

2a. Which two attributes are most strongly cross-correlated with each other?

The two attributes most strongly cross-correlated with each other are NonFict and Romance with a correlation coefficient of -0.80 (absolute value = 0.80). This indicates a strong negative correlation - people who buy non-fiction books are very unlikely to buy romance novels, and vice versa.

b. If someone buys lots of Manga books, else are they likely to buy (or not buy, depending on what is strongest.). In other words, what is the strongest Absolute value of CC with any other category? Are they also likely to buy Horror or Gifts? Or, are they NOT likely to buy Thrillers? Do the analysis and report the answer here.

Manga strongest with Baby\_Toddler at -0.67

c. What other category is Fiction most strongly correlated with?

Fiction strongest with Classics at -0.66

d. What other category is Self Improvement most strongly correlated with?

SelfImprov strongest with Teen at 0.69

e. If someone buys cookbooks, what can you tell about them?

Cooking strongest negative with Journals at -0.56, then Manga at -0.53; strongest positive with Classics at 0.40

f. If someone buys lots of classic novels, what can you tell about them?

Classics strong negatives with Fiction (-0.66), Horror (-0.65), Romance (-0.52); positives with NonFict (0.60), Mysteries (0.47)

g. If someone buys NEWS, what can you tell about them?

News strong negatives with Romance (-0.67), Teen (-0.56), Horror (-0.56); positive with NonFict (0.68)

h. What do you know about people who buy Hairy Pottery?

HairyPottery strongest with Manga at 0.58; negatives with Horror (-0.52), Romance (-0.50), Cooking (-0.44)

i. What are Thrillers most strongly associated with, or not associated with?

Thrillers strongest positive with Mysteries at 0.48; negatives with Baby\_Toddler (-0.48), Sci-Fict (-0.45)

j. What can we infer about people who buy Art & History books?

Art&Hist shows near-zero correlations with everything (-0.02 to 0.02)

3. If you were to delete three attributes, which would you guess were irrelevant? Why?

Art & History, Poetry, and Gifts because they don't vary meaningfully with other purchases. The data doesn't help identify distinct customer groups or patterns.

4d.

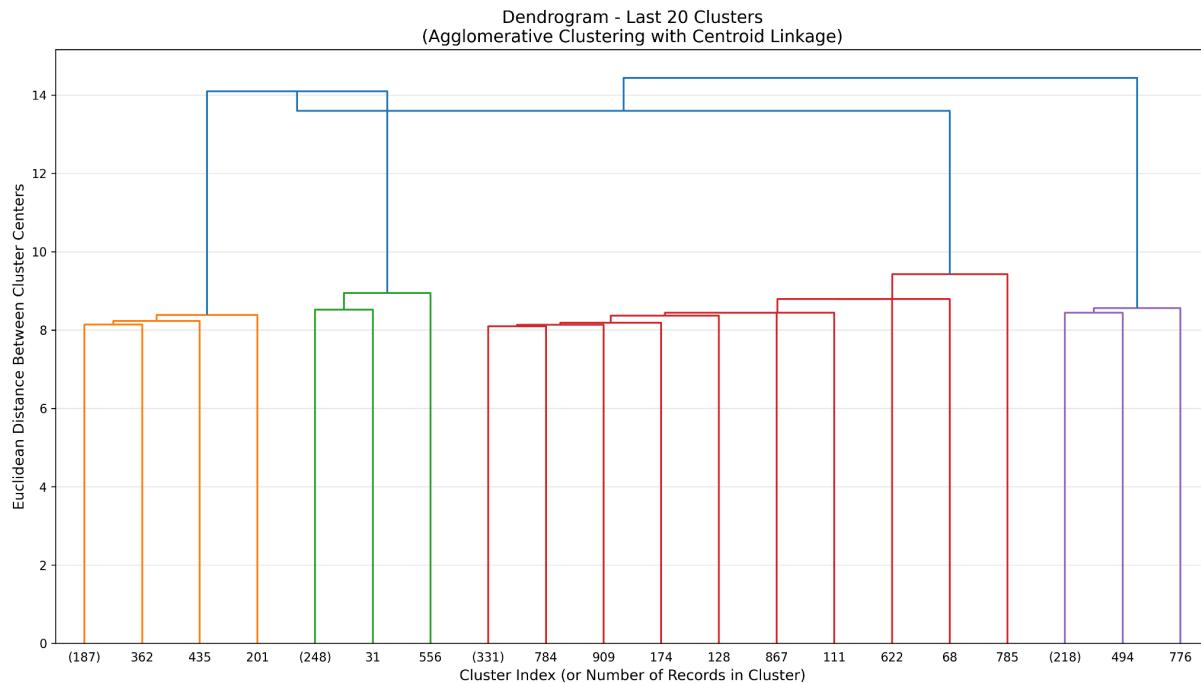
LAST 20 - [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 190, 340, 220]

LAST 10 - [1, 1, 1, 1, 1, 1, 1, 190, 340, 220]

What this tells us is that the first 17 of the last 20 merges involved outliers (size 1) being absorbed into main clusters. Only the final 3 merges combined substantial clusters, indicating 4 stable groups existed before the final consolidation.

4e.

4 clusters because of the last 10 smallest sizes. The dendrogram shows 4 distinct colored clusters.



5. Report the size of each suspected cluster, from smallest to largest size.

Cluster 3: 190 members

Cluster 1: 220 members

Cluster 2: 250 members

Cluster 0: 340 members

6. Report the average prototype of each of these clusters.

**Cluster 0:**

High: Teen (7.94), SelfImprov (7.96), Classics (6.94), Mysteries (6.05), Cooking (5.12), Romance (5.13)

Low: Games (0.99), Art&Hist (0.97), Journals (1.45), Horror (2.01)

**Cluster 1:**

High: NonFict (9.03), Baby\_Toddler (8.52), Classics (7.11), Sci-Fi (5.85), News (5.27), Games (5.05)

Low: Romance (0.50), Horror (0.00), Teen (0.94), Manga (1.01), SelfImprov (1.04)

**Cluster 2:**

High: Horror (9.00), Romance (8.48), Baby\_Toddler (8.40), Games (8.09), Sci-Fi (6.05), Teen (5.92)

Low: Manga (0.22), NonFict (1.03), News (1.04), HairyPottery (0.52)

**Cluster 3:**

High: Fiction (7.04), Sci-Fi (6.87), Teen (6.93), HairyPottery (6.57), Journals (6.54), Manga (5.93)

Low: Cooking (1.03), Baby\_Toddler (1.33), Classics (1.76), News (1.95)

7. What typifies each of the clusters? What typical names should we give each of these prototypes? Is there a family group? Is there a gift-giving group? What typifies each group?  
Cluster 0 consists of middle-aged parents (35-55) with teens, focused on personal growth  
Typified by: High self-help (7.96) + teen books (7.94) + classics (6.94) + mysteries (6.05)

Cluster 1 consists of parents with young children (0-5 years), education-focused

Typified by: Extreme non-fiction (9.03) + baby/toddler books (8.52), no horror

Cluster 2 consists of young adults (20-35) who love escapist fiction, likely buying baby gifts  
Typified by: Horror (9.00) + romance (8.48) + games (8.09), but also baby/toddler (8.40)

Cluster 3 consists of teens/young adults (15-25), imaginative fantasy enthusiasts

Typified by: Fiction (7.04) + sci-fi (6.87) + Harry Potter (6.57) + manga (5.93) + journals (6.54)

9. Write a conclusion about what you learned overall.

We gained a much deeper understanding of how correlation analysis and hierarchical clustering complement each other in segmenting customers based on their underlying similarities.

Through this process, we learned how to interpret relationships between variables and how those relationships can shape the quality of clustering results.

A key lesson from the correlation analysis was the importance of identifying which variables contribute useful information and which ones add noise. We learned how to interpret strong positive and negative correlations as indicators of customer tendencies, and how near-zero correlations can reveal irrelevant attributes that weaken clustering accuracy. This taught us that effective feature selection can be just as valuable as the clustering itself because it improves both efficiency and interpretability.

Working on agglomerative clustering helped me understand not just how the algorithm functions conceptually, but also how to implement and optimize it in practice. Building it from scratch forced us to think carefully about time complexity, data structures, and mathematical precision. We learned that a naive implementation can be extremely slow (had an initial  $O(n^3)$  time complexity) due to repeated distance calculations, and that using data structures like priority queues can dramatically improve performance (improved to  $O(n^2 \log n)$ ). At the same time, we discovered that optimization must be balanced with correctness, shortcuts that simplify computation can compromise the integrity of the results. This reinforced the idea that algorithmic efficiency and statistical accuracy must go hand in hand.

Beyond the technical side, we learned how to interpret clustering results in a meaningful way. Visual tools like dendograms showed us how to determine natural groupings by observing patterns in merge distances. This experience helped us understand how to choose an appropriate number of clusters and how to evaluate whether they make sense both statistically and contextually. We also learned that clustering is inherently exploratory, there is no single “correct” answer, and interpretation often depends on the business context or research goals.