Buds morphometrics – How to distinguish and predict tree species with images of buds

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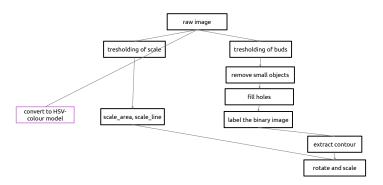


Figure: Setup for taking images

- Goal was to describe buds with image descriptors and make species predictions
- 46 pictures of 1422 buds

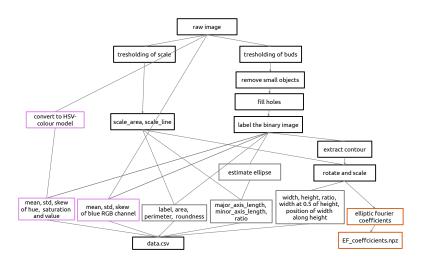
Analysis workflow

Analysis workflow



Analysis workflow

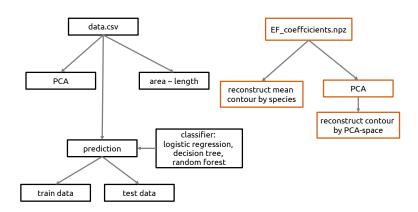
Analysis workflow



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Results

- Acer pseudoplatanus, n=90
- Aesculus hippocastanum, n=39
- Alnus glutinosa, n=361
- Carpinus betulus, n=94
- Fagus sylvatica, n=191
- Populus canadensis, n=220
- Quercus petraea, n=266
- Tilia platyphyllos, n=161

Figure: Colours used in all following images

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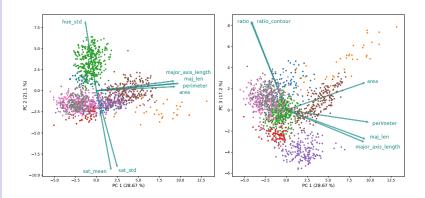


Figure: Principal component analysis of the complete data set

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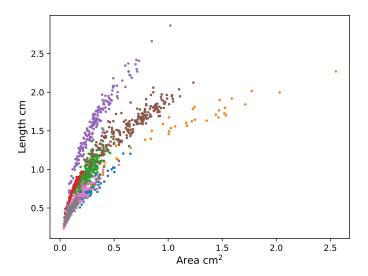


Figure: Area and major axis length of estimated ellipse of all buds

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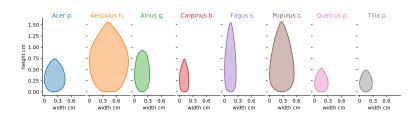


Figure: Mean contours of all species reconstructed from elliptic fourier coefficients

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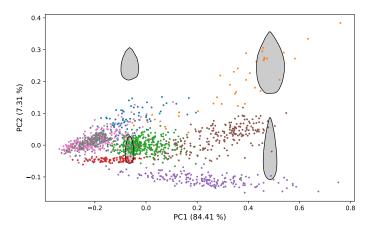


Figure: Principal component analysis of the elliptic fourier coefficients of the shape of buds

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Prediction of species

Table: Result of 200 times predicting the species with the three methods, numbers for the correct assignment are given in percent \pm standard deviation

Method	Train data	Test data
Logistic regression	97.4 ± 0.3	95.9 ± 0.8
Decision Tree	99.3 ± 0.3	92.8 ± 1.3
Random Forest	99.9 ± 0.1	96.2 ± 0.9

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Prediction

Prediction of species

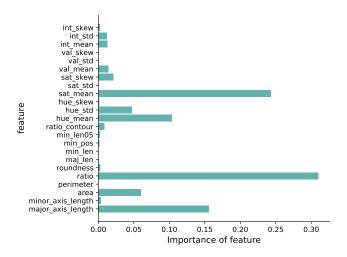


Figure: Importance of image descriptors for the decision tree

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Segmentation of buds was done on a white paper

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- Segmentation of buds was done on a white paper
- Test performance of prediction with higher number of species, buds from different localities

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- Segmentation of buds was done on a white paper
- Test performance of prediction with higher number of species, buds from different localities
- Do the colour values show real differences?

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- Segmentation of buds was done on a white paper
- Test performance of prediction with higher number of species, buds from different localities
- Do the colour values show real differences?
- Lengths from estimated ellipse <> lengths from shape

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Used setup worked overall well, prediction showed high accuracy

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- Used setup worked overall well, prediction showed high accuracy
- next steps:
 - analyse images taken directly on the tree outside
 - add more species
 - add pictures from more locations
 - implement convolutional network / deep learning approach

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Conclusion

- Used setup worked overall well, prediction showed high accuracy
- next steps:
 - analyse images taken directly on the tree outside
 - add more species
 - add pictures from more locations
 - implement convolutional network / deep learning approach
- most important features: overall size (e.g. major axis length), colour values (e.g. mean saturation) and the ratio between the minor and the major axis length

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Used packages in Python 3.8:



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Thank you for your attention! :)

Do you have questions or comments?

All images and the Python code are available at:

https://github.com/FelixNoessler/Budsmorphometrics