ENHANCING MULTIVARIATE ANALYSES IN FORESTRY AND BIOPULPING APPLICATIONS WITH BIPLOT METHODOLOGY

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What is the effect of adding microbiological organisms to wood chips on the chemical properties of the wood pulp? Would there be any effect on the quality properties of the paper made from the pulp? What is the consequence of stress factors like fire damage or insect infestation for the paper and pulp industry? Are the effects different for different tree species?

In order to answer the questions posed above, several measurements on the chemical properties of wood pulp as well as quality properties of paper produced from this pulp were made. Often in practice, each variable is analysed separately which conceals the 'full picture' of interrelationships in the data. Multivariate analyses, such as MANOVA, can be used to analyse the data set as a whole. However, obtaining a single p-value for the analysis might not be very informative. Apart from calculating simultaneous confidence intervals, biplots can be successfully employed in visually assessing the data to arrive at more informative conclusions.

Two experiments will be discussed in this paper. Firstly, different tree species from different locations are compared under various conditions of the pulping process while adding various fungi co-cultures to the pulping process. In the second experiment the effects of insect infestation and fire damage on both the chemical properties of the wood pulp and the quality properties of the paper are investigated.

After a short discussion of the experimental design and one-factor-at-a-time exploratory analysis, it is illustrated how multivariate analyses can be complemented with biplot methods. Different forms of biplots – each aimed at different objectives – can be constructed: Principal Components Analysis (PCA) biplots for optimal representation of the total variation in the data; Canonical Variate Analysis (CVA) biplots for optimal separation of classes in terms of maximising the between to within class variance ratio; and Analysis of Distance (AOD) biplots separating classes of observations without requiring the specific restrictions on the within class covariance matrices needed for CVA.

The different types of biplots will be illustrated and discussed, specifically with reference to answering the questions raised above. As CVA and AOD biplots provide a detailed display of class differences and overlap, it is demonstrated how these visual representations enable the researcher to clearly and easily communicate results to non-statisticians. Guidelines for when to use the different biplots in practice will be discussed. Furthermore, since biplots need not only be employed for exploratory or descriptive purposes, it will be shown how to extend biplot methodology with associated inferential procedures.