Let's go through the steps of Agglomerative Hierarchical Clustering with a simple example.

**Problem Setup**

Suppose we have five data points with the following coordinates in a 2D space:

* A (1, 1)
* B (1, 4)
* C (5, 1)
* D (5, 4)
* E (3, 3)

We’ll perform **Agglomerative Hierarchical Clustering** on these points and track the steps through to completion.

**Steps in Agglomerative Hierarchical Clustering**

**1. Calculate Pairwise Distances**

* First, we calculate the Euclidean distance between each pair of points.

| **Points** | **Distance** |
| --- | --- |
| A-B | 3.0 |
| A-C | 4.0 |
| A-D | 5.0 |
| A-E | 2.83 |
| B-C | 5.0 |
| B-D | 4.0 |
| B-E | 2.24 |
| C-D | 3.0 |
| C-E | 2.83 |
| D-E | 2.24 |

 **Create Initial Clusters**

* Each data point starts as its own cluster:
  + Initial Clusters: {A}, {B}, {C}, {D}, {E}

 **Merge Clusters Based on Linkage Criteria**

* We start with the smallest distance, **2.24**, which occurs for two pairs: **B-E** and **D-E**. We'll process **B-E** first.
* **Step 1:** Merge {B} and {E} into {BE}.
  + Updated Clusters: {A}, {BE}, {C}, {D}
* **Step 2:** We still have **D-E** at 2.24 (since **E** is already merged with **B**).
  + Next, merge {D} and {BE} based on the closest distance.
  + Updated Clusters: {A}, {DBE}, {C}

 **Repeat Merging**

* **Iteration 3:** Now the smallest distance is **2.83** between A and {DBE}.
  + Merge {A} and {DBE}.
  + Updated Clusters: {ADBE}, {C}
* **Iteration 4:** Finally, the last two clusters {ADBE} and {C} are merged.

 **Final Cluster and Dendrogram**

* Cutting at an appropriate level on the dendrogram would yield the desired number of clusters, visualizing which groups naturally formed during merging.