Documentation for "Max Points on a Line"

Description:

Given an array of points on the X-Y plane, where each point is represented as points[i] = [xi, yi], determine the maximum number of points that lie on the same straight line.

Function Signature:

def maxPoints(points: List[List[int]]) -> int:

Parameters:

- **points (List[List[int]]):** A list of n points on the X-Y plane. Each point is represented as a list [xi, yi] where xi and yi are integers. The length of points is between 1 and 300 (inclusive), and the coordinates xi and yi are within the range [-10^4, 10^4]. All points are unique.

Returns:

- **int:** The maximum number of points that lie on the same straight line.

Example 1:

points = [[1,1],[2,2],[3,3]]

assert maxPoints(points) == 3

Example 2:

points = [[1,1],[3,2],[5,3],[4,1],[2,3],[1,4]]

assert maxPoints(points) == 4

Constraints

- The number of points n satisfies $1 <= n <= 300$.
- Each point is given as $[x_i, y_i]$ where $-10^4 <= x_i, y_i <= 10^4$.
- All points are distinct.

Approach

To solve the problem, the algorithm follows these steps:

1. **Handle Edge Cases:**

   - If there is only one point, the maximum number of points on a line is 1.

2. **Define Helper Functions:**

   - *gcd(a, b):* Computes the greatest common divisor of a and b using the Euclidean algorithm.
   - *slope(p1, p2):* Computes the slope of the line defined by points p1 and p2. Handles vertical and horizontal lines explicitly and normalizes the slope using the greatest common divisor.

3. **Main Logic:**
- Iterate through each point and use it as the base point.
- For each base point, compute the slope to all other points.
- Count the occurrences of each slope using a dictionary.
- Track the maximum count of points on the same line for each base point, considering duplicates.

4. **Update and Return Result:**
- Update the maximum number of points on a line with each base point iteration.
- Return the final maximum number.

Explanation

- **GCD Function:** Used to reduce the slope to its simplest form.
- **Slope Calculation:** Differentiates between vertical, horizontal, and other lines to standardize slope representation.
- **Duplicate Handling:** Counts points that are identical to the current base point.
- **Max Calculation:** For each base point, the maximum number of points on the same line is updated considering both the duplicate points and the maximum points with each unique slope.

This approach ensures that the algorithm efficiently handles the constraints and provides the correct result.