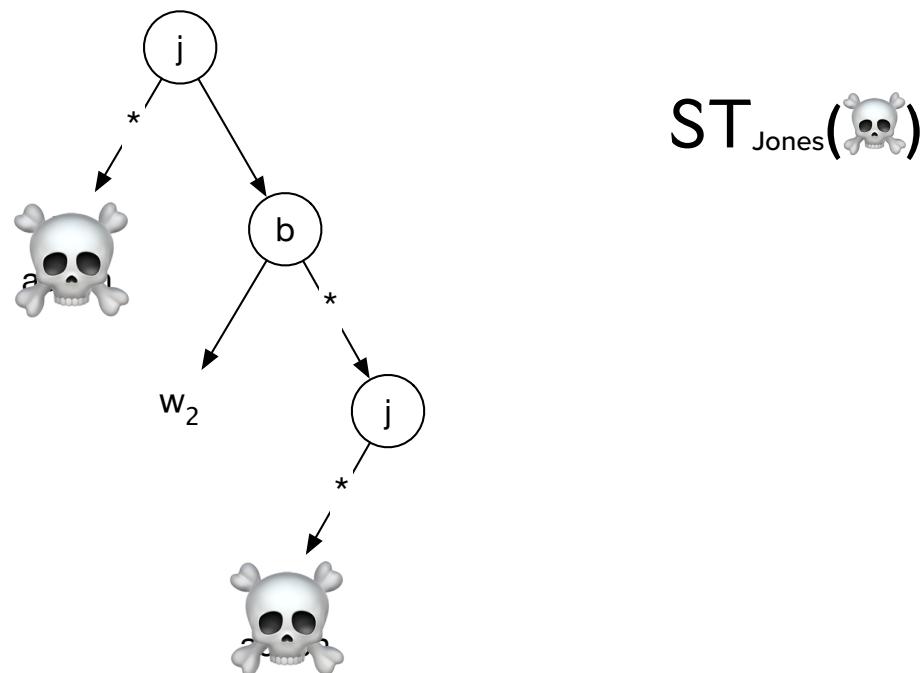
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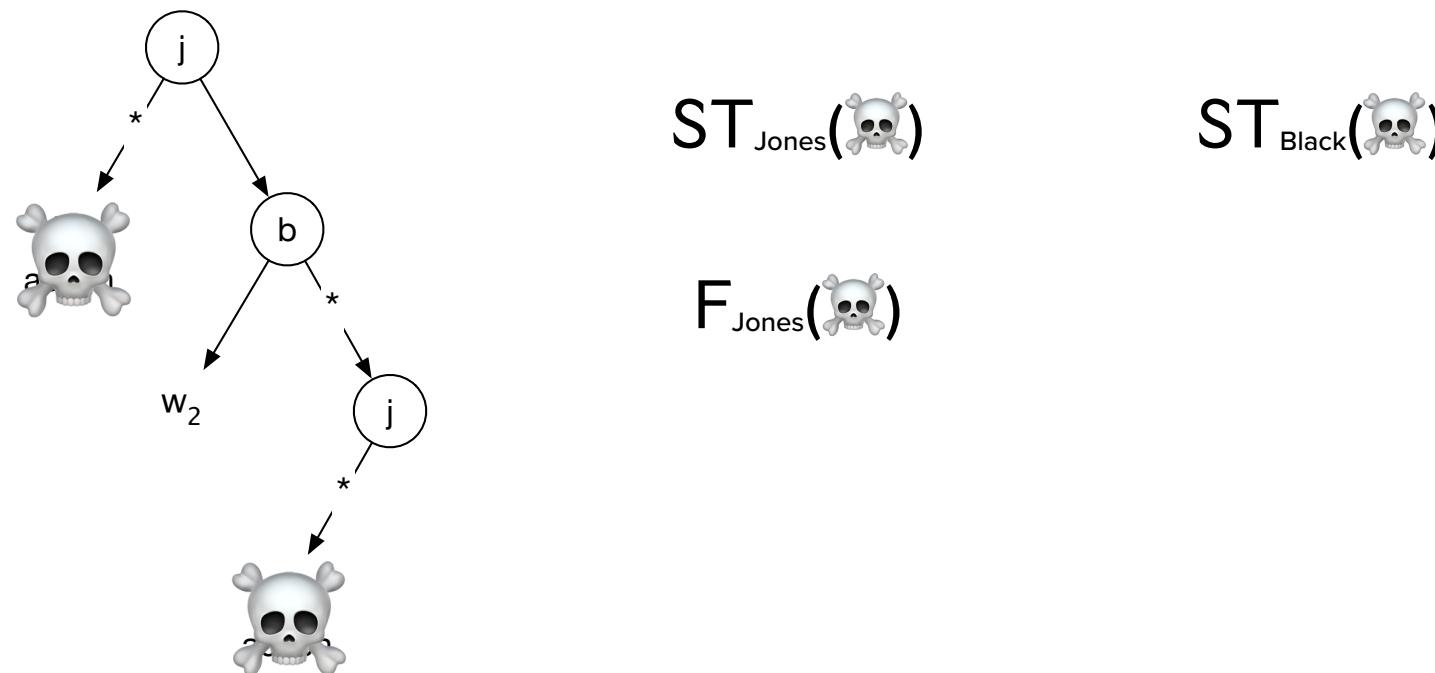
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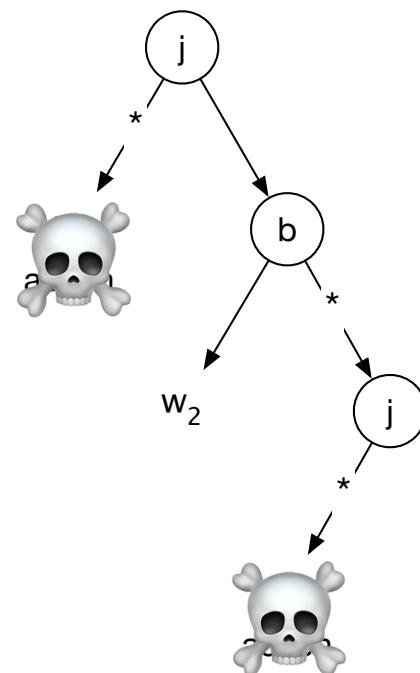
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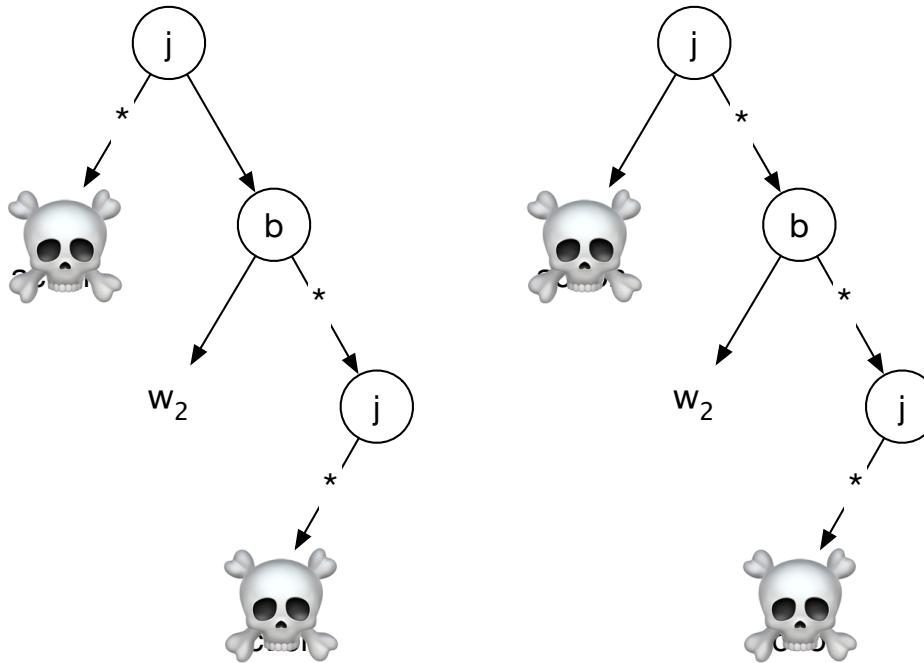
ST<sub>Jones</sub>(💀)

ST<sub>Black</sub>(💀)

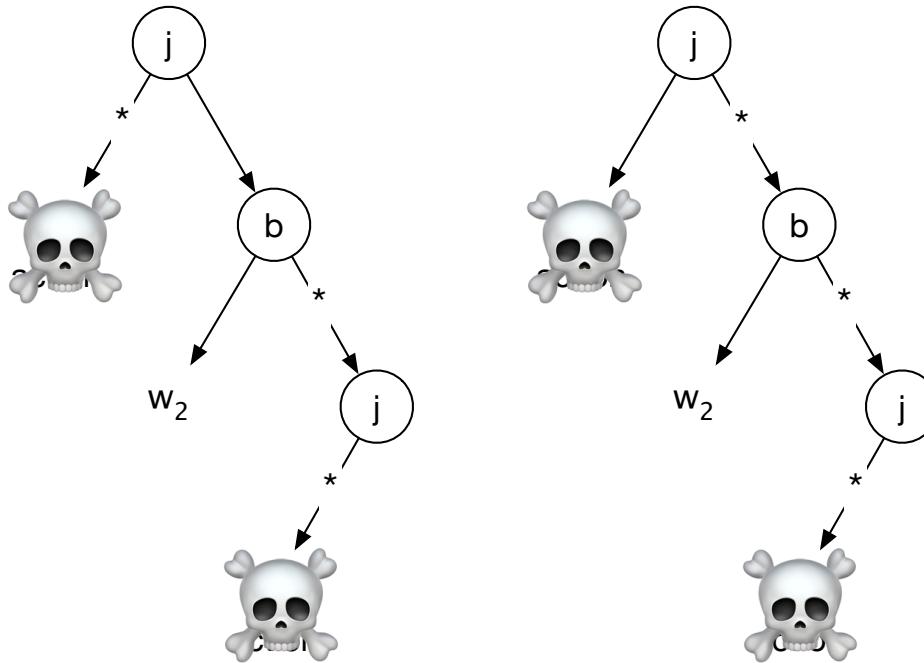
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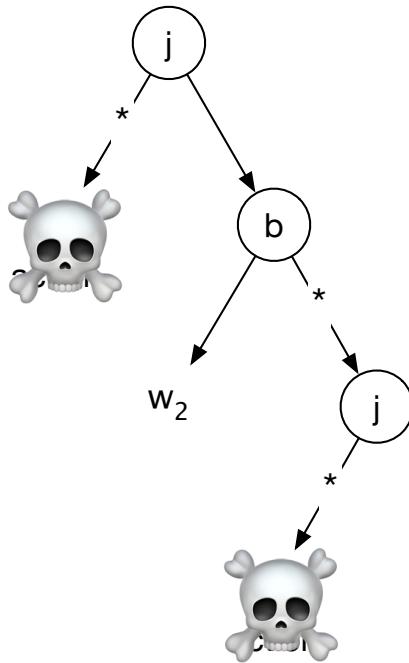


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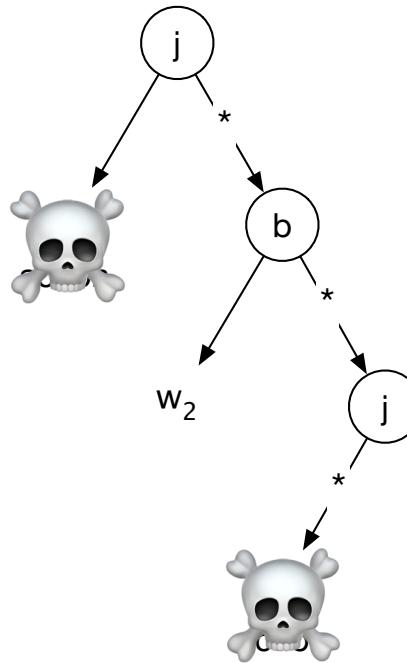


$\text{ST}_{\text{Jones}}(\text{skull})$

# BLACK AND JONES

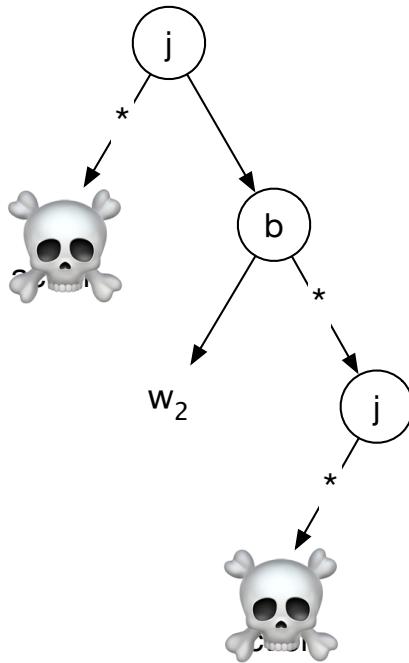


$\text{ST}_{\text{Jones}}(\text{💀})$



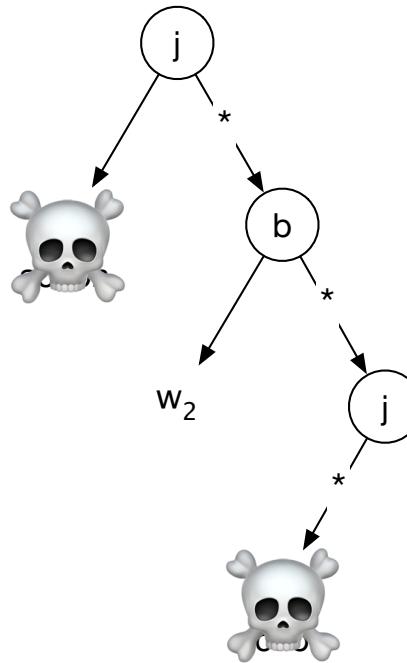
$\neg \text{ST}_{\text{Jones}}(\text{💀})$

# BLACK AND JONES



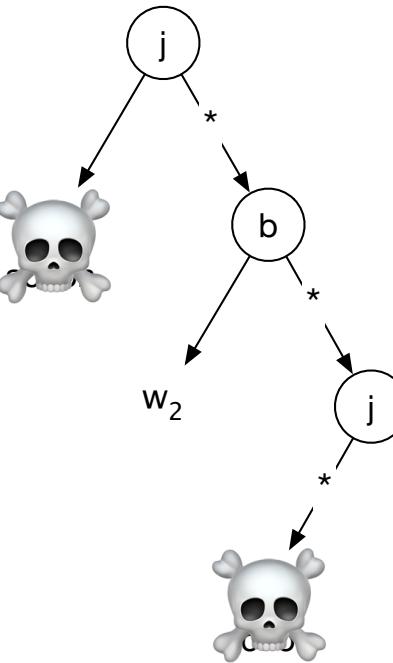
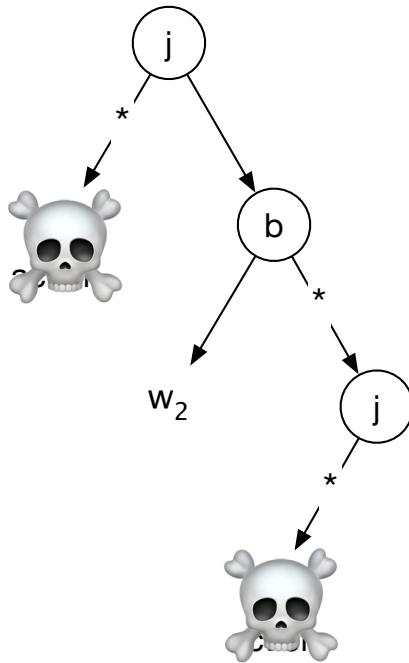
$ST_{Jones}(\text{Skull})$

$ST_{Black}(\text{Skull})$



$\neg ST_{Jones}(\text{Skull})$

# BLACK AND JONES



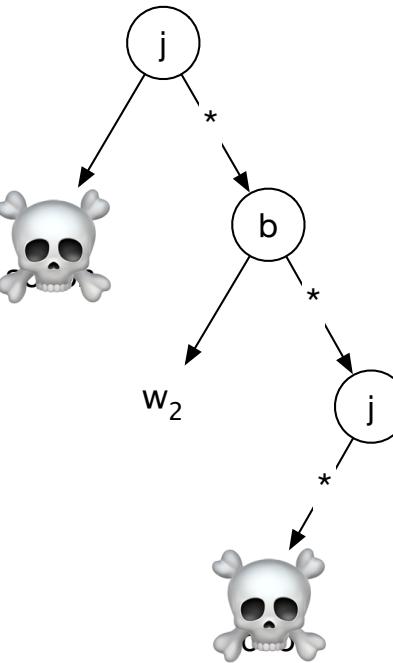
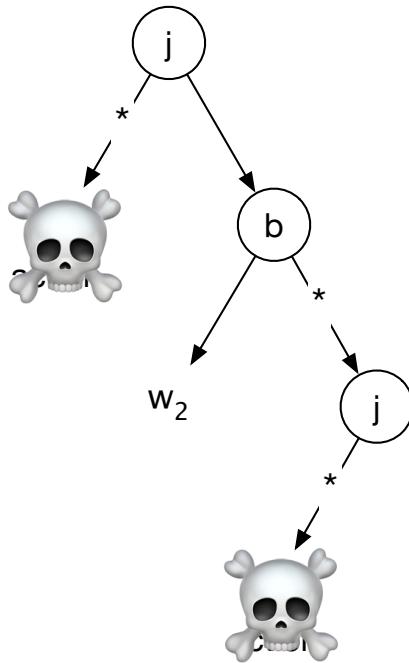
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$ST_{Jones}(\text{skull})$

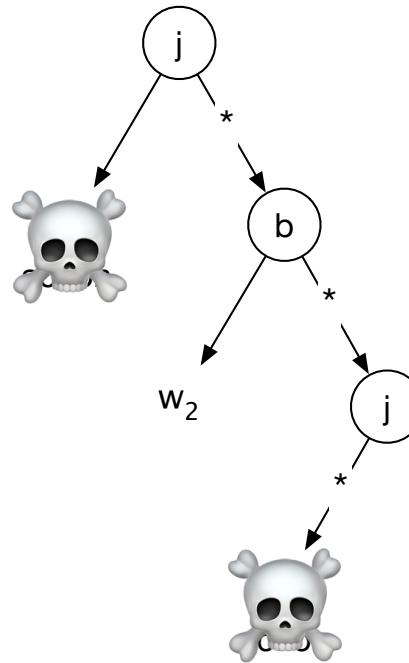
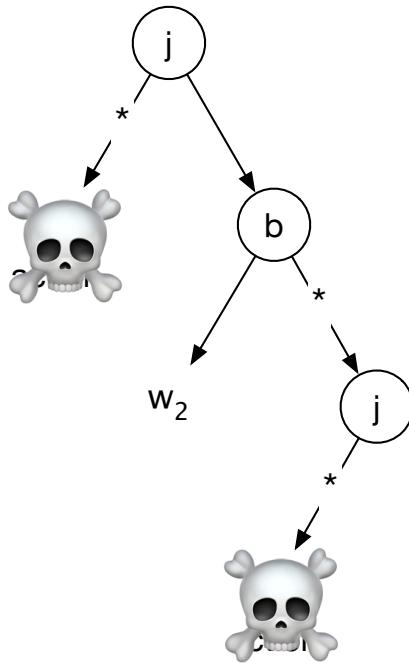
$\neg ST_{Jones}(\text{skull})$

$ST_{Black}(\text{skull})$

$ST_{Black}(\text{skull})$

$F_{Jones}(\text{skull})$

# BLACK AND JONES



$ST_{Jones}(\text{skull})$

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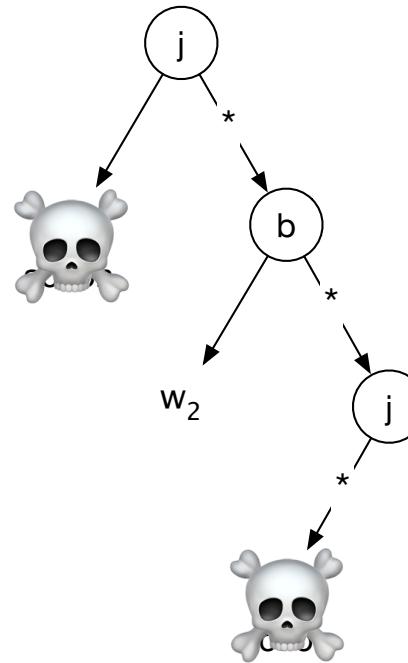
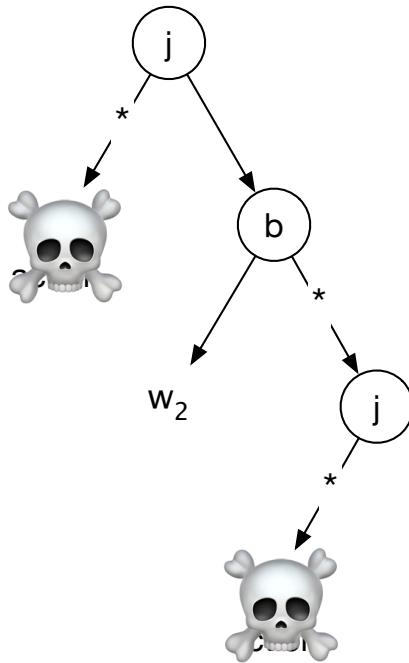
$ST_{Black}(\text{skull})$

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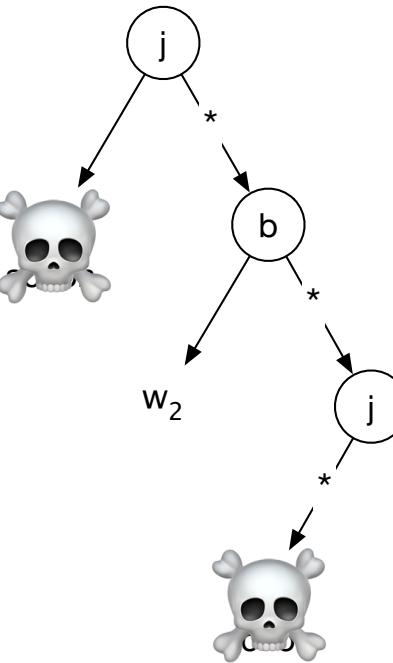
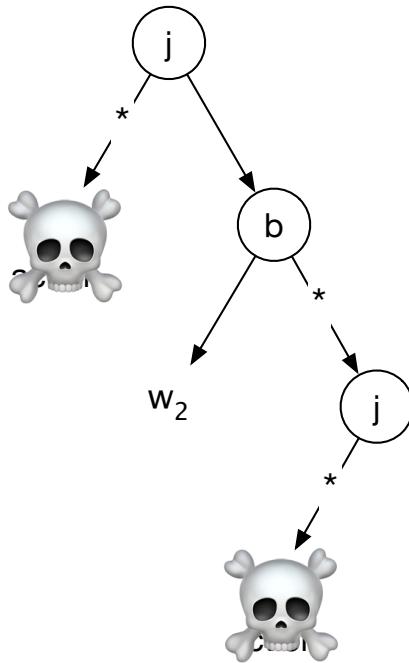
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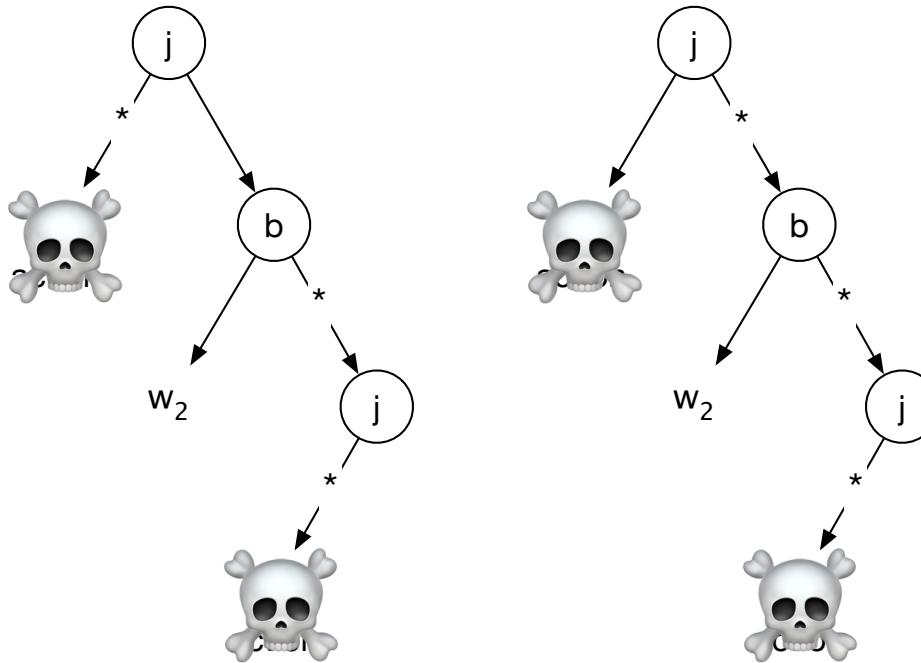
$F_{Jones}(\text{skull})$

$\neg F_{Jones}(\text{skull})$

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$F_{Black}(\text{skull})$

# BLACK AND JONES



$ST_{Jones}(\skull)$      $\neg B_{Jones}(\skull)$

$\neg ST_{Jones}(\skull)$

$ST_{Black}(\skull)$

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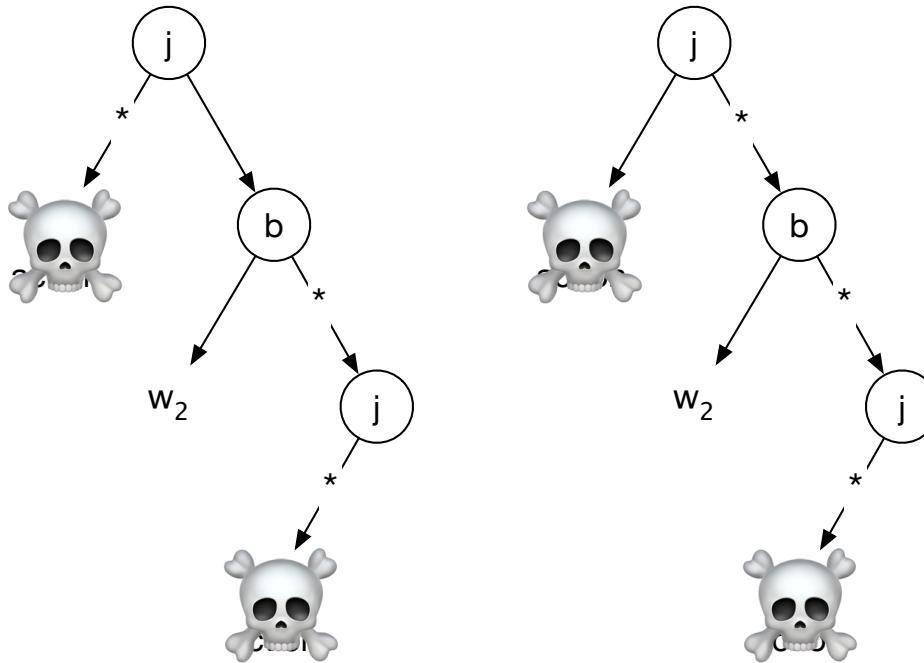
$F_{Jones}(\skull)$

$\neg F_{Jones}(\skull)$

$\neg F_{Black}(\skull)$

$F_{Black}(\skull)$

# BLACK AND JONES



$ST_{Jones}(\text{skull}) \quad \neg B_{Jones}(\text{skull})$

$\neg ST_{Jones}(\text{skull}) \quad \neg B_{Jones}(\text{skull})$

$ST_{Black}(\text{skull})$

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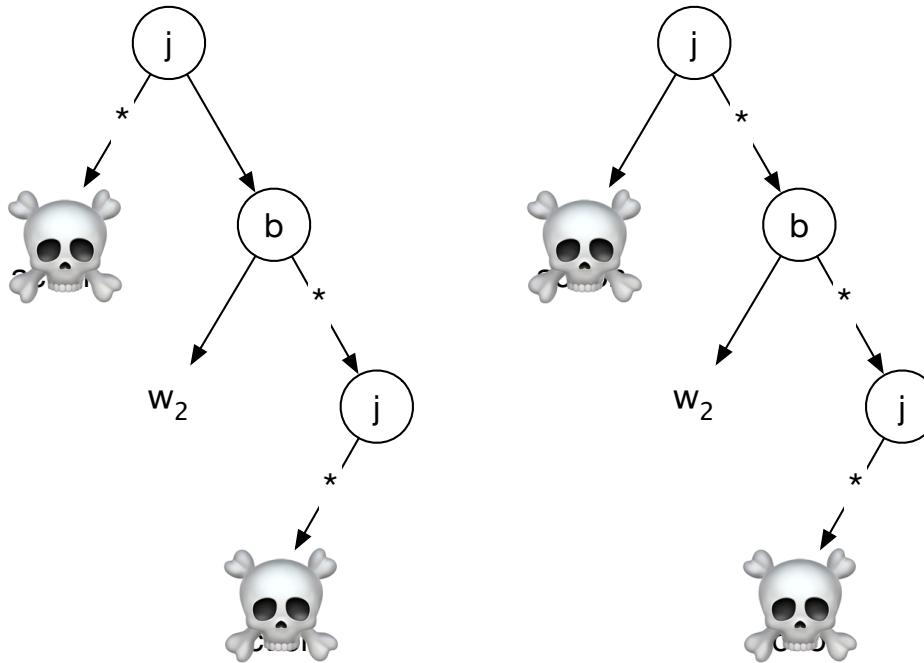
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$\neg ST_{Jones}(\skull)$      $\neg B_{Jones}(\skull)$

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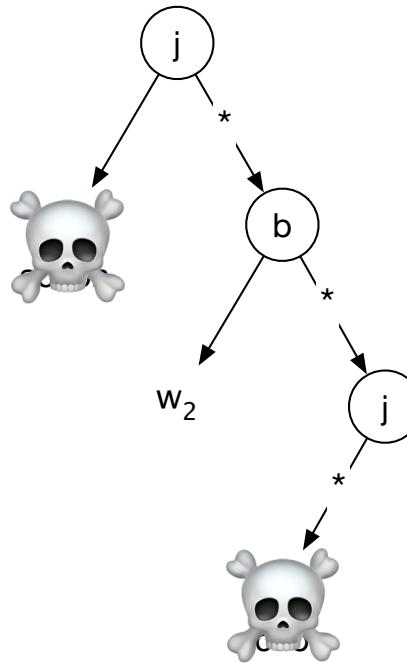
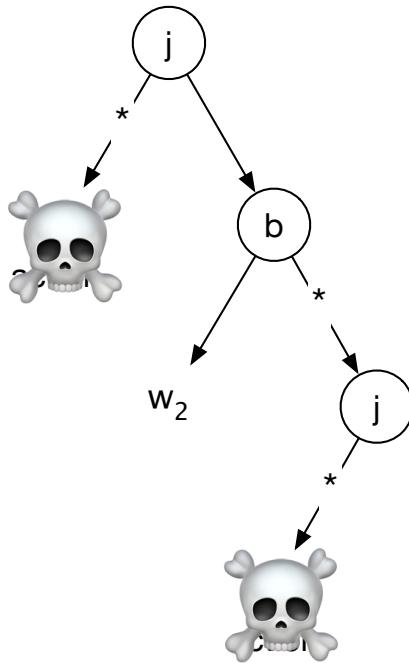
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$ST_{Black}(\text{Skull})$      $\neg B_{Black}(\text{Skull})$

$ST_{Black}(\text{Skull})$      $B_{Black}(\text{Skull})$

$F_{Jones}(\text{Skull})$

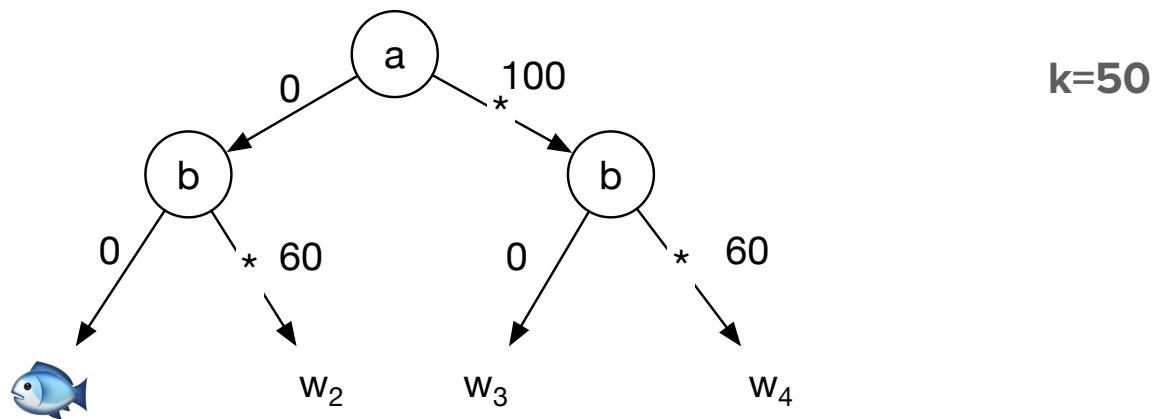
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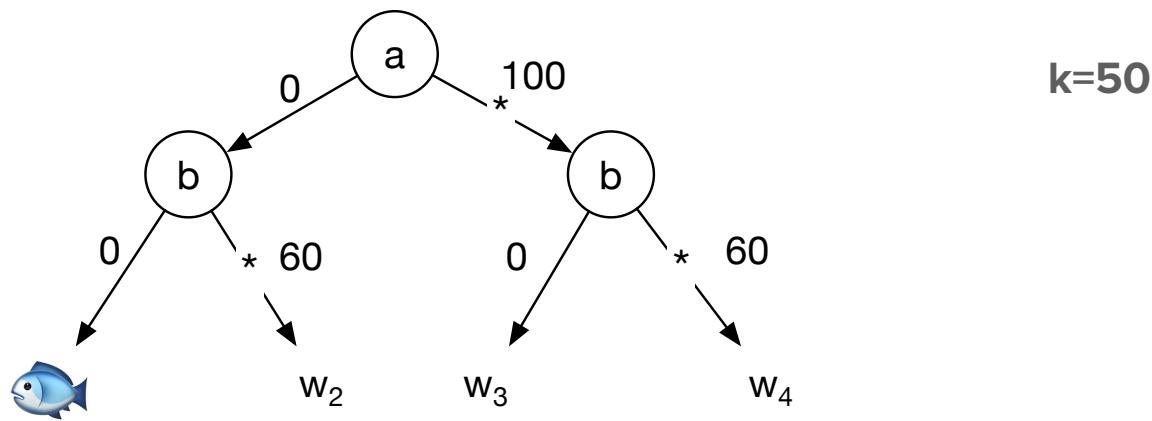
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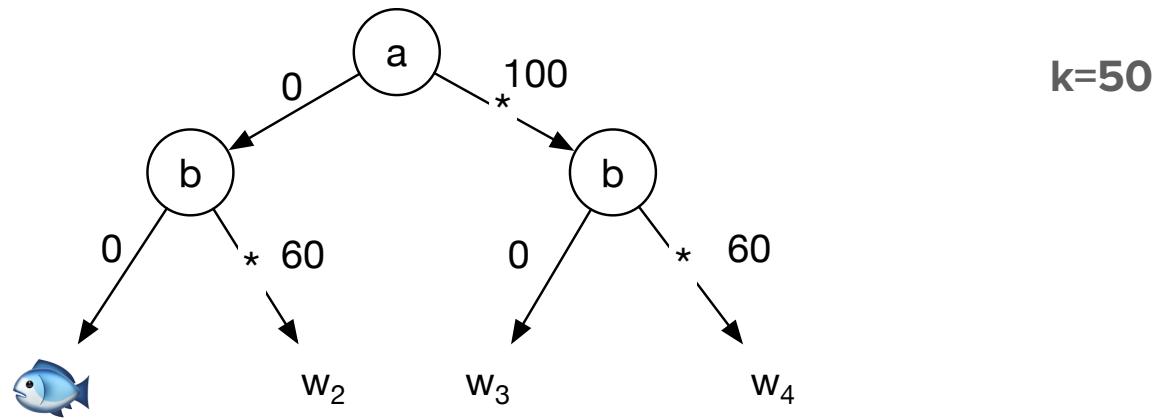
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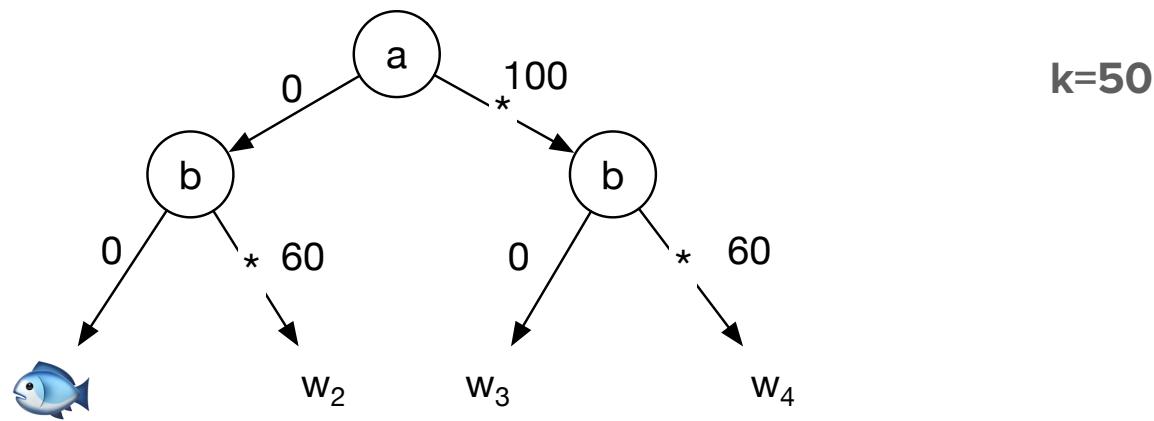


ST<sub>A</sub> (fish dead)

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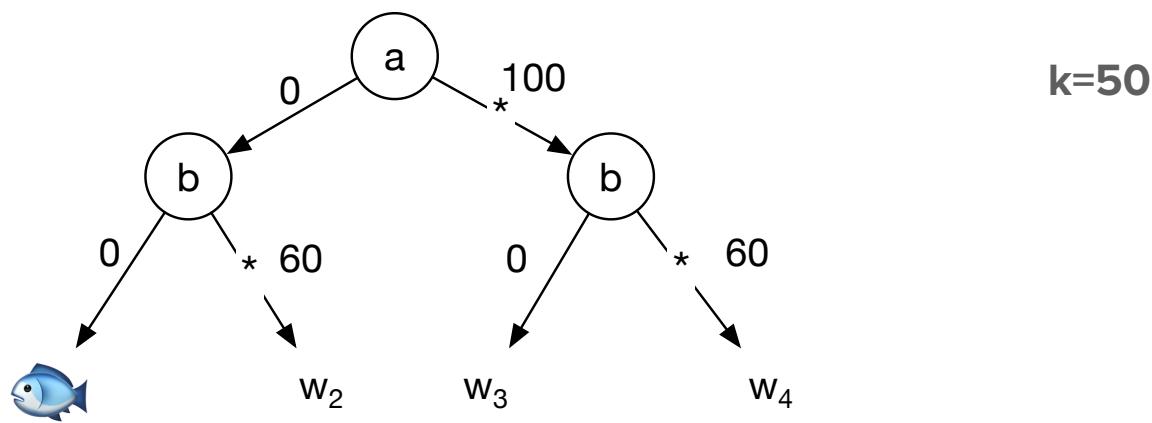
ST<sub>A</sub> (fish dead)

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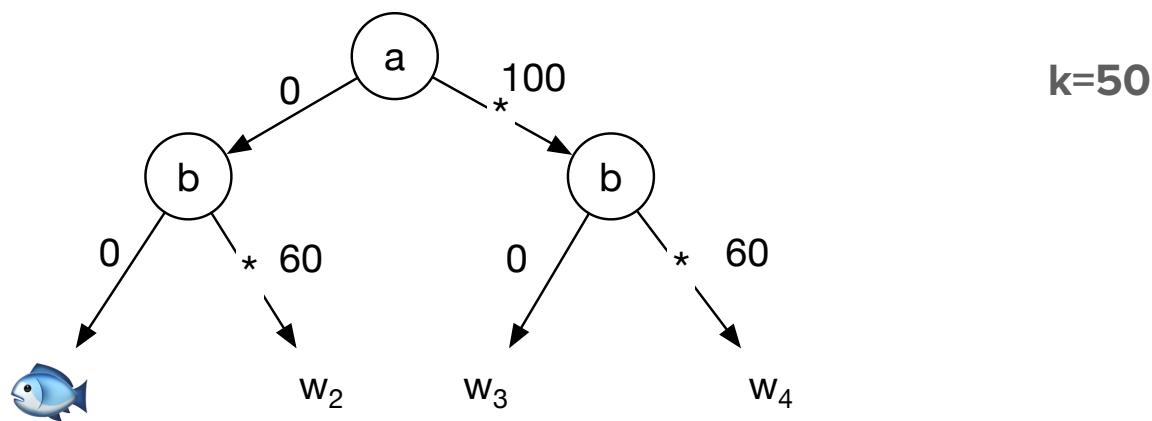
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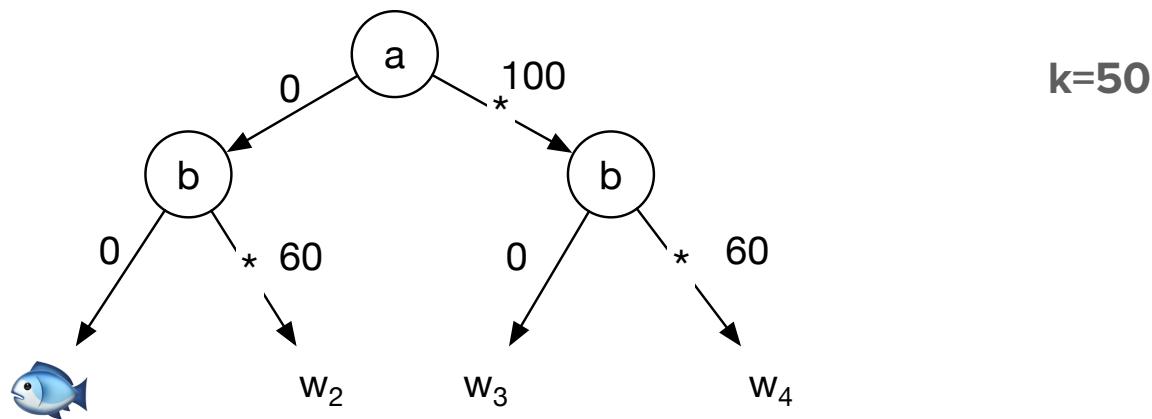
$\neg B_A$  (fish dead)

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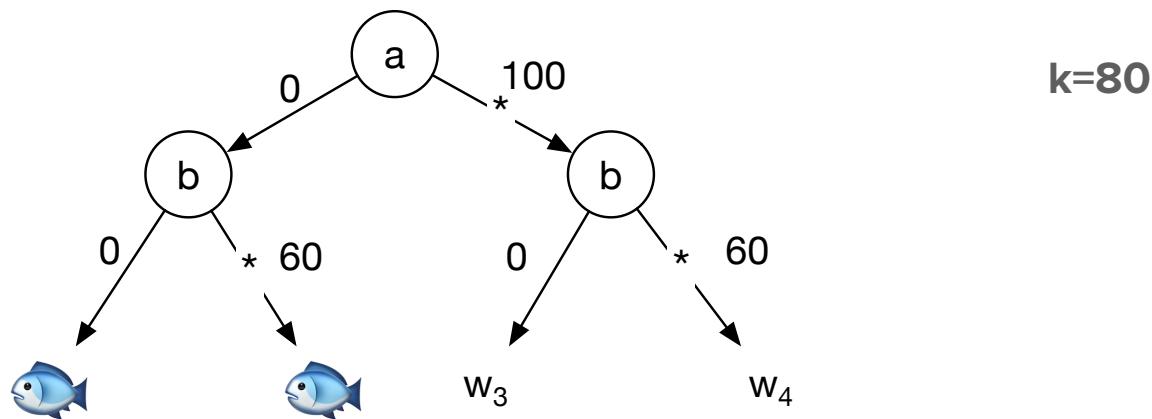
$ST_B$  (fish dead)

$\neg F_B$  (fish dead)

$\neg B_B$  (fish dead)

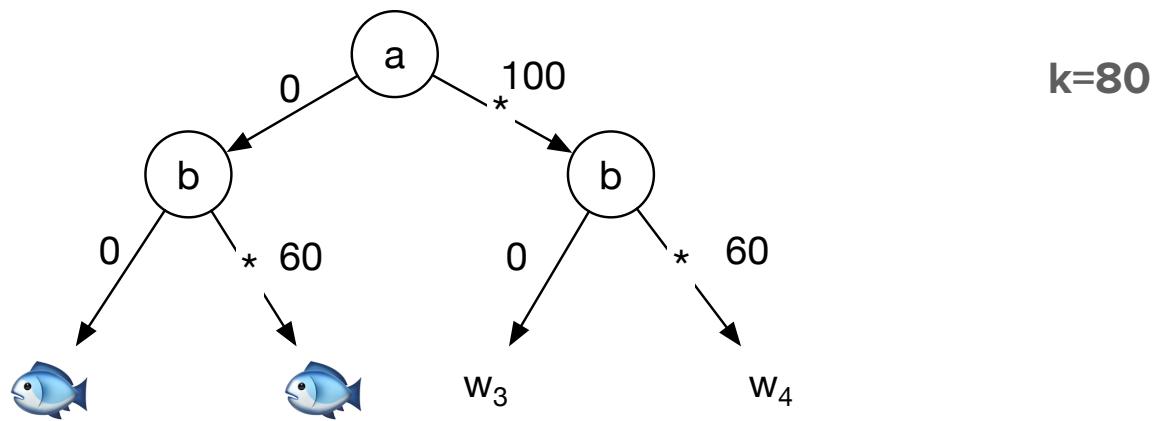
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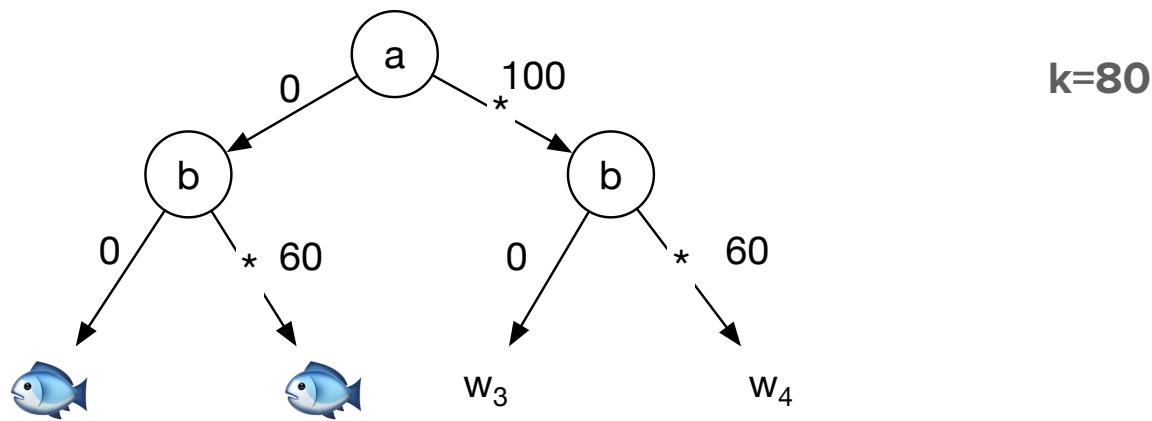
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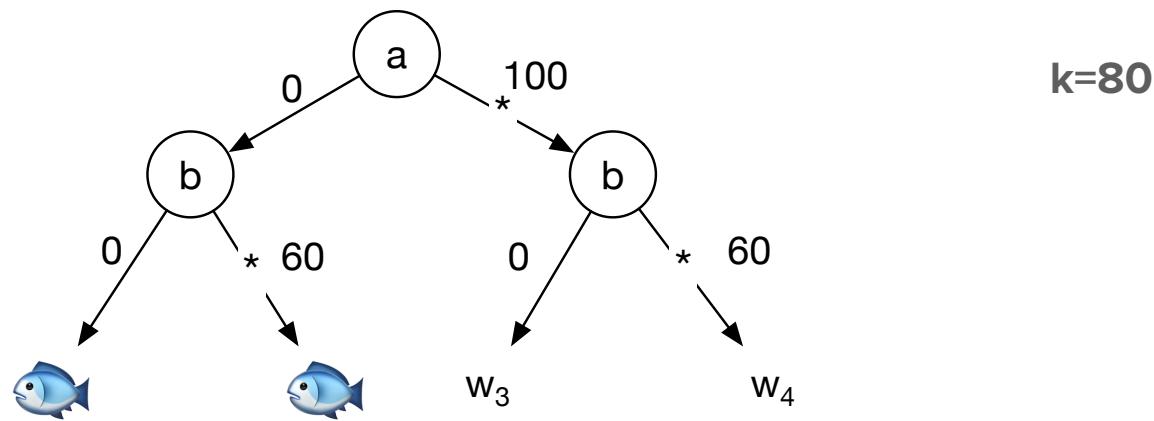


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Suppose that two companies both dump pollutant into the river. Company A dumps 100 kilograms of pollutant; company B dumps 60 kilograms. The fish in the river die. Biologists determine that  $k$  kilograms of pollutant suffice for the fish to die. Which company is the cause of the fish dying if  $k = 120$ , if  $k = 80$ , and if  $k = 50$ ? J. Halpern, 2015



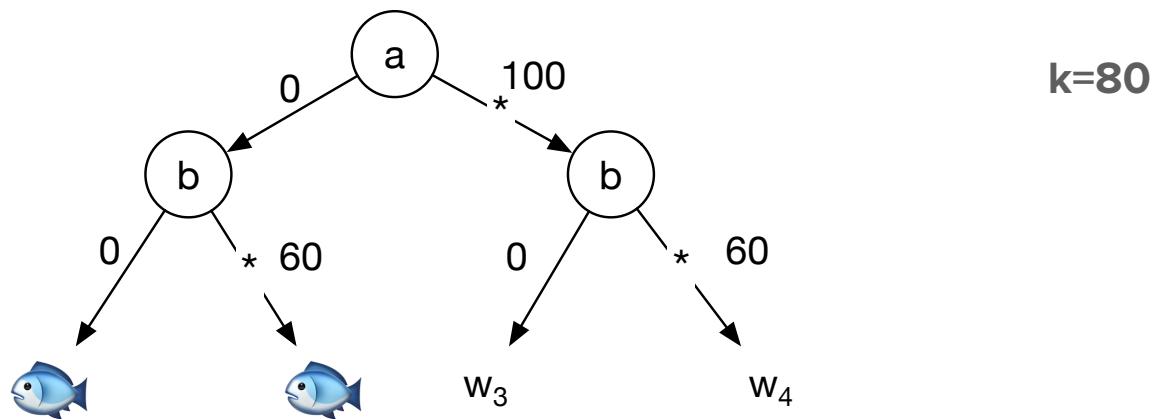
$ST_A$  (fish dead)

$F_A$  (fish dead)

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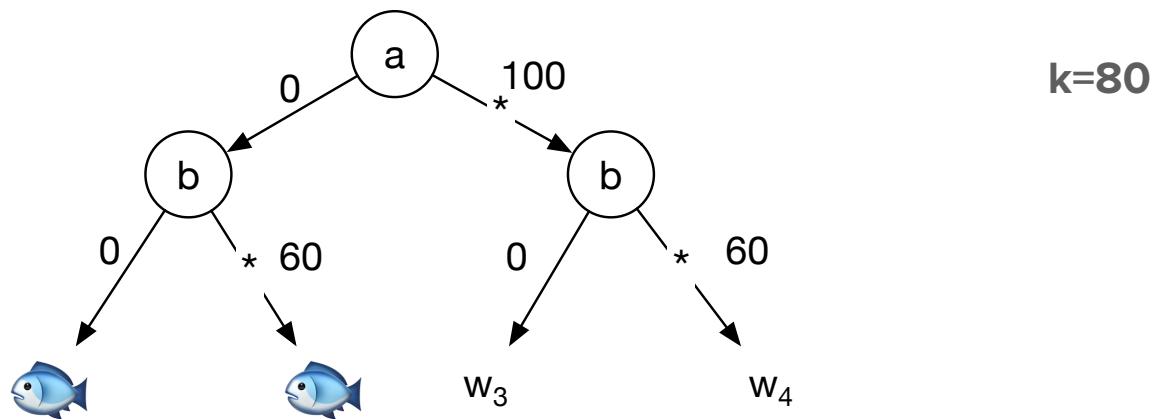
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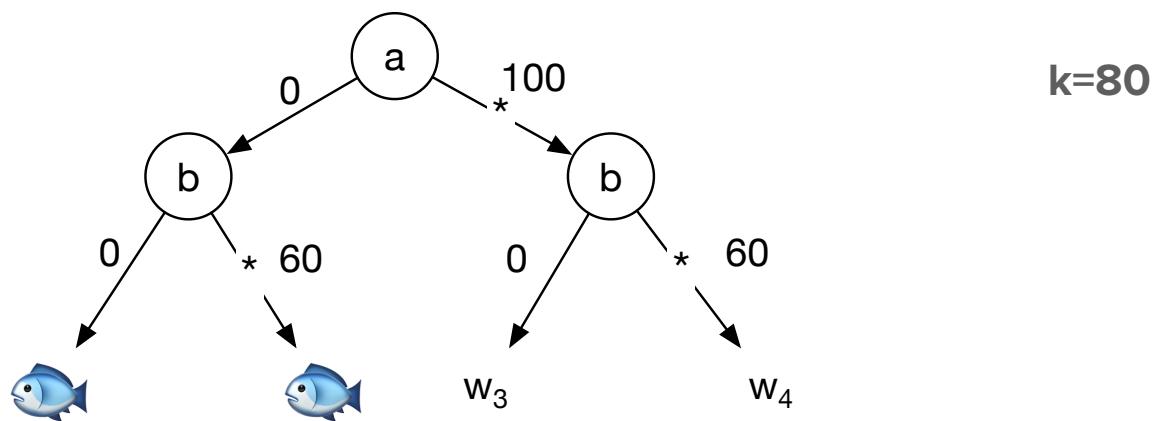
$B_A$  (fish dead)

$\neg ST_B$  (fish dead)

$\neg F_B$  (fish dead)

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$B_A$  (fish dead)

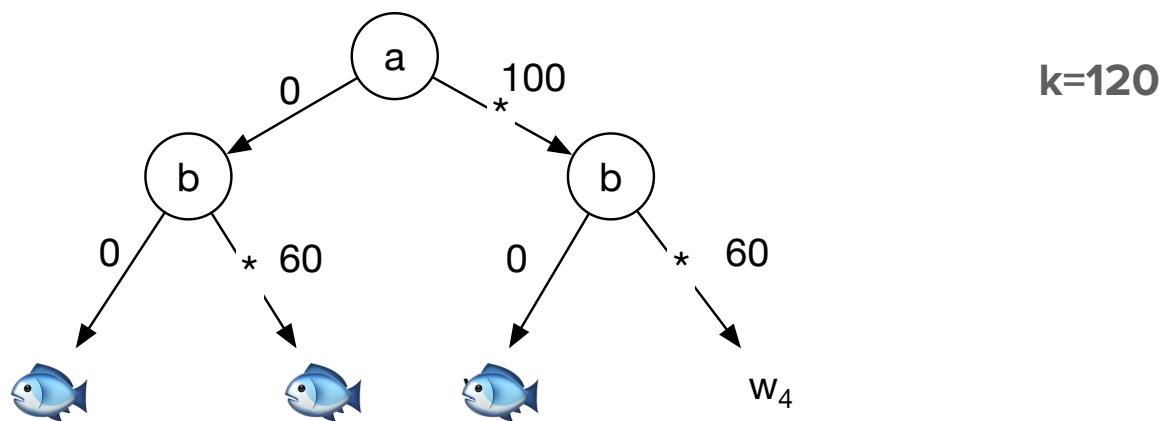
$\neg ST_B$  (fish dead)

$\neg F_B$  (fish dead)

$\neg B_B$  (fish dead)

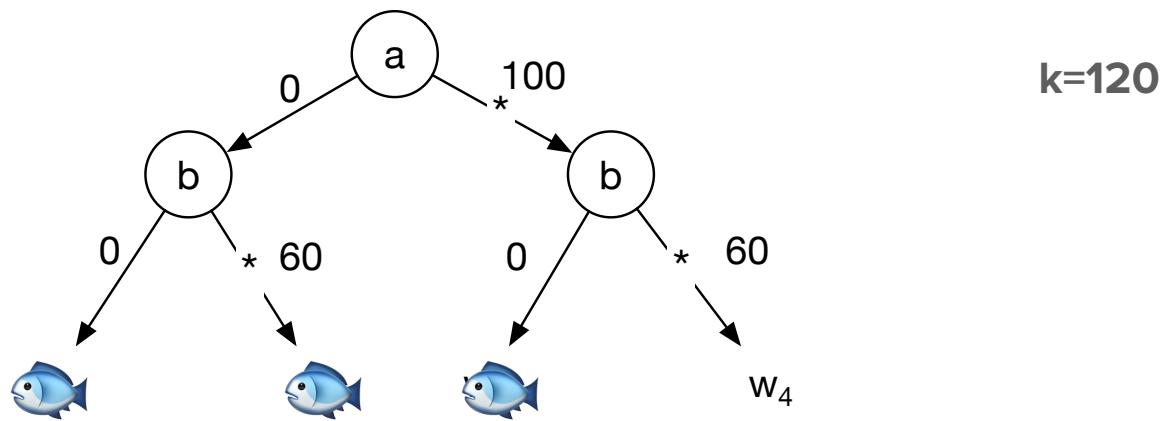
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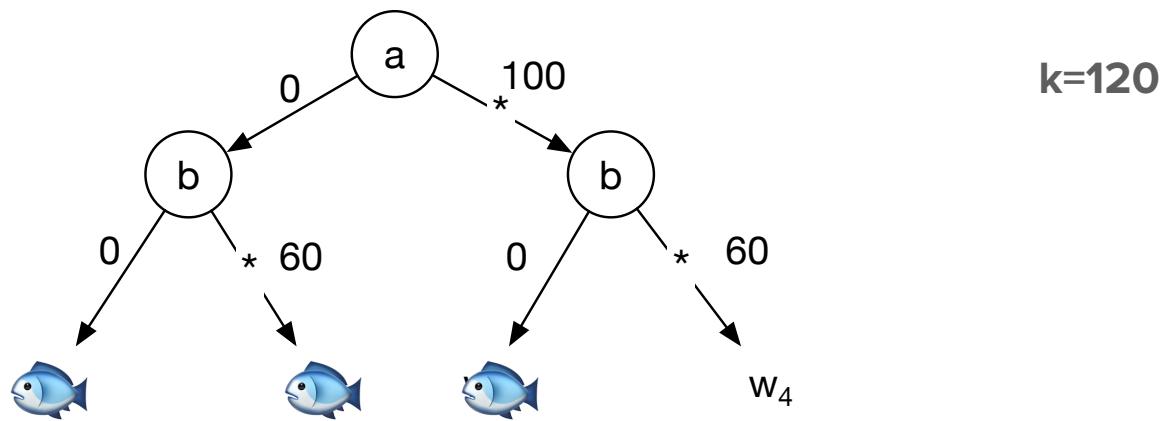
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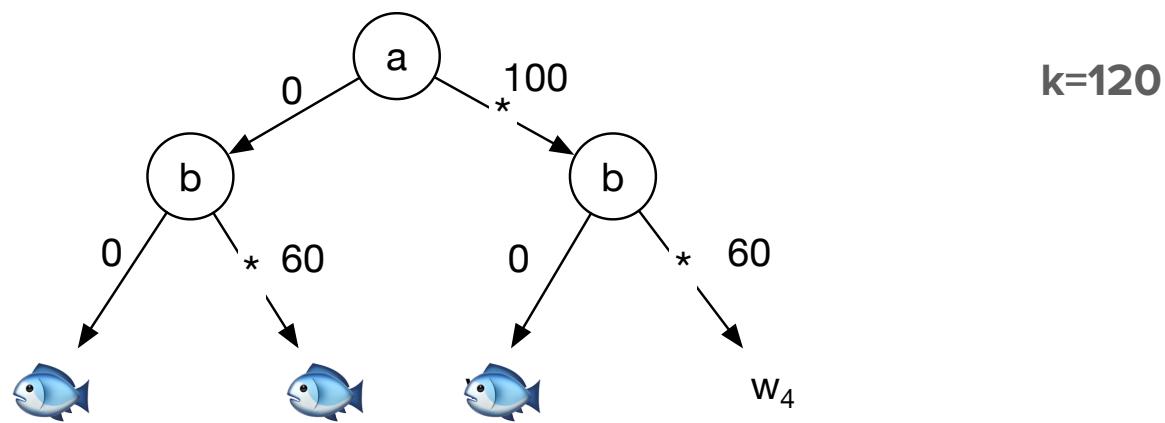


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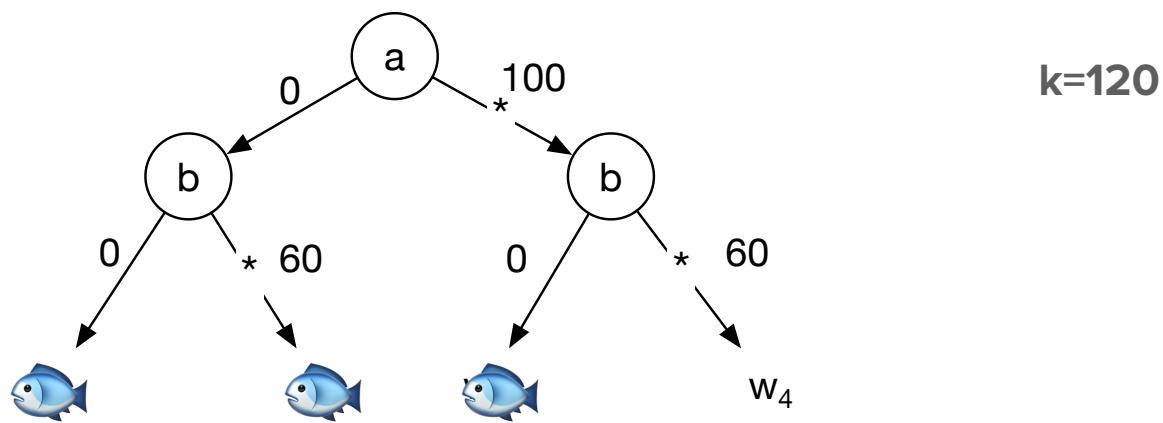
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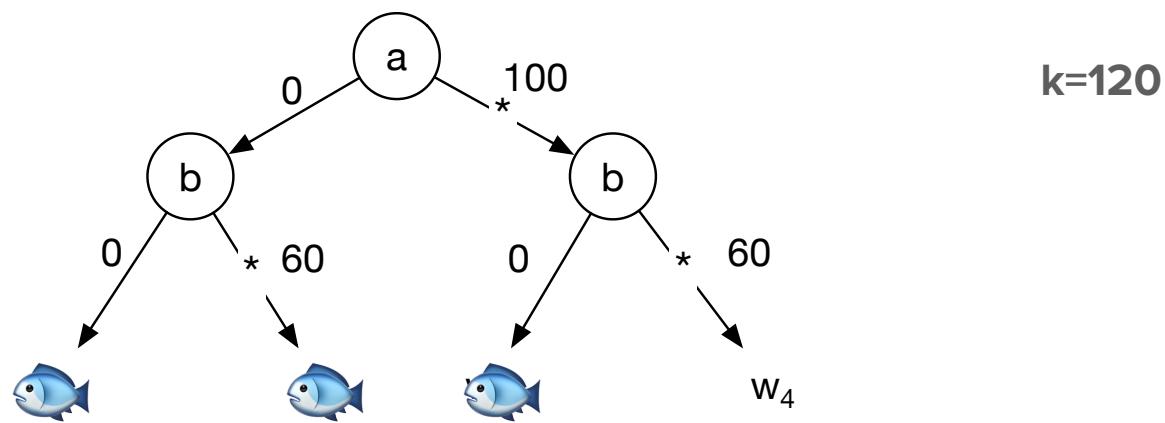
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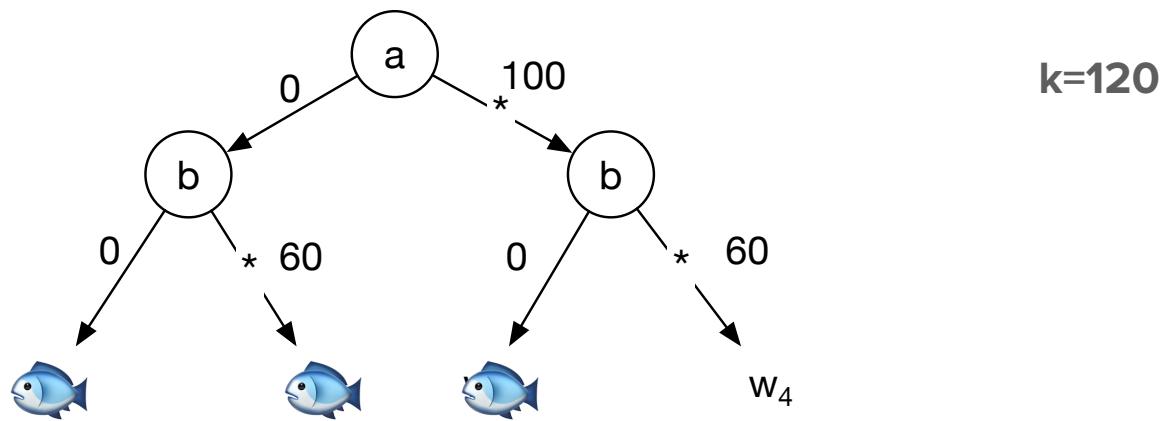
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# KNOWLEDGE

# **KNOW-HOW STRATEGY**





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The rule, which would permit methods including firing squads and electrocution, comes as the administration rushes to execute five more prisoners before President Trump's term ends.

By Hailey Fuchs

Nov. 25, 2020



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CHI

S/5 by AR 633-151, 7 Aug 59

# PROCEDURE FOR MILITARY EXECUTIONS



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DEPARTMENT OF THE ARMY

DECEMBER 1947

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This pamphlet supersedes WD Pamphlet 27-4, 12 June 1944, including C 1,  
12 August 1944

DEPARTMENT OF THE ARMY  
Washington 25, D. C., 9 December 1947

Department of the Army Pamphlet 27-4, Procedure for Military Executions, is published for the information and guidance of all concerned.

[AG 250 (17 Sep 47)]

BY ORDER OF THE SECRETARY OF THE ARMY:

OFFICIAL: DWIGHT D. EISENHOWER  
EDWARD F. WITSELL Chief of Staff,  
*Major General* United States Army  
*The Adjutant General*

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For explanation of distribution formula, see TM 38-405.



## SECTION II

### EXECUTION BY MUSKETRY

#### **13. Officer Charged with Execution**

The officer charged with the execution will command the escort and make the necessary arrangements for the conduct of the execution. He will—

- a.* Instruct and rehearse the escort and the execution party in their duties, insuring that all members of the execution party are qualified in the weapon to be used.
- b.* Arrange for the receipt of the prisoner by the prisoner guard.
- c.* Arrange for an execution party of eight men and one sergeant.
- d.* Arrange for a chaplain to accompany the prisoner.
- e.* Arrange for the presence of a medical officer at the scene of the execution.
- f.* Cause a post with proper rings placed therein for securing the prisoner in an upright position to be erected at the place of execution.
- g.* Cause eight rifles to be loaded in his presence. Not more than three nor less than one will be loaded with blank ammunition. He will place the rifles at random in the rack provided for that purpose.
- h.* Provide a black hood to cover the head of the prisoner.
- i.* Provide a 4-inch round target, white or black as appropriate; a black target will be used when light colored clothing is worn.
- j.* Cause the prisoner's arms to be secured either behind his back or in front at the waist (fig. 1), before or immediately after his receipt by the prisoner guard.
- k.* Arrange for an ambulance or other conveyance with sufficient personnel to be in attendance upon the execution to receive and care for the body. In the event a contract undertaker is used by the quartermaster, his services may be substituted. See AR 30-1820.
- l.* Provide straps to secure the prisoner to the post at waist and ankles. (See par. 29b.)

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**THANK YOU!**