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# Mask R-CNN in GRASS GIS

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

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## Situation

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

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- ▶ higher density of aerial imagery
- ▶ vectorization of analogue maps
- ▶ higher quality
- ▶ open data

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- ▶ higher density of aerial imagery
- ▶ vectorization of analogue maps
- ▶ higher quality
- ▶ open data
- ▶ data standardization

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## Common classification methods

- ▶ manual classification

## GRASS GIS

- ▶ manual classification
  - ▶ GRASS Digitizing tool

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## Common classification methods

- ▶ manual classification
- ▶ supervised classification

## GRASS GIS

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

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## 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

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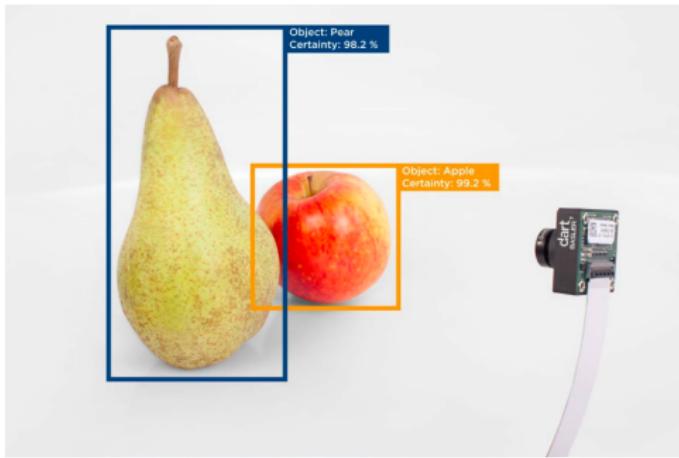
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# Motivation

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## Why neural networks?

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



Source: [1]

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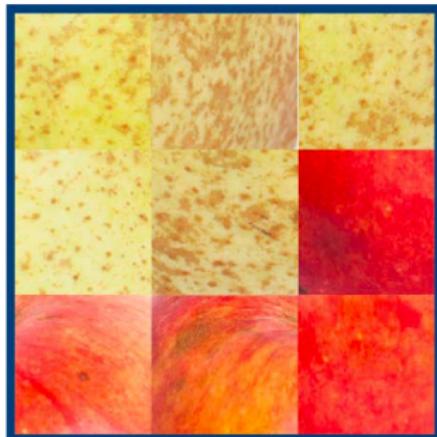
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# Motivation

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## Why neural networks?

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



Source: [1]

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- ▶ we are trying to get human-understandable results



Source: [1]

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105	102	100	97	96
103	99	103	101	102
101	98	104	102	100
99	101	106	104	99
104	104	104	100	98

0	-1	0
-1	5	-1
0	-1	0

89		

105	102	100	97	96
103	99	103	101	102
101	98	104	102	100
99	101	106	104	99
104	104	104	100	98

0	-1	0
-1	5	-1
0	-1	0

89	111	

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105	102	100	97	96
103	99	103	101	102
101	98	104	102	100
99	101	106	104	99
104	104	104	100	98

Kernel Matrix		
0	-1	0
-1	5	-1
0	-1	0

89		

105	102	100	97	96
103	99	103	101	102
101	98	104	102	100
99	101	106	104	99
104	104	104	100	98

Kernel Matrix		
0	-1	0
-1	5	-1
0	-1	0

89	111	

## Why convolutional neural networks?

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

Source: [1]

# Convolutional neural networks

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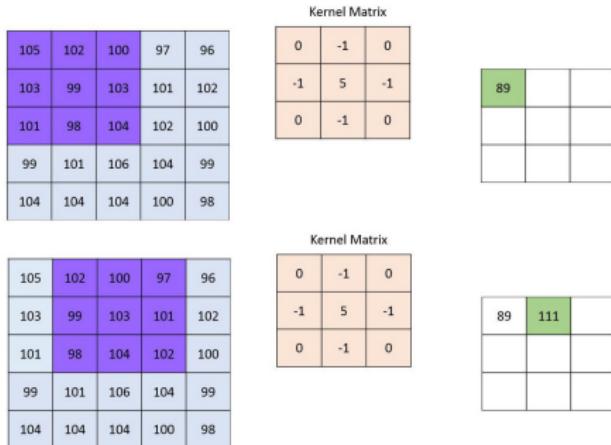
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## Why convolutional neural networks?

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

Source: [1]

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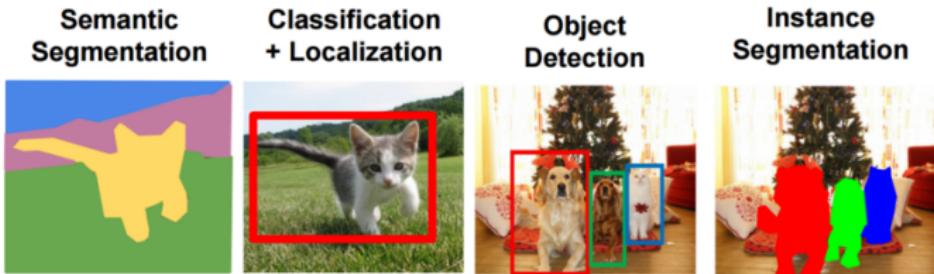
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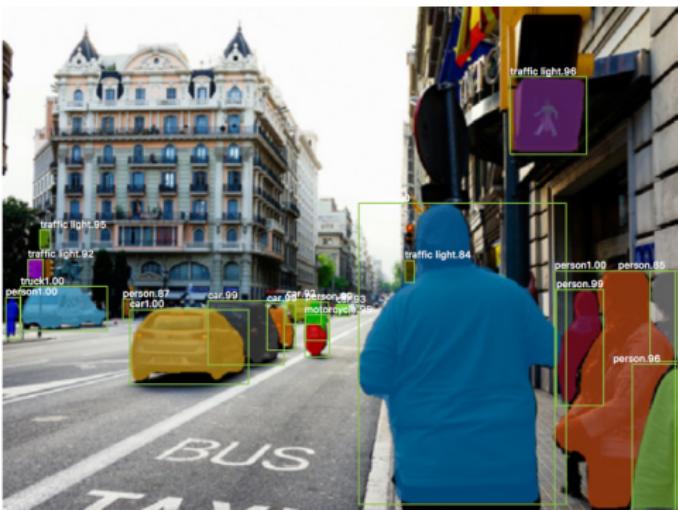


Source: [2]

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## Instance segmentation



Source: [2]

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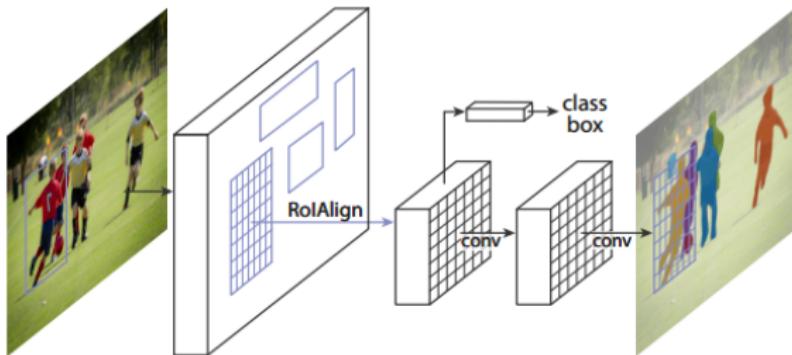
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# Mask R-CNN

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Two parts:

- ▶ backbone
- ▶ head



Source: [3]

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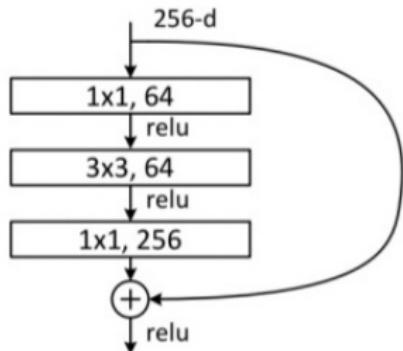
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Backbone architecture:

- ▶ ResNet



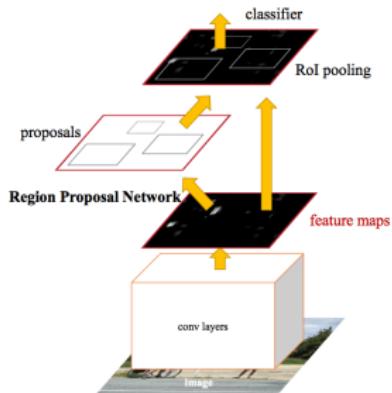
Source: [3]

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Backbone architecture:

- ▶ ResNet
- ▶ RPN



Source: [3]

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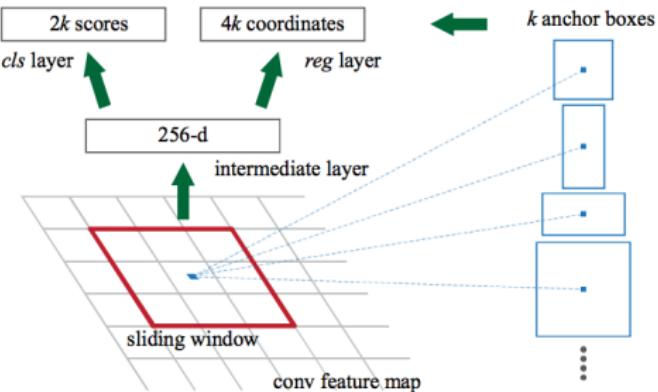
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## Backbone architecture:

- ▶ ResNet
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Source: [3]

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## Head architecture:

- ▶ softmax → class

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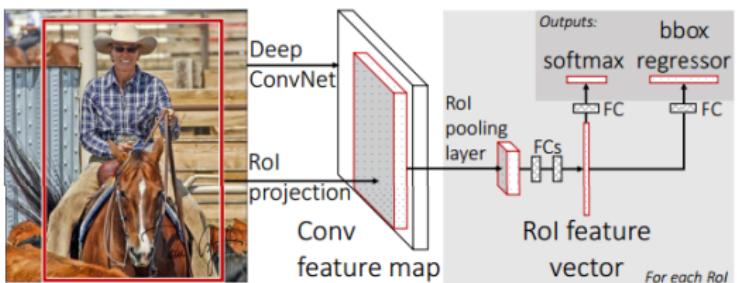
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Source: [4]

## Head architecture:

- ▶ softmax → class
- ▶ regression → bounding box

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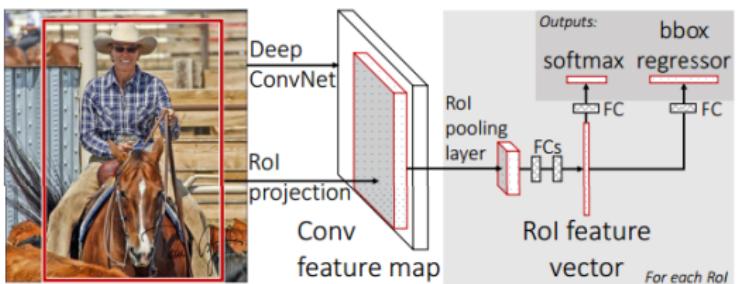
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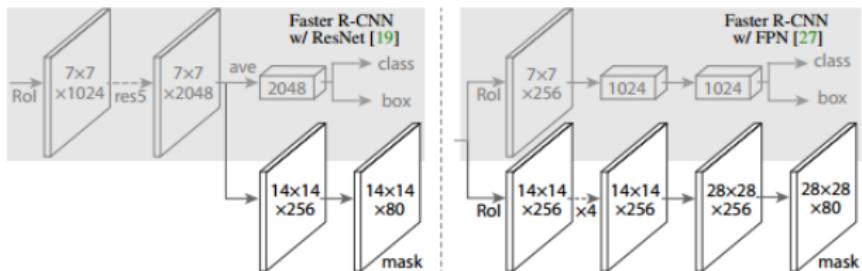
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Source: [4]

## Head architecture:

- ▶ softmax → class
- ▶ regression → bounding box
- ▶ FCN → mask



Source: [4]

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## Workflow:

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- ▶ i.ann.maskrcnn.detect

# i.ann.maskrcnn.train

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## Workflow behind

- ▶ configuration of the model

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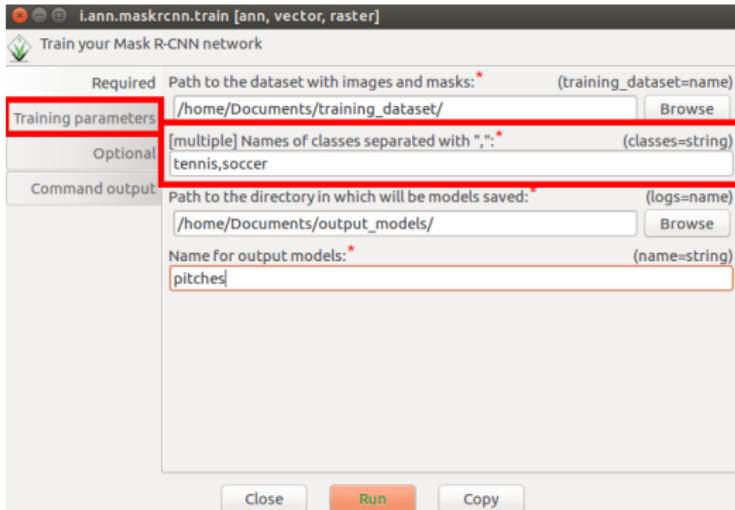
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i.ann.maskrcnn.train training\_dataset=/home/Documents/training\_dataset/ classes=tennis,soccer logs

## Workflow behind

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

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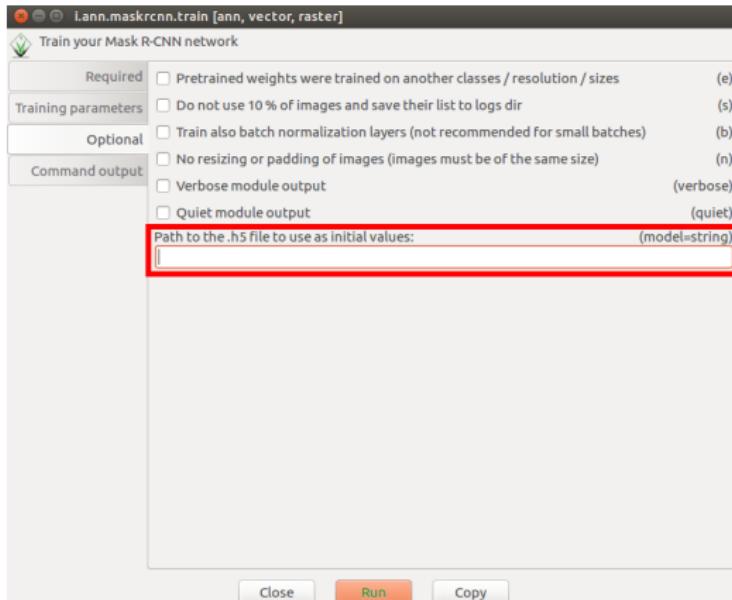
[i.ann.maskrcnn.train](#)

[i.ann.maskrcnn.detect](#)

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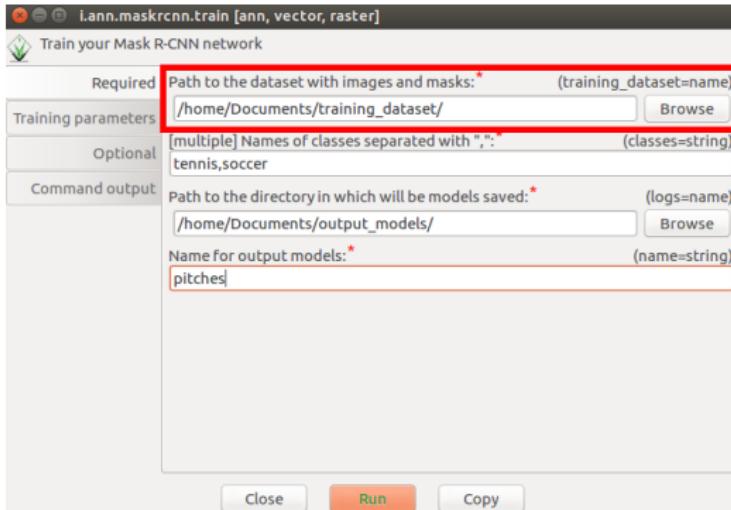
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## Workflow behind

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



i.ann.maskrcnn.train training\_dataset=/home/Documents/training\_dataset/ classes=tennis,soccer logs

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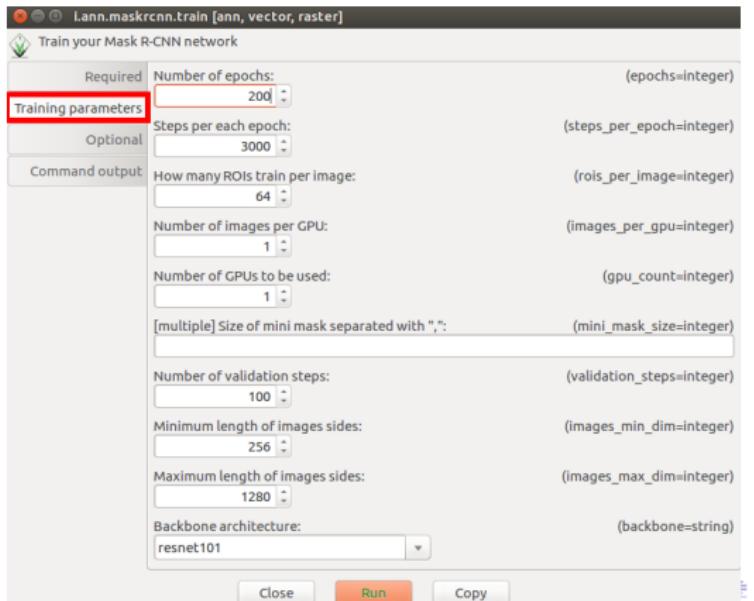
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## Workflow behind

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



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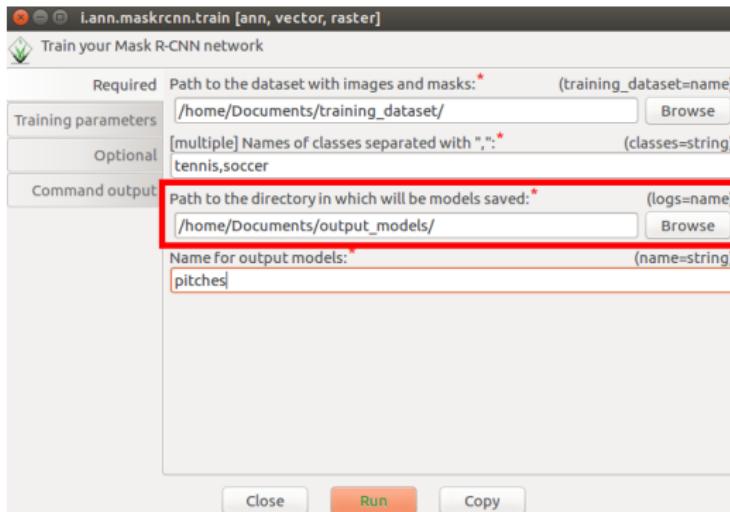
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## Workflow behind

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



i.ann.maskrcnn.train training\_dataset=/home/Documents/training\_dataset/ classes=tennis,soccer logs

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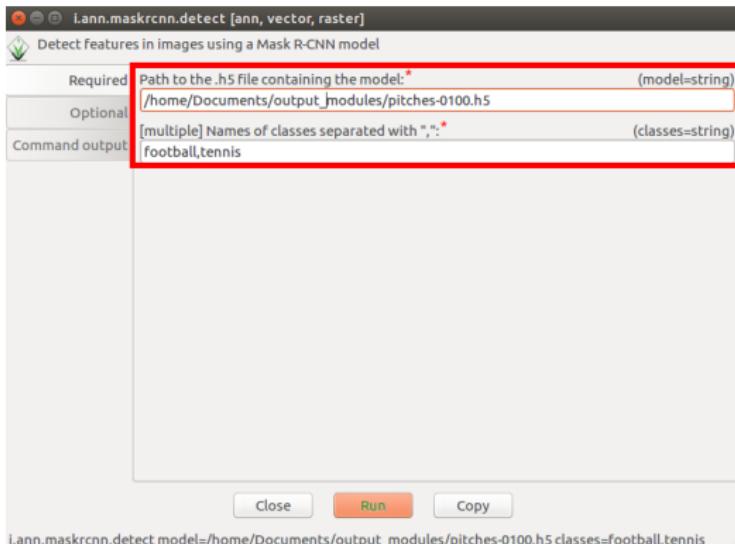
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## Workflow behind

- ▶ load the model



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- ▶ load the model
- ▶ detection for each raster

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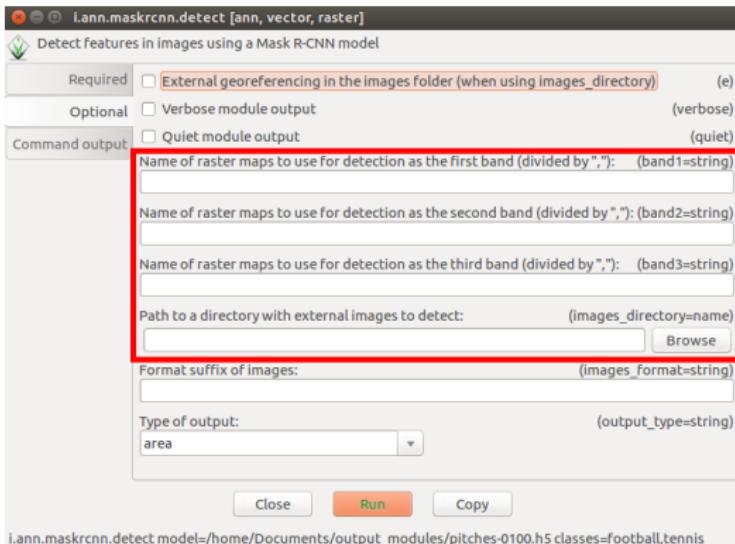
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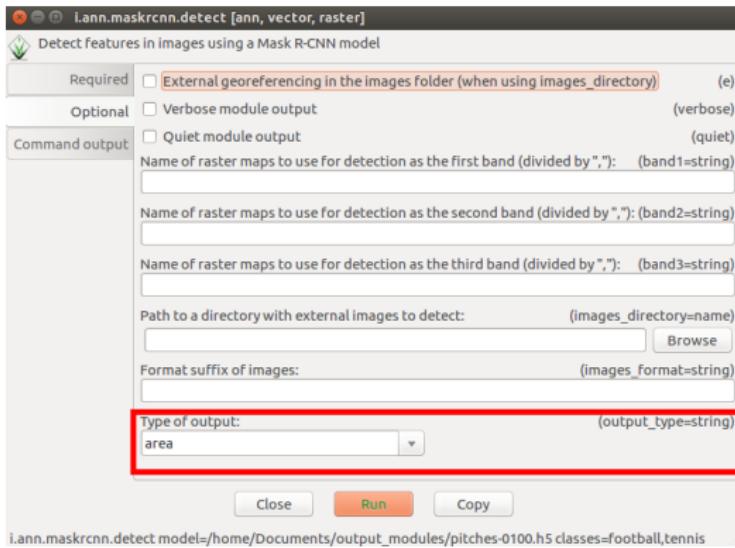
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## Workflow behind

- ▶ load the model
- ▶ detection for each raster
- ▶ vectorization



i.ann.maskrcnn.detect model=/home/Documents/output\_modules/pitches-0100.h5 classes=football,tennis

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Loss function 0.96, 54000 training images

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Loss function 0.96, 54000 training images

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Loss function 0.96, 54000 training images

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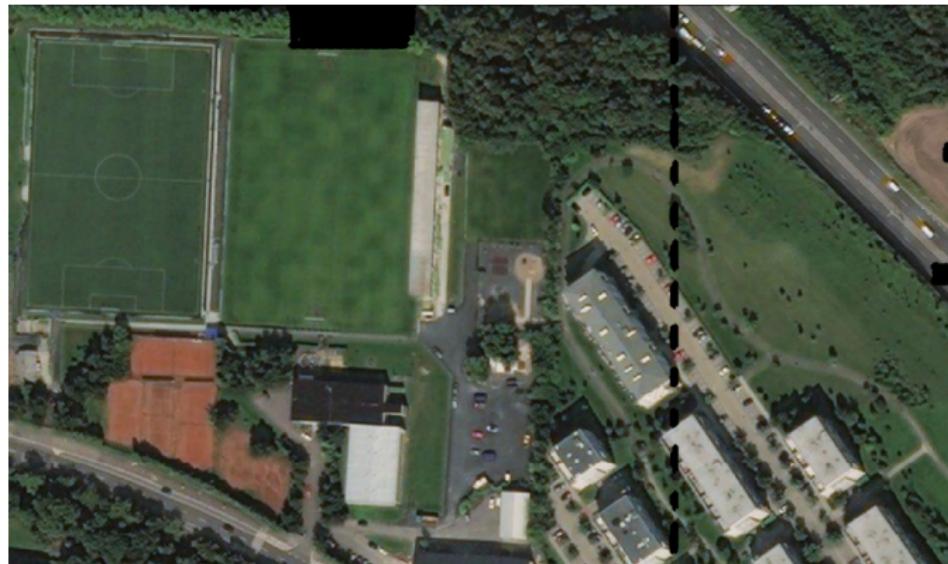
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Epoch 1, loss function 35.01, 2400 training images

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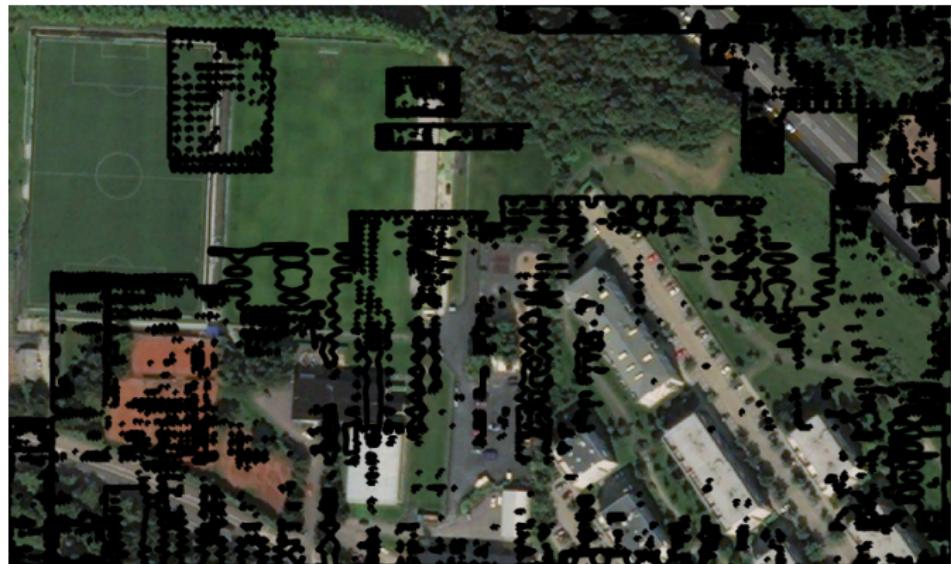
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Epoch 10, loss function 5.87, 2400 training images

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Epoch 50, loss function 1.36, 2400 training images

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- ▶ source code
  - ▶ <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

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- [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.

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