project4.643

Dieudonne

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This the fourth mini Project for my course 643 at CUNY

In general ,businesses have customers database where you can find their past purchase's history but usually there is no actual ratings associated to those purchases .How can we build some kind of ratings based on the quantities purchased and generate a recommender system that could be profitable to a company ?Answering this question is the goal in this project .For this particular assignment I use viavi solutions Quaterly Sales dataset .But this can be generalize to many other cases where we can identify customers,items purchased(or service provided) and the amount or quantity purchased

https://github.com/dieudo/643Summer2016/blob/master/QuarterlySalesProject4.csv http://www.viavisolutions.com/en-us

```
library(recommenderlab)
library(reshape2)
library(ggplot2)
# Read training file along with header
library(arules)
library(recosystem)
#library(SlopeOne)
#library(SVDApproximation)
library(knitr)
library(data.table)
library(RColorBrewer)
library(ggplot2)
df<- read.csv("~/Downloads/QuarterlySalesProject4.csv")
library(psych)
#describe(tr)
head(df)
```

```
##                   Customer         Item Quantity
## 1                      JAS     PathTrak        3
## 2                      JAS       Repair        2
## 3 3 RIVERS COMMUNICATIONS  Accessories        4
## 4 3 RIVERS COMMUNICATIONS   Probe Tips        2
## 5 3 RIVERS COMMUNICATIONS Test Devices        4
## 6      A + COMMUNICATIONS     SDA-5000       10
```

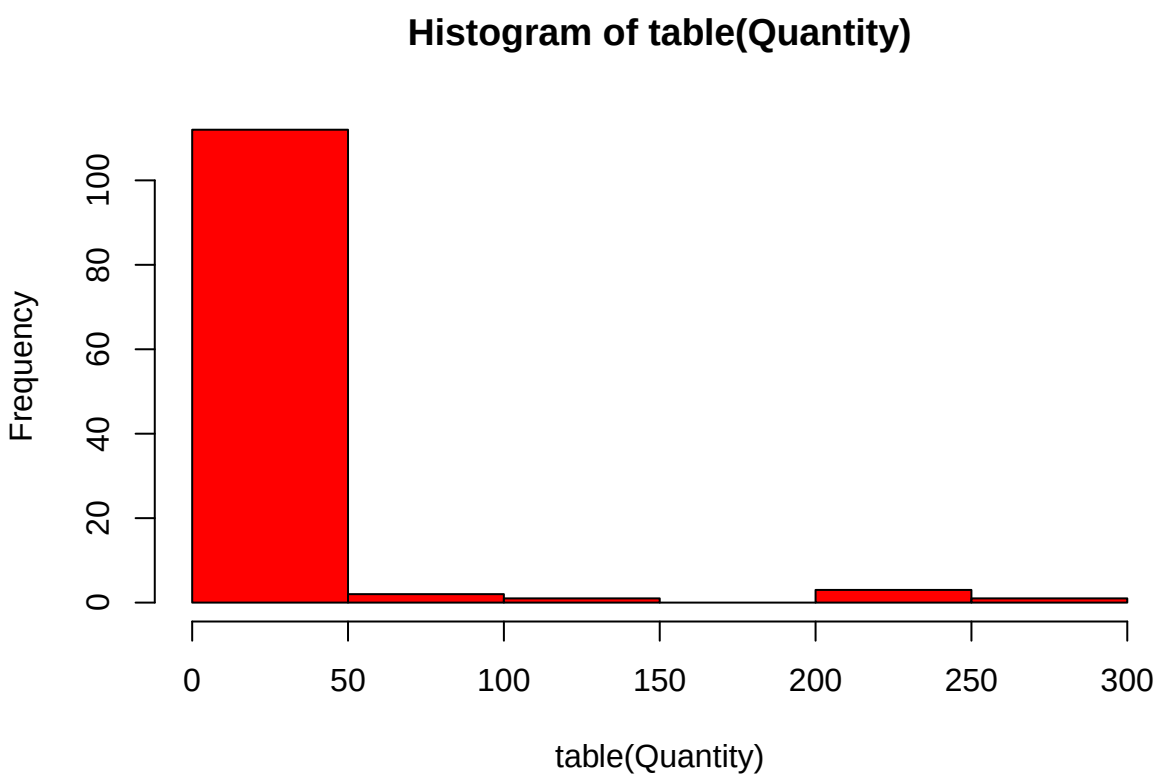
```r
attach(df)
table(Quantity)
```

```
## Quantity
##   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18
## 242 267 225 230  92 111  48  68  38  34  27  47  22  18  13  21  11  16
##  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36
##   9  13   9   7   3   8   8   5   4   4   7   4   5   5   3   4   4   7
##  37  38  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55
##   4   3   5   2   3   1   4   6   2   3   4   2   1   1   2   1   1   1
##  56  57  58  59  60  61  63  64  66  67  69  70  72  75  77  78  81  84
##   1   2   2   1   2   1   1   3   1   1   2   1   1   1   1   1   2   1
##  92  96  98  99 100 108 109 110 115 120 122 123 125 126 135 136 137 141
##   2   1   2   1   1   2   1   1   1   1   1   1   2   1   1   1   1   1
## 146 168 170 176 178 180 183 192 213 216 230 233 234 242 251 271 286 292
##   1   1   1   1   1   1   1   1   2   1   1   1   1   1   1   1   1   1
## 329 345 349 352 390 403 456 470 496 897 965
##   1   1   1   1   1   1   1   1   2   1   1
```

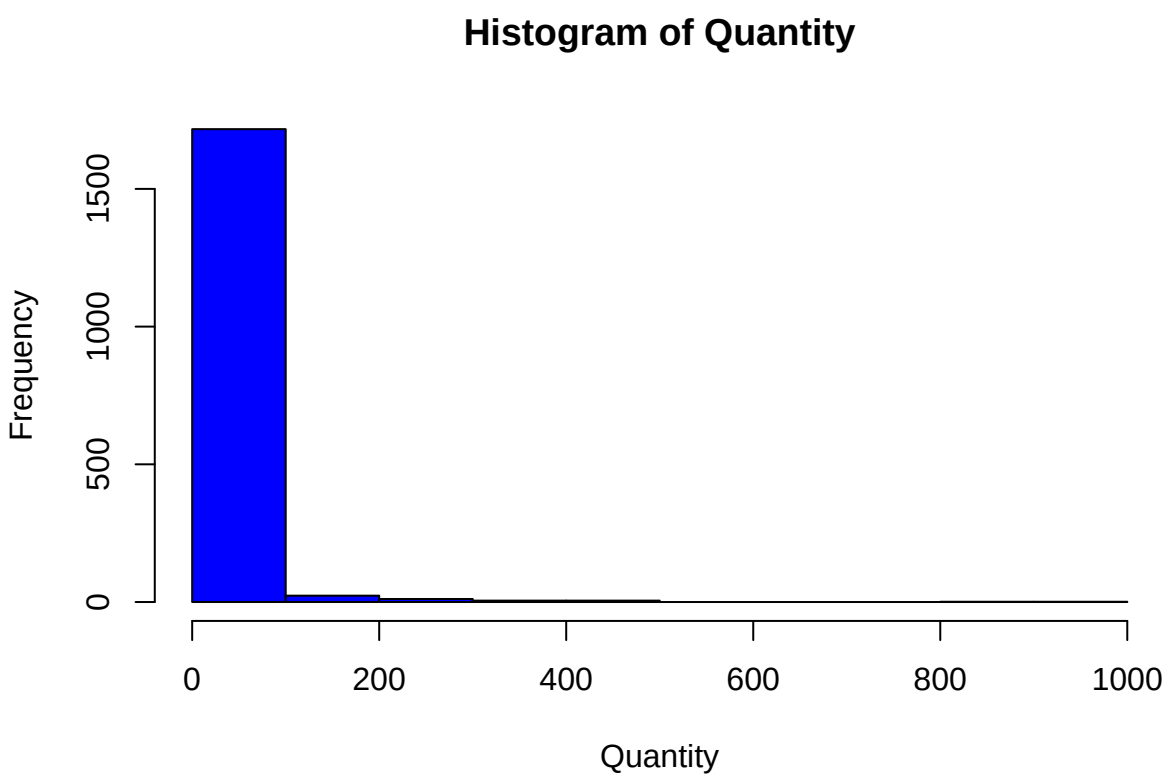
```r
str(Quantity)
```

```
##  int [1:1763] 3 2 4 2 4 10 2 2 2 4 ...
```

```r
hist(table(Quantity),col="red")
```



```r
hist(Quantity,col="blue")
```




```r
names(df)
```

```
## [1] "Customer" "Item"     "Quantity"
```

```r
str(df)
```

```
## 'data.frame':    1763 obs. of  3 variables:
##  $ Customer: Factor w/ 592 levels "3 RIVERS COMMUNICATIONS",..: 288 288 1 1 1 2 3 3 4 4 ...
##  $ Item    : Factor w/ 145 levels "Accessories",..: 81 94 1 84 125 100 16 120 42 43 ...
##  $ Quantity: int  3 2 4 2 4 10 2 2 2 4 ...
```

```r
summary(df)
```

```
##                Customer                              Item
##  COMCAST             :  29   Repair                     : 119
##  TIME WARNER CABLE   :  25   Digital Inspection & Test: 100
##  AT&T/NEW HORIZONS   :  24   DSAM                       :  98
##  MICROLEASE          :  23   T-Berd/MTS-5800            :  94
##  STOCKING CUSTOMER   :  23   Probe Tips                 :  87
##  VERIZON WIRELESS    :  22   Test Devices               :  87
##  (Other)             :1617   (Other)                    :1178
##     Quantity
##  Min.   :  1.00
##  1st Qu.:  2.00
```

```
##  Median :  4.00
##  Mean   : 15.07
##  3rd Qu.: 10.00
##  Max.   :965.00
##
```

```
g<-acast(df, Customer ~ Item)
# Check the class of g
class(g)
```

```
## [1] "matrix"
```

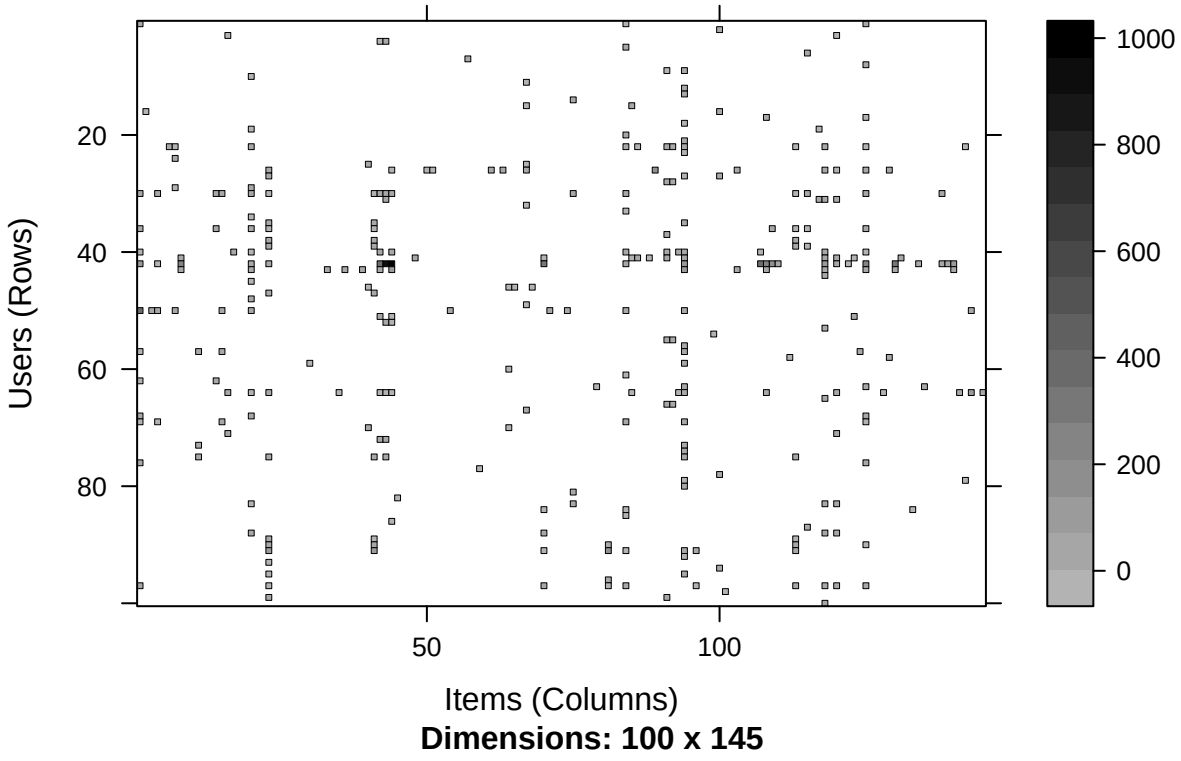
Matrix convertion

```
R<-as.matrix(g)

# Convert R into realRatingMatrix data structure
#   realRatingMatrix is a recommenderlab sparse-matrix like data-structure
r <- as(R, "realRatingMatrix")

# I can turn it into data-frame
kable(head(as(r, "data.frame")))
```

	user	item	rating
1	3 RIVERS COMMUNICATIONS	Accessories	4
878	3 RIVERS COMMUNICATIONS	Probe Tips	2
1610	3 RIVERS COMMUNICATIONS	Test Devices	4
1193	A + COMMUNICATIONS	SDA-5000	10
209	AASKI TECHNOLOGY	Common Product	2
1521	AASKI TECHNOLOGY	TB-6000A Transport Module	2

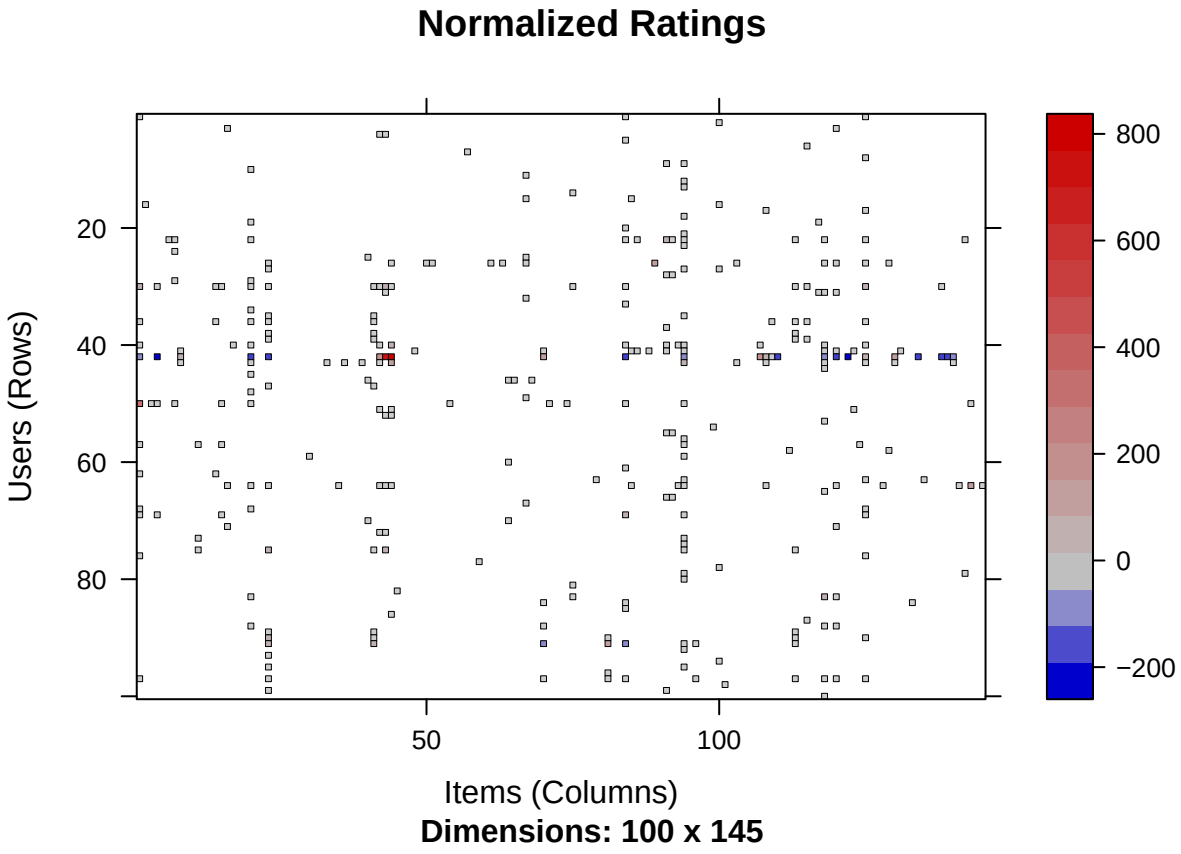
The ratings matrix need to be normalized

```
r_m <- normalize(r)


image(r[1:100], main = "Raw Ratings")
```



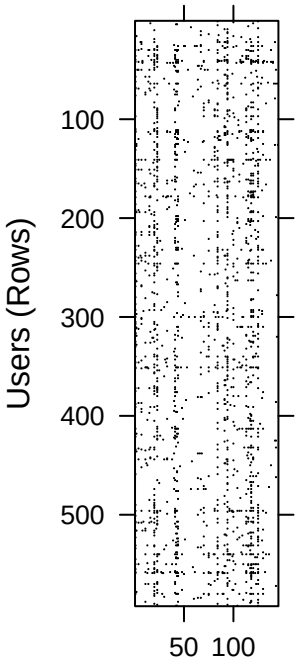
Dimensions: 100 x 145

```
image(r_m[1:100], main = "Normalized Ratings")
```




```
rb <- binarize(r, minRating=1)
#head(as(rb, "matrix"))
image(rb, main = "binarized  Ratings")
```

binarized Ratings



Dimensions: 592 x 145

Modeling and algorithms and similarity measure

```
#UBCF: User-based collaborative filtering
#
model1=Recommender(r[1:nrow(r)],method="UBCF", param=list(normalize = "Z-score",method="Cosine",nn=5, mi
```

```
## Warning: Unknown parameters: minRating
```

```
## Available parameter (with default values):
## method    =  cosine
## nn    =  25
## sample    =  FALSE
## normalize     =  center
## verbose   =  FALSE
```

```
model2=Recommender(r[1:nrow(r)],method="UBCF", param=list(normalize = "Z-score",method="Jaccard",nn=5, m
```

```
## Warning: Unknown parameters: minRating
```

```
## Available parameter (with default values):
## method    =  cosine
## nn    =  25
```

```
## sample    =  FALSE
## normalize     =  center
## verbose   =  FALSE
```

```
#IBCF: Item-based collaborative filtering
#
model3=Recommender(r[1:nrow(r)],method="IBCF", param=list(normalize = "Z-score",method="Jaccard",minRati
```

```
## Warning: Unknown parameters: minRating
```

```
## Available parameter (with default values):
## k     =  30
## method    =  Cosine
## normalize     =  center
## normalize_sim_matrix  =  FALSE
## alpha     =  0.5
## na_as_zero    =  FALSE
## verbose   =  FALSE
```

```
# POPULAR
#
model4=Recommender(r[1:nrow(r)],method="POPULAR")


print(model3)
```

```
## Recommender of type 'IBCF' for 'realRatingMatrix'
## learned using 592 users.
```

```
names(getModel(model3))
```

```
## [1] "description"          "sim"                  "k"
## [4] "method"               "normalize"            "normalize_sim_matrix"
## [7] "alpha"                "na_as_zero"           "verbose"
```

```
getModel(model3)$nn
```

```
## NULL
```

```
print(model1)
```

```
## Recommender of type 'UBCF' for 'realRatingMatrix'
## learned using 592 users.
```

```
names(getModel(model1))
```

```
## [1] "description" "data"        "method"      "nn"          "sample"
## [6] "normalize"   "verbose"
```

```
getModel(model1)$nn
```

```
## [1] 5
```

Predictions and Recommendations to particular customers using differents models

```
# Recommendation to  comcast using model 3
#
Rec.comcast3 <- predict(model3, r["COMCAST",], n=5)

#Top 4  using model4
Rec.comcast4 <- predict(model4, r["COMCAST",], n=10)

Best3comcast <- bestN(Rec.comcast4, n = 3)
Best3comcast
```

```
## Recommendations as 'topNList' with n = 3 for 1 users.
```

```
as(Best3comcast, "list")
```

```
## $COMCAST
## [1] "HST-3000C-CE"              "TB-6000A Transport Module"
## [3] "SmartClass HOME"
```

```
#Recommendation to JAS
#
Rec.JAS <- predict(model3, r["JAS",], n=10)
Best5JAS<-bestN(Rec.JAS,n=5)
as(Best5JAS, "list")
```

```
## $JAS
## [1] "DSAM-6300"                      "Legacy Wireline Services"
## [3] "Location Intelligence Services" "ONX-580"
## [5] "Other - Cable"
```

```
recom <- predict(model3, r[1:nrow(r)], type="ratings")
recom
```

```
## 592 x 145 rating matrix of class 'realRatingMatrix' with 26071 ratings.
```

Models examination

```
# Convert all your recommendations to list structure
rec_list<-as(recom,"list")
head(summary(rec_list))
```

```
##                          Length Class  Mode
## 3 RIVERS COMMUNICATIONS  96     -none- numeric
## A + COMMUNICATIONS        0     -none- numeric
## AASKI TECHNOLOGY          0     -none- numeric
## ABB                      86     -none- numeric
## ACACIA COMMUNICATION      0     -none- numeric
## ACCELINK TECHNOLOGIES     0     -none- numeric
```

```
# Access service and ratings(type and quantity purchased)with id 1 and first item on the list
rec_list[[1]][1]
```

```
##     ACE
## 3.58167
```

```
# Convert to data frame all recommendations for user 1
Udf<-as.data.frame(rec_list[[1]])
#Display other services to be recommended to the same  customer
head(attributes(Udf),10)
```

```
## $names
## [1] "rec_list[[1]]"
##
## $row.names
##  [1] "ACE"
##  [2] "Advanced Signal Conditioning Modules"
##  [3] "Analog Inspection & Test"
##  [4] "ANT-5"
##  [5] "Attenuators & Backreflector Modules"
##  [6] "Benchtop Inspection"
##  [7] "BrightJack"
##  [8] "CA product"
##  [9] "Calibration Plan"
## [10] "Calibrations"
## [11] "CapacityAdvisor Held"
## [12] "Certifier"
## [13] "CleanBlast"
## [14] "Common Product"
## [15] "Converged Assurance Support"
## [16] "CT-650"
## [17] "Digital Inspection & Test"
## [18] "Direct View FM"
## [19] "Dispersion modules"
## [20] "DSAM"
## [21] "DSAM 2300/3300"
## [22] "DSAM-6300"
## [23] "DTS"
## [24] "EA Support"
## [25] "Education"
## [26] "FIT Generic"
## [27] "FST-2310-DS3"
## [28] "FST-2310-OC3"
## [29] "FST-2802 G"
## [30] "GigaStor"
```

```
## [31] "HCU1500"
## [32] "HST-3000 SIMs"
## [33] "HST-3000C"
## [34] "HST-3000C-CE"
## [35] "JMEP"
## [36] "Location Intelligence Product"
## [37] "Location Intelligence Services"
## [38] "MAP Standalone Switches"
## [39] "MAP-200 Chassis, Accessories & Software"
## [40] "Matrix (NMS)"
## [41] "MTS-5100e"
## [42] "NC Ethernet TT"
## [43] "NG Assurance Services"
## [44] "nTAPs"
## [45] "ONX-580"
## [46] "Optical Switch Modules"
## [47] "OSA"
## [48] "OST"
## [49] "OTDR - FiberComplete modules"
## [50] "Other - Solutions Classic"
## [51] "PacketPortal SW & Solutions"
## [52] "Passive Chassis"
## [53] "Passive Plug-ins"
## [54] "PathTrak"
## [55] "PI Product"
## [56] "PT SART"
## [57] "RANAdvisor Product"
## [58] "RANAdvisor Services & Support"
## [59] "RCATS Product"
## [60] "Repair"
## [61] "Replacement Parts"
## [62] "RPM-3000"
## [63] "RPM2000"
## [64] "RSAM"
## [65] "SMART Handhelds"
## [66] "SmartClass ADSL"
## [67] "SmartClass E1"
## [68] "SMARTClass Fiber"
## [69] "SmartClass HOME"
## [70] "SmartClass Triple Play"
## [71] "SmartID"
## [72] "SmartPocket Handhelds"
## [73] "Source, EDFA & BBS Modules"
## [74] "StrataSync"
## [75] "Support Plans"
## [76] "T-BERD 8000"
## [77] "T-Berd/MTS-5800"
## [78] "T3AS"
## [79] "TB-6000A Transport Module"
## [80] "TB/MTS 4000 Platform"
## [81] "TB/MTS 8000 Platform"
## [82] "TB/MTS-6000 Platform"
## [83] "Test Point"
## [84] "Test Productivity Pack"
```

```
## [85] "TrueSpeed"
## [86] "Ultra FED"
## [87] "VSA"
## [88] "WiFi Smart Accessory"
## [89] "WR 10G Trans/Regen"
## [90] "WR 2.5G Trans/Regen"
## [91] "WR Amplification"
## [92] "WR Common"
## [93] "WS 10G Trans/Regen"
## [94] "WS 2.5G Trans/Regen"
## [95] "XGIG - FC 16G"
## [96] "XGIG - Other"
##
## $class
## [1] "data.frame"
```

```
Udf$id<-row.names(Udf)
head(Udf)
```

```
##                                     rec_list[[1]]
## ACE                                      3.581670
## Advanced Signal Conditioning Modules     2.985714
## Analog Inspection & Test                 3.249041
## ANT-5                                    3.299829
## Attenuators & Backreflector Modules      2.939597
## Benchtop Inspection                      3.108974
##                                                                        id
## ACE                                                                   ACE
## Advanced Signal Conditioning Modules Advanced Signal Conditioning Modules
## Analog Inspection & Test                         Analog Inspection & Test
## ANT-5                                                               ANT-5
## Attenuators & Backreflector Modules   Attenuators & Backreflector Modules
## Benchtop Inspection                                 Benchtop Inspection
```

```
evals <- evaluationScheme(r, method="cross-validation",
        k=4, given=1)
evals
```

```
## Evaluation scheme with 1 items given
## Method: 'cross-validation' with 4 run(s).
## Good ratings: NA
## Data set: 592 x 145 rating matrix of class 'realRatingMatrix' with 1763 ratings.
```

```
# creation of recommender model based on ubcf
Rec.ubcf <- Recommender(getData(evals, "train"), "UBCF")
# creation of recommender model based on ibcf for comparison
Rec.ibcf <- Recommender(getData(evals, "train"), "IBCF")
# making predictions on the test data set
p.ubcf <- predict(Rec.ubcf, getData(evals, "known"), type="ratings")
# making predictions on the test data set
p.ibcf <- predict(Rec.ibcf, getData(evals, "known"), type="ratings")
# obtaining the error metrics for both approaches and comparing them
error.ubcf<-calcPredictionAccuracy(p.ubcf, getData(evals, "unknown"))
```

```
error.ibcf<-calcPredictionAccuracy(p.ibcf, getData(evals, "unknown"))
error <- rbind(error.ubcf,error.ibcf)
rownames(error) <- c("UBCF","IBCF")
error
```

```
##          RMSE      MSE      MAE
## UBCF 27.14194  736.685 12.43733
## IBCF 35.70079 1274.547 16.88710
```

```
scheme <- evaluationScheme(r[1:500], method="cross", k=4, given=1,goodRating=5)
results <- evaluate(scheme, method="POPULAR", n=c(1,3,5,10,15,20))
```

```
## POPULAR run fold/sample [model time/prediction time]
##   1  [0.004sec/0.277sec]
##   2  [0.007sec/0.276sec]
##   3  [0.003sec/0.259sec]
##   4  [0.003sec/0.383sec]
```

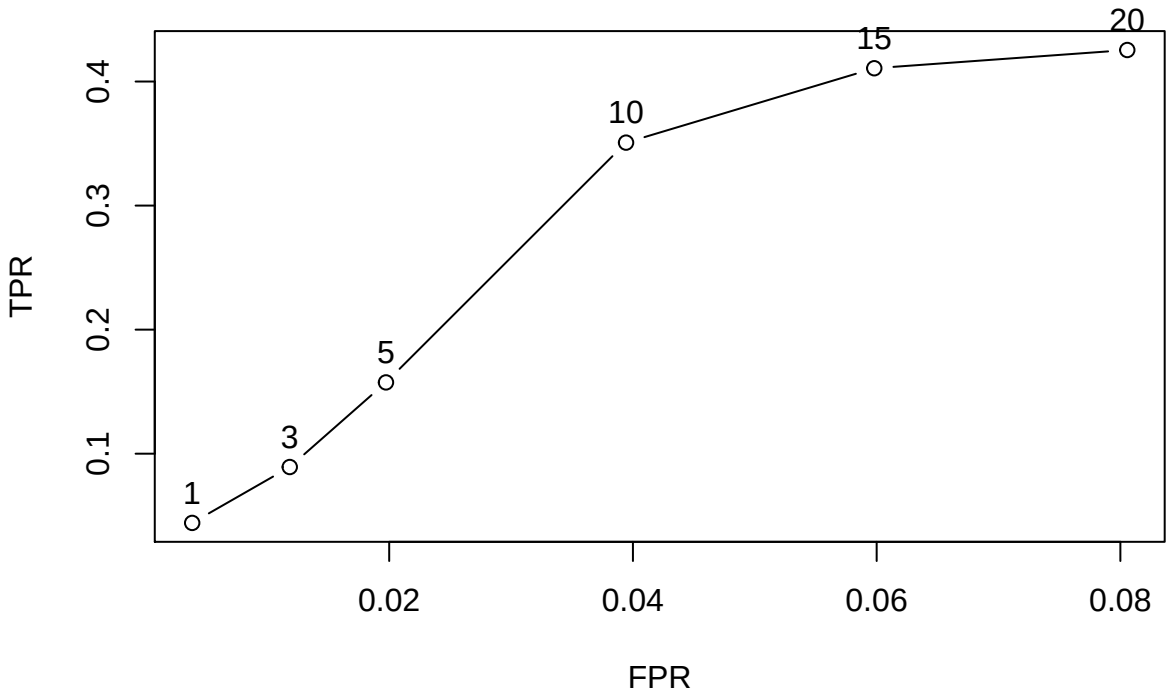
```
getConfusionMatrix(results)[[1]]
```

```
##       TP     FP    FN      TN  precision     recall        TPR         FPR
## 1  0.064  0.496 0.952 142.488 0.11428571 0.06162691 0.06162691 0.003468691
## 3  0.088  1.592 0.928 141.392 0.05238095 0.06947131 0.06947131 0.011160436
## 5  0.136  2.664 0.880 140.320 0.04857143 0.13637438 0.13637438 0.018687785
## 10 0.328  5.272 0.688 137.712 0.05857143 0.37073931 0.37073931 0.036979919
## 15 0.432  7.968 0.584 135.016 0.05142857 0.41804750 0.41804750 0.055886228
## 20 0.464 10.736 0.552 132.248 0.04142857 0.42546207 0.42546207 0.075317530
```

```
avg(results)
```

```
##       TP     FP    FN      TN  precision     recall        TPR         FPR
## 1  0.048  0.548 0.856 142.548 0.08152609 0.04419772 0.04419772 0.003831435
## 3  0.096  1.692 0.808 141.404 0.05351522 0.08924934 0.08924934 0.011839229
## 5  0.160  2.820 0.744 140.276 0.05365008 0.15745478 0.15745478 0.019734623
## 10 0.326  5.634 0.578 137.462 0.05468693 0.35073822 0.35073822 0.039434444
## 15 0.398  8.542 0.506 134.554 0.04466576 0.41069723 0.41069723 0.059804029
## 20 0.416 11.504 0.488 131.592 0.03506645 0.42539181 0.42539181 0.080566512
```

```
plot(results, annotate=TRUE)
```




```
head(as(recom, "matrix")[5,3])   # Rating for user 5 for item at index 3
```

```
## [1] NA
```

```
head(as.integer(as(recom, "matrix")[5,3]))# Just get the integer value
```

```
## [1] NA
```

```
head(as.integer(round(as(recom, "matrix")[9,8]))) # Just get the correct integer value
```

```
## [1] 3
```

```
head(as.integer(round(as(recom, "matrix")[8,7])))
```

```
## [1] NA
```

```
# Convert recommendations to list structure
rec_list<-as(recom,"list")
head(summary(rec_list))
```

```
##                         Length Class  Mode
## 3 RIVERS COMMUNICATIONS  96    -none- numeric
## A + COMMUNICATIONS        0    -none- numeric
## AASKI TECHNOLOGY          0    -none- numeric
## ABB                      86    -none- numeric
## ACACIA COMMUNICATION      0    -none- numeric
## ACCELINK TECHNOLOGIES     0    -none- numeric
```