Automatic tree species recognition with quantitative structure models

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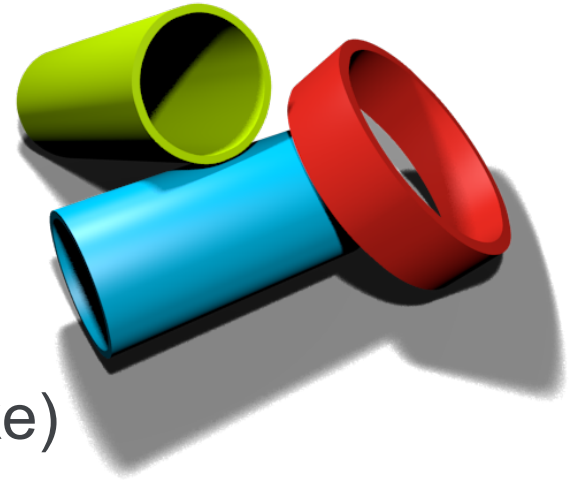
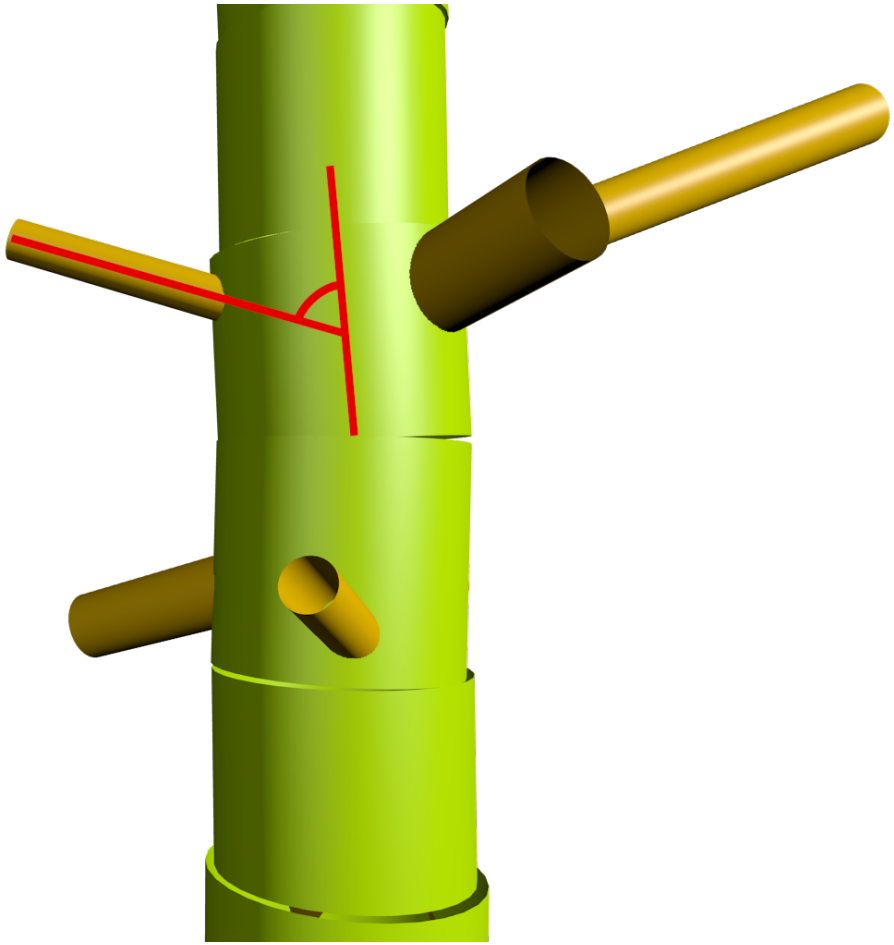


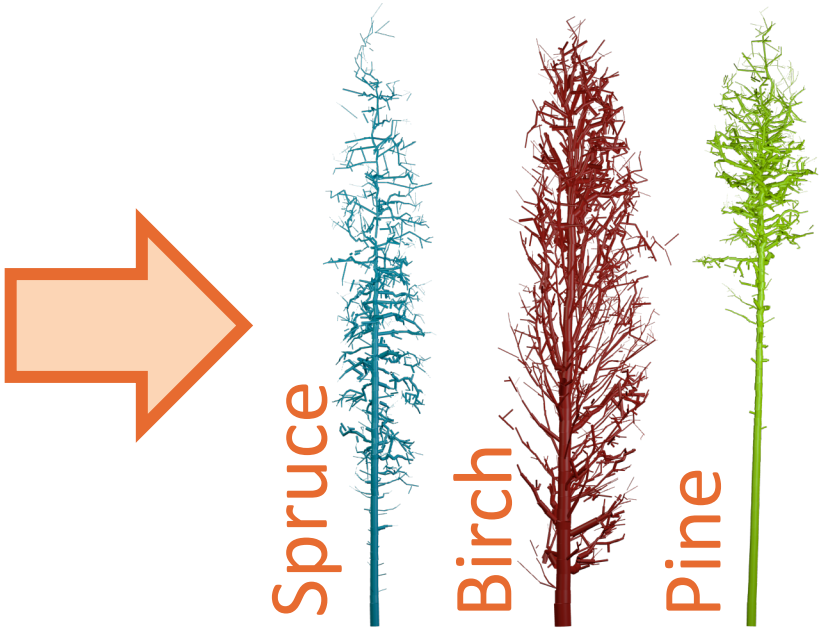
Summary

- Quantitative structure models (QSM) can be reconstructed from terrestrial laser scanner (TLS) data automatically
- QSM offers more than 3 data dimensions from which to derive novel species classification features
- Classification tested using 5 forest plots from Finland and over 1200 trees consisting of 3 species.
- Over 96 % classification accuracy
- As little as 30 training samples per species required



Species recognition from TLS data

- Tree species information is key in, e.g., biomass and biodiversity analysis
- High level of automation is required for large scale analysis
- Some species recognition methods based on TLS data exist, but require human interaction and/or additional data sources
- We propose an automatic approach using reconstructed QSMs



Background

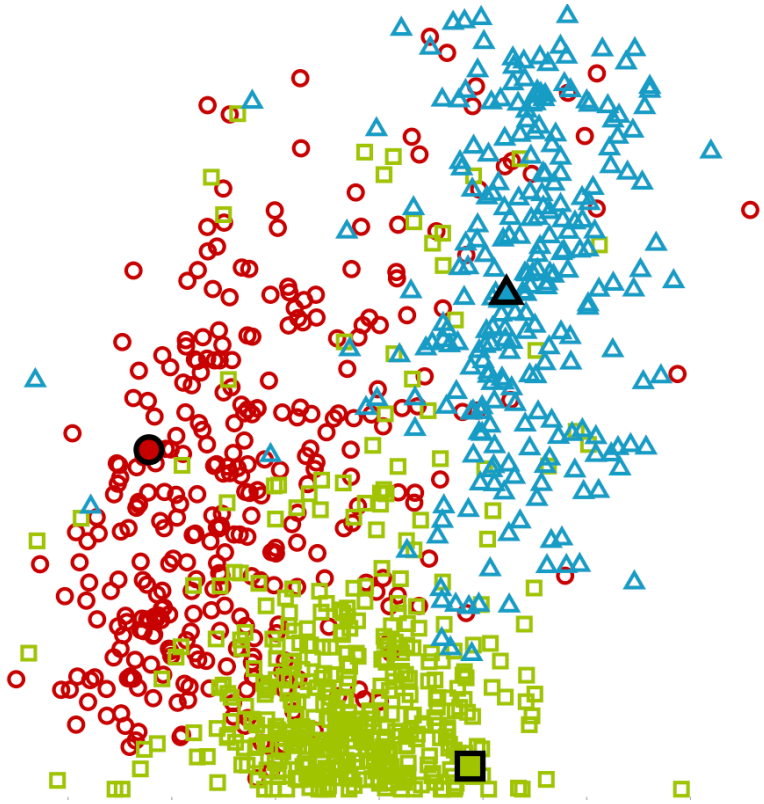
- 2013: Method to reconstruct comprehensive QSMs of single trees from TLS data
- 2015: Generalization to massive scale => automatic forest plot reconstruction
- Now: Use QSMs to compute classification features and detect tree species automatically after reconstruction
- Previous methods require some manual interaction, or additional data sources

Materials and methods

- 3 single-species and 2 multi-species forest plots from Finland scanned terrestrial LiDAR
- Each tree detected and reconstructed automatically as a cylinder-based QSM
- 15 classification features computed
- Feature combinations tested using 5 different classification approaches: k-NN, multinomial regression and 3 support vector machines

Results: single-species forest plots

- Separate forest plots for Silver birch, Scots pine and Norway spruce trees
- Tested all possible feature combinations:
  - 4-NN resulted in best accuracy in most cases, but
  - all approaches performed well with 6 to 15 features
  - maximum accuracy > 96 %
- Only 30 training samples required per tree species



Results: mixed-species forest plots

- Preliminary results from two mixed-species forest plots dominated by Norway spruce trees
- Using single-species forest plot trees as training data:
  - Maximum accuracy 76 %
- Augmenting training data with Norway spruce tree samples from mixed-species forest plots:
  - Maximum accuracy 81 % for all trees
  - Up to 93 % for spruce trees

Single-species plots: Silver birch, Scots pine, Norway spruce

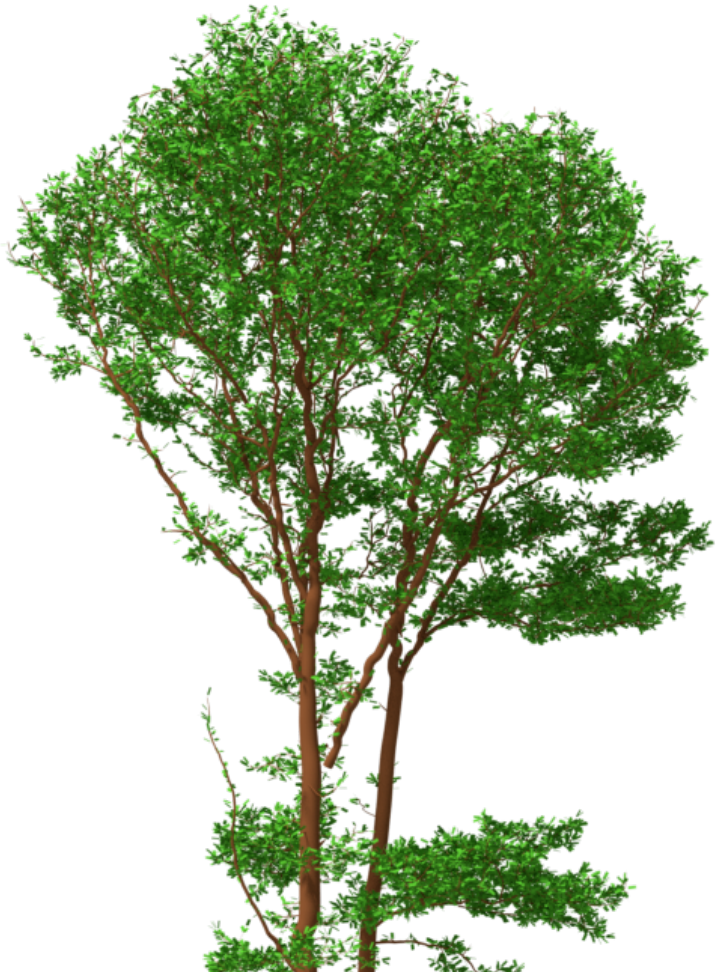
Mixed-species plots: Silver birch, Scots pine, Norway spruce

Conclusion

- QSM reconstruction gives access to new classification features
- High-accuracy tree species classification possible when proper training data is available
- No additional data and no extra high-resolution TLS required
- Fully automatic species classification is possible

3	1200	96%
SPECIES	TREES	ACCURACY

Next steps/future work



- Comprehensive testing with additional tree species
- Determine the best classification features
- Combine with additional data sources
- Test how leaves affect classification accuracy
- Optimize the number of scans and required resolution