Title: Implement SVD building complete application using R.

Tools: R studio

Theory:

SVD:

Singular Value Decomposition (SVD) is a matrix factorization technique widely used in linear algebra, data science, and machine learning. It decomposes any real or complex matrix into three separate matrices: U, Σ, and V^T, such that X=UΣV^T. This decomposition allows complex datasets to be expressed in terms of simpler components, helping in applications like dimensionality reduction, image compression, and system optimization.

The mathematical foundation of SVD involves breaking a matrix into orthogonal components where Uand V are orthogonal matrices representing left and right singular vectors, and Σ is a diagonal matrix containing singular values in descending order. These singular values indicate the strength or importance of each component in representing the original data. Unlike eigenvalue decomposition, SVD can be applied to non-square and non-symmetric matrices, giving it broader applicability in real-world problems.

In R, SVD is performed using the svd() function, which outputs the three matrices U, D, and V. By analyzing the singular values in D, one can determine how much of the data's variance is retained by each component. SVD also forms the basis of Principal Component Analysis, as PCA often uses SVD internally to calculate principal components. Its real-world applications include collaborative filtering, latent semantic analysis in text mining, and data compression, especially in high-dimensional settings.

Implementation Steps:

```
> # Load necessary libraries
> library(shiny)
Warning message:
package 'shiny' was built under R version 4.4.3
> # Define UI
> ui <- fluidPage(
+   titlePanel("Singular Value Decomposition (SVD) on Air Travel Data"),
+
+   sidebarLayout(
+     sidebarPanel(
+       actionButton("compute", "Compute SVD")
+     ),
+
+     mainPanel(
+       tableOutput("originalMatrix"),
+       verbatimTextOutput("svdOutput"),
+       plotOutput("svdPlot")
+     )
+   )
+ )
> # Define Server
> server <- function(input, output) {
+
+   # Download and preprocess data
+   matrixData <- reactive({
+     url <- "https://people.sc.fsu.edu/~jburkardt/data/csv/airtravel.csv"
+     temp_file <- tempfile()
+     download.file(url, temp_file, method = "curl")
+     data <- read.csv(temp_file, header = TRUE, row.names = 1)
+     as.matrix(data)  # Convert to matrix for SVD
+   })
+  # Compute SVD when button is clicked
+   svdResult <- eventReactive(input$compute, {
+     svd(matrixData())
+   })
+   # Display original matrix
+   output$originalMatrix <- renderTable({
+     matrixData()
+   })
+   # Show SVD results
+   output$svdOutput <- renderPrint({
+     req(input$compute)
+     svdResult()
+   })

+  # Plot singular values
+   output$svdPlot <- renderPlot({
+     req(input$compute)
+     barplot(svdResult()$d, main = "Singular Values", col = "blue")
+   })
+ }
> # Run the app
> shinyApp(ui = ui, server = server)

Listening on http://127.0.0.1:3037
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   321  100   321    0     0    114      0  0:00:02  0:00:02 --:--:--   114
```

http://127.0.0.1:3037 Open in Browser Publish

Singular Value Decomposition (SVD) on Air Travel Data

Compute SVD

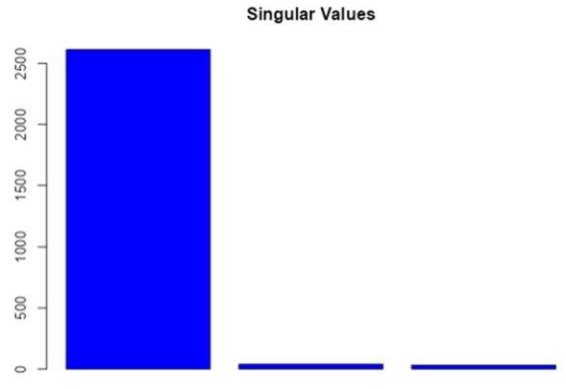
X1958	X1959	X1960
340	360	417
318	342	391
362	406	419
348	396	461
363	420	472
435	472	535
491	548	622
505	559	606
404	463	508
359	407	461
310	362	390
337	405	432

http://127.0.0.1:3037 Open in Browser Publish

```
$d
[1] 2613.01701   38.14255   31.42027

$u
            [,1]        [,2]        [,3]
 [1,] -0.2476794  0.12883146 -0.46045958
 [2,] -0.2330575  0.07226013 -0.31976739
 [3,] -0.2625913 -0.65847885 -0.02882889
 [4,] -0.2679194  0.46748073  0.11952109
 [5,] -0.2788231  0.21965511  0.26491863
 [6,] -0.3197566  0.04810521 -0.35037872
 [7,] -0.3687029  0.22400454 -0.06887204
 [8,] -0.3699511 -0.39048001 -0.18371653
 [9,] -0.3051073 -0.04760078  0.19385495
[10,] -0.2724919  0.20789616  0.08456496
[11,] -0.2356449 -0.11900400  0.28916709
[12,] -0.2606551 -0.11482396  0.55751104

$v
           [,1]       [,2]        [,3]
[1,] -0.5115777 -0.4098611 -0.75518350
[2,] -0.5746226 -0.4902495  0.65533522
[3,] -0.6388248  0.7692004  0.01528524
```



Conclusion:

This Shiny app performs Singular Value Decomposition (SVD) on the Air Travel dataset. It allows users to load the data, compute the SVD interactively, and visualize the resulting singular values. The app helps demonstrate the importance of dimensionality reduction and the distribution of variance in the data.

For Faculty Use

Correction Parameters	Formative Assessment [40%]	Timely completion of Practical [40%]	Attendance / Learning Attitude [20%]	
Marks Obtained				