

## MULTIVARIATE ASSIGNMENT

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### **Q.1. For Principal Component Analysis.**

#### **INPUT:**

```
library(readr)

wine_data_csv <- read_csv("wine_data.csv.csv")

View(wine_data_csv)

Summary(wine_data_csv)

# Apply PCA using prcomp function

my_pca <- prcomp(wine_data_csv, scale = TRUE, center = TRUE, retx = T)

names(my_pca)

# Summary

summary(my_pca)

# View the principal component loading

my_pca

my_pca$rotation

# See the principal components

dim(my_pca$x)

my_pca$x

# Compute standard deviation

my_pca$sdev

# Compute variance

my_pca.var <- my_pca$sdev ^ 2

my_pca.var

# Find Top n principal component

> # which will atleast cover 90 % variance of dimension

which(cumsum(propve) >= 0.9)[1]

# Add a Biplot and Screeplot

biplot(my_pca,scale=0)
```

```

screplot(my_pca,type = "line")

# Add a training set with principal components

train.data <- data.frame(quality = wine_data_csv$quality, my_pca$x[, 1:4])

# Running a Decision tree algorithm

# Installing and loading packages

install.packages("rpart")

install.packages("rpart.plot")

library(rpart)

library(rpart.plot)

rpart.model <- rpart(quality ~ .,
data = train.data, method = "anova")

rpart.plot(rpart.model)

```

## OUTPUT:

```

library(readr)
> wine_data_csv <- read_csv("wine_data.csv.csv")
Rows: 1599 Columns: 12
Column specification
Delimiter: ","
dbl (12): fixed acidity, volatile acidity, citric acid, residual sugar, chlorides, free sulfur ...
> view(wine_data_csv)
> summary(wine_data_csv)
fixed acidity    volatile acidity    citric acid    residual sugar    chlorides
Min.   : 4.60    Min.   :0.1200    Min.   :0.000    Min.   : 0.900    Min.   :0.01200
1st Qu.: 7.10    1st Qu.:0.3900    1st Qu.:0.090    1st Qu.: 1.900    1st Qu.:0.07000
Median : 7.90    Median :0.5200    Median :0.260    Median : 2.200    Median :0.07900
Mean   : 8.32    Mean   :0.5278    Mean   :0.271    Mean   : 2.539    Mean   :0.08747
3rd Qu.: 9.20    3rd Qu.:0.6400    3rd Qu.:0.420    3rd Qu.: 2.600    3rd Qu.:0.09000
Max.   :15.90    Max.   :1.5800    Max.   :1.000    Max.   :15.500    Max.   :0.61100
free sulfur dioxide    total sulfur dioxide    density    pH    sulphates
Min.   : 1.00    Min.   : 6.00    Min.   :0.9901    Min.   :2.740    Min.   :0.3300
1st Qu.: 7.00    1st Qu.: 22.00    1st Qu.:0.9956    1st Qu.:3.210    1st Qu.:0.5500
Median :14.00    Median : 38.00    Median :0.9968    Median :3.310    Median :0.6200
Mean   :15.87    Mean   : 46.47    Mean   :0.9967    Mean   :3.311    Mean   :0.6581
3rd Qu.:21.00    3rd Qu.: 62.00    3rd Qu.:0.9978    3rd Qu.:3.400    3rd Qu.:0.7300
Max.   :72.00    Max.   :289.00    Max.   :1.0037    Max.   :4.010    Max.   :2.0000
alcohol    quality
Min.   : 8.40    Min.   :3.000
1st Qu.: 9.50    1st Qu.:5.000
Median :10.20    Median :6.000
Mean   :10.42    Mean   :5.636
3rd Qu.:11.10    3rd Qu.:6.000
Max.   :14.90    Max.   :8.000
>
> my_pca <- prcomp(wine_data_csv, scale = TRUE,
+                 center = TRUE, retx = T)
> names(my_pca)
[1] "sdev"    "rotation" "center"    "scale"    "x"
>
> summary(my_pca)
Importance of components:
      PC1      PC2      PC3      PC4      PC5      PC6      PC7      PC8      PC9      PC10
Standard deviation  1.7667  1.4973  1.2973  1.1023  0.98654  0.81400  0.78633  0.71125  0.64133  0.57264
Proportion of Variance 0.2601 0.1868 0.1402 0.1013 0.08111 0.05522 0.05153 0.04216 0.03428 0.02733
Cumulative Proportion 0.2601 0.4469 0.5872 0.6884 0.76952 0.82474 0.87626 0.91842 0.95270 0.98002
      PC11      PC12

```

```
Standard deviation      0.42452 0.24396
Proportion of Variance 0.01502 0.00496
Cumulative Proportion  0.99504 1.00000
```

```
> my_pca
```

```
Standard deviations (1, ..., p=12):
```

```
[1] 1.7666827 1.4972916 1.2972739 1.1022799 0.9865412 0.8139977 0.7863319 0.7112472 0.6413326
[10] 0.5726425 0.4245216 0.2439629
```

```
Rotation (n x k) = (12 x 12):
```

	PC1	PC2	PC3	PC4	PC5	PC6
fixed acidity	0.487883358	0.004173212	0.16482854	0.231098077	-0.07877938	0.05553130
volatile acidity	-0.265128984	-0.338967858	0.22708884	-0.041858245	0.29937933	0.29728700
citric acid	0.473335467	0.137358104	-0.10022856	0.056735802	-0.12014871	0.13663328
residual sugar	0.139154423	-0.167736336	-0.24362014	0.383037581	0.70936319	0.10931059
chlorides	0.197426792	-0.189788185	0.02660785	-0.654777820	0.26623723	0.33733656
free sulfur dioxide	-0.045880713	-0.259483136	-0.61611132	0.033711483	-0.15941286	-0.04264807
total sulfur dioxide	0.004066746	-0.363971374	-0.54073214	0.028459726	-0.21845284	0.11595360
density	0.370301191	-0.330780789	0.16872267	0.200693412	0.20879298	-0.42566742
pH	-0.432720849	0.065440145	-0.06977056	0.005466181	0.25764682	-0.48035396
sulphates	0.254535354	0.109333620	-0.21291324	-0.560502367	0.21483493	-0.40374303
alcohol	-0.073176777	0.502708647	-0.22497138	0.091701428	0.25972635	0.39217625
quality	0.112488776	0.473166214	-0.22336929	0.036669226	0.13758414	-0.14183046

	PC7	PC8	PC9	PC10	PC11	PC12
fixed acidity	-0.3072150	-0.20052866	0.17457815	0.182956014	-0.256437921	-0.638579761
volatile acidity	-0.6262337	-0.14612614	0.06022334	-0.155105626	0.377161229	-0.004661681
citric acid	0.2441486	-0.29633271	0.22097505	-0.346085556	0.624327833	0.070036908
residual sugar	0.2838543	0.17062614	-0.27818728	0.052236558	0.088077871	-0.183646374
chlorides	0.2305470	0.18692254	0.41993639	0.003862734	-0.208616670	-0.053931176
free sulfur dioxide	-0.1382604	0.01935607	0.31800012	0.585388580	0.237933171	0.051921666
total sulfur dioxide	-0.1102087	-0.08989655	-0.12182276	-0.589188239	-0.355046842	-0.069792953
density	-0.1225465	-0.07950023	0.24907449	-0.043538098	-0.231453058	0.566644992
pH	0.1856917	-0.31469303	0.46191598	-0.207609889	-0.005599072	-0.341230056
sulphates	-0.2334021	-0.27549158	-0.45268884	0.071918570	0.097637028	-0.067792979
alcohol	-0.1217188	-0.47118865	0.09652795	0.110605247	-0.319948696	0.317640325
quality	-0.4123879	0.61224719	0.24024309	-0.260239788	0.052465707	-0.008470476

```
> my_pca$rotation
```

	PC1	PC2	PC3	PC4	PC5	PC6
fixed acidity	0.487883358	0.004173212	0.16482854	0.231098077	-0.07877938	0.05553130
volatile acidity	-0.265128984	-0.338967858	0.22708884	-0.041858245	0.29937933	0.29728700
citric acid	0.473335467	0.137358104	-0.10022856	0.056735802	-0.12014871	0.13663328
residual sugar	0.139154423	-0.167736336	-0.24362014	0.383037581	0.70936319	0.10931059
chlorides	0.197426792	-0.189788185	0.02660785	-0.654777820	0.26623723	0.33733656
free sulfur dioxide	-0.045880713	-0.259483136	-0.61611132	0.033711483	-0.15941286	-0.04264807
total sulfur dioxide	0.004066746	-0.363971374	-0.54073214	0.028459726	-0.21845284	0.11595360
density	0.370301191	-0.330780789	0.16872267	0.200693412	0.20879298	-0.42566742
pH	-0.432720849	0.065440145	-0.06977056	0.005466181	0.25764682	-0.48035396
sulphates	0.254535354	0.109333620	-0.21291324	-0.560502367	0.21483493	-0.40374303
alcohol	-0.073176777	0.502708647	-0.22497138	0.091701428	0.25972635	0.39217625
quality	0.112488776	0.473166214	-0.22336929	0.036669226	0.13758414	-0.14183046

	PC7	PC8	PC9	PC10	PC11	PC12
fixed acidity	-0.3072150	-0.20052866	0.17457815	0.182956014	-0.256437921	-0.638579761
volatile acidity	-0.6262337	-0.14612614	0.06022334	-0.155105626	0.377161229	-0.004661681
citric acid	0.2441486	-0.29633271	0.22097505	-0.346085556	0.624327833	0.070036908
residual sugar	0.2838543	0.17062614	-0.27818728	0.052236558	0.088077871	-0.183646374
chlorides	0.2305470	0.18692254	0.41993639	0.003862734	-0.208616670	-0.053931176
free sulfur dioxide	-0.1382604	0.01935607	0.31800012	0.585388580	0.237933171	0.051921666
total sulfur dioxide	-0.1102087	-0.08989655	-0.12182276	-0.589188239	-0.355046842	-0.069792953
density	-0.1225465	-0.07950023	0.24907449	-0.043538098	-0.231453058	0.566644992
pH	0.1856917	-0.31469303	0.46191598	-0.207609889	-0.005599072	-0.341230056
sulphates	-0.2334021	-0.27549158	-0.45268884	0.071918570	0.097637028	-0.067792979
alcohol	-0.1217188	-0.47118865	0.09652795	0.110605247	-0.319948696	0.317640325
quality	-0.4123879	0.61224719	0.24024309	-0.260239788	0.052465707	-0.008470476

```
>
```

```
> dim(my_pca$x)
```

```
[1] 1599 12
```

```
> my_pca$x
```

	PC1	PC2	PC3	PC4	PC5	PC6
[1,]	-1.778885068	-1.156941211	1.386146920	4.493009e-02	0.2338113633	-0.9766771337
[2,]	-1.003870619	-2.071189887	-0.007756340	-4.659736e-01	0.1823968236	0.6575690070
[3,]	-0.915496786	-1.392998409	0.699067716	-3.451843e-01	0.0951799254	0.2547432788
[4,]	2.403325260	0.213724711	-0.066359977	8.889039e-01	-1.5242651801	-0.1321764824
[5,]	-1.778885068	-1.156941211	1.386146920	4.493009e-02	0.2338113633	-0.9766771337
[6,]	-1.741753185	-1.181291030	1.135701972	5.266236e-02	0.0406393878	-1.0450129918
[7,]	-1.254595575	-1.144199460	0.772469341	3.769104e-01	-1.0426066528	0.1210407188
[8,]	-2.056524603	1.016511831	0.607444076	1.033694e-01	-0.4156690835	-0.0791138502
[9,]	-0.925482708	0.649265680	1.014901014	1.352193e-01	0.1896456581	-0.8571425537

[10,]	0.528962231	-1.299095133	-1.704354689	7.939482e-01	1.5199172781	-0.2170375330
[11,]	-1.282892555	-1.261792842	-0.411930568	-4.375005e-01	-0.8509591835	0.2117786793
[12,]	0.528962231	-1.299095133	-1.704354689	7.939482e-01	1.5199172781	-0.2170375330
[13,]	-3.128643824	-0.564567019	0.061839133	-5.931411e-01	-0.3456957470	-0.1866850417
[14,]	1.453512206	-0.326102488	0.318455318	-3.801273e+00	0.7469086936	-2.2945157306
[15,]	1.270357658	-3.926016060	-3.307262850	-1.334377e+00	-0.0579702203	0.2254940806
[16,]	1.331166993	-3.878564588	-3.390814974	-1.386431e+00	0.0276098803	0.0617013968
[17,]	1.372826183	0.506210315	-2.861633036	-2.064348e-01	-1.2477420318	-0.5364520967
[18,]	2.503797376	-1.790989163	-0.117594668	-6.339306e+00	1.2342172241	0.8624883804
[19,]	-1.027658243	-1.848989585	1.615247840	6.849976e-01	0.8192241463	-0.1689076387
[20,]	3.315858899	-0.740246624	-0.614381250	-5.130454e+00	0.3692366280	0.8883108075
[21,]	0.671454681	0.058399002	-1.071403405	5.694824e-01	-1.6028301999	-0.8766857995
[22,]	-0.328997947	-0.996178932	-0.673447718	1.012171e-01	-0.4300234506	-1.3373297458
[23,]	0.608484785	-0.251089422	0.647034601	-1.552286e+00	-0.5878731416	-0.5236312647
[24,]	-0.094820673	-0.062768324	0.780052097	2.723644e-01	-0.8931391413	0.3545944260
[25,]	-0.838803129	0.012196654	-0.363726962	-1.318980e-01	-0.1332063484	-1.0663649290
[26,]	-1.241186494	-0.010976312	0.968333636	-4.422069e-01	-1.0518112831	-0.4522170428
[27,]	-0.306605235	0.235102919	1.625841955	-1.849828e-01	-0.6748411214	-0.2732330087
[28,]	0.608484785	-0.251089422	0.647034601	-1.552286e+00	-0.5878731416	-0.5236312647
[29,]	-1.894637305	-1.196452332	1.156548654	-7.449354e-02	0.0885662130	-0.6660827719
[30,]	-1.292830627	0.169847760	1.347834214	-1.435144e-01	0.3073126576	-0.4353389584
[31,]	-1.706486079	-1.253759628	-0.198457307	-9.787722e-02	-0.2476066331	0.5394043500
[32,]	-1.787189303	-0.276570081	-0.091878330	-2.341041e-01	0.7690231156	-0.1290477531
[33,]	-0.267198851	-1.714729203	-0.410497733	-1.335076e-01	-0.7768347676	0.6423587972
[34,]	-0.210246329	-2.918280918	-2.944374298	2.939080e+00	3.8521953410	-0.5829221242
[35,]	-1.177591106	-0.378049486	0.144849461	-6.799949e-01	-1.0011822790	-0.4400579754
[36,]	-0.587950182	-0.707627598	1.169260634	1.093456e+00	2.3006173572	-0.6527762607
[37,]	-0.757899191	0.727479401	1.319410098	1.151920e-01	0.8972830562	-0.3636693727
[38,]	0.641815503	1.138697649	0.017342787	-7.111627e-02	-0.4140358875	-0.9167107908
[39,]	-3.298783351	-1.772955757	2.287248195	-1.876009e+00	0.8651856701	1.7681798317
[40,]	0.660979943	-0.892351174	-1.238016692	5.540199e-01	1.5421735054	-0.3421498568
[41,]	0.660979943	-0.892351174	-1.238016692	5.540199e-01	1.5421735054	-0.3421498568
[42,]	0.043921996	-1.945004462	1.006411871	5.276485e-01	-0.5129313958	0.3834617532
[43,]	1.418632561	-0.065787187	0.665918465	-4.333920e+00	1.9917737546	1.2272986281
[44,]	0.310346625	0.163059381	0.542939050	-1.778399e+00	0.7838443122	-1.2382452632
[45,]	-2.246228363	-0.278341996	1.914719898	2.431115e-01	-0.0081380417	-0.6960304478
[46,]	-4.337813043	1.175164572	-0.638360495	-4.449375e-02	0.6785496306	0.0359060931
[47,]	-0.006511598	-2.599537351	-0.627289254	-8.610608e-01	-0.3407691785	0.7682900563
[48,]	1.152891450	-0.074921850	0.677043170	-2.880931e-01	-1.2917768543	-0.0016575669
[49,]	-1.006184753	0.223150467	1.494146381	-1.673378e-01	-0.8880556924	-0.5869387133
[50,]	-0.755811899	-0.546682527	-0.573618035	-3.914829e-01	-1.8608437390	-0.2494898185
[51,]	0.461323964	-0.575470782	1.876972539	-4.423486e-01	-0.4878165535	-0.0805126591
[52,]	-1.507215921	0.457295613	0.983296371	-2.786427e-01	0.0597526677	-0.8585601667
[53,]	-1.459593654	0.591501612	1.091903595	-3.385877e-01	-0.0076114799	-0.8722074250
[54,]	0.674559643	-1.848479138	-1.726314625	6.518687e-01	-1.4557097556	0.2710424782
[55,]	-0.246094862	-0.645017356	-1.571613674	-3.381158e-01	-0.5023486529	0.7093607054
[56,]	-0.893571883	-1.748113290	0.056701774	6.764028e-01	0.4792294409	-0.2483454408
[57,]	2.227302968	0.129641004	1.566761037	7.903687e-01	-0.4501226286	0.5918753418
[58,]	0.059493095	-3.327925163	-2.940554163	3.330355e-02	0.6514029292	-0.2328197899
[59,]	-0.881705368	-0.917486542	0.285604020	2.391679e-01	-0.0846715434	-0.4773283962
[60,]	-0.467813647	0.324718049	0.307732466	2.998689e-01	-0.4790034832	-0.6582218381
[61,]	0.408186709	-0.856497627	0.106427764	2.355507e-01	-0.6934244934	-1.1654164569
[62,]	0.511259141	-1.925766261	-0.744310131	-8.650151e-01	-1.0290891867	0.6348697958
[63,]	-0.532095149	0.602563907	0.334447153	-1.841604e-01	-0.0277439673	-0.9235036769
[64,]	-1.708313525	-1.137269680	0.755877962	-1.509257e-01	-0.0279640911	-0.0229245414
[65,]	-1.801149339	-0.272865675	1.493081228	1.110149e+00	1.7596211079	0.9547990833
[66,]	-1.801149339	-0.272865675	1.493081228	1.110149e+00	1.7596211079	0.9547990833
[67,]	-1.170984582	-0.513861830	0.983289843	-1.722071e-01	-0.5437240578	-0.6555394929
[68,]	-2.027360952	0.127886321	1.528434552	-2.829751e-01	0.3349962605	-0.0052057182
[69,]	1.360498688	0.046995605	-1.219435751	-6.717266e-02	-1.1248271979	-0.2605416904
[70,]	-0.681802978	0.683476334	0.780813336	-1.182553e+00	0.7902465150	-0.7790938755
[71,]	-0.996086120	-0.256633999	0.879017007	1.276959e-01	-0.2299950705	-0.3201330054
[72,]	-0.948495225	-1.648819853	-0.119965897	2.153877e-01	-0.8775538145	0.6193757121
[73,]	-1.035150685	-1.643198666	-0.087605039	1.996188e-01	-0.9909076741	0.6439321635
[74,]	-0.452786075	-1.829093007	1.556895604	2.050156e-01	-0.5359902911	0.1383172287
[75,]	1.945659855	-1.099749810	-1.267371257	-1.807784e-01	-0.9586314510	-0.8419169149
[76,]	0.856096317	0.159439731	0.465811869	1.805388e-01	0.0487198622	-0.8902967908
[77,]	0.856096317	0.159439731	0.465811869	1.805388e-01	0.0487198622	-0.8902967908
[78,]	-2.148187843	-0.114573423	0.605358536	-2.389852e-01	1.1523348389	-0.0754318239
[79,]	-1.840541072	-1.154818298	0.277297278	-1.184287e-01	-0.2570685280	0.6141126567
[80,]	0.573444975	-2.587143756	-1.253873620	-1.798189e+00	-1.2268028549	-0.7444886450
[81,]	-1.383628205	0.140859066	1.592608676	-2.574181e-01	-0.6325585897	-0.7089109339
[82,]	4.085027941	-1.980428768	-1.017980993	-7.405670e+00	1.3747014864	1.4888116217
[83,]	-0.028869624	-1.237171628	-0.303993871	3.332437e-02	-1.0942491941	-0.2900303237
	PC7	PC8	PC9	PC10	PC11	PC12
[1,]	-1.104930e-01	-4.030734e-02	0.2943281191	-0.0730893134	-0.262854368	-4.834668e-02

[2,]	-1.376359e+00	1.766587e-01	-0.5871582834	0.5655589102	0.048768315	1.395215e-01
[3,]	-7.201128e-01	8.865889e-02	-0.5463238904	0.1620140099	-0.199078185	1.203533e-01
[4,]	2.005975e-01	2.027521e-01	0.5060533785	-0.2410590909	-0.107582211	-3.196639e-01
[5,]	-1.104930e-01	-4.030734e-02	0.2943281191	-0.0730893134	-0.262854368	-4.834668e-02
[6,]	-4.216750e-02	-3.643358e-02	0.3302651543	-0.0377660883	-0.368188743	-3.593670e-02
[7,]	-2.908278e-02	4.169665e-01	-0.1413599926	-0.0038691832	-0.399687890	-1.098325e-01
[8,]	-1.024575e+00	1.703190e+00	0.5855393249	0.0043498069	0.177622262	-3.608190e-01
[9,]	-8.128297e-01	1.825017e+00	0.2652832010	-0.1896347052	-0.129941273	-1.341791e-01
[10,]	8.879245e-01	-6.728498e-01	-1.3172816890	-0.8247318316	-0.044206614	-2.068210e-02
[11,]	3.560875e-01	6.803217e-01	-0.4151661416	-0.1943185519	-0.209178762	6.961431e-02
[12,]	8.879245e-01	-6.728498e-01	-1.3172816890	-0.8247318316	-0.044206614	-2.068210e-02
[13,]	6.672471e-01	4.130868e-02	0.2195109841	-0.3450789543	-0.155714260	-4.305037e-01
[14,]	-9.513192e-01	-1.295673e+00	-2.5094804426	0.2398748666	0.963589710	-1.491325e-01
[15,]	-8.019239e-01	2.260900e-01	0.1604257513	0.7862457238	-0.506439259	-9.958493e-02
[16,]	-8.523015e-01	8.745539e-02	-0.0466184420	0.6697620769	-0.468263501	-1.455678e-01
[17,]	-2.267063e-01	4.182359e-01	0.9753073351	-0.6302732152	0.236365259	1.527490e-01
[18,]	4.606805e-01	3.835007e-01	0.0897362937	0.3826876800	-0.612067334	-2.650834e-01
[19,]	1.518189e+00	7.251083e-02	-0.8046742432	0.2225684424	-0.111739539	-2.855259e-01
[20,]	1.183725e+00	1.425110e+00	0.6459476541	-0.1072633187	-0.232258628	-1.445206e-01
[21,]	1.016145e+00	4.962118e-01	1.1939748608	0.0350418108	0.336358406	-4.008636e-01
[22,]	9.821354e-01	-6.047562e-01	0.6336991249	-0.2634768445	-0.167386765	7.132897e-02
[23,]	2.741079e-01	6.316920e-03	-1.3240642162	0.3656657856	-0.107941063	1.251934e-01
[24,]	3.006120e-01	6.072588e-01	-0.8208958211	-0.1909824346	-0.809112392	-8.474552e-02
[25,]	5.222736e-01	8.644064e-01	0.3319367981	0.2261792505	-0.077618422	8.216895e-02
[26,]	1.280386e+00	5.690295e-01	-0.3848765723	0.2457028352	0.146994608	1.599663e-01
[27,]	1.112809e+00	3.051595e-01	-0.5534803024	0.1588837690	0.122892009	4.041547e-02
[28,]	2.741079e-01	6.316920e-03	-1.3240642162	0.3656657856	-0.107941063	1.251934e-01
[29,]	-1.113245e-01	1.278490e-01	0.2186456917	0.1004204131	-0.088617140	-1.812298e-02
[30,]	-5.023427e-01	8.945514e-01	0.0050875808	0.1143957624	-0.193369145	-2.264840e-01
[31,]	-2.585770e-03	7.967786e-02	-0.3087151069	-0.4282448739	-0.366660494	5.194098e-02
[32,]	-5.061108e-01	5.932269e-01	0.7743324741	0.3752993319	-0.234611263	1.657036e-01
[33,]	-6.786495e-01	-1.786840e-02	-1.0883242917	-0.7596116982	-0.776321102	-7.157324e-02
[34,]	1.044727e+00	1.767320e+00	-0.2917725066	0.5214205860	0.549245336	-3.336645e-01
[35,]	1.968710e+00	6.561148e-01	-0.1657976727	-0.3971330559	0.125412018	4.176089e-01
[36,]	2.139716e-01	1.342986e+00	-0.3095184148	-0.0746919279	-0.315797045	-1.33871e-01
[37,]	-1.512347e-01	1.898045e-01	0.2859487838	-0.3132415162	-0.365965706	2.815577e-01
[38,]	-3.471782e-01	1.433590e+00	-0.2801277881	-0.1712720657	0.273462462	1.268189e-01
[39,]	1.010889e-01	-5.904059e-01	0.6609871016	-0.3152958971	1.037342714	-4.066925e-01
[40,]	1.123491e+00	-5.975510e-01	-1.5243363816	-0.7811304364	-0.079687257	1.157988e-01
[41,]	1.123491e+00	-5.975510e-01	-1.5243363816	-0.7811304364	-0.079687257	1.157988e-01
[42,]	7.569155e-01	-5.642288e-01	-0.1351931494	0.4056368677	0.282703173	-8.508554e-02
[43,]	9.582032e-01	1.338653e+00	1.0490472905	0.3639419950	-0.958222029	1.796087e-01
[44,]	-9.006789e-01	-1.356011e+00	-1.9290468695	0.4103108288	0.606566703	-6.637990e-02
[45,]	2.456969e-01	1.085866e-01	-0.2477480445	-0.0046913120	0.191428332	-1.267456e-01
[46,]	1.912202e+00	-2.956264e+00	0.3052680393	-0.9120901694	-0.692056295	-1.139736e-01
[47,]	-1.085269e+00	-5.559946e-01	-0.1463778892	-1.3926586275	1.068644403	-7.800941e-04
[48,]	1.550095e+00	-5.101514e-02	0.3442281003	-0.1217579895	0.257568998	-5.983092e-03
[49,]	1.395289e+00	4.620052e-01	-0.5675922833	-0.0266135716	0.427703536	1.920078e-01
[50,]	1.626027e+00	2.306996e-01	-0.6727394977	-1.3563675966	0.070594236	3.276213e-01
[51,]	-4.250012e-01	-2.028426e-02	-1.1025770237	0.0003235059	0.498477741	3.546475e-03
[52,]	2.432426e-01	1.154010e+00	-0.524466513	0.0167814359	0.169703990	-1.973761e-01
[53,]	2.986404e-01	1.161633e+00	-0.5752867435	-0.0437003058	0.109448857	-2.024108e-01
[54,]	6.372378e-01	1.564268e-01	-0.2272733445	-0.2920170276	-0.289178872	-1.407610e-01
[55,]	-3.250168e-01	1.122176e+00	-0.0669732527	0.7155742011	-0.067274395	6.835215e-02
[56,]	1.917115e-01	5.381908e-01	0.0047989438	0.8404449629	-0.105527945	6.513903e-02
[57,]	8.955478e-01	-5.738922e-03	-1.0133477375	0.2428460880	0.865066268	-1.751449e-01
[58,]	-3.096716e-01	3.607133e-01	-0.2408022307	1.1413871581	0.139875844	1.540573e-01
[59,]	1.768691e-01	-4.039171e-01	0.2263238242	-0.0736785366	-0.154140246	6.136315e-02
[60,]	9.574552e-01	8.305626e-01	0.1505030300	-0.8336685882	0.210819799	-2.522105e-01
[61,]	9.175638e-01	-4.587074e-01	0.5168668247	-0.1373780932	0.258300002	-3.280392e-01
[62,]	-2.147226e-01	-4.117513e-01	-0.2098696909	-1.3175767186	0.675994294	1.386087e-01
[63,]	-4.773404e-01	1.568186e+00	0.4551872268	-0.5629078612	0.089949642	-5.835630e-02
[64,]	-2.743431e-01	-1.582119e-02	-0.1735468068	-0.2416375127	-0.119076911	8.433819e-02
[65,]	7.186056e-01	1.929747e-01	-0.1620712638	0.1732622407	-0.152434465	-5.753097e-02
[66,]	7.186056e-01	1.929747e-01	-0.1620712638	0.1732622407	-0.152434465	-5.753097e-02
[67,]	4.629625e-01	-1.778190e-02	0.0192250144	-0.0328777198	-0.319059383	-5.243428e-02
[68,]	1.393175e-02	-4.495909e-01	-0.0834996730	0.0379819851	-0.017578926	3.785014e-01
[69,]	6.092493e-01	-1.308945e+00	0.0342472134	0.3493432407	0.389073041	6.174710e-03
[70,]	-1.364956e+00	-1.102205e-01	-1.0048091685	0.2203108368	0.083811769	-1.745662e-01
[71,]	-4.994056e-01	1.067147e+00	0.1854633725	0.1866924310	0.133664116	2.391591e-02
[72,]	1.587559e-02	5.376369e-02	0.0387124601	-0.9216570074	-0.079485719	-2.150970e-01
[73,]	-1.385153e-01	4.447634e-02	0.0325581377	-0.8214135485	-0.007213086	-1.872931e-01
[74,]	5.405373e-01	-6.925484e-01	-0.1905857010	-0.0095856834	0.274691409	6.250822e-03
[75,]	6.131140e-01	-8.423516e-01	0.1020612518	0.0623624608	0.168648096	-1.621071e-01
[76,]	1.322943e+00	-1.603945e+00	1.0931324416	-0.9567072488	0.410972041	5.213087e-02
[77,]	1.322943e+00	-1.603945e+00	1.0931324416	-0.9567072488	0.410972041	5.213087e-02

```

[78,] -6.457536e-01  3.773784e-01  0.8334487478 -0.1267413779 -0.161202606  9.428134e-02
[79,] -1.610344e-01 -1.503418e-01 -0.1760449585 -0.8899320410 -0.164882413  4.461989e-02
[80,] -9.217103e-01 -1.419137e+00 -2.0741116942  0.1028319389 -0.074653561 -6.744292e-02
[81,]  1.333386e+00  3.472035e-01 -0.4405691395 -0.2971886200  0.372620212  7.882750e-02
[82,]  1.862697e+00  1.614948e-01  1.5992053385 -0.1587110302  0.004771539  3.546713e-02
[83,]  8.763405e-01 -1.724730e-01  0.3810367845 -0.6759461503  0.790033375  6.617477e-02
[ reached getOption("max.print") -- omitted 1516 rows ]

> my_pca$sdev
[1] 1.7666827 1.4972916 1.2972739 1.1022799 0.9865412 0.8139977 0.7863319 0.7112472 0.6413326
[10] 0.5726425 0.4245216 0.2439629

> my_pca.var <- my_pca$sdev ^ 2
> my_pca.var
[1] 3.12116770 2.24188204 1.68291969 1.21502087 0.97326362 0.66259224 0.61831780 0.50587256
[9] 0.41130754 0.32791939 0.18021863 0.05951792

> propve <- my_pca.var / sum(my_pca.var)
> propve
[1] 0.260097308 0.186823504 0.140243308 0.101251739 0.081105302 0.055216020 0.051526483
[8] 0.042156046 0.034275628 0.027326616 0.015018219 0.004959826
> which(cumsum(propve) >= 0.9)[1]
[1] 8
> biplot(my_pca,scale = 0)
> screeplot(my_pca,type = "line")

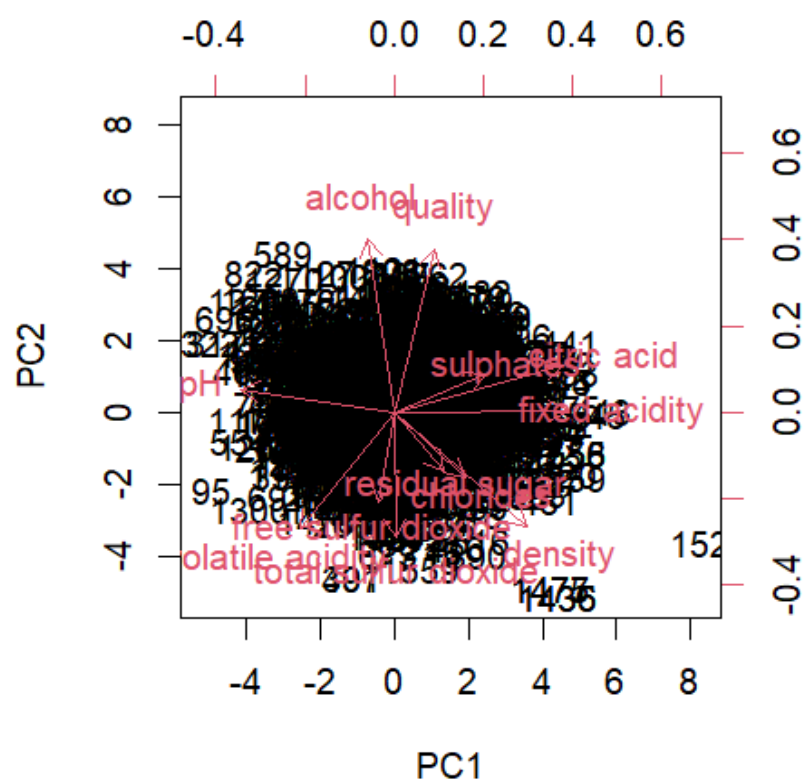
> train.data <- data.frame(quality = wine_data_csv$quality, my_pca$x[, 1:4])
> install.packages("rpart")

package 'rpart' successfully unpacked and MD5 sums checked

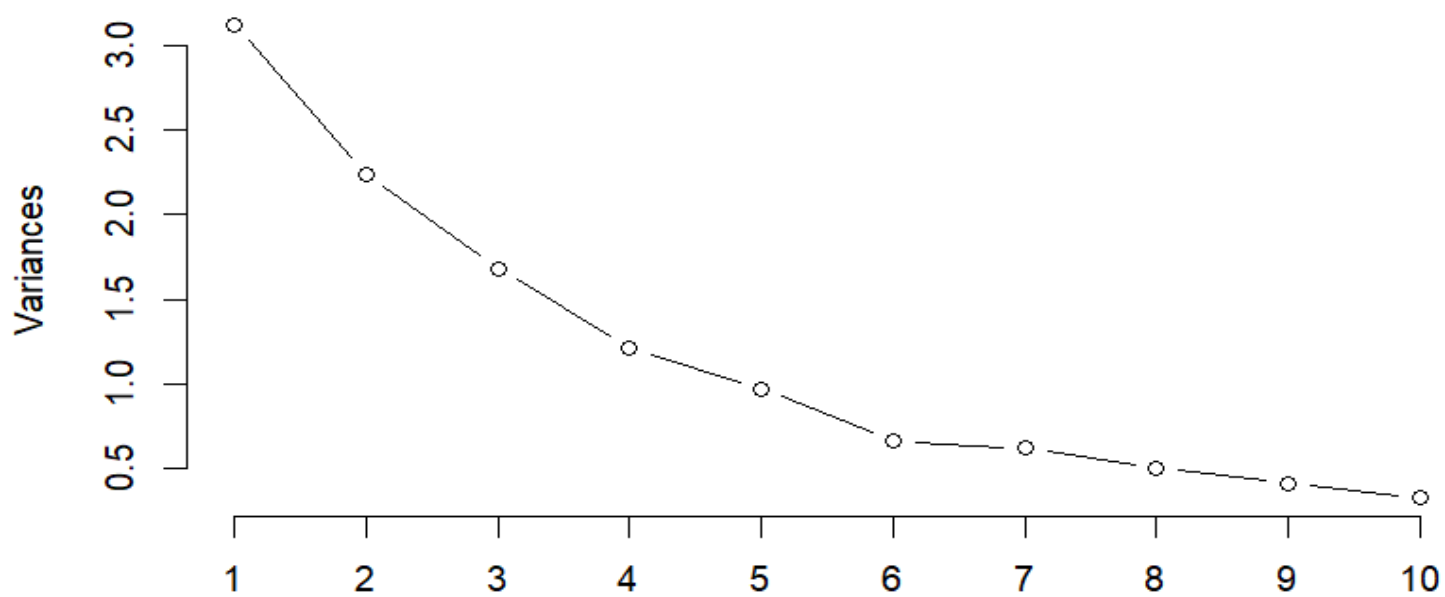
The downloaded binary packages are in
C:\Users\DELL\AppData\Local\Temp\RtmpgBPPCX\downloaded_packages
> install.packages("rpart.plot")
package 'rpart.plot' successfully unpacked and MD5 sums checked

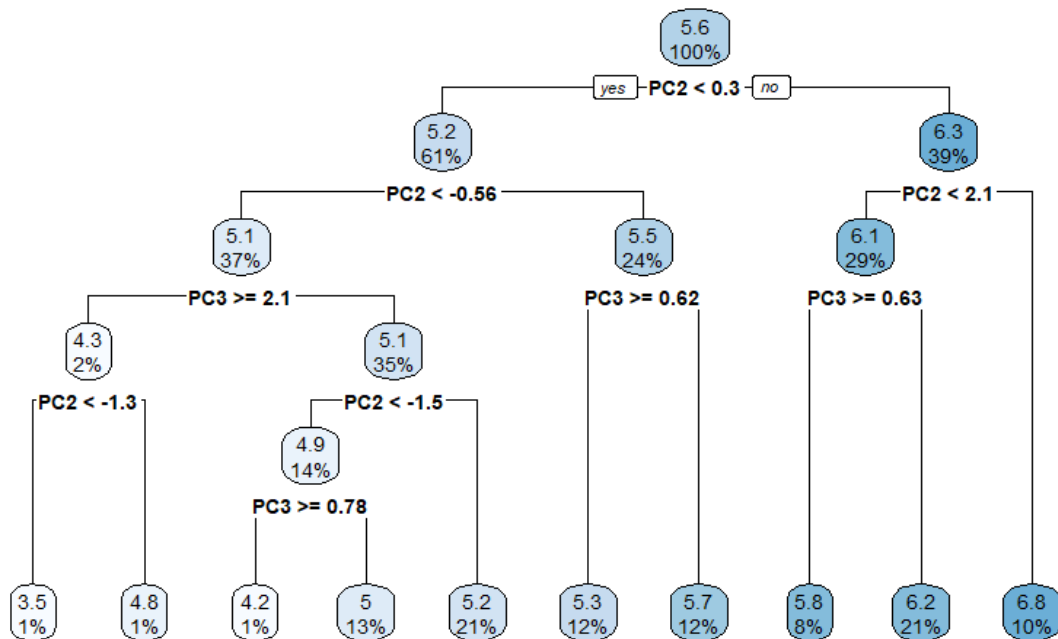
The downloaded binary packages are in
C:\Users\DELL\AppData\Local\Temp\RtmpgBPPCX\downloaded_packages
> library(rpart)
> library(rpart.plot)
> rpart.model <- rpart(quality ~ ., data = train.data, method = "anova")
> rpart.plot(rpart.model)

```



my\_pca





## Q.2. For Factor Analysis.

### INPUT:

```
library(readr)
wine_data_csv <- read_csv("wine_data.csv.csv")
#perform factor analysis
my_fact=factanal(wine_data_csv,factor=5,rotation="varimax")
my_fact
```

### OUTPUT:

```
library(readr)
> wine_data_csv <- read_csv("wine_data.csv.csv")
> my_fact=factanal(wine_data_csv,factor=5,rotation="varimax")
> my_fact
```

```
Call:
factanal(x = wine_data_csv, factors = 5, rotation = "varimax")
```

Uniquenesses:

fixed acidity	volatile acidity	citric acid	residual sugar
0.005	0.503	0.232	0.680
chlorides	free sulfur dioxide	total sulfur dioxide	density
0.864	0.541	0.005	0.005
pH	sulphates	alcohol	quality
0.352	0.775	0.005	0.676



Loadings:

	Factor1	Factor2	Factor3	Factor4	Factor5
fixed acidity	0.935	-0.160		0.162	0.264
volatile acidity	-0.177		-0.120	-0.663	
citric acid	0.568			0.645	0.149
residual sugar		0.157			0.534
chlorides			-0.262	0.245	
free sulfur dioxide		0.669			
total sulfur dioxide		0.984	-0.128		0.103
density	0.499		-0.465		0.724
pH	-0.733		0.158	-0.256	0.134
sulphates				0.434	0.164
alcohol	-0.118		0.975	0.157	
quality		-0.127	0.429	0.347	

	Factor1	Factor2	Factor3	Factor4	Factor5
SS loadings	2.044	1.500	1.484	1.352	0.977
Proportion Var	0.170	0.125	0.124	0.113	0.081
Cumulative Var	0.170	0.295	0.419	0.532	0.613

Test of the hypothesis that 5 factors are sufficient.  
The chi square statistic is 948.81 on 16 degrees of freedom.  
The p-value is 1.01e-191

### Q.3. For Canonical correlation analysis

#### INPUT:

```
library(readr)
wine_data_csv <- read_csv("wine_data.csv.csv")
X<-wine_data_csv[1:6]
Y<-wine_data_csv[7:12]
print(X)
print(Y)
#Perform Canonical Correlation Analysis
cca_result <- cancor(X, Y)
summary(cca_result)
# Canonical Correlation Coefficients
cca_result$cor
# Canonical Loadings for X
cca_result$xcoef
# Canonical Loadings for Y
cca_result$ycoef
```

#### OUTPUT:

```

library(readr)
> wine_data_csv <- read_csv("wine_data.csv.csv")
> X<-wine_data_csv[1:6]
> Y<-wine_data_csv[7:12]
> print(X)
# A tibble: 1,599 × 6
  fixed acidity` volatile acidity` citric acid` residual sugar` chlor
ides
<dbl>          <dbl>          <dbl>          <dbl>          <
1
.076          7.4            0.7            0            1.9            0
2
.098          7.8            0.88           0            2.6            0
3
.092          7.8            0.76           0.04         2.3            0
4
.075          11.2           0.28           0.56         1.9            0
5
.076          7.4            0.7            0            1.9            0
6
.075          7.4            0.66           0            1.8            0
7
.069          7.9            0.6            0.06         1.6            0
8
.065          7.3            0.65           0            1.2            0
9
.073          7.8            0.58           0.02         2            0
10
.071          7.5            0.5            0.36         6.1            0
# i 1,589 more rows
# i 1 more variable: `free sulfur dioxide` <dbl>
# i Use `print(n = ...)` to see more rows
> print(Y)
# A tibble: 1,599 × 6
  total sulfur dioxide` density    pH sulphates alcohol quality
<dbl>          <dbl>    <dbl>    <dbl>    <dbl>    <dbl>
1          34    0.998    3.51    0.56    9.4      5
2          67    0.997    3.2     0.68    9.8      5
3          54    0.997    3.26    0.65    9.8      5
4          60    0.998    3.16    0.58    9.8      6
5          34    0.998    3.51    0.56    9.4      5
6          40    0.998    3.51    0.56    9.4      5
7          59    0.996    3.3     0.46    9.4      5
8          21    0.995    3.39    0.47    10      7
9          18    0.997    3.36    0.57    9.5      7
10         102    0.998    3.35    0.8     10.5     5
# i 1,589 more rows
# i Use `print(n = ...)` to see more rows
> cca_result <- cancel(X, Y)
> summary(cca_result)
      Length Class  Mode
cor         6  -none- numeric
xcoef      36  -none- numeric
ycoef      36  -none- numeric
xcenter     6  -none- numeric
ycenter     6  -none- numeric
> # Canonical Correlation Coefficients
> cca_result$cor
[1] 0.9345108 0.7125917 0.5367743 0.4268398 0.1850280 0.1659524
> cca_result$xcoef
      [,1]      [,2]      [,3]      [,4]
[,5]
fixed acidity -0.0131007129 -0.002065917 -0.0020145043 -0.0051154043
-0.012905377
volatile acidity -0.0026595090 0.040969341 -0.0597674978 -0.0929292538
0.042560290
citric acid -0.0002141502 0.058160549 0.0170363227 0.0546435653
0.112480443

```

```

residual sugar      -0.0046466691  0.003719081 -0.0080595742  0.0007428169
0.010839773
chlorides           -0.0526905389 -0.062448160  0.4145719684 -0.2789677208
0.110895880
free sulfur dioxide  0.0001958465  0.002131788  0.0005084632 -0.0001382334
-0.001134881
                                [,6]
fixed acidity        5.478320e-03
volatile acidity     -1.238271e-01
citric acid          -1.638335e-01
residual sugar       1.099220e-02
chlorides            2.086209e-01
free sulfur dioxide  -8.510995e-07
> cca_result$ycoef
                                [,1]                [,2]                [,3]                [,
4]                                [,5]
total sulfur dioxide  8.200591e-05  0.0007719184  1.732424e-05  8.063418e-
05 -8.145362e-05
density              -1.085307e+01  3.3211597995 -8.146686e+00 -1.898735e+
00  4.707491e+00
pH                   8.856989e-02  0.0148491977 -5.944438e-02 -2.238442e-
02  6.209685e-02
sulphates            8.401829e-03 -0.0056775702  1.260793e-01 -1.876702e-
02  8.461502e-02
alcohol              -1.002391e-02  0.0060564855 -1.148597e-02  9.608252e-
03  2.071206e-02
quality              -3.342330e-04  0.0013589772  2.962052e-04  2.234066e-
02 -1.993577e-02
                                [,6]
total sulfur dioxide -4.110437e-05
density              6.407521e+00
pH                  1.237199e-01
sulphates           3.939217e-02
alcohol             -1.303448e-02
quality             2.146963e-02

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