Application of Satellite Image Segmentation for Urban Planning Optimization
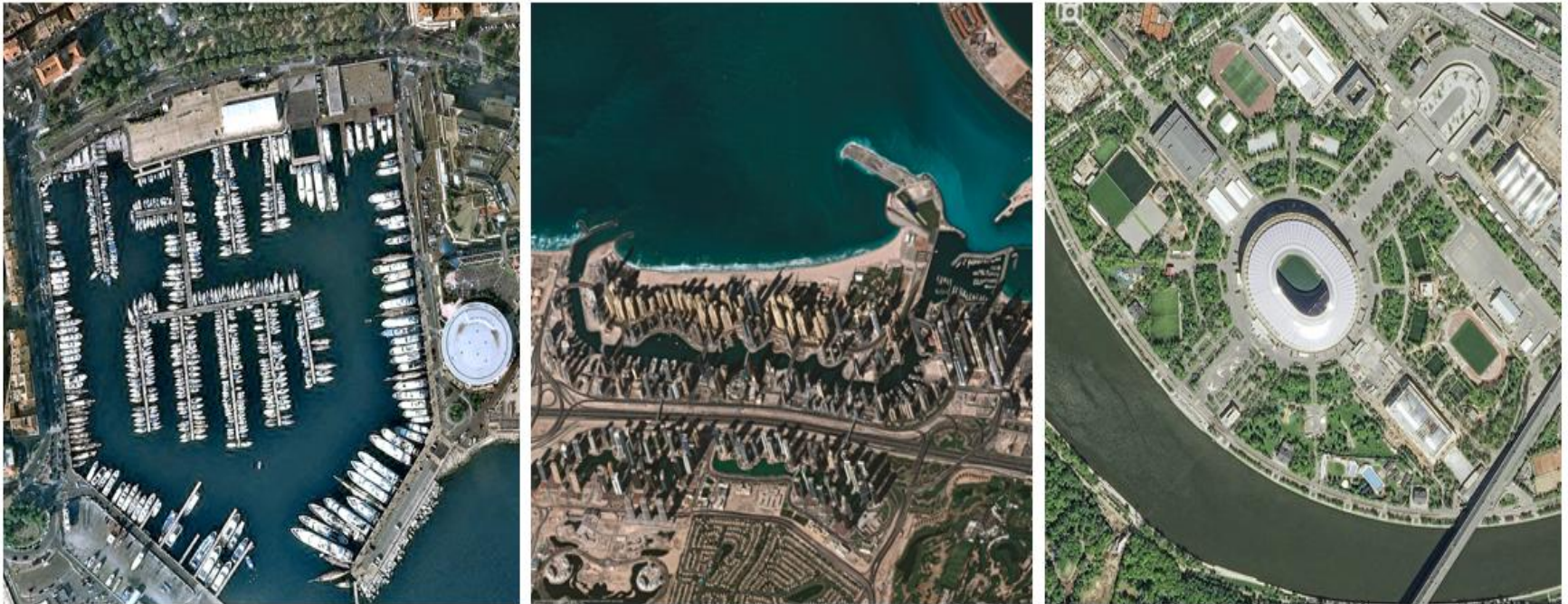
ICDPA 2019, May 11-13, 2019 | Shanghai, China

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Introduction

Goal of investigation: development of effective algorithm for building detection on satellite images based on deep learning methods

Examples of images from the Pleiades-1B database (spatial resolution of 0.5 m / pixel)

Algorithm requirements

- Take into account the small size of objects

- Be invariant to rotation

- Have enough training examples

- Have an ability to handle huge pictures

- Cope with noise

Approaches

- Traditional machine learning methods

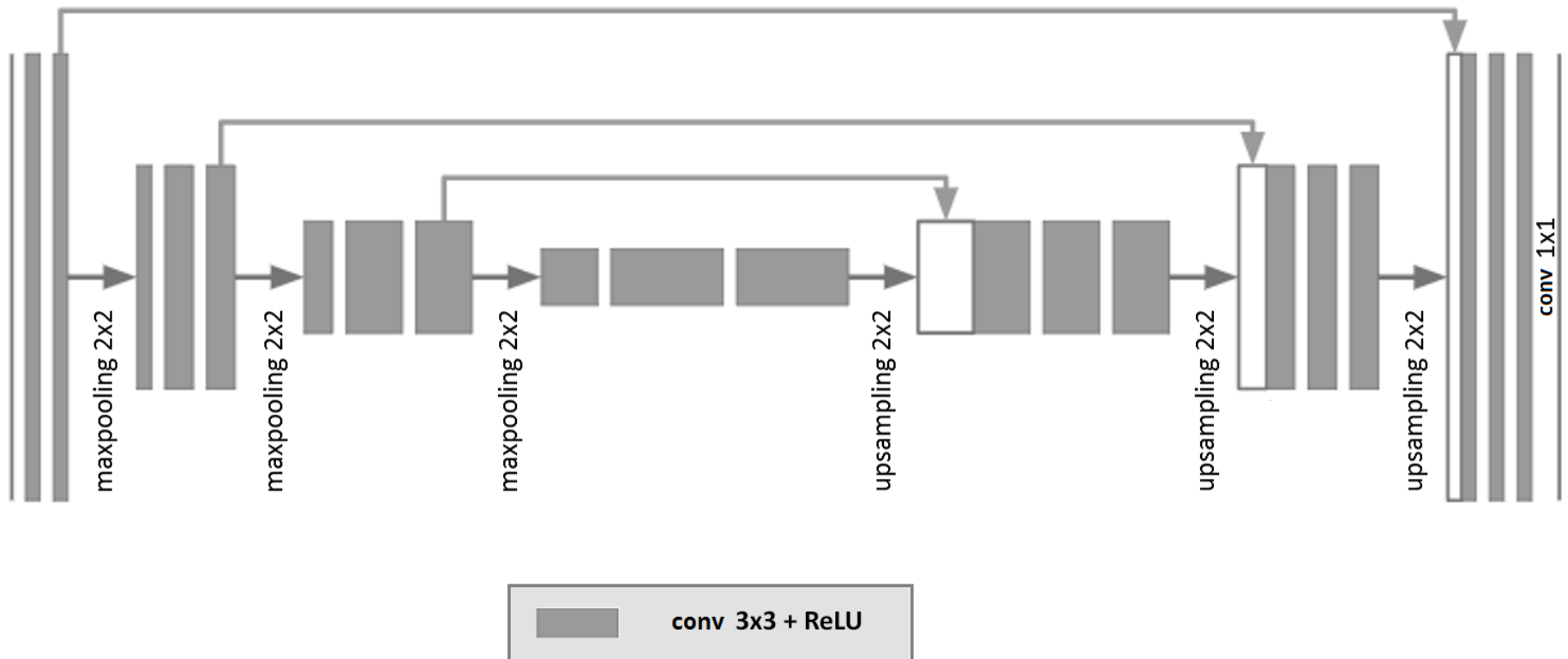 (k-means clustering, EM-algorithm)

- Convolutional neural networks

 (SegNet, LinkNet, TernausNet, Fully convolutional networks)

U-Net

Trainable parameters: 7.8 mil

O. Ronneberger, P. Fischer, T. Brox. U-Net: Convolutional Networks for Biomedical Image Segmentation. *Medical Image Computing and Computer-Assisted Intervention (MICCAI), Springer, LNCS*, vol. 9351, 2015, pp. 234–341.
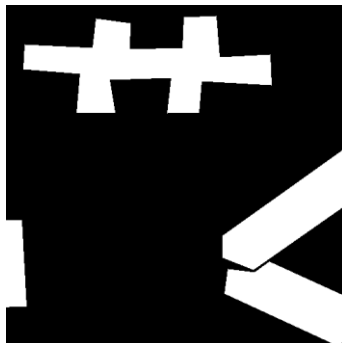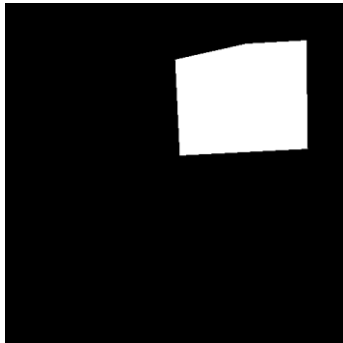
Planet database

- 14 samples in JPG format
- Manual image markup (*https://supervise.ly*)
- Resolution: 8192x8192 px, 0.5 m/pixel
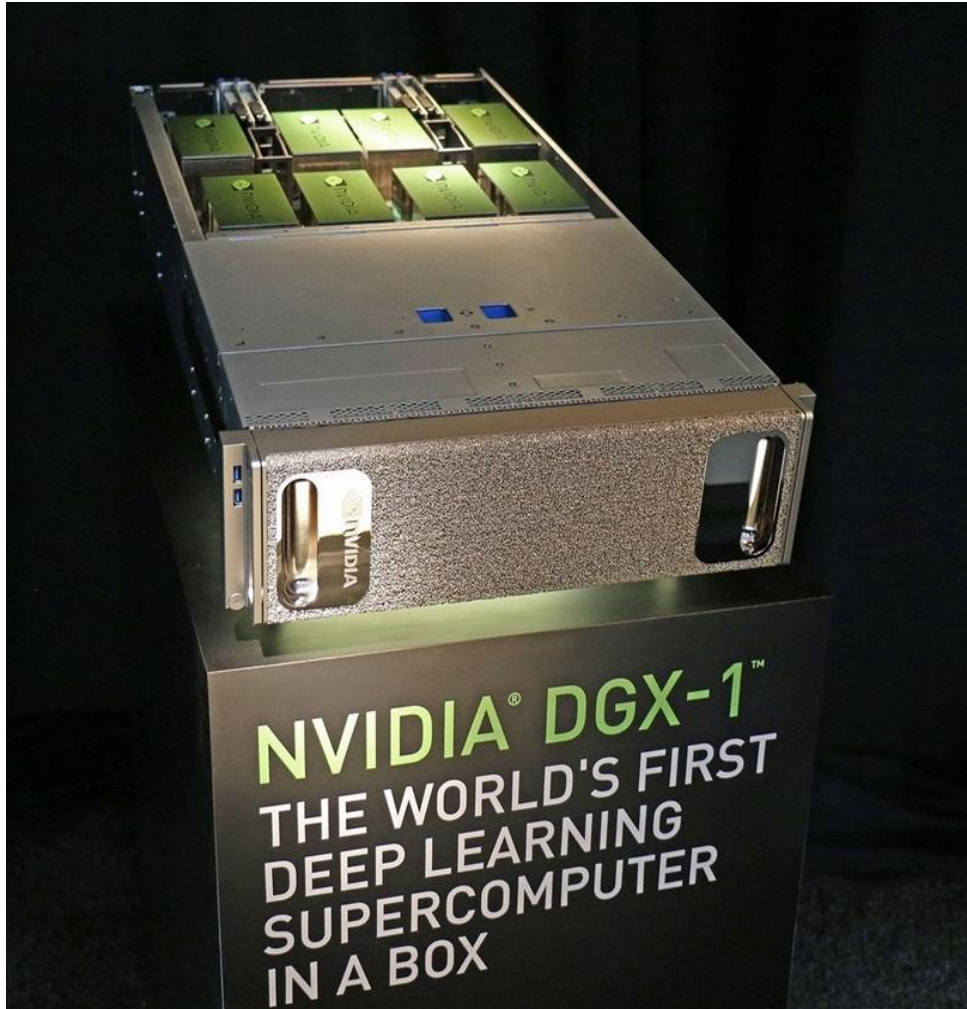- 3 Russian cities: Moscow, Yaroslavl, Rybinsk
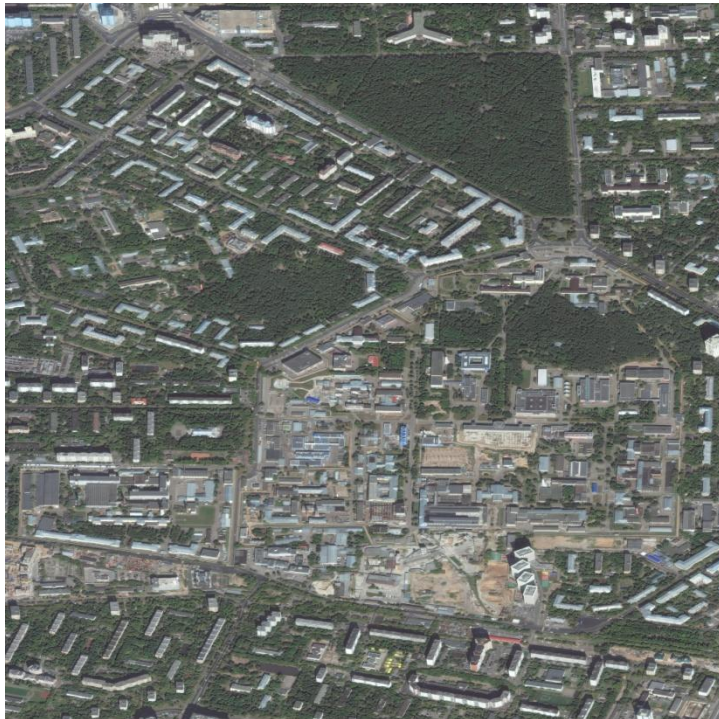
Dataset preparation

- Cropped image resolution: 512x512 px
- Augmentation: mirror reflection + rotation (+90, +180, -90)
- Training set: 20888 images
- Test set: 5224 photos

Training process

Metrics: Jaccard index (J)

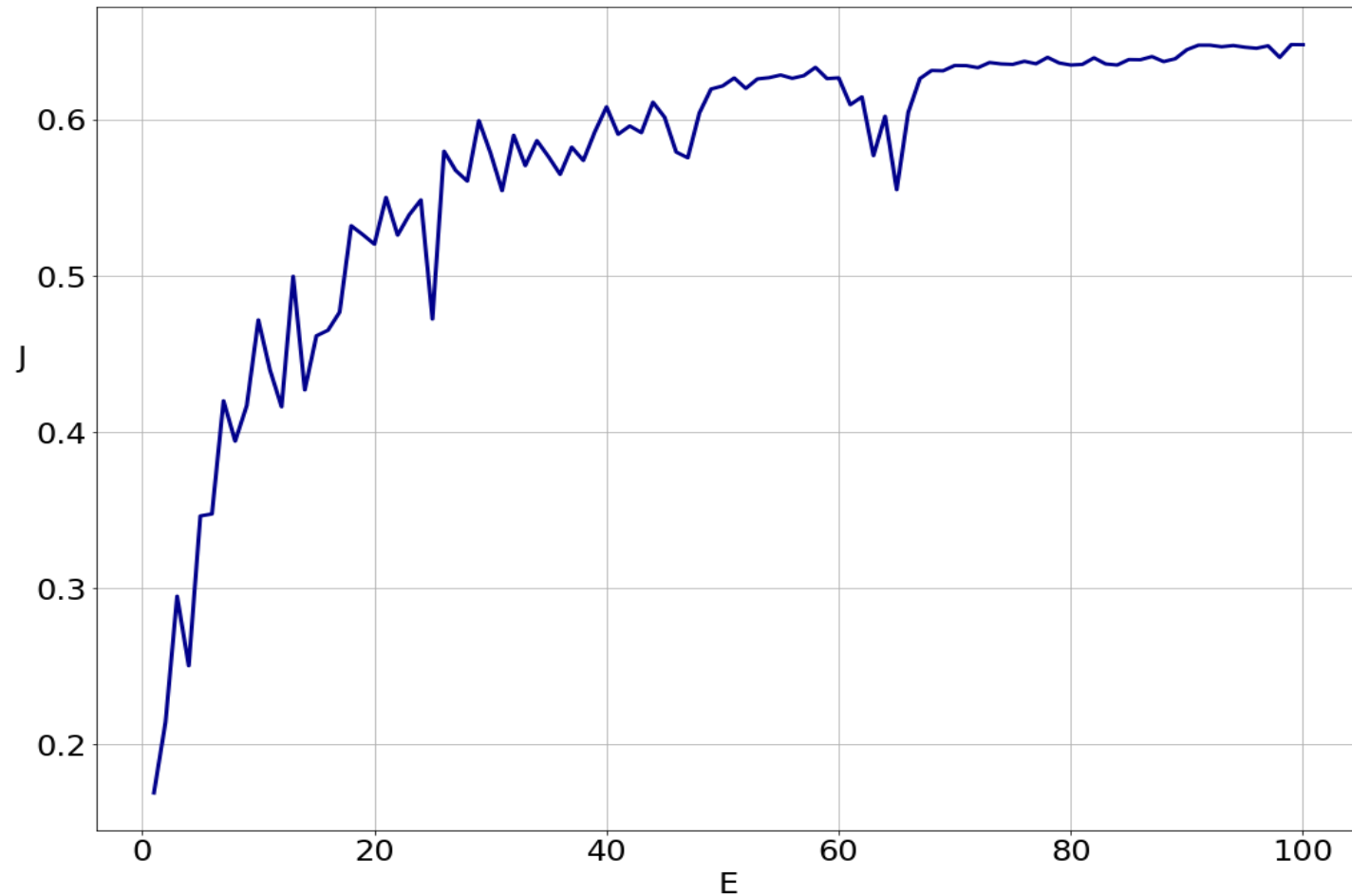Loss function: binary cross-entropy

Optimizer: Adam

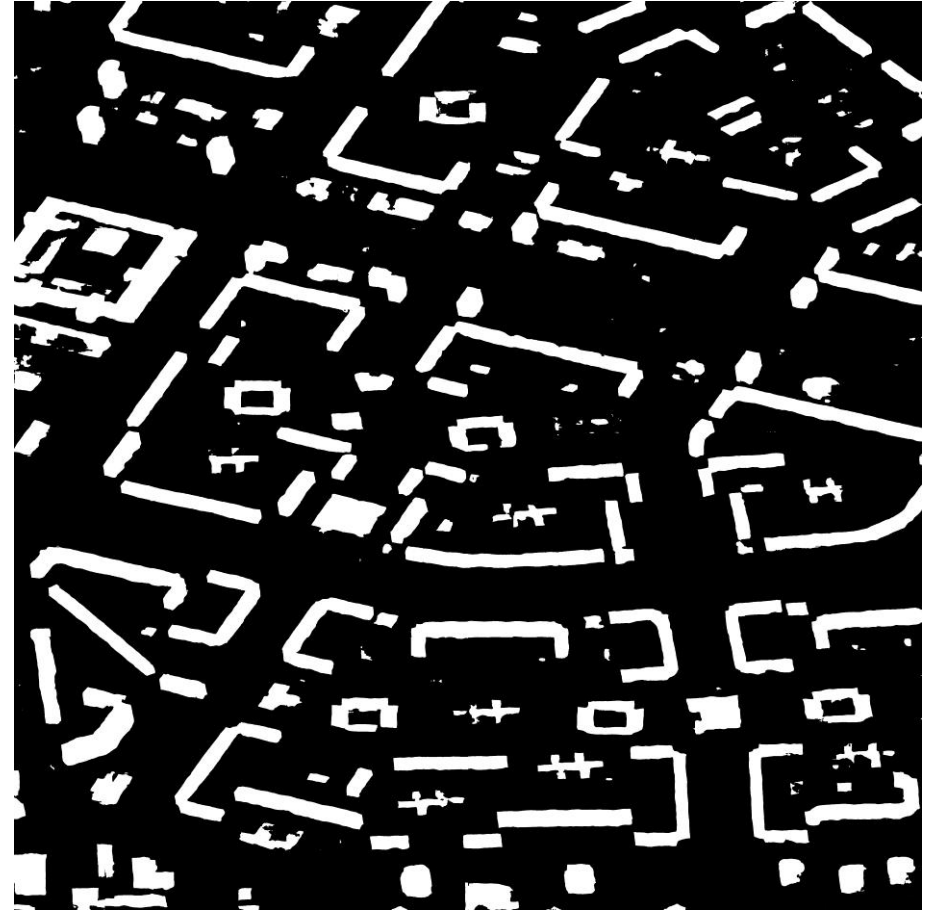Batch size: 36 cropped samples

Epochs (E): 100

Time: 4 hours
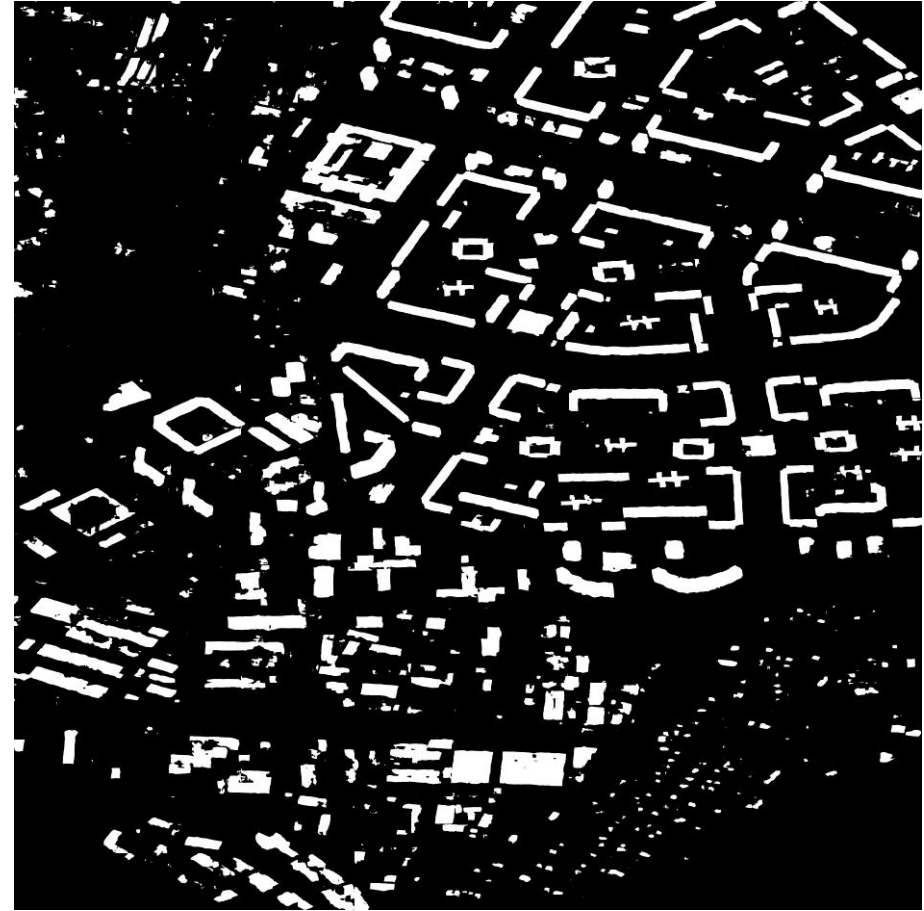
demid.ai

Dependency of Jaccard index on training epochs

$$J = 0{,}65$$

Examples of detection

Examples of detection

Application

- Search best locations for outlets

- Urban planning

- Building control

Conclusions

- CNNs can be effectively used for building detection on aerial photos

- U-Net was developed to cope with satellite images segmentation

- The training of CNN was carried out on supercomputer NVIDIA DGX-1

- The value of Jaccard index is equal to 0.65

Future plans

- Try more complicated loss functions

- Detect building corners

- Try mask search algorithms (Mask R-CNN, Faster-CNN)

- Shift color channels

Acknowledgment

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