DBSCAN Clustering – Complete Step-by-Step Mathematical Example

1. Dataset
We are given seven points in 2D space:
A(1,1), B(1,2), C(2,1), D(2,2), E(8,8), F(8,9), G(25,25)

2. Parameters
Epsilon (ε) = 1.5
MinPts = 4

3. Distance Formula
Euclidean Distance:
$d(p,q) = \sqrt{[(x■ - x■)^2 + (y■ - y■)^2]}$

4. ε-Neighborhood Definition
$N\varepsilon(p) = \{q \mid d(p,q) \leq \varepsilon\}$

5. Distance Calculations for Point A
$d(A,B)=1$, $d(A,C)=1$, $d(A,D)=\sqrt{2}\approx 1.414$
All $\leq \varepsilon \Rightarrow N\varepsilon(A) = \{A,B,C,D\}$

6. Core Point Condition
$|N\varepsilon(A)| = 4 \geq$ MinPts $\Rightarrow$ A is a Core Point

7. Repeating for B, C, D
Each has 4 neighbors within $\varepsilon \Rightarrow$ All are Core Points

8. Points E and F
$N\varepsilon(E)=\{E,F\}$, $N\varepsilon(F)=\{E,F\}$
Only 2 points $\Rightarrow$ Not Core

9. Point G
$N\varepsilon(G)=\{G\} \Rightarrow$ Noise

10. Cluster Formation
Cluster 1 = {A,B,C,D} (density-connected core points)

11. Noise Points
{E, F, G}

12. Final Result
Cluster: {A,B,C,D}
Noise: {E,F,G}