Faculty of Science and Engineering

2020 Australian Government Research Training Program Scholarships

Strategic Project Profile

PROJECT TITLE: Mapping planetary surface ages at ultimate resolution with machine learning

FIELD OF RESEARCH CODE: 0201, 0403, 0402

PROJECT SYNOPSIS:

Planetary science is the study of the planets and moons in our solar system and the processes that formed them. Understanding the geological history of another world has an importance of its own, but there is a larger significance beyond that. Our solar system shows us the many different pathways geological bodies can evolve along over time and therefore provides a template for understanding planet formation and evolution not just here, but throughout the universe. Abodes for life here might well be abodes for life elsewhere.

For geologists who study the planets, moons, asteroids and comets in our solar system, the baseline datasets are imagery of the surface and a geologic map that includes age information. How do we determine ages for worlds that we have never visited? By counting the number of craters of a given size that we see on their surfaces. The more craters, the older the surface. The technique was invented in the early-60s. On its own, crater counting provides a relative age, but if we can obtain a radioisotope age from a sample of a cratered surface, that relative age can be calibrated. It becomes an absolute chronometer. Advances in technology mean that image resolution has increased dramatically (from km/pixel to cm/pixel) there has been no change in how that data is processed to derive ages for surfaces. The default method remains manual crater counts. This effectively limits us to craters >1km. There are >1,000,00 of these on the Moon. They were counted and measured by hand. The available image resolutions let us see craters down to 100m in size. There are millions more of these craters. If we could measure all of them we could have age maps at ultimate resolution. With ARC Discovery Program support (DP170102972) my team of planetary scientists, engineers and computer scientists, have developed an advanced machine learning algorithm to do just that, and validated it against the manually counted dataset. Our algorithm can automatically count craters at any size, on any number of high resolution images. The available image repository is vast – the very definition of Big Data – with multi-spectral images from every NASA mission over the last 60 years freely available due to the generosity of the NASA Planetary Data System.

This project will use the technique of counting craters on the highest resolution images available to establish surface ages across the Earth's moon. This method can be applied to not just surfaces, but to individual craters as well. We currently have very precise Pb-Pb ages of lunar glasses (returned by the Apollo 14 mission) that we can use to create an absolute timeline for the moon in that area. Previous work in this area is hampered by the fact that the provenance of the materials was not well constrained to its locale. This project makes use of the traditionally recorded age data to identify specific areas of the moon that could be the source craters of the glasses.

The student will apply the algorithm to the images of the moon, calculate surface ages at all resolutions, locate craters of specific ages and tie these together with the ages of glass beads that are specifically formed during impact. The outcomes will be a more precise absolute age calibration for the moon, which will have knock on effects for the absolute ages of all the planetary bodies whose surface ages are determined this way.

FEASIBILITY AND RESOURCING – DESCRIPTION OF THE SUPPORT THIS PROJECT WILL RECEIVE:

This project is possible because of the development of a Crater Detection Algorithm, based on funds that were competitively won from the Australian Research Council. This algorithm was created through a collaboration between members of the SSTC (Benedix, Paxman, Towner, Lagain) covering a range of expertise in planetary geology and engineering along with the Curtin Institute of Computation, all of whom are still involved. We have the existing infrastructure to carry out the project (computing, lab space, expertise).
Funding is secured within the SSTC but is also the subject of a recently submitted ARC DP grant.

WHAT MINIMAL ATTRIBUTES AND SKILLS EXPECTED BY THE CANDIDATE BE COMPETITIVE:

The competitive student should have a degree in geology, physics, astrophysics, or geophysics and have an interest in planetary science.
Although not essential, a background in computer science would be extremely beneficial.

THE SIGNIFICANCE OF THE PROJECT/ PROGRAM FOR THE ENROLLING SCHOOL OR INSTITUTION:

The Space Science & Technology Centre is home to 35 staff and students; is the largest planetary science research group in the Southern Hemisphere; and uniquely brings together pure and applied research in space and planetary science, with engineering and industry engagement. This project is specifically listed as an area of emerging strategic research within the centre.

Students are advised to contact the Project Lead listed below prior to submission of their scholarship application to discuss their suitability to be involved in this strategic project.

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