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Next steps to a modular machine learning-based data pipeline for automated snow avalanche detection in the Austrian Alps

Kathrin Lisa Kapper[1], Thomas Goelles[1,2], Stefan Muckenhuber[1,2], Andreas Trügler[1,3,4], Jakob Abermann[1], Birgit Schlager[1,2], Christoph Gaisberger[1], Jakob Grahn[5], Eirik Malnes[5], Alexander Prokop[6], and Wolfgang Schöner[1]

[1]Institute of Geography and Regional Science, University of Graz, Graz, Austria (kathrinlisa.kapper@uni-graz.at)
[2]E/E & Software, Virtual Vehicle Research GmbH, Graz, Austria
[3]Know-Center GmbH, Graz, Austria
[4]Institute of Interactive Systems and Data Science, Graz University of Technology, Graz, Austria
[5]NORCE Research Institute, Bergen, Norway
[6]SnowScan GmbH, Vienna, Austria

Snow avalanches pose a significant danger to the population and infrastructure in the Austrian Alps. Although rigorous prevention and mitigation mechanisms are in place in Austria, accidents cannot be prevented, and victims are mourned every year. A comprehensive mapping of avalanches would be desirable to support the work of local avalanche commissions to improve future avalanche predictions. In recent years, mapping of avalanches from satellite images has been proven to be a promising and fast approach to monitor the avalanche activity. The Copernicus Sentinel-1 mission provides weather independent synthetic aperture radar data, free of charge since 2014, that has been shown to be suitable for avalanche mapping in a test region in Norway. Several recent approaches of avalanche detection make use of deep learning-based algorithms to improve the detection rate compared to conventional segmentation algorithms.

Building upon the success of these deep learning-based approaches, we are setting up a modular data pipeline to map previous avalanche cycles in Sentinel-1 imagery in the Austrian Alps. As segmentation algorithm we make use of a common U-Net approach as a baseline and compare it to mapping results from an additional algorithm that has originally been applied to an autonomous driving problem. As a first test case, the extensive labelled training dataset of around 25 000 avalanche outlines from Switzerland will be used to train the U-Net; further test cases will include the training dataset of around 3 000 avalanches in Norway and around 800 avalanches in Greenland. To obtain training data of avalanches in Austria we tested an approach by manually mapping avalanches from Sentinel-2 satellite imagery and aerial photos.

In a new approach, we will introduce high-resolution weather data, e.g., weather station data, to the learning-based algorithm to improve the detection performance. The avalanches detected with the algorithm will be quantitatively evaluated against held-out test sets and ground-truth data where available. Detection results in Austria will additionally be validated with in situ

measurements from the MOLISENS lidar system and the RIEGL VZ-6000 laser scanner. Moreover, we will assess the possibilities of learning-based approaches in the context of avalanche forecasting.