

Task 5

Task 5

Introduction

In a study on Morse code signals Rothkopf (1957) asked 598 subjects to indicate for each pair of signals (acoustically presented after each other) whether the two signals were equal. Note that each signal consists of a sequence of short beeps (0.05 sec) and long beeps (0.15 sec) separated by a silence (0.05 sec). The data set `confusion.Rdata` contains a 36 x 36 matrix of confusion rates for all pairs of signals included in the study. The signals in the subsequent rows of the confusing matrix are the letters of the alphabet A, B, C... in alphabetical order and the numbers 1,2,3,4,5,6,7,8,9,0. The value in cell (i,j) of the matrix represents the percentage of subjects who indicated that signal i was equal to signal j, when signal j was presented after signal i.

Methodology

We compute a symmetric matrix of similarities by taking the average of corresponding elements in the confusion matrix above and below the diagonal, next we convert the matrix of similarities into a matrix of dissimilarities, and finally we put all diagonal elements of the dissimilarity matrix equal to 0: #
Results

Question 1

1. Use `smacofSym()` to conduct MDS with 2 dimensions and assuming different measurement levels (i.e., *ratio*, *interval*, *mspline*, *ordinal*) for the observed dissimilarities.

1.1 ratio

```
m1 <- smacofSym(delta=dissim, ndim=2, type="ratio", init="torgerson")
```

1.2 interval

```
m2 <- smacofSym(delta=dissim, ndim=2, type="interval", init="torgerson")
```

1.3 mspline

```
m3<-smacofSym(delta=dissim, ndim=2, type="mspline", spline.degree =4, spline.intKnots = 4, init="torgerson")
```

1.4 ordinal

```
m4 <- smacofSym(delta=dissim, ndim=2, type="ordinal", init="torgerson")
```

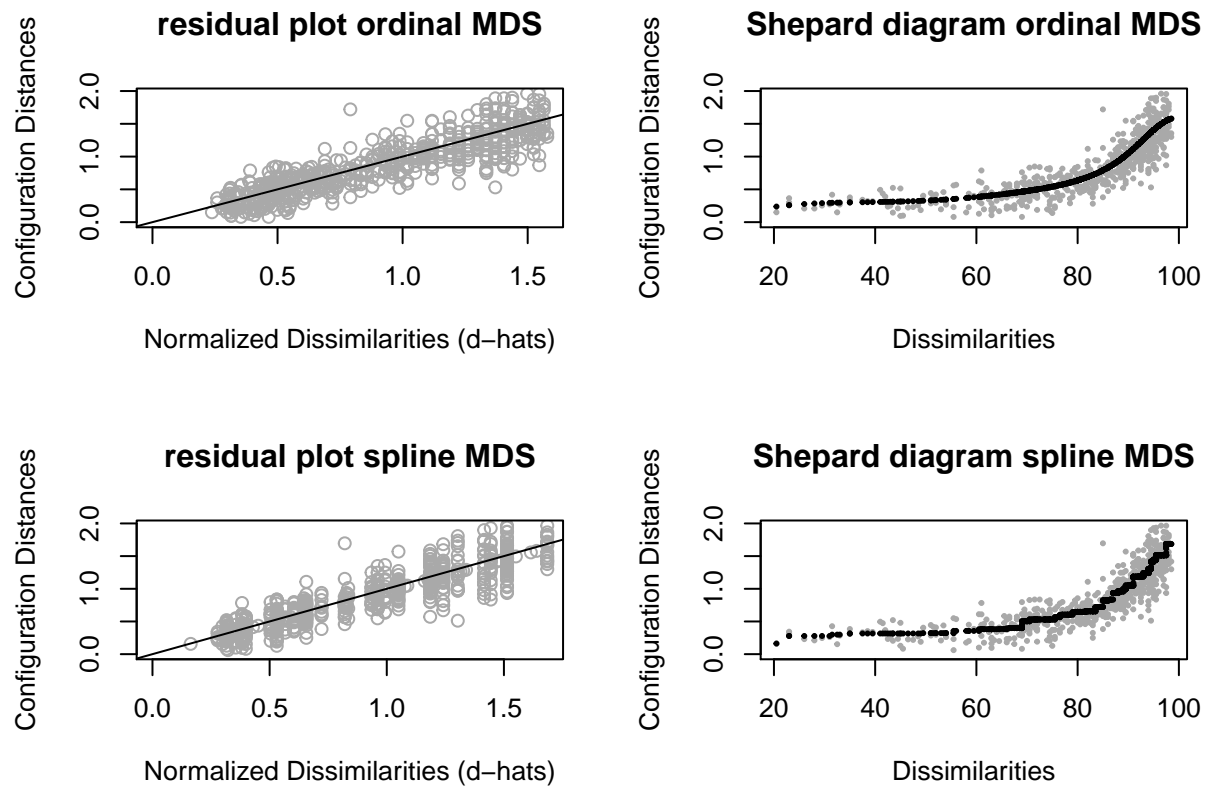
```
round(c(m1$stress,m2$stress,m3$stress,m4$stress),3)
```

```
## [1] 0.300 0.262 0.205 0.191
```

```
par(mfrow=c(2,2))
```

```
plot(m3,plot.type="resplot",main="residual plot ordinal MDS")
plot(m3,plot.type="Shepard",main="Shepard diagram ordinal MDS")
```

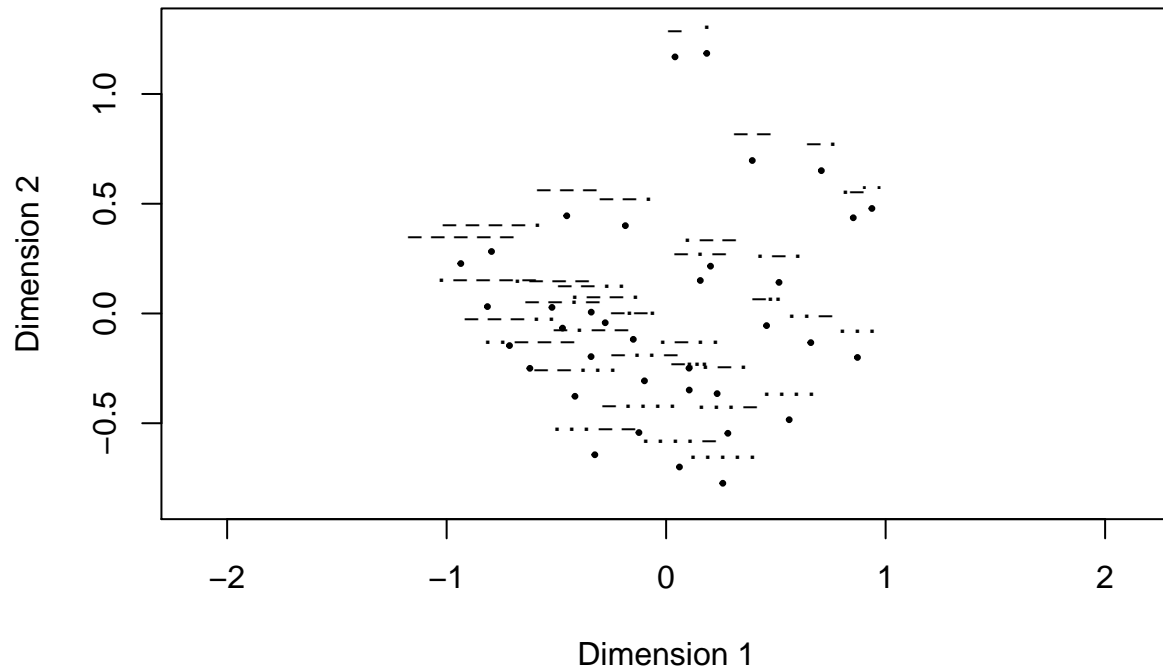
```
plot(m4,plot.type="resplot",main="residual plot spline MDS")
plot(m4,plot.type="Shepard",main="Shepard diagram spline MDS")
```



```
#configuration ordinal MDS
```

```
plot(m3,plot.type="conf")
```

Configuration Plot



Question 2

- Evaluate the goodness of fit of solutions with different measurement levels using *stress-1*, and by computing stress norms with the functions *randomstress()* and *permutation()*. Discuss which solution you would select. Investigate the stability of the selected solution using the Jackknife.

```
#stress norm
set.seed(1)
rstress<-randomstress(n=10,ndim=2,nrep=500,type="ordinal")
#distribution of stress for random data
mean(rstress)-2*sd(rstress)
```

```
## [1] 0.1450965
```

```
#permutation test
set.seed(1)
perm.car<-permtest(m3,nrep=500)
```

```
## Permutation:    1 Stress:    0.3557197397
## Permutation:    2 Stress:    0.3630844603
## Permutation:    3 Stress:    0.3604222792
## Permutation:    4 Stress:    0.3533634019
## Permutation:    5 Stress:    0.3528723915
## Permutation:    6 Stress:    0.3592026324
```

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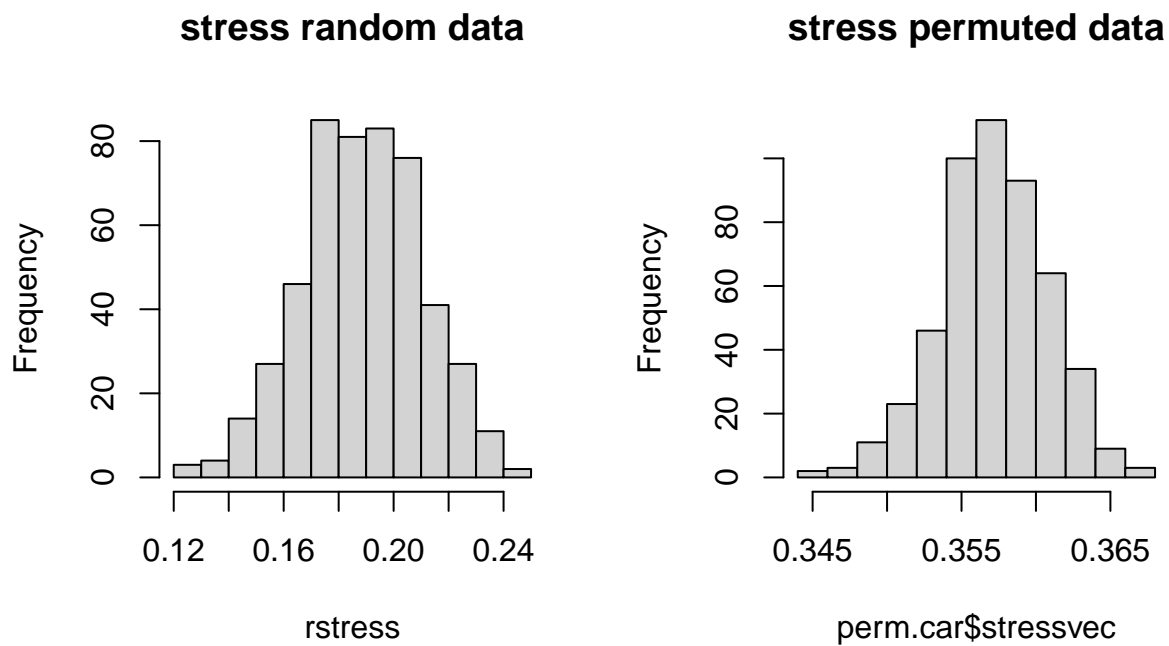
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##	Permutation:	374	Stress:	0.3601057308
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##	Permutation:	378	Stress:	0.3547719705
##	Permutation:	379	Stress:	0.3571875808
##	Permutation:	380	Stress:	0.3523563862
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##	Permutation:	382	Stress:	0.3638790783
##	Permutation:	383	Stress:	0.3588820019
##	Permutation:	384	Stress:	0.3522647769

Permutation: 385 Stress: 0.3577634711
Permutation: 386 Stress: 0.3538309366
Permutation: 387 Stress: 0.3523446565
Permutation: 388 Stress: 0.3546633068
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Permutation: 394 Stress: 0.3575684637
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Permutation: 397 Stress: 0.3589910105
Permutation: 398 Stress: 0.3626350275
Permutation: 399 Stress: 0.3606361737
Permutation: 400 Stress: 0.3514373247
Permutation: 401 Stress: 0.3577300483
Permutation: 402 Stress: 0.3615241478
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Permutation: 413 Stress: 0.3554749667
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Permutation: 418 Stress: 0.3595948377
Permutation: 419 Stress: 0.3517179947
Permutation: 420 Stress: 0.3576931118
Permutation: 421 Stress: 0.3575793985
Permutation: 422 Stress: 0.3637464877
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Permutation: 424 Stress: 0.3598978067
Permutation: 425 Stress: 0.3562904192
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Permutation: 428 Stress: 0.3619607918
Permutation: 429 Stress: 0.3592481813
Permutation: 430 Stress: 0.3488028245
Permutation: 431 Stress: 0.3548368804
Permutation: 432 Stress: 0.3605910492
Permutation: 433 Stress: 0.3564185186
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Permutation: 436 Stress: 0.3558442187
Permutation: 437 Stress: 0.3609095216
Permutation: 438 Stress: 0.3536910202

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##	Permutation:	441	Stress:	0.3573814363
##	Permutation:	442	Stress:	0.3574626410
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##	Permutation:	466	Stress:	0.3603304805
##	Permutation:	467	Stress:	0.3508421319
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##	Permutation:	473	Stress:	0.3534335169
##	Permutation:	474	Stress:	0.3580013483
##	Permutation:	475	Stress:	0.3591311037
##	Permutation:	476	Stress:	0.3557447658
##	Permutation:	477	Stress:	0.3613734806
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##	Permutation:	479	Stress:	0.3566080436
##	Permutation:	480	Stress:	0.3548245916
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##	Permutation:	484	Stress:	0.3558584666
##	Permutation:	485	Stress:	0.3588304360
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##	Permutation:	487	Stress:	0.3593990924
##	Permutation:	488	Stress:	0.3559409175
##	Permutation:	489	Stress:	0.3553360065
##	Permutation:	490	Stress:	0.3594760556
##	Permutation:	491	Stress:	0.3606394626
##	Permutation:	492	Stress:	0.3523977238

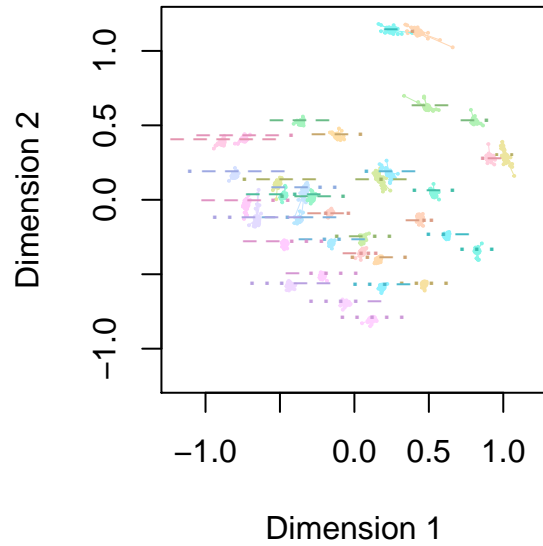
```
## Permutation: 493 Stress: 0.3613989138
## Permutation: 494 Stress: 0.3508025273
## Permutation: 495 Stress: 0.3557111968
## Permutation: 496 Stress: 0.3614722568
## Permutation: 497 Stress: 0.3605388112
## Permutation: 498 Stress: 0.3602631187
## Permutation: 499 Stress: 0.3471474025
## Permutation: 500 Stress: 0.3574293136
```

```
#plot distribution stress
par(mfrow=c(1,2),pty="s")
hist(rstress,main="stress random data")
hist(perm.car$stressvec,main="stress permuted data")
```



```
#stability of solution using jackknife
jack.car<-jackmids(m3)
plot(jack.car,xlim=c(-1.2,1.2),ylim=c(-1,1))
```

SMACOF Jackknife Plot



Question 3

3. Construct a data set of external variables that describe the signals (e.g. length of the signal, proportion of short beeps in the signal, etc.). Use an *MDSbiplot* to project the external variables in the configuration plot of the selected solution, and interpret the results of the analysis.