Deep Rock: Igneous Rock Image Classification

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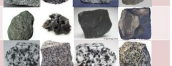
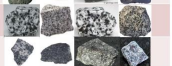
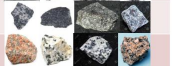
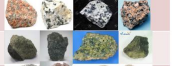
Motivation

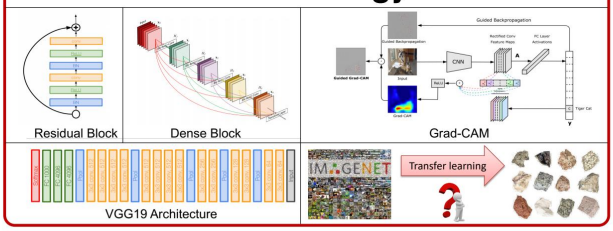
- State-of-the-art rock identification suffers from three major issues:
  1. Time-consuming
  2. Expensive
  3. Subject to human bias
- Geologists do not reliably identify rocks during field trips, and rather send samples to the laboratory
- After all, we all would love to have an app to classify rocks during outdoor activities

Dataset

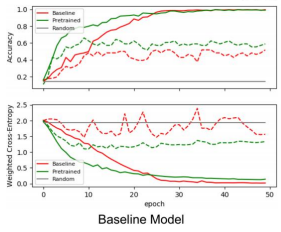
No open-source rock image dataset exists, so we scraped the web!

Class	Rock	Examples
1	Andesite	
2	Basalt	
3	Diorite	
4	Gabbro	
5	Granite	
6	Peridotite	
7	Rhyolite	

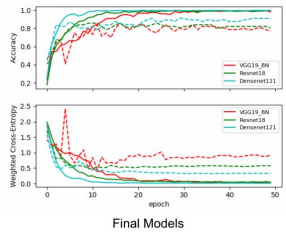
Methodology



Results



Baseline Model

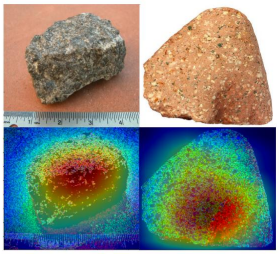


Final Models

Rock	1	2	3	4	5	6	7
1	6	1	0	1	0	0	0
2	0	7	0	1	0	0	0
3	0	0	7	0	1	0	0
4	0	0	0	8	0	0	0
5	0	0	0	0	8	0	0
6	0	0	0	1	0	7	0
7	0	0	0	0	0	0	8

Precision	0.911
Recall	0.927
F1 Score	0.912

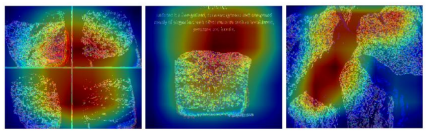
Evaluation Metrics



Gabbro Rhyolite

Error Analysis

- Grad-CAM is used to further filter out the dataset and interpret the deep learning model predictions
- Greyscale data augmentation dramatically lowers performance, indicating that color is important



Multiple Objects Background Illumination

Conclusions

- Deep Learning is capable of automating rock classification
- Validation results show over 91% F1 score using pretrained DenseNet121
- Adding attention module can ensure that the rock is not confused with background objects

References

Chanou, A., Osinski, G. R., & Grieve, R. A. F. (2014). A methodology for the semi-automatic digital image analysis of fragmental impactites. Meteoritics & Planetary Science, 49(4), 621-635.
Cheng, G., & Guo, W. (2017, August). Rock images classification by using deep convolution neural network. In Journal of Physics: Conference Series (Vol. 887, No. 1, p. 012089). IOP Publishing.
He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 770-778).