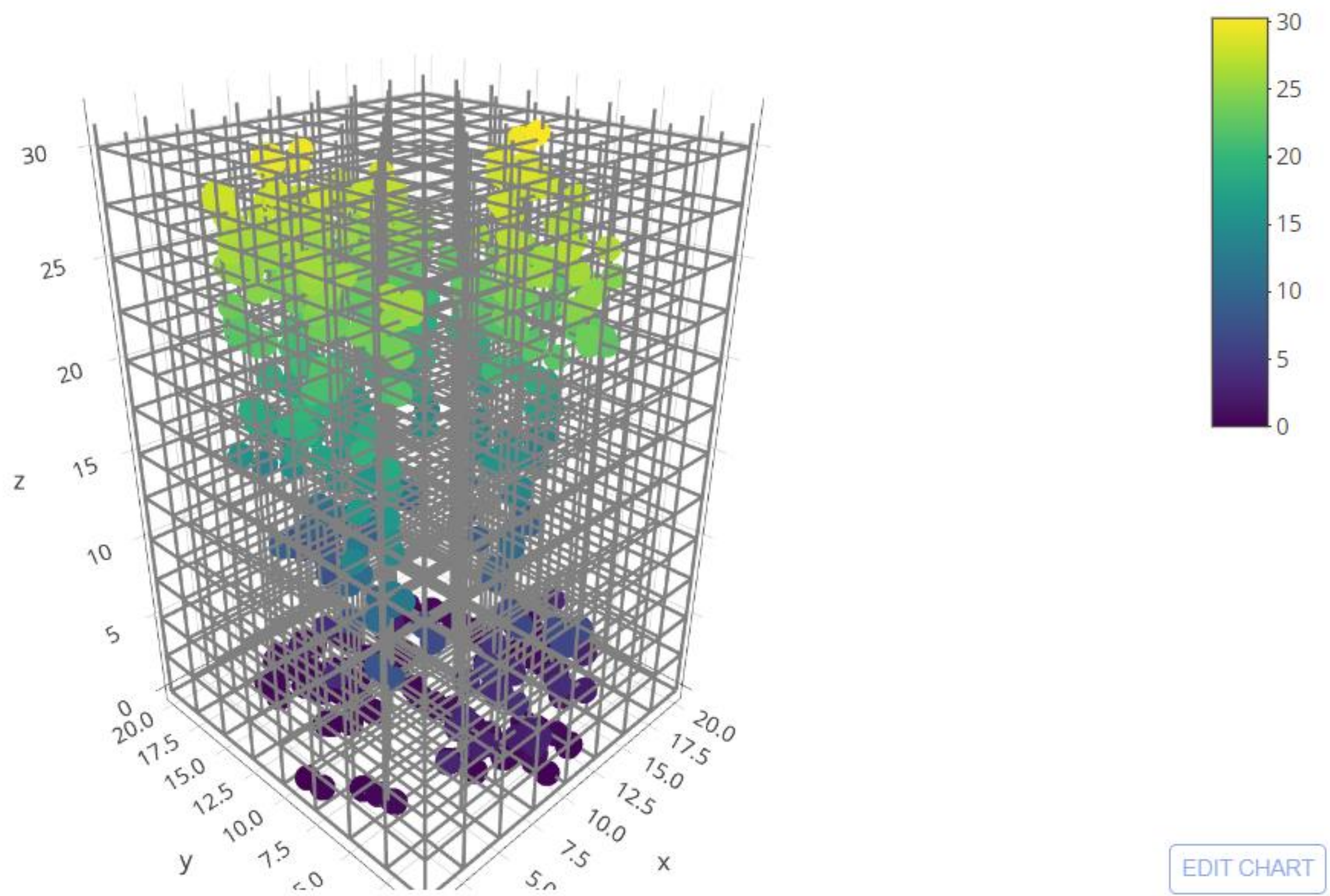
Predicting tree species specific growing stock using ALS point clouds and a 3D-Convolutional Neural Network

Seminar - Machine Learning with spatial data
Helsinki, CSC, 27.2.2024

Neural Networks have revolutionized many aspects of our lives, can they do the same in forestry related applications?

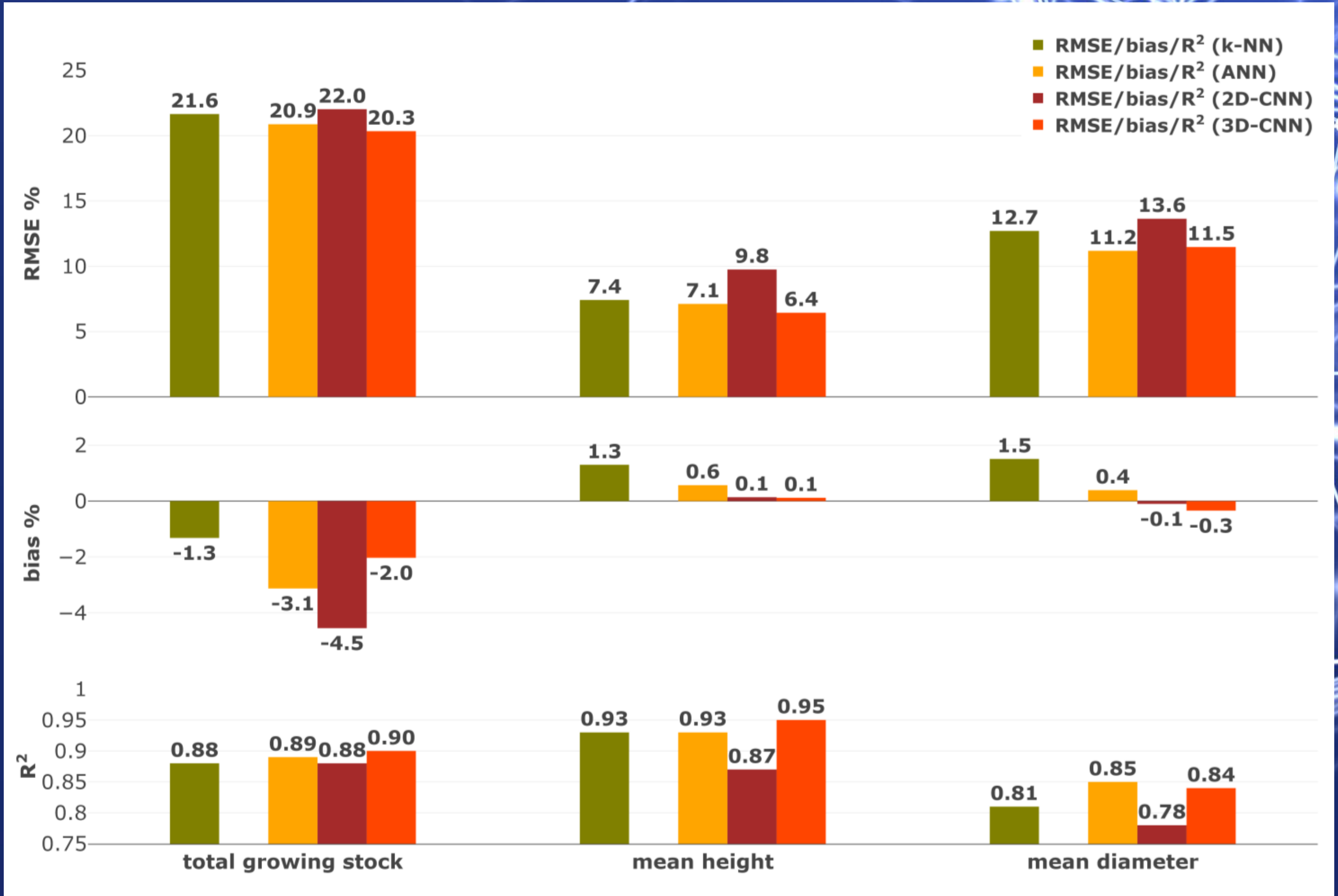
Benchmark method	Neural Networks
k-Nearest Neighbor with genetic algorithm	Artificial Neural Network
	2D Convolutional NN
	3D Convolutional NN

Increasing complexity



Source: https://plotly.com/~balazsan/7/

Edit


RMSE/bias/R² (k-NN)
RMSE/bias/R² (ANN)
RMSE/bias/R² (2D-CNN)
RMSE/bias/R² (3D-CNN)
RMSE %
bias %
R²
21.6
20.9
22.0
20.3
7.4
7.1
9.8
6.4
12.7
11.2
13.6
11.5
-1.3
-3.1
-4.5
-2.0
1.3
0.6
0.1
0.1
1.5
0.4
-0.1
-0.3
0.88
0.89
0.88
0.90
0.93
0.93
0.87
0.95
0.81
0.85
0.78
0.84
total growing stock
mean height
mean diameter

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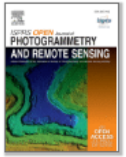

Comparison of neural networks and k-nearest neighbors methods in forest stand variable estimation using airborne laser data

Andras Balazs, Eero Liski, Sakari Tuominen, Annika Kangas

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Next steps:

- Adjusting voxel size → adjusting kernel sizes

Next steps:

- Adjusting voxel size → adjusting kernel sizes
- Tree species specific estimates

Tree species specific estimates:

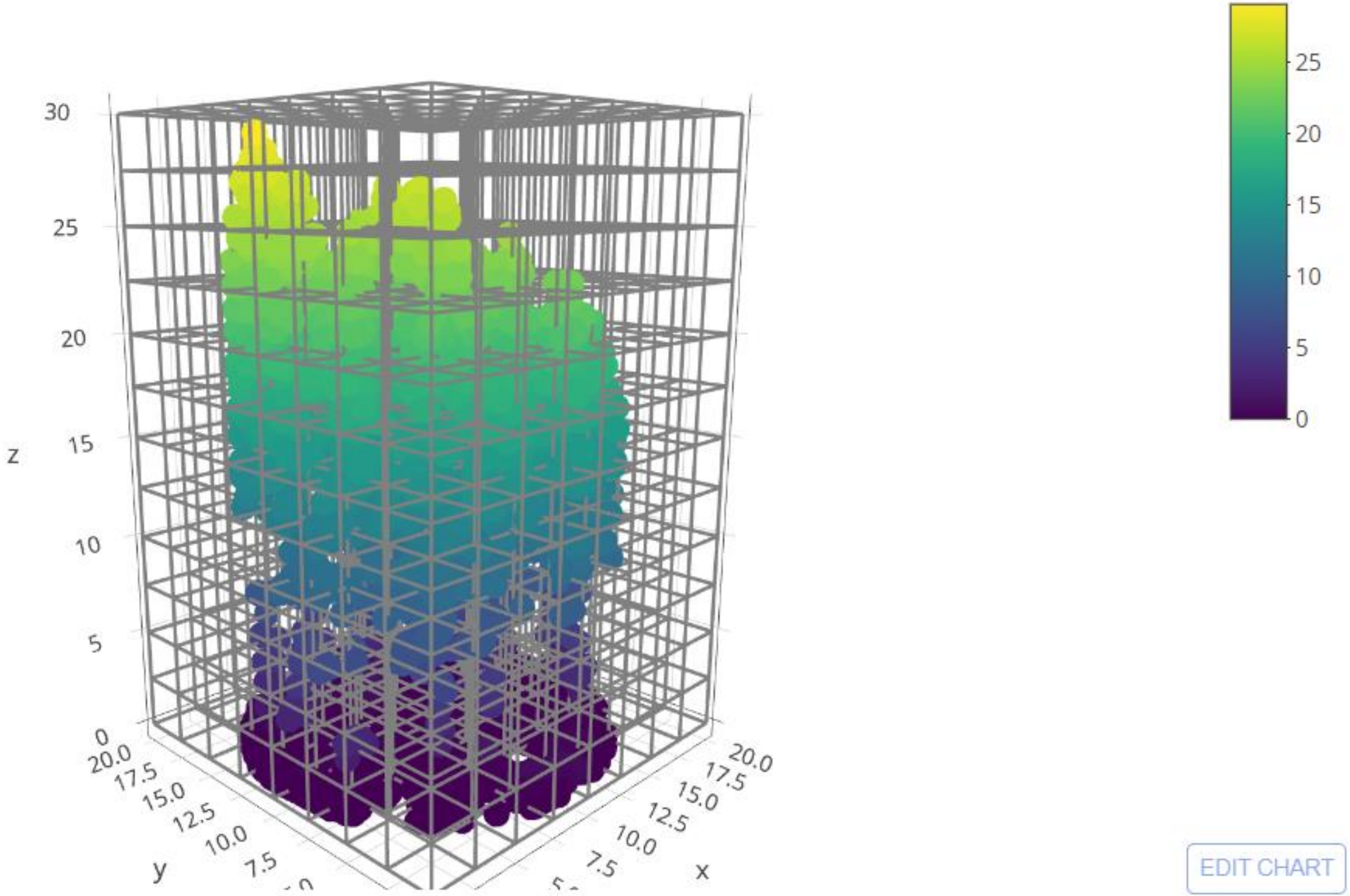
$$V_{total} = V_{pine} + V_{spruce} + V_{broadleaf}$$

$$pred_{prop} = Softmax(Concat([pred_{pine}, pred_{spruce}, pred_{broadleaf}]))$$

$$pred_{V(p,s,b)} = pred_{V(total)} \times pred_{prop}$$

Next steps:

- Adjusting voxel size → adjusting kernel sizes
- Tree species specific estimates
- Testing new generation 5p/m^2 pulse density ALS data



Source: https://plotly.com/~balazsan/5/

To test:

- NNs with point cloud input (no need for voxelization → loss of information)

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Deep point cloud regression for above-ground forest biomass estimation from airborne LiDAR

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Kiitos!