SNAG: Correlations

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Variables

Because correlations require observations with the same vector length, this was done for participants who have all tasks completed.

Dependent variables:

Names of variables and brief description

- SBSOD (Santa Barbara Sense of Direction scale)
- SOT (estimated angle [SOT_Angle] and angular error [SOT_Error]; if anything, just SOT_Angle is the measure we care about)
- MRM (Money Road Map)
- DSP_Wayfinding (proportion correct)
- DSP_SI (solution index strict coding)
- MAZE_Wayfinding (proportion correct)
- MAZE_Moves (number of moves during exploration)
- LOOP_MeanPositionErr (averge meters across 3 radii)
- LOOP_PositionPSTD (average PSTD for position error across 3 radii)
- LOOP_MeanDegrees (average degrees across 3 radii)
- LOOP_DegreesPSTD (average PSTD for degrees traveled across 3 radii)

Data

```
#Load data
corr_dat <- read.csv("Correlations_ALL.csv")

#Remove SubjectID column
corr_dat <- corr_dat[,c(2:13)]

#Show first 10 rows/subjects
head(corr_dat, 10)
```

```
##       SBSOD SOT_Angle SOT_Error       MRM DSP_Wayfinding     DSP_SI
## 1  3.333333  176.4167 33.583333 100.00000           0.65 0.15384615
## 2  4.200000  170.0833 30.250000 100.00000           0.60 0.25000000
## 3  5.400000  198.4167 74.750000  80.00000           0.75 0.00000000
## 4  4.066667  182.7500 24.750000 100.00000           0.65 0.23076923
```

```
## 5  6.000000  180.4167 31.083333  75.00000           0.60 0.08333333
## 6  6.400000  209.5000 35.500000  94.11765           1.00 0.20000000
## 7  6.533333  194.7500 10.250000 100.00000           0.75 0.20000000
## 8  4.333333  194.3333  9.166667 100.00000           0.65 0.15384615
## 9  5.600000  182.5833 17.750000 100.00000           0.75 0.40000000
## 10 4.400000  179.6667 24.666667  92.85714           0.45 0.33333333
##    MAZE_Wayfinding MAZE_Moves LOOP_MeanPositionErr LOOP_PositionPSTD
## 1         0.000000        269             1.370606         0.8371334
## 2         8.333333        266             1.171936         0.7405337
## 3        20.833333        288             1.438188         0.9525353
## 4        12.500000        299             1.989072         0.9758353
## 5         4.166667        266             1.555377         1.0987158
## 6        62.500000        273             2.062230         1.1552127
## 7        12.500000        315             1.230118         0.7726145
## 8         8.333333        269             2.328188         0.8999634
## 9        29.166667        274             1.243972         0.6625947
## 10        4.166667        288             2.879014         0.8607178
##    LOOP_MeanDegrees LOOP_DegreePSTD
## 1          396.5134        35.59109
## 2          332.6236        33.17871
## 3          350.5439        37.01638
## 4          416.8381        68.13490
## 5          347.5976        69.32251
## 6          420.3662        58.15037
## 7          344.9175        44.90391
## 8          332.4740        83.55519
## 9          341.1140        41.96415
## 10         258.1615        70.45680
```

Correlation matrix with p-values

```r
#Save correlation matrix into variable
res <- rcorr(as.matrix(corr_dat), type = "pearson")
res
```

```
##                      SBSOD SOT_Angle SOT_Error   MRM DSP_Wayfinding DSP_SI
## SBSOD                 1.00      0.26     -0.17  0.34           0.03   0.06
## SOT_Angle             0.26      1.00     -0.49  0.09           0.10  -0.11
## SOT_Error            -0.17     -0.49      1.00 -0.40          -0.15   0.09
## MRM                   0.34      0.09     -0.40  1.00          -0.10   0.05
## DSP_Wayfinding        0.03      0.10     -0.15 -0.10           1.00  -0.24
## DSP_SI                0.06     -0.11      0.09  0.05          -0.24   1.00
## MAZE_Wayfinding       0.04      0.05      0.03  0.01           0.49   0.22
## MAZE_Moves           -0.17     -0.07      0.00 -0.02           0.07  -0.08
## LOOP_MeanPositionErr -0.26     -0.29      0.21 -0.41          -0.03   0.04
## LOOP_PositionPSTD     0.00     -0.02      0.31 -0.30          -0.02  -0.08
## LOOP_MeanDegrees      0.01     -0.20      0.22  0.02          -0.03  -0.05
## LOOP_DegreePSTD      -0.02      0.04      0.06 -0.20          -0.02  -0.17
##                      MAZE_Wayfinding MAZE_Moves LOOP_MeanPositionErr
## SBSOD                           0.04      -0.17                -0.26
## SOT_Angle                       0.05      -0.07                -0.29
## SOT_Error                       0.03       0.00                 0.21
## MRM                             0.01      -0.02                -0.41
```

```
## DSP_Wayfinding                  0.49       0.07                -0.03
## DSP_SI                          0.22      -0.08                 0.04
## MAZE_Wayfinding                 1.00       0.34                 0.05
## MAZE_Moves                      0.34       1.00                -0.01
## LOOP_MeanPositionErr            0.05      -0.01                 1.00
## LOOP_PositionPSTD               0.03       0.15                 0.36
## LOOP_MeanDegrees               -0.10      -0.07                 0.11
## LOOP_DegreePSTD                -0.11       0.08                 0.39
##                       LOOP_PositionPSTD LOOP_MeanDegrees LOOP_DegreePSTD
## SBSOD                              0.00             0.01           -0.02
## SOT_Angle                         -0.02            -0.20            0.04
## SOT_Error                          0.31             0.22            0.06
## MRM                               -0.30             0.02           -0.20
## DSP_Wayfinding                    -0.02            -0.03           -0.02
## DSP_SI                            -0.08            -0.05           -0.17
## MAZE_Wayfinding                    0.03            -0.10           -0.11
## MAZE_Moves                         0.15            -0.07            0.08
## LOOP_MeanPositionErr               0.36             0.11            0.39
## LOOP_PositionPSTD                  1.00             0.09            0.65
## LOOP_MeanDegrees                   0.09             1.00            0.29
## LOOP_DegreePSTD                    0.65             0.29            1.00
##
## n= 41
##
##
## P
##                       SBSOD  SOT_Angle SOT_Error MRM    DSP_Wayfinding
## SBSOD                        0.0956    0.2918    0.0281 0.8379
## SOT_Angle             0.0956           0.0010    0.5923 0.5142
## SOT_Error             0.2918 0.0010             0.0092 0.3537
## MRM                   0.0281 0.5923    0.0092           0.5405
## DSP_Wayfinding        0.8379 0.5142    0.3537    0.5405
## DSP_SI                0.7162 0.4943    0.5733    0.7371 0.1342
## MAZE_Wayfinding       0.8063 0.7727    0.8722    0.9409 0.0010
## MAZE_Moves            0.3006 0.6786    0.9812    0.9087 0.6836
## LOOP_MeanPositionErr 0.0960 0.0670    0.1794    0.0085 0.8410
## LOOP_PositionPSTD     0.9822 0.8834    0.0514    0.0574 0.8863
## LOOP_MeanDegrees      0.9490 0.2160    0.1632    0.8950 0.8350
## LOOP_DegreePSTD       0.9119 0.8078    0.7185    0.2078 0.8886
##                       DSP_SI MAZE_Wayfinding MAZE_Moves
## SBSOD                 0.7162 0.8063          0.3006
## SOT_Angle             0.4943 0.7727          0.6786
## SOT_Error             0.5733 0.8722          0.9812
## MRM                   0.7371 0.9409          0.9087
## DSP_Wayfinding        0.1342 0.0010          0.6836
## DSP_SI                       0.1713          0.6389
## MAZE_Wayfinding       0.1713                 0.0290
## MAZE_Moves            0.6389 0.0290
## LOOP_MeanPositionErr 0.7831 0.7498          0.9660
## LOOP_PositionPSTD     0.6142 0.8523          0.3622
## LOOP_MeanDegrees      0.7433 0.5459          0.6415
## LOOP_DegreePSTD       0.2894 0.4889          0.6368
##                       LOOP_MeanPositionErr LOOP_PositionPSTD
## SBSOD                 0.0960               0.9822
```

```
## SOT_Angle            0.0670               0.8834
## SOT_Error            0.1794               0.0514
## MRM                  0.0085               0.0574
## DSP_Wayfinding       0.8410               0.8863
## DSP_SI               0.7831               0.6142
## MAZE_Wayfinding      0.7498               0.8523
## MAZE_Moves           0.9660               0.3622
## LOOP_MeanPositionErr                      0.0194
## LOOP_PositionPSTD    0.0194
## LOOP_MeanDegrees     0.5112               0.5839
## LOOP_DegreePSTD      0.0109               0.0000
##                      LOOP_MeanDegrees LOOP_DegreePSTD
## SBSOD                0.9490           0.9119
## SOT_Angle            0.2160           0.8078
## SOT_Error            0.1632           0.7185
## MRM                  0.8950           0.2078
## DSP_Wayfinding       0.8350           0.8886
## DSP_SI               0.7433           0.2894
## MAZE_Wayfinding      0.5459           0.4889
## MAZE_Moves           0.6415           0.6368
## LOOP_MeanPositionErr 0.5112           0.0109
## LOOP_PositionPSTD    0.5839           0.0000
## LOOP_MeanDegrees                      0.0627
## LOOP_DegreePSTD      0.0627
```

Table

Formatting a correlation matrix into a table with 4 columns containing :

- Column 1 : row names (variable 1 for the correlation test)
- Column 2 : column names (variable 2 for the correlation test)
- Column 3 : the correlation coefficients
- Column 4 : the p-values of the correlations

```r
#Create function to combine coefficients and p-values

#coeff_mat: matrix of the correlation coefficients
#p_mat : matrix of the correlation p-values

CorMat <- function(coeff_mat, p_mat) {

  #Save upper half triangle of coefficients
  #This is because the other half is redundant
  up_half <- upper.tri(coeff_mat)

  #Save into dataframe
  data.frame(

    #Variable 1
    Var1 = rownames(coeff_mat)[row(coeff_mat)[up_half]],
    #Variable 2
    Var2 = rownames(coeff_mat)[col(coeff_mat)[up_half]],
    #Correlation coefficient
```

```
    Corr  =(coeff_mat)[up_half],
    #p-value
    p_value = p_mat[up_half]
    )
}
```

```
#Pearson correlation
res2 <- rcorr(as.matrix(corr_dat), type="pearson")

#Use function to place into table

#res2$r = correlation coefficient
#res2$P = associated p-value
CorMat(res2$r, res2$P)
```

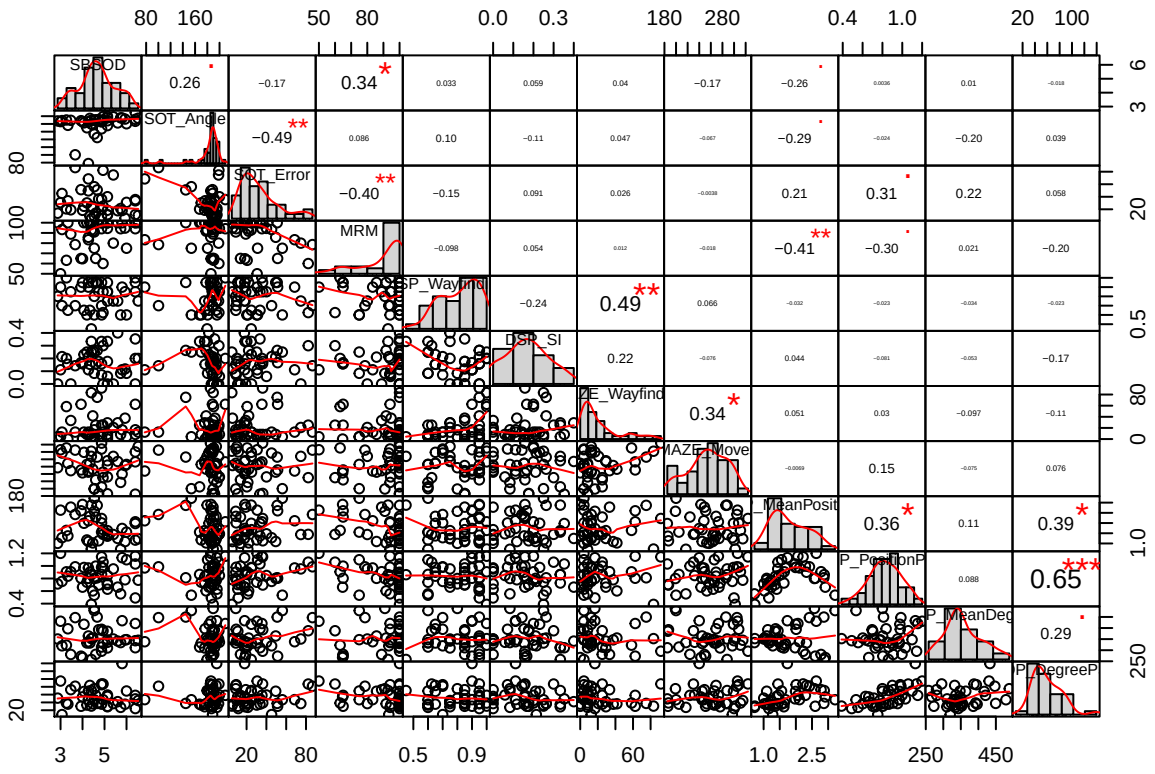
```
##                   Var1                Var2         Corr      p_value
## 1                SBSOD           SOT_Angle  0.263770767 9.563712e-02
## 2                SBSOD           SOT_Error -0.168658749 2.918280e-01
## 3            SOT_Angle           SOT_Error -0.494369157 1.018526e-03
## 4                SBSOD                 MRM  0.343019202 2.812320e-02
## 5            SOT_Angle                 MRM  0.086136315 5.923167e-01
## 6            SOT_Error                 MRM -0.401691924 9.235629e-03
## 7                SBSOD      DSP_Wayfinding  0.032965705 8.378759e-01
## 8            SOT_Angle      DSP_Wayfinding  0.104837981 5.141870e-01
## 9            SOT_Error      DSP_Wayfinding -0.148636267 3.536827e-01
## 10                 MRM      DSP_Wayfinding -0.098401485 5.404848e-01
## 11               SBSOD              DSP_SI  0.058529368 7.162368e-01
## 12           SOT_Angle              DSP_SI -0.109824807 4.942615e-01
## 13           SOT_Error              DSP_SI  0.090578142 5.732941e-01
## 14                 MRM              DSP_SI  0.054059111 7.371061e-01
## 15      DSP_Wayfinding              DSP_SI -0.237874042 1.342309e-01
## 16               SBSOD     MAZE_Wayfinding  0.039505760 8.062760e-01
## 17           SOT_Angle     MAZE_Wayfinding  0.046530094 7.726727e-01
## 18           SOT_Error     MAZE_Wayfinding  0.025922672 8.721881e-01
## 19                 MRM     MAZE_Wayfinding  0.011938209 9.409464e-01
## 20      DSP_Wayfinding     MAZE_Wayfinding  0.494226307 1.022495e-03
## 21              DSP_SI     MAZE_Wayfinding  0.217821637 1.712813e-01
## 22               SBSOD          MAZE_Moves -0.165656040 3.006286e-01
## 23           SOT_Angle          MAZE_Moves -0.066697417 6.786351e-01
## 24           SOT_Error          MAZE_Moves -0.003798538 9.811953e-01
## 25                 MRM          MAZE_Moves -0.018489419 9.086524e-01
## 26      DSP_Wayfinding          MAZE_Moves  0.065619856 6.835542e-01
## 27              DSP_SI          MAZE_Moves -0.075507548 6.389245e-01
## 28     MAZE_Wayfinding          MAZE_Moves  0.341227693 2.900984e-02
## 29               SBSOD LOOP_MeanPositionErr -0.263513495 9.597306e-02
## 30           SOT_Angle LOOP_MeanPositionErr -0.288827174 6.703277e-02
## 31           SOT_Error LOOP_MeanPositionErr  0.213857946 1.794002e-01
## 32                 MRM LOOP_MeanPositionErr -0.405941657 8.454177e-03
## 33      DSP_Wayfinding LOOP_MeanPositionErr -0.032312093 8.410487e-01
## 34              DSP_SI LOOP_MeanPositionErr  0.044341955 7.830997e-01
## 35     MAZE_Wayfinding LOOP_MeanPositionErr  0.051367419 7.497637e-01
## 36          MAZE_Moves LOOP_MeanPositionErr -0.006878604 9.659543e-01
## 37               SBSOD    LOOP_PositionPSTD  0.003588921 9.822328e-01
## 38           SOT_Angle    LOOP_PositionPSTD -0.023630030 8.834105e-01
```

```
## 39            SOT_Error    LOOP_PositionPSTD  0.306297958 5.144967e-02
## 40                  MRM    LOOP_PositionPSTD -0.299217710 5.737083e-02
## 41       DSP_Wayfinding    LOOP_PositionPSTD -0.023047564 8.862654e-01
## 42               DSP_SI    LOOP_PositionPSTD -0.081105266 6.141921e-01
## 43      MAZE_Wayfinding    LOOP_PositionPSTD  0.029999024 8.522966e-01
## 44           MAZE_Moves    LOOP_PositionPSTD  0.146064389 3.621661e-01
## 45 LOOP_MeanPositionErr    LOOP_PositionPSTD  0.363815291 1.937290e-02
## 46                SBSOD     LOOP_MeanDegrees  0.010309374 9.489922e-01
## 47            SOT_Angle     LOOP_MeanDegrees -0.197436384 2.159621e-01
## 48            SOT_Error     LOOP_MeanDegrees  0.221908150 1.631911e-01
## 49                  MRM     LOOP_MeanDegrees  0.021257347 8.950485e-01
## 50       DSP_Wayfinding     LOOP_MeanDegrees -0.033551509 8.350344e-01
## 51               DSP_SI     LOOP_MeanDegrees -0.052743899 7.432825e-01
## 52      MAZE_Wayfinding     LOOP_MeanDegrees -0.097104093 5.458628e-01
## 53           MAZE_Moves     LOOP_MeanDegrees -0.074924274 6.415245e-01
## 54 LOOP_MeanPositionErr     LOOP_MeanDegrees  0.105585664 5.111741e-01
## 55    LOOP_PositionPSTD     LOOP_MeanDegrees  0.088090442 5.839137e-01
## 56                SBSOD      LOOP_DegreePSTD -0.017820876 9.119422e-01
## 57            SOT_Angle      LOOP_DegreePSTD  0.039178855 8.078487e-01
## 58            SOT_Error      LOOP_DegreePSTD  0.058038704 7.185179e-01
## 59                  MRM      LOOP_DegreePSTD -0.200935995 2.077690e-01
## 60       DSP_Wayfinding      LOOP_DegreePSTD -0.022564442 8.886344e-01
## 61               DSP_SI      LOOP_DegreePSTD -0.169491196 2.894180e-01
## 62      MAZE_Wayfinding      LOOP_DegreePSTD -0.111177900 4.889244e-01
## 63           MAZE_Moves      LOOP_DegreePSTD  0.075989905 6.367775e-01
## 64 LOOP_MeanPositionErr      LOOP_DegreePSTD  0.393534924 1.091006e-02
## 65    LOOP_PositionPSTD      LOOP_DegreePSTD  0.649551570 4.328181e-06
## 66     LOOP_MeanDegrees      LOOP_DegreePSTD  0.293282301 6.274341e-02
```

Visualize correlation matrix

Scatter and chart

```
#Scatter plot, histogram, and correlation value
chart.Correlation(corr_dat, histogram=TRUE, pch=19)
```

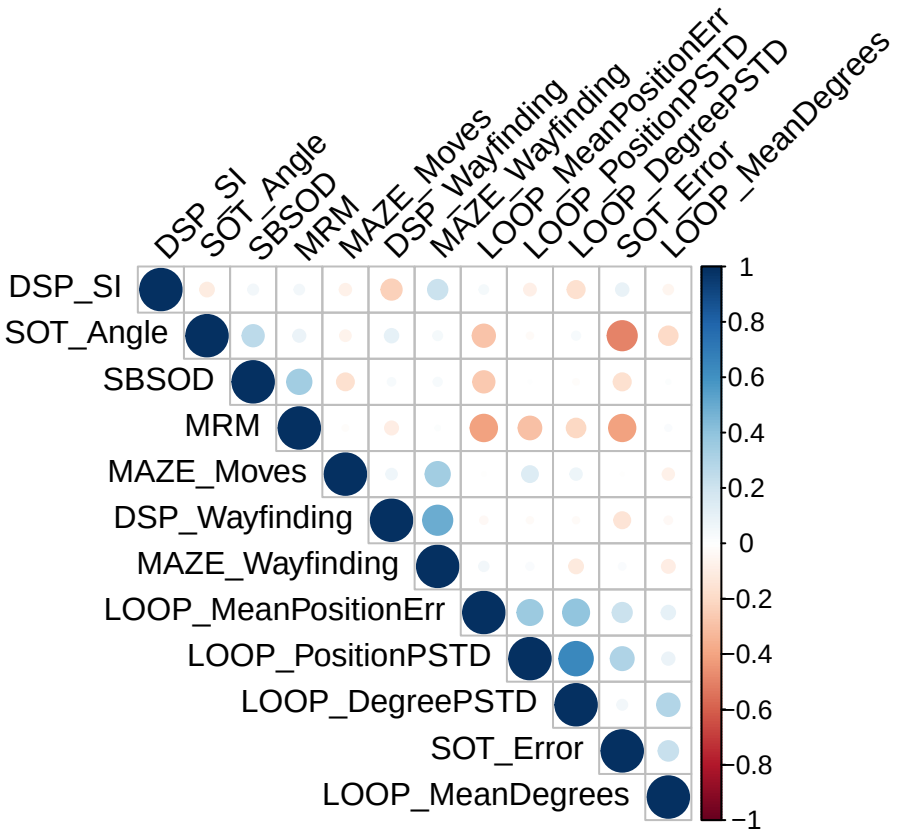


In the above plot:

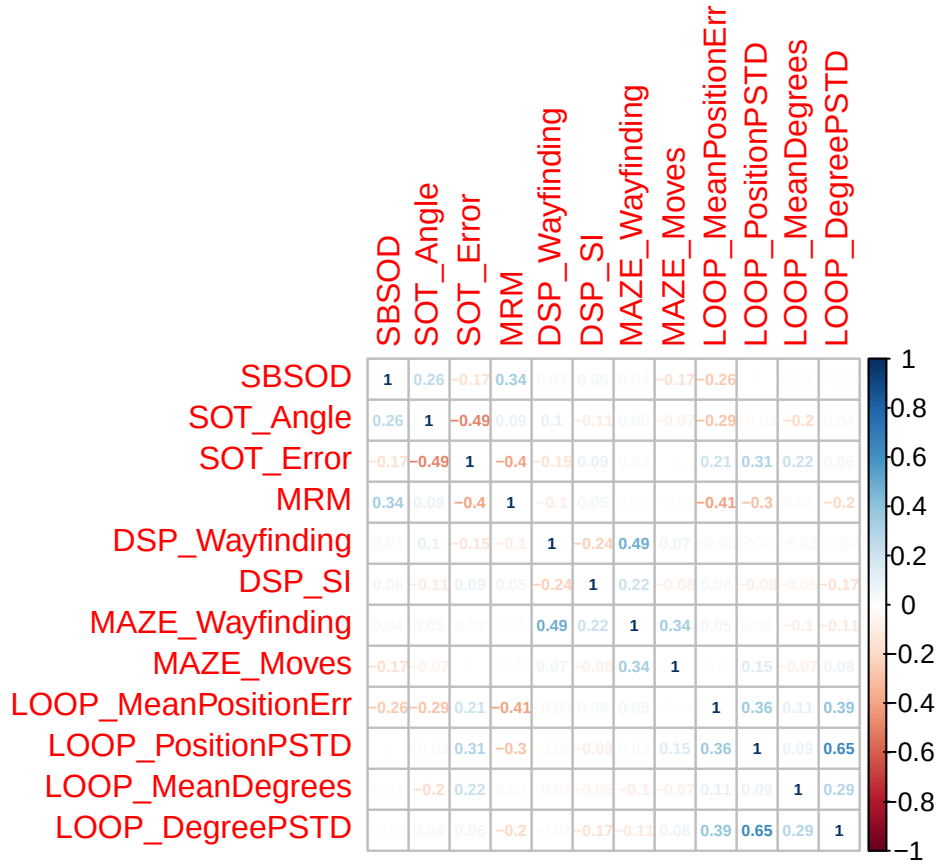
- The distribution of each variable is shown on the diagonal.
- On the bottom of the diagonal : the bivariate scatter plots with a fitted line are displayed
- On the top of the diagonal : the value of the correlation plus the significance level as stars
- Each significance level is associated to a symbol : p-values(0, 0.001, 0.01, 0.05, 0.1, 1) <=> symbols(***, **, *, ., ‘ ‘)

Correlation

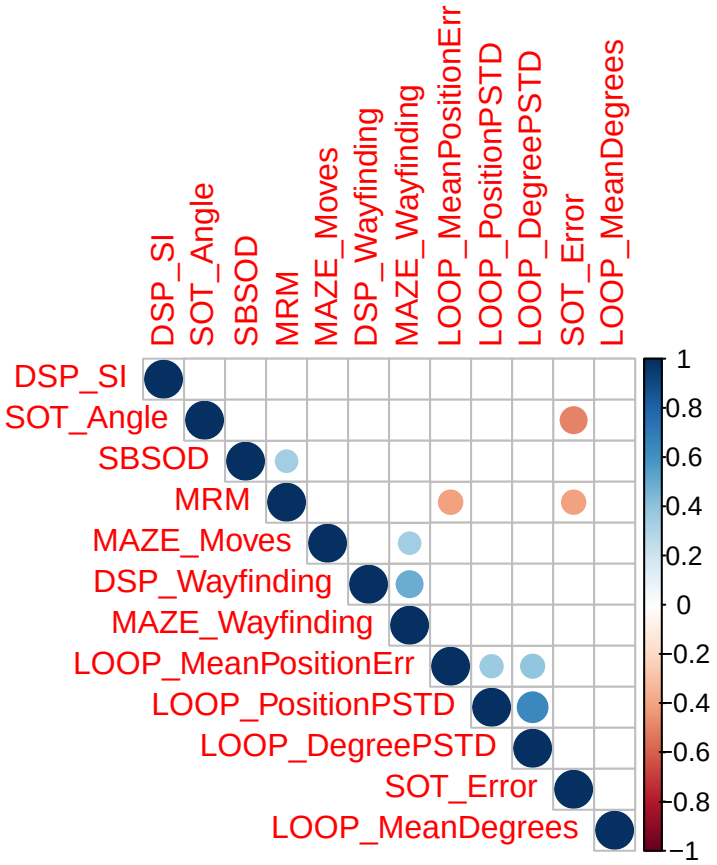
```
#Display only "upper" triangular portion to cut redundancy

corrplot(res2$r, type = "upper", order = "hclust",
         tl.col = "black", tl.srt = 45)
```



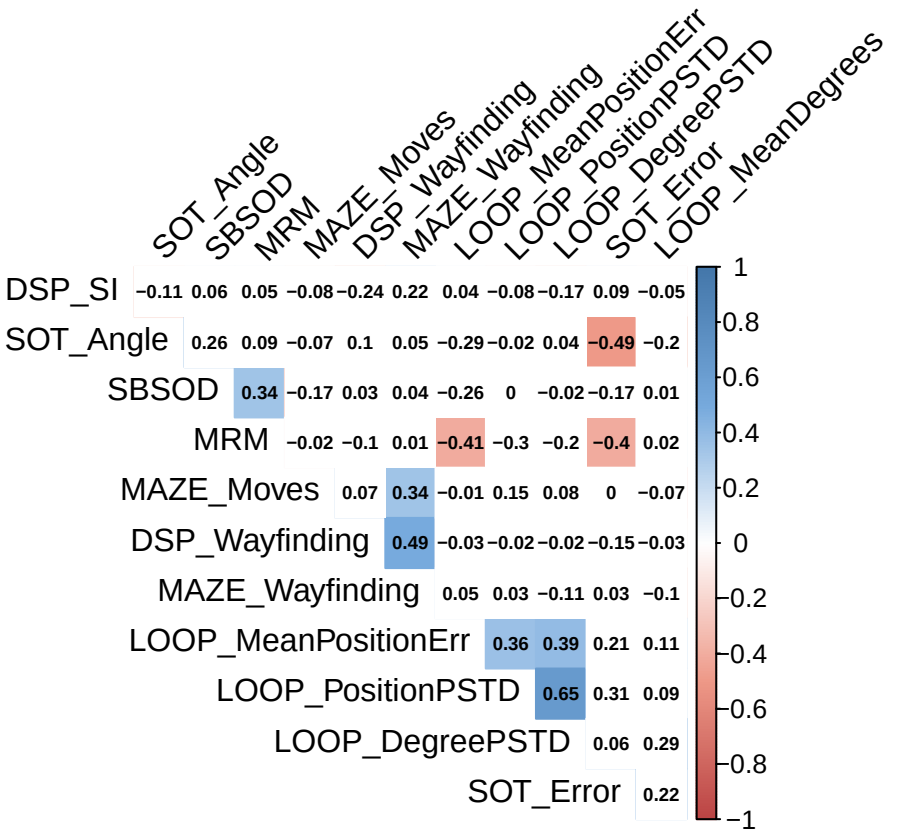

```
#Show correlation coefficient numbers

corrplot(res2$r, method="number", number.cex=0.5)
```




```
#Significance at p = 0.05

#Insignificant correlations are left blank
corrplot(res2$r, type="upper", order="hclust",
         p.mat = res2$P, sig.level = 0.05, insig = "blank")
```




```
#Numbers are correlation coefficients
#Colored squares are those that meet significance (alpha = 0.05)

#Color palette taken from Reference [1] and [2]
col <- colorRampPalette(c("#BB4444", "#EE9988", "#FFFFFF", "#77AADD", "#4477AA"))

corrplot(res2$r, method="color", col=col(200),
         type="upper", order="hclust",
         #Add coefficient of correlation
         addCoef.col = "black",
         #Text label color and rotation
         tl.col="black", tl.srt=45,
         # Combine with significance
         p.mat = res2$P, sig.level = 0.05, insig = "blank", number.cex=0.6,
         #Hide correlation coefficient on the principal diagonal
         diag=FALSE
         )
```



Positive correlations are displayed in blue and negative correlations in red color. Color intensity and the size of the circle are proportional to the correlation coefficients. On the right side of the correlogram, the legend color shows the correlation coefficients and the corresponding colors.

References

1. Correlation matrix : A quick start guide to analyze, format and visualize a correlation matrix using R softwards. http://www.sthda.com/english/wiki/correlation-matrix-a-quick-start-guide-to-analyze-format-and-visualize-a-correlation-matrix-using-r-software

2. Visualize correlation matrix using correlogram. http://www.sthda.com/english/wiki/visualize-correlation-matrix-using-correlogram