Machine learning with neural networks for recognize impact craters in other planets with satellite images

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Abstract

The classification of geoforms, especially of meteorite impacts in the field of planetary sciences, has been a fundamental task in space exploration and the treatment of satellite images in other rocky bodies of the solar system. In this study, we implement supervised machine learning algorithm (neural networks) to classify meteorite impacts on planetary surfaces. Different characteristics of image analysis we taken into account: shape, grey level, contours, brightness of each pixel that makes up the panchromatic image obtained from the various space missions that have reached different planets. The data set was created with the satellite images of the Mars Odyssey mission. Our code achieve an average of 89% accuracy in the image classification.
Keywords: *Neural networks, image classification,*

1. Introduction

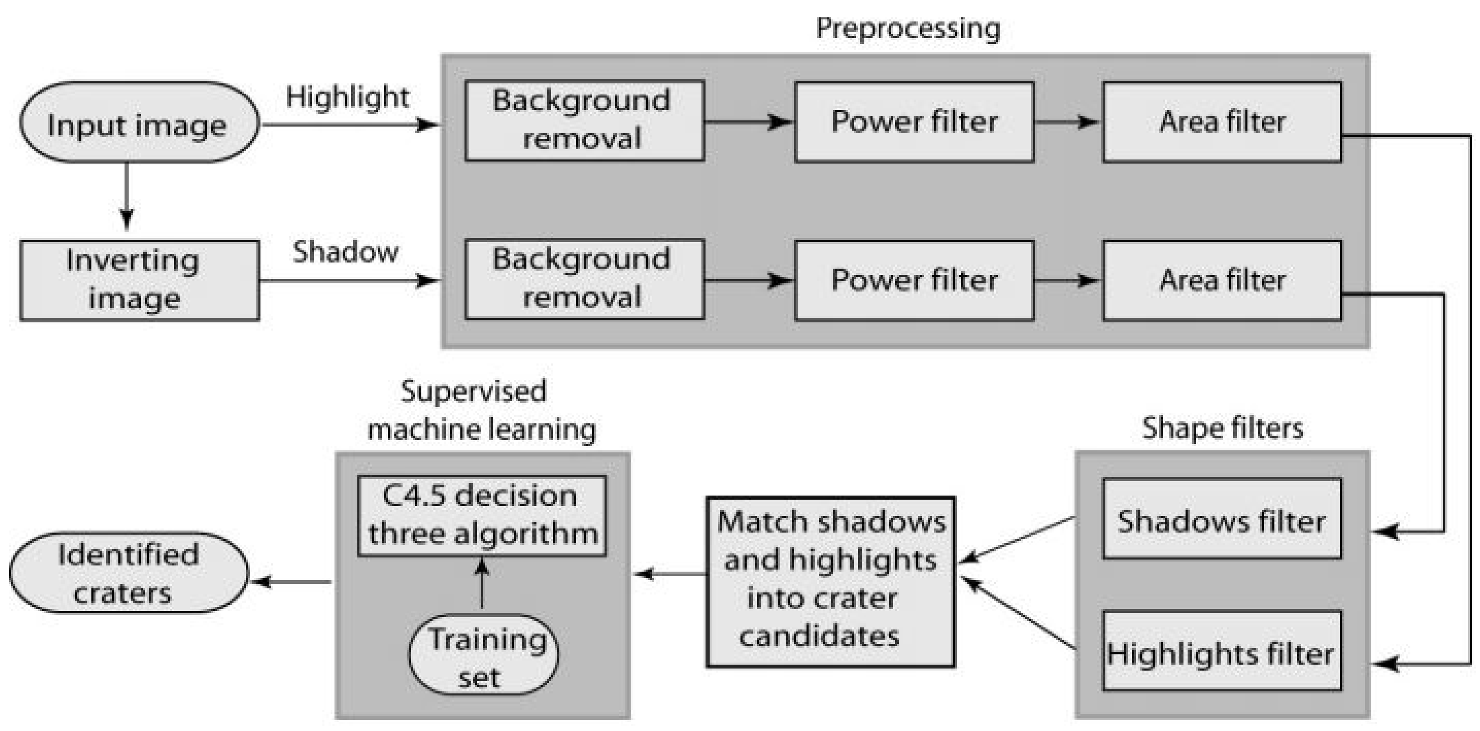

Figure 1: *Classification routine of the neural network [1].*

2. Methods

A data set of craters was created with the Mars Odyssey mission and compared with the surface of desert of Atacama and Utah. In this step, the algorithm is trained with the a data set already classified. The code is expected to learn the main features of the data set.

2.1 Filters

- Shape
- Background noise
- Area

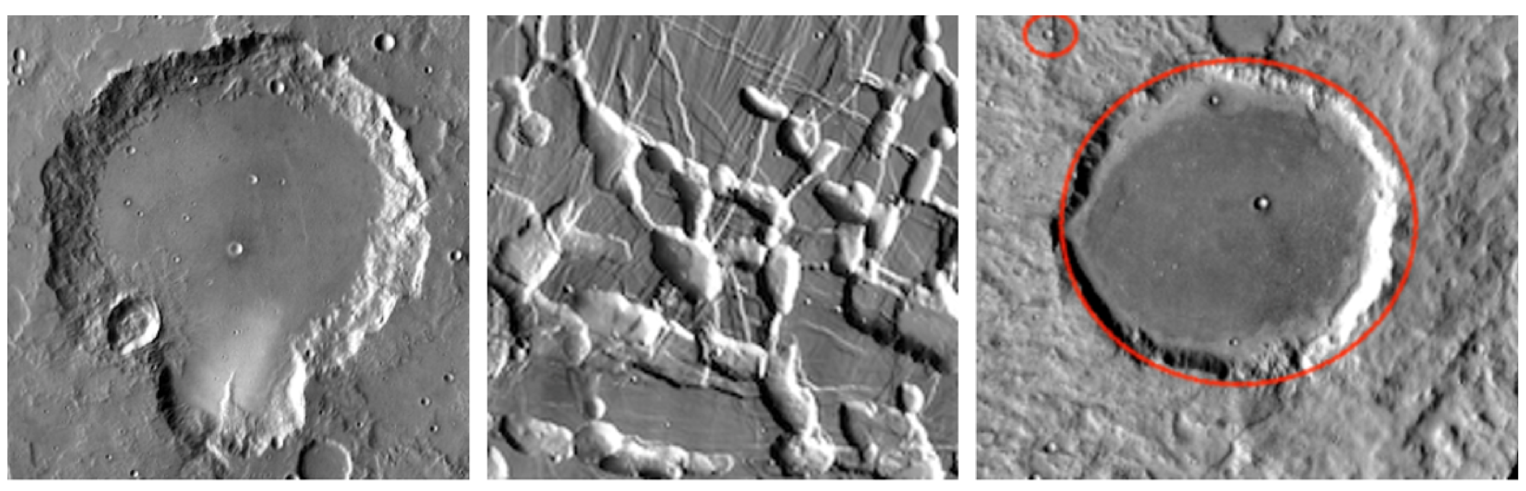

Figure 2: *Filters applied to the RAW image for train the algorithm.*

2.2 Supervised Classification

1 0

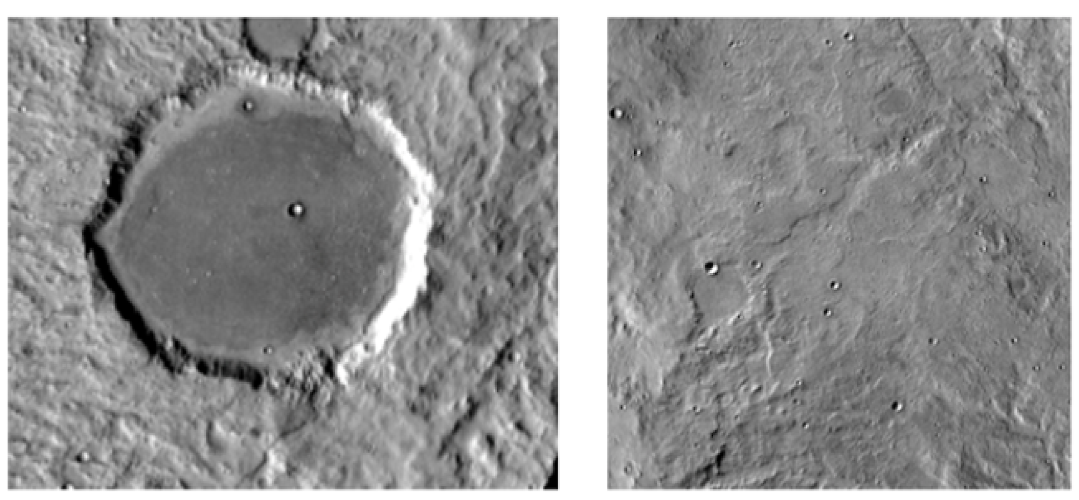

Figure 3: *The images that correspond to impact craters are labeled as 1, otherwise they are labeled as 0.*

3. Results

Results of the code are presented in the table 1. Each epoch correspond a new cycle of determining the weights for each neuron in order to improve the important values. These results shows a very high accuracy (89%) of a data set of around 1000 images.

Epoch	Time (s)	Loss	Accuracy
1	31	0.9506	70.5
2	26	0.3904	92.4
3	27	0.1183	96.5
4	26	0.4138	89.9
5	27	0.0579	98.5
Average	**27.4**	**0.3862**	**89.5**

Table 1: *Results obtained from the training process*

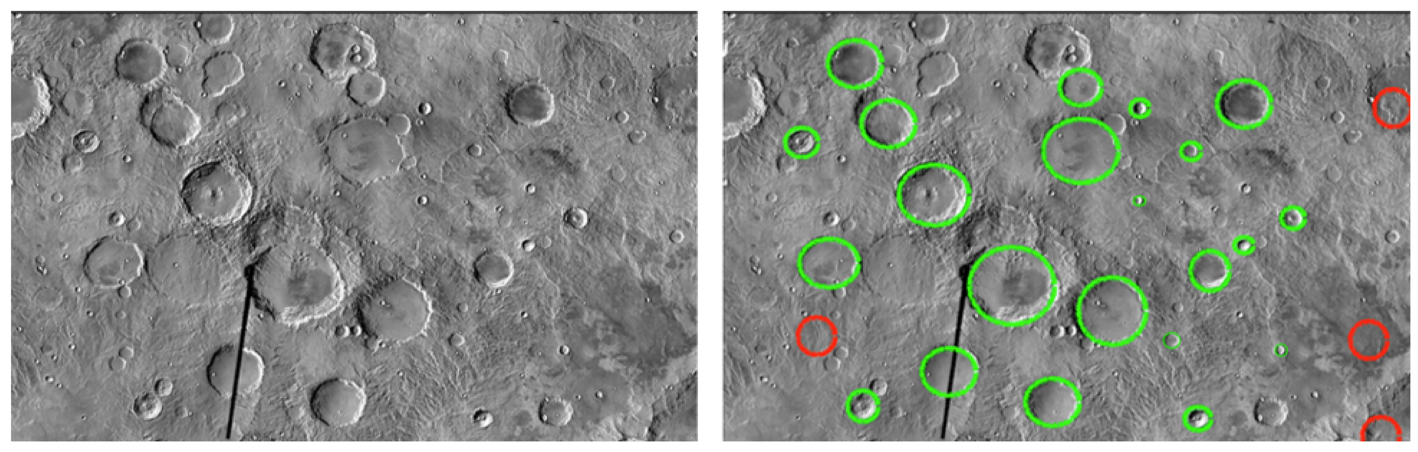

Figure 4: *Classification results*

3.1 Algorithm verification

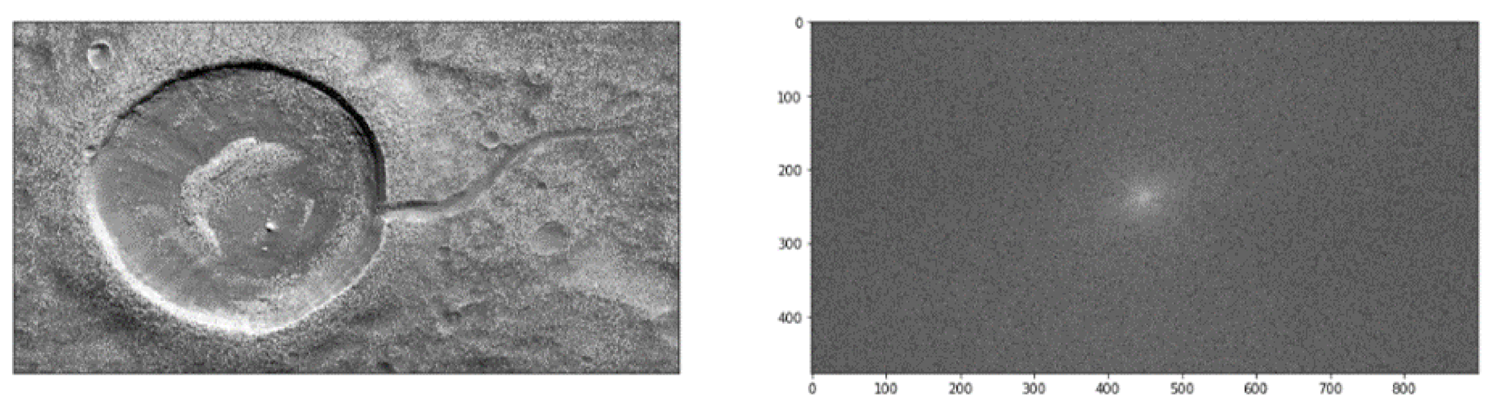

Figure 5: *Fourier analysis made to a imapact crater image.*

4. Conclusions

- The machine learning code allows us to easily classify geoforms such as impact and volcanic craters. Supervised classification training and different morphological filters made is possible to distinguish between craters or non-craters.
- The algorithm is constructed under supervised classification from a satellite images and with the help of different morphological filters it is possible to distinguish between craters or non-craters.
- All the extracted information was storage in the neurons of the Neuronal Network. This allowed the algorithm to identify better the features.
- The accuracy and the speed of processing allows the analysis of big data set with small resources.

References

[1] Urbach, E. R., Stepinski, T. F. (2008, March). Automatic detection of sub-kilometer craters in high resolution images of Mars. In Lunar and Planetary Science Conference (Vol. 39, p. 2184).

[2] Silva, M. P. S., Câmara, G., Souza, R. C. M., Valeriano, D. M., Escada, M. I. S. (2005, November). Mining patterns of change in remote sensing image databases. In Fifth IEEE International Conference on Data Mining (ICDM'05) (pp. 8-pp). IEEE.

[3] Palafox, L., Alvarez, A., Hamilton, C. (2015, March). Automated detection of impact craters and volcanic rootless cones in mars satellite imagery using convolutional neural networks and support vector machines. In 46th Lunar and Planetary Science Conference (pp. 1-2).

[4] Honda, R., Azuma, R. (2000). Crater extraction and classification system for lunar images. Mem. Fac. Sci. Kochi Univ.(Inform. Sci.), 21, 13-22.

5. Acknowledgments

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