# Data augmentation for image-based rock fragment recognition using StyleGAN

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## ABSTRACT

The analysis of rock fragment sizes plays a pivotal role in various stages of geotechnical and mining engineering. Traditional case-based methods often falter in addressing the variability in rock fragment images due to fluctuating geological conditions and imaging environments. To counter this challenge, AI-based models necessitate training on expansive and diverse datasets, encompassing a wide range of conditions and fragment types. However, the creation of such datasets is often hampered by financial and environmental constraints. This paper introduces a novel approach for rock fragment recognition, which leverages the power of AI for data augmentation, automated annotation and prediction. The methodology integrates three key components: StyleGAN for data augmentation, the Segment Anything Model (SAM) for automated annotation, and the YOLO-MS real-time instance segmentation model. The proposed method begins by training a new StyleGAN model using the original dataset. It then delves into exploring the latent vectors of different rock fragment images to generate specific "style representations" for controlled image data augmentation with StyleGAN. These latent vectors form the foundational elements of each image in a high-dimensional space, encapsulating critical features such as size, shape, texture, and color variations. The next step involves conducting quality checks on the generated images to ensure their realism and suitability as training data. Subsequently, the augmented image set is annotated using modified SAM module, followed by training the YOLO-MS real-time instance segmentation model. The performance of this model, trained on the augmented dataset, is compared with a model trained on the original dataset, particularly in terms of generalization abilities in new scenarios. The results exhibit a significant enhancement in accuracy, robustness, and generalizability of the model trained on the augmented dataset, underscoring the potential of StyleGAN as a powerful tool for data augmentation in geotechnical engineering image analysis. This approach presents a feasible and cost-effective solution for data-scarce tasks in other mining engineering applications.