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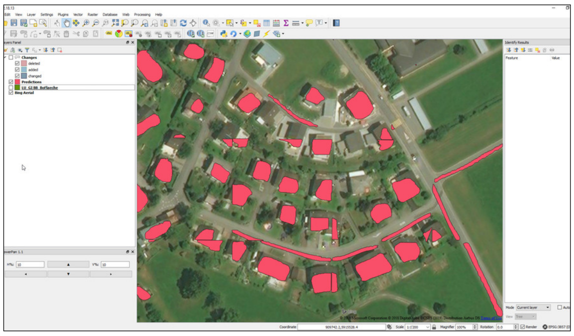
Subject Area	Software and Systems

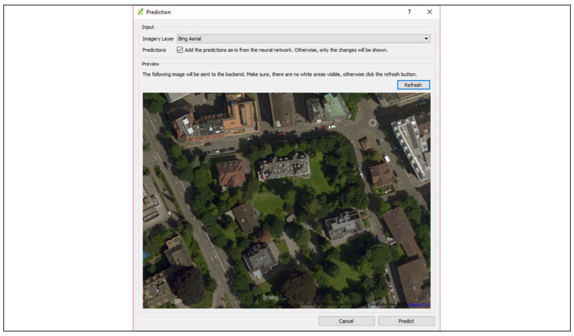
Image Segmentation using Convolutional Neural Networks for Change Detection of Landcover

Intelligence Augmentation using Open Data and Deep Learning



Result of the detection of buildings and streets based on imagery, visualized using QGIS Desktop

Detected buildings where artefacts of shrinked geometries are visible (colors just indicate separate instances)



Dialog of the implementedd QGIS plugin

Introduction: Cadastral surveying keeps track of real property boundaries, such as buildings, as well as roads, and other landcover objects. Certain objects are only updated periodically, which means that the cadastral survey data must be refreshed after some years. Generally, this means finding changes in the landcover, based on aerial imagery such as orthophotos, lidar sensor data, and terrestrial measurements. The changes consist of new objects that have been added, existing objects that have changed, or objects that have been removed since the last survey. The renewal of these data requires substantial manual work because it is often not easy to identify the changes. At the same time the clearable prices decrease constantly, which asks for automation of the update process.

Objective: This study used an approach in which machine learning is applied and a modern, open source geographic information system (GIS) is used as an editing tool. The goal was to reduce the amount of manual labor required. Unfortunately, state-of-the-art technologies are not advanced enough yet to rely on completely, when trying to find these changes. Instead, they can provide support for human work and use artificial intelligence called “intelligence augmentation”. In this study, selected objects from landcover in a recent orthophoto are analyzed and compared with a given, outdated landcover vector data from cadastral survey. Additionally, this goal should be reached using open data such as OpenStreetMap (OSM) for the vector data and Microsoft Bing for the aerial imagery. As a result of this, anyone can reproduce the results of this work. Furthermore, for the generation of training datasets, a tool called 'Airtiler' written in Python has been developed, which generates data for the neural network based in multiple bounding boxes (tiles) and OSM attributes.

Result: The result of this work was a QGIS desktop plugin written in Python. The plugin sends the current extent of an image together with loaded cadastral survey vector data to the backend. The backend - written in Python too - predicts all objects within the classes using a retrained "Mask R-CNN" neural network, which has been developed at Facebook AI Research (FAIR). The selected classes were: building, highway, vineyard, tennis court and swimming pool. In a next step, these predictions were vectorized and georeferenced. Then the changes were determined by comparing the actual vector data from the cadastral vector data to the predictions. Finally, the changes were sent back to QGIS and visualized there according to their change type (changed, deleted, added). The tests revealed that about 95% of the predictions were correct. An explanation of the errors is that satellite imagery often had displacement compared to vector data from OpenStreetMap. Other errors are due to the fact that OpenStreetMap data was used for training but cadastral survey data for tests. Future work could be to use a larger and less imbalanced imagery of higher resolution as well as cadastral survey as for training data input. Additionally, the training of multiple neural networks (one per class) to predict, should also lead to improvements in the predictions.