

# multivariate\_assignment

*Julius Alipala*

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For this assignment will be analyzing data on the Vegetation and Environment in Dutch Dune Meadows.

To import the data and read the metadata run the following:

```
library(vegan)
```

```
## Warning: package 'vegan' was built under R version 3.5.2
```

```
## Loading required package: permute
```

```
## Warning: package 'permute' was built under R version 3.5.2
```

```
## Loading required package: lattice
```

```
## This is vegan 2.5-4
```

```
data(dune)
```

```
data(dune.env)
```

1. Conduct an indirect ordination on the dune plant community. Specifically, visually examine a NMDS plot using the bray-curtis distance metric. Below is some code to help you develop a potential plot that emphasizes the role of the environmental variable “Moisture”. Describe how you interpret the graphic. What is the goal of creating such a plot? Does this analysis suggest any interesting findings with respect to the dune vegetation?

```
dune_mds = metaMDS(dune)
```

```
## Run 0 stress 0.1192678
```

```
## Run 1 stress 0.1183186
```

```
## ... New best solution
```

```
## ... Procrustes: rmse 0.02027653  max resid 0.06498439
```

```
## Run 2 stress 0.1183186
```

```
## ... New best solution
```

```
## ... Procrustes: rmse 4.396904e-05  max resid 0.0001462374
```

```
## ... Similar to previous best
```

```
## Run 3 stress 0.1808919
```

```
## Run 4 stress 0.1886532
```

```
## Run 5 stress 0.1183186
```

```
## ... Procrustes: rmse 0.0001028911  max resid 0.0002996981
```

```
## ... Similar to previous best
```

```
## Run 6 stress 0.1183186
```

```
## ... New best solution
```

```
## ... Procrustes: rmse 8.289255e-06  max resid 1.998522e-05
```

```
## ... Similar to previous best
```

```
## Run 7 stress 0.1192679
```

```
## Run 8 stress 0.1183186
```

```
## ... Procrustes: rmse 4.64706e-05  max resid 0.0001541444
```

```
## ... Similar to previous best
```

```
## Run 9 stress 0.1192679
```

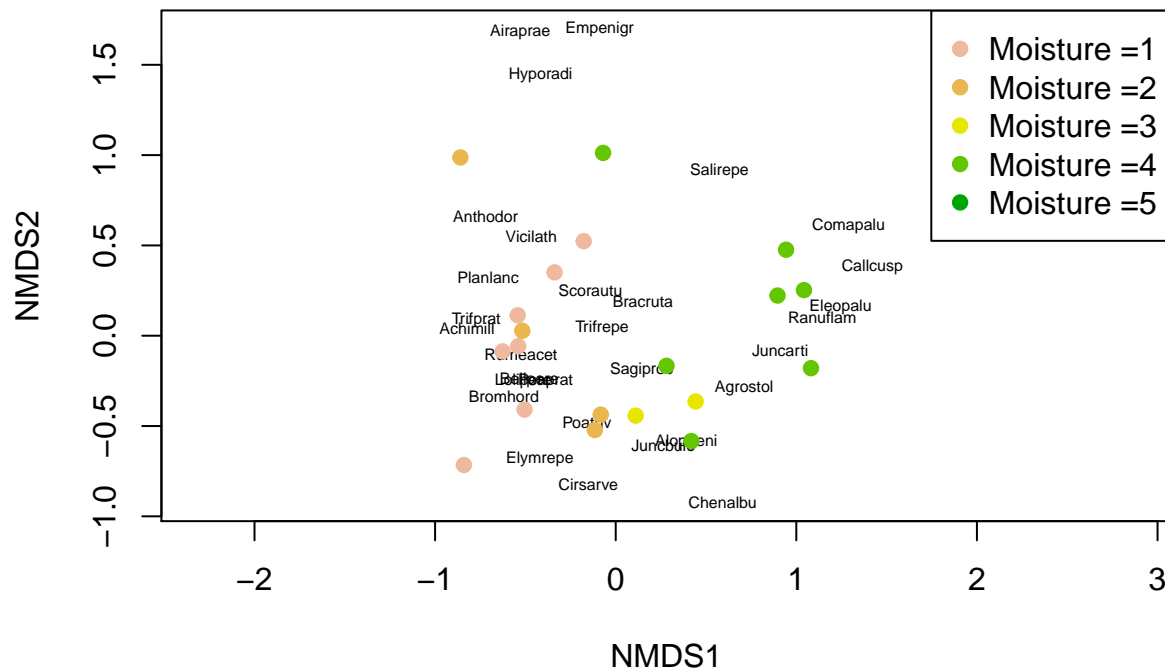
```
## Run 10 stress 0.1183186
```

```
## ... New best solution
```

```
## ... Procrustes: rmse 1.636532e-05  max resid 5.472759e-05
```

```
## ... Similar to previous best
## Run 11 stress 0.1192678
## Run 12 stress 0.1192679
## Run 13 stress 0.1183186
## ... New best solution
## ... Procrustes: rmse 7.784371e-06  max resid 2.294923e-05
## ... Similar to previous best
## Run 14 stress 0.1192678
## Run 15 stress 0.1183186
## ... New best solution
## ... Procrustes: rmse 6.034426e-06  max resid 2.025625e-05
## ... Similar to previous best
## Run 16 stress 0.1183186
## ... Procrustes: rmse 9.994654e-06  max resid 2.493044e-05
## ... Similar to previous best
## Run 17 stress 0.1922241
## Run 18 stress 0.1808911
## Run 19 stress 0.1192683
## Run 20 stress 0.1183186
## ... Procrustes: rmse 2.672927e-06  max resid 5.852324e-06
## ... Similar to previous best
## *** Solution reached
```

```
plot(dune_mds, type='n')
text(dune_mds, 'sp', cex=.5)
# generate vector of colors
color_vect = rev(terrain.colors(6))[-1]
points(dune_mds, 'sites', pch=19,
       col=color_vect[dune.env$Moisture])
legend('topright', paste("Moisture =", 1:5, sep=' '),
       col=color_vect, pch=19)
```



This plot shows that each site's position along the horizontal axis is dependent on its moisture level. This indicates that moisture is a key factor in determining what species are found at a site. A species commonly found in a site with a certain moisture level has a good chance of appearing in another site with that same moisture level.

2. Carry out a direct ordination using CCA in order to test any potential hypotheses that you developed after examining the MDS plot. Specifically, carry out a test of the entire model (i.e., including all constrained axes) and also carry out tests at the scale of individual explanatory variables you included in your model if you included more than one variable. Plot your results.

```
dune_cca = cca(dune ~ ., data=dune.env)
```

```
RsquareAdj(dune_cca, 100)
```

```
## $r.squared
## [1] 0.7106267
##
## $adj.r.squared
## [1] 0.2151041
```

```
anova(dune_cca, permutations=999)
```

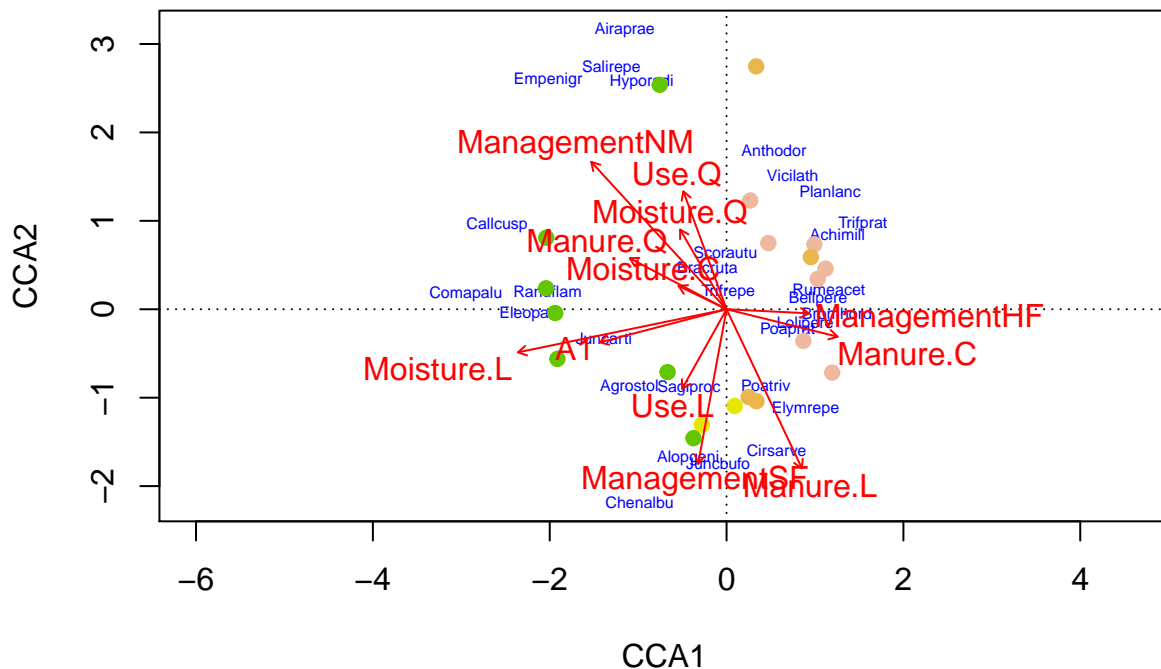
```
## Permutation test for cca under reduced model
## Permutation: free
## Number of permutations: 999
##
## Model: cca(formula = dune ~ A1 + Moisture + Management + Use + Manure, data = dune.env)
##           Df ChiSquare      F Pr(>F)
```

```
## Model      12      1.5032 1.4325   0.04 *
## Residual   7      0.6121
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

anova(dune_cca, by='margin', permutations=999)

## Permutation test for cca under reduced model
## Marginal effects of terms
## Permutation: free
## Number of permutations: 999
##
## Model: cca(formula = dune ~ A1 + Moisture + Management + Use + Manure, data = dune.env)
##              Df ChiSquare      F Pr(>F)
## A1              1   0.11070 1.2660 0.225
## Moisture         3   0.31587 1.2041 0.221
## Management       2   0.15882 0.9081 0.564
## Use              2   0.13010 0.7439 0.769
## Manure          3   0.25490 0.9717 0.504
## Residual        7   0.61210

plot(dune_cca, type='n', scaling=1)
text(dune_cca, display='sp', cex=0.5, scaling=1, col='blue')
points(dune_cca, 'sites', pch=19,
       col=color_vect[dune.env$Moisture])
text(dune_cca, display='bp', col='red')
```



```

dune_cca_m = cca(dune ~ Moisture, data=dune.env)

RsquareAdj(dune_cca_m, 100)

## $r.squared
## [1] 0.2970359
##
## $adj.r.squared
## [1] 0.1627251

anova(dune_cca_m, permutations=999)

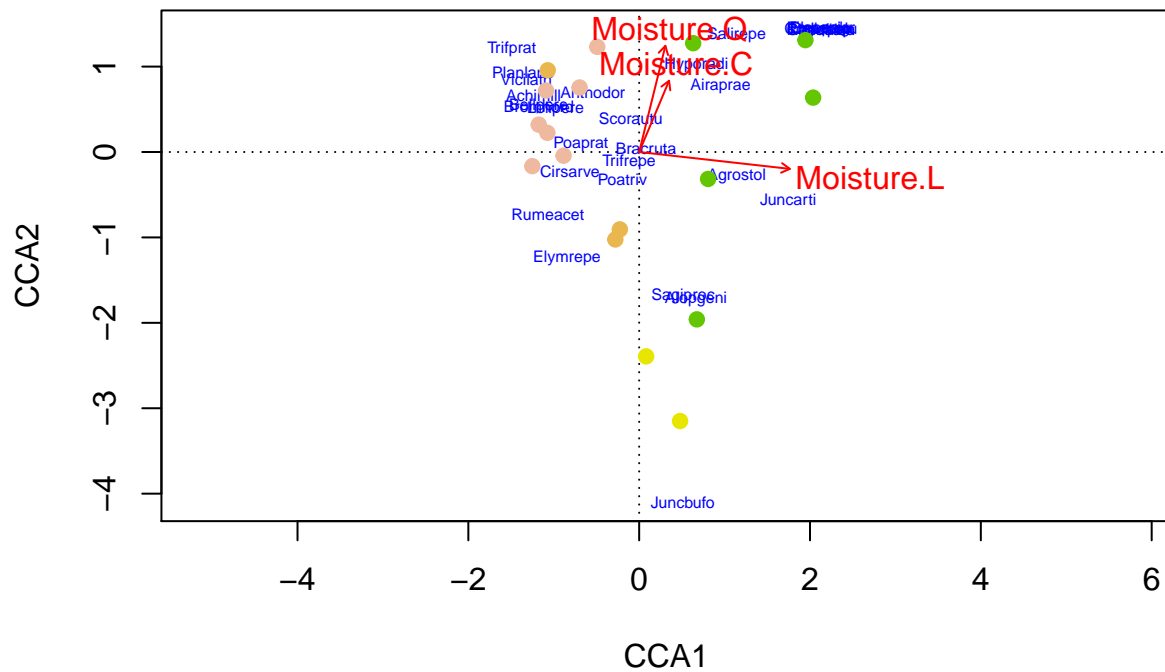
## Permutation test for cca under reduced model
## Permutation: free
## Number of permutations: 999
##
## Model: cca(formula = dune ~ Moisture, data = dune.env)
##           Df ChiSquare      F Pr(>F)
## Model      3    0.62831 2.2536 0.004 **
## Residual  16    1.48695
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

anova(dune_cca_m, by='margin', permutations=999)

## Permutation test for cca under NA model
## Marginal effects of terms
## Permutation: free
## Number of permutations: 999
##
## Model: cca(formula = dune ~ Moisture, data = dune.env)
##           Df ChiSquare      F Pr(>F)
## Moisture   3    0.62831 2.2536 0.002 **
## Residual  16    1.48695
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

plot(dune_cca_m, type='n', scaling=1)
text(dune_cca_m, display='sp', cex=0.5, scaling=1, col='blue')
points(dune_cca_m, 'sites', pch=19,
       col=color_vect[dune.env$Moisture])
text(dune_cca_m, display='bp', col='red')

```



dune ~ Moisture is the better model according to adjusted  $R^2$ .

3. Do your two analyses agree with one another or complement one another or do these two analyses seem to be suggesting different take home messages? Which analysis do you find to be more useful?

The plot of dune ~ Moisture shows that Moisture.L explains most of the variance along the horizontal axis. This agrees with the observations made during the NMDS analysis. I find the CCA analysis to be more useful since it can easily test hypotheses made during earlier analysis.