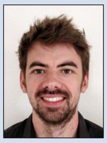

Damian Schori

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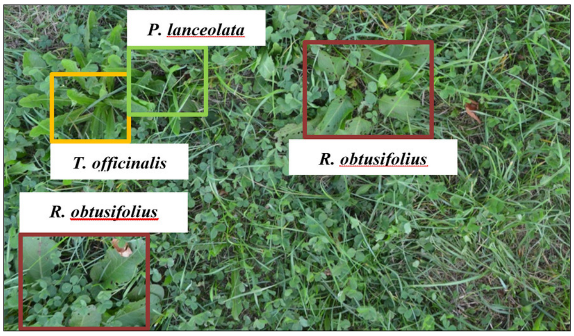
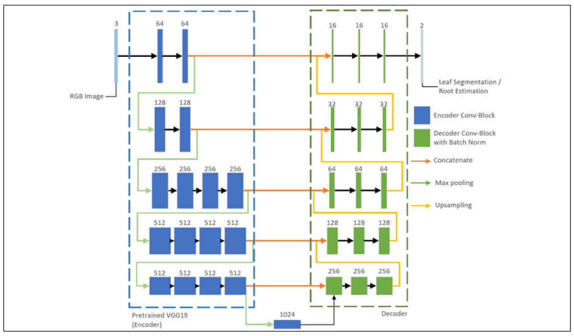
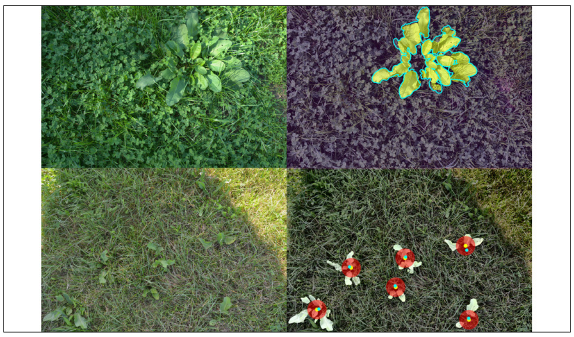
Using Fully Convolutional Networks for Rumex Obtusifolius segmentation and detection



Detail of a training image containing similar plants in size and shape to R. obtusifolius
Own presentment



Proposed Network Architecture based on U-Net
Own presentment



Predictions on Test Data (yellow: predicted, cyan: ground truth).
Top: Leaf Segmentation, Bottom: Root Detection
Own presentment

Problem: In the field of agriculture automation, it is an essential task to locate individual plants from images in grassland.

The process of detecting and segmenting individual Rumex obtusifolius plants in their natural environment is an challenging task due to plants showing significantly varying poses, sizes and complex shapes. Furthermore, the habitus of R. obtusifolius varies in function of its natural environment and appears in different sizes and constellations in a field. Additional factors such as changing light and field properties influence the detection.

Approach / Technology: Due to recent advances in Deep Learning, exploration of new processing procedures became far less time consuming. Particularly in the field of image analysis, deep convolutional neural networks (CNN) have proven to be state of the art as they can automatically learn and extract important features of an image.

The proposed plant segmentation and root detection scheme is mainly making use of an adapted version of U-Net, a fully convolutional neural network (FCNs). FCNs were introduced in the literature as a natural extension of CNNs to tackle per pixel prediction problems such as semantic image segmentation. FCNs add up-sampling layers to standard CNNs to recover the spatial resolution of the input at the output layer.

The proposed network was trained on 400 images and validated on 100. To teach the network the desired invariance and robustness properties we made use of real time data augmentation during training time. In the case of field-images primarily shift and rotation invariance as well as robustness to light, size and bluring variations is needed.

Result: With the proposed method the following results concerning leaf segmentation and root detection could be achieved:

- The overall leaf segmentation rate is 83.9% measured by the dice coefficient
- The root detection shows a accuracy of 84.4% with a tolerance radius of 30 pixels considering a maximum of 6 plants per image.

The following advantages result from the proposed method:

- Robust to changing environmental conditions
- Trainable on small Datasets
- No high- resolution images required
- Fast predictions

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