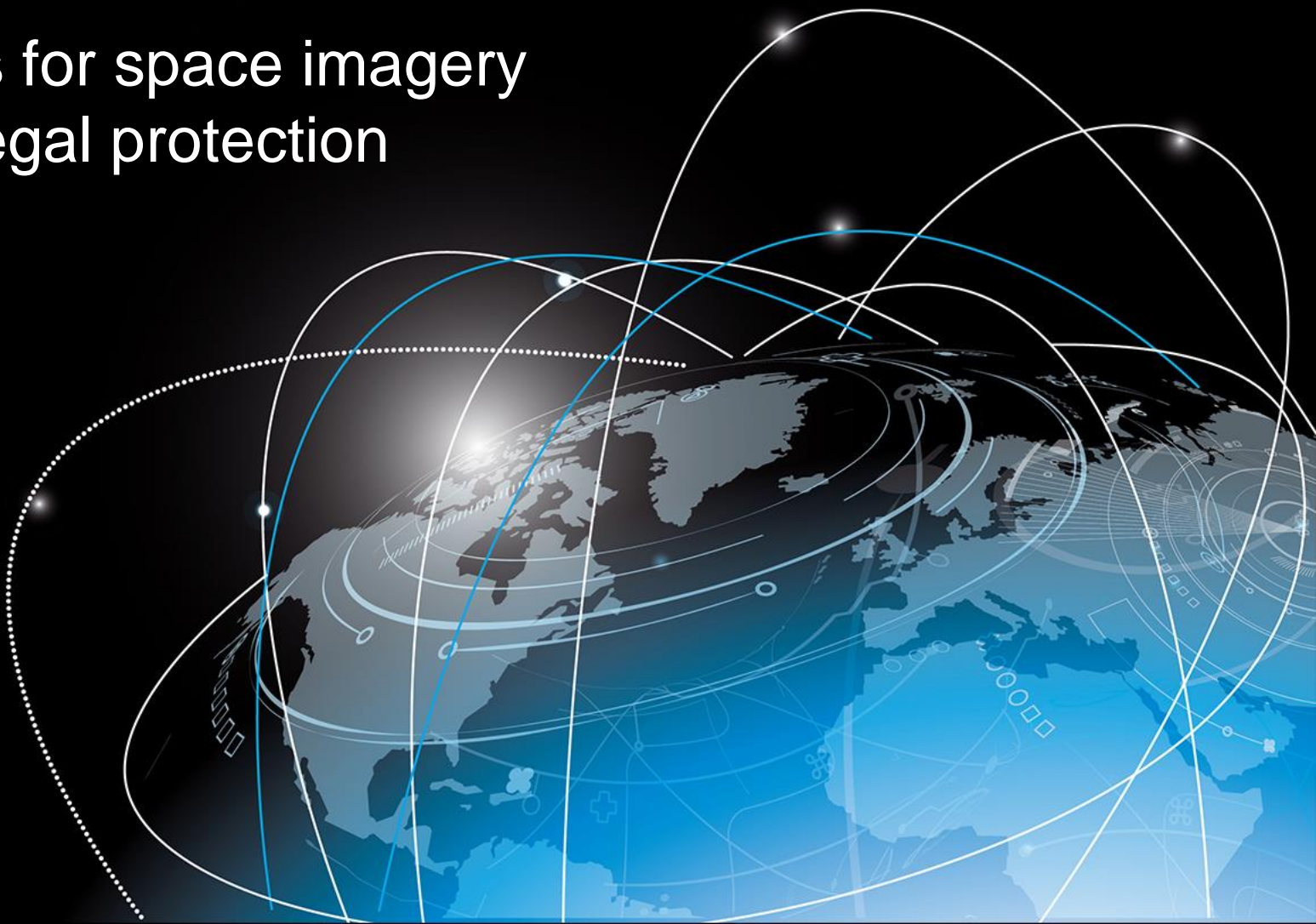


Neural network technologies for space imagery processing as an object of legal protection

Territory Project

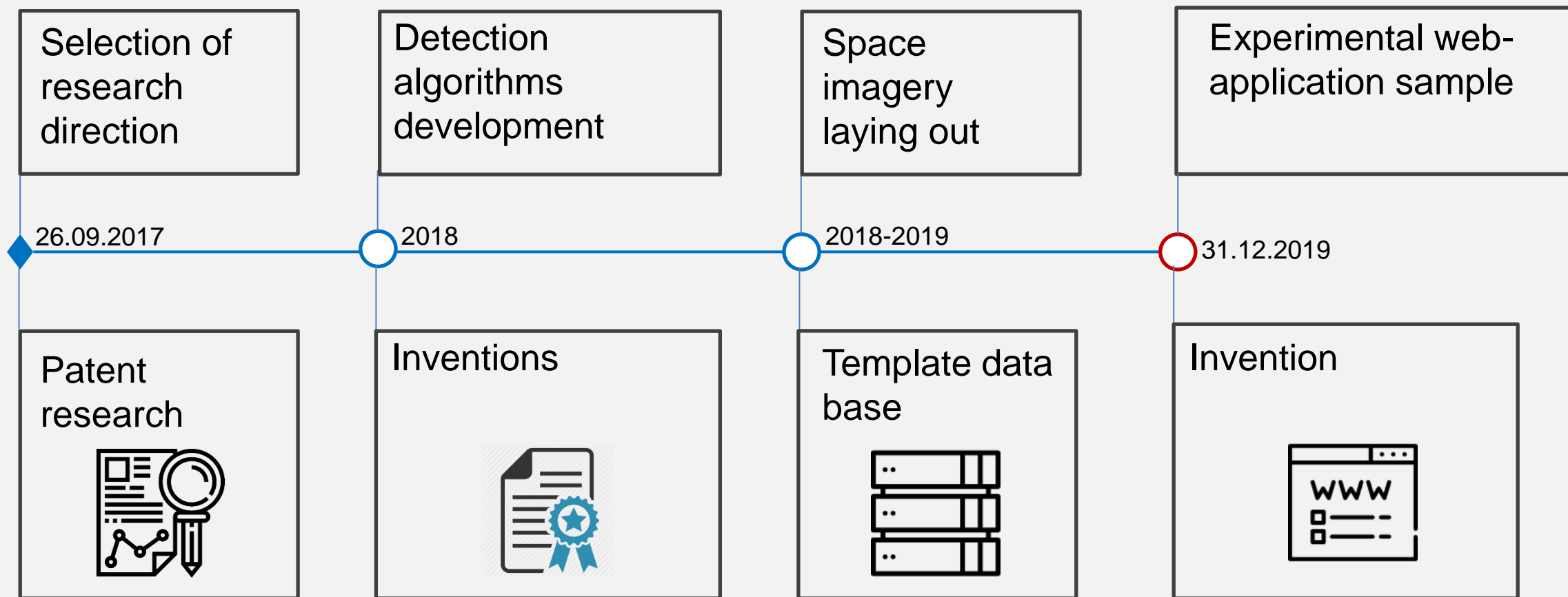


Objective:

To develop a product enabling automatic processing of big ERS data for addressing tasks relating to construction, forestry and mining



Works implementation and intellectual activity results



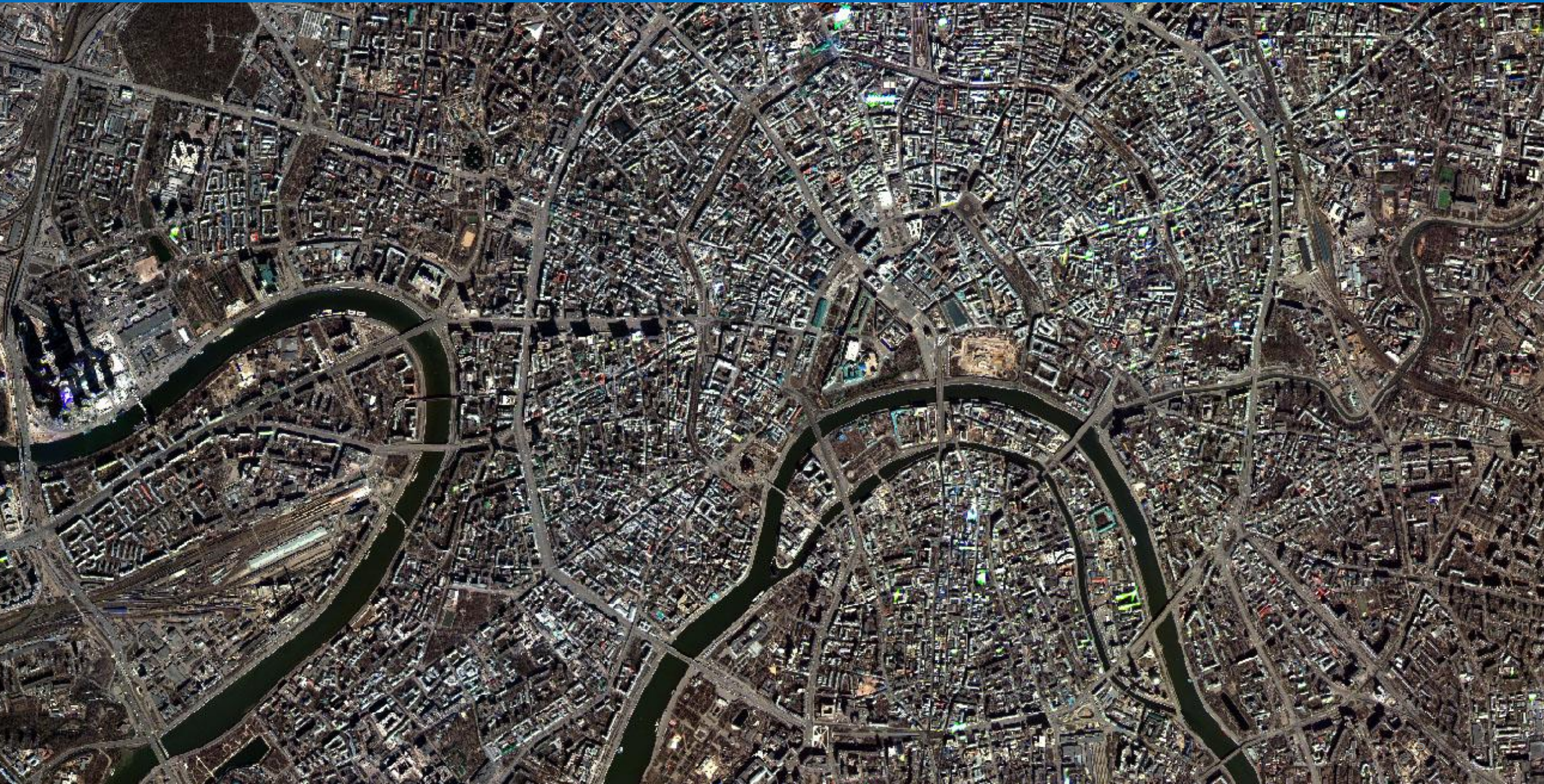
Problem

Collection, integration and processing of big ERS data for solving industrial tasks is very money-consuming



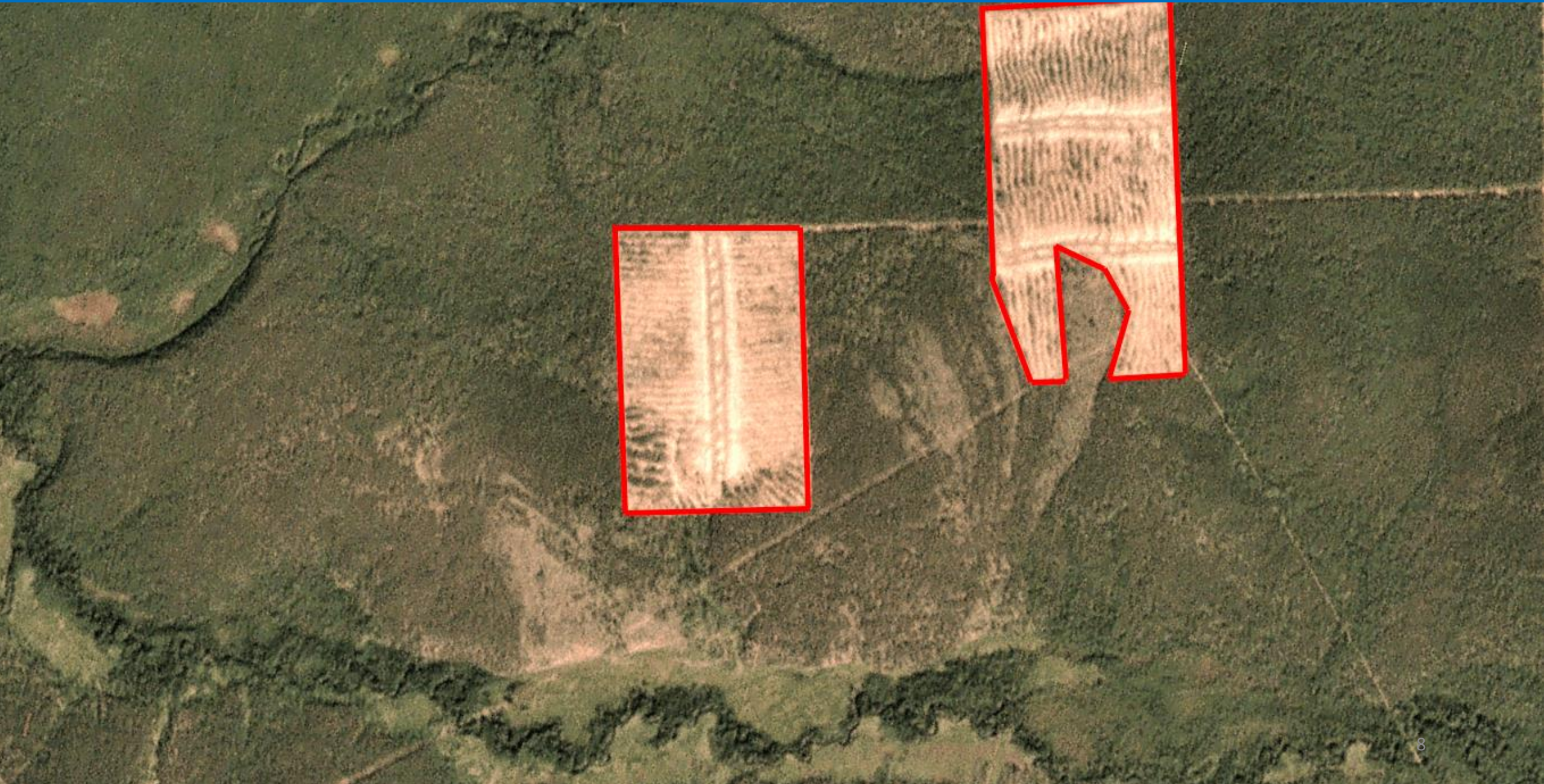
Average man-hours required to process
1 sq km of urbanized area covered with high-rise
buildings *

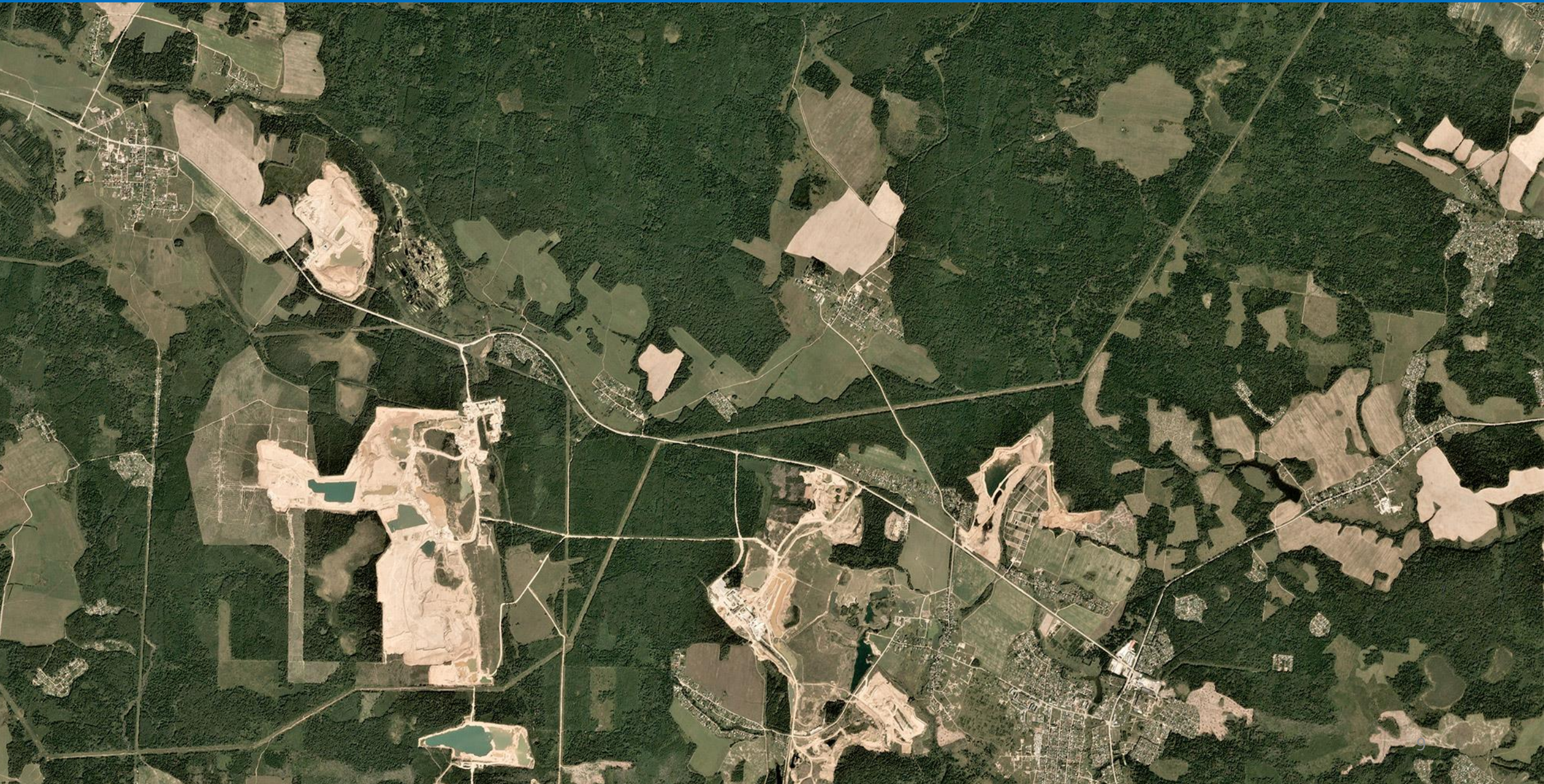
**The man-hours were calculated on the basis of Aggregative estimate prices for topographic and geodetic works SUR-2002.*













Solution



Application of artificial intelligence for objects detection in satellite imagery



Detection algorithms

Scientific researches elaborated convolution neural network methods, software was implemented for three types of surfaces:



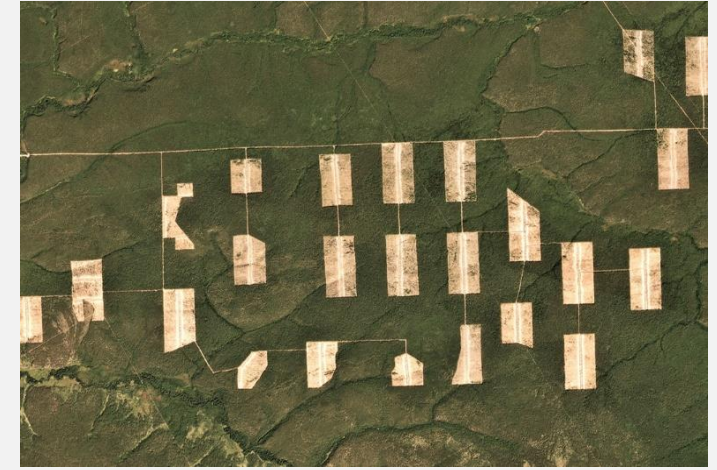
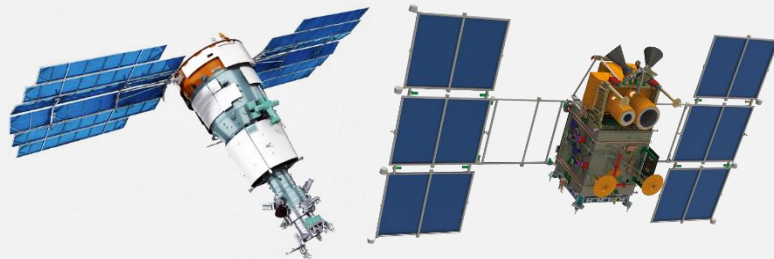
Buildings and constructions

Resurs-P



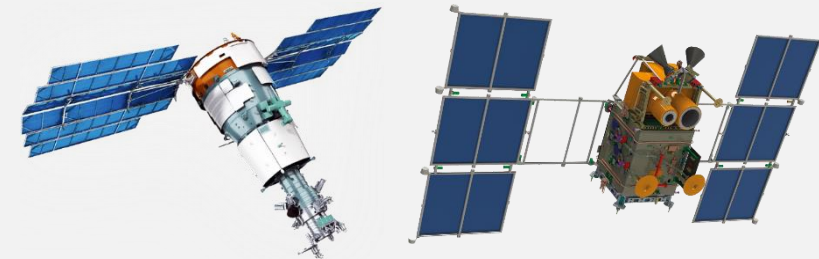
Open-pit mining

Resurs-P, Kanopus-V, Planet



Changes in forest resources
(windfalls, burnt-outs, cuttings)

Resurs-P, Kanopus-V, Planet



Space imagery laying-out

Initial data should be laid-out, learning templates for neural networks should be created

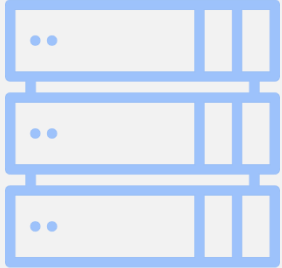


Resurs-P image patch



Patch with a laid-out area for target objects

9
template data
bases



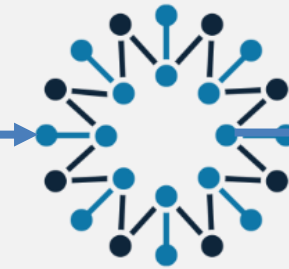
Currently developed

Laid-out images collected from Resurs-P



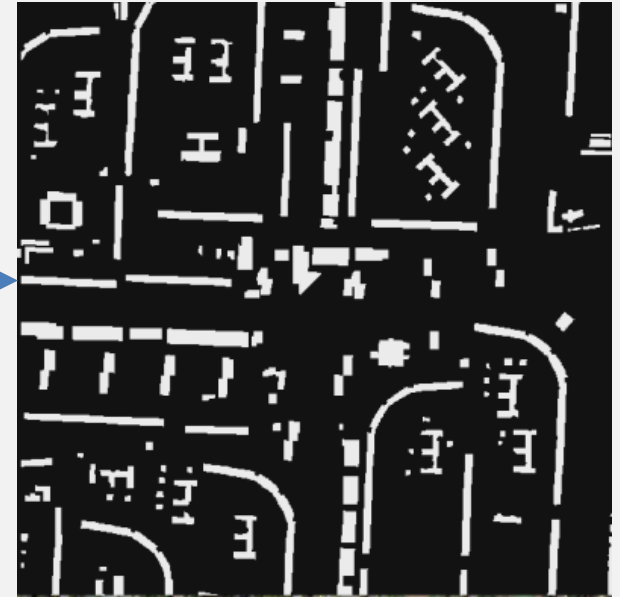
Neural network application in ERS image

Resurs-P image

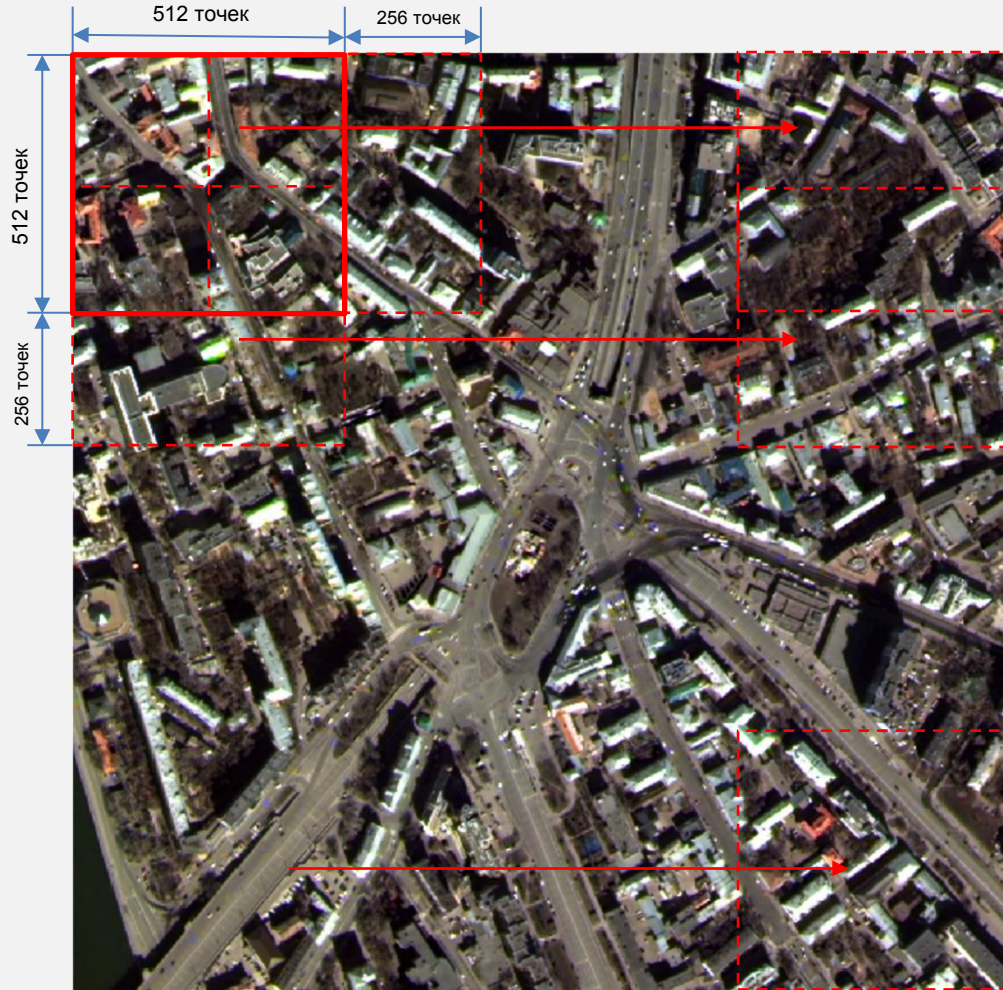


Neural network detection

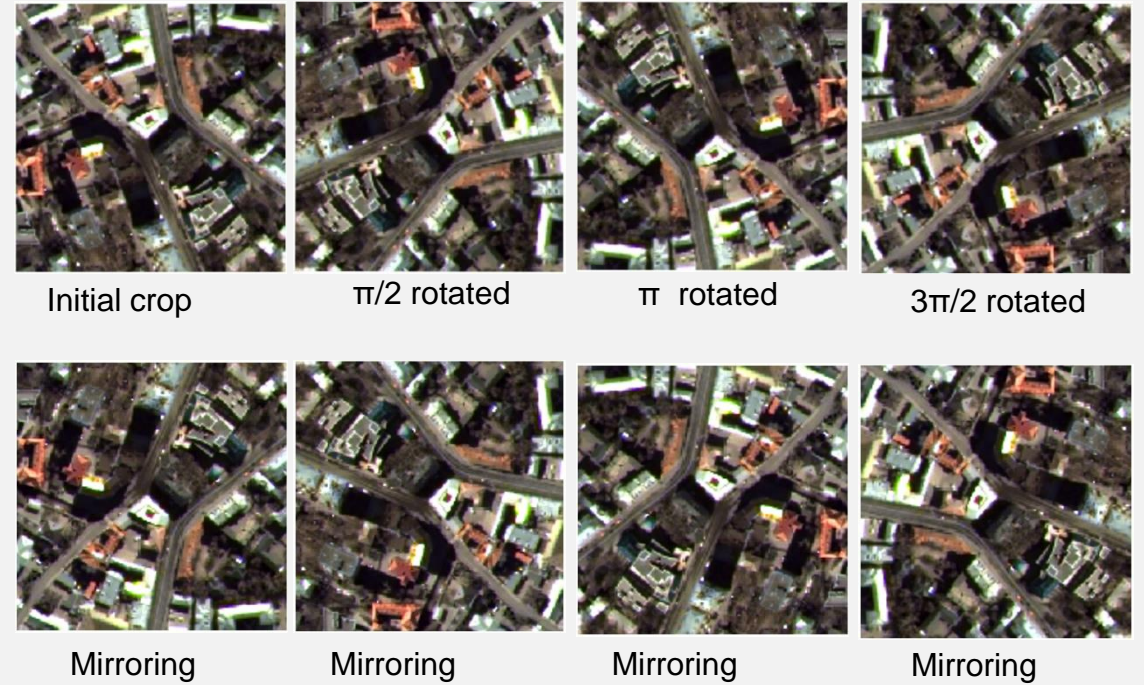
Result



Sliding window method



Initial image segmentation into a fixed size by sliding window method allows shape image fragments (crops)

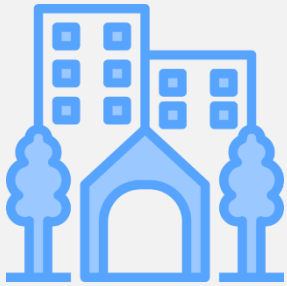


Generation of eight images in each crop mean that an initial patch can be varied differently through its rotation by 90 degrees and mirroring

Inventions



Neural network architectures are the backbone of created inventions



Intelligence system for
buildings and constructions
monitoring

Intelligence system for pits
monitoring

Intelligence system for
monitoring changes of forest
resources (windfalls, burnt-
outs, cuttings)

Operability check of buildings and constructions detection algorithm

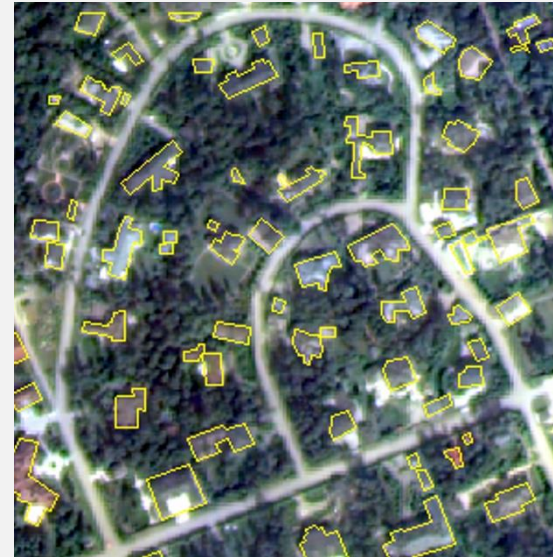
Trial learning **using a limited set of reference laid-out data** was accomplished to check operability of the algorithm:



Highly urbanized area covered with high-rise buildings



Highly urbanized area covered with mixed buildings (high-rise and low-rise buildings)



Medium urbanized area covered predominantly with low-rise buildings



Low urbanized area with detached buildings and constructions

Operability check of buildings and constructions detection algorithm (a limited number of templates)

Detection accuracy

Segmentation accuracy

200 m



75 m



10 m



71,03%

62,02%

22,66%

71,96%

70,92%

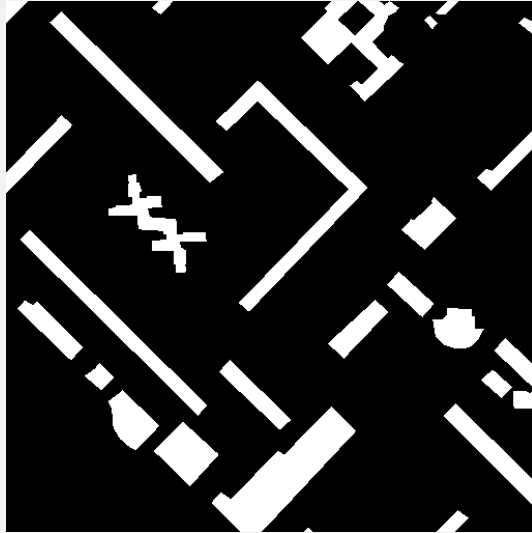
27,91%

Operability check of buildings and constructions detection algorithm (a limited number of templates)

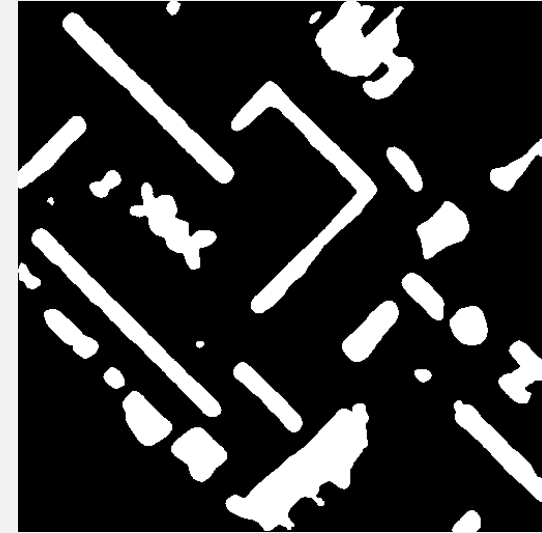
Image



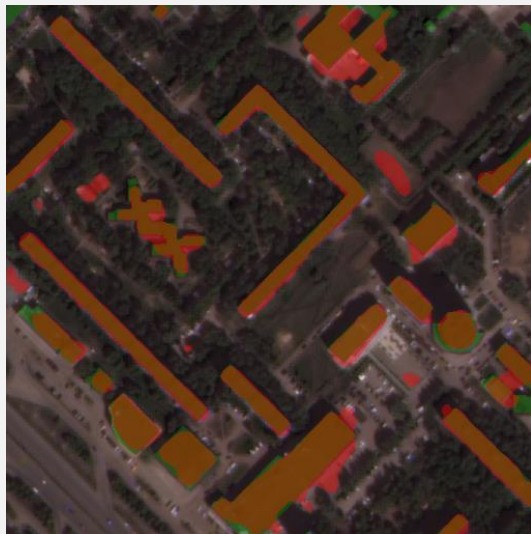
Lay-out



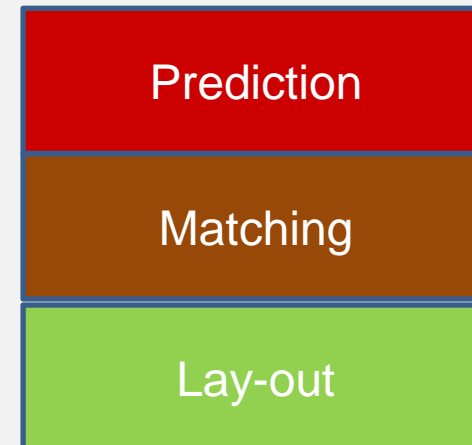
Prediction



Comparison



Legend



Artificial intelligence benefits

Processing results of
1 sq km of urbanized area with high-rise buildings


Human-made



Time:
5 hours



Neural network applied



Time:
~ 3 sec.

Man-hours ratio
~ 6000 times

Demonstration prototype of Territory web-application

Territory - the service of objects detection in satellite imagery
This service will allow define presence of buildings and constructions, open pits, identify changes in forest resources (windfalls, burnt-outs, cuttings) at any given territory. Simple steps allow to perform quick search of objects.

This service is a result of scientific researches based on using AI, modern neural networks algorithms for machine learning.

Website: Territory.RussianSpaceSystems.ru

The screenshot displays the Territory web-application interface. A map shows a selected area labeled "Зона 1" with an area of 441,62 km². A pop-up window titled "ТИП РАСПОЗНАНИЯ" (Recognition Type) lists three categories: "Вырубка" (Clearing) with a tree icon, "Карьеры" (Quarries) with a truck icon, and "Здания" (Buildings) with a building icon. A button "Выбрать территорию" (Select territory) is visible on the map. To the right, a table titled "ИНФОРМАЦИЯ О ЗОНЕ" (Zone Information) provides details about the zone's area and the number of objects detected.

ИНФОРМАЦИЯ О ЗОНЕ	
КАРЬЕРЫ	441,62 площадь зоны (км²)
23 ОБЪЕКТА	2,84 площадь участков (км²)
26/07/17	0,8
26/07/17	15,92
26/07/17	0,57
26/07/17	0,89
26/07/17	1,11
26/07/17	0,36
26/07/17	31,96
26/07/17	6,72
26/07/17	20,58
26/07/17	133,86
26/07/17	8,25

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