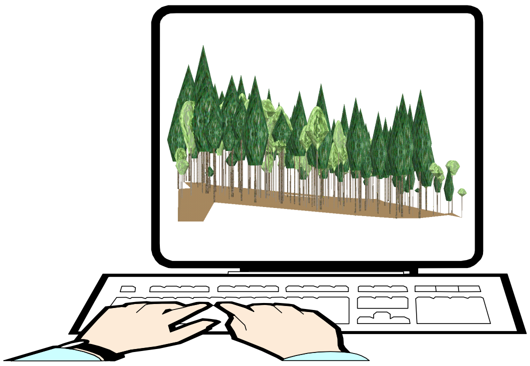
Experimental Silviculture

Diversity Monitoring & Analysis



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1 Introduction

Applying nearest-neighbour indices based on the "Structural Group of Four" (Füldner, 1995, 1996) allows the quantification of spatially explicit diversity characteristics without measuring tree locations. This is a so-called "in situ" diversity survey, i.e. structural indices are determined for every tree of a circular sample plot directly in the forest. An alternative that we will not use is the collection of raw data in the field followed by a calculation of structural indices at the computer back in the office. The objective of this exercise among other things is to demonstrate and to acquire the straightforward practical application of nearest neighbour indices.

2 Method

A Structural Group of Four is determined for every tree in a circular sample plot by identifying the four nearest neighbours according to intertree distance (see Fig. 1). Then a structural measure is assigned to the reference tree (every tree of a circular sample plot acts once as reference tree) using information of the nearest neighbour trees. As part of this exercise your task is to determine the following diversity indices:

- Species mingling $M_i^{(4)}$
- Diameter dominance $U_i^{(4)}$
- Diameter differentiation (1st neighbour only) T_i

This implies measurements (i.e. mostly visual assessments: For determining diameter dominance for example you just need to check whether the reference tree has a smaller or larger stem diameter than the neighbour trees), which are shown in Fig. 1.

Diameter and tree species are known from previous surveys so that you can read this information from the printout of the attached MS Excel tables. For orientation in the field and for recognising the sample trees the maps in the appendix may prove helpful.

In order to avoid *edge bias effects* please consider the following recommendations (Pommerening und Stoyan, 2006; Motz *et al.*, 2010):

1. The locations (i.e. stem centre coordinates) of all reference trees need to be inside the circular sample plots (i.e. all trees on the maps in the appendix).

2. The stem centre coordinates of the neighbours of reference trees can be outside the circular sample plot. These off-plot trees should be considered for determining diversity measures if they are closer to a given reference tree than any alternative neighbour tree inside the circular sample plot (plus-sampling).

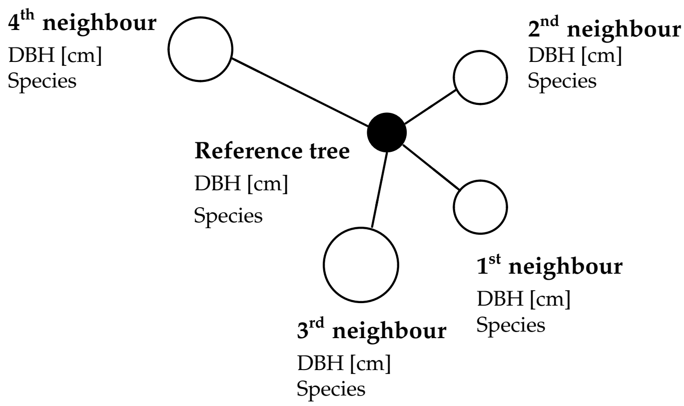

Figure 1. A hypothetical Structural Group of Four and the measurents/assessments necessary for this exercise.

For measuring the diversity of tree locations we use the "mean of angles" index by Assunção (1994, see Fig. 2).

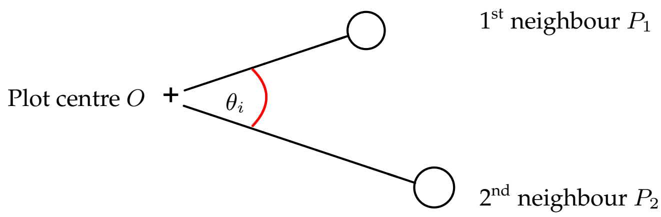

Figure 2. Measurements required for the "mean of angles" index θ_i by Assunção (1994) applied to the plot centre.

θ_i is only measured *once* in the centre of each circular sample plot. P_1 and P_2 are the trees closest to the plot centre. Please note that always the smallest angle between

P_1OP_2 is recorded so that $\theta_i < 180^o$.

3 Practical interpretation guides

To ease the assessment of species mingling, diameter dominance and diameter differentiation in the Structural Groups of Four please use the following guidelines. The verbal statements always relate to the reference tree.

3.1 Species mingling

M_i^4	**Description**	**Mingling**
0.00	4 of 4 neighbours = species of reference tree	No
0.25	3 of 4 neighbours = species of reference tree	Weak
0.50	2 of 4 neighbours = species of reference tree	Moderate
0.75	1 of 4 neighbours = species of reference tree	Intimate
1.00	0 of 4 neighbours = species of reference tree	Very intimate

3.2 Diameter dominance

U_i^4	**Description**	**Dominance**
0.00	4 of 4 neighbour DBHs > DBH of reference tree	Overtopped
0.25	3 of 4 neighbour DBHs > DBH of reference tree	Suppressed
0.50	2 of 4 neighbour DBHs > DBH of reference tree	Co-dominant
0.75	1 of 4 neighbour DBHs > DBH of reference tree	Dominant
1.00	0 of 4 neighbour DBHs > DBH of reference tree	Predominant

3.3 Diameter differentiation

For calculating diameter differentiation we require the DBH of the reference tree and its first nearest neighbour only. Then we compute $T_i = 1 - \frac{\text{Smaller DBH}}{\text{Larger DBH}}$ no matter whether the reference tree or its neighbour has the larger or smaller DBH.

T_i	**Description**	**Differentiation**
$[0.0, 0.3)$	Smaller tree has at least 70% of larger tree's dimension	Weak

$[0.3, 0.5)$	Smaller tree has at least 50% of larger tree's dimension	Average
$[0.5, 0.7)$	Smaller tree has at least 30% of larger tree's dimension	Strong
$[0.7, 1.0)$	Smaller tree has less than 30% of larger tree's dimension	Very strong

4 Data analysis

Your task is to calculate the following characteristics for the whole stand and separately for the most common species by pooling the data of all circular sample plots:

- Arithmetic mean of species mingling, diameter dominance, diameter differentiation and "mean of angles",
- Relative-frequency distributions of species mingling, diameter dominance and diameter differentiation.

The relative frequency distributions can be calculated by using the 4-5 categories or classes of the corresponding interpretation guide and counting the number of trees in each of the categories across all circular sample plots (separately for the whole stand and for the main species). Finally you divide the number of trees in each category by the total number of trees in all circular sample plots. You can do these calculations in R or in MS Excel. Present your results in a PowerPoint presentation and include interpretations and conclusions.

References

Assunção, R. 1994. Testing spatial randomness by means of angles. *Biometrics* **50**, 531 - 537.

Füldner, K. 1995. *Strukturbeschreibung von Buchen-Edellaubholz-Mischwäldern*. [Description of structure in mixed beech forests.] PhD thesis Göttingen University. Cuvillier Verlag Göttingen, 162p.

Füldner, K. 1996. Die „Strukturelle Vierergruppe" - ein Stichprobenverfahren zur Erfassung von Strukturparametern in Wäldern. [The Structural Group of Four – a sampling method for monitoring forest structure.] In: Gadow, K. v. und Beisch, Th., 1996. *Beiträge zur Waldinventur. Festschrift zum 60. Geburtstag von Prof. Dr. Alparslan Akça*. Cuvillier Verlag Göttingen, pp 13-30.

Pommerening, A. and Stoyan, D. 2006. Edge-correction needs in estimating indices of spatial forest structure. *Can. J. For. Res.* **36**, 1723-1739.

Motz, K., Sterba, H. and Pommerening, A. 2010. Sampling measures of tree diversity. *For. Ecol. Manage*. **260**, 1985-1996.

5 Appendix: Sample plot maps

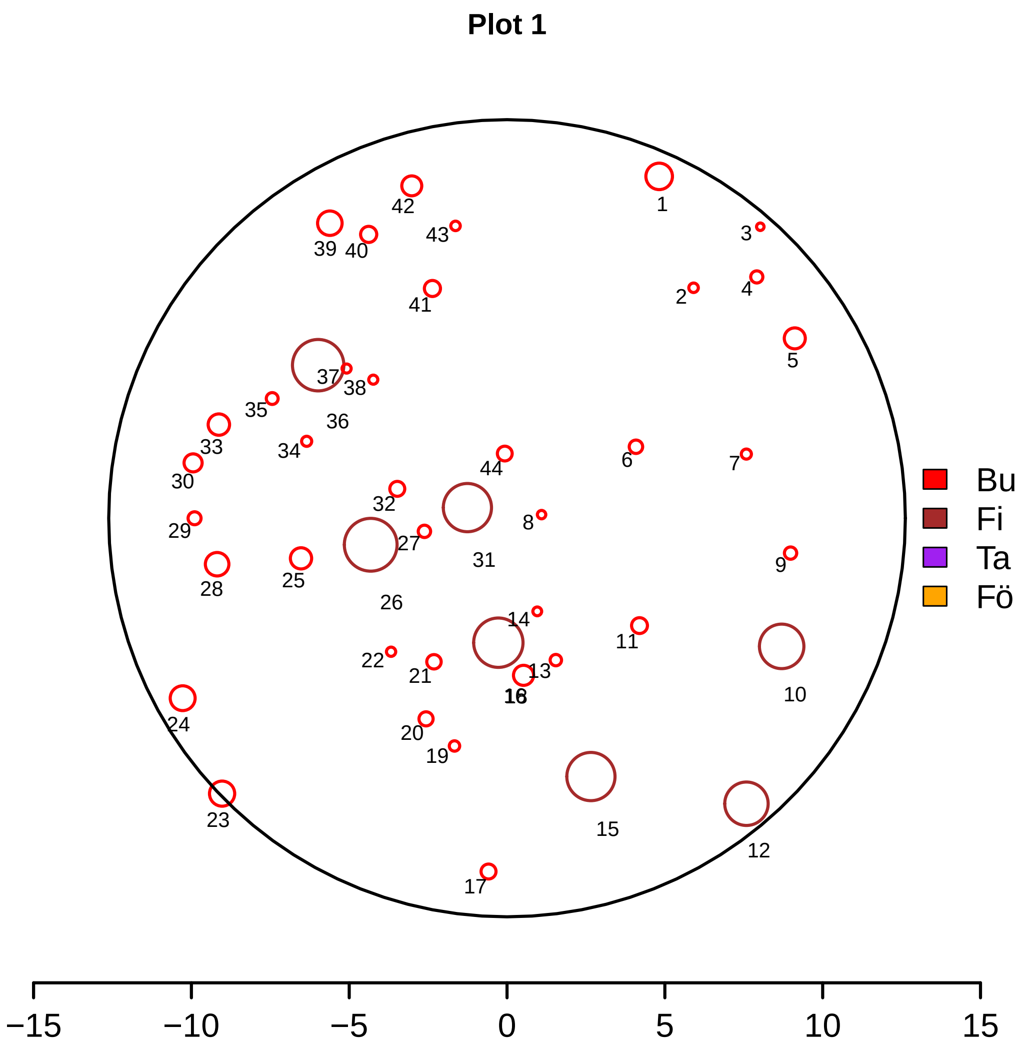

Figure 3. Tree locations in plot 1. The circular shapes denoting tree locations were weighted with the corresponding DBH.

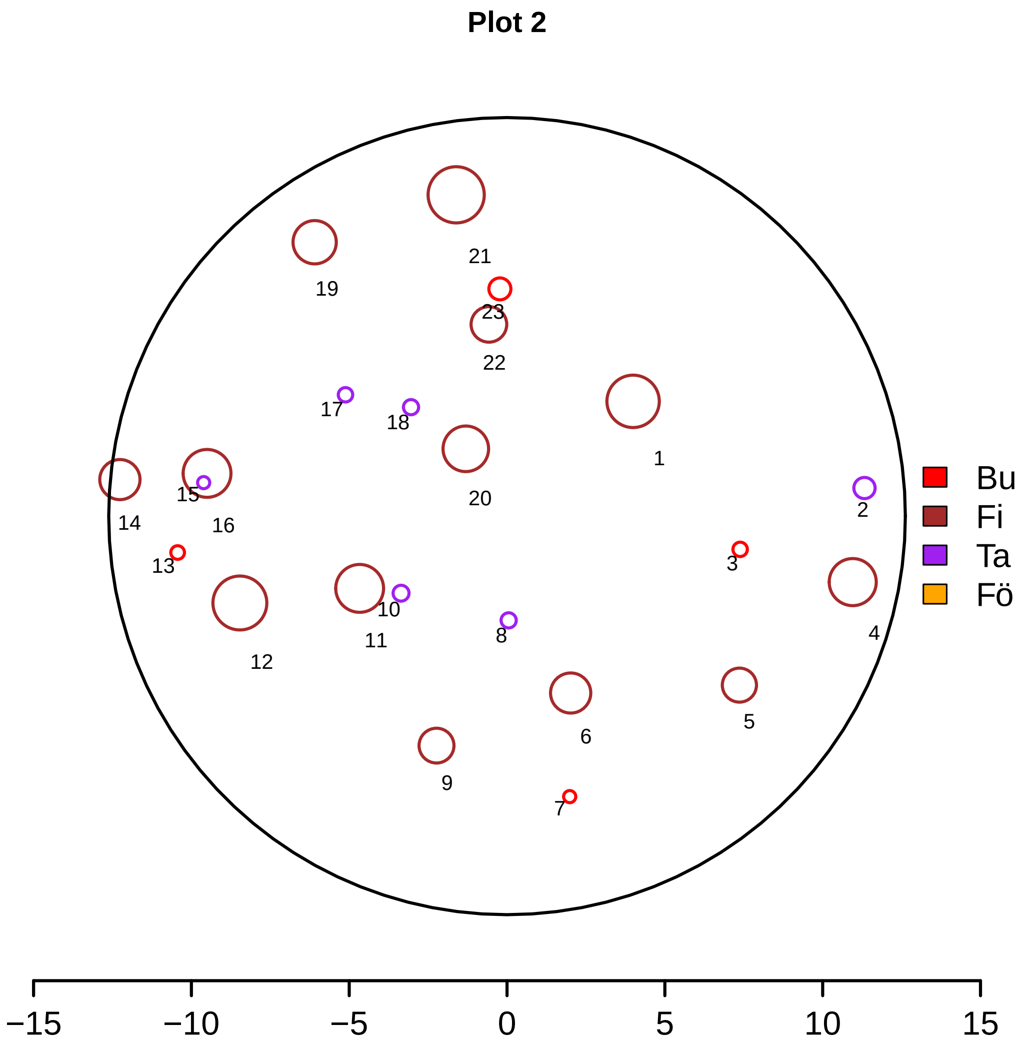

Figure 4. Tree locations in plot 2. The circular shapes denoting tree locations were weighted with the corresponding DBH.

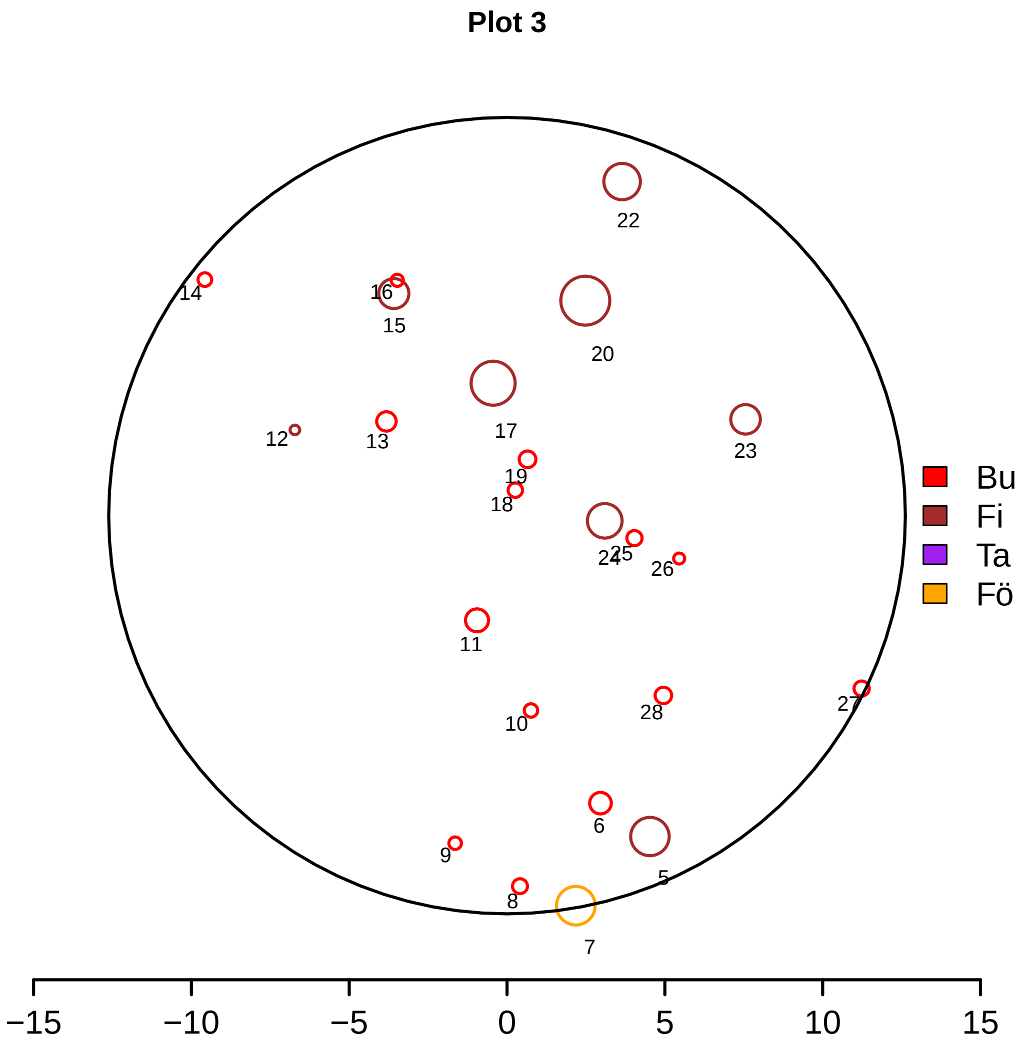

Figure 5. Tree locations in plot 3. The circular shapes denoting tree locations were weighted with the corresponding DBH.

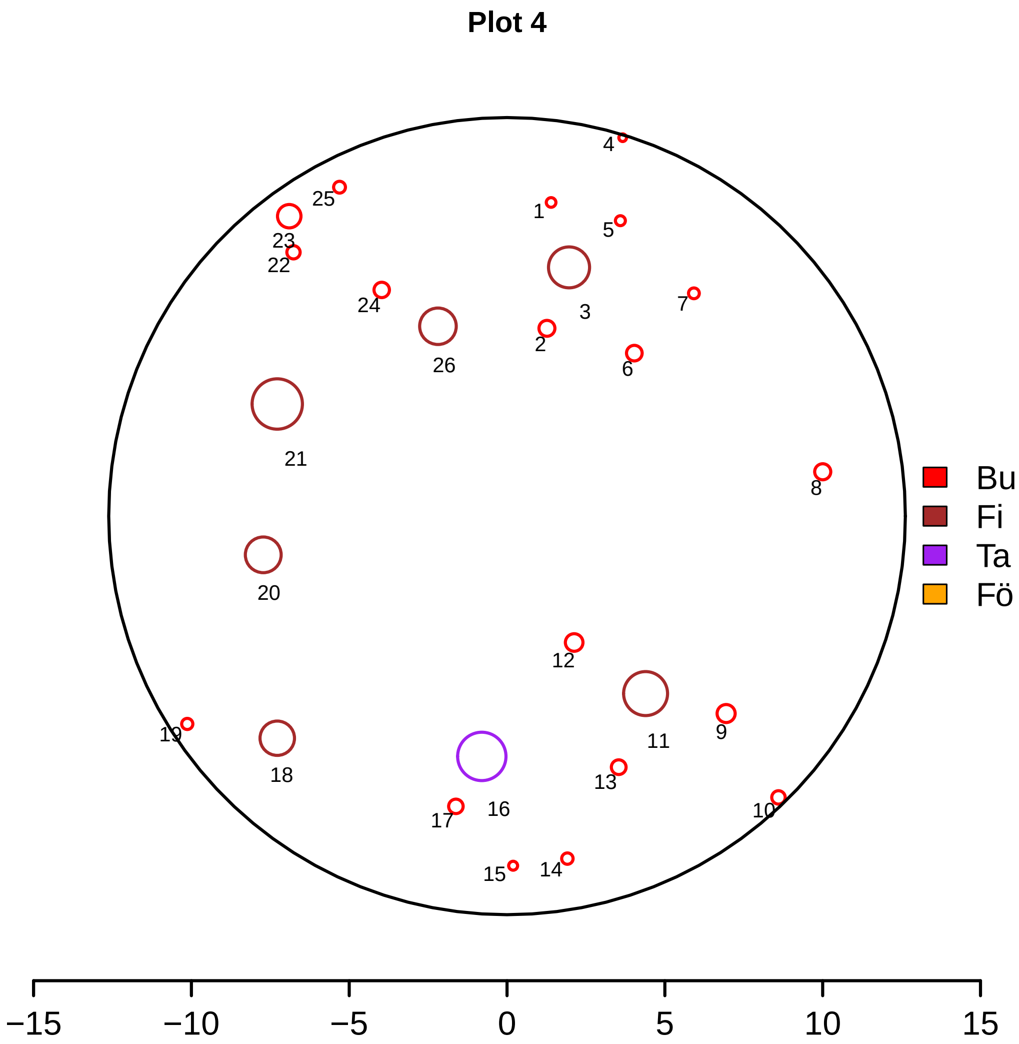

Figure 6. Tree locations in plot 4. The circular shapes denoting tree locations were weighted with the corresponding DBH.