# Mask R-CNN in GRASS GIS

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# Motivation

Situation

- higher density of the satellite monitoring systems
- higher density of aerial imagery
- vectorization of analogue maps

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- higher density of the satellite monitoring systems
- higher density of aerial imagery
- vectorization of analogue maps
- higher quality
- open data
- data standardization

# Motivation

Common classification methods

- manual classification

GRASS GIS

- manual classification
  - GRASS Digitizing tool

# Motivation

Common classification methods

- manual classification
- supervised classification

GRASS GIS

- manual classification
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- supervised classification
  - g.gui.iclass + i.maxlik

# Motivation

Common classification methods

- manual classification
- supervised classification
- unsupervised classification

GRASS GIS

- manual classification
  - GRASS Digitizing tool
- supervised classification
  - g.gui.iclass + i.maxlik
- unsupervised classification
  - i.cluster + i.maxlik

# Motivation

Why neural networks?

- human brain is the most powerful tool we know
- we are trying to get human-understandable results

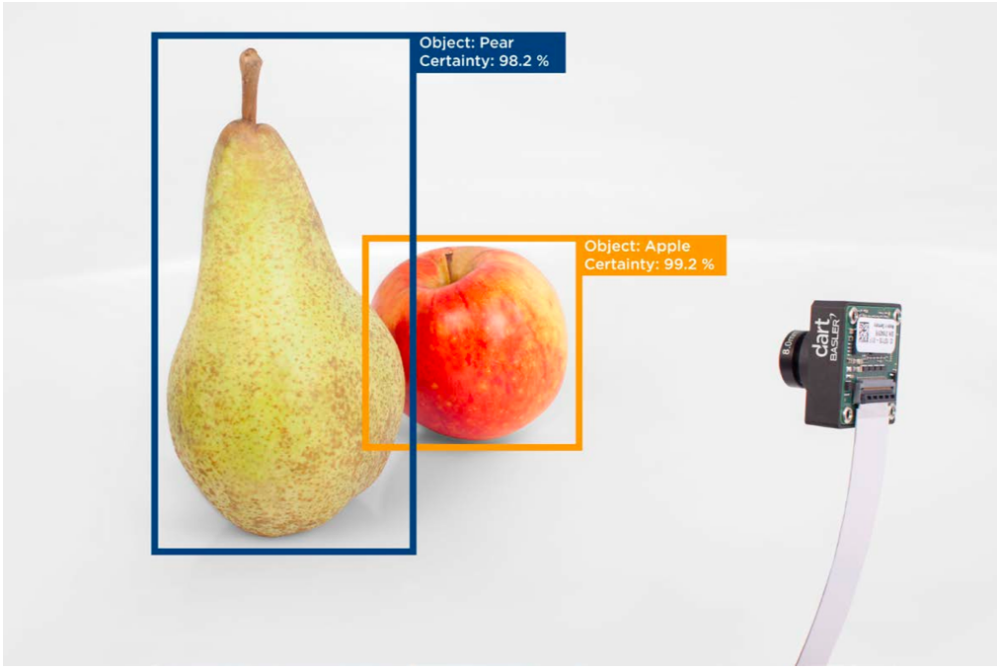


Figure: Zdroj: [1]

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# Motivation



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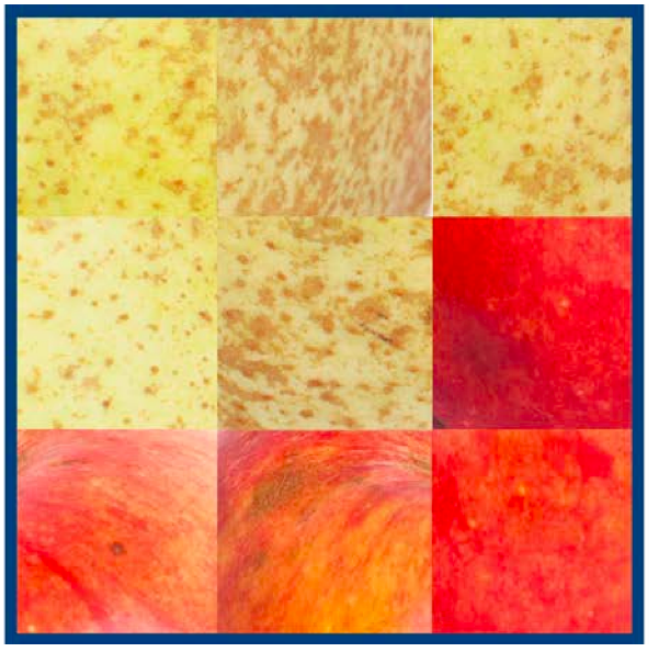

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Figure: Zdroj: [1]

# Convolutional neural networks

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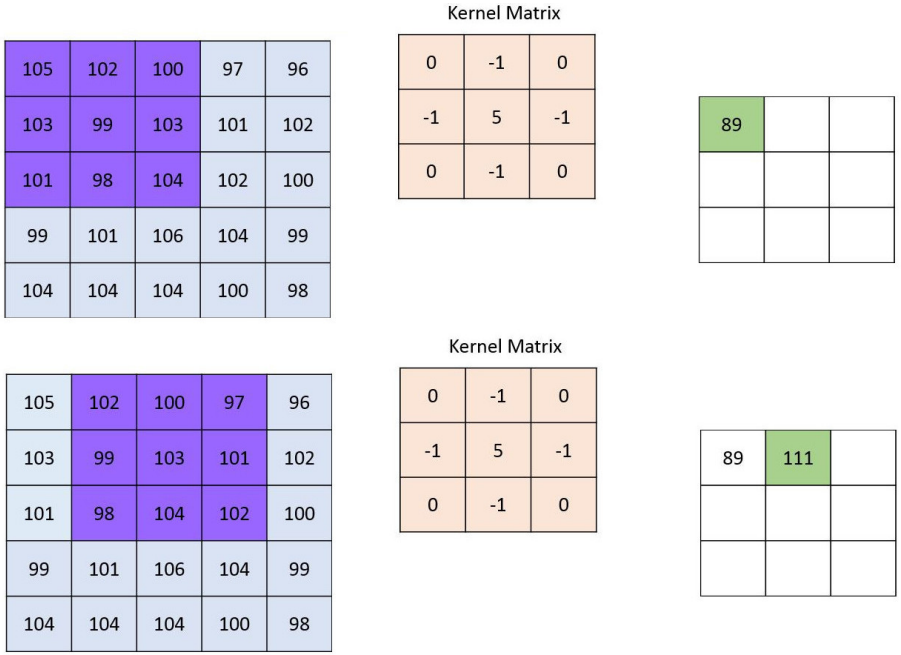
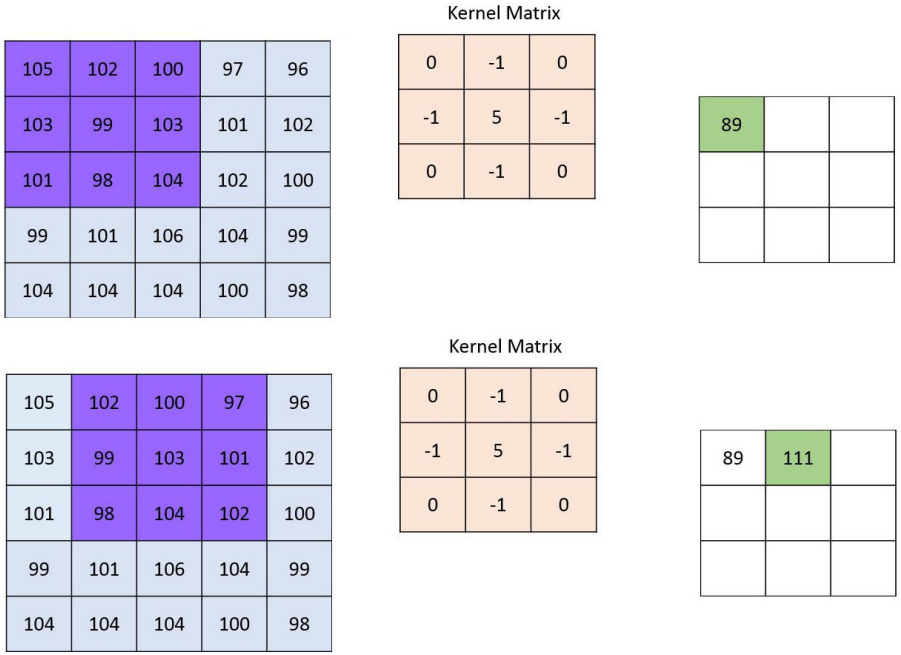


# Convolutional neural networks




Why convolutional neural networks?

- ResNet got in ILSVRC 2016 top 5 error of 3.6 %

Source: [1]

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# Convolutional neural networks

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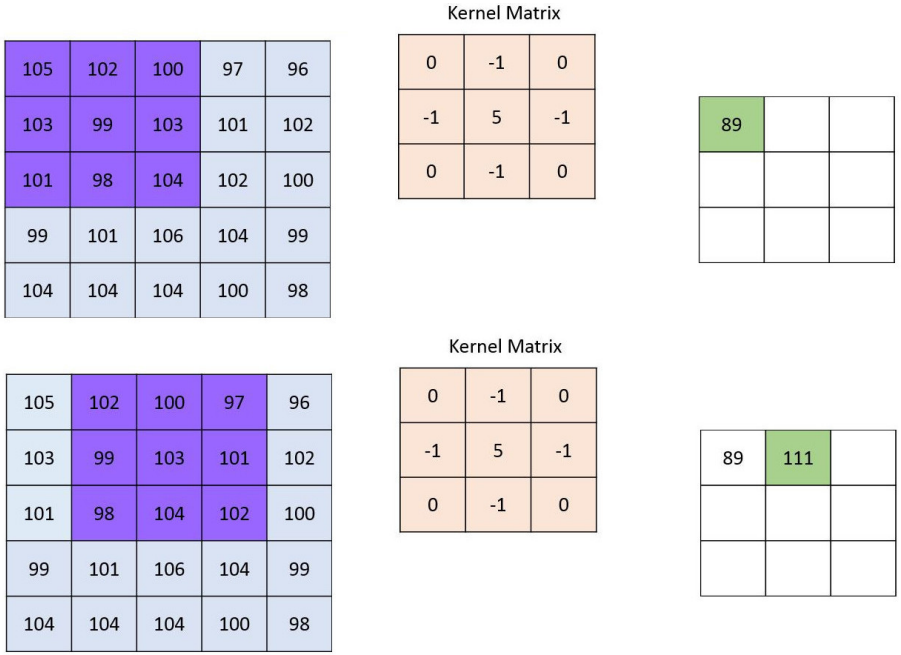


Why convolutional neural networks?

- ResNet got in ILSVRC 2016 top 5 error of 3.6 %
- human 8 %

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# Mask R-CNN

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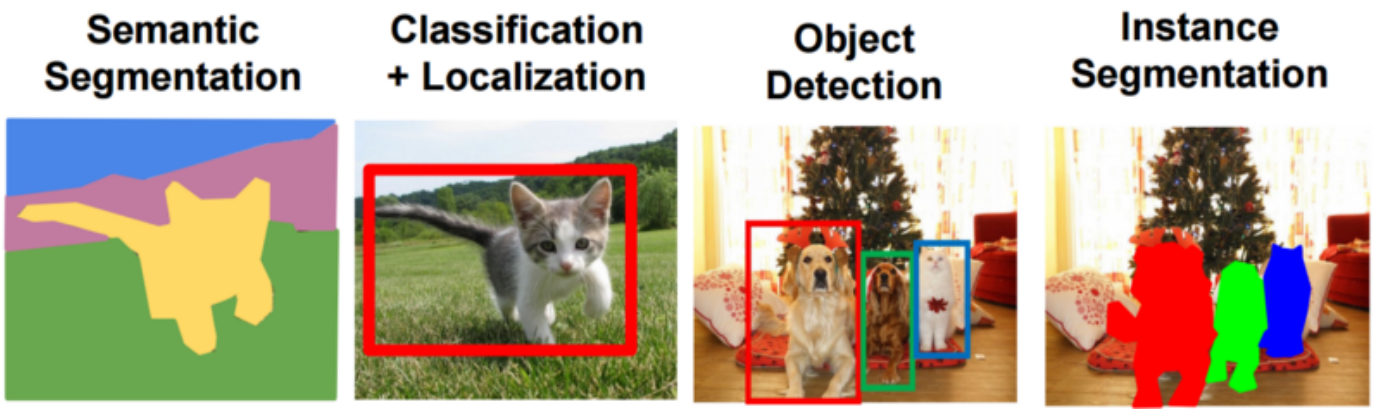


Figure: Source: [2]

# Mask R-CNN

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## Instance segmentation

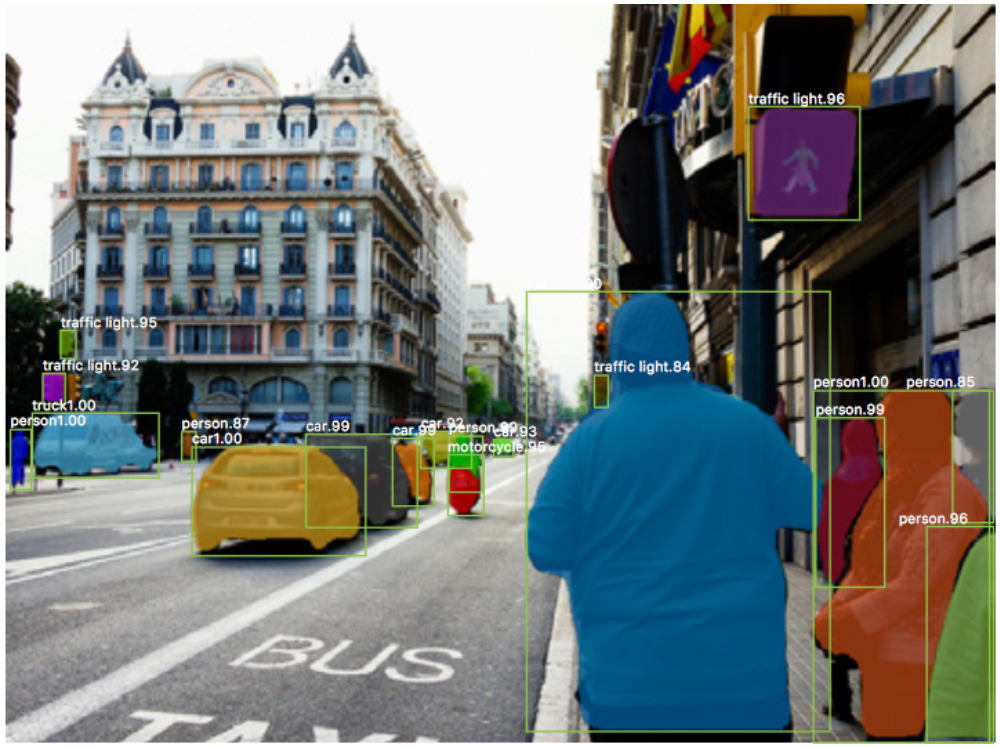


Figure: Source: [2]

# Mask R-CNN

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Two parts:

- backbone
- head

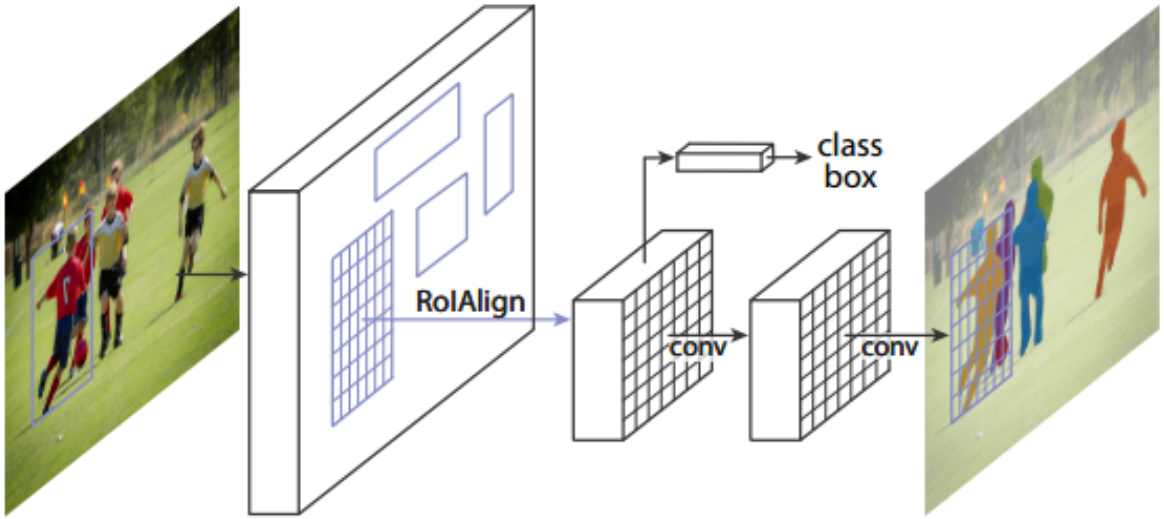


Figure: Source: [3]

# Mask R-CNN





Backbone architecture:

- ResNet

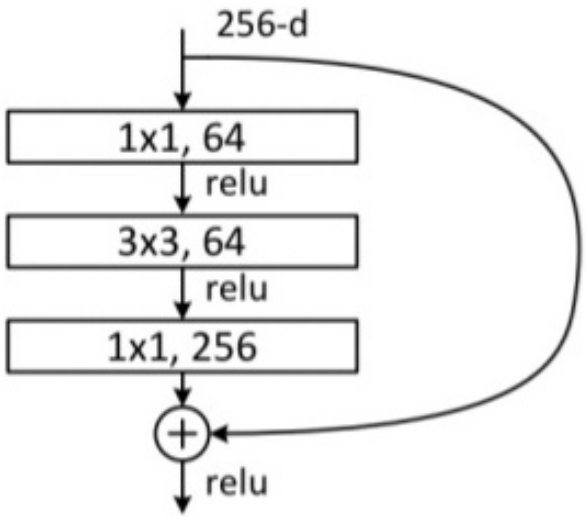


Figure: Source: [3]

# Mask R-CNN

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Backbone architecture:

- ResNet
- RPN

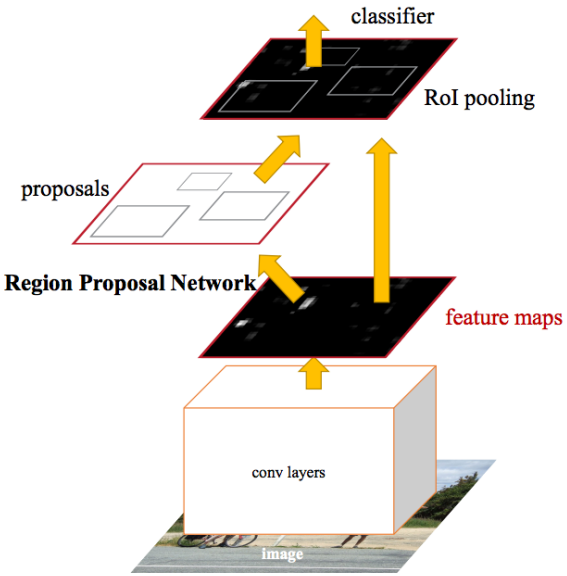


Figure: Source: [3]

# Mask R-CNN

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Backbone architecture:

- ResNet
- RPN

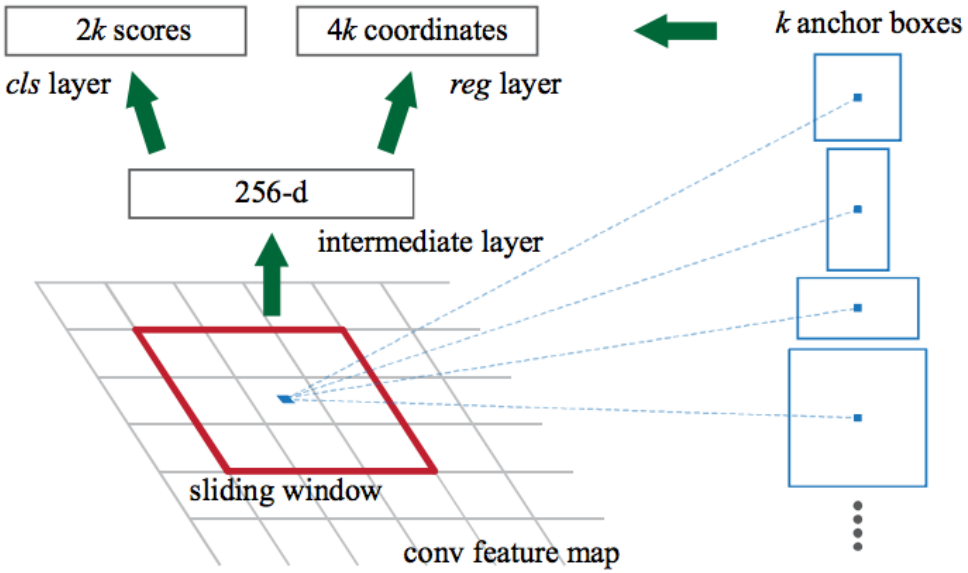


Figure: Source: [3]

# Mask R-CNN

Head architecture:

- softmax $\rightarrow$ class

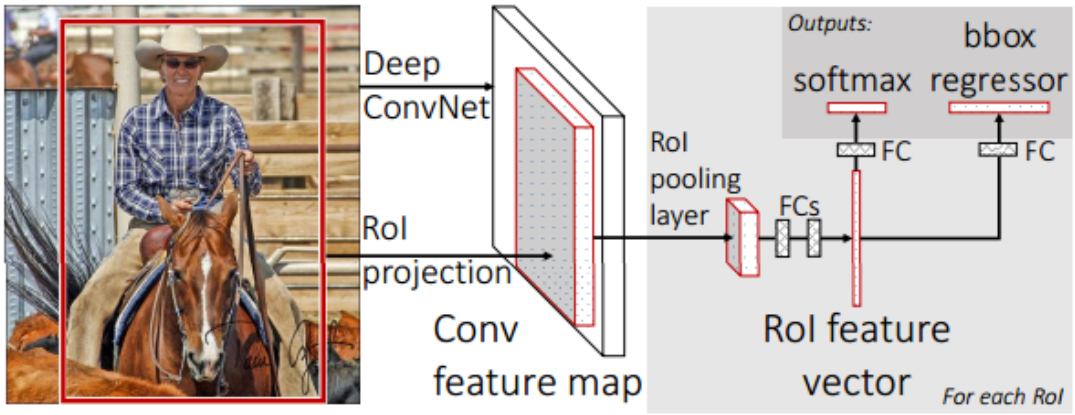


Figure: Source: [4]

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# Mask R-CNN

Head architecture:

- softmax $\rightarrow$ class
- regression $\rightarrow$ bounding box

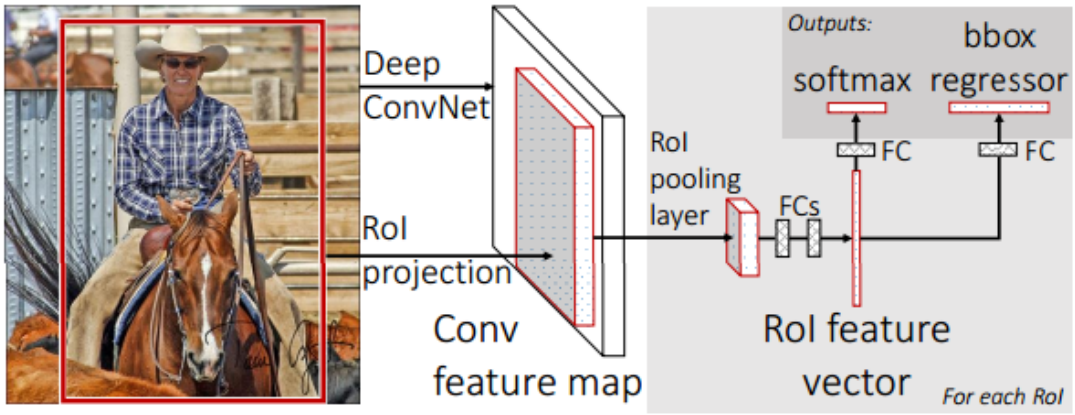


Figure: Source: [4]

# Mask R-CNN

Head architecture:

- softmax $\rightarrow$ class
- regression $\rightarrow$ bounding box
- FCN $\rightarrow$ mask

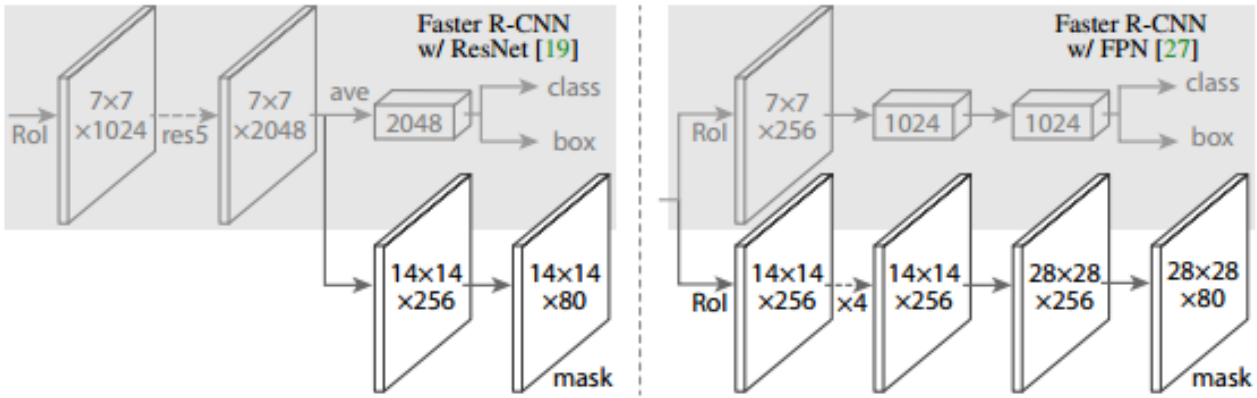


Figure: Source: [4]

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# Usage

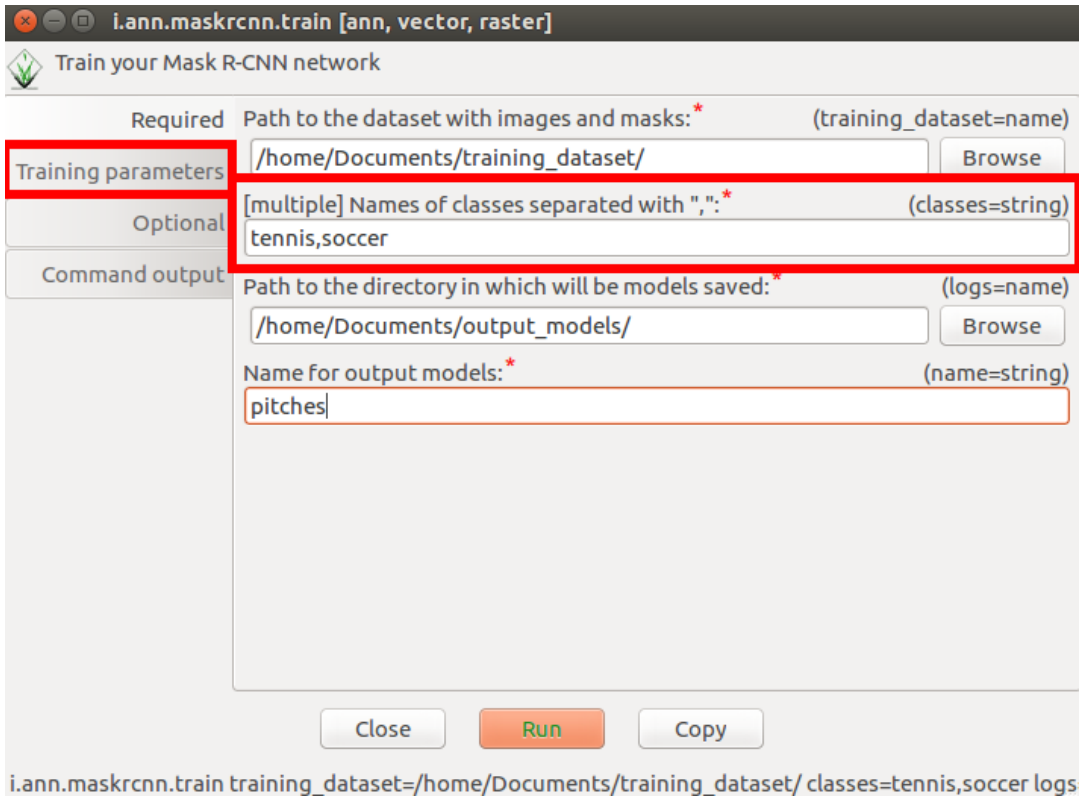
Workflow:

- i.ann.maskrcnn.train
- i.ann.maskrcnn.detect

# i.ann.maskrcnn.train

## Workflow behind

- configuration of the model

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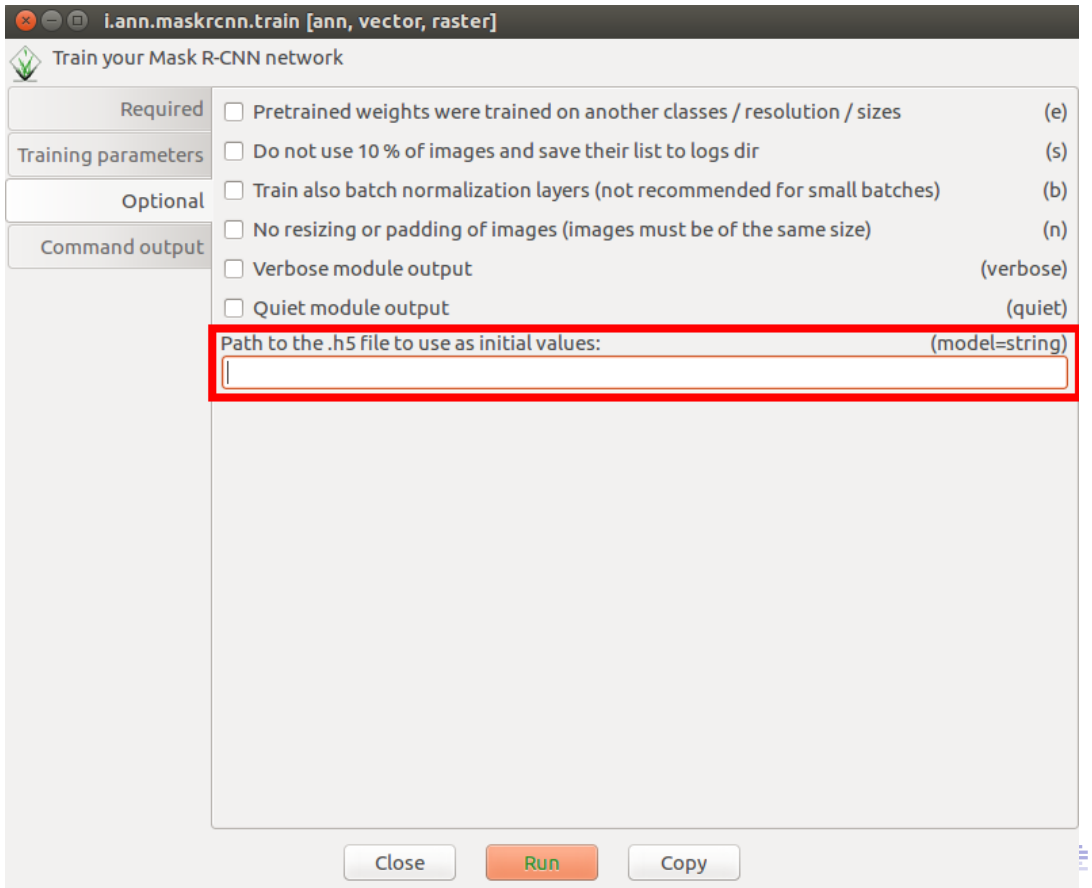
# i.ann.maskrcnn.train

## Workflow behind

- configuration of the model
- feed the model with pre-trained weights

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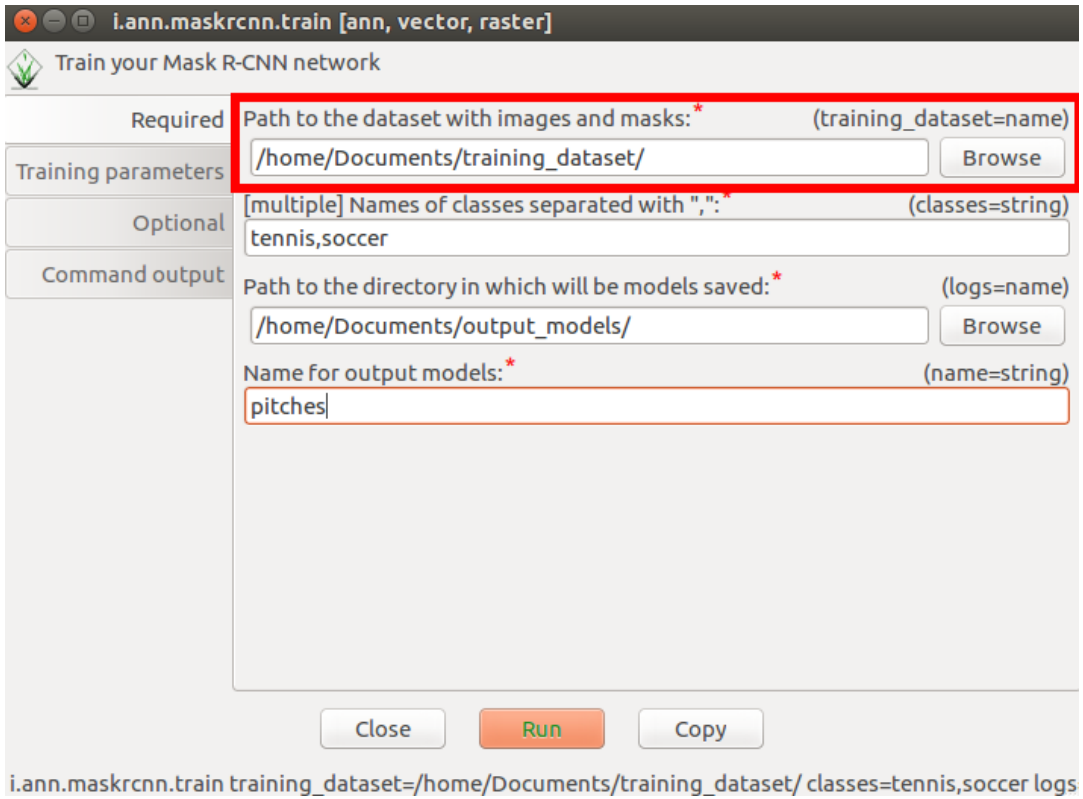
# i.ann.maskrcnn.train

## Workflow behind

- configuration of the model
- feed the model with pre-trained weights
- read the training dataset

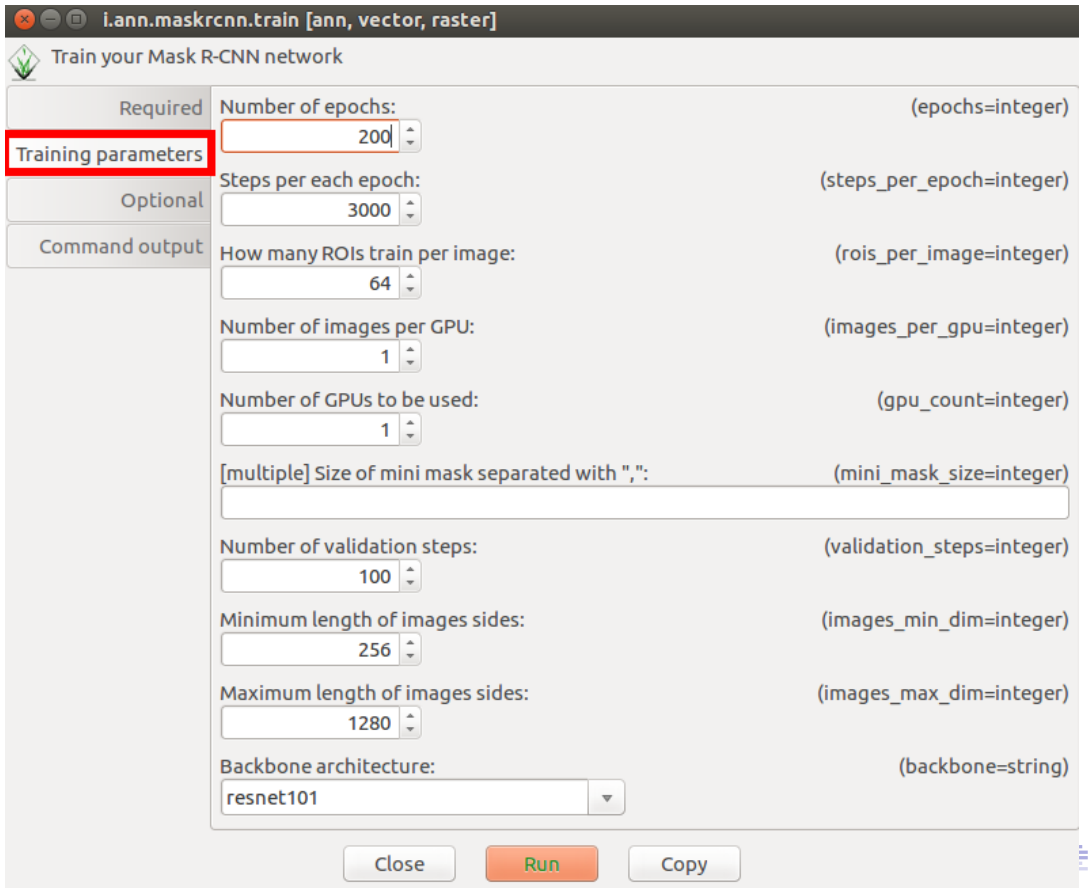



Ondřej Pešek

# i.ann.maskrcnn.train

## Workflow behind

- configuration of the model
- feed the model with pre-trained weights
- read the training dataset
- train

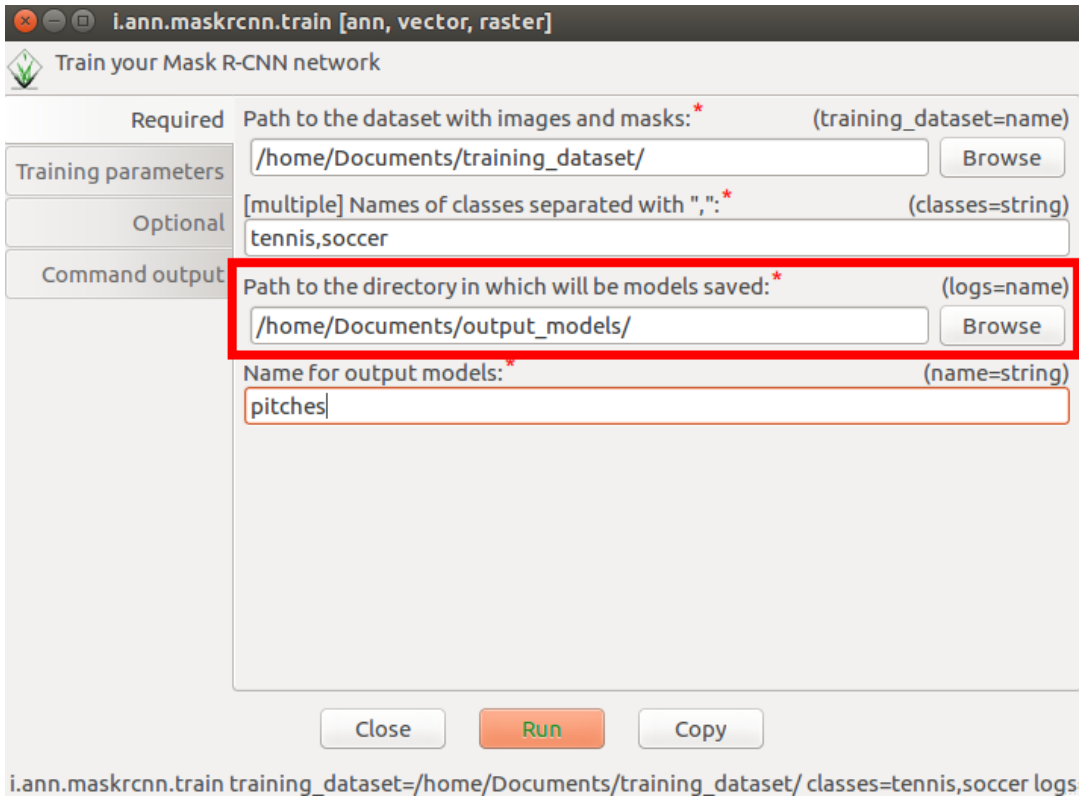



Ondřej Pešek

# i.ann.maskrcnn.train

## Workflow behind

- configuration of the model
- feed the model with pre-trained weights
- read the training dataset
- train
- save the model

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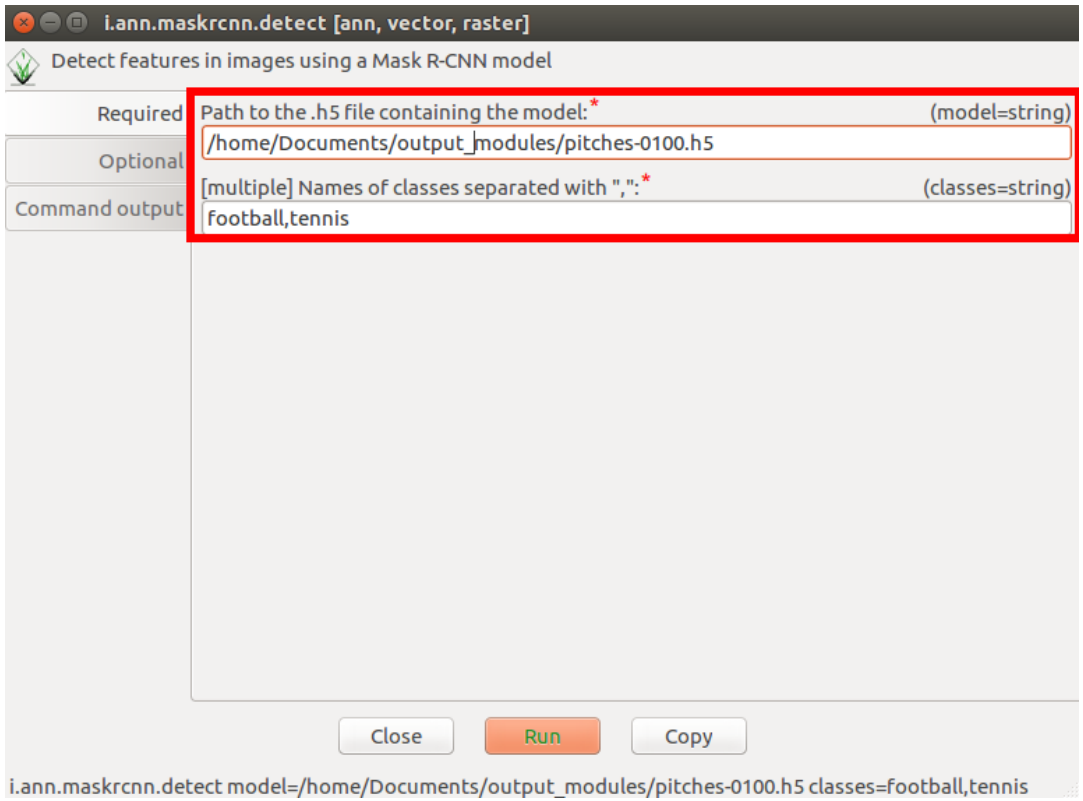
# i.ann.maskrcnn.detect

## Workflow behind

- load the model

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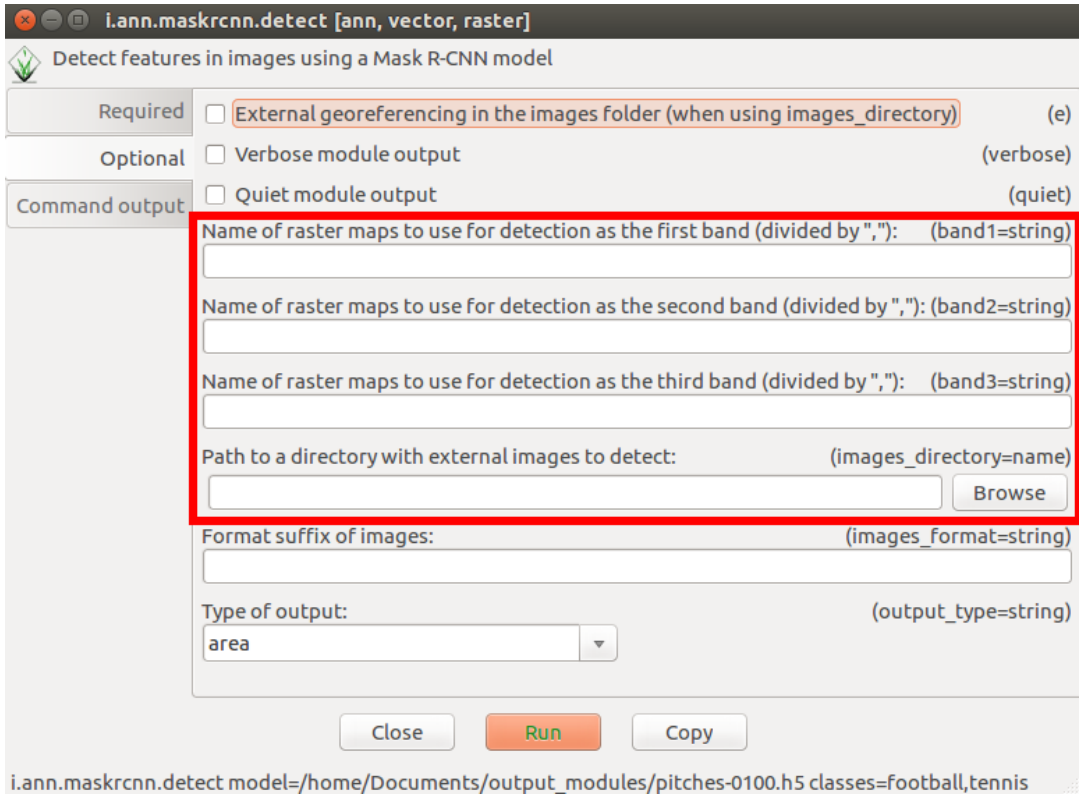
# i.ann.maskrcnn.detect

## Workflow behind

- load the model
- detection for each raster

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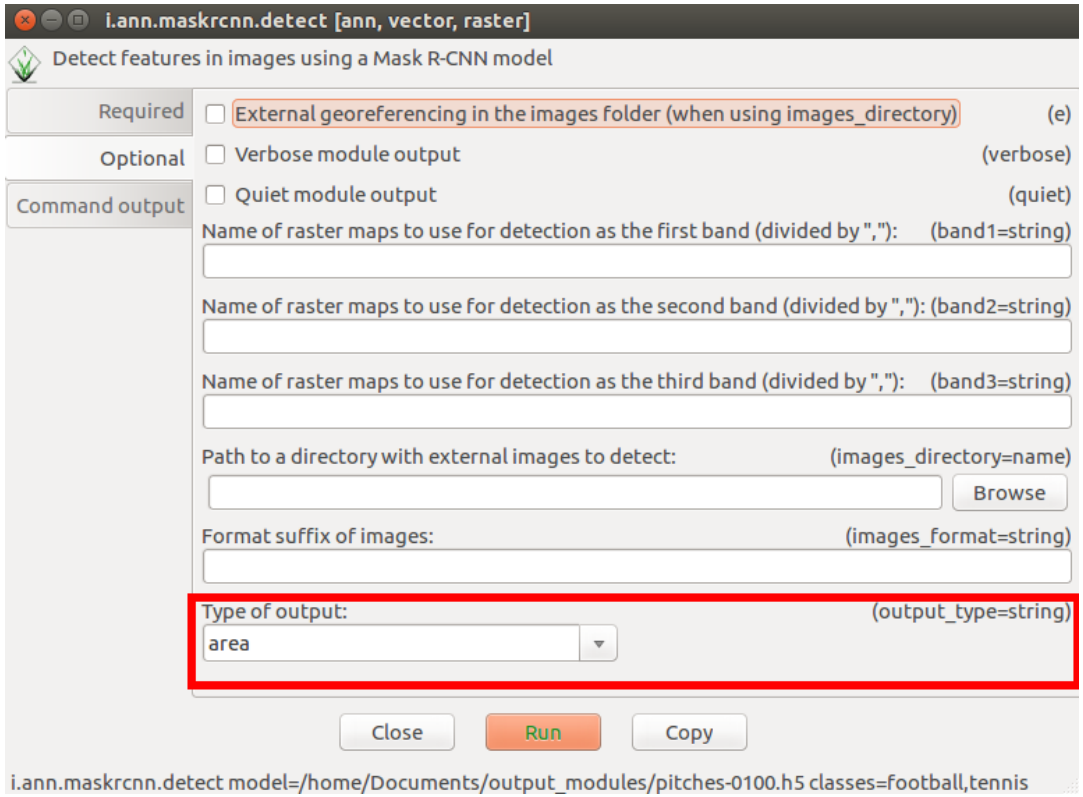
# i.ann.maskrcnn.detect

## Workflow behind

- load the model
- detection for each raster
- vectorization

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# Results





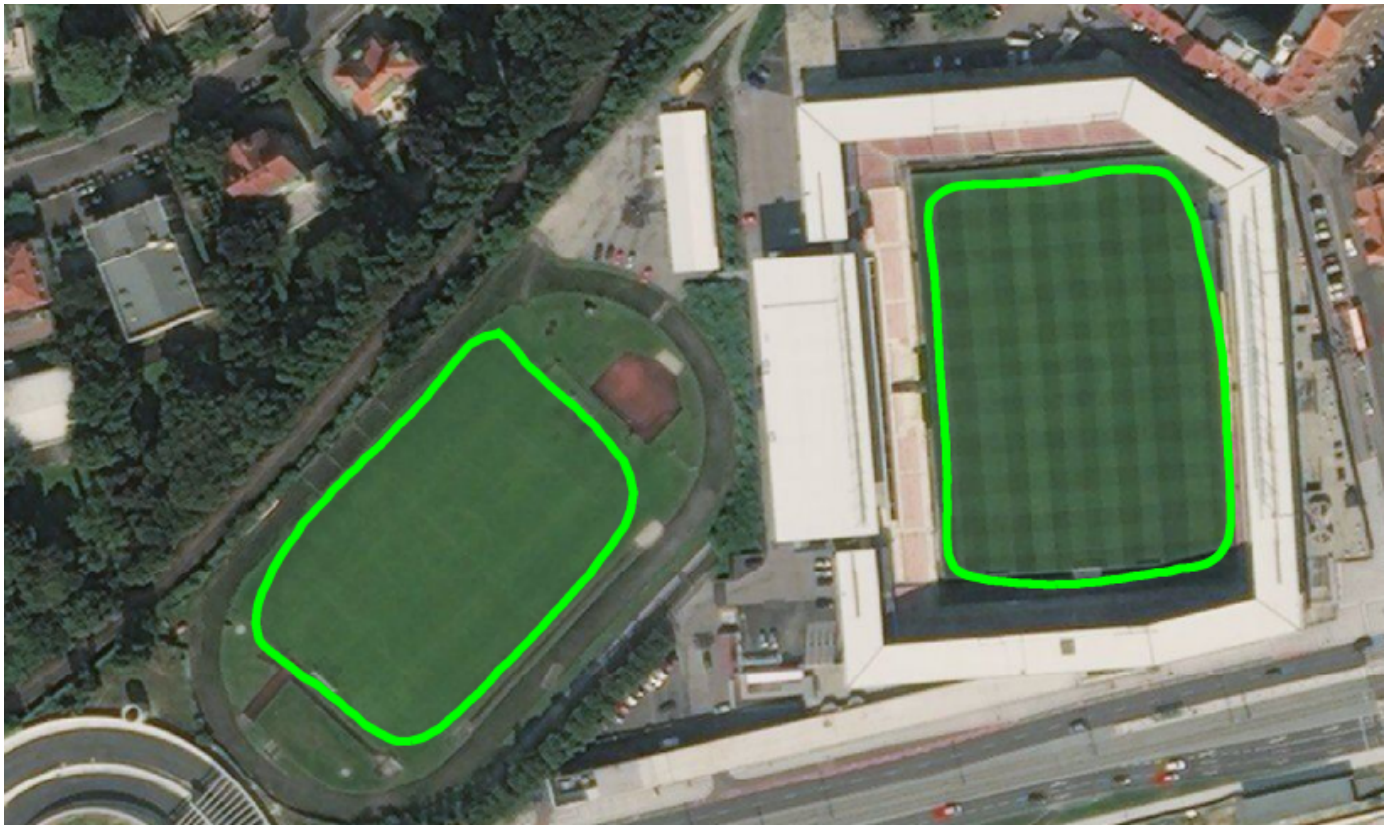

Figure: loss function 0.96, 54000 training images

# Results

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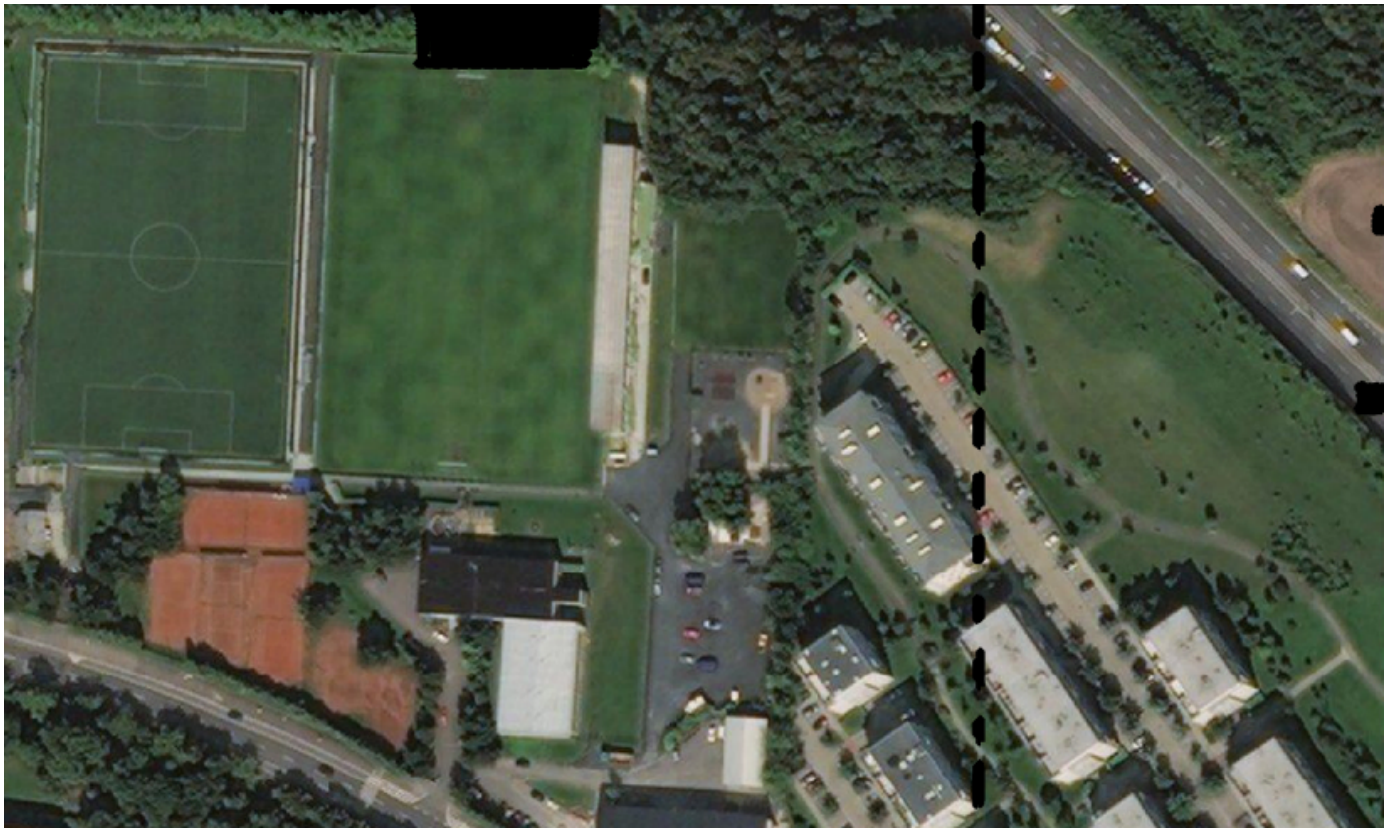

Figure: epoch 1, loss function 35.01, 2400 training images

# Results

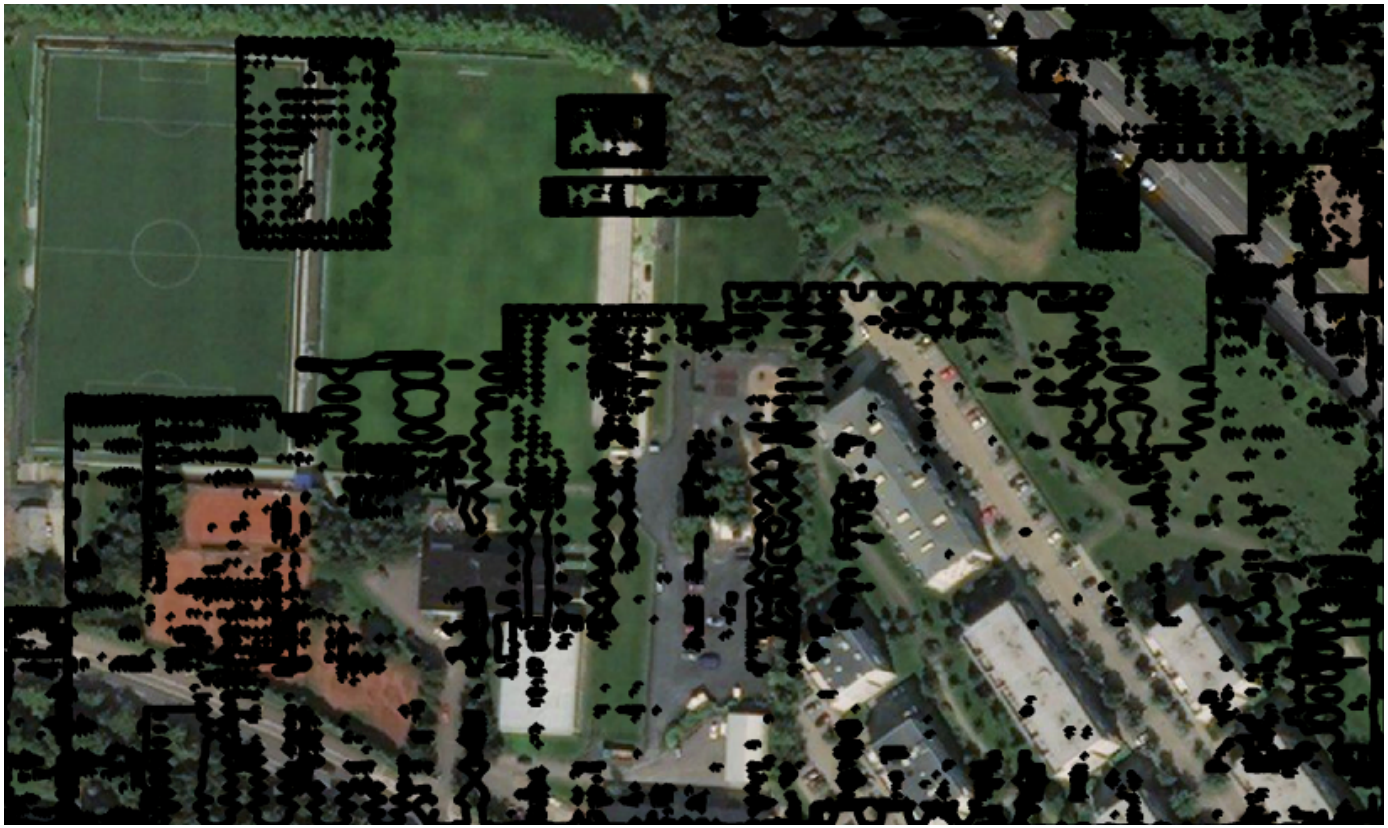

Figure: epoch 10, loss function 5.87, 2400 training images

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# Results





Figure: epoch 50, loss function 1.36, 2400 training images

# Results

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Figure: epoch 150, loss function 0.63, 2400 training images

# Results





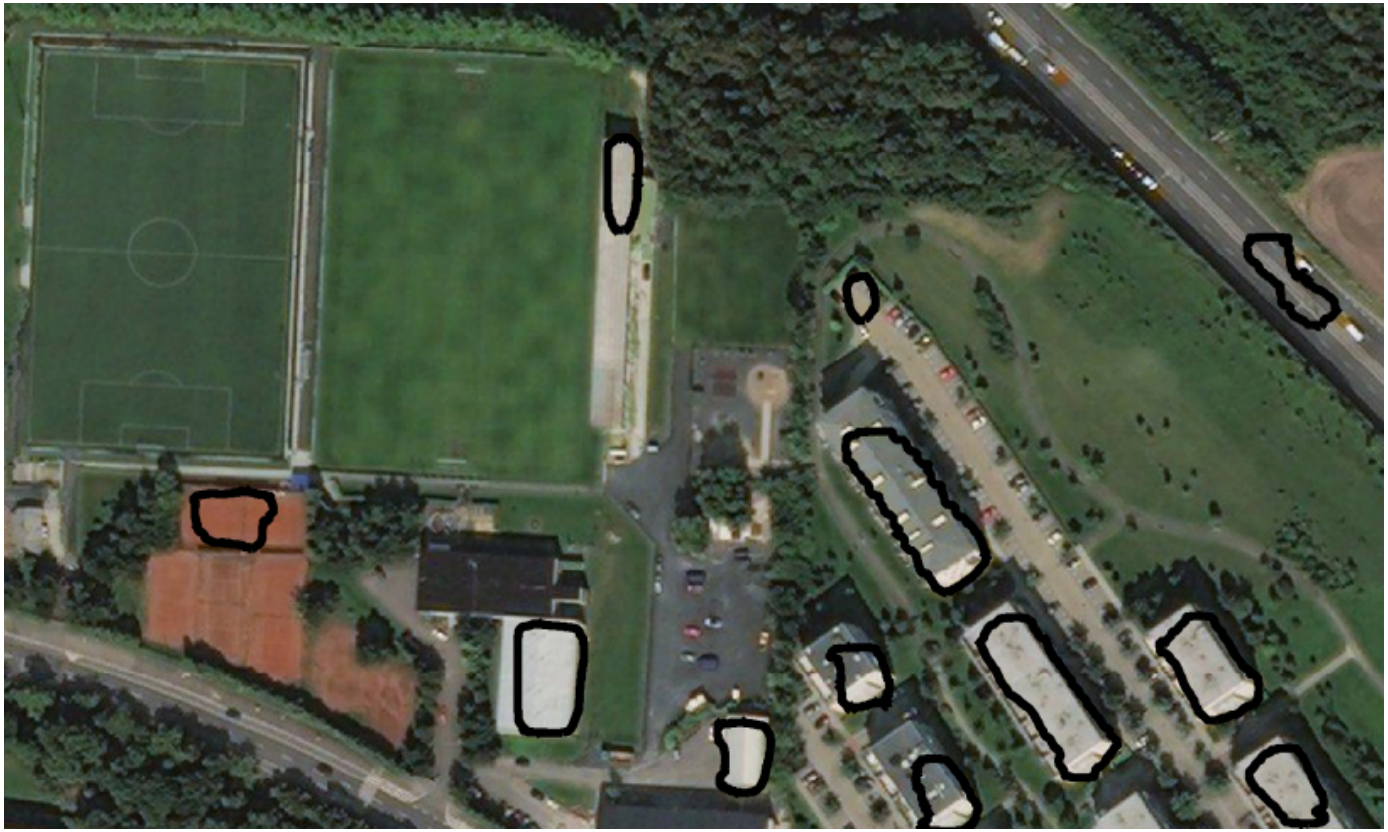

Figure: epoch 180, loss function 0.50, 2400 training images

# Conclusion

- source code
  - `https://github.com/ctu-geoforall-lab/i.ann.maskrcnn`
  - `https://github.com/OSGeo/grass-addons/tree/master/grass7/imagery/i.ann.maskrcnn`
- installation using command

  `g.extension extension=i.ann.maskrcnn`
- next steps
  - multispectral rasters
  - training on rasters and vectors imported in GRASS
  - more architectures

# Sources

[1] RUSSAKOVSY, Olga et al. ImageNet Large Scale Visual Recognition Challenge. International Journal of Computer Vision IJCV. 2015, 115, n. 3, pp. 211–252.
[2] http://cs231n.stanford.edu/
[3] HE, Kaiming et al. Mask R-CNN. In: International Conference on Computer Vision (ICCV). 2017.
[4] GIRSHICK, Ross. Fast R-CNN. In: International Conference on Computer Vision (ICCV). 2015.

Thank you for your attention.