Development of a service for segmentation of satellite data using deep learning algorithms and the OpenVINO toolkit

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Development of a satellite image segmentation service based on Landsat-8 data

The purpose of the work is to develop a semantic segmentation service for satellite images for forest fire areas. The source code for all modules is available on GitHub: github.com/itlab-vision/satellite_images_processing. The service has a modular structure, the list of modules is presented below:

- *Selecting an area for collecting satellite data*. To select the area where fires need to be segmented, a graphical window with map was developed. It is based on the openstreetmap service, with which you can find a point of interest on the map. The leaflet library was used to built in the map into the user application.
- *Landsat-8 data obtaining.* To obtain Landsat-8 images, we use the Python package landsatxplore, which provides an interface to the EarthExplorer portal for searching and loading Landsat Collections scenes through a command line interface. Data search in the database can be performed by latitude and longitude coordinates, time interval, image cloud level.
- *Data segmentation using the model in the OpenVINO format.* Data segmentation based on a deep learning model based on the U-Net architecture. Deep learning models are computationally expensive, so the actual issue in addition to the quality of work is the issue of solution performance.

Segmentation of satellite images

For the first version of the service, it was decided to use an existing dataset and a pre-trained deep learning segmentation model from Activefire project (github.com/pereira-gha/activefire). Authors used the Landsat-8 images available in August 2020 around the globe, excluding only the Antarctic continent, to a total of 8,194 images of size ≈ 7,600×7,600 pixels covering a 185×180 km area (1.6 TB of data in total).

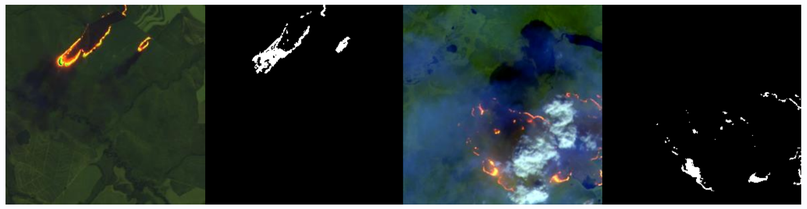

Fig. 1. Original images of active forest fires and segmentation results

In the future, we are planning to train a model that will simultaneously segment active fires and clouds.

OpenVINO toolkit

OpenVINO toolkit is an open-source software for optimizing and deploying AI inference. OpenVINO toolkit is designed to improve the performance of deep learning models by optimizing models with a built-in optimizer and leveraging available hardware acceleration. Acceleration of model inference is provided by analyzing and optimizing the computational graph, efficient processing planning and data vectorization, as well as various deep model compression methods. OpenVINO toolkit is focused on developing cross-platform computer vision applications with a strong focus on optimizing image processing performance. OpenVINO toolkit has a small number of dependencies, making it easy to integrate it with existing software

Performance measuring

To measure the model performance, the OpenVINO Deep Learning Workbench module was used. This module allows you to experiment with varying trigger parameters (number of data streams processed independently; data burst size processed simultaneously; use of half-precision data type). Table 1 shows the performance data of the model in various processing modes on the Intel i5 10600 CPU (6 cores 12 threads 3.3GHz). The best performance is achieved by the configuration when the number of threads working in parallel is equal to the number of physical processor cores, in this mode each calculation on one batch is not parallelized into several cores, but is performed on one core.

Table 1. Performance of deep learning models using the OpenVINO toolkit

Batch size	Number of streams	Weights type	Frames per second	Weights type	Frames per second
1	1	FP16	4.83	FP32	4.88
1	2	FP16	5.26	FP32	5.30
1	**6**	**FP16**	**5.94**	**FP32**	**5.91**
2	1	FP16	4.38	FP32	4.41
2	2	FP16	5.35	FP32	5.34
2	6	FP16	5.93	FP32	5.90
4	1	FP16	4.32	FP32	4.28
4	2	FP16	5.48	FP32	5.38
4	6	FP16	5.92	FP32	5.90

The conducted experiments have shown that using the OpenVINO toolkit, there is no need to collect images in one large package to obtain high performance. It is enough to set the number of parallel threads in OpenVINO equal to the number of physical processor cores and send images for processing asynchronously (it is also very convenient for web applications).

УНИВЕРСИТЕТ ЛОБАЧЕВСКОГО

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