

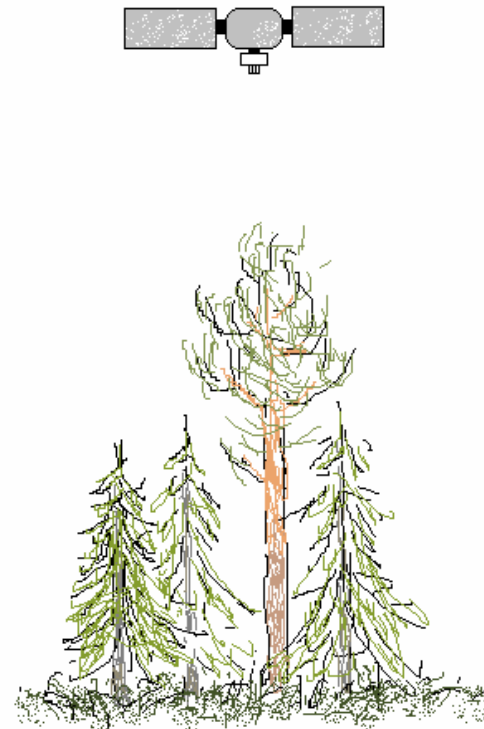


Single Tree Detection in High Resolution Satellite Images and Digital Aerial Images using Artificial Neural Networks and a Geometric- Optical Forest Model

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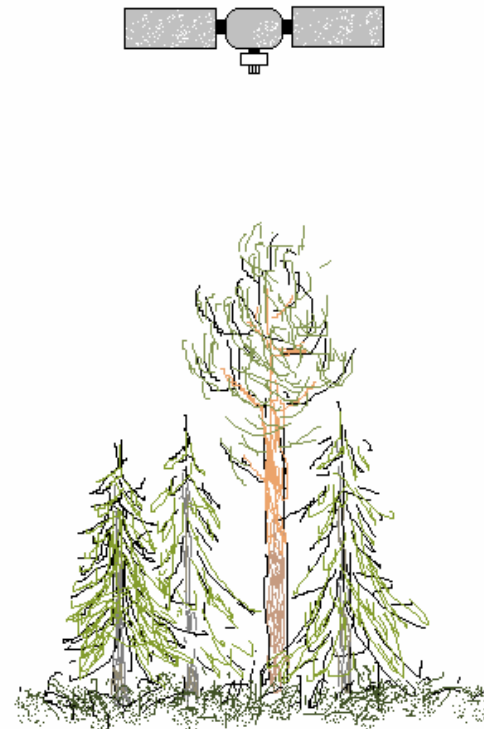
Single tree detection techniques

- Every tree is unique
- Irregular crown shapes
- View angle
- Cast shadow



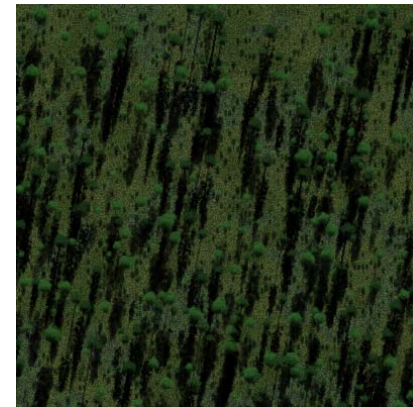
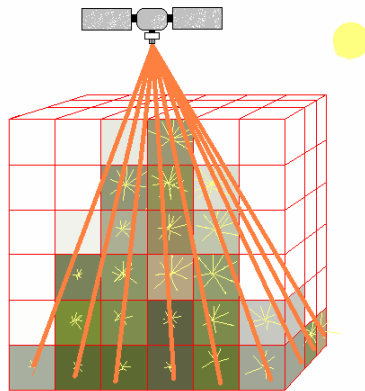
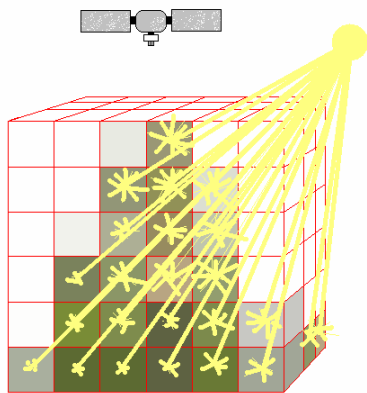
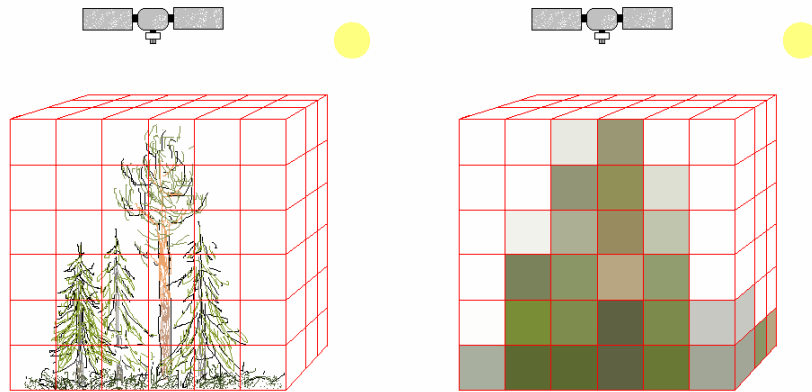
Empirical methods

- Learning systems
- Neural networks
- Large training datasets

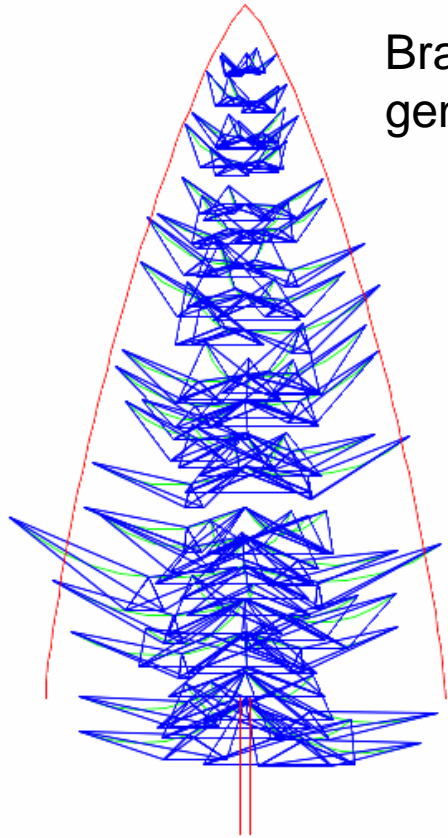


Geometric-optical forest model

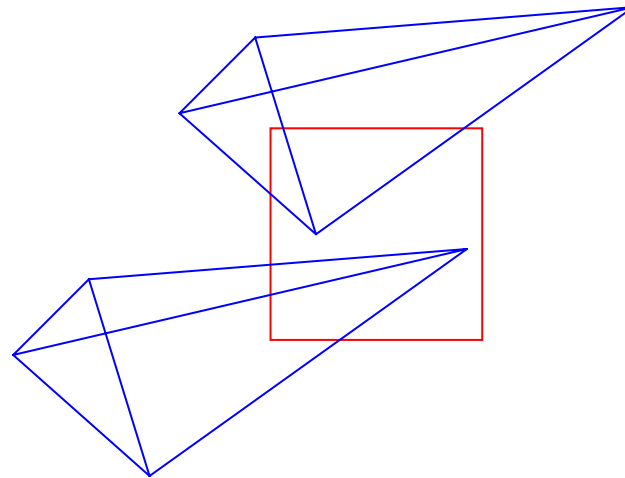
- Scene model
- Radiative transfer model
- Sensor model



Branch structure

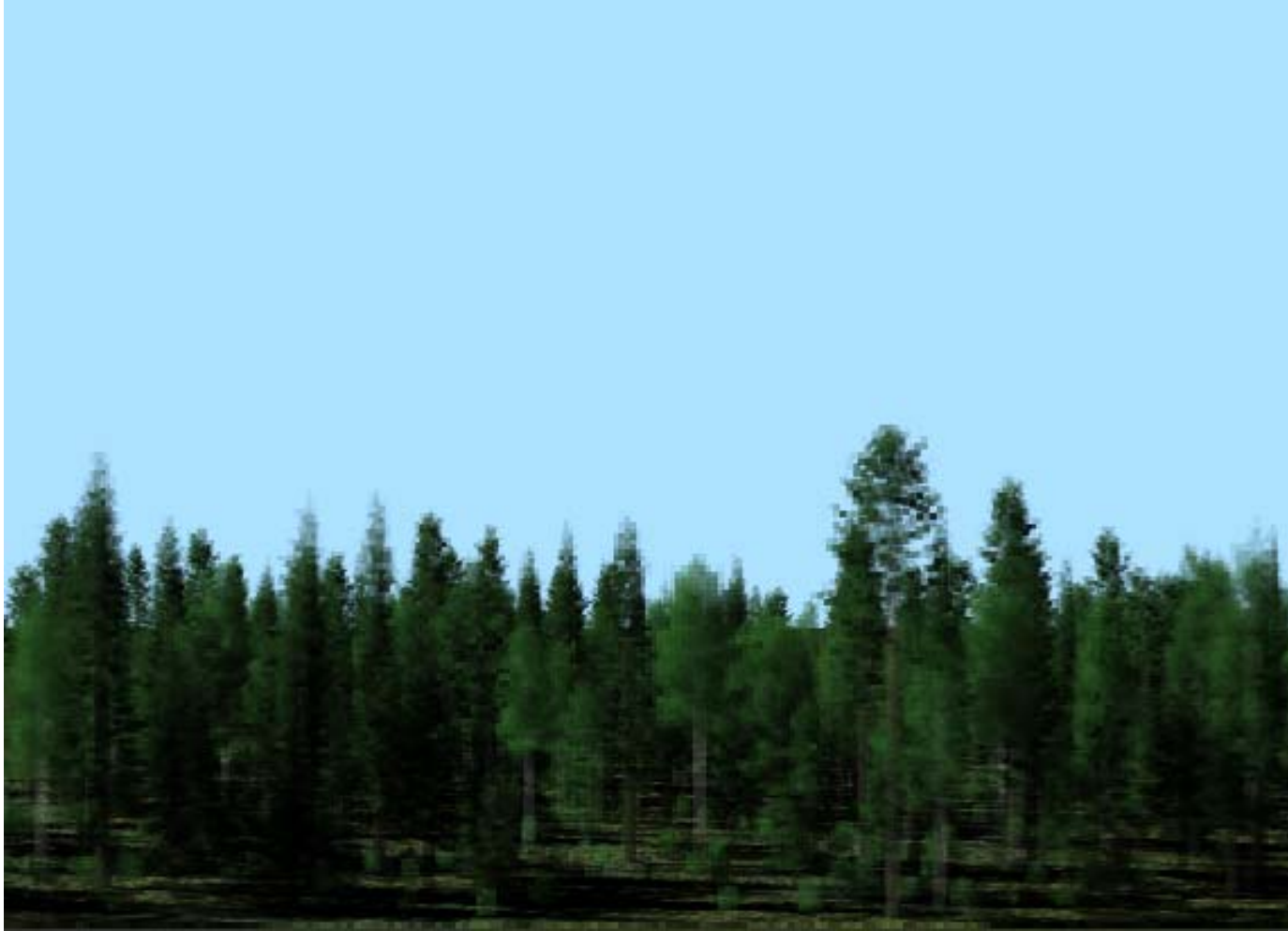


Branch structure generated within a generalized ellipsoid of revolution

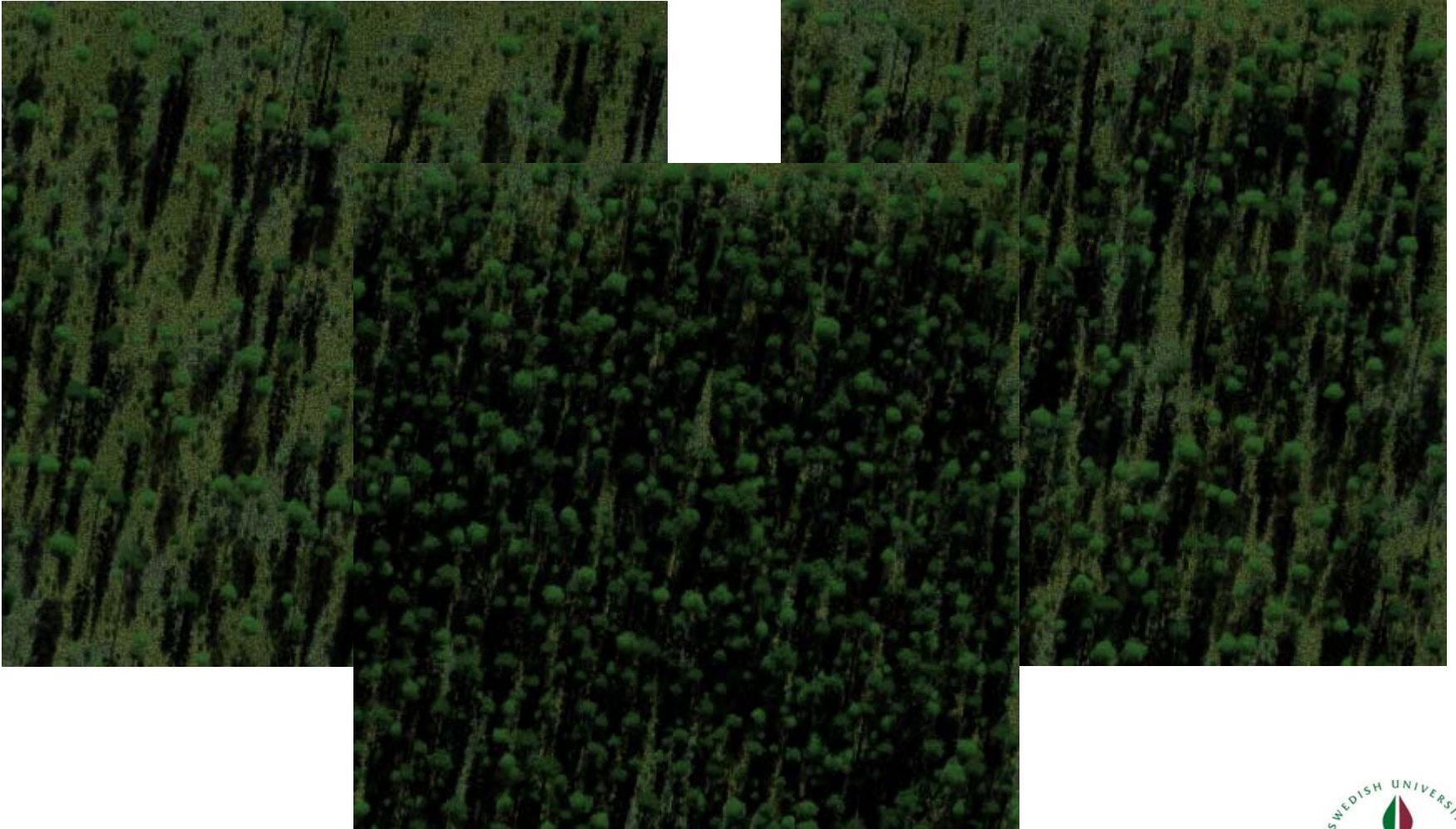


The optical properties of a voxel is determined by the properties of the material tetrahedrons and their volume proportion

Virtual forest



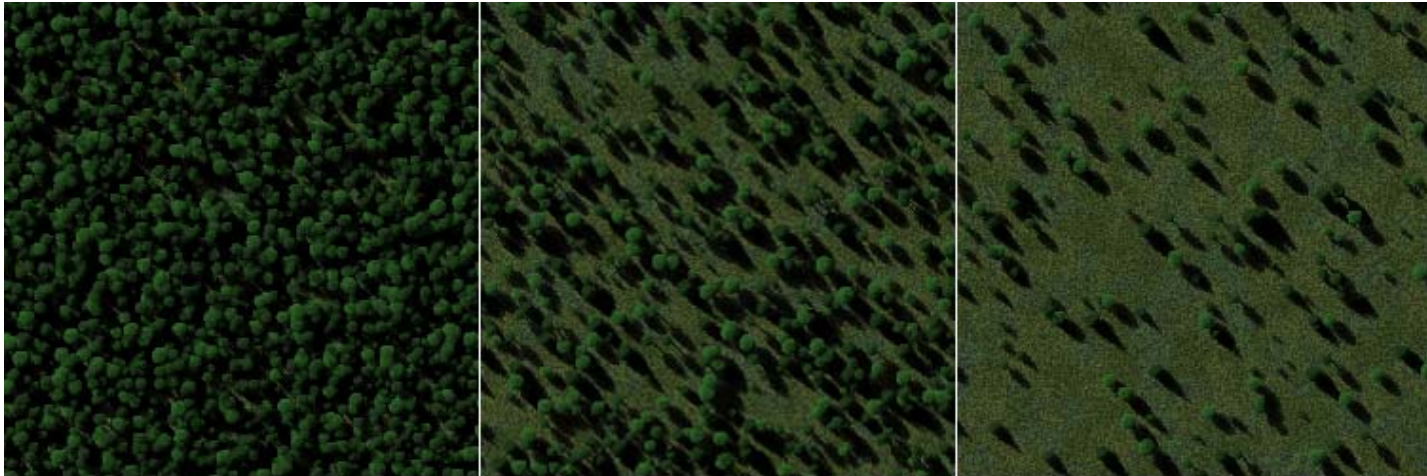
Nadir view



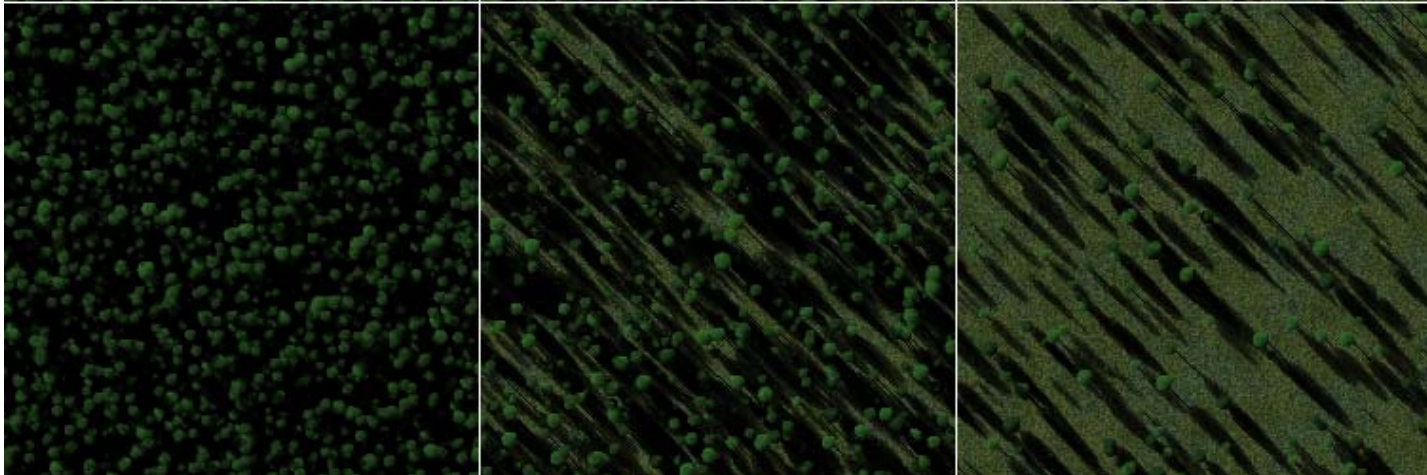
Satellite image simulation

Sun elevation angle

45°



20°



Ground Pixel size
0.6 [m]

Sensor altitude
450 [km]

Stems / hectare

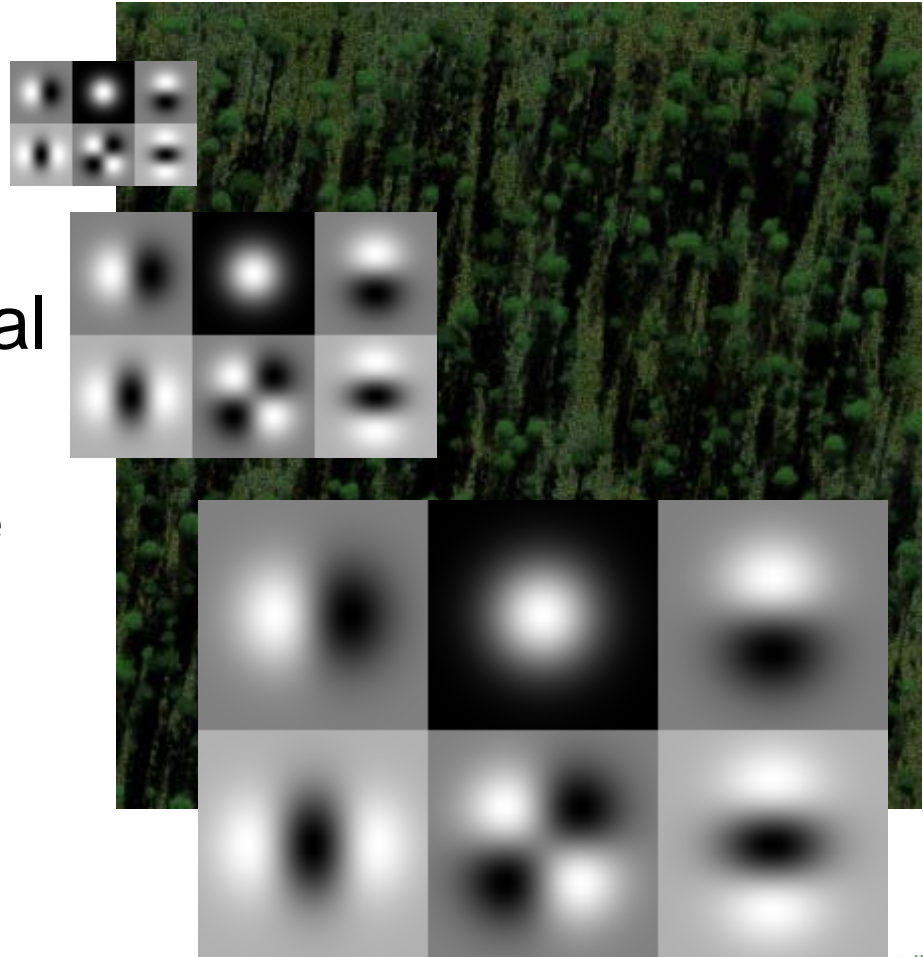
1200

300

75

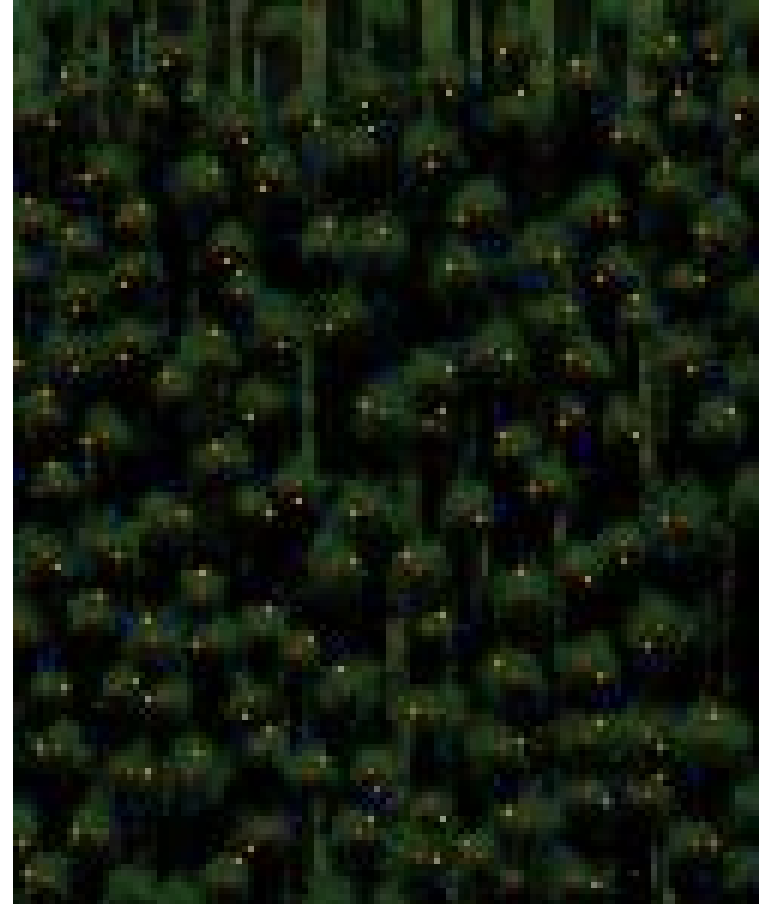
Training data

- INPUT: Filters with different scale operating on a virtual image
- OUTPUT: Tree size and tree position in the virtual image

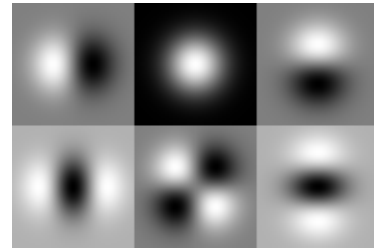


Training data for neural network

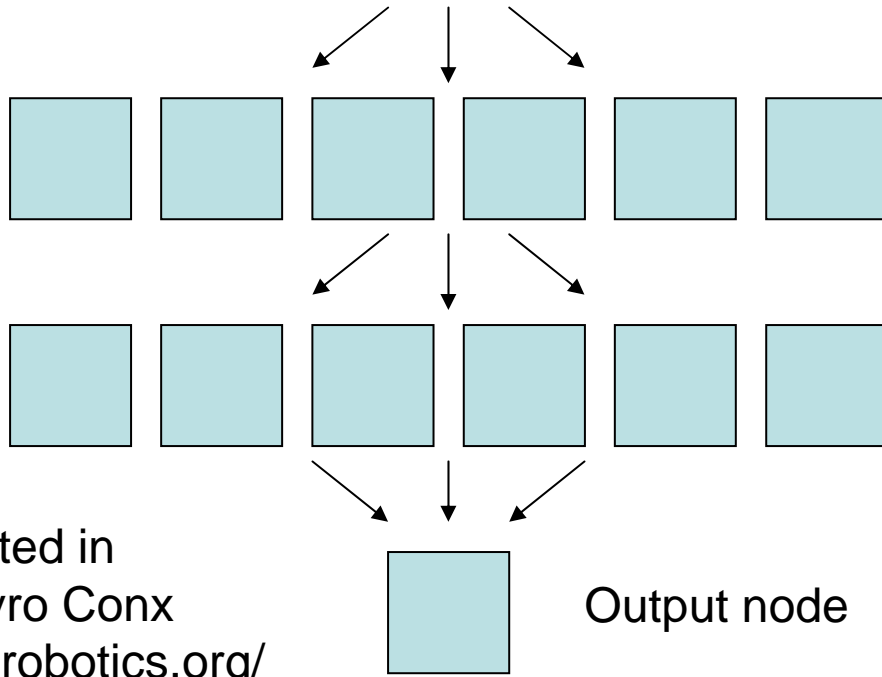
- Positions on the tree tops
- Positions on edges
- Positions between the trees



Preliminary experiment with a simple backpropagation neural network



Filter answers at position i,j



Input nodes

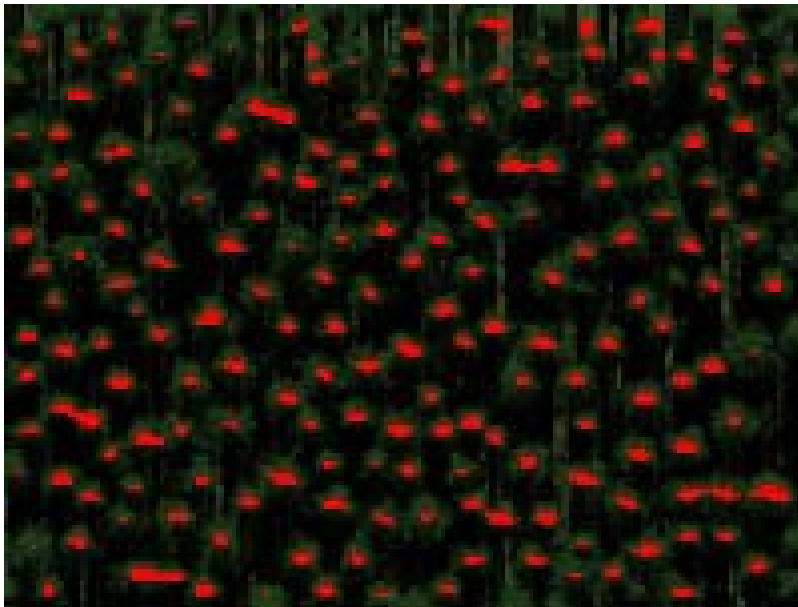
Hidden nodes

Output node

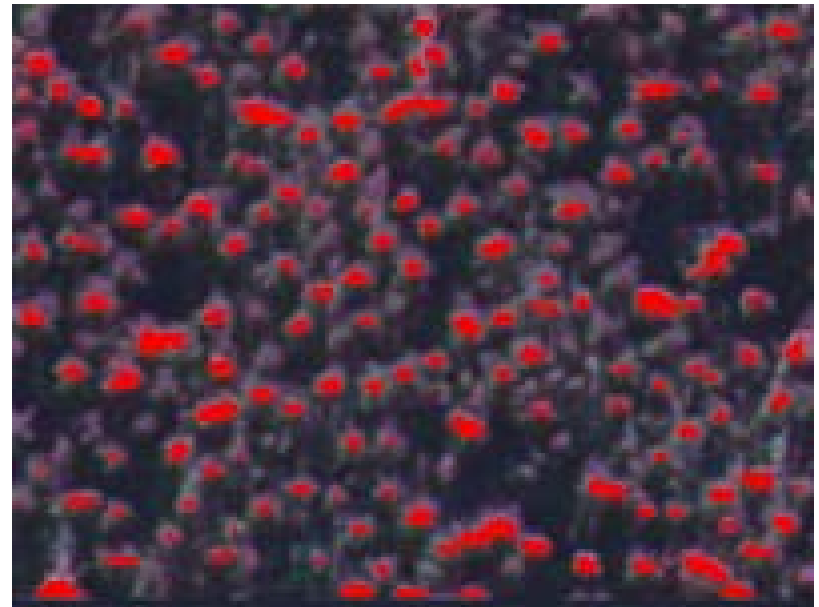
Implemented in
Python Pyro Conx
<http://pyrorobotics.org/>

Using a trained network to detect single trees in aerial and satellite images

Virtual image/training data set

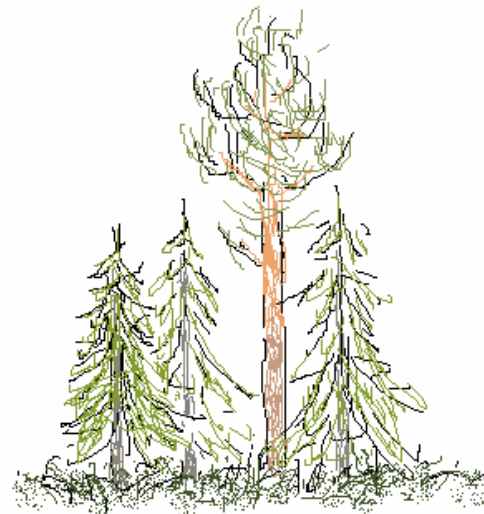
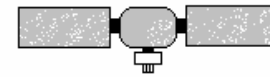


Aerial image



Future work

- Atmospheric transfer model
- Multiple scattering
- Large training set for neural network inversion
- Investigating different types of filters



Acknowledgements

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