Characterizing the Mars Surface Using Deep Learning

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The surface of Mars is covered by more than 300,000 craters of varying sizes and shapes. In this project you would apply supervised learning methods with deep learning tools to accurately measure various properties of craters identified by a Deep neural network.

Lee (2019) developed a deep neural network that could identify impact craters on the surface of Mars with an accuracy approaching human experts (Silburt et al., 2019). Over summer 2019 the accuracy of that network was improved and now matches or exceeds human experts at identifying impact features on the surface of Mars and on the Moon (Lee and Hogan, 2021). During summer 2020 this work was applied to polar fans on the surface (e.g. Aye et al., 2019) by NSERC USRA students.

In this project you will extend the existing Deep Learning tools by developing and training a neural network to identify features on the surface of Mars, improving the characterization of craters and polar ice features. You will adapt state of the art neural networks to find and characterize features on the surface of Mars, and validate a sample of this data to compare with the results reported in the literature.

The project requires knowledge of Python and data analysis, and you would benefit from experience of using neural networks for image processing. Previous experience with atmospheric physics and geophysics is useful but not necessary.

This project has opportunities for up to 2 students. For more information, please feel free

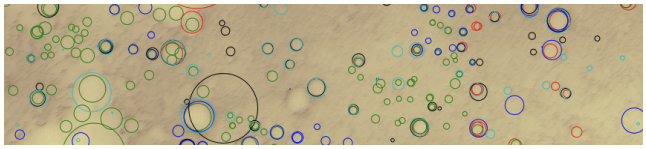

Figure 1: *Craters detected at the landing site of the Mars 2020 rover in Jezero crater, found by neural networks (magenta, cyan, black) and humans (red, green, blue). Topography data from NASA/Caltech/MSSS.*

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Bibliography

Aye, K. Michael et al. (2019). "Planet Four: Probing Springtime Winds on Mars by Mapping the Southern Polar CO2 Jet Deposits". In: *Icarus* 319.September 2018, pp. 558–598. ISSN: 10902643. DOI: 10.1016/j.icarus.2018.08.018.

Lee, C. (2019). "Automated Crater Detection on Mars Using Deep Learning". In: *Planetary and Space Science* in review.

Lee, Christopher and James Hogan (Feb. 2021). "Automated Crater Detection with Human Level Performance". In: *Computers and Geosciences* 147, p. 104645. ISSN: 00983004. DOI: 10.1016/j.cageo.2020.104645.

Silburt, Ari et al. (2019). "Lunar Crater Identification via Deep Learning". In: *Icarus* 317, pp. 27–38. ISSN: 10902643. DOI: 10.1016/j.icarus.2018.06.022.