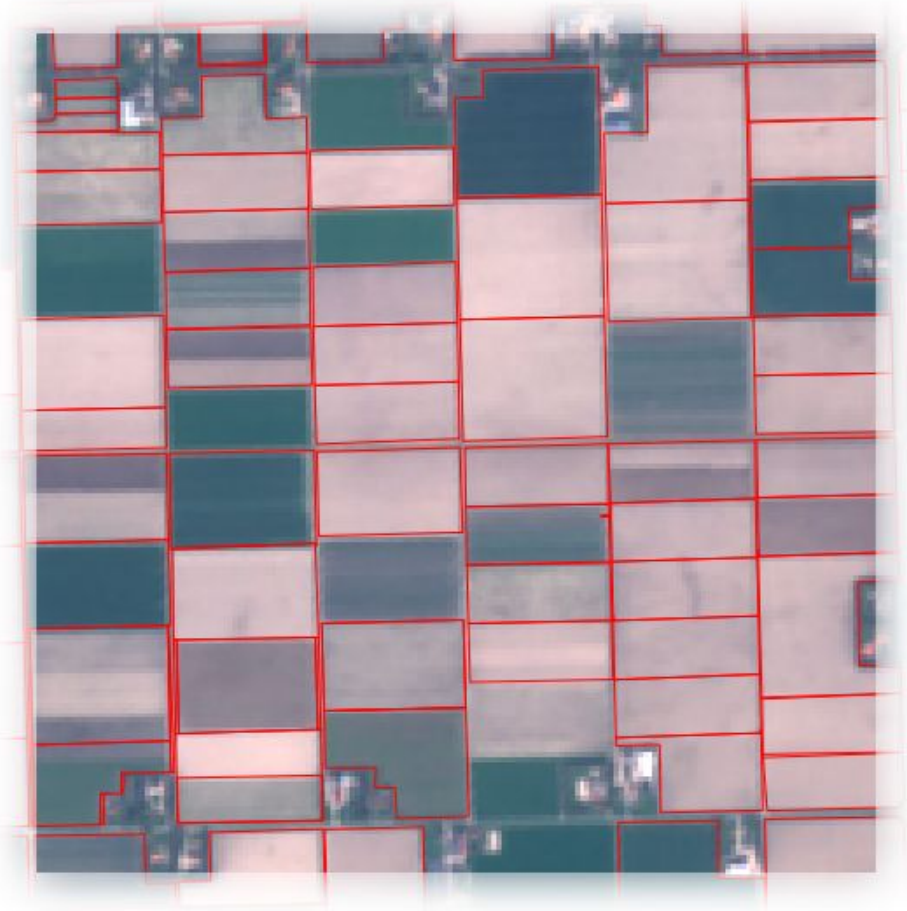
20.04.2017
Christoph Rieke

Deep Learning for Instance Segmentation of Agricultural Fields

supervised by

Prof. Dr. Christiane Schmullius (FSU Jena)
Adam Erickson (MPI BGC Jena)

Agricultural Field Boundaries



Applications:

- Crop type / yield monitoring
- Subsidy management
- Precision farming

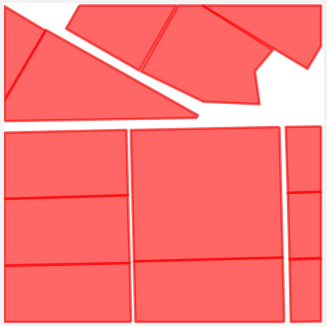
Existing datasets:

- LPIS (EU)
- CLU (US)

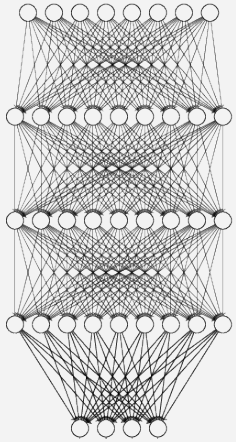
Objective

Training

Train Image



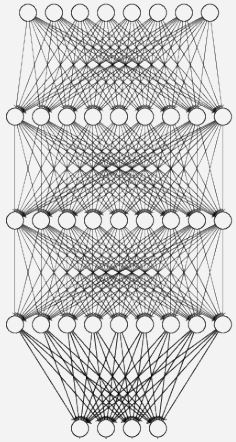
Train Fields



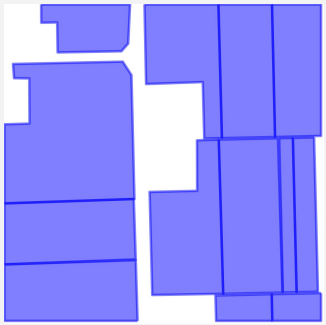
Trained Model

Prediction

Test Image



Trained Model

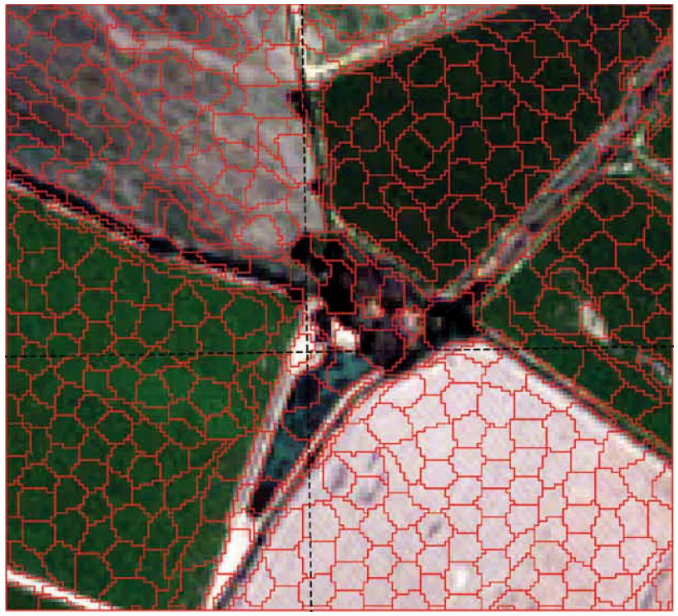


Predicted Fields

Traditional Segmentation

Traditional

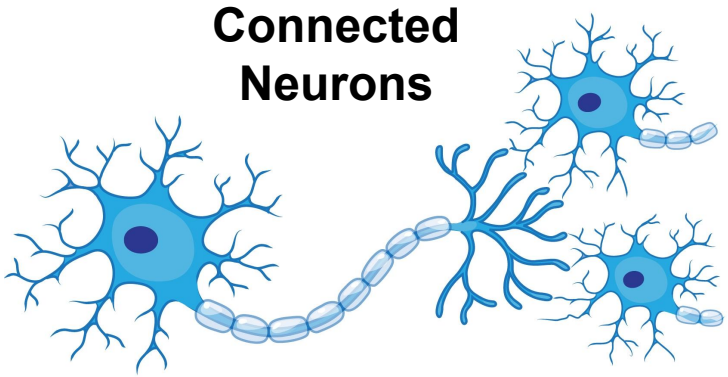
- Homogenous regions
- Human engineered features & tresholds
- Iterative refinement
- Trained SVM (classifier)



Challenges For Automatic Methods

Visual System Feature Hierarchy

© dogbreed.com



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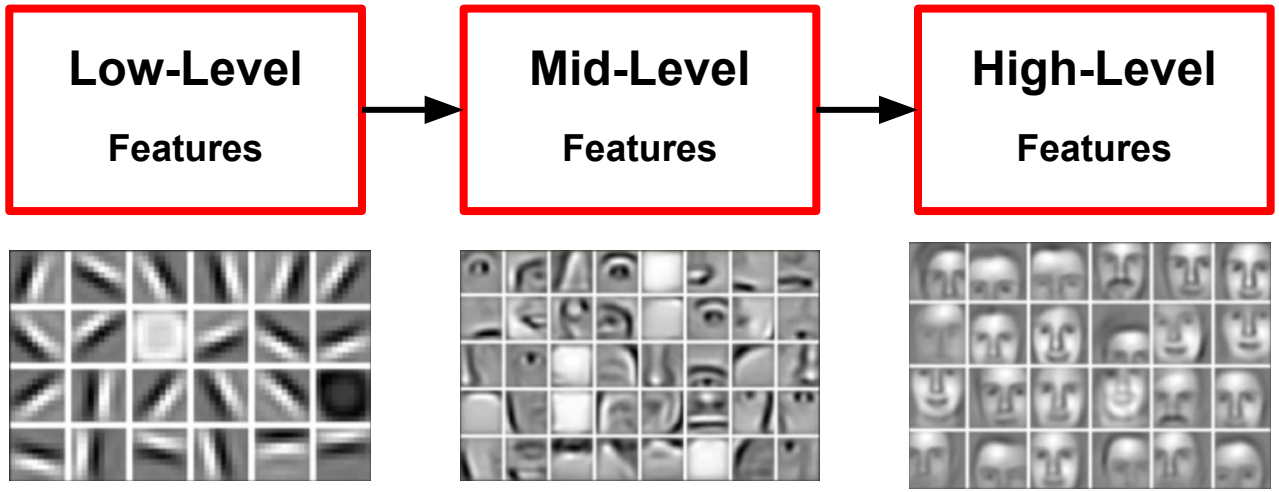
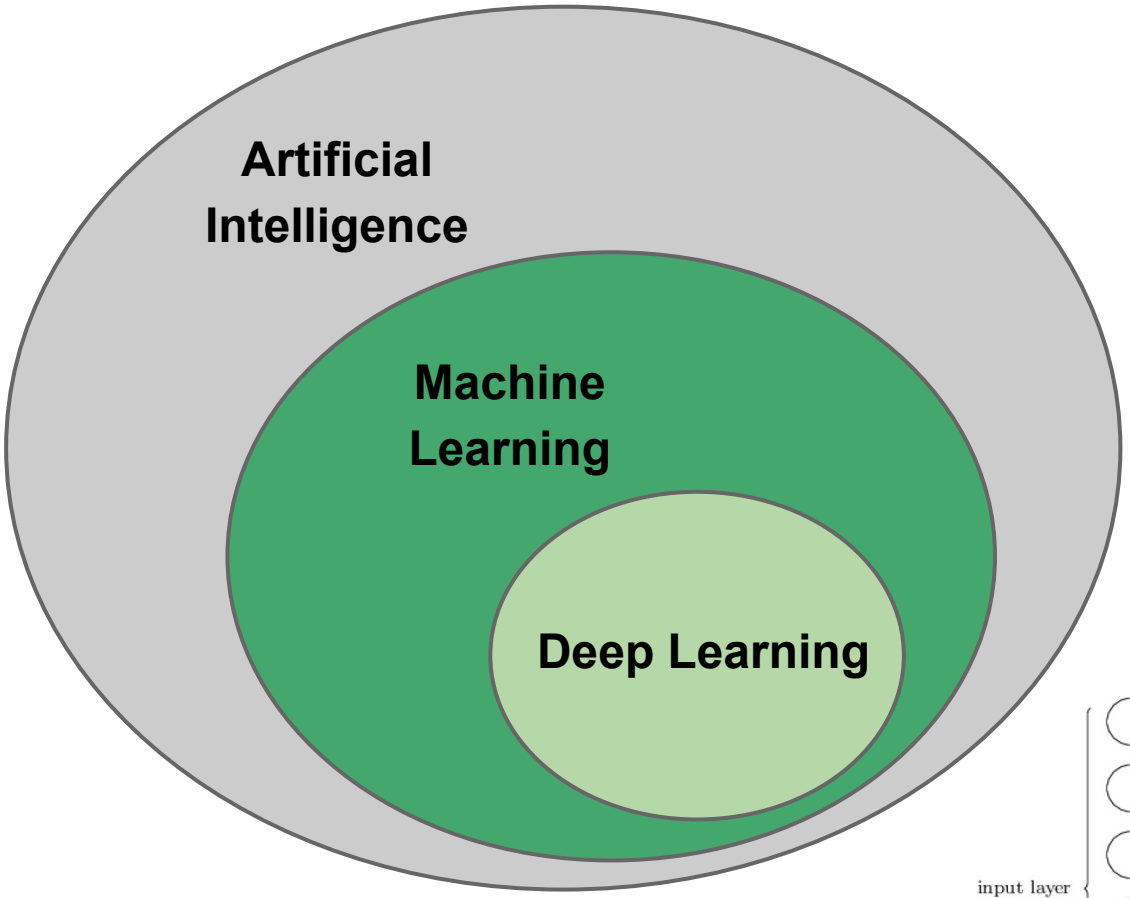
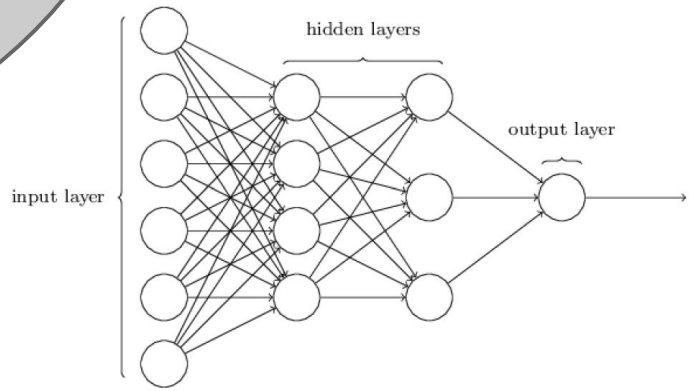


Adapted © Jones (2014)

Deep Learning



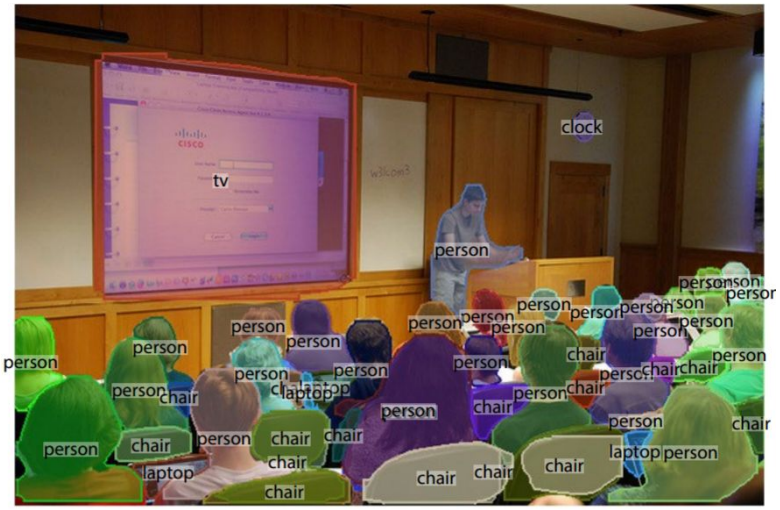


Neural Network with two hidden layers (Nielsen 2015)

ConvNets & Instance Segmentation

Convolutional Neural Network

- Feature hierarchy
- Computer learned features
- Abstract features



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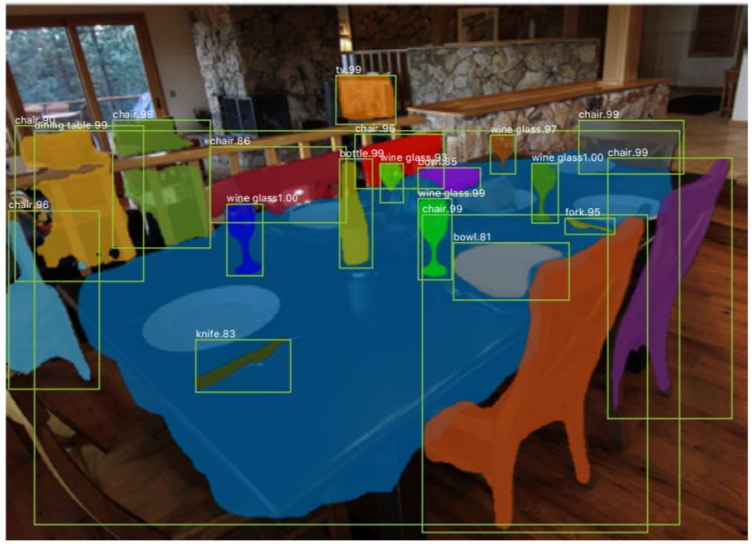
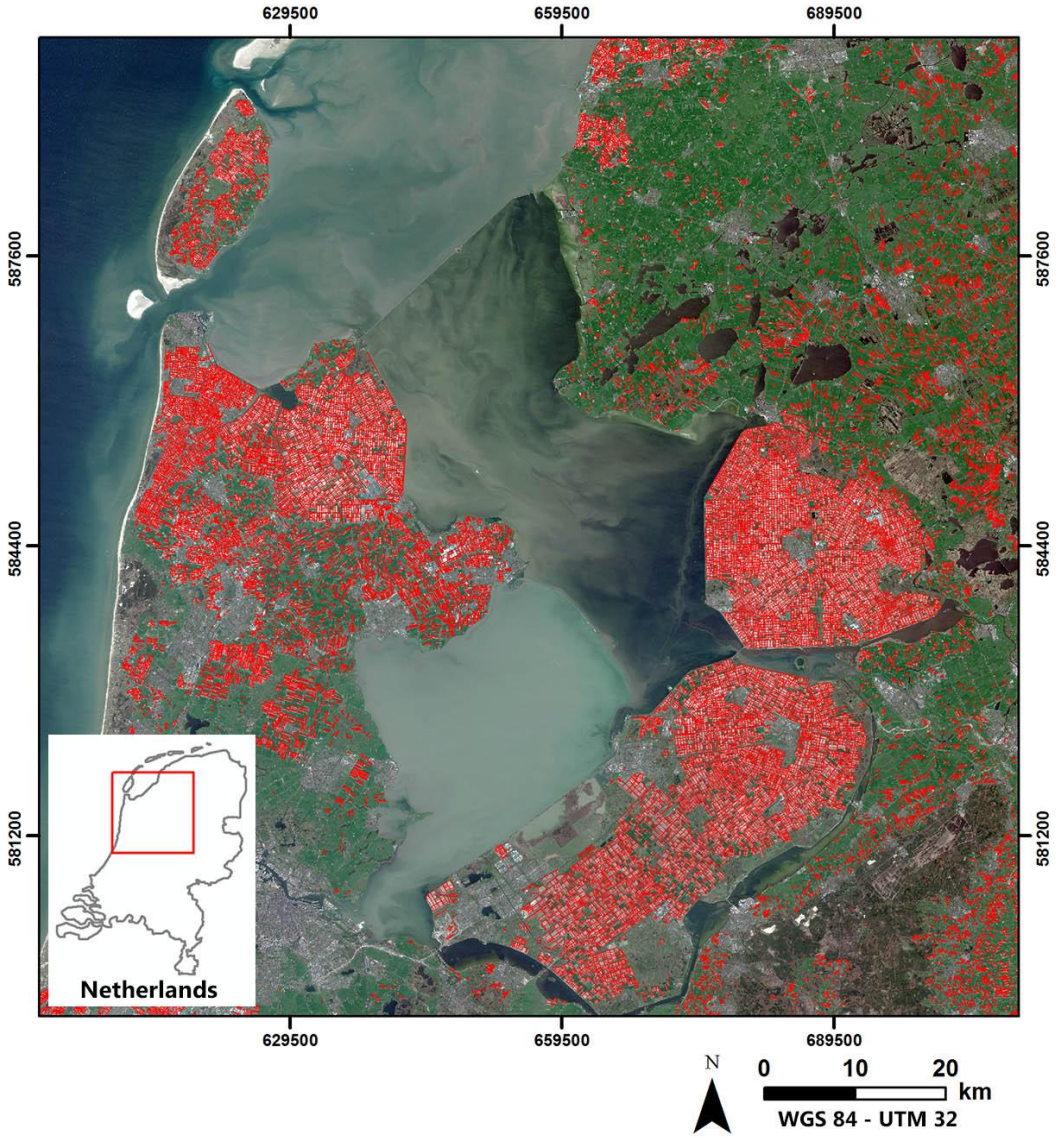
Basis for
Instance Segmentation



© He et al. (2017)

Training Data

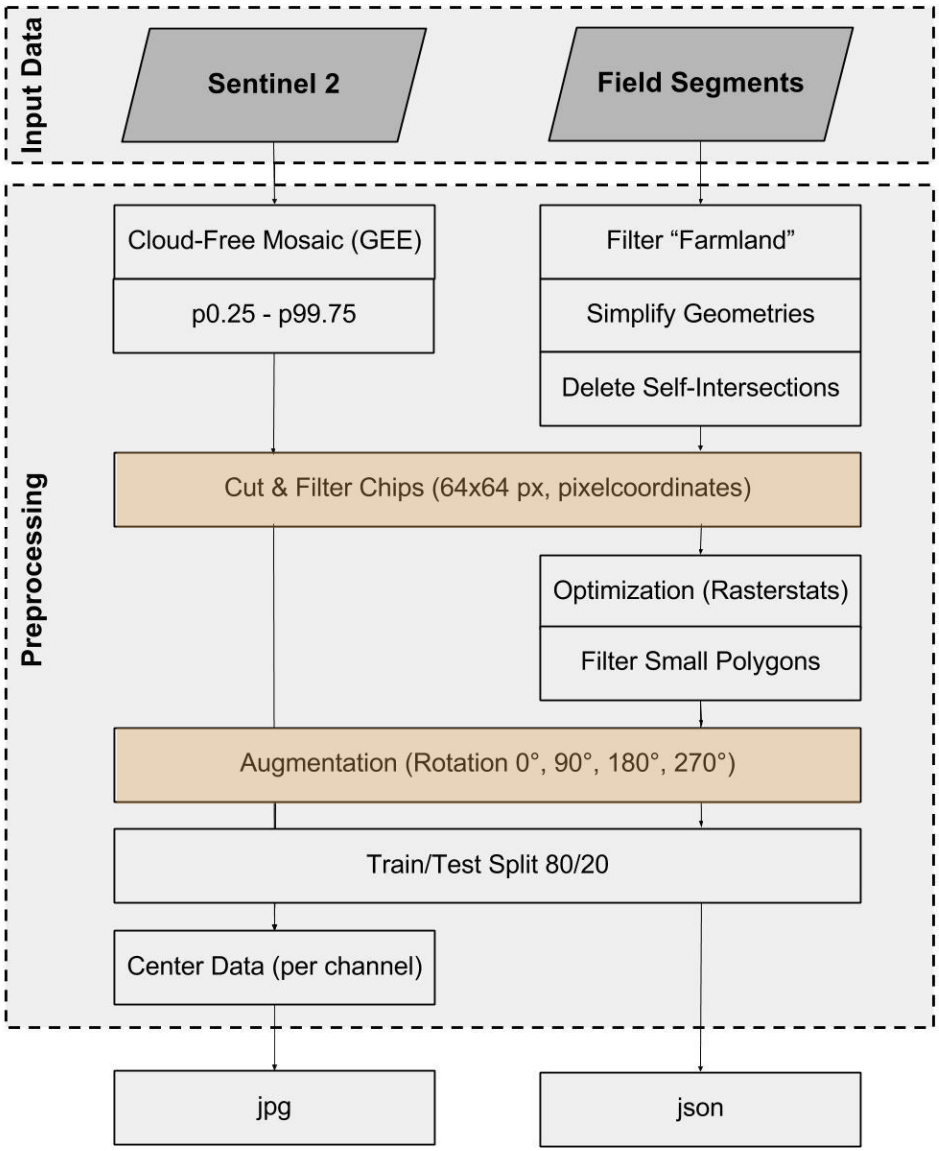


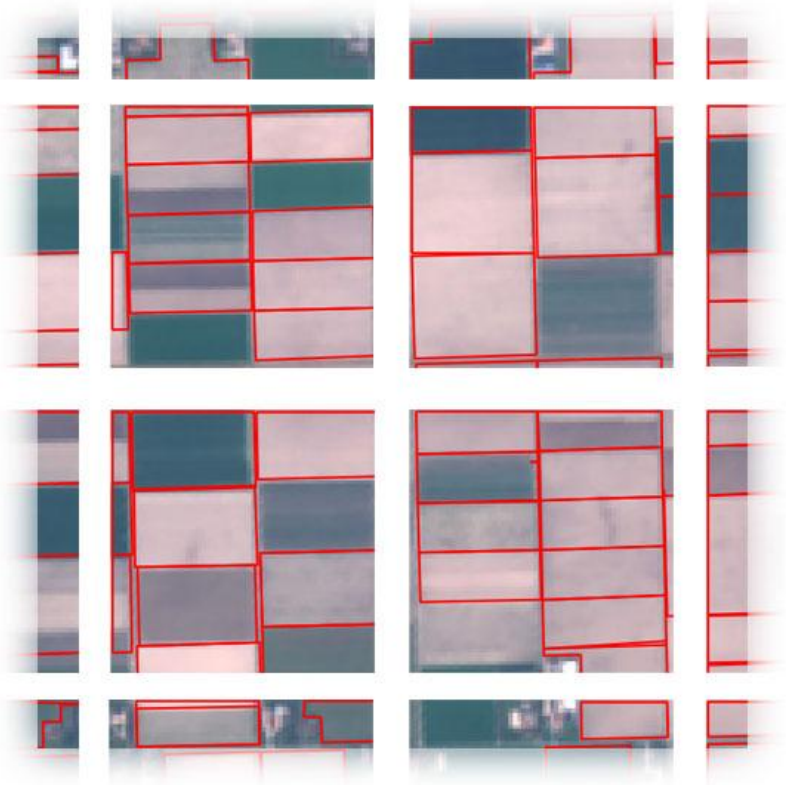
2016 Basis Registration Parcels (BRP)

AOI:

~ 40k farmland polygons

Preprocessing

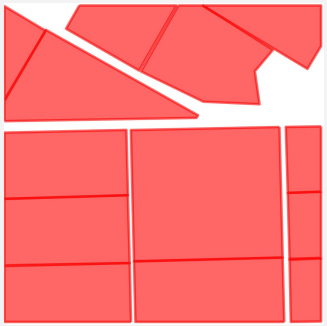




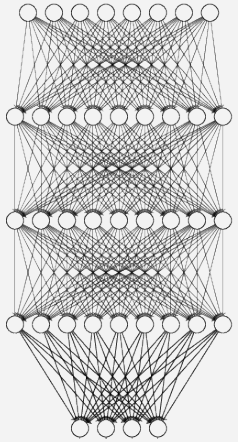
Objective

Training

Train Image



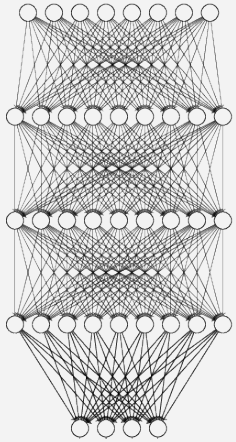
Train Fields



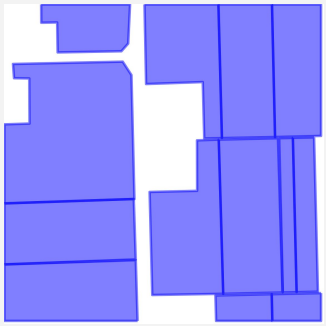
Trained Model

Prediction

Test Image



Trained Model



Predicted Fields

Model

Deepmask
(Pinheiro et al. 2015)

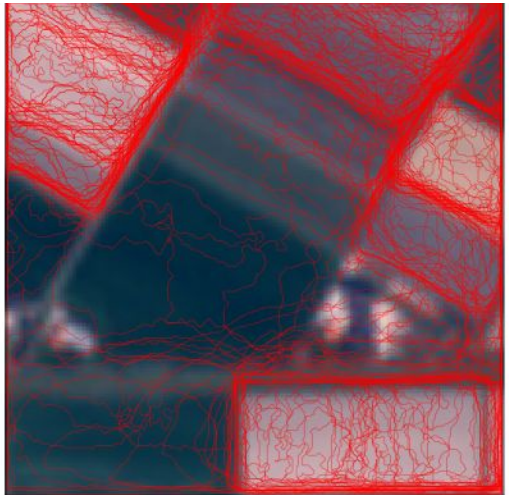
Predicts Segment Proposals

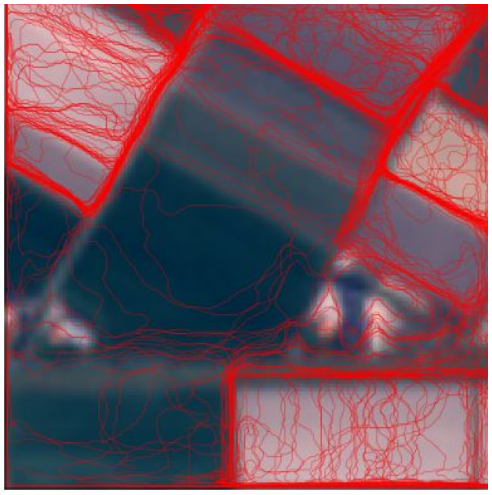
Sharpmask
(Pinheiro et al. 2016)

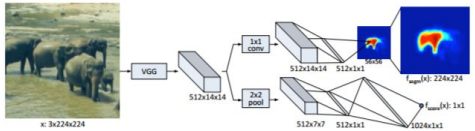
Improves

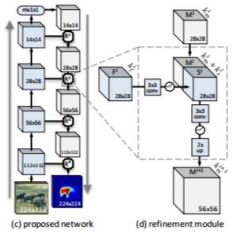
MultiPath-Net
(Zagoruyko et al. 2016)

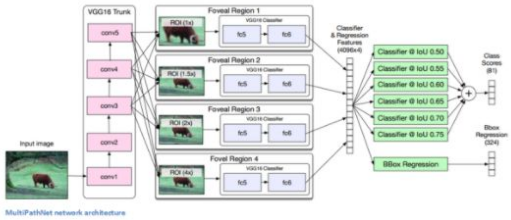
Suppresses & Classifies







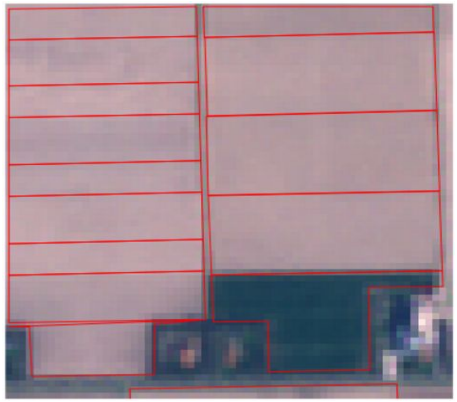


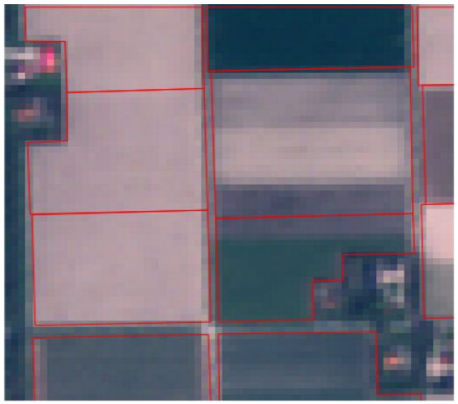


Challenges / Outlook

Challenges:

- Complex Training
- Partly property boundaries
- GPU cost > AWS





Outlook:

- Finish Multipathnet / Switch model (MNC, FCIS, Mask-RCNN)
- Crop classes
- Transferability (Thuringia usage mapping ?)
- (RGB vs. 8 bands)

Sources / Figures

Sources:

Girshick, R. & Donahue, J. & T. Darrell & Malik, J. (2014): Rich feature hierarchies for accurate object detection and semantic segmentation. IEEE Conference on Computer Vision and Pattern Recognition (CVPR). arXiv:1311.2524.

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Figures:

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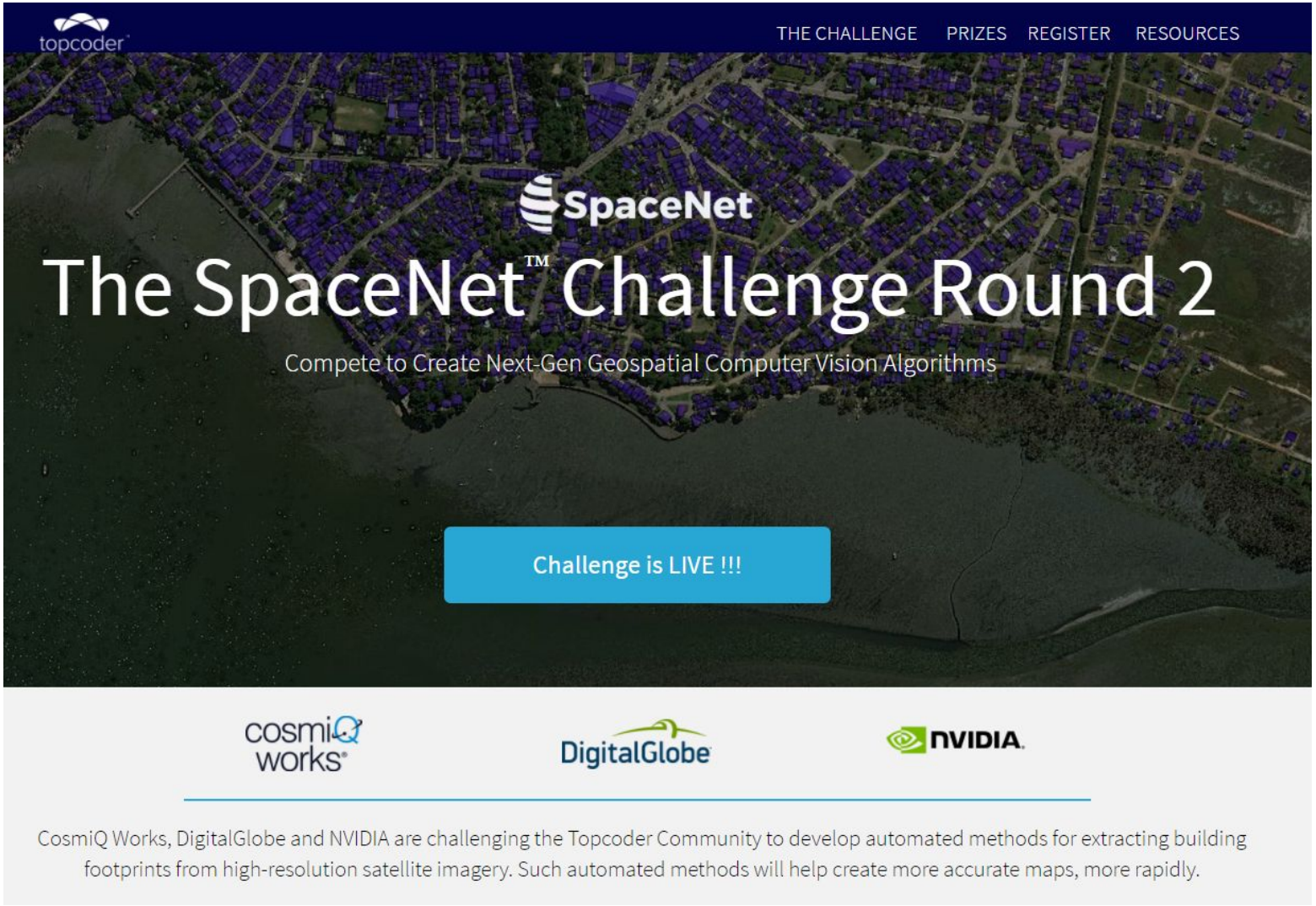


https://crowdsourcing.topcoder.com/spacenet

CS231n: Convolutional Neural Networks for Visual Recognition

Spring 2017

cs231n.stanford.edu

Neural Networks and Deep Learning

Neural Networks and Deep Learning is a free online book. The book will teach you about:

- Neural networks, a beautiful biologically-inspired programming paradigm which enables a computer to learn from observational data
- Deep learning, a powerful set of techniques for learning in neural networks

neuralnetworksanddeeplearning.com

Fully Convolutional Instance-aware Semantic Segmentation

Yi Li, Haozhi Qi, Jifeng Dai, Xiangyang Ji, Yichen Wei

(Submitted on 23 Nov 2016 (v1), last revised 10 Apr 2017 (this version, v2))

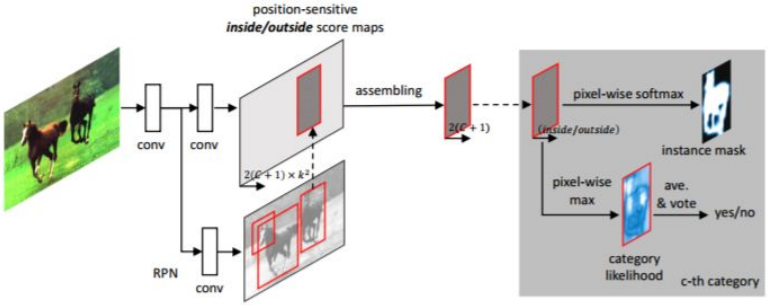
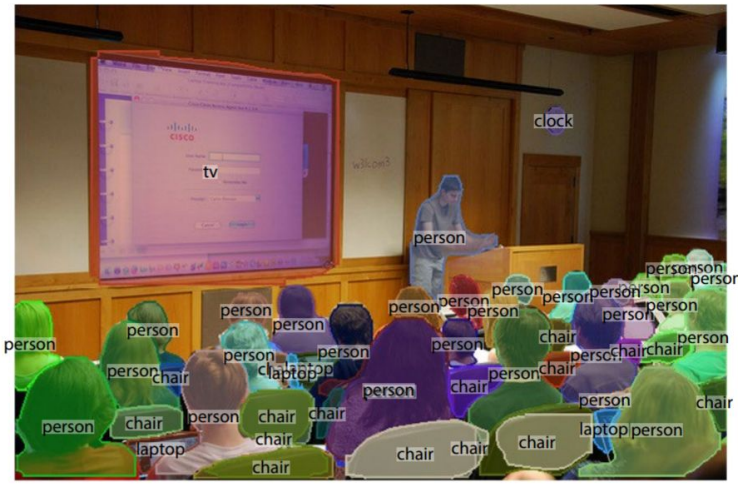


Figure 3. Overall architecture of FCIS. A region proposal network (RPN) [34] shares the convolutional feature maps with FCIS. The proposed region-of-interests (ROIs) are applied on the score maps for joint object segmentation and detection. The learnable weight layers are fully convolutional and computed on the whole image. The per-ROI computation cost is negligible.



Mask R-CNN

Kaiming He, Georgia Gkioxari, Piotr Dollár, Ross Girshick

(Submitted on 20 Mar 2017 (v1), last revised 5 Apr 2017 (this version, v2))

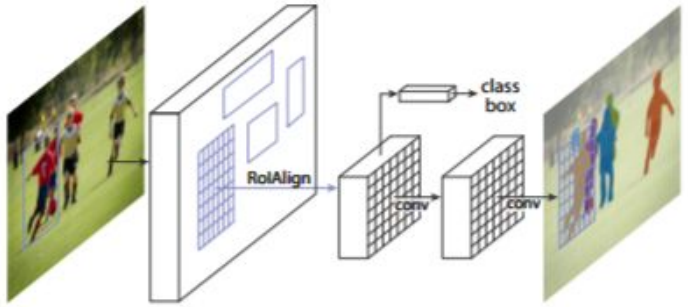
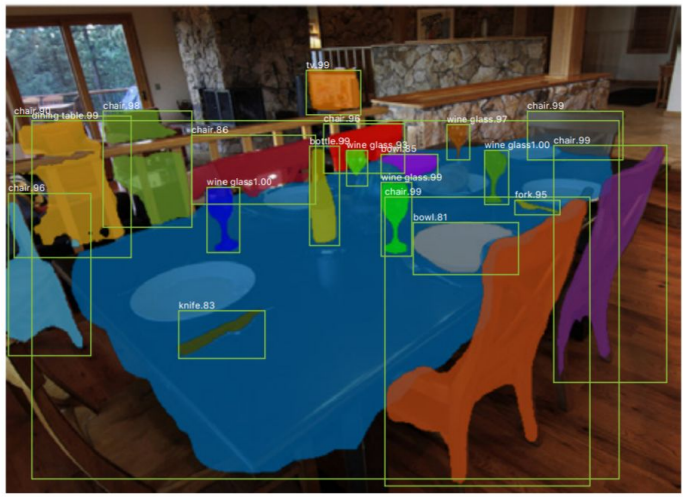
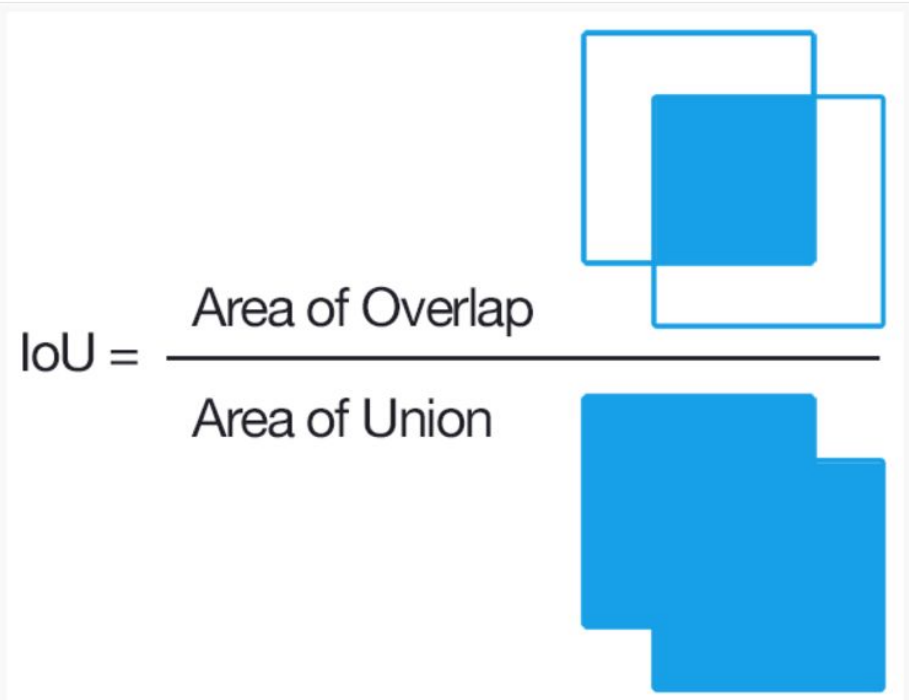


Figure 1. The **Mask R-CNN** framework for instance segmentation.





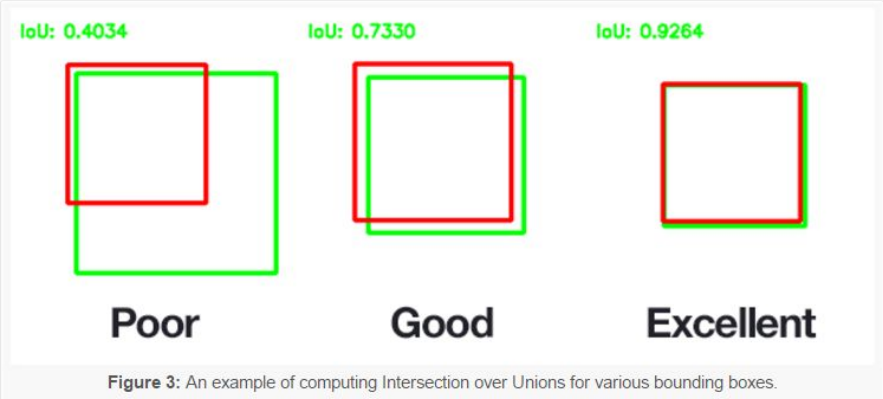
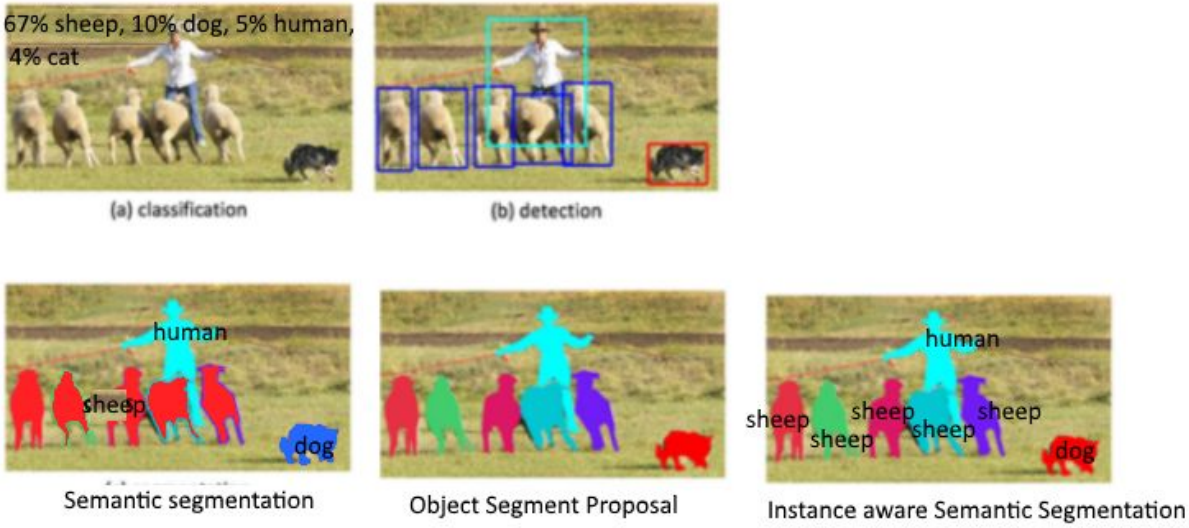
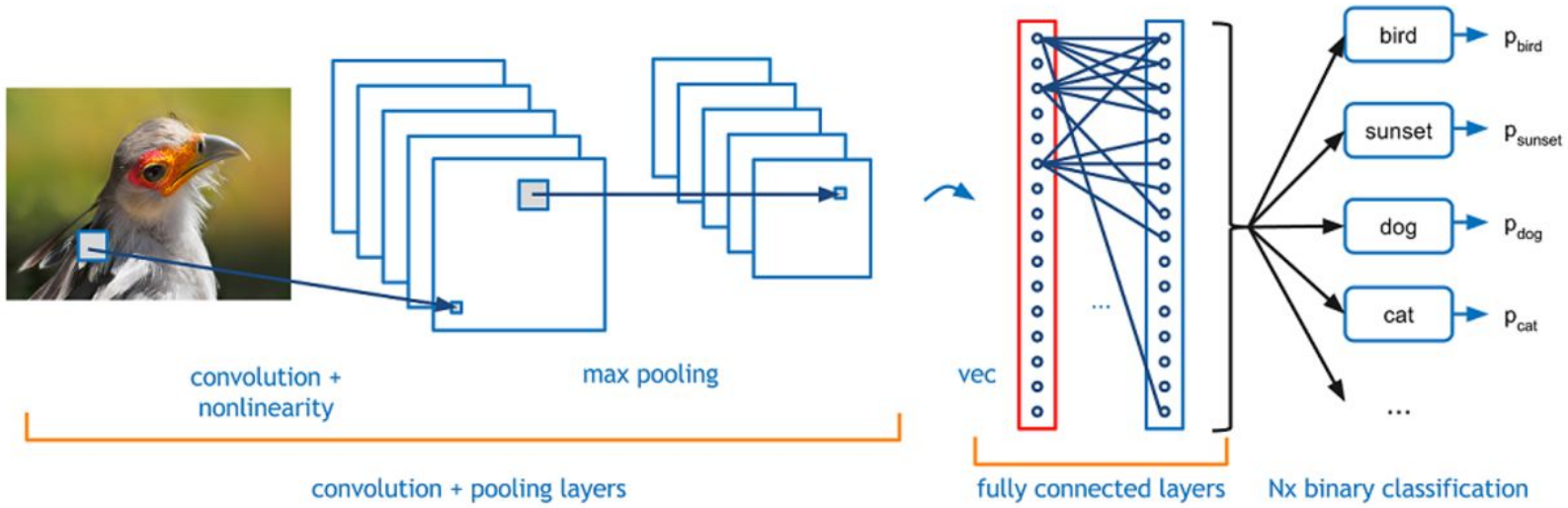


Figure 3: An example of computing Intersection over Unions for various bounding boxes.

http://www.pyimagesearch.com/2016/11/07/intersection-over-union-iou-for-object-detection/





https://adeshpande3.github.io/adeshpande3.github.io/A-Beginner's-Guide-To-Understanding-Convolutional-Neural-Networks/