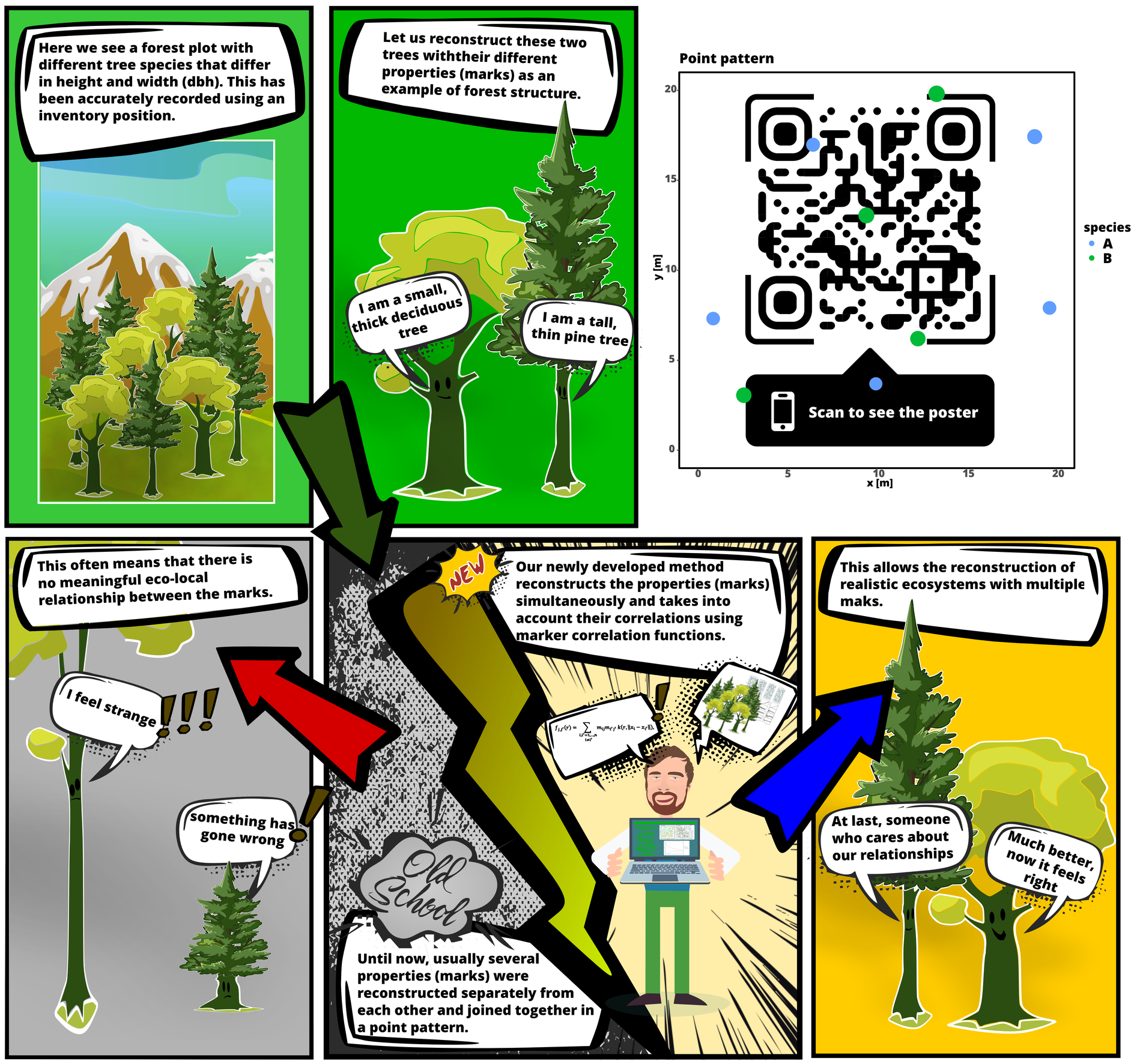
Multi-trait point pattern reconstruction of plant ecosystems

Chris Wudel[1], Robert Schlicht[1], Uta Berger[1]

[1]TU Dresden, Institute of Forest Growth and Forest Computer Sciences, Chair of Forest Biometrics and Systems Analysis, Tharandt, Germany

Background

- Plants interact locally through a variety of processes.
- Processes include competition for resources, natural regeneration, mortality and subsequent succession.
- These interactions give rise to complex patterns and dynamics.
- Local plant interactions give rise to specific spatial patterns.
- These patterns change over time as a result of evolving processes.
- Spatial data refers to the location of individual plants and their characteristics.
- Example: Locations of specific tree species and their diameters.
- Statistical analysis of point patterns helps to understand the underlying processes. This analysis can reveal changes caused by different environmental scenarios.
- Numerical reconstruction is a key technique in dot pattern analysis.
- It serves two main purposes:
- To generate null models for comparison with the observed patterns.
- To evaluate the information in the observed data using summary statistics.
- Reconstructed data can be used to initiate individual-based or agent-based plant models.
- These models use artificially generated realistic data.
- The purpose is to analyse and predict the evolution of plant systems.



Methods

- Method uses second-order point pattern analysis.
- Uses summary statistics such as pair correlation and mark correlation functions.
- Involves iterative modification of the reconstructed spatial pattern.
- Aims to minimise the distance (energy) between generated and observed patterns.
- Aims for high statistical similarity by minimising differences in summary statistics.

$$f_{j,j'}(r) = \sum_{\substack{i,i'=1,\dots,n \\ i \neq i'}} m_{ij} m_{i'j'}\, k(r, \|x_i - x_{i'}\|)$$

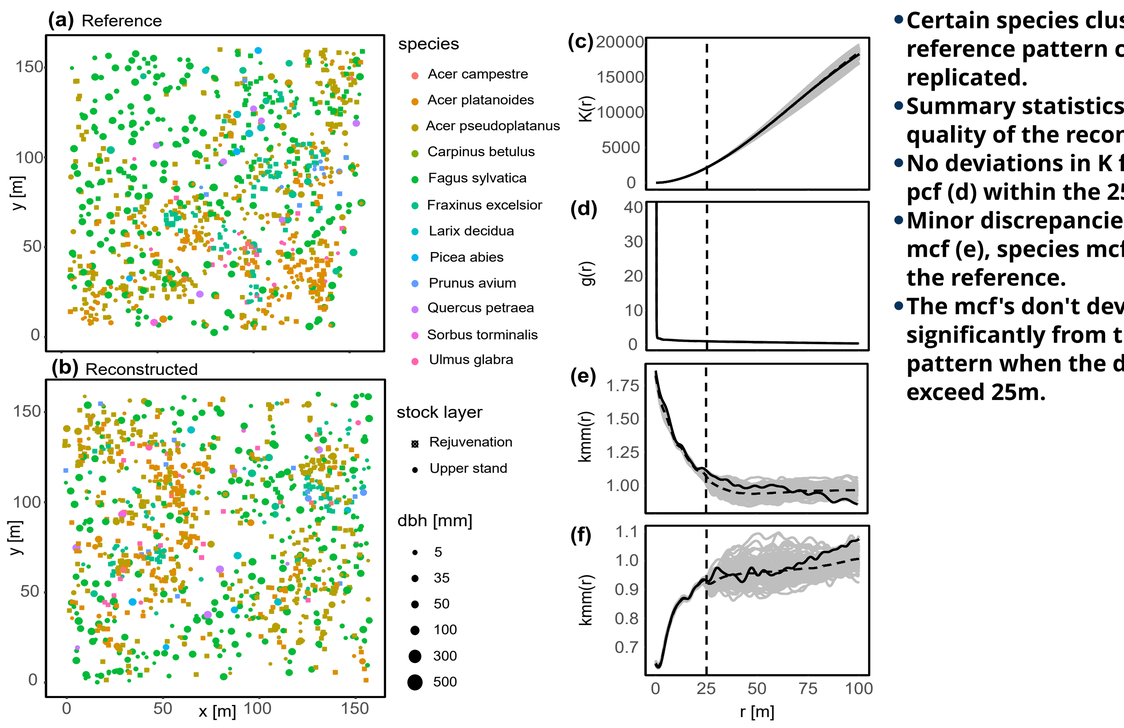
$x_i, x_{i'}$ = locations of points i and i'

$\|x_i - x_{i'}\|$ = Euclidean distance

$mij, mi'j'$ = marks j and j' of points i and i'

$k(r,\cdot)$ = integration kernel at distance r

Results



- Certain species clusters in the reference pattern can be replicated.
- Summary statistics show the high quality of the reconstruction.
- No deviations in K function (c) and pcf (d) within the 25m range.
- Minor discrepancies in diameter mcf (e), species mcf (f) are close to the reference.
- The mcf's don't deviate significantly from the reference pattern when the distance doesn't exceed 25m.

Conclusion

- Method is ideal for creating statistically plausible versions of real forest stands.
- Useful for initialising individual-based forest growth models.
- Applicable beyond forests, suitable for reconstructing different point patterns.
- Effective for cases with significant points (two or more).
- Adaptable to spatial systems with fixed object positions and multiple landmarks.
- Examples of applicable systems: grass/coral communities, settlement areas.

Acknowledgements and Reference

- Funded by Federal Ministry of Food and Agriculture Waldklimafonds, Berlin, Germany. Function code: 2219WK17X4

Reference:
Scan to checkout the publication

- The publication on which this poster is based can be found with the following QR code.

- Wudel, C., Schlicht, R., & Berger, U. (2023). Multi-trait point pattern reconstruction of plant ecosystems. Methods in Ecology and Evolution, 00, 1–12. https://doi.org/10.1111/2041-210X.14206

- Contact: M.Sc. Chris Wudel
E-Mail: chris.wudel@tu-dresden.de

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