Content-based Classification of Mars Imagery for the PDS Image Atlas

Poster ID 42

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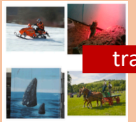
Contributions

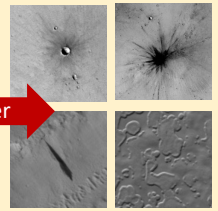
1. Train machine learning classifiers to recognize image content
2. Classifier calibration for reliable posterior probabilities
3. Enable users to search millions of Mars images for content of interest
4. Deploy classifiers at the NASA Planetary Data System archive

Earth images



transfer

HiRISE Orbital Images



- Eight classes (e.g., crater, slope streak, etc.)
- Dynamic landmarking
- 10K labeled images
- Transfer learning

Calibration	Test Acc. (0.9 thresh.)	Calibration Error
Before	94%	0.056
After	**97%**	**0.022**

Data: https://doi.org/10.5281/zenodo.4002935

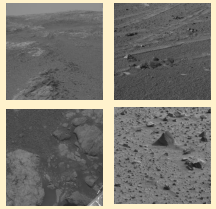
MSL Rover Images

- 19 classes (e.g. float rock)
- 3K labeled images
- Transfer learning
- Active learning experiments

Calibration	Test Acc. (0.9 thresh.)	Calibration Error
Before	87%	0.142
After	**90%**	**0.080**

Data: https://doi.org/10.5281/zenodo.4033453

MER Rover Images



- 25 classes
- 3K labeled images
- Multi-label transfer learning
- Classifier chain

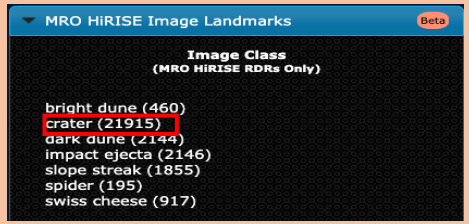
Calibration	Avg. Prec. (0.9 thresh.)	Avg. Recall (0.9 thresh.)	Avg. ECE
Before	89%	**53%**	0.031
After	**95%**	45%	**0.015**

Data: https://doi.org/10.5281/zenodo.4302760

NASA Deployment

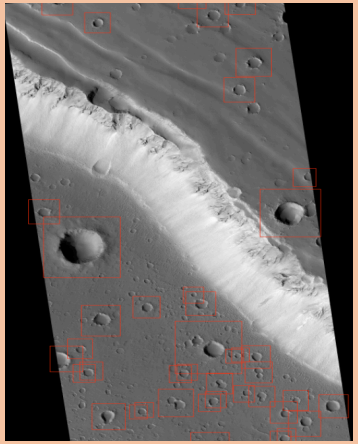
- Classified 1.1M images
- Access via PDS Image Atlas: https://pds-imaging.jpl.nasa.gov/search/

(1) Select class of interest

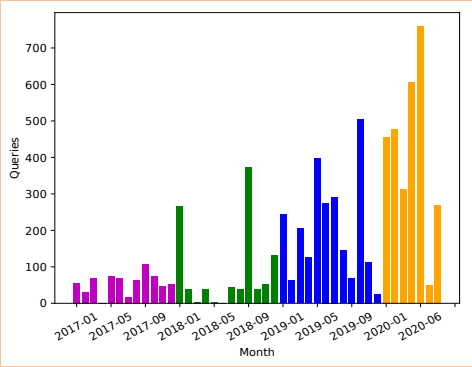


(2) Select from matches

(3) Classified content



Increasing usage over time



Next Steps

1. Characterize use cases for further Image Atlas improvements
2. Use tree-based multi-label learning approach to improve the performance of minority classes for MER classifier
3. Use label shift adaptation to adapt to new environments for MSL classifier
4. Create a classifier for Lunar Reconnaissance Orbiter (LRO)

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