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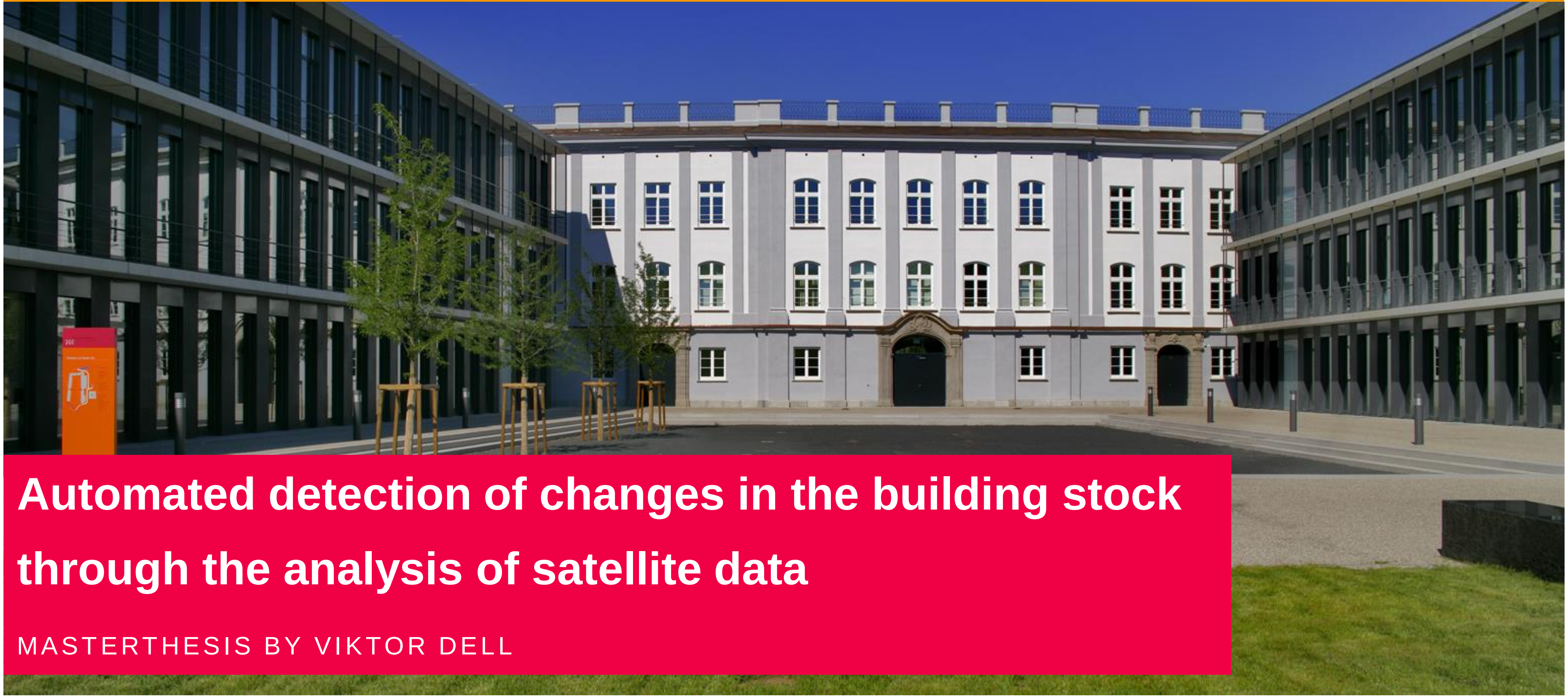
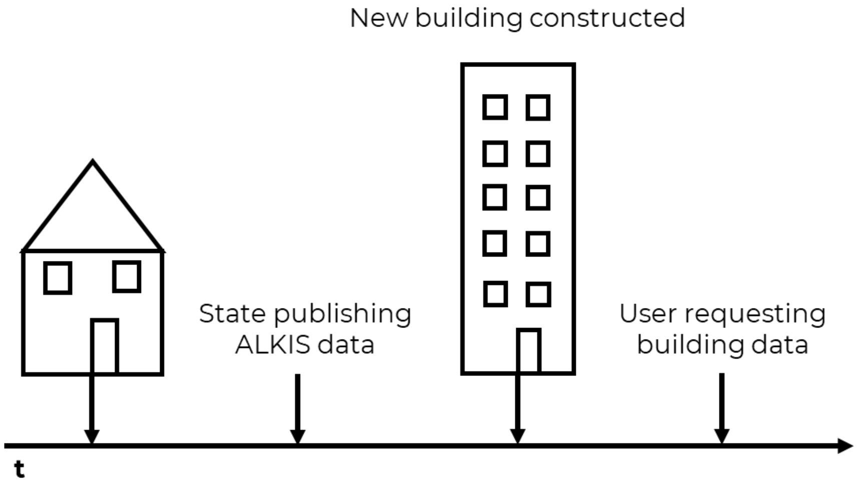


Automated detection of changes in the building stock through the analysis of satellite data

MASTERTHESIS BY VIKTOR DELL

Problem statement



The German state has to publish building information by EU-law (INSPIRE). Since the data is uploaded unregularely, there is a possibility that a user requesting the data accesses building information about a building that was removed in reality but still available in the published dataset. This wrong information leads to unsatisfied customers/users due to a lack of trust towards the data and the governmental institution publishing it.

Possible Data Sources

In comparison, satellite data seems to be the best fit for an additional datasource to analye id a building was removed or not. Satellite data is reliable, it‘s availability is high and there is a frequent update cycle in Germany.

	Alkis/ CityGML	Lidar/ Ortho	OSM/other Open-Data	Satellites
Reliability	High	High	Low	High
Resolution	High	High	Low	Low
Update Frequency	Low	Low	Undefined	High
Availability	Depending on legislator	Depending on legislator	High	High

Types of Satellites

Optical

Sentinel 2a + 2b

© Google Earth

SAR

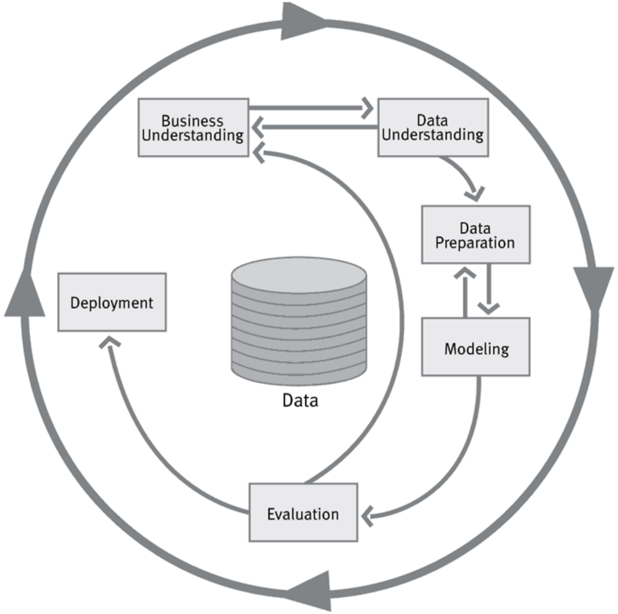
Sentinel 1a + 1b

|HH+VV| |HV | |HH-VV|

In this research, both Sentinel missions were used. Optical data were derived from the Sentinel 2 mission and SAR GRD data were taken from both Sentinel 1 satellites.

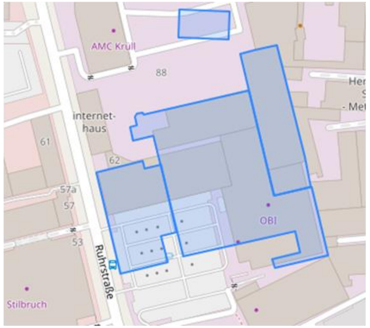
ML Approach

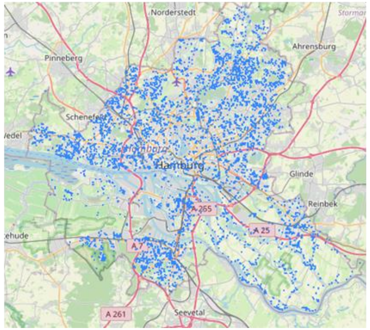
To evaluate wether satellite data is an useful add-on for this specific usecase, the Crisp DM-cycle method was applied to coordinate the research.



ML Approach

Deriving the Groundtruth





As groundtruth, state published ALKIS data from the city of Hamburg was used. Hamburg provided exports of the building stock for intervalls of three months. Data points from 2016 to 2020 were used. The analysis resulted in 8.619 removed buildings within the timeframe (at an total of 902.344 buildings). The evenly sampled training data set, that included building footprints of buildings that were not removed (negatives) resulted in a total of 17.238 buildings.

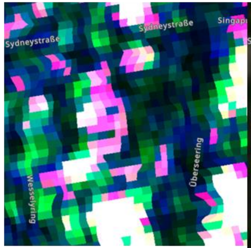
ML Approach

Underlying Data

The satellite data was merged to the identified groundtruth. Following example shows the SAR and image data of an existing building (09.07.2017) and the same surface after it was removed (12.07.2018)

09.07.2017

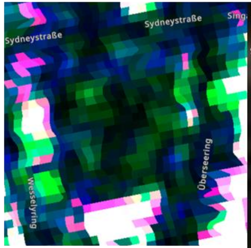
SAR



Image

12.07.2018

SAR

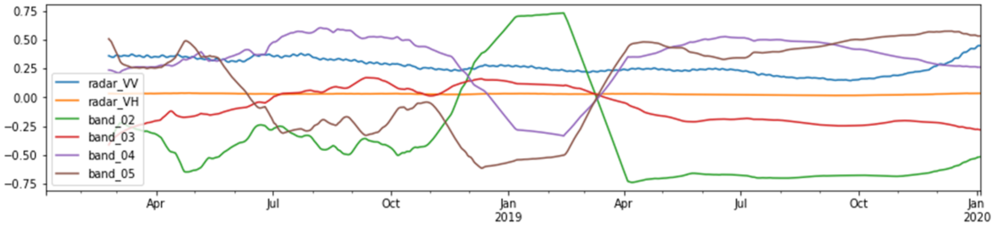


Image

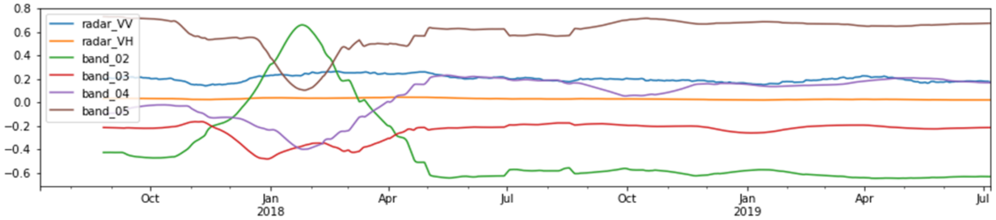
ML Approach

Underlying Data

Change



No change



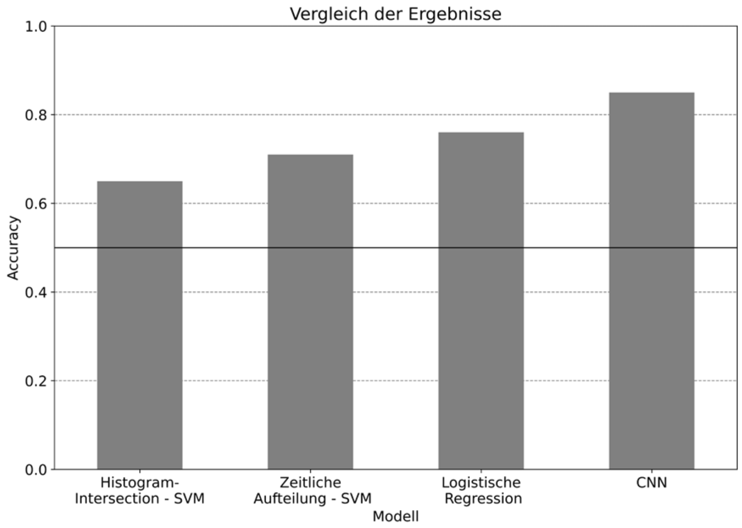
Following graphs show examples of normalized and interpolated satellite data for two periods of time and two different places. One where the building was removed and one where it remained

ML Approach

Results

Different ML-algorithms were applied to determine which can identify changes in building stock best. The CNN model was able to achieve an overall accuracy of 0.85 with 0.87 precision and 0.83 recall. 0.65 accuracy was achieved only using Sentinel-1 data and 0.78 with Sentinel-2.
For buildings with a footprint area smaller than $50m^2$ only 0.66 accuracy could be achieved.

In summary, it is possible to use satellite data as a source to tackle this issue. Due to the low performance of the ML-models it is recommended to use the model to make suggestions but to use commercial satellite data with higher resolution to verify manually.



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