**Explanation of Assumptions in the Expected Value and Goals Metrics**

In this code, **Expected Value (xG)** is calculated for each shot based on its location and other contextual factors (such as distance, angle, and shot type). Here's a breakdown of the assumptions and why they make sense from a hockey analytics perspective:

**1. Goal Scoring Probabilities**

The code assumes two main **goal probabilities**:

* **Danger Zone Shots (xG = 0.18)**: Shots taken from the "danger zone" (close to the crease and high-scoring areas) have an **18% chance of resulting in a goal**.
* **Non-Danger Zone Shots (xG = 0.09)**: Shots taken from outside the danger zone are assumed to have a **9% chance of resulting in a goal**.

**Why it makes sense**:

* **Danger Zone**: The "danger zone" is well recognized in hockey analytics as the area closest to the net, where the probability of scoring is much higher due to proximity and angle. This assumption aligns with a vast amount of empirical data and research that shows the higher likelihood of goals being scored from these areas.
* **Non-Danger Zone**: Shots taken farther from the net (from the blue line or the perimeter) generally have a lower probability of resulting in a goal. A **9% chance** for shots outside the danger zone reflects the lower expected scoring efficiency from these areas.

**2. Expected Goals Calculation**

* The **distance** and **angle** of the shot are factored into the expected goals calculation, with the code using the following logic:
  + **Distance Calculation**: The code calculates the **distance from the net** using the Euclidean distance formula based on the X and Y coordinates of the shot.
  + **Angle Calculation**: The code also calculates the **angle of the shot** to understand the angle relative to the goal, where shots taken at wider angles have a lower chance of scoring.

**Why it makes sense**:

* **Distance**: Shots from farther away are typically less accurate and have a lower likelihood of scoring. The assumption that distance affects the goal probability is supported by years of analysis showing that closer shots (e.g., from within 10-15 feet) are far more likely to result in goals than long-range shots.
* **Angle**: A shot taken from a **tighter angle** (closer to the goal line) generally has a lower probability of scoring compared to a shot taken from the center of the ice. This angle calculation is based on fundamental hockey knowledge that shooting from a better angle increases the likelihood of scoring.

**3. xG Weighting Based on Situation (Even Strength, Powerplay, Shorthanded)**

* **Expected goals** are adjusted based on whether the shot occurred during **even strength**, **powerplay**, or **shorthanded** situations. This adjustment is made using different **weightings** for each situation:
  + **Powerplay**: The weight is lower because, while powerplays increase shot opportunities, the defense often tightens and goalies perform better.
  + **Shorthanded**: The weight is higher for shorthanded situations because the team is at a numerical disadvantage, which makes scoring harder for the defending team, meaning even fewer shots have a higher expected value when scored.
  + **Even Strength**: Default weight is used when the teams are balanced in terms of skaters.

**Why it makes sense**:

* **Powerplay and Shorthanded Context**: The assumption here is that the context of a powerplay or shorthanded situation influences shot quality. For example, powerplays often lead to more shots but may not always result in higher-quality shots due to defensive systems, while shorthanded shots can be more dangerous due to opposing team fatigue or mismatches. This approach helps account for the fact that **not all shots are created equal** in different game situations.

**4. Calculating Goals Above Expected**

* The **goals above expected** metric compares the number of actual goals scored by a player or team with the expected goals (xG) from all their shots.

**Why it makes sense**:

* **Efficiency**: The goals above expected measure is used in hockey analytics to evaluate a player or team’s shooting efficiency. If a player has more goals than expected based on their shot quality (xG), it may indicate that they are either **exceptionally skilled at scoring** (e.g., with great accuracy or shot selection) or benefiting from **good luck**. If they score fewer goals than expected, it may signal that they are **underperforming** relative to their shot quality.

To calculate the **shot angle** based on the x and y coordinates of where a shot was taken, the code uses the following method:

1. **Standardizing Coordinates:**
   * If the shot is taken on the **right side** of the rink (i.e., x-coordinate > 100), the code "mirrors" the shot location to the left side by transforming the x-coordinate as x\_coord = 200 - x\_coord.
   * Similarly, the **y-coordinate** is flipped as y\_coord = 85 - y\_coord, standardizing the shot location to a consistent perspective (with the goal always at the far end of the rink).
2. **Angle Calculation:**
   * After standardizing the coordinates, the **angle of the shot** is calculated using the math.atan2() function. This function computes the angle between the shot's x, y coordinates and the center of the rink (which is set at (0, 42.5) to represent the middle of the rink's y-axis, assuming the rink is 85 feet in height).

The formula for the angle is:

angle=∣atan2(ycoord−42.5,xcoord)∣\text{angle} = \left| \text{atan2}(y\_{\text{coord}} - 42.5, x\_{\text{coord}}) \right|angle=∣atan2(ycoord​−42.5,xcoord​)∣

* + **atan2(y, x)** computes the angle in radians between the point (x, y) and the origin (0, 0). The abs() is used to ensure that the angle is always positive.

1. **Effect on Expected Goals:**
   * The angle impacts the expected goals (xG) by reducing the expected goal probability the more acute the angle is. The code then adjusts the expected goals using the **distance** and **angle**:
   * It uses 0.985 \*\* (math.degrees(angle)) to reduce the expected goal value the higher the angle becomes (since higher angles typically represent more difficult shots). The angle is converted from radians to degrees using math.degrees(angle).
2. **Conclusion:**
   * The **shot angle** influences the **expected goals (xG)** by modifying the chance of scoring based on the difficulty of the shot. Shots taken at sharper angles (usually near the boards or corners) are less likely to result in goals compared to shots taken from higher-percentage areas near the center of the net.

The dataset only provides the x and y coordinates for each shot (as shown in the screenshot), and the angle is derived directly from these coordinates using the standard formulas for calculating the angle in a 2D plane. The angle plays a key role in adjusting the **expected goals (xG)** and thus the total shot value used in the analysis.