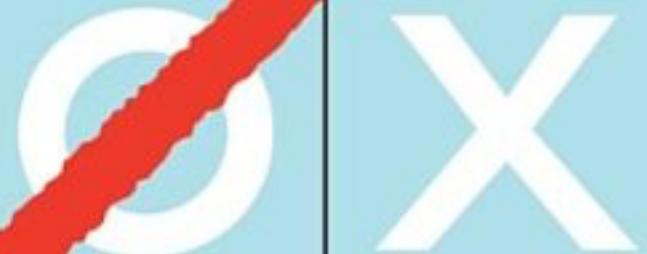
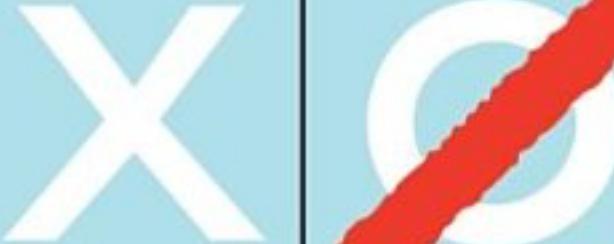


Case Study: Tic Tac Toe

Tic Tac Toe (Plan 1)

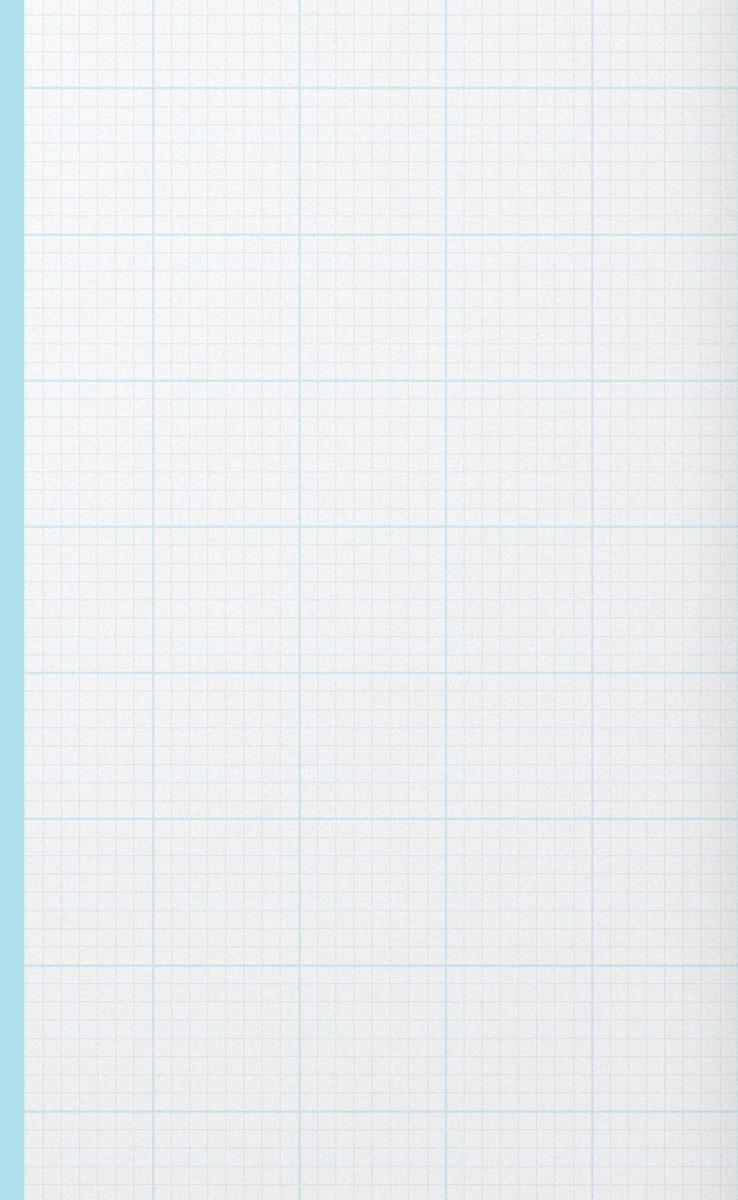
- * 2D board containing {empty, X, 0}
- * a large vector containing 3^9 (19,683) specially chosen boards & the next move
- * use the current board as an index into the vector, make the move

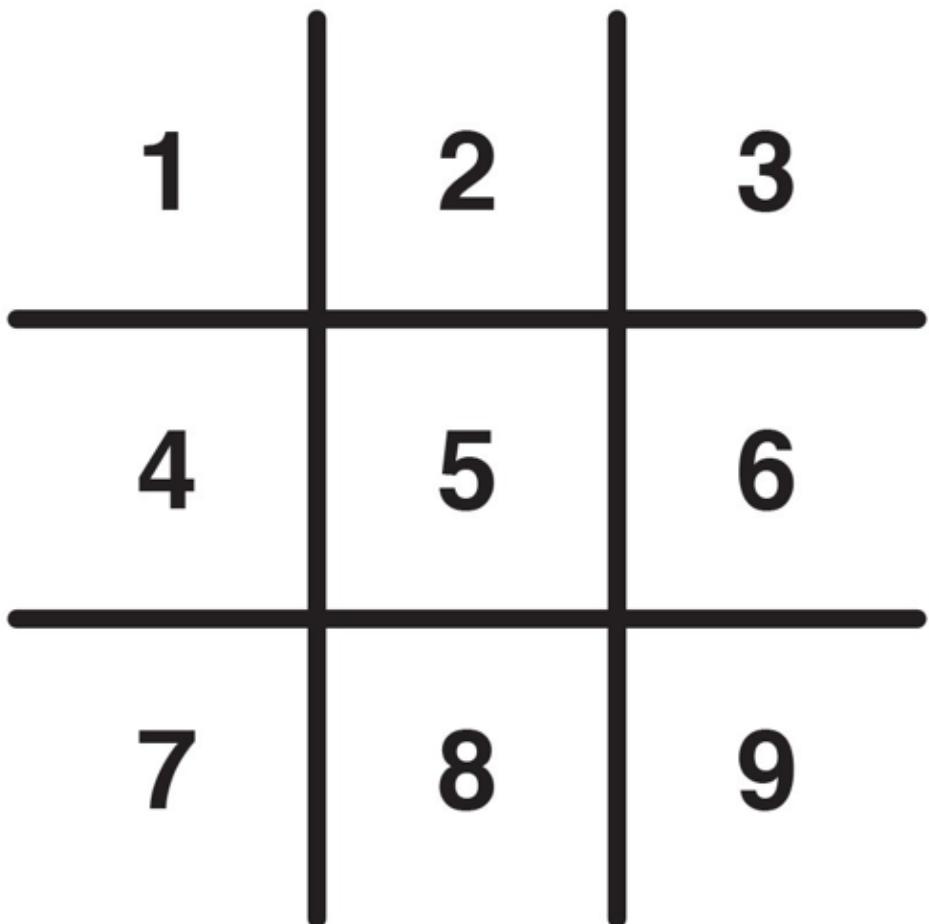
TIC
TAC
TOME



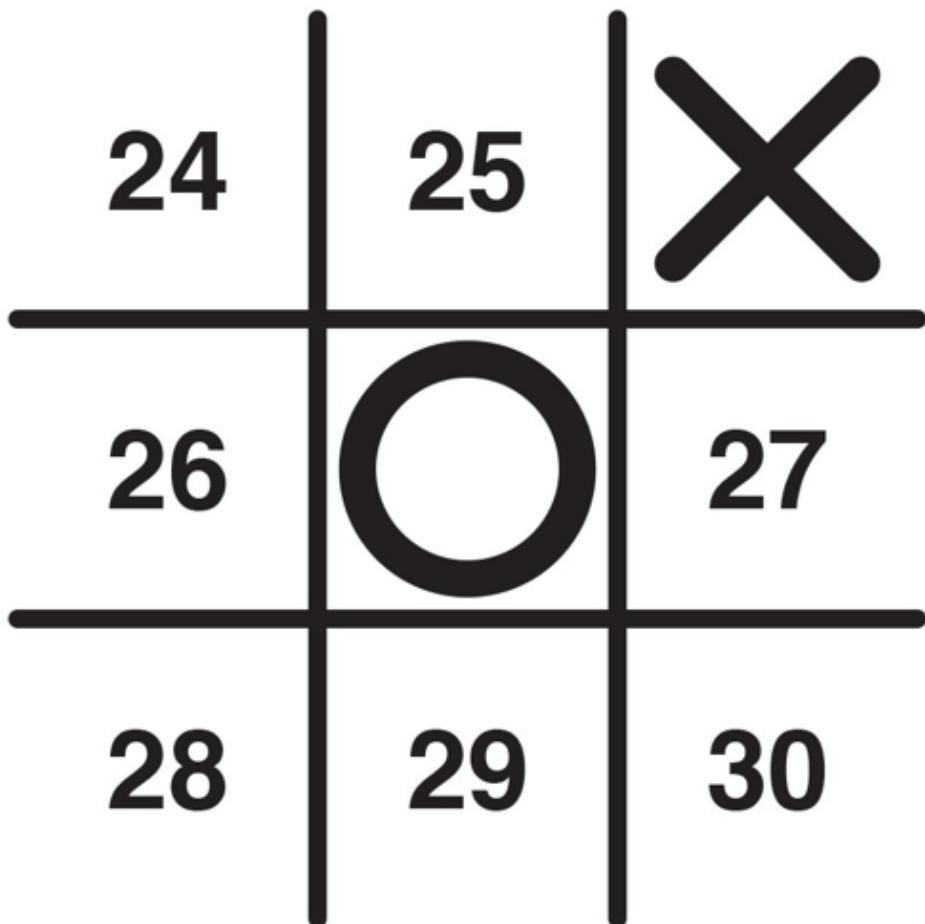
**The Book
That Will
Beat You at
Tic-Tac-Toe**

by Willy Yonkers

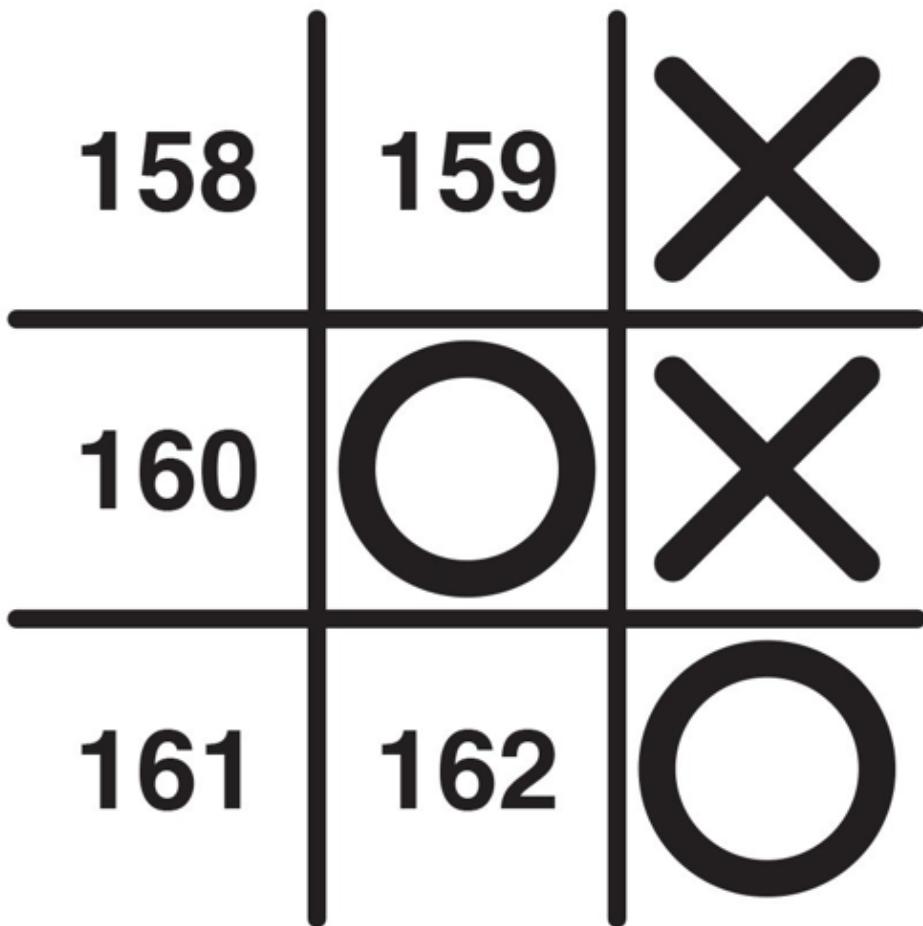




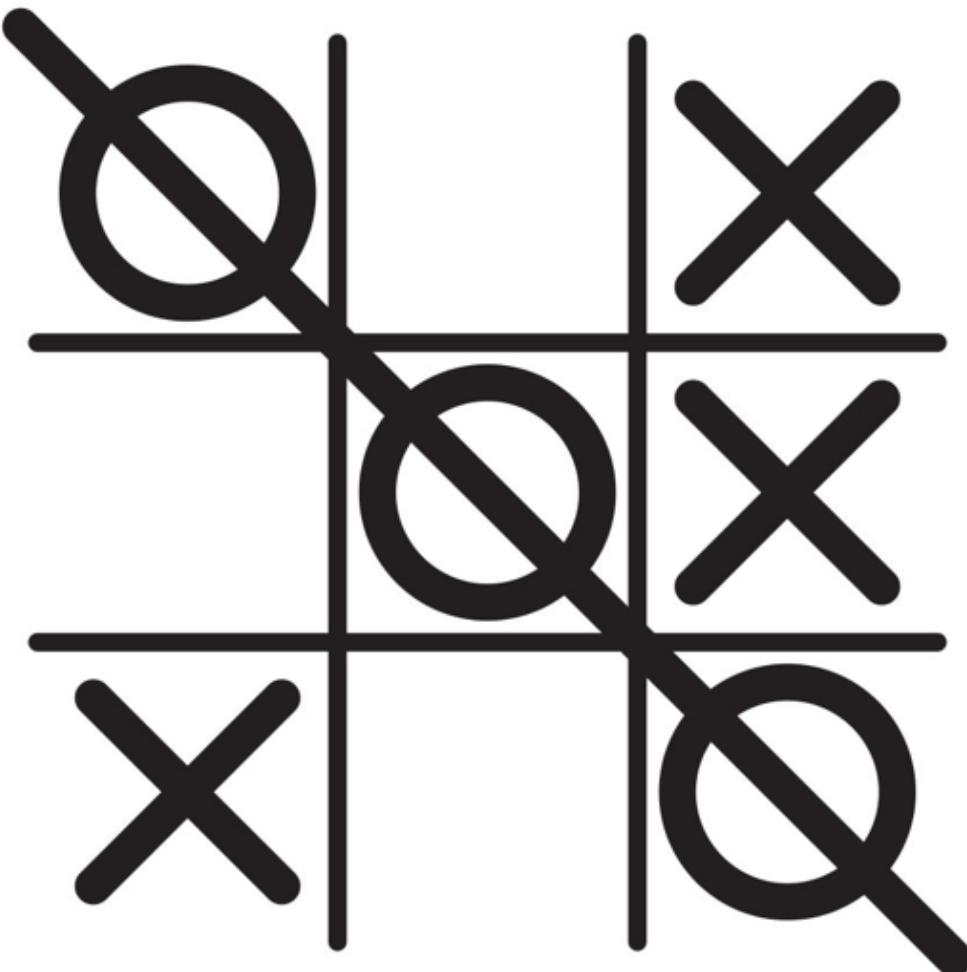
0



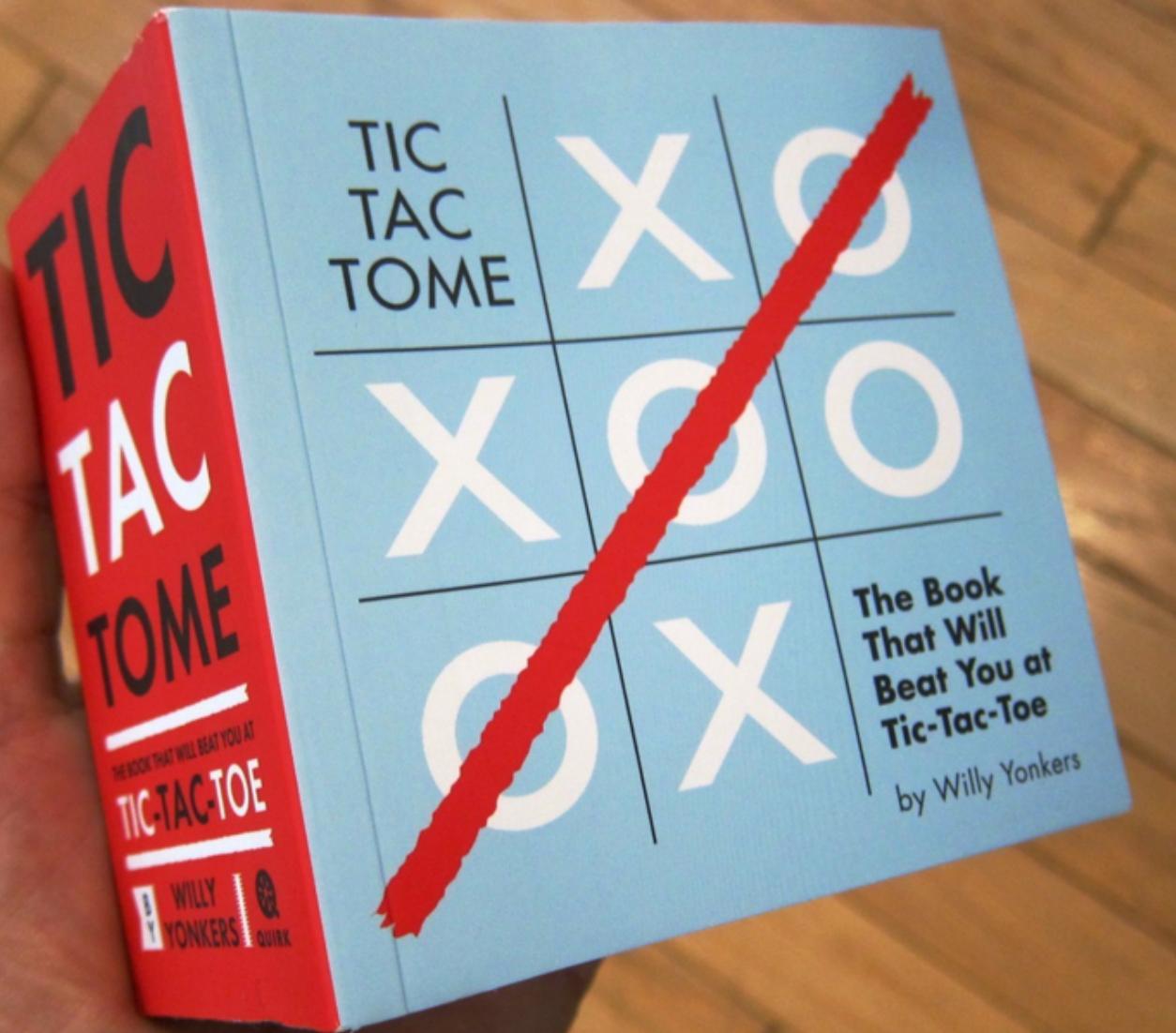
3



27



161



1400+ Pages

"I've beaten it once, and I think it's because the book lets you win."
- azjordan, amazon

Tic Tac Toe (Plan 2)

- * an 2D board {empty, X, 0}
- * an integer representing which turn it is (e.g. 1, 2, 3.... 9)
- * three special procedures, and a fixed strategy

make2

- * returns the center or any blank non-corner square

```
* int Make2()
* { if Board[5] == 2
*     return 5;
* else
*     for (int x = 2; x < 9; x+=2)
*         if Board[x] == 2 return x;
* }
```

Posswin(p)

- * returns 0 if player cannot win on next move, else returns square needed to win

Gol(n, p)

- * Places an X or O at position n

Strategy for X

- * TURN 1: Go(1,X)
- * TURN 3: If Board[9] == 2 Go(5,X) else Go(3,X).
- * TURN 5: If Posswin(X) then Go(Posswin(X),X) else
If Posswin(O) then Go(Posswin(O),X) else
- *
- *
- If Board[7] == 2 Go(7,X) else Go(3,X).
- * TURN 7: If Posswin(X) then Go(Posswin(X),X) else
If Posswin(O) then Go(Posswin(O),X) else
Go(Blank,X) (anywhere that is blank.)
- *
- *
- * TURN 9: Same as TURN 7.

Tic Tac Toe (Plan 3)

- * Some kind of search

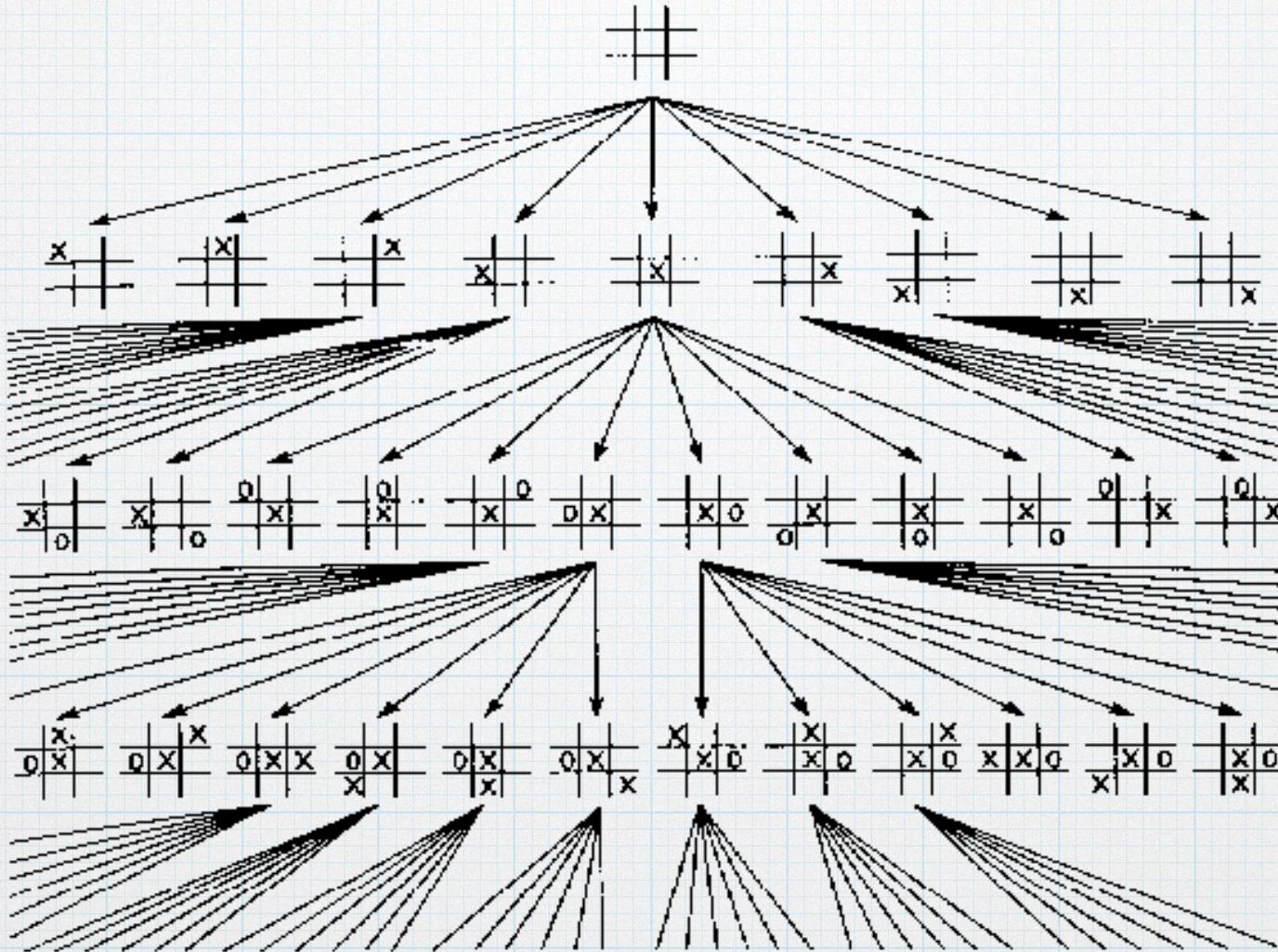
- * representation

- 2D Array

- * search strategy

- Exhaustive

- How exhaustive?



Why 9! ????

**How many ways can you arrange
one person in a photograph?**



$$1 = 1!$$

How many ways can you arrange
two people in a photograph?

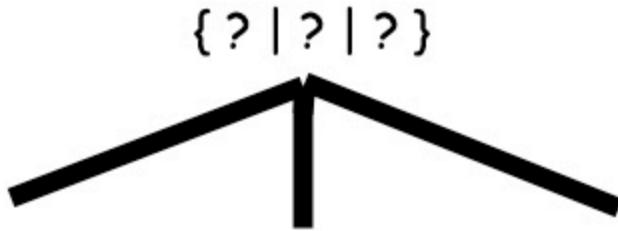


2 = 2!

How many ways can you arrange
three people in a photograph?



$$6 = 3!$$



on the left

who is left?

{ Jess, Maggs } { Steph, Maggs } { Steph, Jess }

on the left

in the middle

the photo:



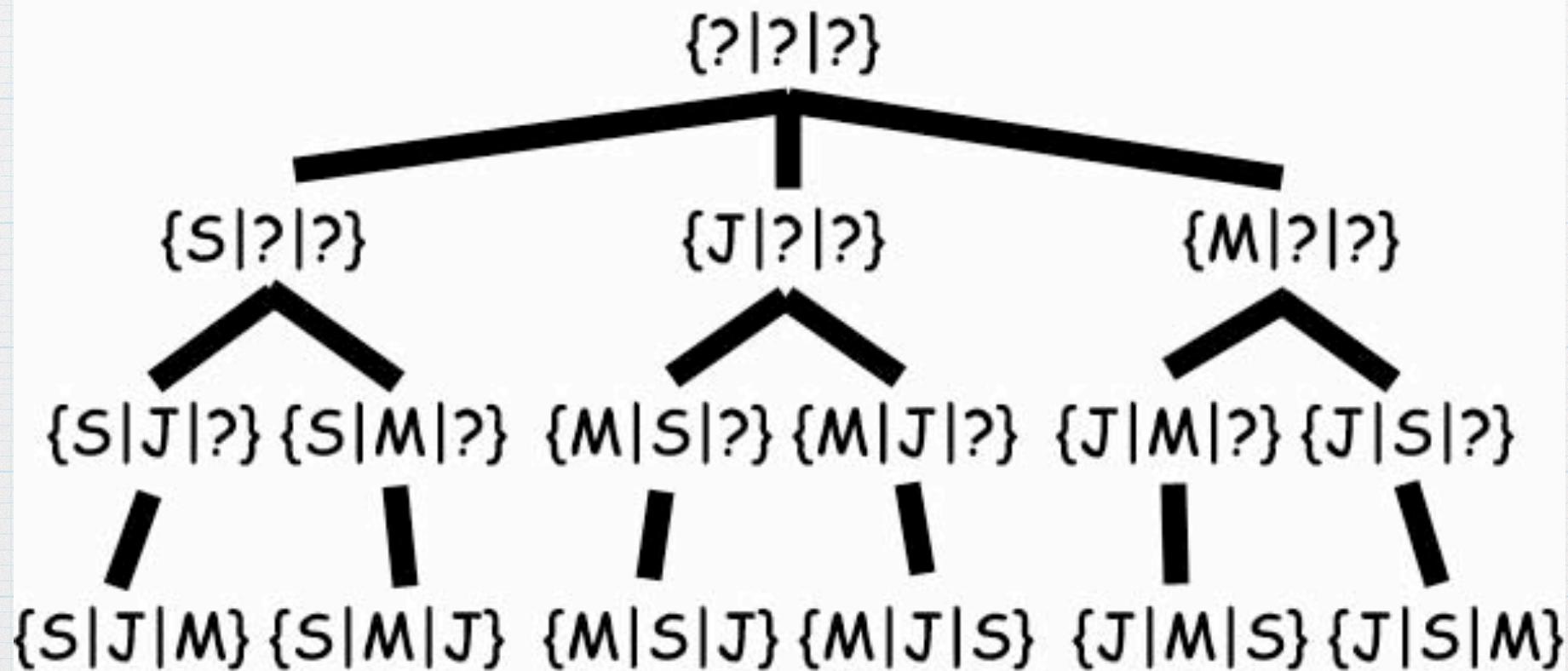
{Steph|Jess|?}

{Steph|Maggs|?}

{Steph | ? | ?}

{Steph|Maggs|?}







Steph, Jess, Maggs



Steph, Maggs, Jess



Maggs, Steph, Jess



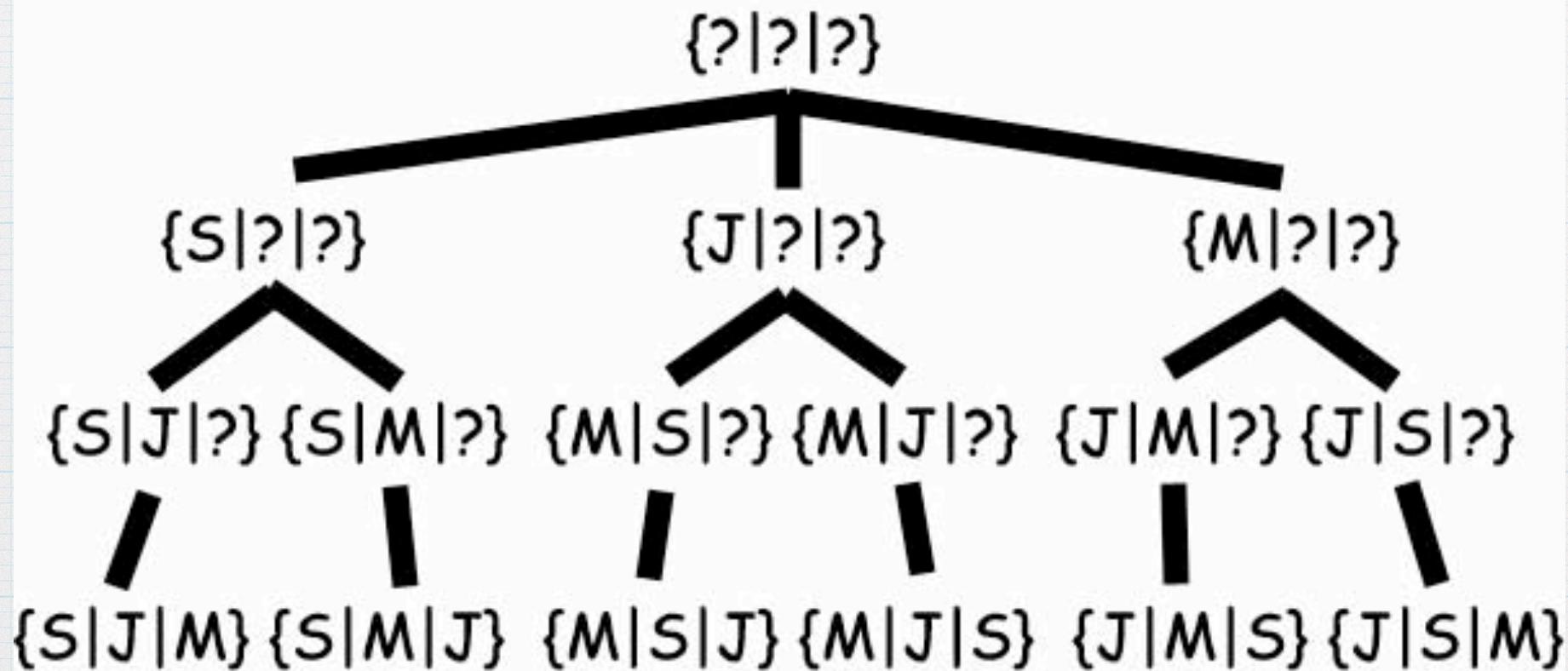
Maggs, Jess, Steph



Jess, Maggs, Steph



Jess, Steph, Maggs



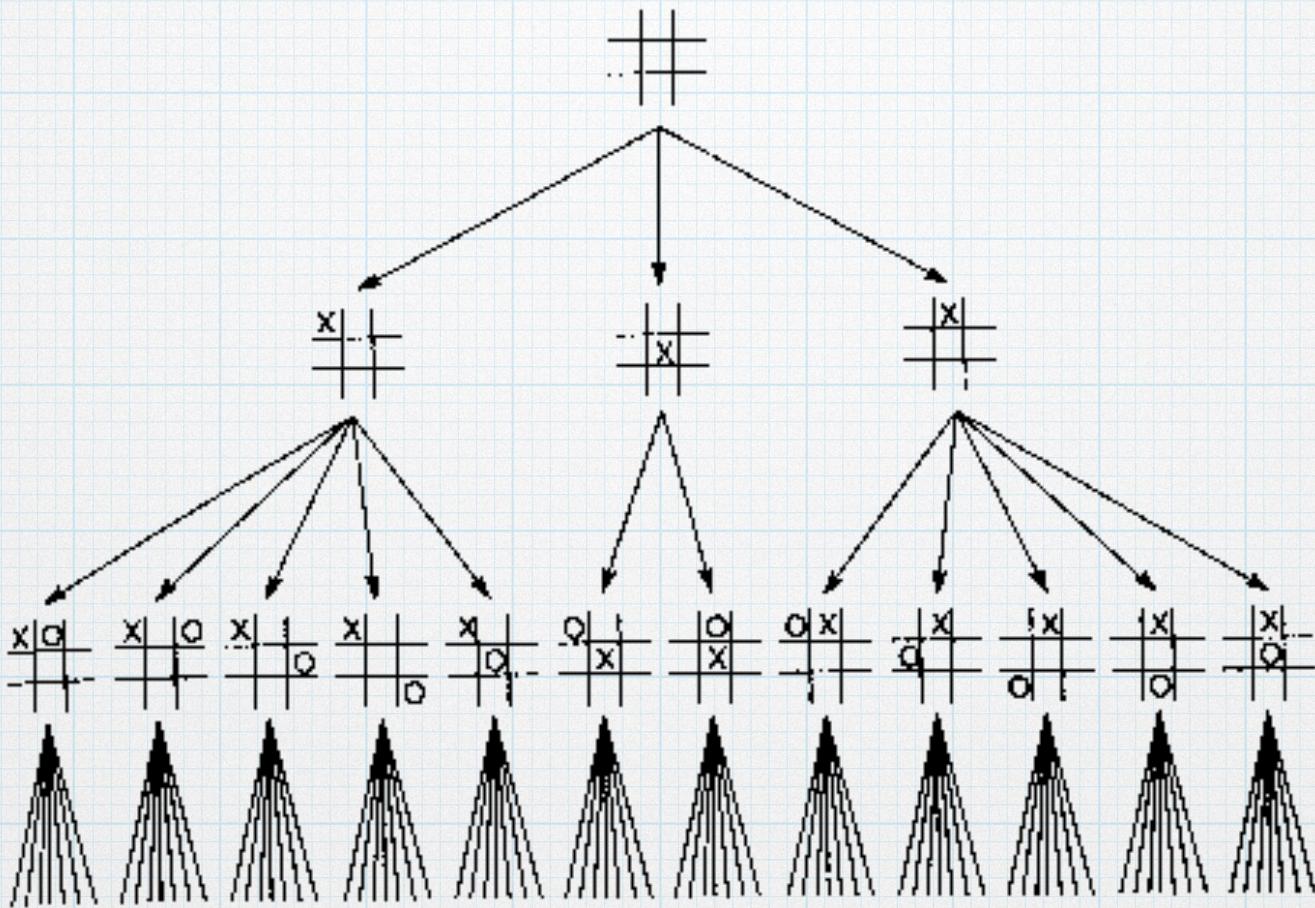
How many ways can you arrange
four people in a photograph?



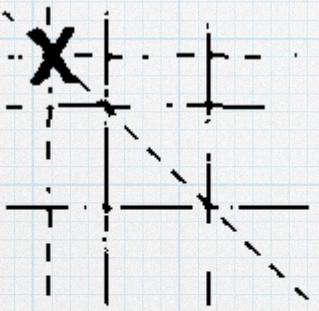
4 people,
4 places,
4!

Back to Tic Tac Toe

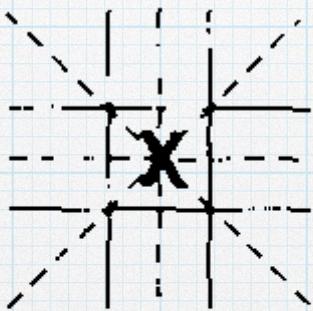
- * Reduce size of tree w/ symmetry
- * Limit number of plys w/ heuristic
- * Reduce size of tree w/ $\alpha\beta$ pruning



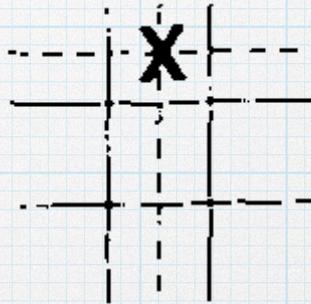
Example Heuristic



Three wins through
a corner square

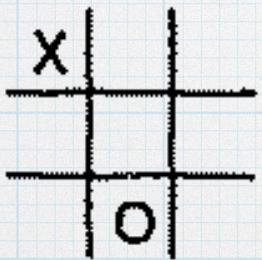


Four wins through
the center square

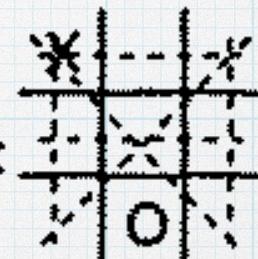


Two wins through
a side square

Combined Heuristic



X has 6 possible win paths:



O has 5 possible wins:

$$E(n) = 6 - 5 = 1$$

