DATA-643, Final Project

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Introduction

The goal of the project is to build a recommendation system for books based on user ratings. A user is asked to rate a fixed number of books from our dataset and based on the user's rating for these selected books and ratings given to them by other individuals, our recommendation system recommends other books from our dataset that matches user's interest based on ratings.

Data Exploration

Data samples

Table 1: USERS

User.ID	Location	Age
1	nyc, new york, usa	NULL
2	stockton, california, usa	18
3	moscow, yukon territory, russia	NULL
4	porto, v.n.gaia, portugal	17
5	farnborough, hants, united kingdom	NULL
6	santa monica, california, usa	61
7	washington, dc, usa	NULL
8	timmins, ontario, canada	NULL
9	germantown, tennessee, usa	NULL
10	albacete, wisconsin, spain	26

ISBN	Book.Title	Book
0195153448	Classical Mythology	Mark

ISBN	Book.Title	Book
0002005018	Clara Callan	Rich
0060973129	Decision in Normandy	Carl
0374157065	Flu: The Story of the Great Influenza Pandemic of 1918 and the Search for the Virus That Caused It	Gina
0393045218	The Mummies of Urumchi	E. J.
0399135782	The Kitchen God's Wife	Amy
0425176428	What If?: The World's Foremost Military Historians Imagine What Might Have Been	Robe
0671870432	PLEADING GUILTY	Scot
0679425608	Under the Black Flag: The Romance and the Reality of Life Among the Pirates	Davi
074322678X	Where You'll Find Me: And Other Stories	Ann

Table 3: RATING

User.ID	ISBN	Book.Rating
276725	034545104X	0
276726	0155061224	5
276727	0446520802	0
276729	052165615X	3
276729	0521795028	6
276733	2080674722	0
276736	3257224281	8
276737	0600570967	6
276744	038550120X	7
276745	342310538	10

Data Fields

Table 4: USERS Columns

USERS
User.ID
Location
Age

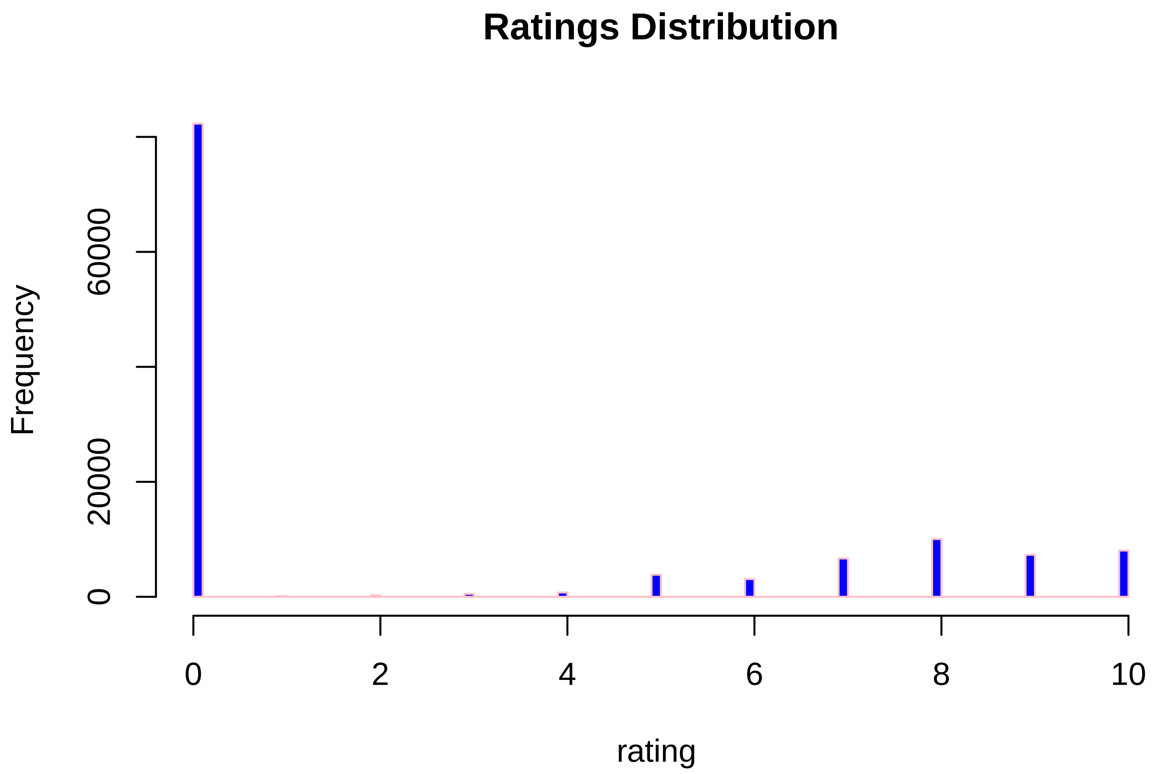
Table 5: BOOKS Columns

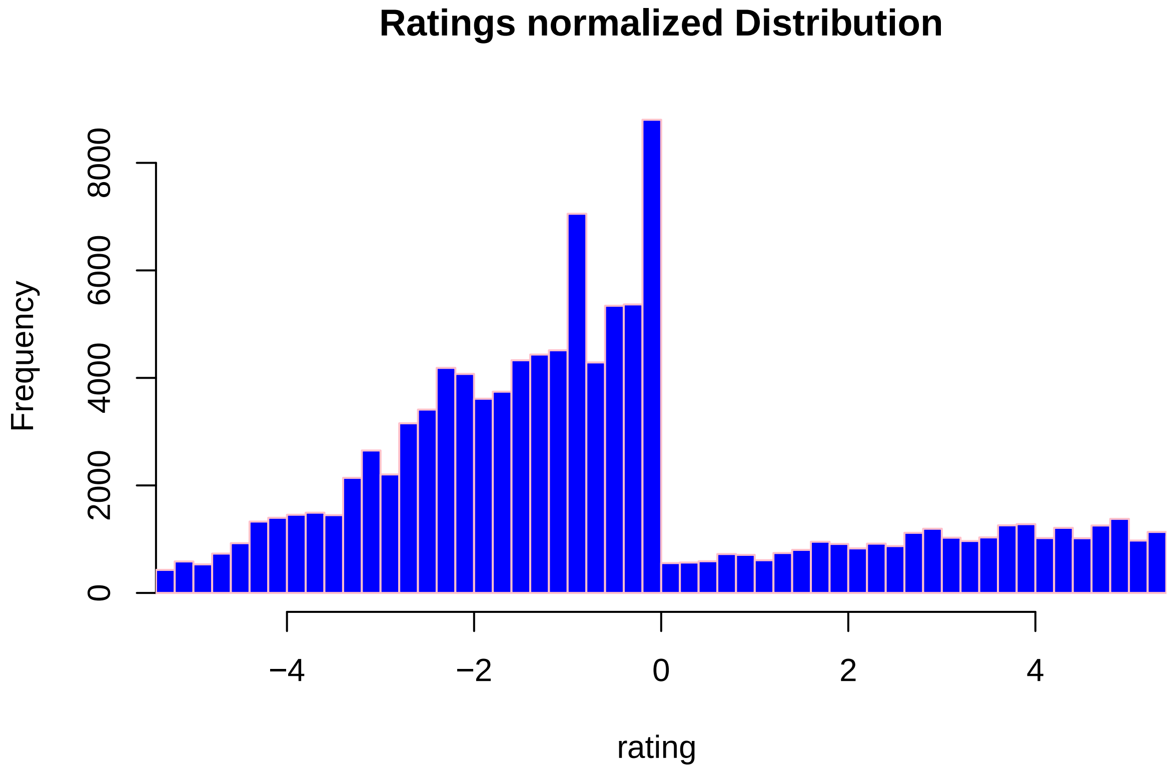
names.books.
ISBN
Book.Title
Book.Author
Year.Of.Publication
Publisher
Image.URL.S
Image.URL.M
Image.URL.L

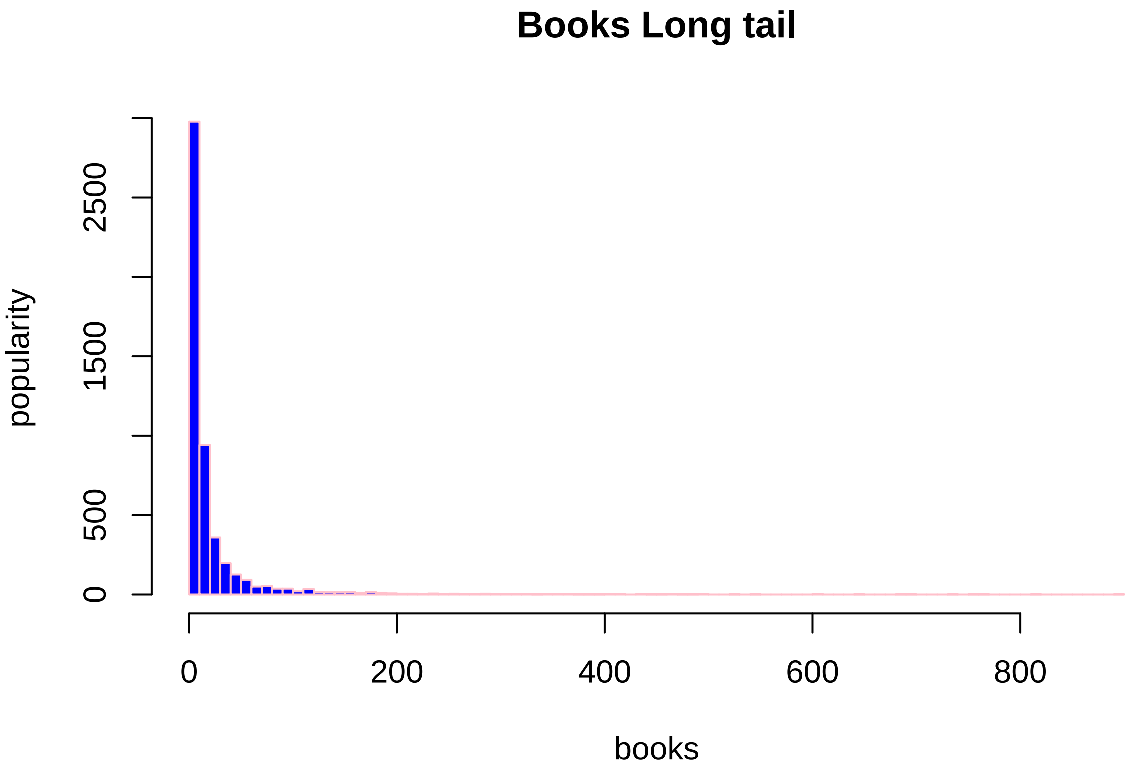
Table 6: RATING Columns

names.rating.
User.ID
ISBN
Book.Rating

Plots


Ratings Distribution
Frequency
0
20000
60000
0
2
4
6
8
10
rating


Ratings normalized Distribution
Frequency
0
2000
4000
6000
8000
−4
−2
0
2
4
rating



Methods

- We used Sparklyr Package to interface with Spark
- We used the Alternating Least Squares (ALS) matrix factorization to reduce our rating matrix.
- We used Collaborative Filtering.

## Data Preparation

Our data preparation methodology follows the below approach:

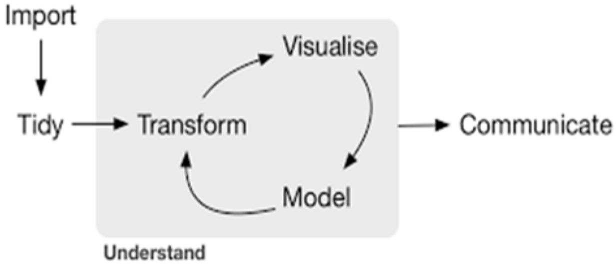


Figure 1:

Data Import and Cleansing Process

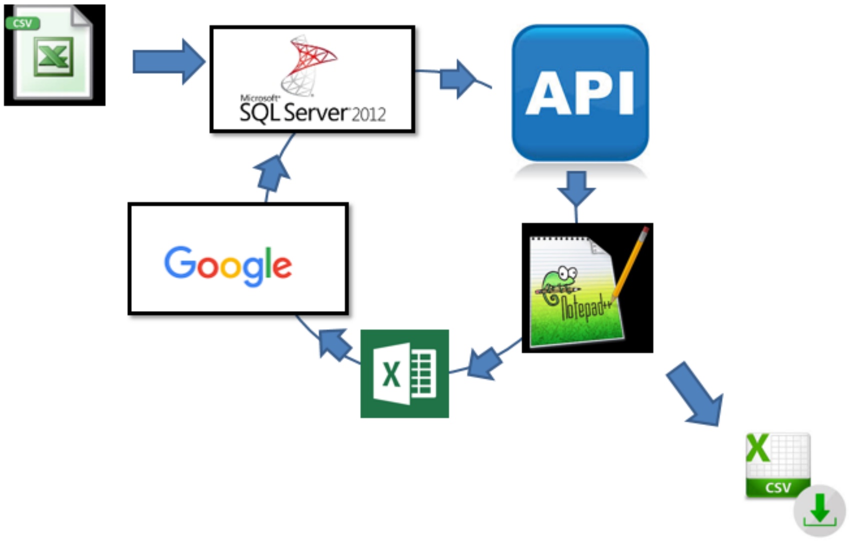


Figure 2:

Model Creation

Since our real rating matrix is a sparse matrix as it has 89890 rows and 212931 columns with only 965290 ratings; which is about 0.00522 %, we chose to use collaborative filtering along with ALS for matrix factorization.

```
##                  Length Class      Mode
## item.factors     11     data.frame list
## user.factors     11     data.frame list
## data              2     spark_jobj environment
## ml.options        6     ml_options list
## model.parameters  2     -none-     list
## .call             9     -none-     call
## .model            2     spark_jobj environment
```

Model Evaluation

We use RMSE (root mean square error) to evaluate our model against regularization

```
## [1] 1.348361
```

```
## [1] 1.459424
```

And with regularization learning rate of 0.1, our RMSE is 1.348361; however, with .2, our RMSE is 1.459424

Conclusion

The project presented a number of challenges. Given, the data size, we had to use Spark specifically Sparklyr package to process the data. All our non-Spark attempts failed and resulted in insufficient memory errors. The data cleaning and preparation process was another challenge that took almost 60% of the project time. Spark on Databricks presented limited options as we could not load Recommenderlab package as it requires the latest version of R that Spark on Databricks did not provide. Finally, in the positive note, the combination of ALS and Spark has delivered robust and fast solution that enabled us to successfully process a large dataset.

Appendix A: DATA643 Final Project R Code

```
library(recommenderlab)
library(cluster)
library(knitr)

setwd("C:/CUNY/Courses/IS-643/Final/data")


users = read.csv("BX-Users.csv",sep = ";")
books = read.csv("BX-Books.csv",sep = ";")
rating = read.csv("Bx-Book-Ratings.csv",sep = ";",header = T)

#str(rating)
```

```
kable(head(users, 10), caption = "USERS")
kable(head(books,10), caption = "BOOKS")
kable(head(rating, 10), caption = "RATING")



#str(users) # 140291 obs. of  3 variables, "User.ID"  "Location" "Age"
USERS1 <- data.frame(names(users))
USERS1$USERS<- USERS1$names.users.
USERS1$names.users.<- NULL
kable(USERS1, caption = 'USERS Columns')
#
#str(books) # 115253 obs. of  8 variables
#kable(names(books))

BOOKS1 <- data.frame(names(books))
BOOKS1$BOOKS<- BOOKS1$names.BOOKS.
BOOKS1$names.BOOKS.<- NULL
kable(BOOKS1, caption = 'BOOKS Columns')

##

#str(rating) # 493813 obs. of  3 variables:
#kable(names(rating))

RATING1 <- data.frame(names(rating))
RATING1$RATING<- RATING1$names.RATING.
RATING1$names.RATING.<- NULL
kable(RATING1, caption = 'RATING  Columns')

ratings <- read.csv("C:/CUNY/Courses/IS-643/Final/data/Bx-Book-Ratings.csv", sep=";",header = T)


ratings = subset(ratings,ratings$Rating > 0)
RatingMatrix = as(rating,"realRatingMatrix")
RatingMatrix = RatingMatrix[rowCounts(RatingMatrix)>10,colCounts(RatingMatrix)>10]


hist(getRatings(RatingMatrix), breaks = 100, col = "blue", border = "pink", xlim= range(0:10),
     main = "Ratings Distribution", xlab = 'rating ')

hist(getRatings(normalize(RatingMatrix)), breaks = 100, col = "blue", border = "pink", xlim= range(-5:5
     main = "Ratings normalized Distribution", xlab = 'rating ')



# We can get the values of how many books each user has rated and mean rating of each book



hist(rowCounts(RatingMatrix), breaks = 100, col = "blue", border = "pink",
     main = "Books Long tail", xlab = 'books', ylab='popularity'
                )


library(sparklyr)
library(dplyr)
library(randomForest)
library(magrittr)
library(methods)

sc <- spark_connect(master = "local")

ratings_df <- read.csv("C:/CUNY/Courses/IS-643/Final/Presentation/Senthil/BxBookRating.csv", head=T)
ratings_df <- ratings_df[,c(1,3,4)]
ratings_df <- ratings_df[,c('UserID','BookID','Rating')]
colnames(ratings_df)[1:3] <- c("user","item","rating")




book_rating <- copy_to(sc, ratings_df, overwrite = T)
model <- ml_als_factorization(book_rating, rating.column = "rating", user.column = "user",
                              item.column = "item", rank = 10L, regularization.parameter = 0.1,
                              iter.max = 10L, ml.options = ml_options())

summary(model)
predictions <- model$.model %>%
  invoke("transform", spark_dataframe(book_rating)) %>%
  collect()

sqrt(mean(with(predictions, prediction-rating)^2))

######### using learning rate of .2

model <- ml_als_factorization(book_rating, rating.column = "rating", user.column = "user",
                              item.column = "item", rank = 10L, regularization.parameter = 0.2,
                              iter.max = 10L, ml.options = ml_options())

predictions <- model$.model %>%
  invoke("transform", spark_dataframe(book_rating)) %>%
  collect()

sqrt(mean(with(predictions, prediction-rating)^2))
```