A BRIEF INTRODUCTION TO VEGAN

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BASIC ORDINATION

UNCONSTRAINED ORDINATION

What is unconstrained

First we look for major variation, then relate it to environmental variation

vs. constrained ordination, where we only want to see what can be explained by environmental variables of interest

How well do we explain the main patterns in the species data vs how large are the patterns we can expain with the measured data

EXAMPLES OF UNCONSTRAINED ORDINATION

- Principal Components Analysis — PCA
- Correspondance Analysis — CA
- Nonmetric Multidimensional Scaling — NMDS

BEFORE WE GET STARTED

Housekeeping

```r
setwd(”your/working/dir”)
```

```r
library(”vegan”)
data(dune)
data(dune.env)
```

Data from: Jongman, R.H.G, ter Braak, C.J.F & van Tongeren, O.F.R. (1987). Data Analysis in Community and Landscape Ecology. Pudoc, Wageningen.

BEFORE WE GET STARTED | SPECIES

```
dim(dune)                                # number of samples, species
```

```
[1] 20 30
```

```
head(dune[,1:6])
```

```
  Achimill Agrostol Airaprae Alopgeni Anthodor Bellpere
1        1        0        0        0        0        0
2        3        0        0        2        0        3
3        0        4        0        7        0        2
4        0        8        0        2        0        2
5        2        0        0        0        4        2
6        2        0        0        0        3        0
```

BEFORE WE GET STARTED | ENVIRONMENT

```r
head(dune.env, n=3)
```

```
   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
```

```r
summary(dune.env)
```

```
       A1         Moisture Management       Use     Manure
 Min.   : 2.800   1:7      BF:3       Hayfield:7   0:6
 1st Qu.: 3.500   2:4      HF:5       Haypastu:8   1:3
 Median : 4.200   4:2      NM:6       Pasture :5   2:4
 Mean   : 4.850   5:7      SF:6                    3:4
 3rd Qu.: 5.725                                    4:3
 Max.   :11.500
```

BASIC ORDINATION

PCA finds linear combinations of the variables that explain the largest amounts of variance in the data

```r
(pca <- rda(dune))
```

```

Call: rda(X = dune)

              Inertia Rank
Total           84.12     
Unconstrained   84.12   19
Inertia is variance 

Eigenvalues for unconstrained axes:
   PC1    PC2    PC3    PC4    PC5    PC6    PC7    PC8 
24.795 18.147  7.629  7.153  5.695  4.333  3.199  2.782 
(Showed only 8 of all 19 unconstrained eigenvalues)
```

BASIC ORDINATION

Vegan has a wrapper function for doing NMDS ordinations using best practices:

- `metaMDS()`

This will do handy things

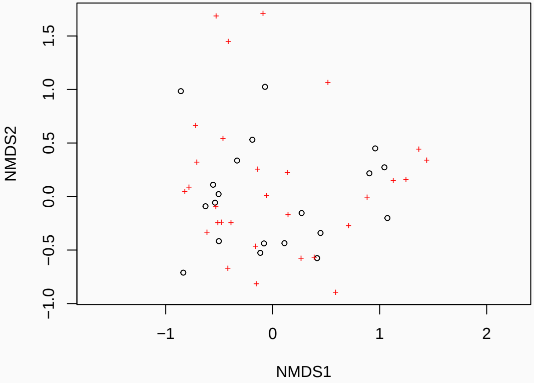
- standardize your data if necessary
- perform rotation to PCs
- scale coordinates in half change units

BASIC ORDINATION AND PLOTTING

```
dune.bray.ord <- metaMDS(dune, distance = ”bray”, k = 2, trymax = 50)
```

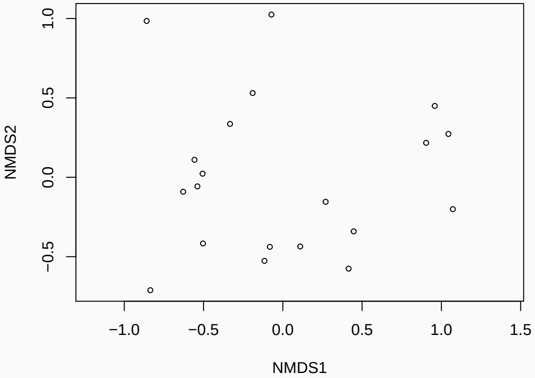
BASIC ORDINATION AND PLOTTING (USING ALL DEFAULTS)

```r
plot(dune.bray.ord)
```



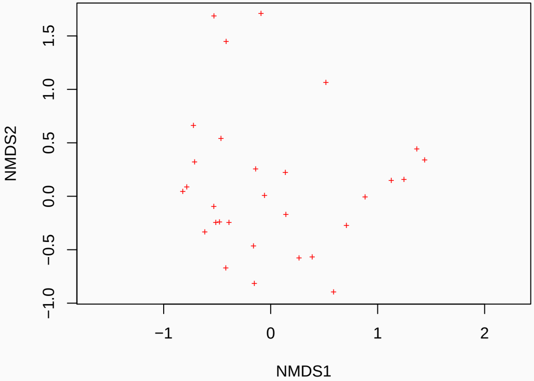
BASIC ORDINATION AND PLOTTING (JUST PLOTS)

```
plot(dune.bray.ord, display = "sites")
```



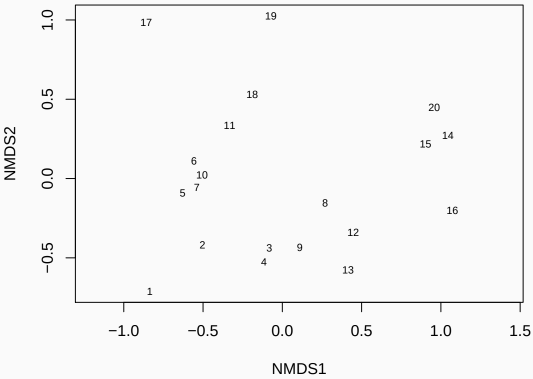
BASIC ORDINATION AND PLOTTING (JUST SPECIES)

```
plot(dune.bray.ord, display = "species")
```



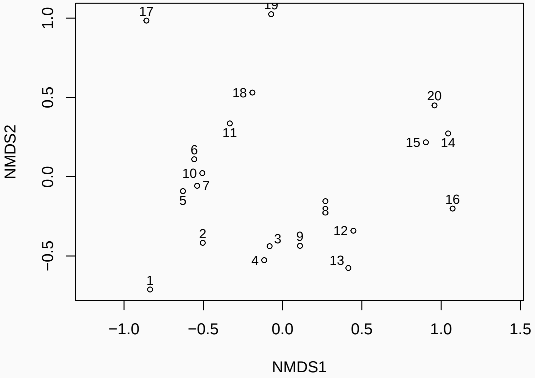
SITE NAMES INSTEAD OF POINTS

```
plot(dune.bray.ord, display = ”sites”, type = ”text”)
```



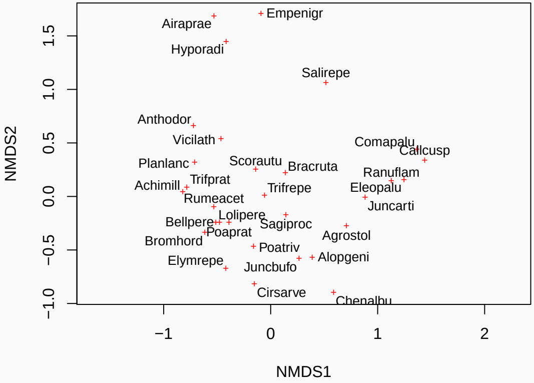
SITE NAMES INSTEAD OF POINTS

```
plot(dune.bray.ord, display = "sites")
set.seed(314) ## make reproducible
ordipointlabel(dune.bray.ord, display = "sites", scaling = 3, add = TRUE)
```



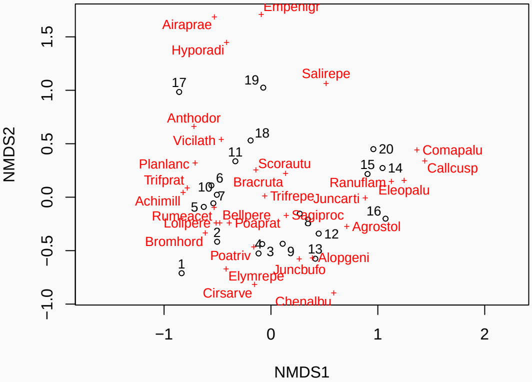
SITE NAMES INSTEAD OF POINTS

```
plot(dune.bray.ord, display = "species")
set.seed(314) ## make reproducible
ordipointlabel(dune.bray.ord, display = "species", scaling = 3, add = TRUE)
```



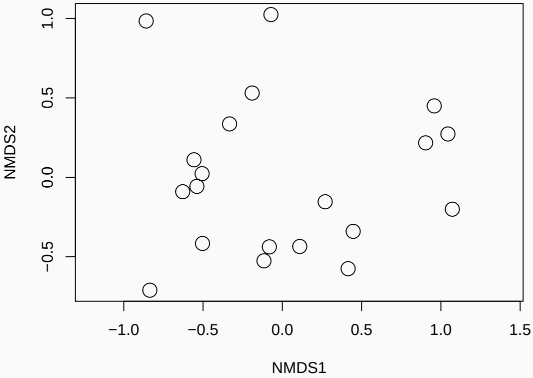
SITE NAMES INSTEAD OF POINTS

```
plot(dune.bray.ord)
set.seed(314) ## make reproducible
ordipointlabel(dune.bray.ord, scaling = 3, add = TRUE)
```



LARGER POINTS

```
plot(dune.bray.ord, display = ”sites”, cex=2)
```

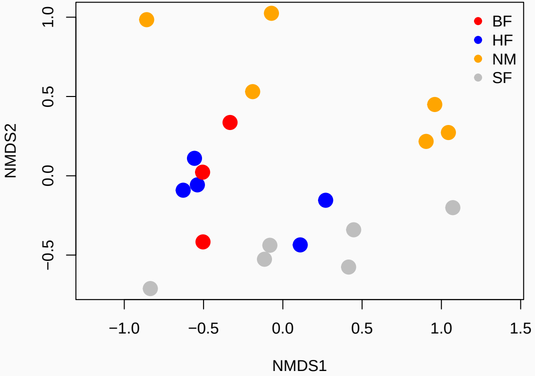


MODIFYING THE DISPLAY OF THE POINTS WITH ENVIRONMENTAL DATA

- Color
- Shape
- Size

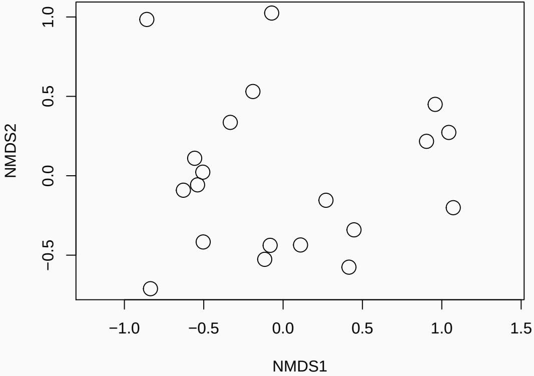
MODIFYING THE COLOR OF POINTS

```
colors.vec <- c(”red”, ”blue”, ”orange”, ”grey”)
plot(dune.bray.ord, display = ”sites”, type = ”n”)
points(dune.bray.ord, display = ”sites”, cex=2, pch = 21,
       col = colors.vec[dune.env$Management],
       bg = colors.vec[dune.env$Management])
legend(”topright”, legend = levels(dune.env$Management), bty = ”n”,
                              col = colors.vec, pch = 21, pt.bg = colors.vec)
```



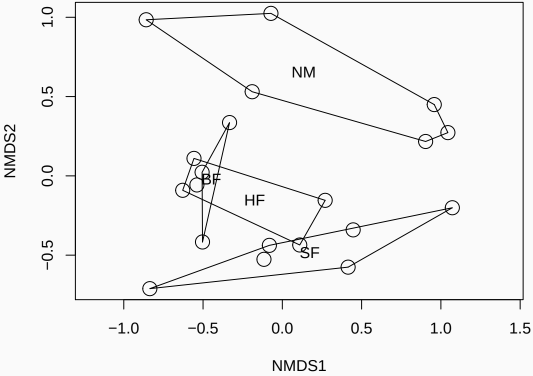
ADDING OTHER LAYERS

```
plot(dune.bray.ord, display = "sites", cex=2) # just site points
```



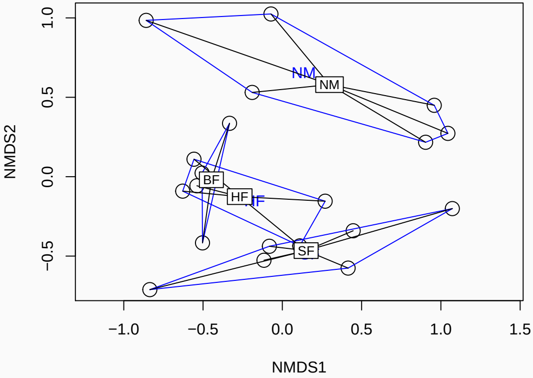
ADDING OTHER LAYERS

```
plot(dune.bray.ord, display = "sites", cex=2)
ordihull(dune.bray.ord,groups = dune.env$Management, label = TRUE) # convex hulls
```



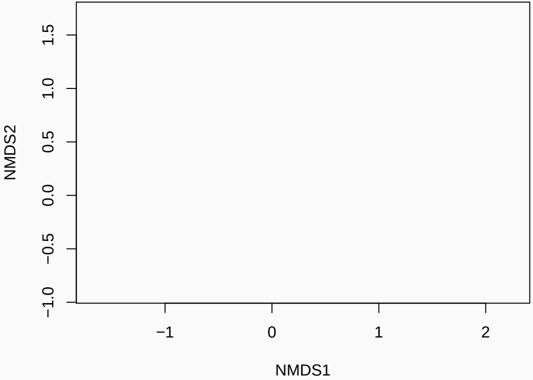
ADDING OTHER LAYERS

```
plot(dune.bray.ord, display = "sites", cex=2)
ordihull(dune.bray.ord,groups = dune.env$Management, label = TRUE, col = "blue")
ordispider(dune.bray.ord,groups = dune.env$Management, label = TRUE)
```



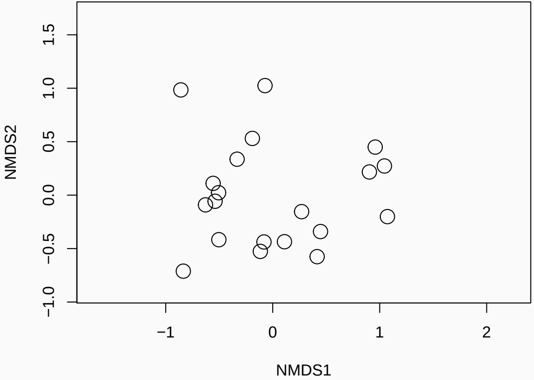
ADDING OTHER LAYERS - AXES SCALING

```
plot(dune.bray.ord, type = ”n”)
```



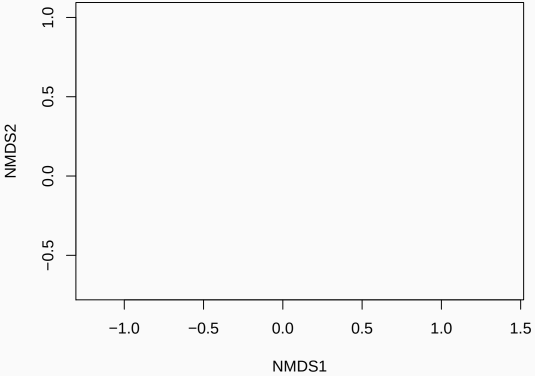
ADDING OTHER LAYERS - AXES SCALING

```
plot(dune.bray.ord, type = ”n”)
points(dune.bray.ord, display = ”sites”, cex = 2)
```



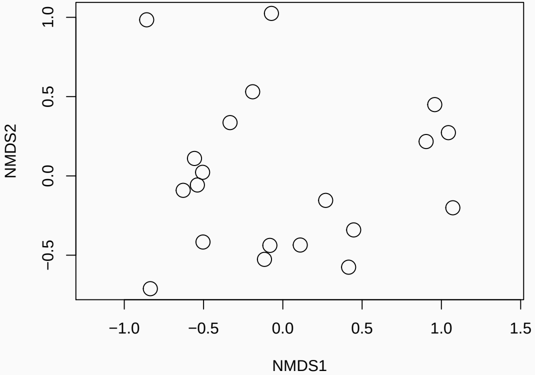
ADDING OTHER LAYERS - AXES SCALING

```
plot(dune.bray.ord, display = ”sites”, type = ”n”)
```



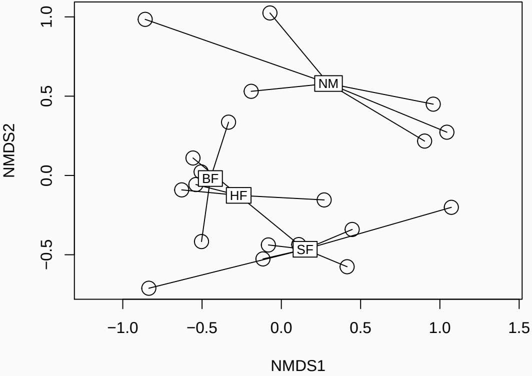
ADDING OTHER LAYERS - AXES SCALING

```
plot(dune.bray.ord, display = "sites", type = "n")
points(dune.bray.ord, display = "sites", cex = 2)
```



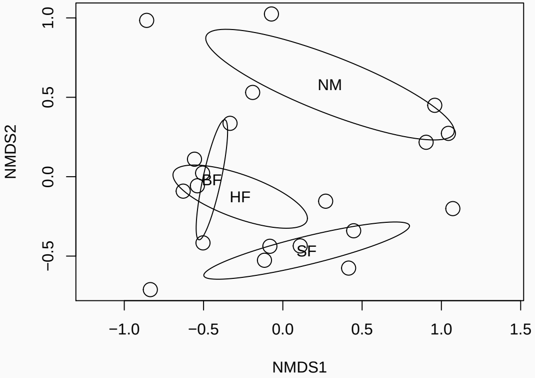
ADDING OTHER LAYERS

```
plot(dune.bray.ord, display = "sites", type = "n")
points(dune.bray.ord,display = "sites", cex = 2)
ordispider(dune.bray.ord,groups = dune.env$Management, label = TRUE)
```



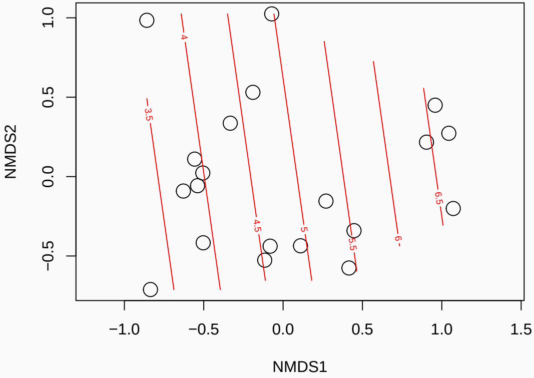
ADDING OTHER LAYERS

```
plot(dune.bray.ord, display = "sites", type = "n")
points(dune.bray.ord, display = "sites", cex = 2)
ordiellipse(dune.bray.ord,groups = dune.env$Management, label = TRUE)
```



ADDING OTHER LAYERS

```
plot(dune.bray.ord, display = "sites", type = "n")
points(dune.bray.ord,display = "sites", cex = 2)
ordisurf(dune.bray.ord,dune.env$A1, add = TRUE)
```



VECTORS IN ORDINATION SPACE

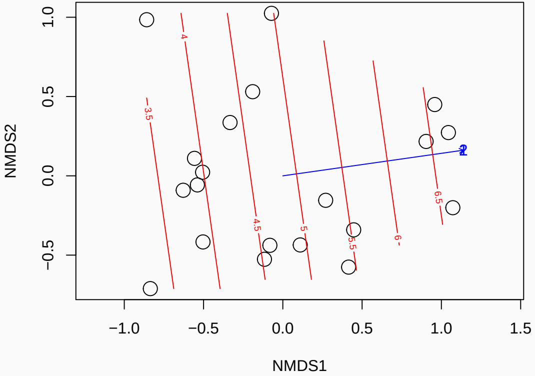
```r
dune.bray.ord.A1.fit <- envfit(dune.bray.ord,dune.env$A1, permutations = 1000)
dune.bray.ord.A1.fit
```

```
***VECTORS

       NMDS1   NMDS2     r2  Pr(>r)
[1,] 0.99008 0.14052 0.3798 0.01698 *
---
Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 ’.’ 0.1 ’ ’ 1
Permutation: free
Number of permutations: 1000
```

VECTORS IN ORDINATION SPACE

```
plot(dune.bray.ord, display = "sites", type = "n")
points(dune.bray.ord,display = "sites", cex = 2)
plot(dune.bray.ord.A1.fit, add = TRUE)
ordisurf(dune.bray.ord,dune.env$A1, add = TRUE)
```


NMDS2
NMDS1