4.2 Rationale

Just as PERMANOVA does a partitioning of variation in a data cloud described by a resemblance matrix according to an ANOVA model, DISTLM does just such a partitioning, but according to a regression (or multiple regression) model. For an ANOVA design, the predictor variables are categorical (i.e., levels of factors), whereas in a regression model, the predictor variables are (generally) quantitative and continuous. ANOVA is simply a specific kind of linear model, so DISTLM can therefore also be used to analyse models that contain a mixture of categorical and continuous predictor variables[74].

The approach implemented by DISTLM is called *distance-based redundancy analysis* (dbRDA), which was first coined by Legendre & Anderson (1999) and later refined by McArdle & Anderson (2001) . Legendre & Anderson (1999) described dbRDA as a multivariate multiple regression of PCO axes on predictor variables. They included a correction for negative eigenvalues for situations when these occurred (see chapter 3 regarding negative eigenvalues and how they can arise in PCO). McArdle & Anderson (2001) refined this idea to provide a more direct approach which is the method now implemented by DISTLM and described here. It does not require PCO axes to be calculated, nor does it require any corrections for negative eigenvalues. These two approaches are equivalent for situations where no negative eigenvalues would arise in a PCO of the resemblance matrix being analysed.

Both of the PERMANOVA+ routines discussed in this chapter (DISTLM and dbRDA) actually do distance-based redundancy analysis. The DISTLM routine is used to perform partitioning, test hypotheses and build models, while the dbRDA routine is used to perform an ordination of fitted values from a given model. In the dbRDA routine, the structure of the data cloud is viewed through the eyes of the model (so-to-speak) by doing an eigen-analysis of the *fitted* data cloud. While a PCO on the original resemblance matrix is an *unconstrained* ordination (because the resemblance matrix alone is examined, free of any specific model or hypothesis), dbRDA is *constrained* to find linear combinations of the predictor variables which explain the greatest variation in the data cloud.

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[74] The categorical variables in DISTLM models are always treated as *fixed*, so use the PERMANOVA routine instead when dealing with *random* factors. Quantitative continuous variables can be included in a PERMANOVA model by treating them as *covariables* (see chapter 1).

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