

CSE 442

Machine

Learning Project

We are group 02

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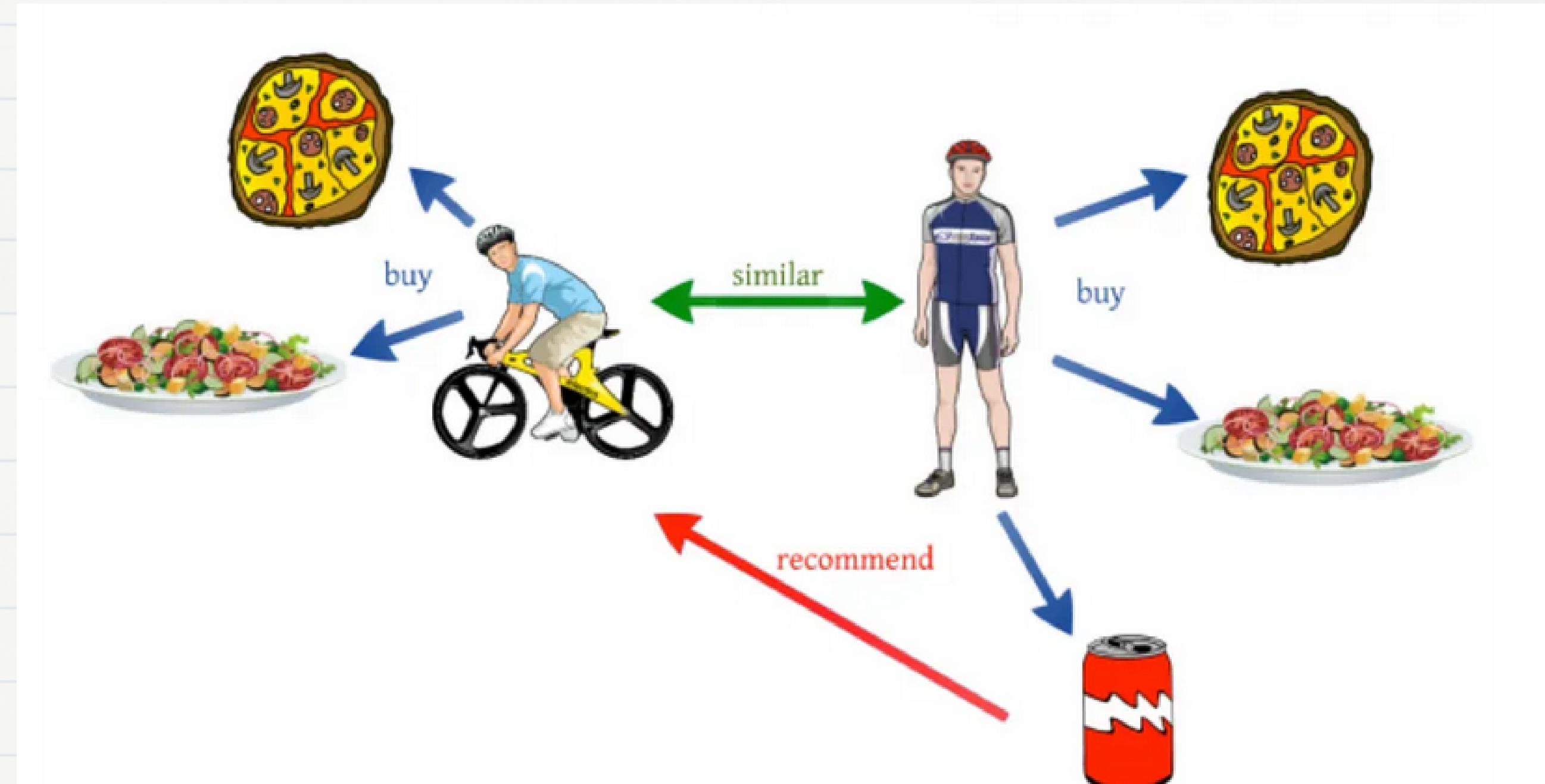
202014051

Overview

- Lit Review
- Sources of the Dataset
- Analyzing the Dataset
- Feature Selection Methods
- ML Model Methodology
- Output Comparison
- Performance Analysis



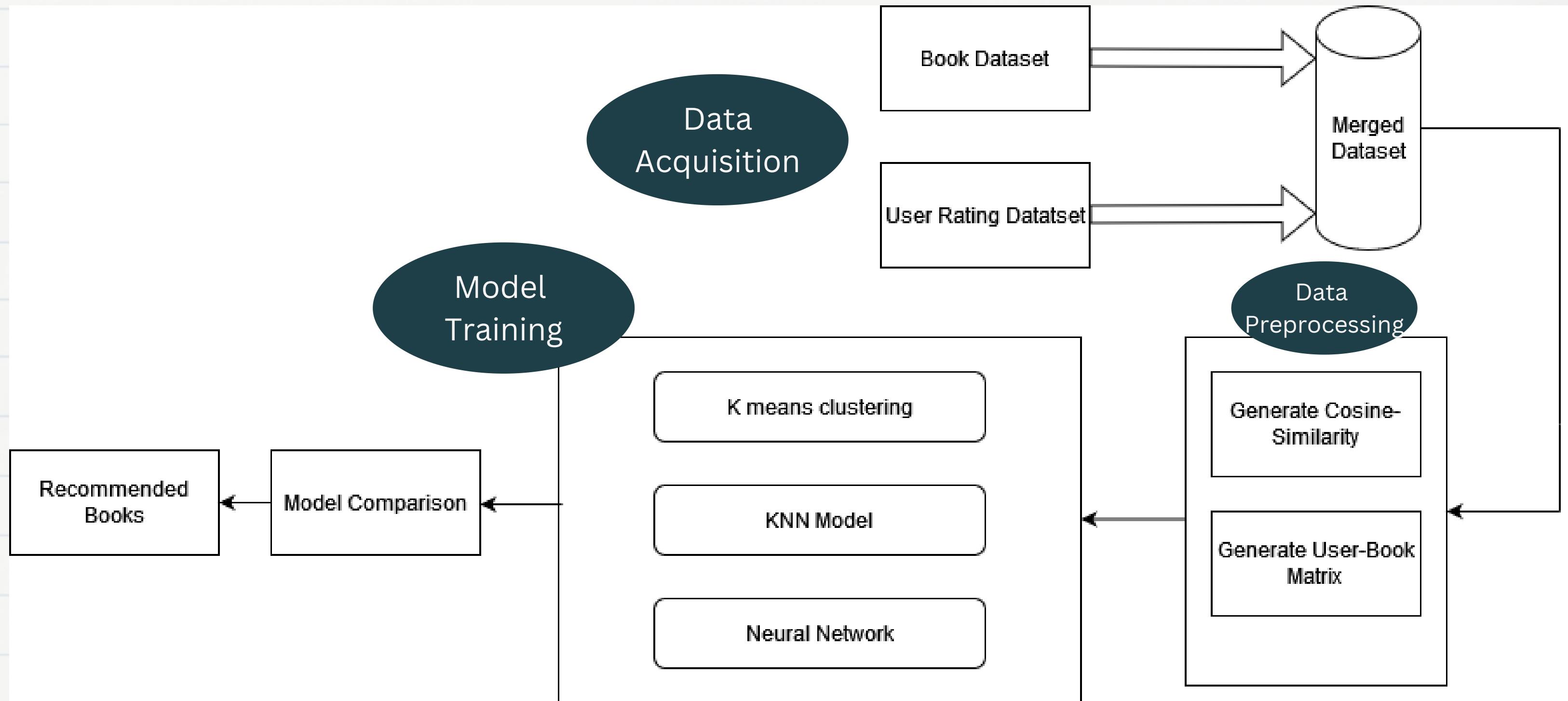
BoiPoka 2.0 : Collaborative Filtering Based Bangla Book Recommendation System

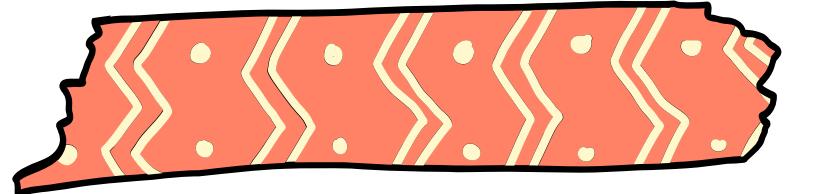


Lit Review: Collaborative Filtering for English books

Work	Approach Used
<p>Xin, Liu, et al. "Collaborative book recommendation based on readers' borrowing records." 2013 International Conference on Advanced Cloud and Big Data. IEEE, 2013.</p>	<ul style="list-style-type: none">Created users' ratings based on borrowing records with timestampsItem-based KNN and user-based KNN algorithms.Two blending methods, NN (neural network) and LR (logistic regression)Performance evaluation using RMSE
<p>Rohit, Sai Sabitha, and Tanupriya Choudhury. "Proposed approach for book recommendation based on user k-NN." Advances in Computer and Computational Sciences: Proceedings of ICCCCS 2016, Volume 2. Springer Singapore, 2018.</p>	<ul style="list-style-type: none">KNN based on attributes such as age, location and interestPerformance evaluation using RMSE, MAEPearson Correlation and Cosine Similarity
<p>Sarma, Dhiman, Tanni Mitra, and Mohammad Shahadat Hossain. "Personalized book recommendation system using machine learning algorithm." International Journal of Advanced Computer Science and Applications 12.1 (2021)</p>	<ul style="list-style-type: none">K means clusteringCosine SimilarityEvaluation Metrics such as F1 Score, Sensitivity and Specificity

Methdology Flow Chart





Sources of the Dataset

Available dataset:

“BanglaBook: A Large-scale Bangla Dataset for Sentiment Analysis from Book Reviews- Mohsinul Kabir, Obayed Bin Mahfuz, Syed Rifat Raiyan, Hasan Mahmud, Md Kamrul Hasan, May 2023”- this dataset contain **book information**.

Custom-made dataset:

Generated **User Rating dataset** containing **User ID**, **Book name**, and **User rating**.

Book Info Dataset

	id	Book_Name	Writer_Name	Category	Rating	Review	Site	sentiment	label
0	96523	মুক্তাখাৰ হানীস	মাওলাৰ মো: সাধাৱয়াত	হানিস ও সুজ্ঞাত		1 (%) বই টি শত শত জান ই	Rokomari	negative	0
1	39118	মেঘাঞ্জ স্টোর (পেপারবাৰা) শাইখ আন্দুল মালিক আল :	শ্রীমাল, আকিন্দা ও ভাওবাহ			1 বই বিভিন্ন : মেঘাঞ্জ স্টো	Rokomari	negative	0
2	141682	সামষ্টিক অৰ্থনৈতি (পাৰ্স কে সুকেশ চন্দ্ৰ জোয়াৱদাব)	ডিপি			1 পড়তে চাই	Rokomari	negative	0
3	136770	ছাত্রীগৱেষ ইতিহাস বাংলাৰ সাইচুৱ ইতিহাস গোহাগ	প্ৰসঞ্চ: বাংলাদেশৰ রাজনী			1 ঠিক আছে	Rokomari	negative	0
4	82740	এসএসসি বিজ্ঞান মেইড ইঁ পাজৰীৰ সম্পাদনা পৰ্বদ (সং বয়ম ও দশম (এসএসসি): f				1 এটি এসএসসি শিক্ষাবীৰ ২০	Rokomari	negative	0
5	15117	সাইমুম সিৱিজ ৮ : সিংকিয় আবুল আসাদ	শিশু-কিশোৱ: রহসা, গো:			1 বিষ্ণুকিৰণ	Rokomari	negative	0
6	56632	নিয়মাল-ই-শামস ভাৰতীয় জালাগুণীল কুমী (বহু:)	আধাৰিকভাৱে ও সুচিকৰণ			1 জানাল উদ্বিল কুমী আমাদে	Rokomari	negative	0
7	4188	ভল কুইক্সেটেৰ অভিযান (। মিউনেল দে সার্টিফিস	বয়স যথৰ ৮-১২: রহসা,			1 বই ভল কুইক্সেটে নামক এই	Rokomari	negative	0
8	146927	নারী (হার্ডকভাৱ)	ইমামুল আজাদ	নারী		1 "বৈষ্টোৱ নাম নারী হলো ক	Rokomari	negative	0
9	130633	ওঁছ ছাইলাল মডেল টেস্ট: সামী আহমেদ পাতেল	মানবিক বিভাগ ভক্তি প্ৰস্তুতি			1 কুলে ভৱা একটি বই, প্ৰে	Rokomari	negative	0
10	40365	বেটিদেৱ Spoken English ভোঝে মাটেসুন	বয়স যথৰ ৮-১২: বেকারে			1 এটি একটি আবৰ্জনা বই	Rokomari	negative	0
11	6396	বিষ্ট কোয়েষ্ট সিৱিজ ৮-১২ আভাস ব্ৰেড	শিশু-কিশোৱ: রহসা, গো:			1 বই এৱং কভাৱ ঠিক আছে।	Rokomari	negative	0
12	69154	গুৰুপমালা (হামিও আৱোগ ডা. আলমৰীৰ মতি	ভেষজ ও আয়ুৰ্বেদিক			1 আমি কিনেছিলাম। কুৰা বই	Rokomari	negative	0
13	99441	কাকতানুয়াৰ হাসি (পেপার মাহবুব সাদিক	বয়স যথৰ ৮-১২: গৱ			1 অধ্যানেৰ সক্ষাবেনা হেঁড়া	Rokomari	negative	0
14	75048	ফটোগ্রাফি টুকিটোকি (হাৰ্ড ভোক্সেল নথী	ফটোগ্রাফি কোশল			1 একদম ক্ষি তে দিনও এই ব	Rokomari	negative	0
15	81424	Blue Book of: The La Napoleon Hill	Foreign Language B			1 থাপ্পাৰ	Rokomari	negative	0
16	46116	মাসুদ মালা ৪৬৩ : ছায়াচ কাজী আনোয়াৰ হোসেল	রহসা ও গোয়েল্লা			1 দাক্ক একটা বই।সেৱা ব্ৰক	Rokomari	negative	0
17	96524	বেহেশ্তী জেওৱ	মাওলাৰ মো: সাধাৱয়াত	ইসলামি বিধি-বিধান ও মাজ		1 (%) বেহেশ্তী জেওৱ বইটি	Rokomari	negative	0
18	68851	হিউমান সেক্য (হার্ডকভাৱ) ডা: কে.এইচ.এম জামাল হৈ শাশা বিশ্বক বিবিধ বই				1 মোটামুটি বুক	Rokomari	negative	0
19	75642	বিসিএস - সাহিত্যিক পৰিচি রংয়েল সম্পাদনা পৰ্বদ (সং বাংলা ভাষা ও সাহিত্য				1 রংয়েল এৱ বই ওলোৱ মান	Rokomari	negative	0
20	129510	বৰ্মালা (পেপারবাৰা) বি: শ্ৰীৰ ওবায়েন্দুৱাহ	বিশ্ববিদ্যালয় ভক্তি প্ৰস্তুতি			1 এই বই টা তে অনেক লুন।	Rokomari	negative	0
21	53480	ছায়াচক আইসিটি সামিট: ছায়াচক পাবলিকেশন (সং বিশ্ববিদ্যালয় ভক্তি প্ৰস্তুতি				1 ফালকু একটা বই বইটা কি	Rokomari	negative	0

- It has almost 15000 books
- Null values present
- Duplicate titles present
- Some irrelevant features

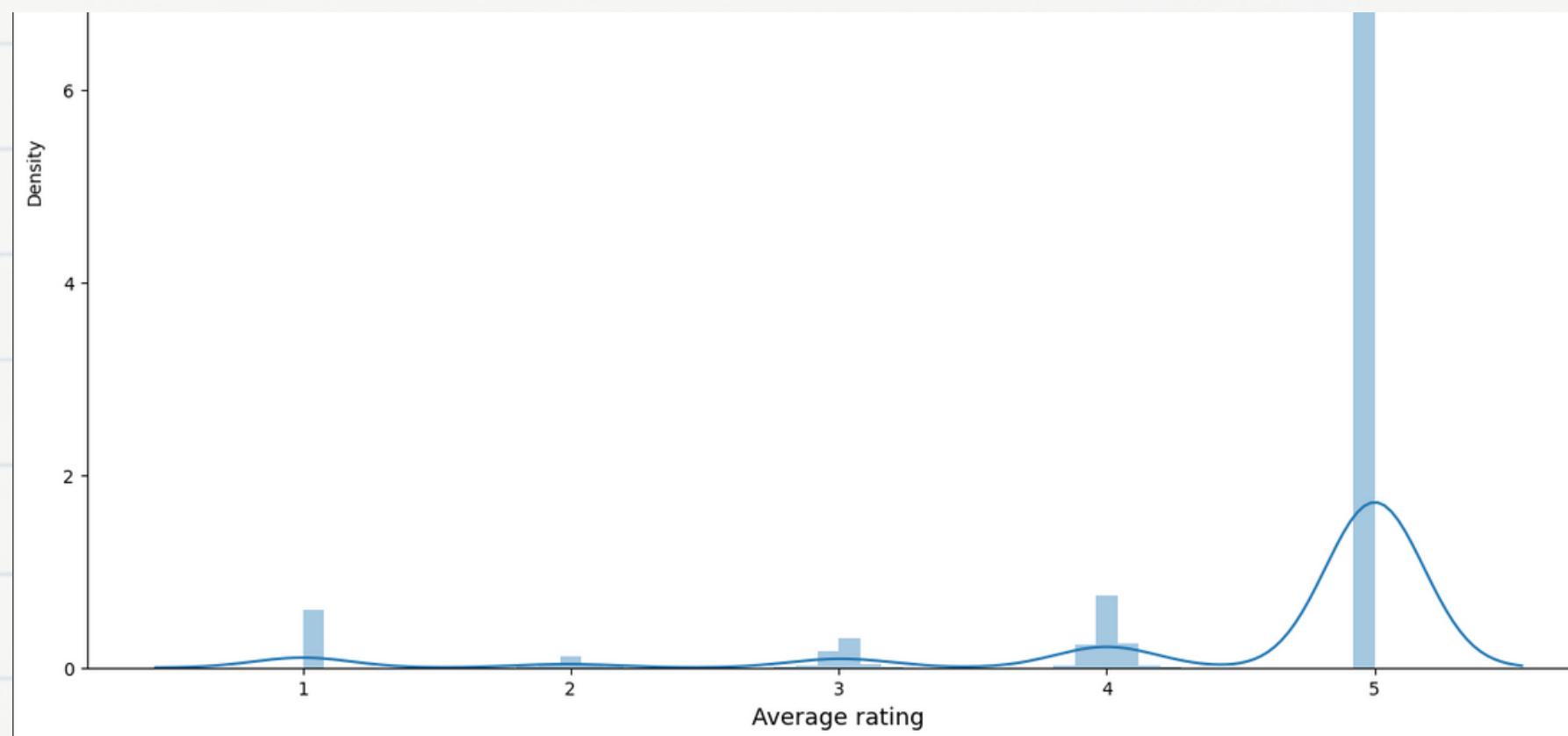
Features Present

- ID
- Book_Name
- Writer_Name
- Category
- Rating
- Review
- Site
- Sentiment
- Label

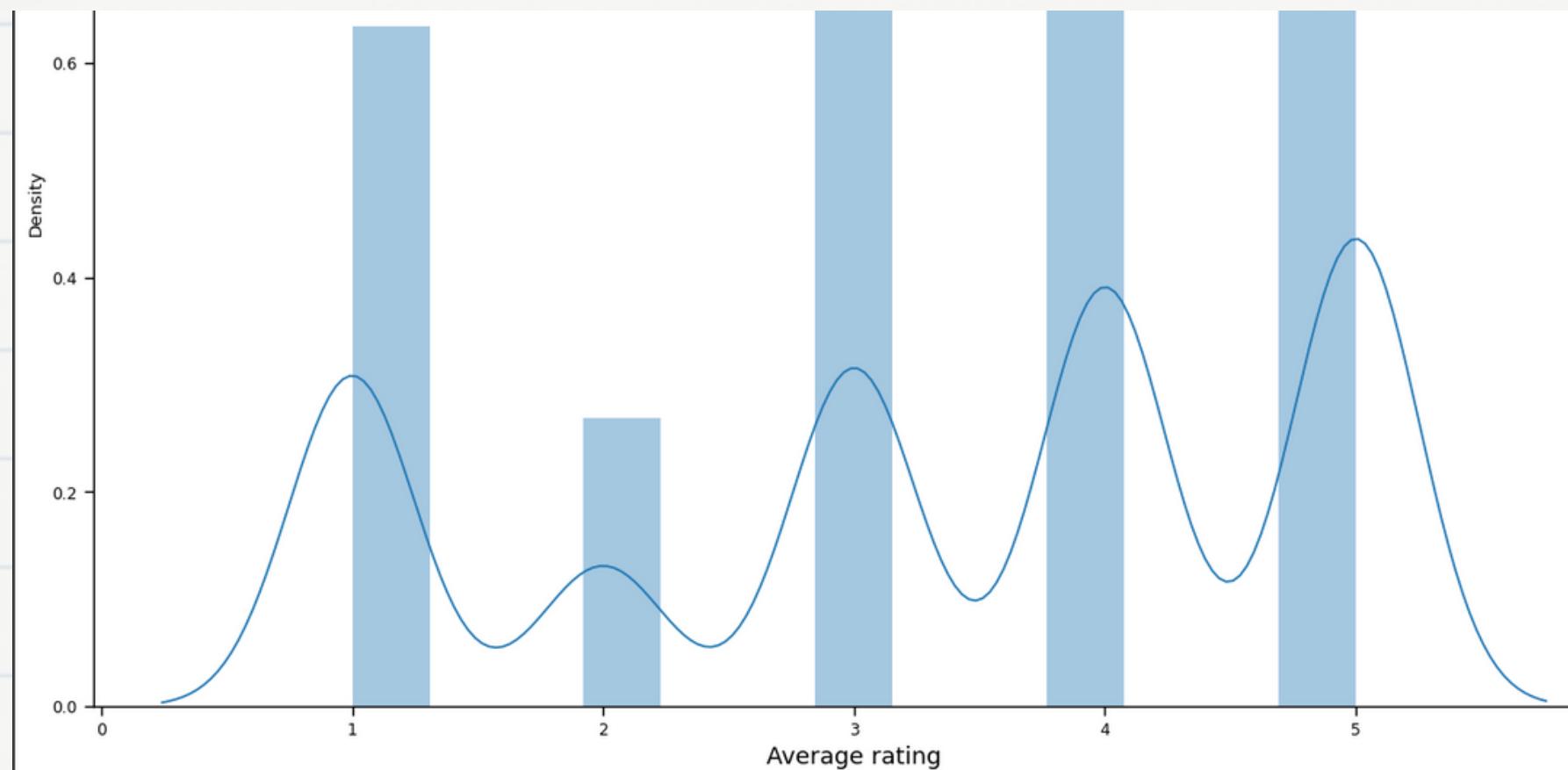


Book Info Dataset

Before:



After Modification:



Now the Dataset has,

- 6310 Unique books
- All null value rows removed
- Removal of duplicate titles
- Renaming columns for convenience

User-Rating Dataset

book_id	user1	user2	user3	user4	user5	user6	user7	user8	user9	user10
98523		1	1	1	1	1	1	1	1	1
39118	0	0	0	1	0	0	0	0	1	0
141682	0	0	1	1	1	1	0	1	1	0
136770	1	1	1	0	1	0	1	0	0	1
82740	1	1	0	1	1	1	1	1	0	0
15117	1	0	1	0	1	1	0	0	0	1
56632	0	0	0	0	0	1	1	0	1	1
4188	1	1	1	1	0	1	1	1	1	1
146927	1	1	1	1	1	1	1	0	1	1
130633	0	1	1	1	0	1	0	0	0	1
40365	1	1	1	1	1	1	1	1	1	1
6396	1	1	0	0	1	1	1	1	1	1
69154	0	0	1	0	0	1	1	1	0	1
99441	1	0	0	1	0	0	0	0	0	0
75048	0	1	0	1	1	1	1	0	0	1
81424	0	0	0	0	0	0	0	0	0	0
46116	1	1	0	0	0	0	1	0	0	1
98524	0	1	0	1	0	0	1	0	0	0
68851	0	0	0	0	0	0	1	0	0	1
75642	0	0	0	0	1	0	0	1	0	0
129510	0	1	1	0	0	0	1	0	1	0
53480	0	0	0	0	0	0	0	0	0	0
105650	0	0	0	0	0	1	0	1	0	0
109716	0	0	0	0	0	0	0	1	0	0
29192	1	1	1	1	0	1	1	1	1	1
35434	0	0	0	0	0	0	0	0	0	0
157930	1	1	0	1	0	1	1	0	1	1

Note: Cell value '1' means the **book has been rated** by that user and '0' means the **book has not been rated** by that user



- 100 users randomly rated the books



User-Rating Generation Algorithm

Ratings <- average ratings of the books (array)

Iterate through all books:

Ratedby <- randomly select how many users will rate [0-100]

People <- randomly select who will rate

totalVal <- RatedBy * average rating of that book

cnt <- 0

Iterate through all People:

rating <- random rating of that person [1-5]

if ((totalVal - rating) >= (RatedBy-cnt-1)) and ((totalVal - rating) >= (RatedBy-cnt-1)*5):

 this person gave rate = rating

 totalVal -= rating

elif (totalVal - rating) < (RatedBy-cnt-1):

 this person gave rate = 1

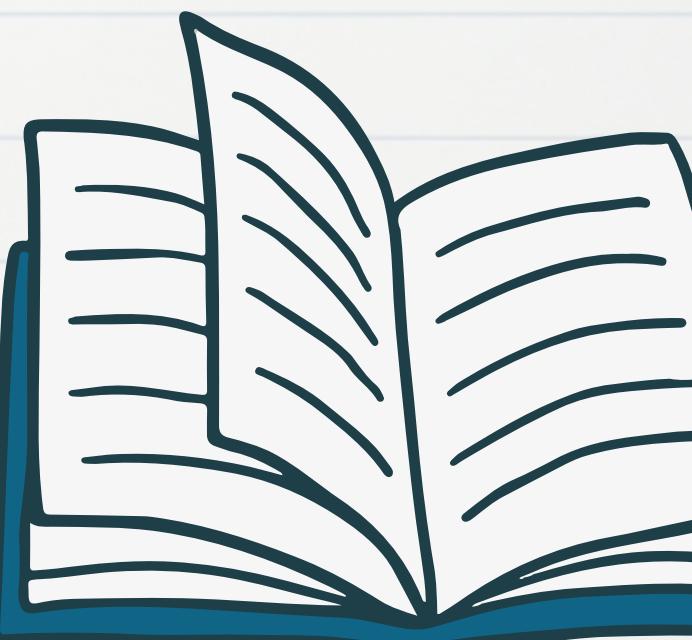
 totalVal -= 1

else:

 this person gave rate = 5

 totalVal -= 5

 cnt += 1



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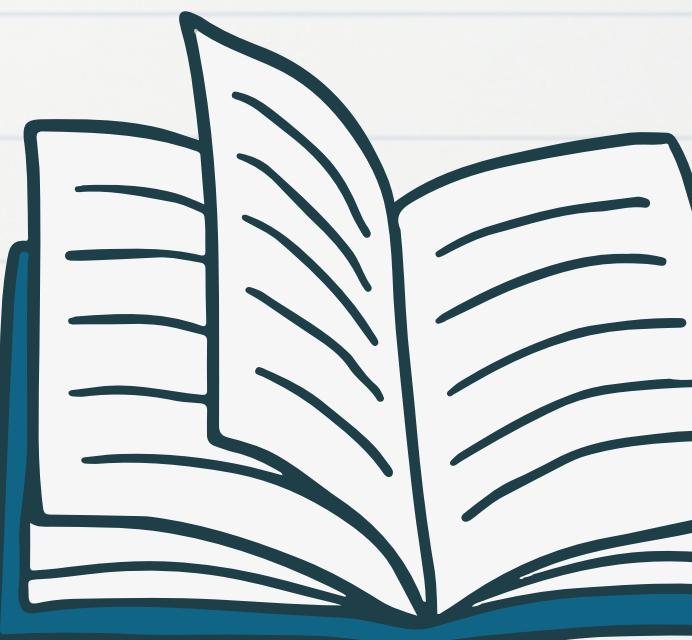
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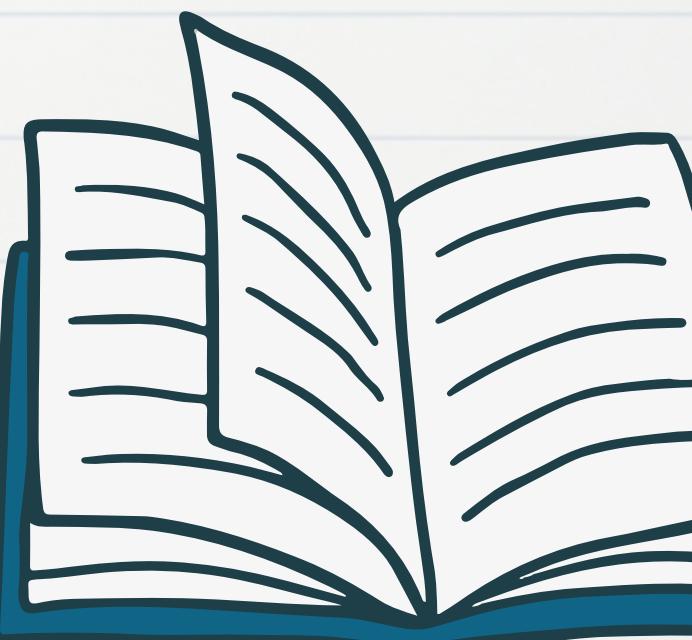
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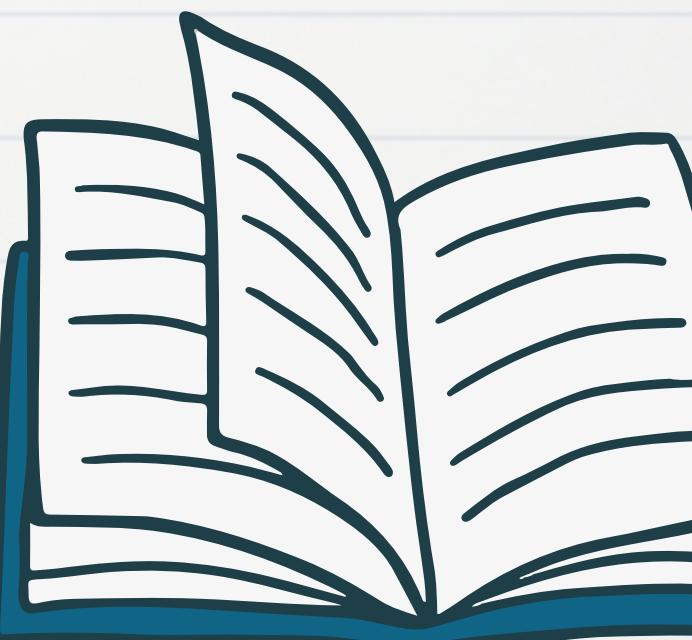
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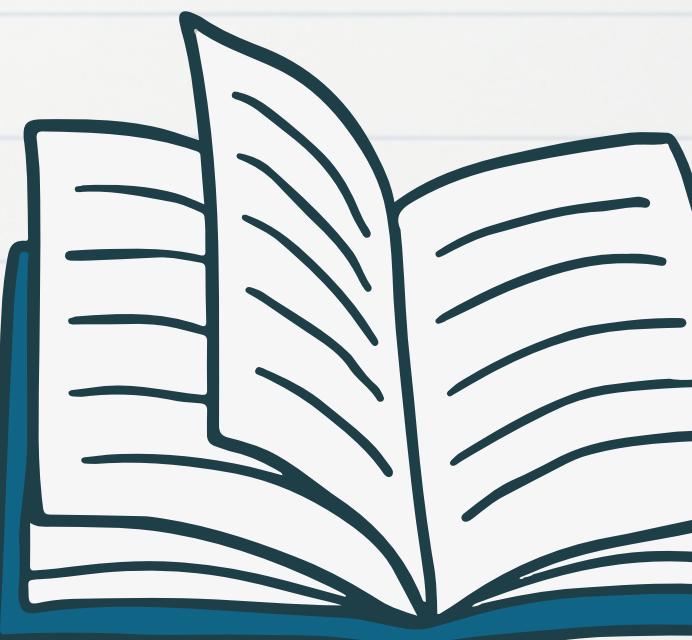
totalVal -= 1

else:

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cnt += 1



User-Rating Generation Snap

```
import random

ratings = books_df['Rating']

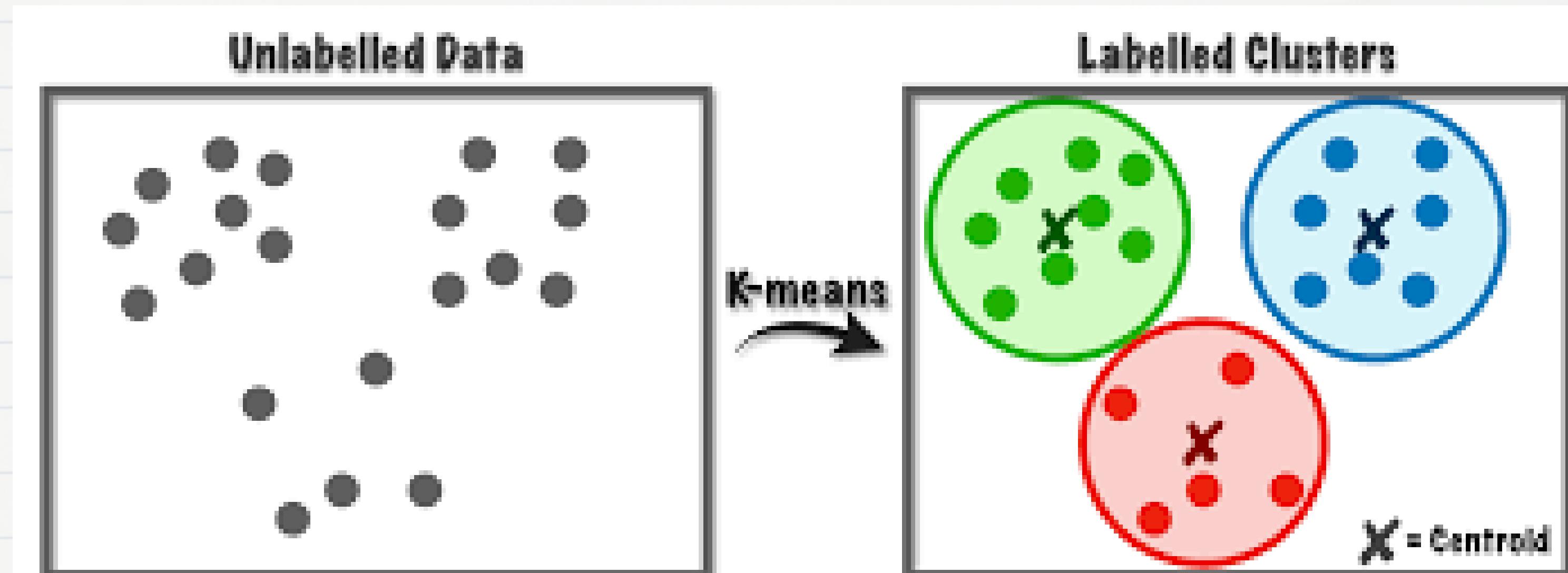
for index, rating in enumerate(ratings):
    ratedBy = random.randint(1, 100)
    people = random.sample(range(1, 101), ratedBy)
    totalVal = ratedBy * rating
    cnt = 0

    for person in people:
        x = random.randint(1, 5)
        stri = 'user'
        stri += str(person)

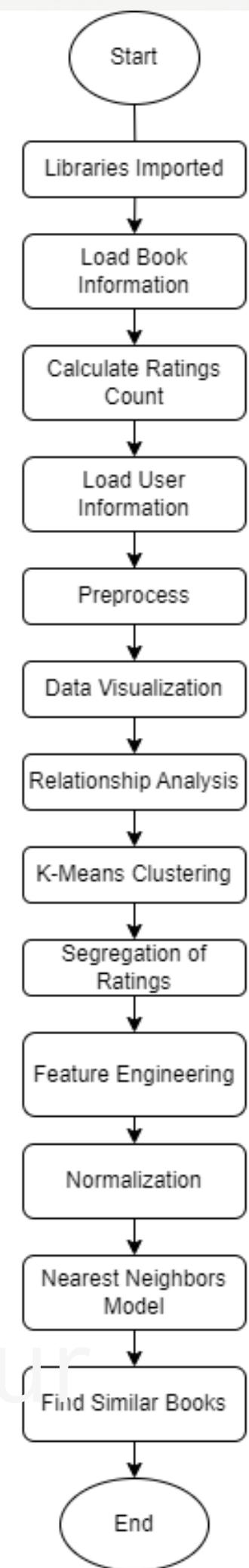
        if((totalVal - x) >= (ratedBy-cnt-1)) and ((totalVal-x) <= (ratedBy-cnt-1)*5):
            df1[stri][index] = x
            totalVal -= x
        elif(totalVal - x) < (ratedBy-cnt-1):
            df1[stri][index] = 1
            totalVal -= 1
        else:
            df1[stri][index] = 5
            totalVal -= 5
    cnt += 1;
```



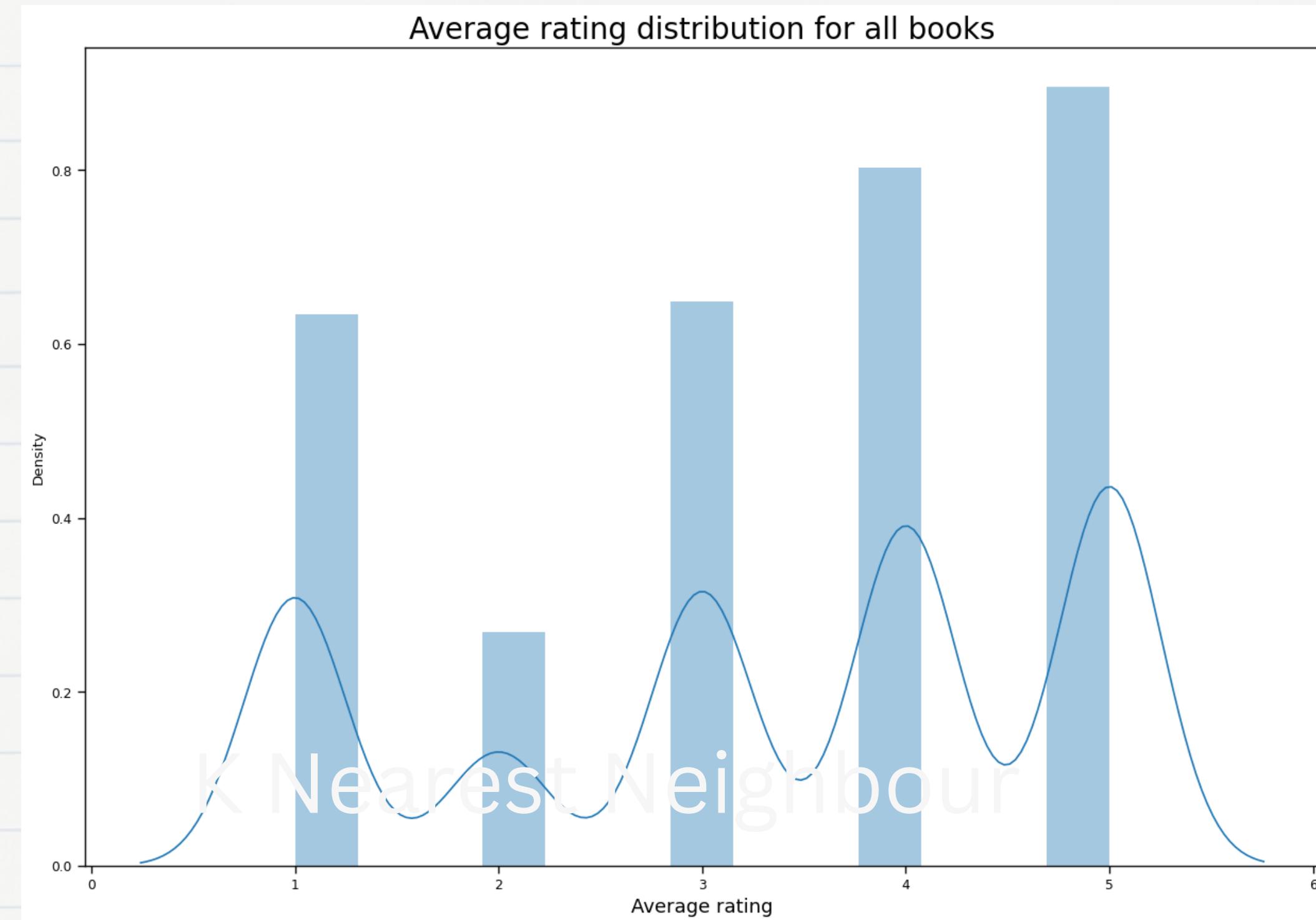
K Means Clustering



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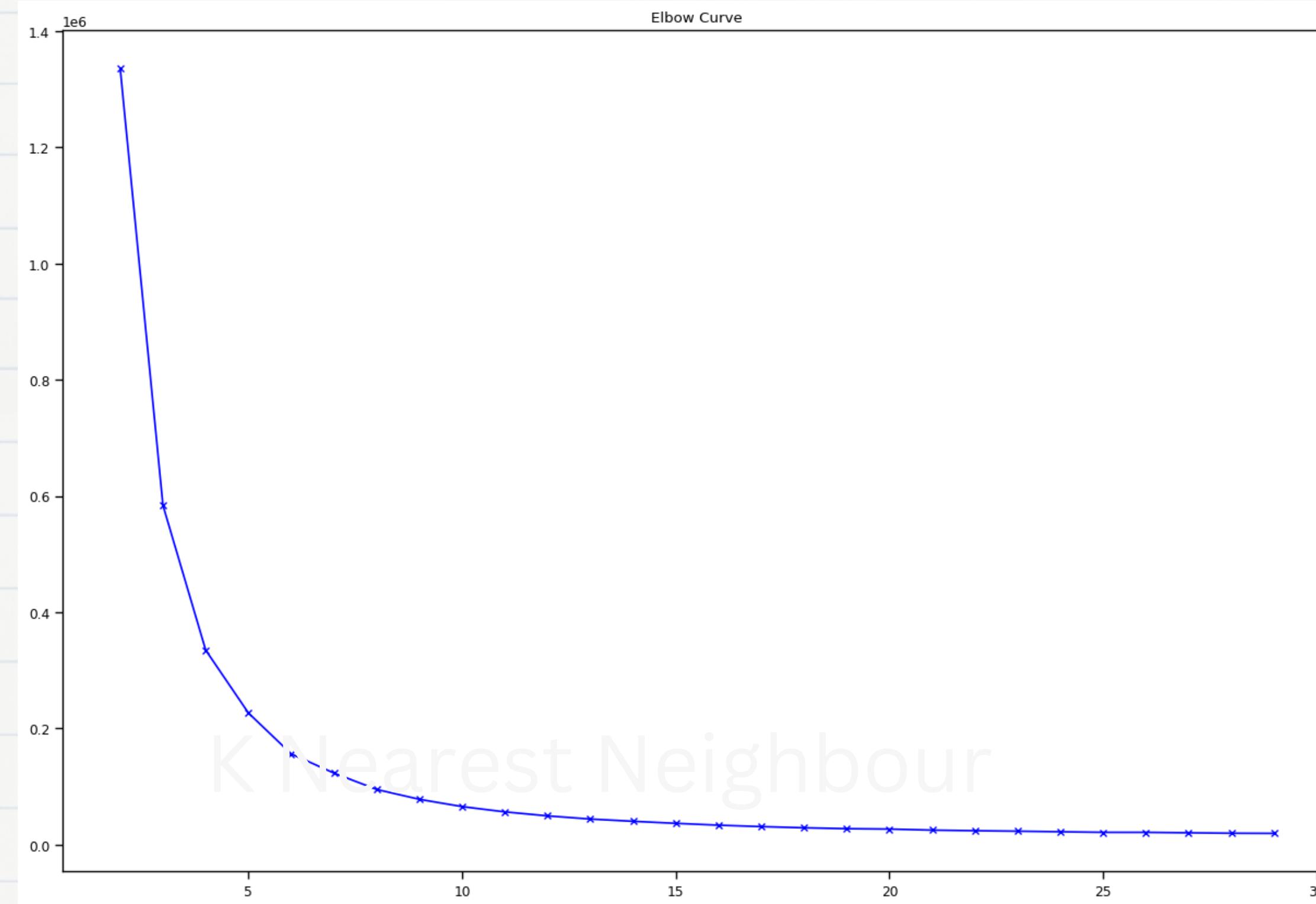


K Means Clustering



K Means Clustering

Elbow Curve



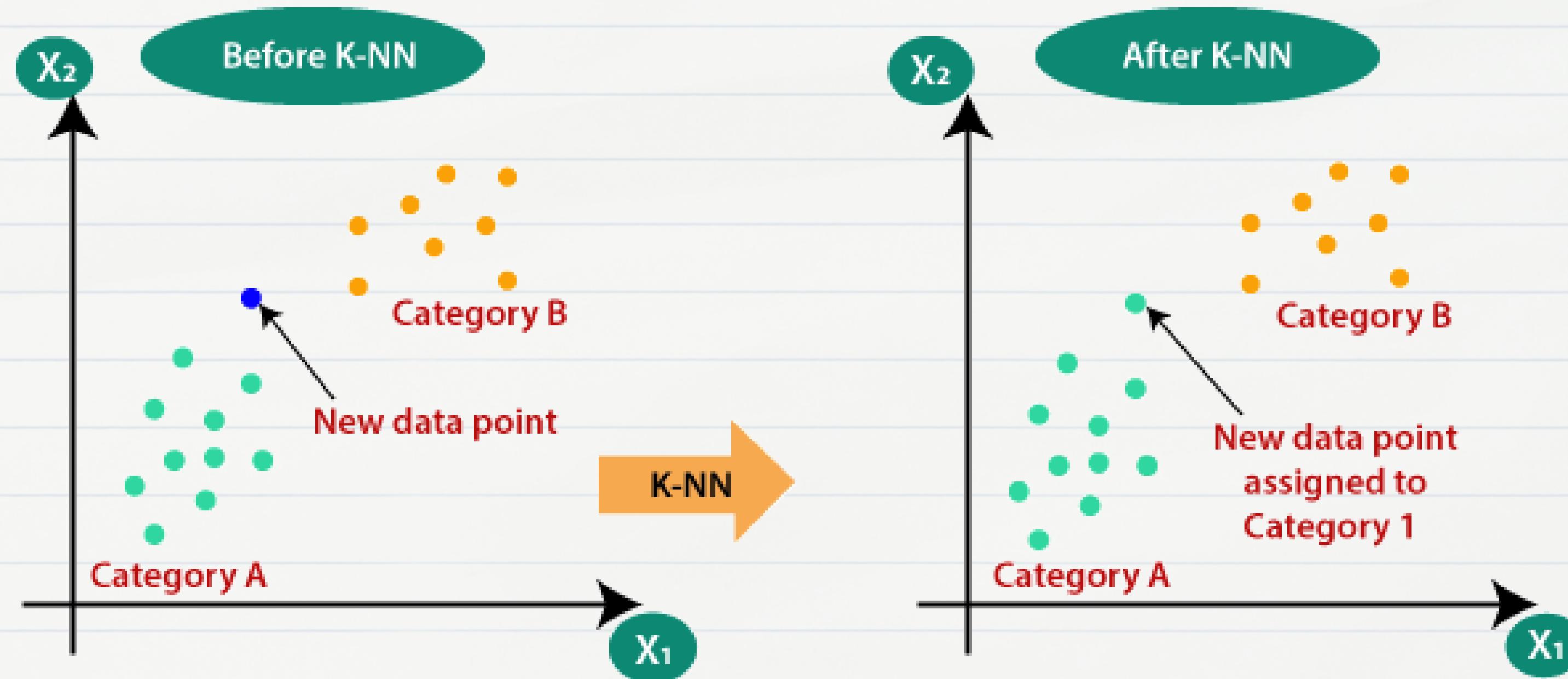
K Means Clustering

Silhouette Score: 0.5327335607525849

Within-Cluster

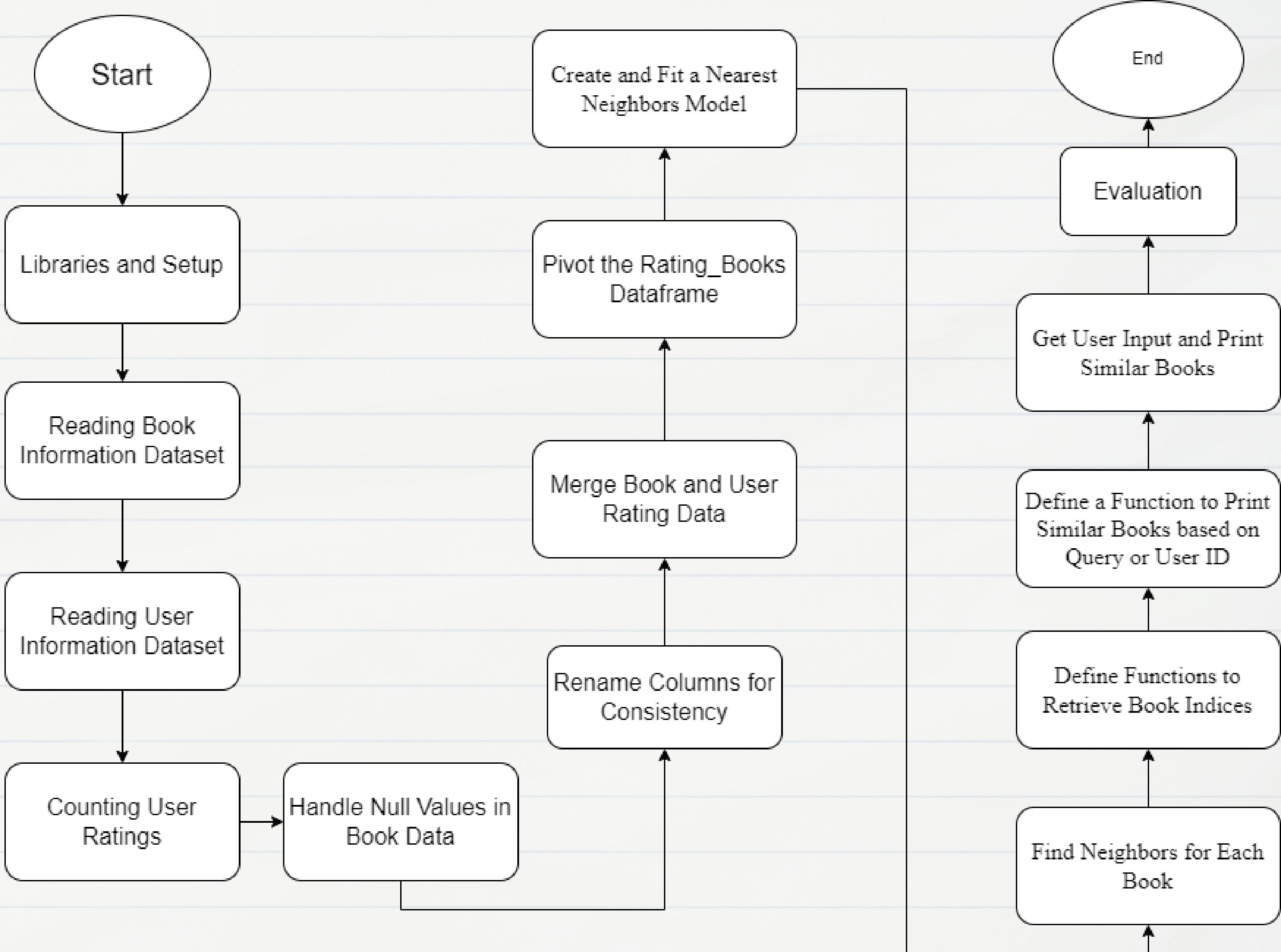
Sum of Squares (WCSS): 227579.44734093337

K Nearest Neighbours



Work/Flow Steps Result

K Nearest Neighbour



K Nearest Neighbour

rating_books_pivot

	User	user1	user10	user100	user11	user12	user13	user14	user15	user16	user17	...	user90	user91	user92	user93	user94	user95	user96	user97	user98	user99
	Book_Name																					
Florence Nursing Book Series for 1st Year B.Sc in Nursing (Post Basic/Post Basic Public Health Nursing) Students	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
আরবি রস (পেপারব্যাক) আরবি ভাষা ও সাহিত্যের মজা।	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
উত্তরণ প্রকাশনীর ৫ টি বইয়ের প্যাকেজ (হার্ডকভার)	0.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
এরাবিয়ান নাইটস এন্ড ডেইজ (পুরুষারপ্রাপ্ত লেখকদের বই)	5.0	5.0	5.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	0.0	...	5.0	0.0	5.0	5.0	5.0	5.0	0.0	0.0	5.0	5.0
কফিমেকার (গোয়েন্দা কাহিনি) (হার্ডকভার)	0.0	5.0	5.0	0.0	5.0	0.0	0.0	5.0	5.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	
...	
হে বোন কুরআন তোমাকে ঘা বলেছে (নীল কভার)	4.0	0.0	2.0	0.0	1.0	0.0	4.0	0.0	0.0	0.0	...	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	
হোয়াই কাস্টমারস ডেন্ট ডু হোয়াট ইউ	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

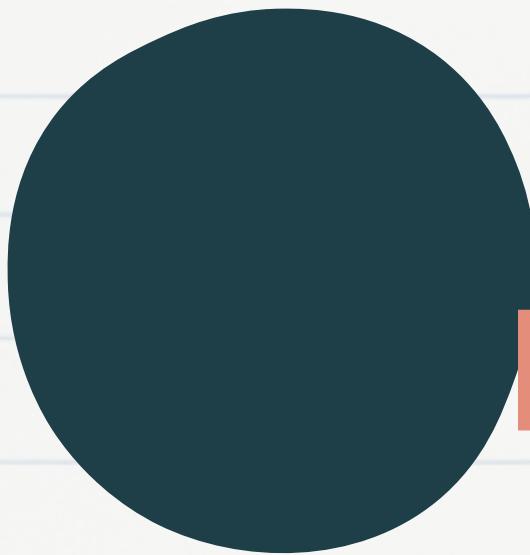
K Nearest Neighbour

MAE: 1.4367

RMSE: 1.8314

Neural Network

Input layer

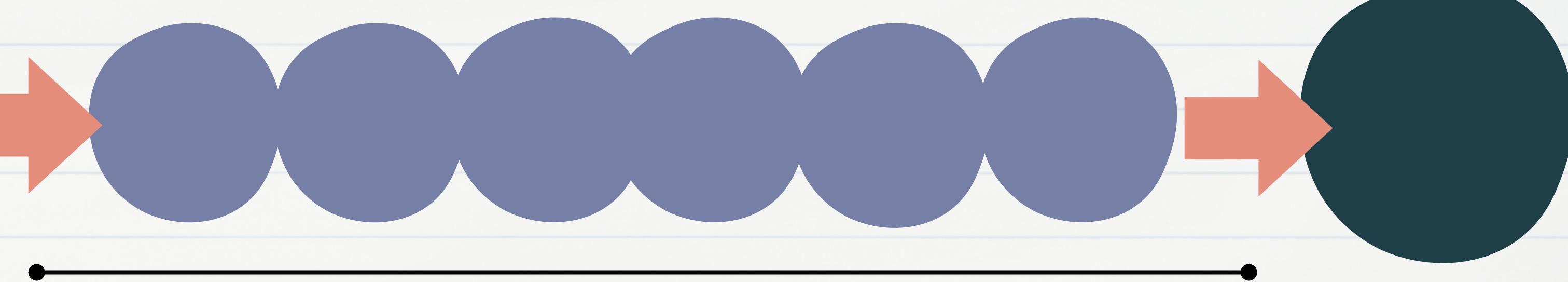


Dense layer

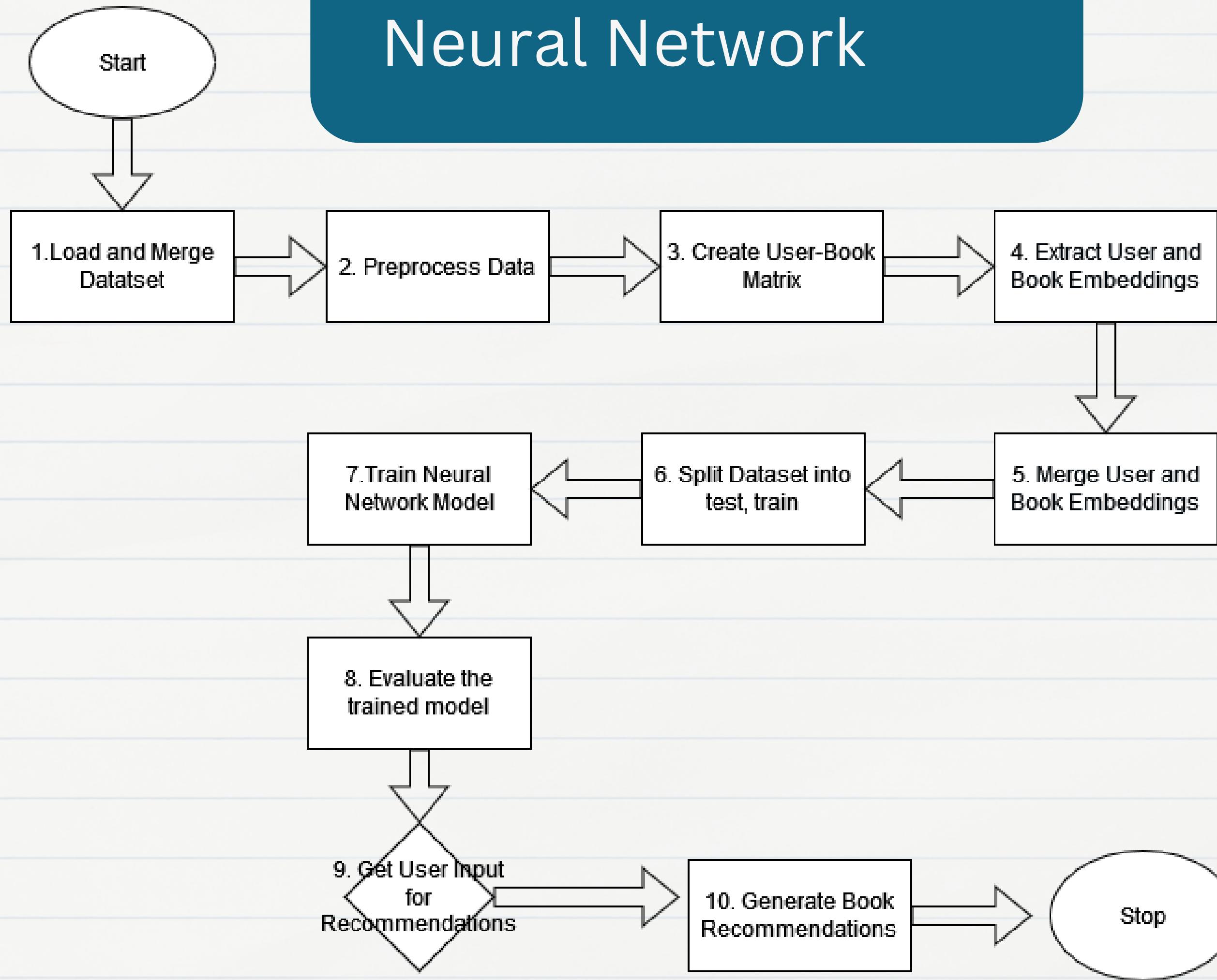
Dropout layer

Batch Normalisation

Output layer



Neural Network

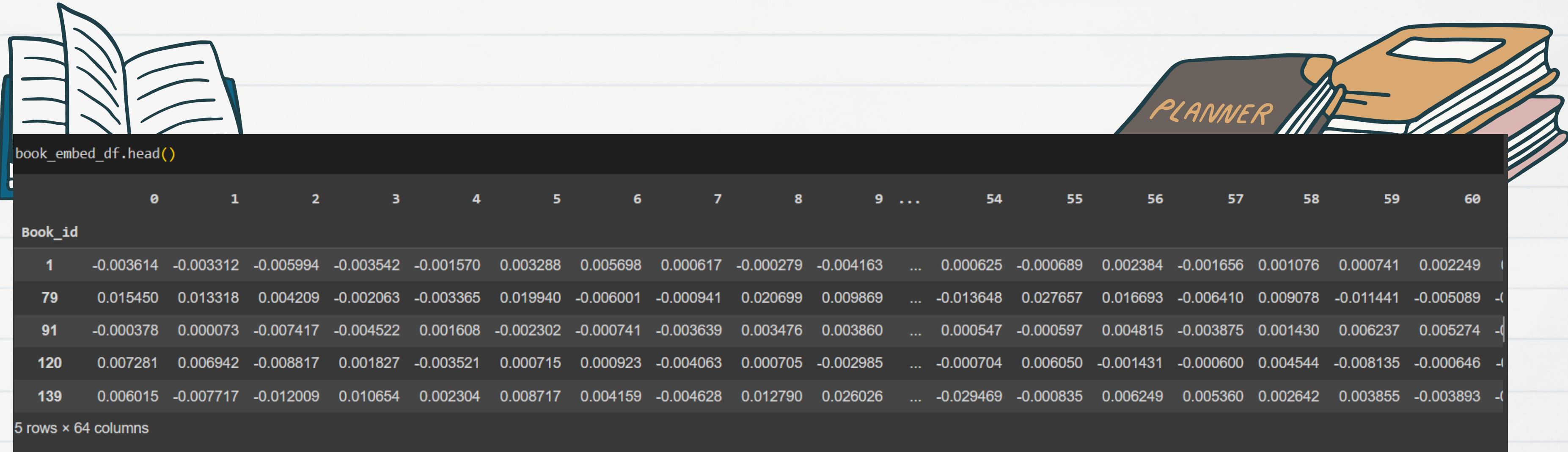




User-Book Matrix



Book_id	32	39	58	66	73	123	151	184	190	218	...	157844	157905	157906	157926	157927	157942	157943	157972	157991	158042
User																					
user1	5	5	0	5	0	5	5	5	0	1	...	5	5	5	5	5	5	5	5	5	5
user10	5	5	5	5	0	5	0	5	5	0	...	5	0	5	5	5	5	5	5	5	5
user100	0	0	0	5	5	5	5	5	5	1	...	5	5	0	0	5	1	0	5	5	0
user11	5	5	0	5	0	5	5	5	5	1	...	5	5	5	5	5	0	5	5	5	1
user12	5	0	0	5	0	5	5	5	5	1	...	5	0	0	0	0	0	5	5	5	1
user13	5	0	0	5	0	5	5	0	5	1	...	0	5	5	0	5	5	5	5	5	4
user14	5	5	0	5	0	5	0	5	5	1	...	5	5	5	0	0	0	5	0	5	1
user15	5	0	0	5	5	5	5	5	5	1	...	5	5	5	0	5	0	0	5	5	5
user16	0	5	0	5	0	0	5	5	5	1	...	5	0	5	5	5	0	5	0	5	0
user17	5	0	0	5	5	5	5	0	0	1	...	0	5	5	0	0	0	5	5	5	4



```
user_embed_df.head()
```

	0	1	2	3	4	5	6	7	8	9	...	54	55	56	57	58	59	60
User																		
user1	0.171828	-0.051819	-0.057392	0.001634	-0.011585	-0.051878	-0.129945	-0.060293	0.099787	-0.025370	...	-0.283486	-0.128242	0.224629	-0.005532	0.024513	-0.016386	-0.147452
user10	0.142213	0.157116	-0.095550	0.113844	0.025394	0.117989	-0.107569	0.058792	0.276623	0.013974	...	-0.105841	0.057240	-0.054211	0.054735	0.074979	0.093890	-0.002330
user100	0.066237	-0.041414	-0.178463	-0.154415	0.046649	-0.087300	-0.049166	0.164700	0.092488	-0.024964	...	0.106205	-0.008177	0.034254	-0.011909	-0.121930	-0.050944	0.170532
user11	-0.140076	-0.015346	-0.072643	-0.013798	-0.083207	-0.109318	0.075058	-0.079847	-0.000932	0.043628	...	-0.015052	0.086752	0.026244	0.168248	0.053017	-0.059006	-0.163318
user12	0.023557	-0.224133	-0.008873	-0.054043	-0.075093	-0.002645	0.077314	0.113647	0.140350	-0.019114	...	-0.048724	0.126202	-0.047215	-0.019763	-0.115804	0.162468	0.040644



Full Vector



	<u>Book_id</u>	<u>Book_Name</u>	<u>User</u>	<u>Rating</u>	<u>Full-Vector</u>
0	96523	মুনতাখাব হাদীস	user1	1.0	[0.17182794514735752, -0.05181897858331404, -0...
1	96523	মুনতাখাব হাদীস	user2	1.0	[-0.17816125681105827, 0.08101036069522005, 0...
2	96523	মুনতাখাব হাদীস	user3	1.0	[-0.0038345329517008747, 0.053931889682234786,...
3	96523	মুনতাখাব হাদীস	user4	1.0	[-0.1022856149246052, -0.008446413021760754, 0...
4	96523	মুনতাখাব হাদীস	user5	1.0	[0.23274603690764864, -0.08392081395612734, 0...

Neural Network

MAE: 0.5658344111728641
RMSE: 0.9624714130783303

User ID :34

Book_id	User	Full-Vector	Trained_Items	Book_Name
5872	145600 user4	[-0.1022856149246052, -0.008446413021760754, 0...	1.535398	মেঘের পরে আনন্দের রোদ (হার্ডকভার)
3720	94320 user4	[-0.1022856149246052, -0.008446413021760754, 0...	1.340585	বিশ্বের সেরা মনীষীদের জীবনী (হার্ডকভার)
2897	76664 user4	[-0.1022856149246052, -0.008446413021760754, 0...	1.256624	সুপারকন্ডাক্টর (হার্ডকভার)
416	9153 user4	[-0.1022856149246052, -0.008446413021760754, 0...	1.240086	Hallowe'en Party: A Hercule Poirot Mystery (P...
		52, -0.008446413021760754, 0...	1.196761	দিনের ফাঁকে আবেদন (হার্ডকভার)

Neural Network

Enter User ID (e.g., user28): user34

K means Clusters

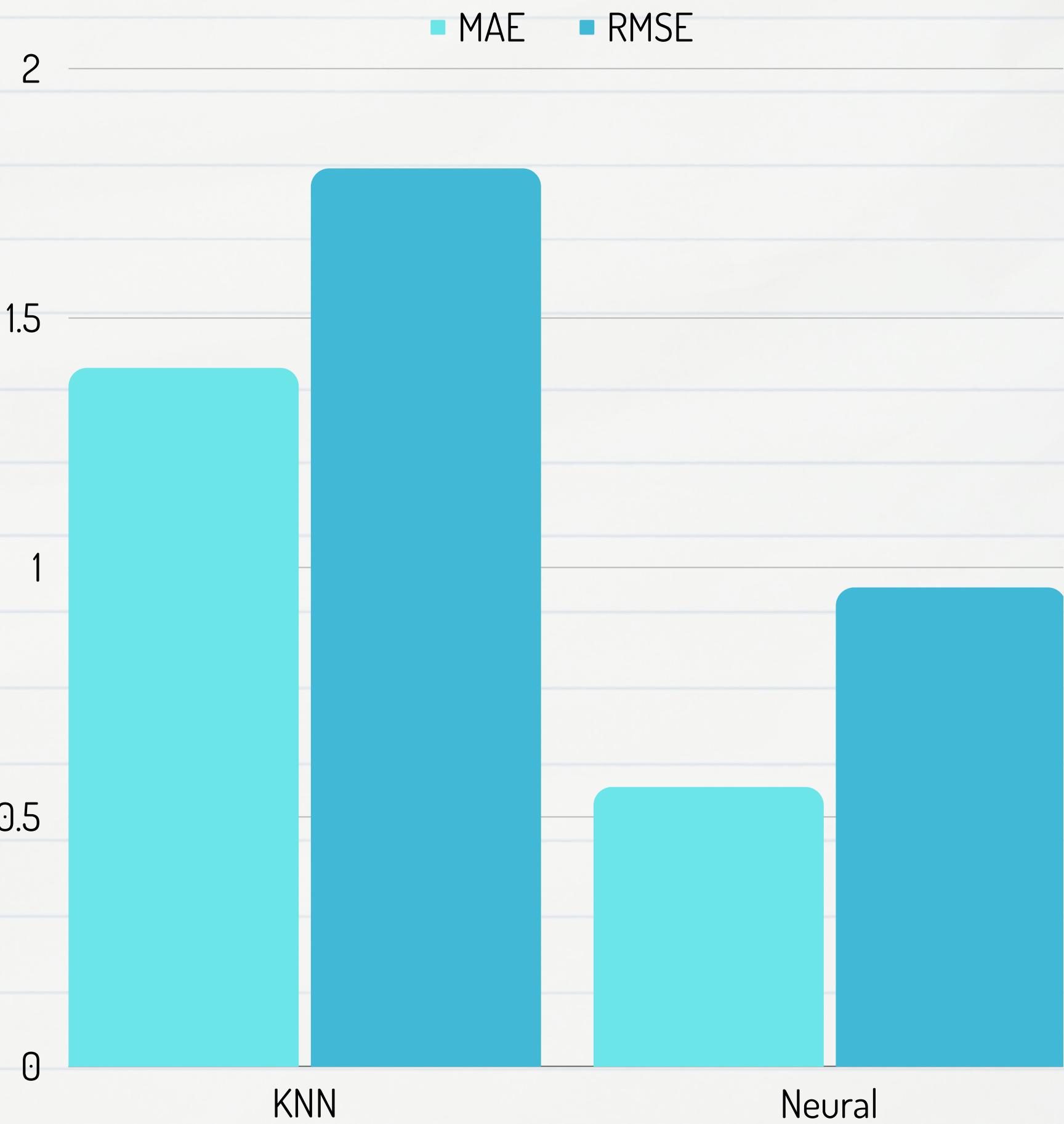
Recommended Books for User user34 based on similar user preferences (cluster 0):

- দ্য মার্টিয়ার লিডার সুলতান ইমাদউদ্দীন জেঙ্গী রহ.
- পাঞ্জেরী ভূগোল ও পরিবেশ স্পেশাল সাপ্লাইমেন্ট (এসএসসি ২০২৩ সংক্ষিপ্ত সিলেবাস) (পেপারব্যাক) সংক্ষিপ্ত সিলেবাসে পূর্ণাঙ্গ প্রস্তুতি (short Syllabus)
- নৈবেদ্য (হার্ডকভার)
- গালিভরের সফরনামা
- চর্যাপদ

KNN

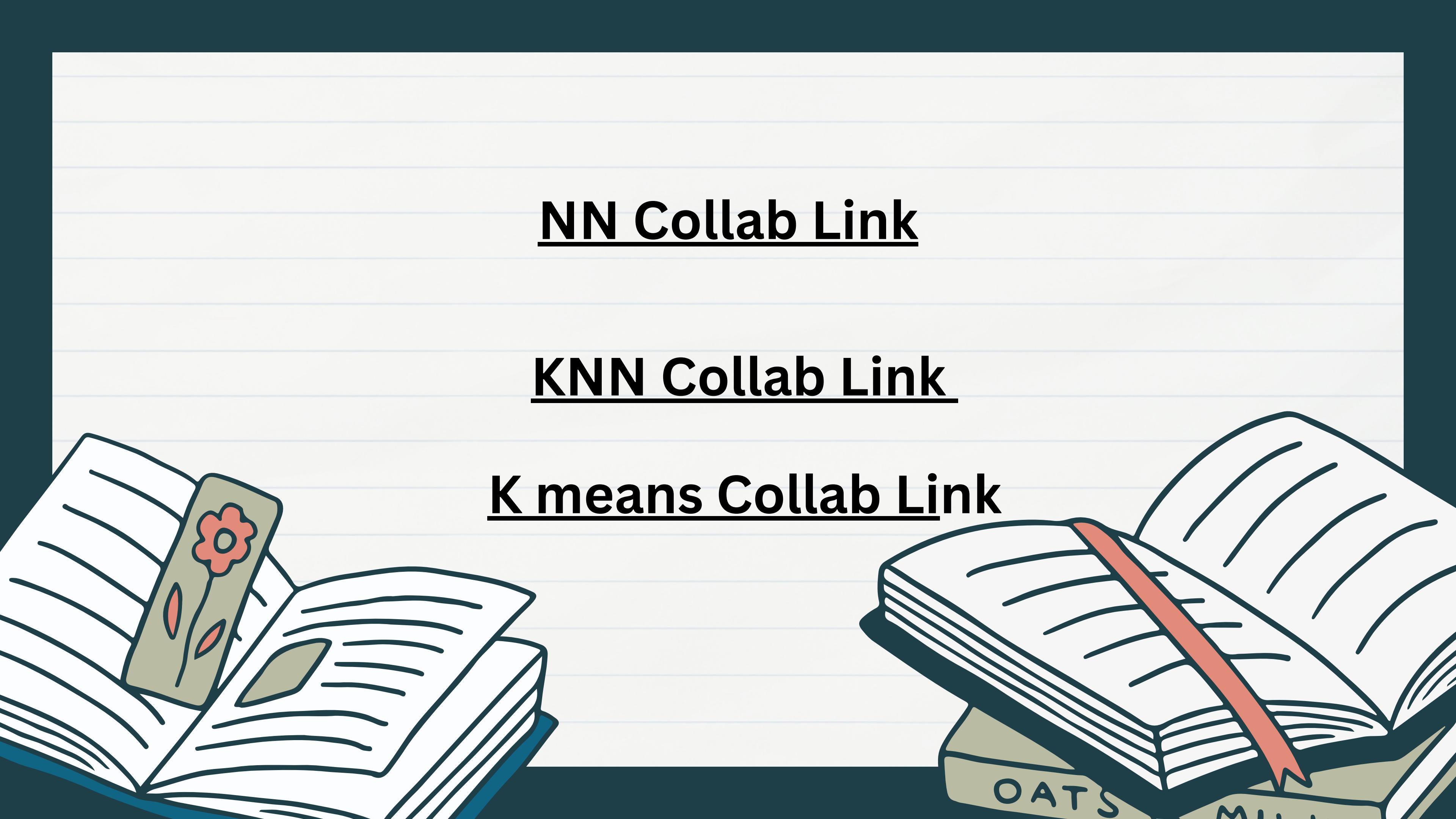
		Book_Name	book_id
5588	How to Teach English (Paperback)	An Elite bo...	43614
3852	সোফির জগৎ (হার্ডকভার)	আন্তর্জাতিক পুরুষকার প...	38660
686		দিওয়ান-ই-শায়সু তাবরিজ (হার্ডকভার)	56632
2685		মুসলিম শরীফ (১ম-৬ষ্ঠ খণ্ড)	157930
958	গুচ্ছ ফাইনাল মডেল টেস্ট (পেপারব্যাক)	গুচ্ছ ব...	130633

Comparative Analysis: KNN vs NN



Discussion

- First of its kind Bangla book recommendation system
- Successful implementation of three ML approaches for collaborative-filtering book recommendation
- Output and Performance comparison
- Apply the approaches using improved user data



NN Collab Link

KNN Collab Link

K means Collab Link

Thank You



