

HW4

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When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
A_1 = matrix(c(1,0,0,1,1,0,0,0,0,0), nrow=1, ncol=10)
A_2 = matrix(c(1,1,0,0,0,0,0,0,0,0), nrow=1, ncol=10)
A_3 = matrix(c(1,1,1,0,0,0,0,0,0,0), nrow=1, ncol=10)
A_4 = matrix(c(0,1,0,1,0,0,0,0,0,0), nrow=1, ncol=10)
A_5 = matrix(c(0,1,0,1,1,0,0,0,0,0), nrow=1, ncol=10)
A_6 = matrix(c(0,0,1,0,1,0,0,0,0,0), nrow=1, ncol=10)
A_7 = matrix(c(0,0,1,0,0,0,0,0,0,1), nrow=1, ncol=10)
A_8 = matrix(c(0,0,0,0,0,1,1,1,1,0), nrow=1, ncol=10)
A_9 = matrix(c(0,0,0,0,0,0,1,1,0,0), nrow=1, ncol=10)
A_10 = matrix(c(0,0,0,0,0,0,0,1,1,1), nrow=1, ncol=10)
A_11 = matrix(c(0,0,0,0,0,1,0,0,0,0), nrow=1, ncol=10)
A <- rbind(A_1,A_2,A_3,A_4,A_5,A_6,A_7,A_8,A_9,A_10,A_11)
A[1,]
```

```
## [1] 1 0 0 1 1 0 0 0 0 0
```

```
B <- t(t(A)/sqrt(colSums(A)))
```

```
B
```

```

##          [,1] [,2]          [,3]          [,4]          [,5]          [,6]          [,7]
## [1,] 0.5773503 0.0 0.0000000 0.5773503 0.5773503 0.0000000 0.0000000
## [2,] 0.5773503 0.5 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [3,] 0.5773503 0.5 0.5773503 0.0000000 0.0000000 0.0000000 0.0000000
## [4,] 0.0000000 0.5 0.0000000 0.5773503 0.0000000 0.0000000 0.0000000
## [5,] 0.0000000 0.5 0.0000000 0.5773503 0.5773503 0.0000000 0.0000000
## [6,] 0.0000000 0.0 0.5773503 0.0000000 0.5773503 0.0000000 0.0000000
## [7,] 0.0000000 0.0 0.5773503 0.0000000 0.0000000 0.0000000 0.0000000
## [8,] 0.0000000 0.0 0.0000000 0.0000000 0.0000000 0.7071068 0.7071068
## [9,] 0.0000000 0.0 0.0000000 0.0000000 0.0000000 0.0000000 0.7071068
## [10,] 0.0000000 0.0 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [11,] 0.0000000 0.0 0.0000000 0.0000000 0.0000000 0.7071068 0.0000000
##          [,8]          [,9]          [,10]
## [1,] 0.0000000 0.0000000 0.0000000
## [2,] 0.0000000 0.0000000 0.0000000
## [3,] 0.0000000 0.0000000 0.0000000
## [4,] 0.0000000 0.0000000 0.0000000
## [5,] 0.0000000 0.0000000 0.0000000
## [6,] 0.0000000 0.0000000 0.0000000
## [7,] 0.0000000 0.0000000 0.7071068
## [8,] 0.5773503 0.7071068 0.0000000
## [9,] 0.5773503 0.0000000 0.0000000
## [10,] 0.5773503 0.7071068 0.7071068
## [11,] 0.0000000 0.0000000 0.0000000

```

t(B)

```
##           [,1]      [,2]      [,3]      [,4]      [,5]      [,6]
## [1,] 0.5773503 0.5773503 0.5773503 0.0000000 0.0000000 0.0000000
## [2,] 0.0000000 0.5000000 0.5000000 0.5000000 0.5000000 0.0000000
## [3,] 0.0000000 0.0000000 0.5773503 0.0000000 0.0000000 0.5773503
## [4,] 0.5773503 0.0000000 0.0000000 0.5773503 0.5773503 0.0000000
## [5,] 0.5773503 0.0000000 0.0000000 0.0000000 0.5773503 0.5773503
## [6,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [7,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [8,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [9,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [10,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
##           [,7]      [,8]      [,9]     [,10]     [,11]
## [1,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [2,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [3,] 0.5773503 0.0000000 0.0000000 0.0000000 0.0000000
## [4,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [5,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [6,] 0.0000000 0.7071068 0.0000000 0.0000000 0.7071068
## [7,] 0.0000000 0.7071068 0.7071068 0.0000000 0.0000000
## [8,] 0.0000000 0.5773503 0.5773503 0.5773503 0.0000000
## [9,] 0.0000000 0.7071068 0.0000000 0.7071068 0.0000000
## [10,] 0.7071068 0.0000000 0.0000000 0.7071068 0.0000000
```

```
C <- B %*% t(B)
C
```

```
##          [,1]      [,2]      [,3]      [,4]      [,5]      [,6]
## [1,] 1.0000000 0.3333333 0.3333333 0.3333333 0.6666667 0.3333333
## [2,] 0.3333333 0.5833333 0.5833333 0.2500000 0.2500000 0.0000000
## [3,] 0.3333333 0.5833333 0.9166667 0.2500000 0.2500000 0.3333333
## [4,] 0.3333333 0.2500000 0.2500000 0.5833333 0.5833333 0.0000000
## [5,] 0.6666667 0.2500000 0.2500000 0.5833333 0.9166667 0.3333333
## [6,] 0.3333333 0.0000000 0.3333333 0.0000000 0.3333333 0.6666667
## [7,] 0.0000000 0.0000000 0.3333333 0.0000000 0.0000000 0.3333333
## [8,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [9,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [10,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
## [11,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
##          [,7]      [,8]      [,9]      [,10] [,11]
## [1,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0
## [2,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0
## [3,] 0.3333333 0.0000000 0.0000000 0.0000000 0.0
## [4,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0
## [5,] 0.0000000 0.0000000 0.0000000 0.0000000 0.0
## [6,] 0.3333333 0.0000000 0.0000000 0.0000000 0.0
## [7,] 0.8333333 0.0000000 0.0000000 0.5000000 0.0
## [8,] 0.0000000 1.8333333 0.8333333 0.8333333 0.5
## [9,] 0.0000000 0.8333333 0.8333333 0.3333333 0.0
## [10,] 0.5000000 0.8333333 0.3333333 1.3333333 0.0
## [11,] 0.0000000 0.5000000 0.0000000 0.0000000 0.5
```

```
s <- svd(B)
s$d # singular values
```

```
## [1] 1.7114244 1.5953511 1.1791731 0.9625898 0.8840054 0.7827506 0.6786837
## [8] 0.4850693 0.3002795 0.1691663
```

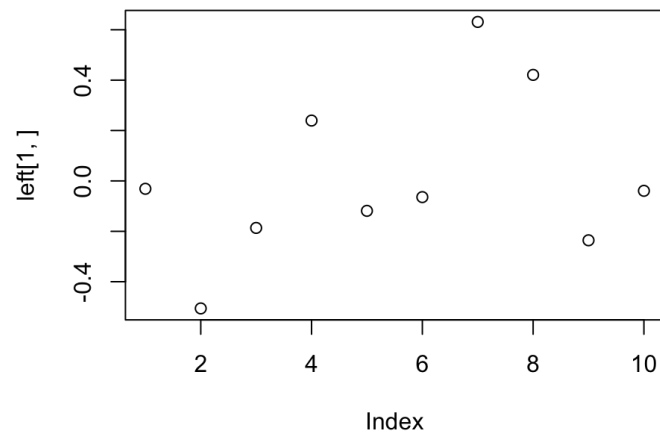
```
s$u # left singular vectors
```

```
##          [,1]      [,2]      [,3]      [,4]      [,5]
## [1,] -0.03126160 -0.50607482 -0.1865440  0.23956573 -0.11876447
## [2,] -0.02096855 -0.31850677 -0.0363983 -0.41775071  0.39067518
## [3,] -0.04546305 -0.42834871  0.2308382 -0.61320668  0.07504165
## [4,] -0.01898202 -0.32876150 -0.1806796  0.14661458  0.31695044
## [5,] -0.02999410 -0.49639331 -0.2267280  0.39121533 -0.02407364
## [6,] -0.03550658 -0.27747374  0.2211880  0.04914478 -0.65665760
## [7,] -0.13426160 -0.13286861  0.6627099  0.02074564 -0.15835423
## [8,] -0.74302383  0.08476297 -0.2954798 -0.16200157 -0.15964541
## [9,] -0.37638582  0.04431242 -0.1804759 -0.08970471 -0.03250186
## [10,] -0.50874829  0.01565615  0.4370616  0.37991015  0.40417093
## [11,] -0.15295017  0.02072297 -0.1659162 -0.18988454 -0.28359671
##          [,6]      [,7]      [,8]      [,9]     [,10]
## [1,] -0.06425296  0.63108721  0.42088732 -0.235640352 -0.03928848
## [2,]  0.01727030  0.19466024 -0.04948477  0.466657717  0.33352230
## [3,] -0.04923141 -0.03714435 -0.16571704 -0.251440778 -0.29158621
## [4,]  0.14486628 -0.53469742  0.10575873 -0.401696085 -0.23984327
## [5,]  0.05770621 -0.31563828 -0.21137778  0.382020365  0.23255495
## [6,] -0.15366178 -0.01274544 -0.43336878  0.065617955 -0.15271029
## [7,]  0.08065669 -0.27042579  0.51704018 -0.008425265  0.39062988
## [8,]  0.14556367  0.00302477 -0.15916396 -0.315449417  0.39452743
## [9,] -0.70037291 -0.21679168  0.34386818  0.292540895 -0.27083006
## [10,]  0.09967078  0.23484705 -0.21903203  0.136404615 -0.33249464
## [11,]  0.64581005 -0.03839662  0.30064087  0.384851921 -0.41847884
```

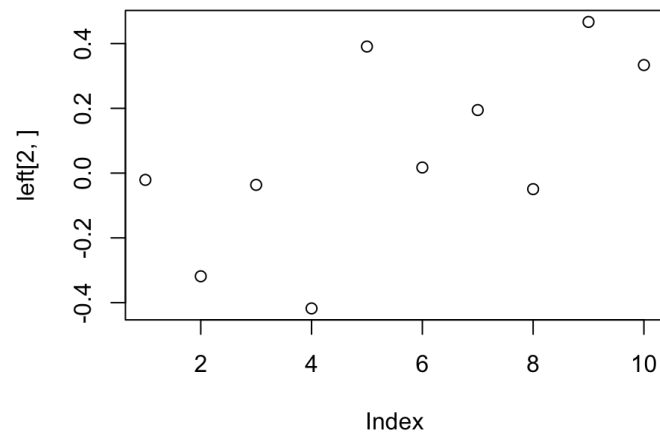
```
s$v # right singular vectors
```

```
##           [,1]      [,2]      [,3]      [,4]      [,5]
## [1,] -0.03295687 -0.45342974  0.003866009 -0.47466760  0.2265971
## [2,] -0.03371686 -0.49268473 -0.090303878 -0.25614622  0.4290662
## [3,] -0.07260841 -0.30351845  0.545800453 -0.32587483 -0.4832798
## [4,] -0.02706825 -0.48176590 -0.290812378  0.46627295  0.1137140
## [5,] -0.03264283 -0.46320510 -0.094048731  0.40781169 -0.5221564
## [6,] -0.37018829  0.04675449 -0.276682232 -0.25849126 -0.3545448
## [7,] -0.46250488  0.05721003 -0.285413173 -0.18490037 -0.1536966
## [8,] -0.54926026  0.05237768 -0.019043458  0.07689521  0.1384742
## [9,] -0.51719289  0.04450873  0.084901395  0.16007300  0.1955934
## [10,] -0.26567148 -0.05195203  0.659492600  0.29431688  0.1966262
##           [,6]      [,7]      [,8]      [,9]      [,10]
## [1,] -0.07096668  0.67085778  0.24481571 -0.03926829  0.009036097
## [2,]  0.10898195 -0.51041439 -0.33069592  0.32559864  0.102407470
## [3,] -0.09016062 -0.27248967 -0.09765424 -0.37348261 -0.183159667
## [4,]  0.10202332 -0.18651278  0.37524581 -0.49089859 -0.158962650
## [5,] -0.11816847  0.25750722 -0.26644688  0.40761047  0.138414849
## [6,]  0.71489656 -0.03685321  0.20623710  0.16343098 -0.100115726
## [7,] -0.50119332 -0.22271942  0.26925145 -0.05394564  0.517048946
## [8,] -0.33570630  0.01793269 -0.04085844  0.21821999 -0.712607497
## [9,]  0.22153536  0.24783384 -0.55131291 -0.42161978  0.259294022
## [10,]  0.16290090 -0.03706877  0.43441956  0.30136941  0.243002460
```

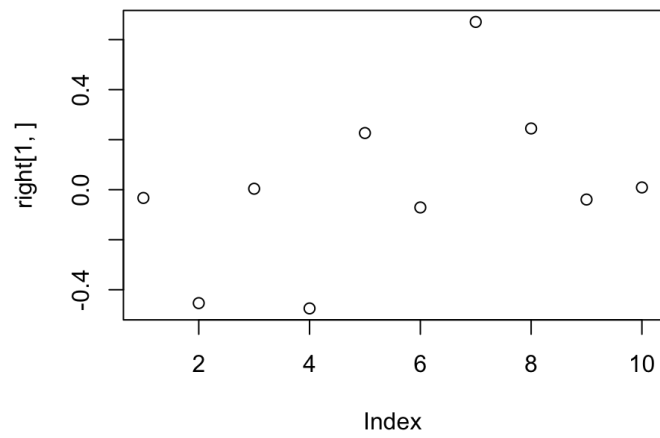
```
left <- s$u[c(1,2),]
plot(left[1,])
```



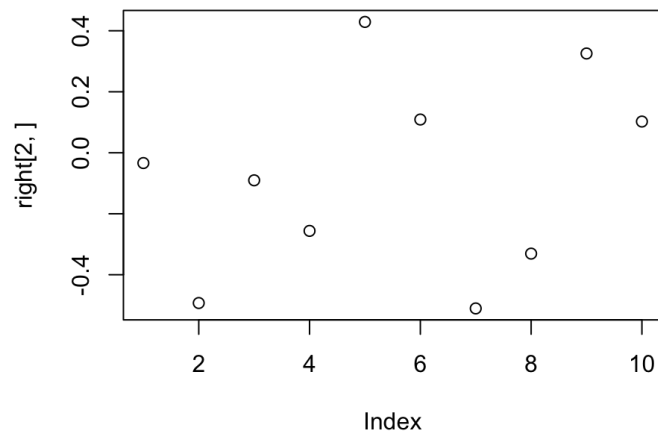
```
plot(left[2,])
```



```
right <- s$v[c(1,2),]  
plot(right[1,])
```

```
plot(right[2,])
```

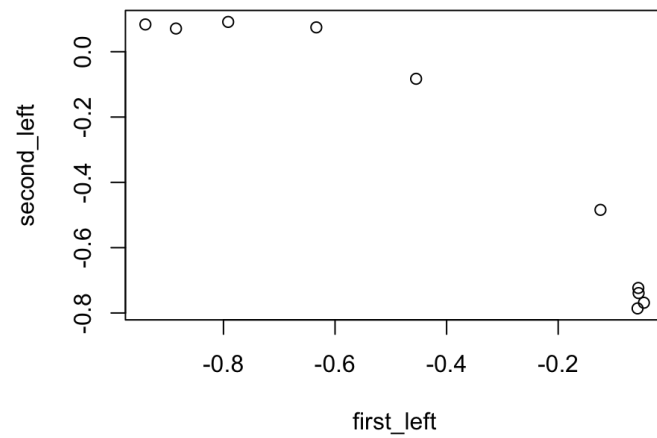


```
first <- s$u[,1]
second <- s$u[,2]

first_left <- first %*% A[,1]/norm(t(A[,1]),type="F")
for (i in 2:10){
  first_left <- append(first_left, first %*% A[,i]/norm(t(A[,i]),type="F"))
}

second_left <- second %*% A[,1]/norm(t(A[,1]),type="F")
for (i in 2:10){
  second_left <- append(second_left, second %*% A[,i]/norm(t(A[,i]),type="F"))
}

plot(first_left, second_left)
```



```

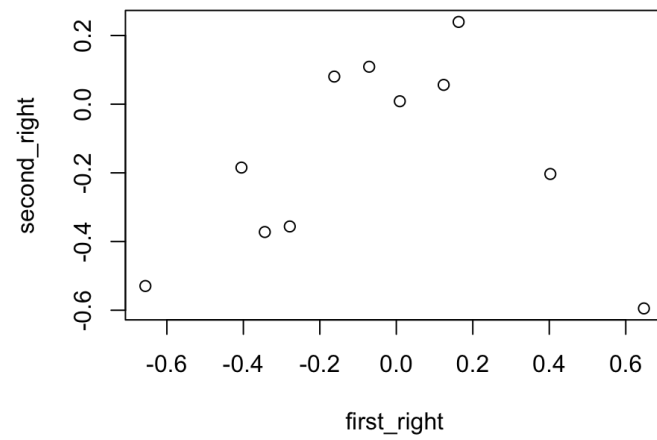
first <- s$v[1,]
second <- s$v[2,]

first_right <- first %*% A[1,]/norm(t(A[1,]),type="F")
for (i in 2:11){
  first_right <- append(first_right, first %*% A[i,]/norm(t(A[i,]),type="F"))
}

second_right <- second %*% A[1,]/norm(t(A[1,]),type="F")
for (i in 2:11){
  second_right <- append(second_right, second %*% A[i,]/norm(t(A[i,]),type="F"))
}

plot(first_right, second_right)

```



You can also embed plots, for example:

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.