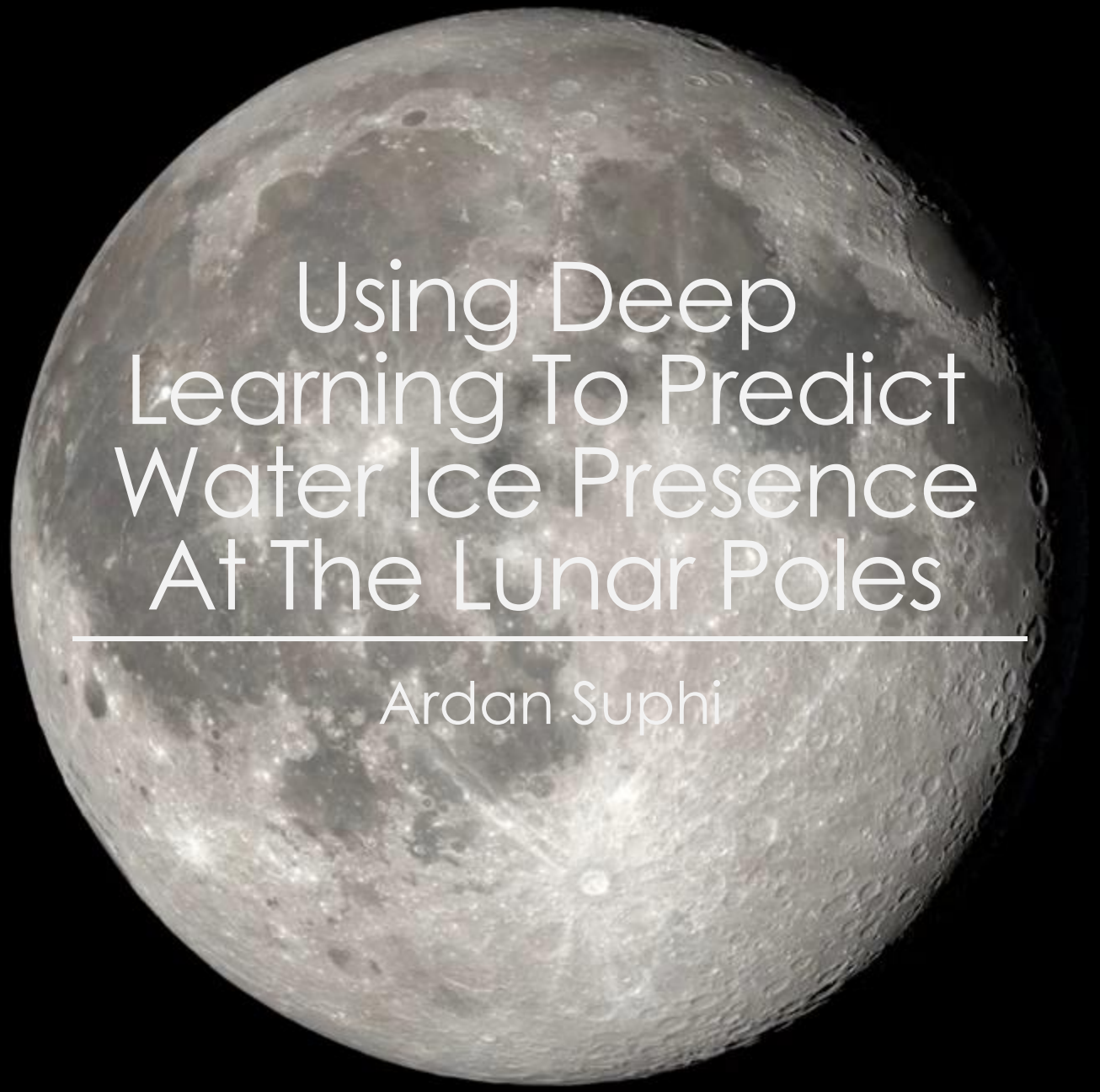


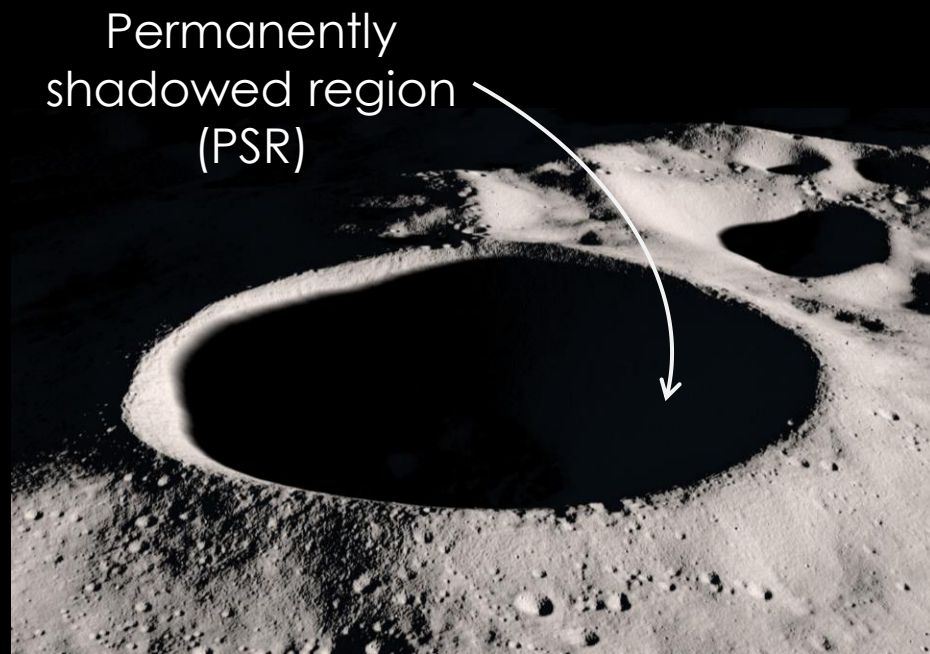
Using Deep Learning To Predict Water Ice Presence At The Lunar Poles

Ardan Suphi

Objective

Use a data driven approach to predict the likelihood of water ice anywhere at the lunar poles.

- Using entire datasets allows for predictions at any point, not just in PSRs.
- Machine learning can be used to identify areas of high water ice potential using fewer datasets.



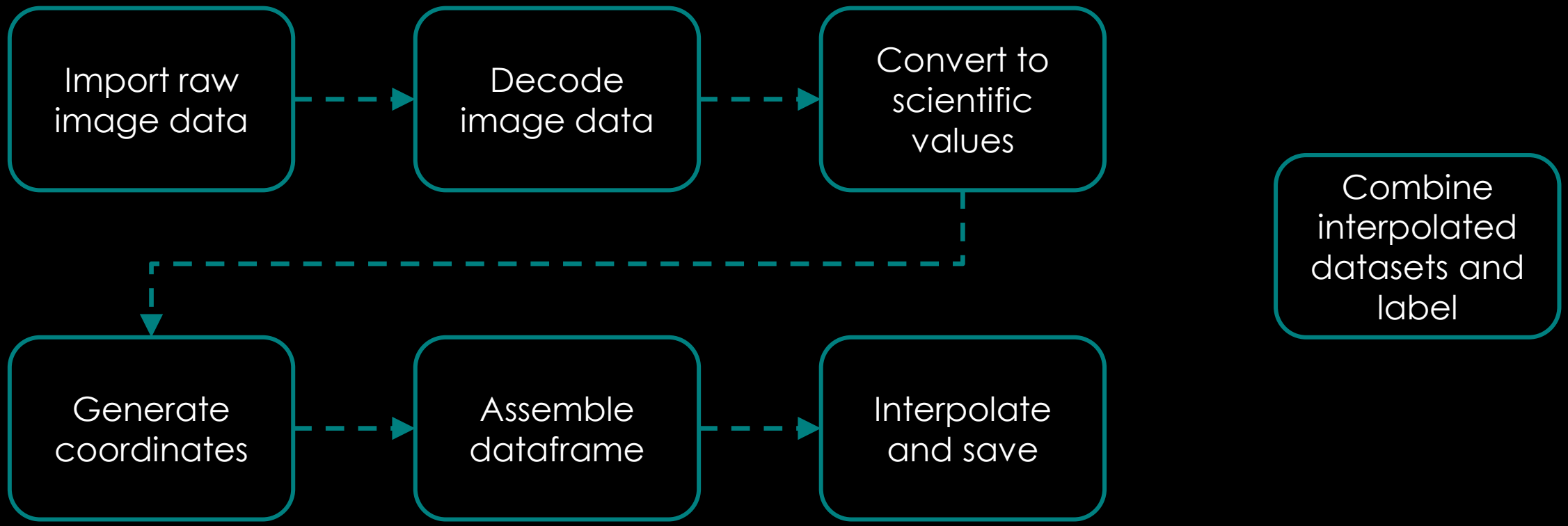
Data

Instrument	Measurement
Diviner	Surface temperature
LOLA (albedo)	Surface reflectivity
LOLA (elevation)	Surface topography
M^3	Spectral reflectance
Mini-RF	Circular polarisation ratio

Lunar Reconnaissance Orbiter

Chandrayaan-1

Method – Data Processing



Method – Labelling Criteria

Dataset	Strongly Consistent (2)	Consistent (1)	Inconsistent / No Detection (0)
Diviner	<110 K	n/a	>110 K
LOLA	Observations consistent with water ice cover >3 km²	Observations consistent with water ice cover <3 km²	No observations consistent with water ice
M³	Ice detections cover >2.4 km²	Ice detections cover <2.4 km²	No ice detection
Mini-RF	n/a	CPR-anomalous	Rough, multi-bounce, or no enhanced radar signature

Method – Machine Learning

Features	Target
Latitude	Label (0-7)
Longitude	
Diviner	
LOLA albedo	
LOLA elevation	
M^3	
Mini-RF	

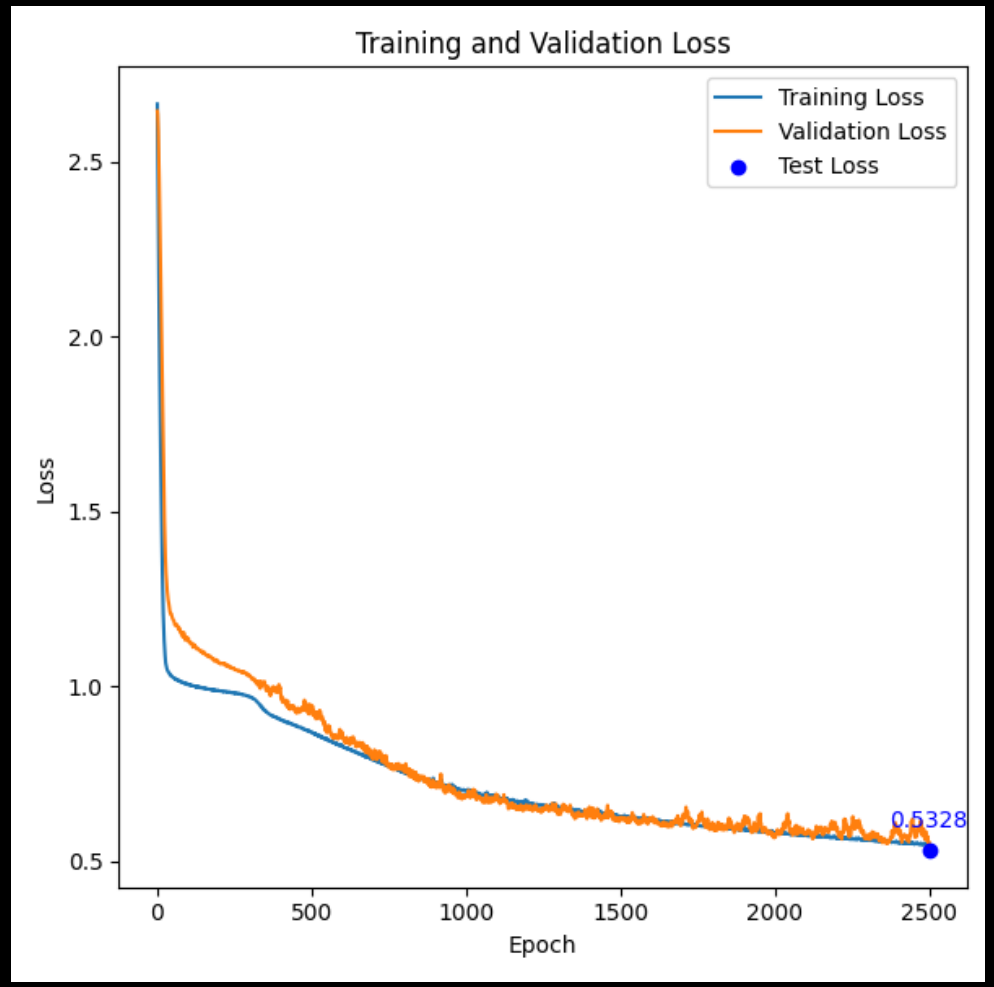
Fully Connected Neural Network

FCNN with self-attention and a residual connection

Graph Convolutional Network

GCN with self-attention and a residual connection

Results

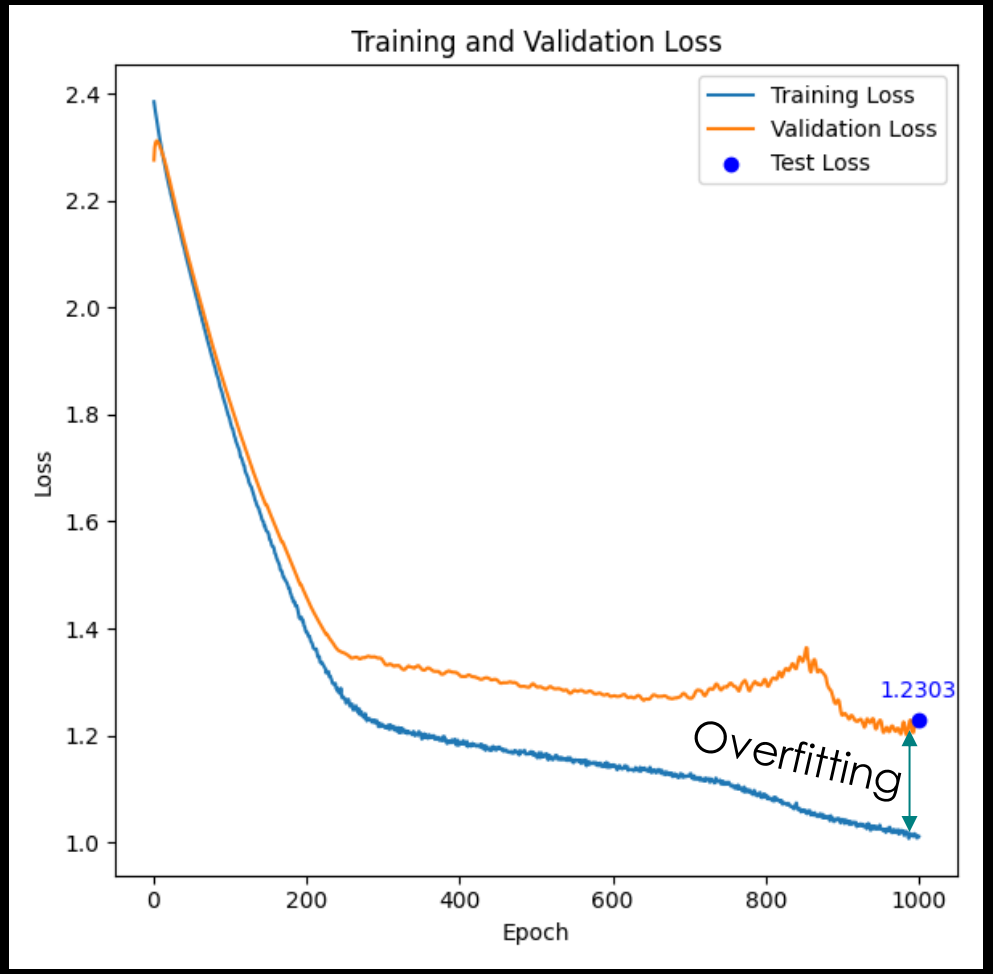


FCNN

- Loss : 0.53
- R^2 : 0.82

GCN

- Loss : 1.23
- R^2 : 0.33



Results – Examples

FCNN

Latitude	Longitude	True label	Predicted label
77.64	88.57	0	0.065
88.07	63.61	1	1.093
-87.05	131.78	2	2.361
87.13	132.07	3	3.331
82.72	202.15	4	3.972
-82.88	266.33	5	5.017
-81.74	147.86	6	6.174
-86.07	246.92	7	5.331
-84.84	37.27	1	-0.026

GCN

Latitude	Longitude	True label	Predicted label
-76.51	270.51	0	-1.29
76.27	50.98	1	-0.31
88.68	334.95	2	2.46
-83.87	0.25	3	0.70
83.67	320.28	4	1.62
-88.94	322.15	5	2.74
84.80	252.03	6	5.62
-89.85	150.04	7	4.55
79.84	244.55	1	0.13

Review

Interpolation technique

Spatial awareness between models

Future work

Acknowledgements

Dr Kathryn Hadler, Dr Philippa Mason

Questions?