

## Explanation of the Utility Function

This function evaluates the quality of a **Connect Four** board state by assigning a numerical score:

- **Higher values favor our player.**
- **Lower values favor the opponent.**

### 1. Check for Terminal States

Before analyzing individual cells, the function first checks if the game has already ended:

- **Draw** → Return **0**.
- **Our win** → Return **max\_utility** (the score when the board is completely filled with our pieces).
- **Opponent's win** → Return **min\_utility** (the score when the board is completely filled with the opponent's pieces).

If the game is over, there's no need for further evaluation.

### 2. Evaluate Each Cell on the Board

The function examines each cell to determine how much it contributes to a potential win:

- **If the cell contains our piece or is empty**, we assess its potential to help us form a four-in-a-row.
- **If the cell contains an opponent's piece**, we assess its potential to help them form a four-in-a-row and subtract this from our score.

Each cell's utility is determined by checking its possible four-in-a-row connections in all eight directions (represented by the compass directions):

- **North (N), Northeast (NE), East (E), Southeast (SE), South (S), Southwest (SW), West (W), and Northwest (NW).**

The **total utility of a cell** is the sum of its contributions across all these directions.

### 3. Directional Win Analysis

For each of the **eight directions**, the function evaluates how close the sequence is to forming four in a row:

- **Blocked (opponent's piece or board edge)** → Score **-1**.
- **Open with no pieces** → Score **1**.

- **One of our pieces** → Score **2**.
- **Two of our pieces** → Score **3**.
- **Three of our pieces (one move away from winning)** → Score **4**.

#### **4. Calculating the Total Utility**

- The **overall board utility** is computed by summing up the utility of every cell.
- The opponent's potential wins are evaluated the same way, and their score is subtracted from ours.
- The final score represents **how favorable the board is for our player**.