Modeling Dune Data

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Begin by installing the necessary packages and the data about the dunes

```
#install.packages("vegan")
library(vegan)
```

```
## Loading required package: permute

## Loading required package: lattice

## This is vegan 2.3-3
```

```
#install.packages("dummies")
library(dummies)
```

```
## dummies-1.5.6 provided by Decision Patterns
```

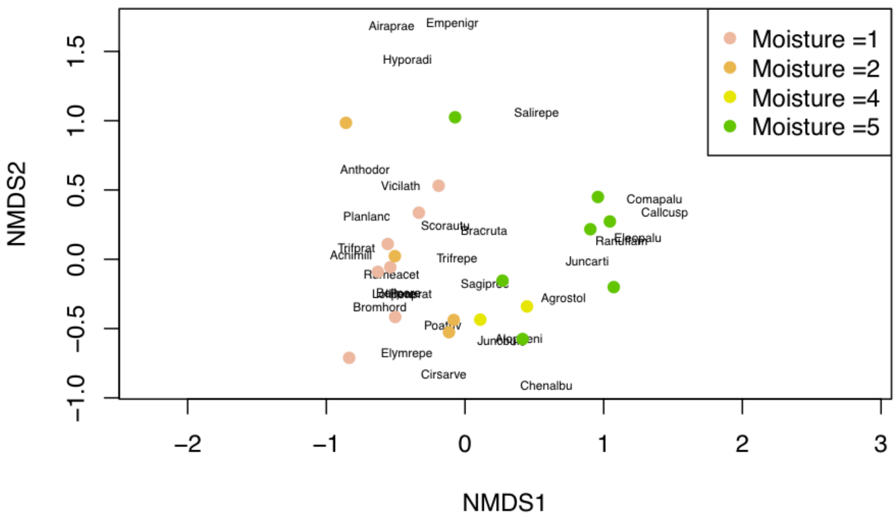
```
library(vegan)
data(dune)
data(dune.env)
?dune
```

Begin by conducting an indirect ordination on the dune plant community using the metaMDS function. Furthermore we plot the values and see the significance

```
#making a MDS analysis thing
dune_mds=metaMDS(dune)
```

```
## Run 0 stress 0.1192678
## Run 1 stress 0.2075713
## Run 2 stress 0.119268
## ... procrustes: rmse 0.000264736  max resid 0.0008142103
## *** Solution reached
```

```
#making a plot

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 =", c(1,2,4,5), sep=''), #fixed it holla originally 1:5
       col=color_vect, pch=19)
```




```
#how to zoom like a pleb plot(nmds, xlim=c(-10, -5), ylim)
```

Lower moisture ones are all clumped together in with lower ds1 and ds2 and the higher moisture ones are also fairly clumped but are a lil more spread apart.

CCA Testing

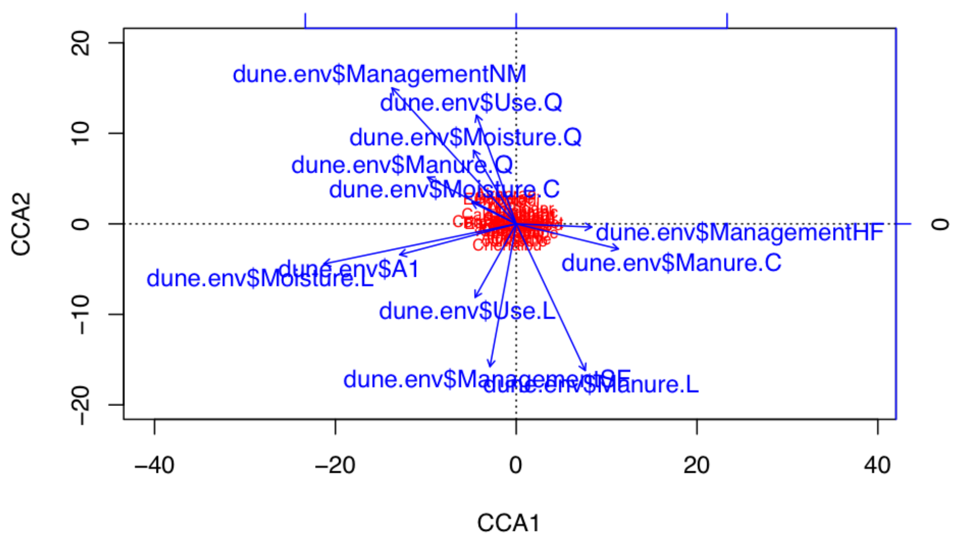
A CCA model is created so that it can later be prepared to the first RDA model. Begins by including all of the possible variables and is graphed and testing is done.

```
#creating the dune model using the cca method where it accounts for the variables a1, moisture, managem
cca_dune=cca(dune ~ dune.env$A1 + dune.env$Moisture + dune.env$Management + dune.env$Use + dune.env$Manu

#teachers board writing stuff
#anova(dune_cca) "overall model signifigance"
#anova(cca_objm[some variable], by="margin")

#gives the eigenvalues and more info
cca_dune
```

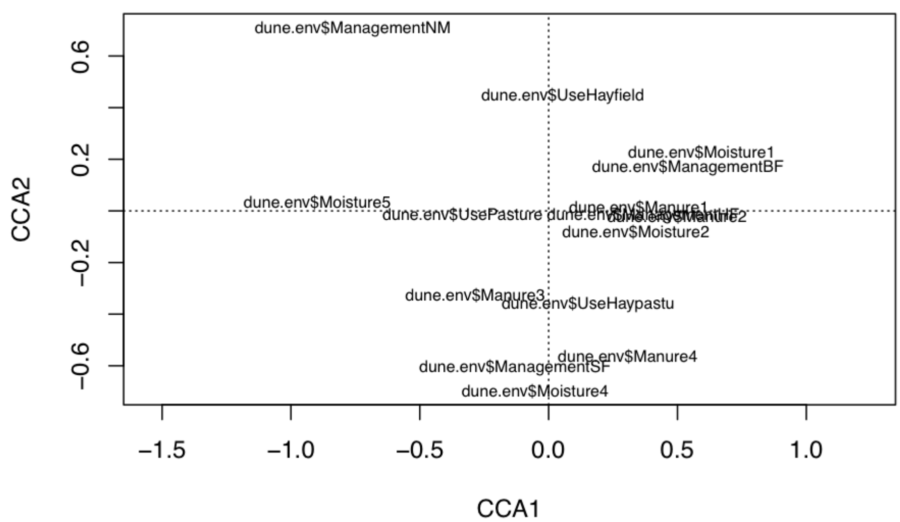
```
## Call: cca(formula = dune ~ dune.env$A1 + dune.env$Moisture +
## dune.env$Management + dune.env$Use + dune.env$Manure)
##
```

```
##                Inertia Proportion Rank
## Total           2.1153     1.0000
## Constrained     1.5032     0.7106   12
## Unconstrained  0.6121     0.2894    7
## Inertia is mean squared contingency coefficient
## Some constraints were aliased because they were collinear (redundant)
##
## Eigenvalues for constrained axes:
##   CCA1   CCA2   CCA3   CCA4   CCA5   CCA6   CCA7   CCA8   CCA9  CCA10
## 0.4671 0.3410 0.1761 0.1532 0.0953 0.0703 0.0589 0.0499 0.0318 0.0260
##  CCA11  CCA12
## 0.0228 0.0108
##
## Eigenvalues for unconstrained axes:
##     CA1     CA2     CA3     CA4     CA5     CA6     CA7
## 0.27237 0.10876 0.08975 0.06305 0.03489 0.02529 0.01798
```

```r
#plot it
plot(cca_dune, ylim=c(-20, 20), display=c('sp','bp'), scaling=1)

#give it a name really, nothing different bp=biplot
plotdune=plot(cca_dune, ylim=c(-20, 20), display=c('sp','bp'), scaling=1)
```




```r
#a different kind of graph visual using centroids
plot(cca_dune, display=c('cn'), scaling=1)
```




```
#gives some info
plotdune
```

```
## $species
##                CCA1        CCA2
## Achimill  1.25492690  0.84738144
## Agrostol -1.09878179 -0.87403204
## Airaprae -1.15089656  3.16359412
## Alopgeni -0.43420117 -1.68765705
## Anthodor  0.53600745  1.79675824
## Bellpere  1.03459795  0.11336963
## Bromhord  1.24856529 -0.04479289
## Chenalbu -0.98364433 -2.18450268
## Cirsarve  0.56489830 -1.59685273
## Comapalu -2.94874909  0.17888829
## Eleopalu -2.21751679 -0.05256048
## Elymrepe  0.89316528 -1.13280574
## Empenigr -2.01741224  2.59304832
## Hyporadi -0.95892895  2.56615801
## Juncarti -1.38768935 -0.32693579
## Juncbufo -0.09421348 -1.73961870
## Lolipere  0.88842733 -0.16927281
## Planlanc  1.17109230  1.32933035
## Poaprat   0.69015643 -0.23626637
## Poatriv   0.44468395 -0.85789652
## Ranuflam -2.02508840  0.20056138
```

```
## Rumeacet  1.15737841  0.22350748
## Sagiproc -0.42541431 -0.89284485
## Salirepe -1.30209055  2.73397355
## Scorautu -0.01439415  0.65009249
## Trifprat  1.54265121  0.97154141
## Trifrepe  0.02150547  0.19497917
## Vicilath  0.74828555  1.51704976
## Bracruta -0.21606507  0.47854617
## Callcusp -2.59465145  0.95131127
##
## $biplot
##                             CCA1        CCA2
## dune.env$A1           -0.5522284 -0.14625614
## dune.env$Moisture.L   -0.9119085 -0.18984518
## dune.env$Moisture.Q   -0.2019396  0.34771164
## dune.env$Moisture.C   -0.2096150  0.10180106
## dune.env$ManagementHF  0.3578911 -0.01529945
## dune.env$ManagementNM -0.5893380  0.64373816
## dune.env$ManagementSF -0.1243145 -0.67611508
## dune.env$Use.L        -0.1947790 -0.34791425
## dune.env$Use.Q        -0.1882986  0.51499752
## dune.env$Manure.L      0.3272520 -0.69453755
## dune.env$Manure.Q     -0.4201628  0.22075154
## dune.env$Manure.C      0.4843232 -0.11872035
## attr(,"arrow.mul")
## [1] 23.32487
##
## attr(,"class")
## [1] "ordiplot"
```

```
#do some permutations
anova(cca_dune, by='margin', permutations = 10)
```

```
## Permutation test for cca under reduced model
## Marginal effects of terms
## Permutation: free
## Number of permutations: 10
##
## Model: cca(formula = dune ~ dune.env$A1 + dune.env$Moisture + dune.env$Management + dune.env$Use + du
##                     Df ChiSquare      F  Pr(>F)
## dune.env$A1          1   0.11070 1.2660 0.09091 .
## dune.env$Moisture    3   0.31587 1.2041 0.27273
## dune.env$Management  2   0.15882 0.9081 0.63636
## dune.env$Use         2   0.13010 0.7439 0.36364
## dune.env$Manure      3   0.25490 0.9717 0.54545
## Residual             7   0.61210
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#tells us what variables are significant
anova(cca_dune)
```

```
## Permutation test for cca under reduced model
```

```
## Permutation: free
## Number of permutations: 999
##
## Model: cca(formula = dune ~ dune.env$A1 + dune.env$Moisture + dune.env$Management + dune.env$Use + du
##          Df ChiSquare      F Pr(>F)
## Model    12    1.5032 1.4325  0.017 *
## Residual  7    0.6121
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

none of the variables have strong partial effect but the model itself has marginal significance moisture was important somewhere up higher, what about doin a cca with just moisture?

```r
summary(cca_dune)
```

```
##
## Call:
## cca(formula = dune ~ dune.env$A1 + dune.env$Moisture + dune.env$Management +      dune.env$Use + dune
##
## Partitioning of mean squared contingency coefficient:
##               Inertia Proportion
## Total          2.1153     1.0000
## Constrained    1.5032     0.7106
## Unconstrained  0.6121     0.2894
##
## Eigenvalues, and their contribution to the mean squared contingency coefficient
##
## Importance of components:
##                         CCA1   CCA2    CCA3    CCA4    CCA5    CCA6
## Eigenvalue            0.4671 0.3410 0.17606 0.15317 0.09528 0.07027
## Proportion Explained  0.2208 0.1612 0.08323 0.07241 0.04504 0.03322
## Cumulative Proportion 0.2208 0.3821 0.46529 0.53770 0.58275 0.61596
##                          CCA7    CCA8    CCA9   CCA10   CCA11   CCA12
## Eigenvalue            0.05887 0.04993 0.03183 0.02596 0.02282 0.01082
## Proportion Explained  0.02783 0.02360 0.01505 0.01227 0.01079 0.00511
## Cumulative Proportion 0.64379 0.66740 0.68245 0.69472 0.70551 0.71063
##                          CA1     CA2     CA3     CA4     CA5     CA6
## Eigenvalue            0.2724 0.10876 0.08975 0.06305 0.03489 0.02529
## Proportion Explained  0.1288 0.05142 0.04243 0.02981 0.01649 0.01196
## Cumulative Proportion 0.8394 0.89081 0.93324 0.96305 0.97954 0.99150
##                           CA7
## Eigenvalue            0.01798
## Proportion Explained  0.00850
## Cumulative Proportion 1.00000
##
## Accumulated constrained eigenvalues
## Importance of components:
##                         CCA1   CCA2   CCA3   CCA4    CCA5    CCA6    CCA7
## Eigenvalue            0.4671 0.3410 0.1761 0.1532 0.09528 0.07027 0.05887
## Proportion Explained  0.3108 0.2269 0.1171 0.1019 0.06339 0.04674 0.03916
## Cumulative Proportion 0.3108 0.5376 0.6548 0.7567 0.82005 0.86679 0.90595
##                          CCA8    CCA9   CCA10   CCA11   CCA12
## Eigenvalue            0.04993 0.03183 0.02596 0.02282 0.01082
```

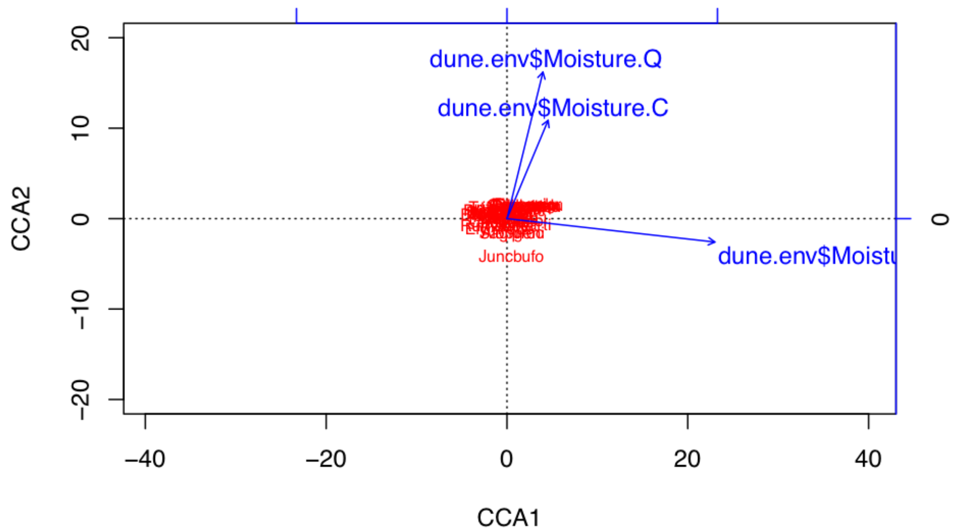
```
## Proportion Explained  0.03322 0.02118 0.01727 0.01518 0.00720
## Cumulative Proportion 0.93917 0.96035 0.97762 0.99280 1.00000
##
## Scaling 2 for species and site scores
## * Species are scaled proportional to eigenvalues
## * Sites are unscaled: weighted dispersion equal on all dimensions
##
##
## Species scores
##
##               CCA1     CCA2      CCA3      CCA4      CCA5      CCA6
## Achimill  0.857707  0.49484 -0.045074 -0.057950  0.670679  0.056946
## Agrostol -0.750987 -0.51041 -0.001514 -0.006522  0.110328 -0.113279
## Airaprae -0.786606  1.84744  0.777309  1.068417  0.558936 -0.142093
## Alopgeni -0.296764 -0.98554  0.015875  0.454024  0.295335  0.124614
## Anthodor  0.366346  1.04925 -0.217724  0.412435  0.563903 -0.226744
## Bellpere  0.707119  0.06620  0.500239 -0.369709  0.592272 -0.330213
## Bromhord  0.853359 -0.02616  0.335626 -0.427024  0.865565 -0.093885
## Chenalbu -0.672293 -1.27568 -0.417041  0.994310  0.640906  0.521336
## Cirsarve  0.386092 -0.93251  0.963978 -0.468823  0.239146 -0.908823
## Comapalu -2.015388  0.10446 -1.185954 -1.972940 -0.083546 -0.219456
## Eleopalu -1.515611 -0.03069 -0.455387 -0.508862  0.111183 -0.132850
## Elymrepe  0.610453 -0.66152  0.628614 -0.124262 -0.491387 -0.510855
## Empenigr -1.378845  1.51426  1.387645  0.973499 -0.434196 -0.642379
## Hyporadi -0.655401  1.49855  0.738512  0.362909 -0.104564  0.310460
## Juncarti -0.948447 -0.19092 -0.028958  0.148431 -0.292973 -0.155408
## Juncbufo -0.064392 -1.01588 -0.297937  1.118684 -0.196979  0.823725
## Lolipere  0.607215 -0.09885  0.262228 -0.409402 -0.312573  0.082660
## Planlanc  0.800409  0.77629 -0.606615 -0.038048 -0.021902  0.152465
## Poaprat   0.471703 -0.13797  0.252857 -0.205726 -0.176841  0.061944
## Poatriv   0.303929 -0.50098 -0.033488  0.157680  0.180752 -0.110423
## Ranuflam -1.384091  0.11712 -0.129524 -0.120128  0.041536 -0.207804
## Rumeacet  0.791036  0.13052 -1.100806  0.537567 -0.416656 -0.396323
## Sagiproc -0.290759 -0.52139  0.288191  0.373446 -0.109281  0.193977
## Salirepe -0.889942  1.59655  1.182347  0.817665 -0.457263 -0.271421
## Scorautu -0.009838  0.37963  0.098333 -0.075560  0.001781  0.125526
## Trifprat  1.054359  0.56735 -1.455764  0.398295 -0.539708 -0.564846
## Trifrepe  0.014698  0.11386 -0.184205 -0.244273  0.089510  0.207091
## Vicilath  0.511432  0.88591  0.273760 -1.050861 -0.335122  1.591159
## Bracruta -0.147674  0.27946 -0.137684  0.084272 -0.210685  0.147748
## Callcusp -1.773372  0.55553 -0.188876 -0.426816 -0.097141 -0.008786
##
##
## Site scores (weighted averages of species scores)
##
##        CCA1     CCA2      CCA3    CCA4     CCA5     CCA6
## 1   1.19460 -0.71633  1.656429 -1.4249 -2.23242 -1.09183
## 2   0.86805 -0.35777  0.934868 -0.9242  1.33133 -0.48738
## 3   0.33794 -1.04078  0.824936 -0.1786 -0.04887 -0.42012
## 4   0.25095 -0.99294  1.237259 -0.4411  0.35593 -1.14729
## 5   1.11991  0.45932 -1.022763  0.2895  0.27912 -1.76102
## 6   0.99305  0.73388 -2.001441  0.3758 -1.04277 -0.73162
## 7   1.03098  0.34363 -1.083231  0.2079 -0.14394  0.29945
## 8  -0.66671 -0.71037  0.004385 -0.1742 -0.10923  0.07552
```

```
## 9   0.09269 -1.09341  0.218954  0.9201 -1.32966  0.09022
## 10  0.95315  0.58996  0.146744 -0.9667  1.81728  0.84400
## 11  0.47318  0.74856  0.535395 -1.0620 -1.51667  3.25324
## 12 -0.27934 -1.30695 -0.512852  2.0022  0.26928  1.96951
## 13 -0.37400 -1.45815 -0.153034  1.4764  1.08084  1.21481
## 14 -2.04173  0.23744 -1.448971 -2.6038  0.41722 -0.22568
## 15 -1.93799 -0.04255 -1.367867 -1.8081 -0.32644 -0.85946
## 16 -1.91272 -0.56130 -0.881308 -0.5388  0.40537 -0.81739
## 17  0.33533  2.74717  0.494859  1.7252  3.00069  0.15330
## 18  0.26805  1.23029  0.753438 -0.3018 -1.09614  1.50399
## 19 -0.75573  2.53794  2.225936  2.4221  0.13516  0.14348
## 20 -2.03905  0.80938  0.463176  0.2188 -1.15999 -1.41953
##
##
## Site constraints (linear combinations of constraining variables)
##
##       CCA1    CCA2      CCA3     CCA4    CCA5     CCA6
## 1   0.7577 -1.0533  2.075818 -0.62357 -2.6193 -0.57163
## 2   1.0307 -0.2511  0.942759 -0.72795  1.0939  0.10633
## 3   0.3825 -0.9571  0.943652 -0.50806  0.2566 -0.92249
## 4   0.3861 -0.9325  0.963978 -0.46882  0.2391 -0.90882
## 5   1.0281  0.3743 -1.180481 -0.15376  0.1863 -2.04984
## 6   1.0753  0.8100 -1.860152  0.77287 -0.9596 -0.47288
## 7   1.0282  0.1537 -0.720078  0.01393 -0.2159  0.69023
## 8  -0.8347 -0.6324 -0.367053 -0.18633  0.2121 -0.93866
## 9   0.2553 -0.9868  0.226845  1.11630 -1.5671  0.68393
## 10  0.8517  0.5884  0.543136 -0.45186  1.9874  0.90302
## 11  0.3961  0.6106 -0.007613 -2.01145 -1.4337  2.39468
## 12 -0.4745 -1.4349 -0.522321  1.76672  0.5542  1.25706
## 13 -0.6723 -1.2757 -0.417041  0.99431  0.6409  0.52134
## 14 -2.3490  0.6722 -1.087969 -2.00082 -0.2983 -0.03446
## 15 -1.6817 -0.4633 -1.283939 -1.94506  0.1312 -0.40445
## 16 -1.4075 -0.6080 -0.607258  0.19306  0.5431  0.63171
## 17  0.1018  2.3472 -0.138197  1.21079  2.0486  0.60834
## 18  0.4019  1.7339  0.567131  0.27132 -0.4606  0.67225
## 19 -1.3788  1.5143  1.387645  0.97350 -0.4342 -0.64238
## 20 -1.3717  1.5635  1.428297  1.05197 -0.4691 -0.61505
##
##
## Biplot scores for constraining variables
##
##                          CCA1    CCA2     CCA3     CCA4     CCA5     CCA6
## dune.env$A1            -0.5522 -0.1463 -0.51591 -0.29706  0.10631 -0.18332
## dune.env$Moisture.L    -0.9119 -0.1898  0.03915  0.20902  0.10538 -0.03575
## dune.env$Moisture.Q    -0.2019  0.3477 -0.29349 -0.20611 -0.28362 -0.13473
## dune.env$Moisture.C    -0.2096  0.1018  0.30630 -0.29946  0.52413 -0.28239
## dune.env$ManagementHF  0.3579 -0.0153 -0.54867  0.22163 -0.32970 -0.28950
## dune.env$ManagementNM -0.5893  0.6437  0.15687 -0.01426 -0.04765 -0.07934
## dune.env$ManagementSF -0.1243 -0.6761  0.21198  0.15451  0.10333 -0.01935
## dune.env$Use.L         -0.1948 -0.3479 -0.33163 -0.42684 -0.10232  0.22884
## dune.env$Use.Q         -0.1883  0.5150 -0.02175 -0.01096 -0.05112  0.16095
## dune.env$Manure.L       0.3273 -0.6945  0.04111 -0.03004  0.04278 -0.26545
## dune.env$Manure.Q      -0.4202  0.2208  0.52839 -0.20156 -0.12699 -0.23457
## dune.env$Manure.C       0.4843 -0.1187  0.31321 -0.19926 -0.15232  0.17747
```

```
##
##
## Centroids for factor constraints
##
##                            CCA1     CCA2     CCA3      CCA4     CCA5
## dune.env$Moisture1      0.86961  0.39190 -0.30729 -0.271184 -0.42482
## dune.env$Moisture2      0.49529 -0.13803  0.71613 -0.298514  0.95955
## dune.env$Moisture4     -0.07641 -1.19047 -0.11369  1.411949 -0.60287
## dune.env$Moisture5     -1.31323  0.06247 -0.07829  0.008202  0.07168
## dune.env$ManagementBF  0.79133  0.29313  0.53596 -0.977522  0.73099
## dune.env$ManagementHF  0.53656 -0.02637 -0.81693  0.330865 -0.48837
## dune.env$ManagementNM -1.11223  1.21134  0.29730 -0.029662 -0.09172
## dune.env$ManagementSF -0.19081 -1.03722  0.32552  0.237132  0.15857
## dune.env$UseHayfield   0.08045  0.76460  0.35627  0.470345  0.07734
## dune.env$UseHaypastu   0.22445 -0.61214  0.02544  0.013349  0.06101
## dune.env$UsePasture   -0.48763 -0.02094 -0.53183 -0.668114 -0.20870
## dune.env$Manure1       0.51300  0.02905  0.27896 -0.315483 -0.22424
## dune.env$Manure2       0.72919 -0.03448 -0.70675  0.367543  0.16244
## dune.env$Manure3      -0.41706 -0.55693 -0.52936  0.221143  0.26656
## dune.env$Manure4       0.44964 -0.96318  1.15039 -0.511103 -0.25361
##                          CCA6
## dune.env$Moisture1     0.0229
## dune.env$Moisture2    -0.2087
## dune.env$Moisture4     0.9444
## dune.env$Moisture5    -0.2261
## dune.env$ManagementBF  1.0250
## dune.env$ManagementHF -0.4322
## dune.env$ManagementNM -0.1446
## dune.env$ManagementSF -0.0296
## dune.env$UseHayfield  -0.1392
## dune.env$UseHaypastu  -0.1916
## dune.env$UsePasture    0.5131
## dune.env$Manure1       1.2323
## dune.env$Manure2      -0.3713
## dune.env$Manure3       0.1926
## dune.env$Manure4      -0.8552
```

It seemed like moisture had the most significance so now we cut the model and make a new version including only the moisture variables and rerun the plot.

```
cca_dune_moisture=cca(dune ~ dune.env$Moisture)

plot(cca_dune_moisture, ylim=c(-20, 20), display=c('sp','bp'), scaling=1)
```



both of them are saying moisture is most important but in total none of it is super signifigant. The CCA model was more useful to me.