
Clustering Wikipedia Articles

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Abstract

Clustering Wikipedia articles using unsupervised learning techniques including K-Means, Latent Dirichlet Allocation (LDA), and spectral clustering.

1 Dataset

The provided dataset contains 15,903 Wikipedia articles in tf-idf format. There are 10,574 unique words in this dataset. Each document is represented as a sparse vector with one dimension for each word.

2 K-Means Clustering

For the project milestone, I have implemented K-Means clustering on the provided subset of Wikipedia articles.

2.1 Choosing K

2.1.1 Minimizing Distortion

Given K clusters C_1, C_2, \dots, C_K where each cluster is a set of document vectors and μ_i is the centroid of C_i , the total distortion is defined as follows:

$$\sum_{i=1}^K \sum_{d \in C_i} \|d - \mu_i\|^2$$

To minimize the distortion, we could set K equal to the number of documents, but then the clusters would be meaningless. We want to choose a K with low distortion that also results in interpretable clusters. Figure 1 shows a plot of K versus total distortion. When $1 \leq K \leq 16$, adding additional clusters has a large impact on the distortion, but once $K > 16$, adding additional clusters has little impact on the distortion. From this alone, it makes sense to set $K = 16$ since it provides a good balance of distortion and interpretability.

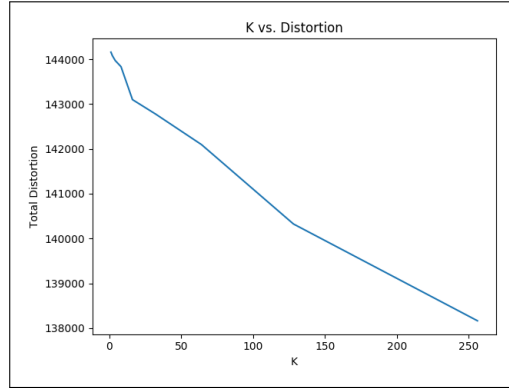


Figure 1: K versus total distortion for $K \in \{1, 2, 4, \dots, 256\}$

2.2 K and Cluster Size

As K increases, the clusters become more sparse. Once $K = 256$, over half of the clusters have only one document, and are essentially useless. When $K = 16$, the median cluster size is 8.5, and the cluster sizes are as follows:

[10061, 3013, 1128, 909, 707, 30, 23, 13, 4, 4, 3, 2, 2, 2, 1, 1]

Over half of the clusters are very small, and one of the clusters is too large to be interpretable. This indicates that the data has significant outliers and may lack a structure conducive to clustering.

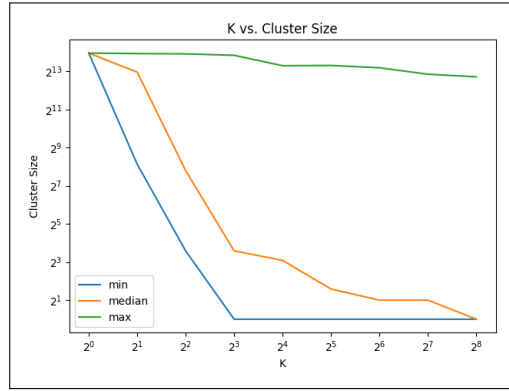


Figure 2: K versus minimum, median, and maximum cluster size for $K \in \{1, 2, 4, \dots, 256\}$ with a \log_2 scale on both axes.

2.3 Exploring Clusters

Table 1 shows the clusters with at least 10 documents for K-Means clustering with $K = 16$. The words in each cluster are the dimensions of the centroid with the largest magnitude. The documents shown are those that are closest to the centroid of the cluster.

Overall, the generated clusters make sense, but there are some points of confusion:

- The words that make up cluster 0 have little relation to each other. This cluster contains the majority of the documents.
- Cluster 1 contains churches as well as colleges.
- Cluster 3 contains documents related to TV shows and sports because both contain the word "season."

Table 1: K-Means clusters with $K = 16$ and at least 10 documents.

Cluster	Size	Words	Documents
0	10061	females station family located north	mcgillpainquestionnaire historyofthefamily thetussaudsgroup nadiraactress mansfieldsummithighschool
1	3013	church college students published institute	edmondscommunitycollege helderbergcollege oberlincongregationalchurch lundbyoldchurch dioceseoffimerickandkillaloe
2	1128	party served general member senate	partyidentification labourfarmerparty democraticalliancesouthafrica liberaldemocratsitaly christiancreditparty
3	909	season club playing seasons player	dancingwiththestars davidmccracken gilbertcurgenven bjsamsamericanfootball livingstonewalker
4	707	album released songs records rock	thegreatestdaytakethalbum conflictingemotions primalscram leftbacklp elisamartin
5	30	nba basketball points season seasons	kcjones hakeemolajuwon albertkingbasketball ballstatecardinalsmensbasketball 201011southfloridabullsmensbasketballteam
6	23	riots police murder captured robbery	sowetouprising 1992losangelesriots nikolaybogolepov josephlamothe jenmi
7	13	congo subtropical republic zambia zimbabwe	republicofcabinda brownrumpedbunting copperbeltprovince leptopelisviridis yellowthroatedpetronia

3 Next Steps

3.1 Recursive K-Means

One of the largest issues with applying K-Means to this dataset is that it produces clusters with huge size variations. Some clusters contain 10,000 documents, whereas others contain only one. Recursively applying K-means to large clusters could address this problem and even produce a sort of hierarchical clustering.

3.2 Latent Dirichlet Allocation

Some of the clusters contain documents that refer to difference meanings of the same word. For example, "season" could refer to a football season or a TV show season. I would like to explore Latent Dirichlet Allocation and whether or not it could help with this situation.