Tackling Central Asian Natural Hazards using Machine Learning

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Natural disasters ravage the cities, valleys, and coasts of Central Asia every month. From floods to wildfires, climate change has exacerbated the frequency and intensity of these extreme weather events. As a result, informing local governments, nonprofit organizations, and individuals in locations prone to natural disasters about the most effective ways to respond has become a top priority. Having precise and efficient mechanisms for assessing infrastructure damage is essential to channel resources and minimize the loss of life. With the rise of big data and artificial intelligence, automated computational methodologies have become increasingly useful in this context.

The Academy for Mathematics, Science and Engineering (AMSE) research aims to find computational solutions to the ongoing and growing humanitarian crisis mentioned above. Specifically, it advances more interpretable machine learning models, which are lacking in previous literature.

By using a dataset that includes labeled pre- and post- disaster satellite imagery, the xBD dataset, AMSE trains multiple convolutional neural networks to assess building damage on a per-building basis. In order to investigate how to best classify building damage, AMSE presents a highly interpretable deep-learning methodology that seeks to explicitly convey the most useful information required to train an accurate classification model. AMSE also researches which loss functions best optimize these models. Findings show that loss of ordinal-cross entropy is the most optimal loss function to use and that including the type of disaster that caused the damage combined with a pre- and post-disaster image best predicts the extent of damage caused. The highest accuracy percentage on the testing set that AMSE has achieved is 74.6%. The non-optimal nature of this is largely attributed to the limited discernibility between the major and minor damage categories. Through gradient class-activation maps, AMSE is also making progress in the area of qualitative representations of which parts of the images that the model is using to predict damage levels.