Welling Multivariate modeling assignment

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)
```

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

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

```
## This is vegan 2.4-5
```

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

head(dune)
```

```
##   Achimill Agrostol Airaprae Alopgeni Anthodor Bellpere Bromhord Chenalbu
## 1        1        0        0        0        0        0        0        0
## 2        3        0        0        2        0        3        4        0
## 3        0        4        0        7        0        2        0        0
## 4        0        8        0        2        0        2        3        0
## 5        2        0        0        0        4        2        2        0
## 6        2        0        0        0        3        0        0        0
##   Cirsarve Comapalu Eleopalu Elymrepe Empenigr Hyporadi Juncarti Juncbufo
## 1        0        0        0        4        0        0        0        0
## 2        0        0        0        4        0        0        0        0
## 3        0        0        0        4        0        0        0        0
## 4        2        0        0        4        0        0        0        0
## 5        0        0        0        4        0        0        0        0
## 6        0        0        0        0        0        0        0        0
##   Lolipere Planlanc Poaprat Poatriv Ranuflam Rumeacet Sagiproc Salirepe
## 1        7        0       4       2        0        0        0        0
## 2        5        0       4       7        0        0        0        0
## 3        6        0       5       6        0        0        0        0
## 4        5        0       4       5        0        0        5        0
## 5        2        5       2       6        0        5        0        0
## 6        6        5       3       4        0        6        0        0
##   Scorautu Trifprat Trifrepe Vicilath Bracruta Callcusp
## 1        0        0        0        0        0        0
## 2        5        0        5        0        0        0
## 3        2        0        2        0        2        0
## 4        2        0        1        0        2        0
## 5        3        2        2        0        2        0
## 6        3        5        5        0        6        0
```

```
head(dune.env)
```

```
##    A1 Moisture Management      Use Manure
## 1 2.8        1         SF Haypastu      4
## 2 3.5        1         BF Haypastu      2
## 3 4.3        2         SF Haypastu      4
## 4 4.2        2         SF Haypastu      4
## 5 6.3        1         HF Hayfield      2
## 6 4.3        1         HF Haypastu      2
```

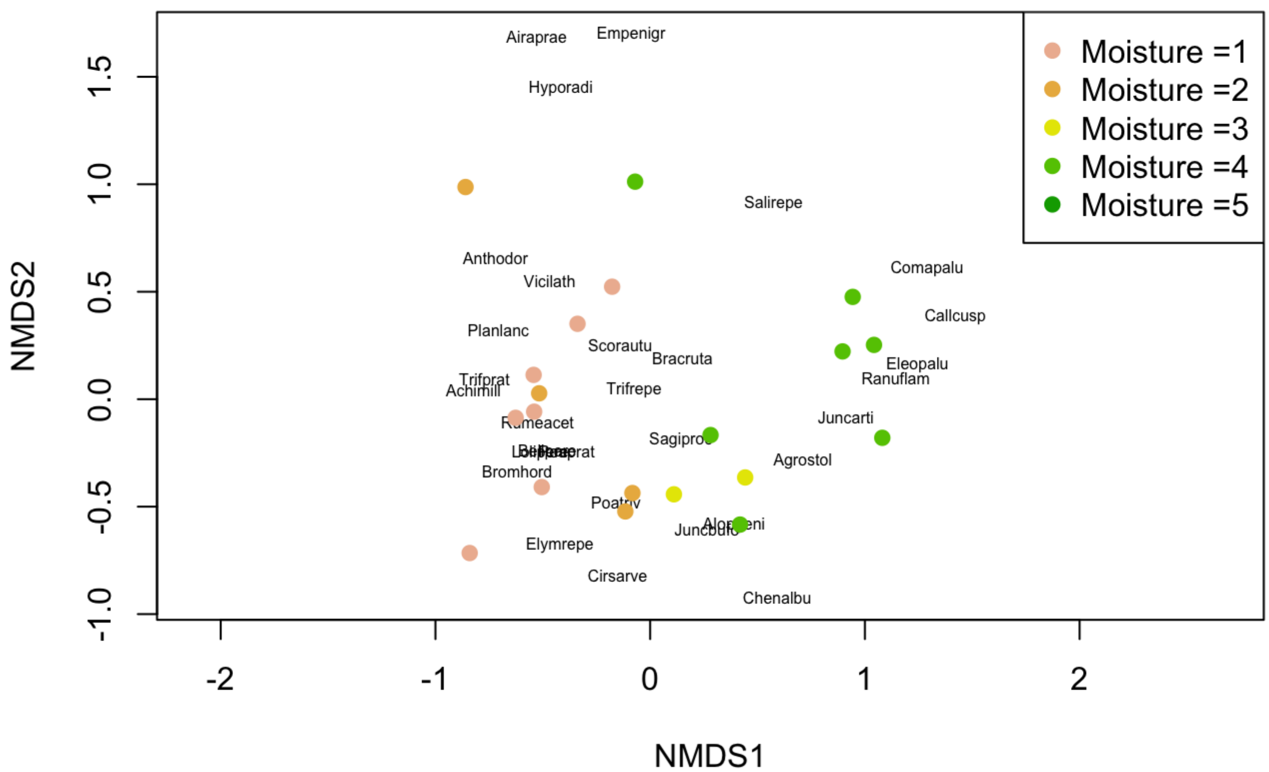
1. Conduct an indirect ordination on the dune plant community. Specifically, visually examine a NMDS plot using the bray-curtis distance metric. Below is some code to help you develop a potential plot that emphasizes the role of the environmental variable “Moisture”. Describe how you interpret the graphic.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

The sites that appear closest together have the higher degrees of similarity. This type of plot is a good way to visualize groupings and/or clusters of similarities. It looks like the dune vegitation is arranged along a moisture gradient.

```
dune_mds <- metaMDS(dune)
```

```
## Run 0 stress 0.1192678
## Run 1 stress 0.1192689
## ... Procrustes: rmse 0.0006035597  max resid 0.001865496
## ... Similar to previous best
## Run 2 stress 0.1183186
## ... New best solution
## ... Procrustes: rmse 0.02027091  max resid 0.06495737
## Run 3 stress 0.181294
## Run 4 stress 0.119268
## Run 5 stress 0.1812933
## Run 6 stress 0.1982912
## Run 7 stress 0.1183186
## ... New best solution
## ... Procrustes: rmse 4.77315e-05  max resid 0.0001589411
## ... Similar to previous best
## Run 8 stress 0.1183186
## ... New best solution
## ... Procrustes: rmse 3.676511e-05  max resid 0.0001193664
## ... Similar to previous best
## Run 9 stress 0.1192683
## Run 10 stress 0.1192686
## Run 11 stress 0.1192678
## Run 12 stress 0.1886532
## Run 13 stress 0.1192678
## Run 14 stress 0.1183186
## ... New best solution
## ... Procrustes: rmse 7.968174e-06  max resid 1.87002e-05
## ... Similar to previous best
## Run 15 stress 0.1192678
## Run 16 stress 0.1183186
## ... Procrustes: rmse 1.899467e-05  max resid 6.283569e-05
## ... Similar to previous best
## Run 17 stress 0.1922242
## Run 18 stress 0.1183186
## ... Procrustes: rmse 1.072535e-05  max resid 3.270837e-05
## ... Similar to previous best
## Run 19 stress 0.1192678
## Run 20 stress 0.1192679
## *** 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)
```



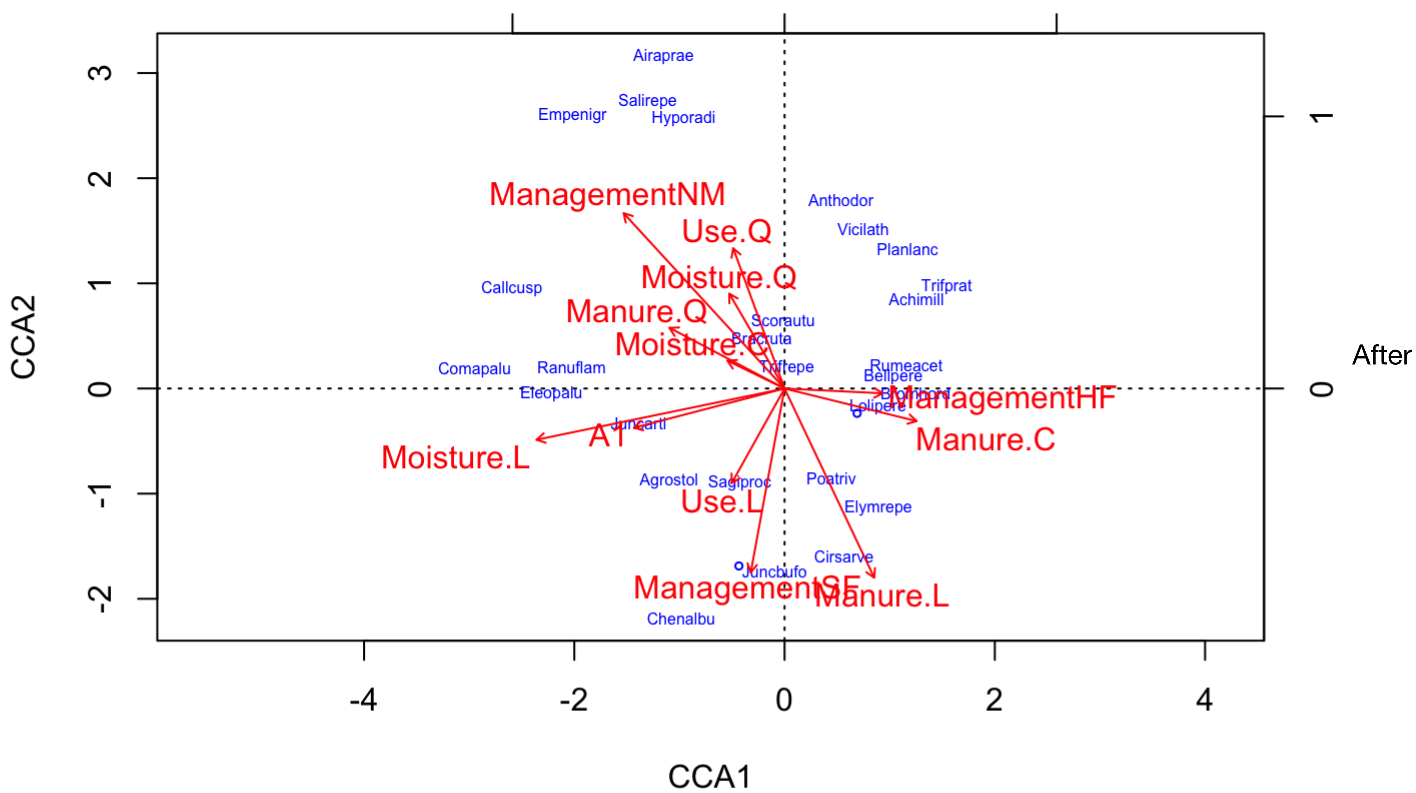
2. Carry out a direct ordination using CCA in order to test any potential hypotheses that you developed after examining the MDS plot. Specifically, carry out a test of the entire model (i.e., including all constrained axes) and also carry out tests at the scale of individual explanatory variables you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

plot(cca_tree, type=‘n’, scaling=1) orditorp(cca_tree, display=‘sp’, cex=0.5, scaling=1, col=‘blue’) text(cca_tree, display=‘bp’, col=‘red’)

```
#all variables included
cca_dune <- cca(dune~., data=dune.env)
anova(cca_dune, 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.en
v)
##            Df ChiSquare      F Pr(>F)
## A1          1   0.11070 1.2660  0.249
## Moisture    3   0.31587 1.2041  0.233
## Management  2   0.15882 0.9081  0.576
## Use         2   0.13010 0.7439  0.795
## Manure      3   0.25490 0.9717  0.505
## Residual    7   0.61210
```

```
plot(cca_dune, type='n', scaling=1)
orditorp(cca_dune, display='sp', cex=0.5, scaling=1, col='blue')
text(cca_dune, display='bp', col='red')
```

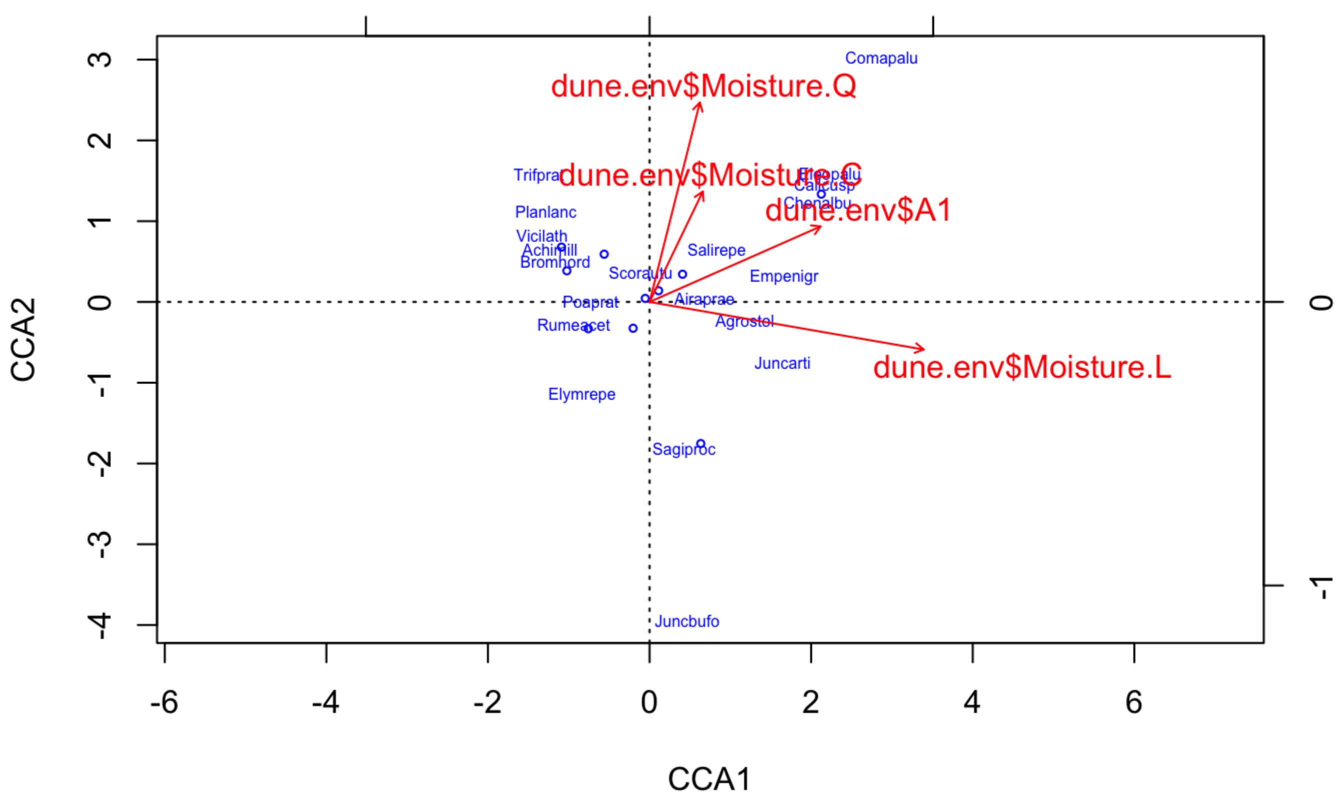


this analysis, only A1 and moisture seem to explain a large portion of variance.

```
#only A1 and moisture
cca_dune2 <- cca(dune~dune.env$A1 + dune.env$Moisture)
anova(cca_dune2, 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 ~ dune.env$A1 + dune.env$Moisture)
##                   Df ChiSquare      F Pr(>F)
## dune.env$A1        1   0.11543 1.2624  0.197
## dune.env$Moisture  3   0.51898 1.8920  0.006 **
## Residual          15   1.37153
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

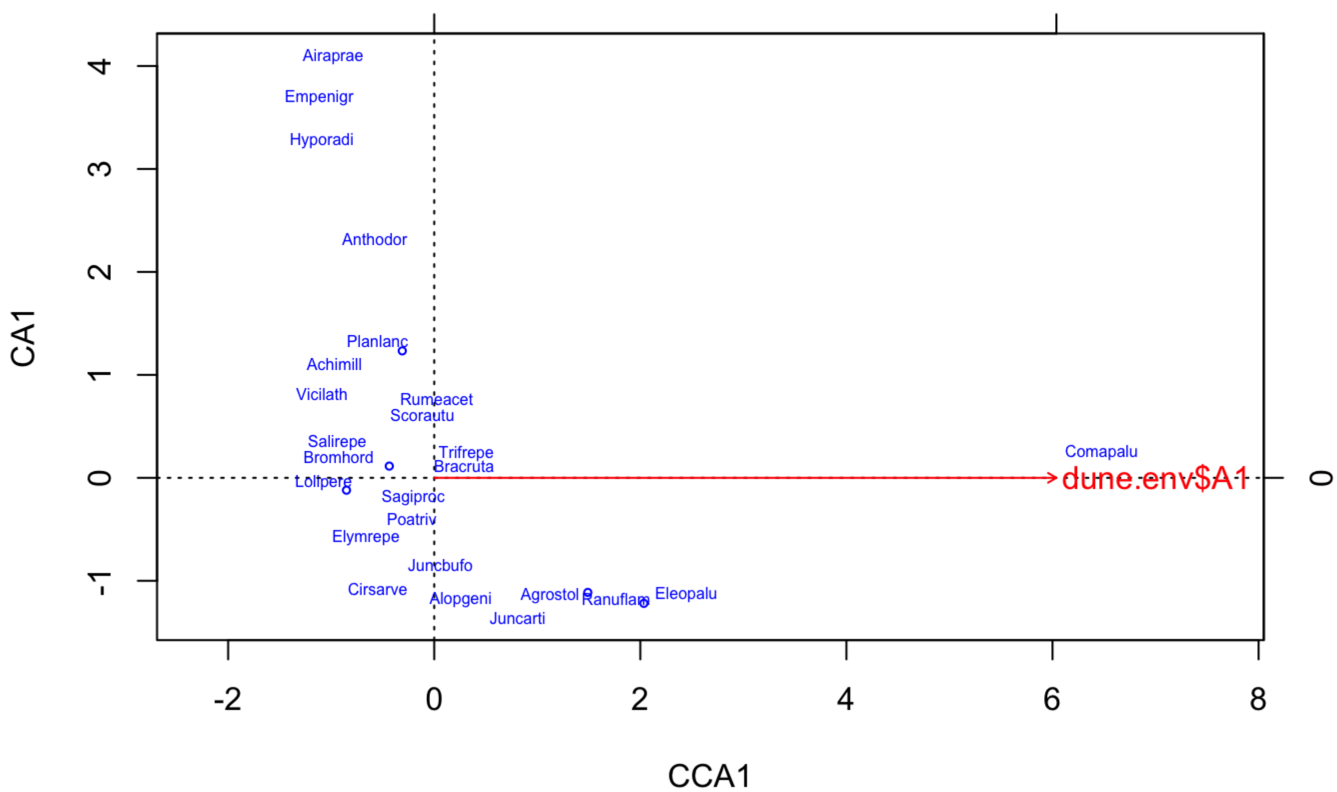
```
plot(cca_dune2, type='n', scaling=1)
orditorp(cca_dune2, display='sp', cex=0.5, scaling=1, col='blue')
text(cca_dune2, display='bp', col='red')
```



```
#only A1
cca_dune3 <- cca(dune~dune.env$A1)
anova(cca_dune3, 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 ~ dune.env$A1)
##             Df ChiSquare     F Pr(>F)
## dune.env$A1  1   0.22476 2.14  0.022 *
## Residual    18   1.89050
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

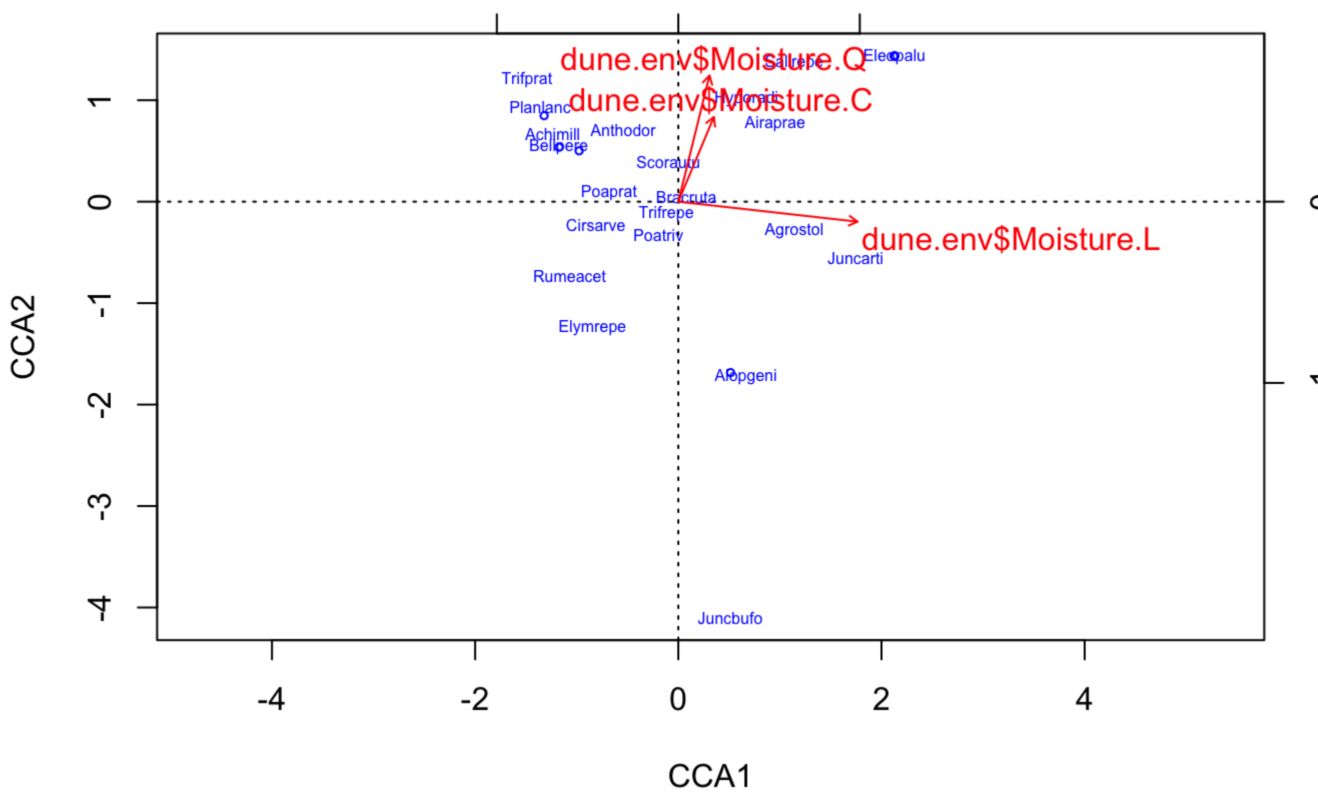
```
plot(cca_dune3, type='n', scaling=1)
orditorp(cca_dune3, display='sp', cex=0.5, scaling=1, col='blue')
text(cca_dune3, display='bp', col='red')
```



```
#only moisture
cca_dune4 <- cca(dune~dune.env$Moisture)
anova(cca_dune4, 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 ~ dune.env$Moisture)
##                   Df ChiSquare      F Pr(>F)
## dune.env$Moisture  3   0.62831 2.2536  0.003 **
## Residual          16   1.48695
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
plot(cca_dune4, type='n', scaling=1)
orditorp(cca_dune4, display='sp', cex=0.5, scaling=1, col='blue')
text(cca_dune4, display='bp', col='red')
```



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 analyses do seem to agree that moisture is a very important variable influencing dune vegitation distribution. While unconstrained analyses seem useful for exploring data, the constrained analysis gave me a clearer picture of what seemed to be going on.