

# Density-Based Clustering

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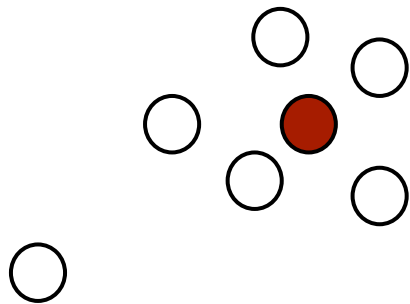
**Goal:** cluster together points that are densely packed together.

How should we define density?

Given a fixed radius  $\epsilon$  around a point, if there are at least **min\_pts** number of points in that area, then this section is dense.

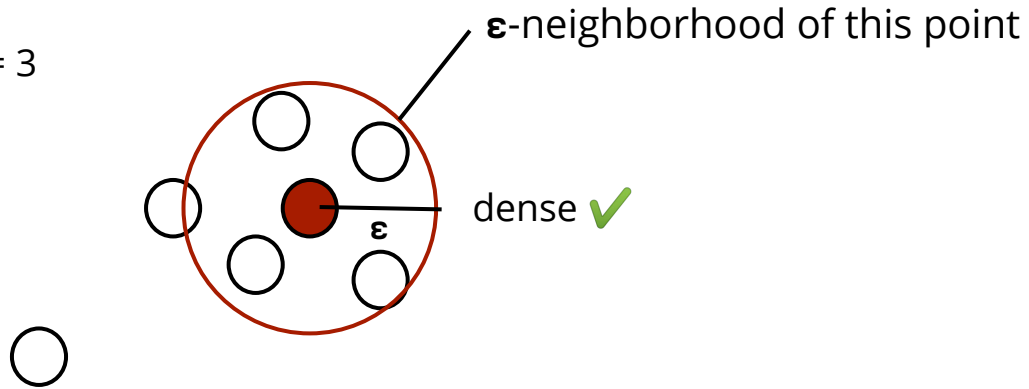
# Example

Min\_pts = 3



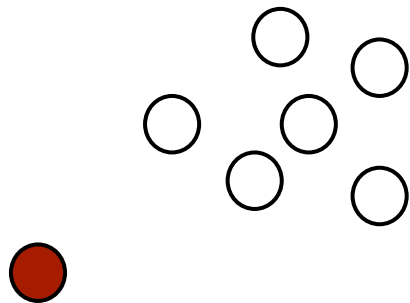
# Example

Min\_pts = 3



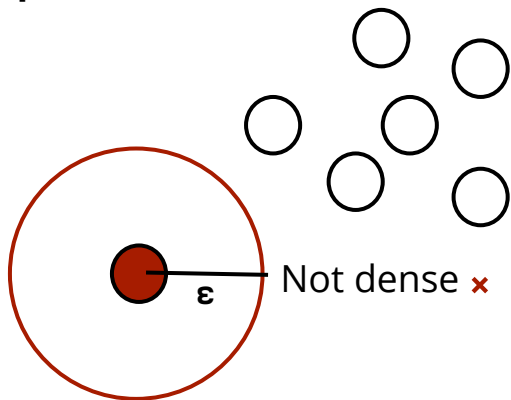
# Example

Min\_pts = 3



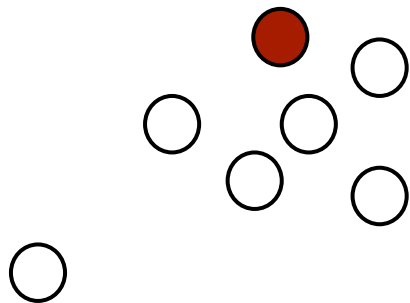
# Example

Min\_pts = 3



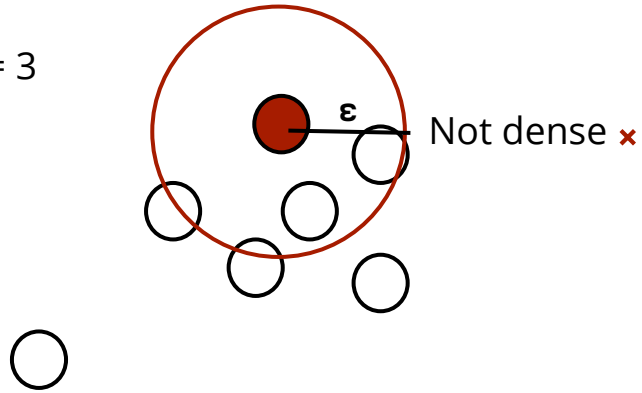
# Example

Min\_pts = 3



# Example

Min\_pts = 3



But... That point was part of a dense section earlier...



# Density-Based Clustering

We need to distinguish between points at the core of a dense region and points at the border of a dense region.

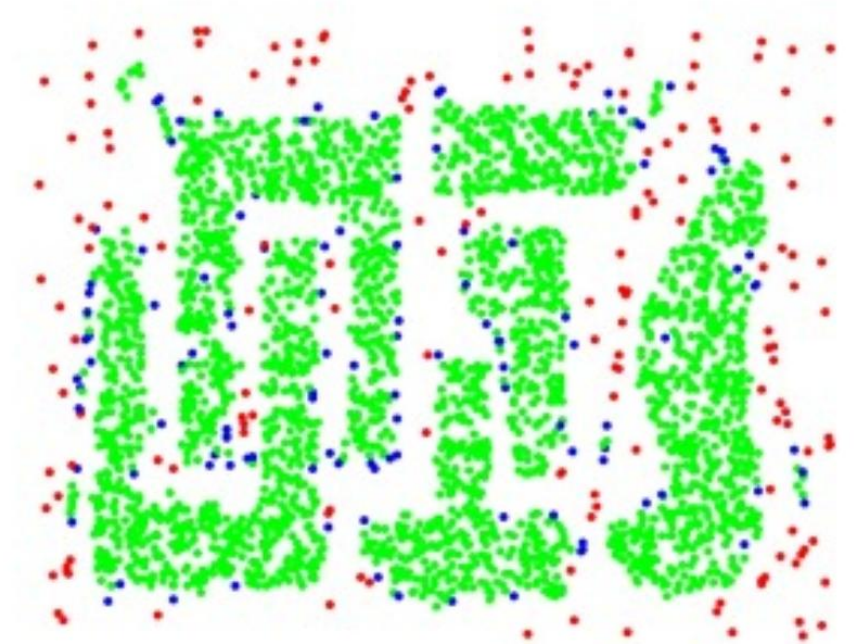
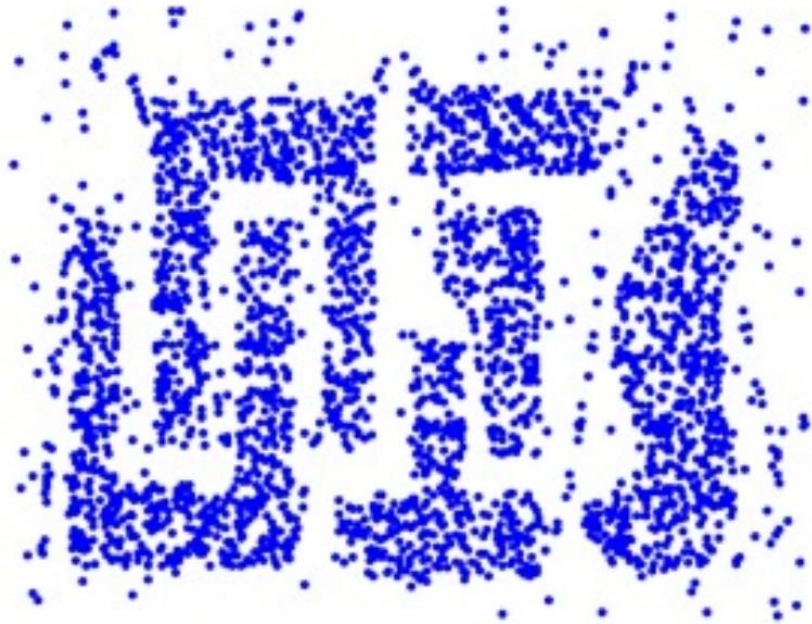
Let's define:

**Core** point: if its  $\epsilon$ -neighborhood contains at least **min\_pts**

**Border** point: if it is in the  $\epsilon$ -neighborhood of a core point

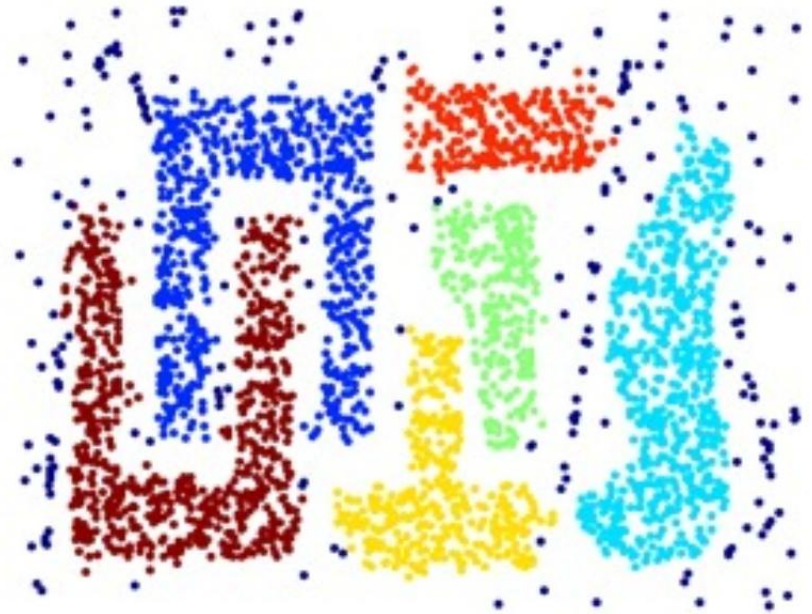
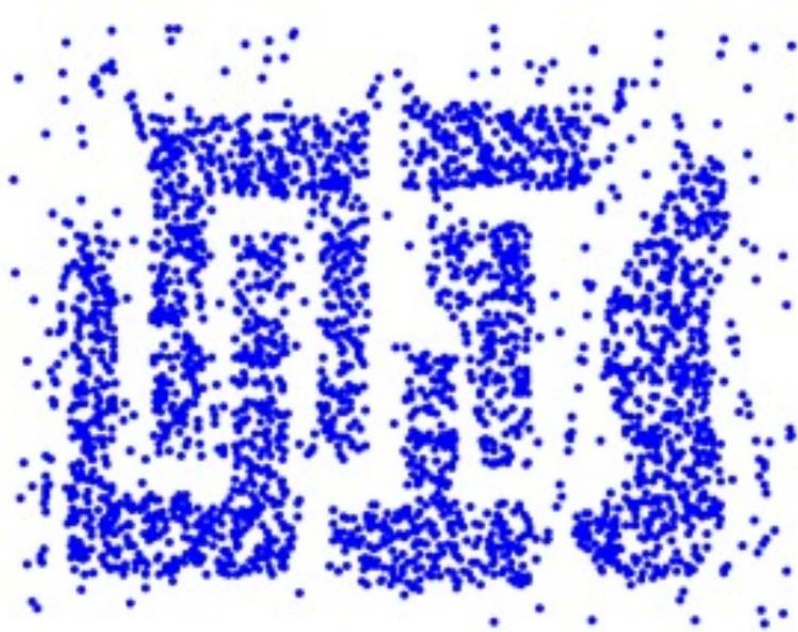
**Noise** point: if it is neither a core nor border point

# Density-Based Clustering



Core | Border | Noise

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Create clusters by connecting core points

# DBScan Algorithm

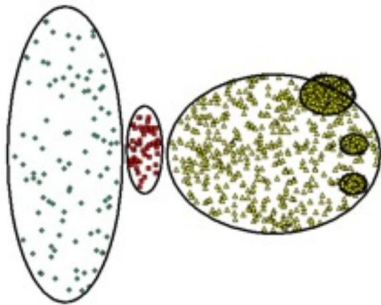
$\epsilon$  and **min\_pts** given:

1. Find the  $\epsilon$ -neighborhood of each point
2. Label the point as **core** if it contains at least **min\_pts**
3. Label points in its neighborhood that are not **core** as **border**
4. Label points as **noise** if they are neither **core** nor **border**
5. For each **core** point, assign to the same cluster all **core** points in its neighborhood
6. Assign border points to nearby clusters

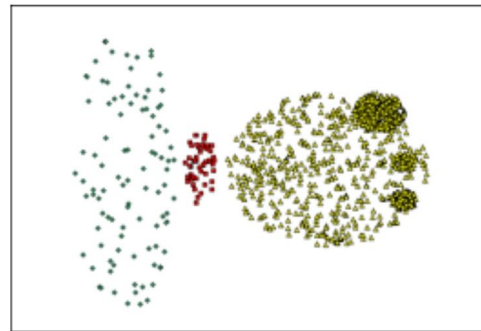
# DBScan - Benefits

1. Can identify clusters of different shapes and sizes
2. Resistant to noise

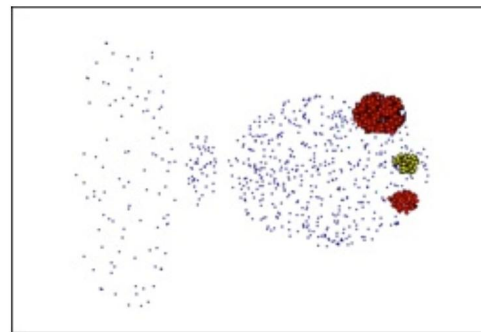
# DBScan - Limitations



1. Can fail to identify clusters of varying densities.
2. Tends to create clusters of the same density.
3. Notion of density is problematic in high-dimensional spaces



(MinPts=4, Eps=9.75).



(MinPts=4, Eps=9.92)

**Demo**