

Raster Miner: An Open-Source Toolkit for Knowledge Discovery in Satellite Imagery Data

by

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Outline

- Introduction
- Importance of Imputation
- Problem Definition
- Proposed Approach
- Experimental Results
- Conclusions

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Introduction

- Raster Miner is an open-source software for discovering knowledge hidden in Raster Data.
- Availability: GitHub
- Liscence: GNU V3
- Platforms: Windows and Mac
- Type of Execution: GUI, Terminal, and Python.

Knowledge Discovery Tasks

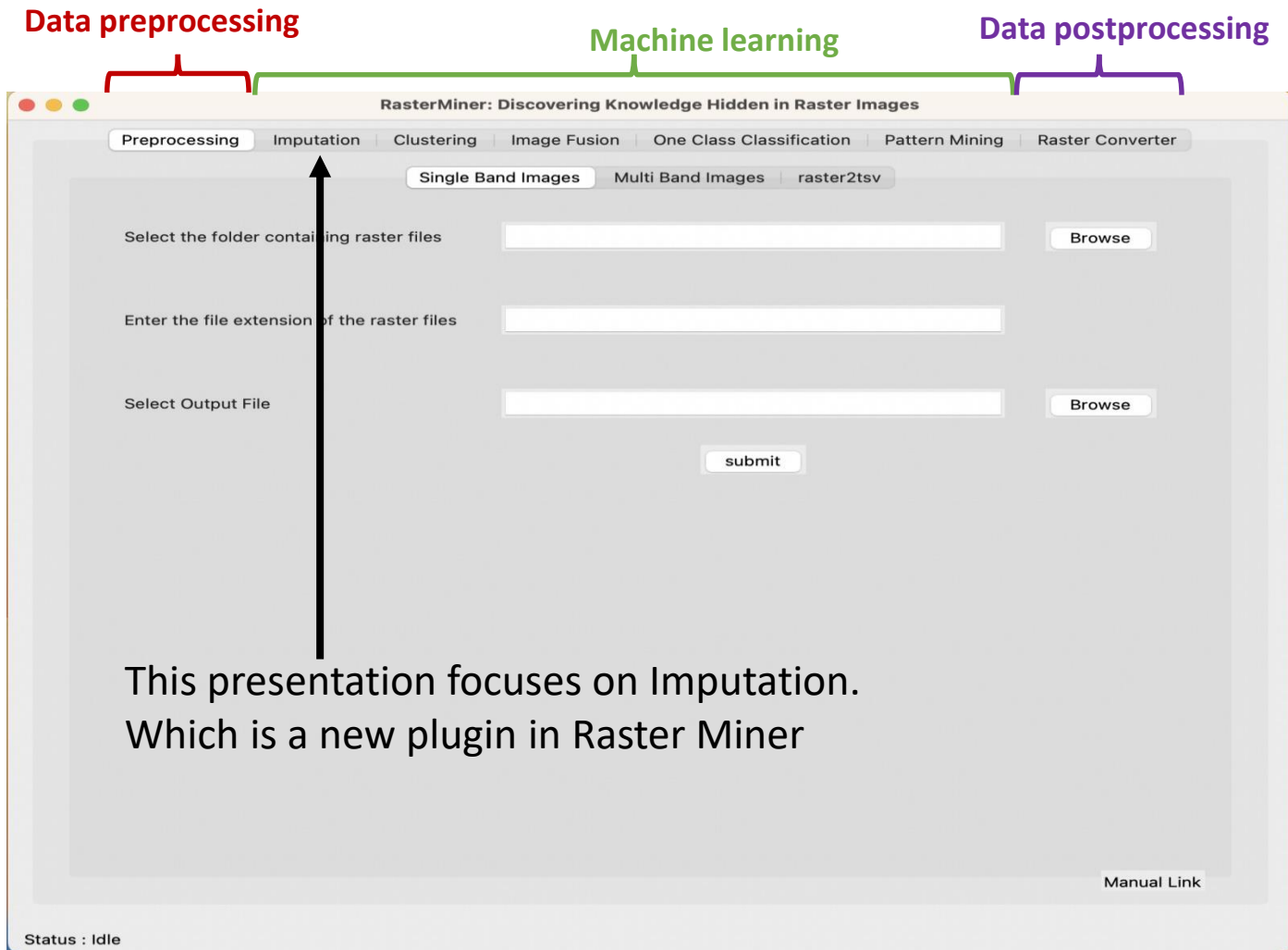


Fig. 1. Front-end of Raster Miner

Data preprocessing:

- Converts raster images into tsv files
- Support various formats of raster images
 - lbl, tiff, geotiff ...

Machine learning:

- Contains techniques for various ML tasks
- ML topics currently available are:
 1. Imputation
 2. Clustering
 3. Image Fusion
 4. One Class Classification
 5. Pattern Mining

Data Postprocessing:

Converts the tsv data back into raster/tiff format

Imputation

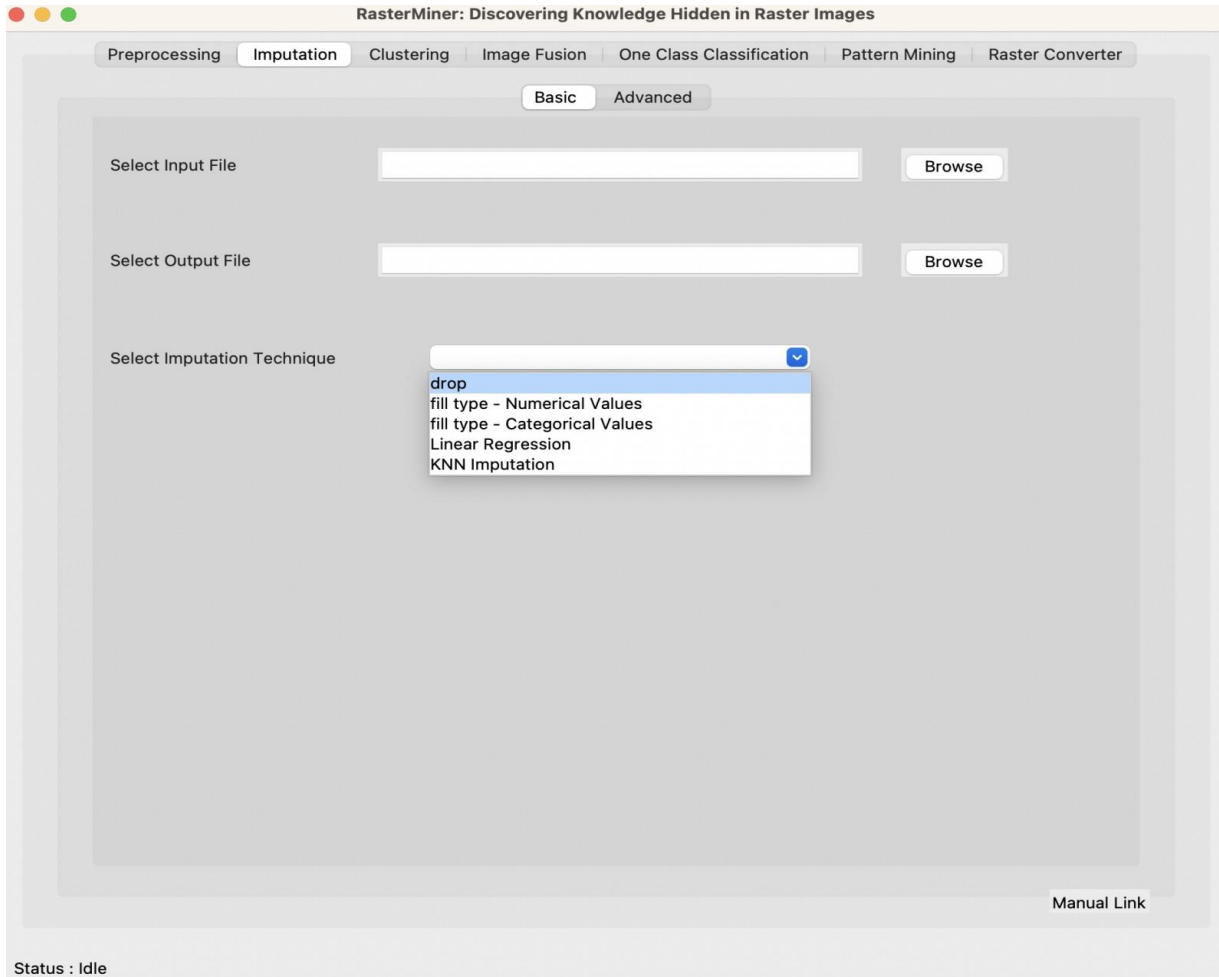


Fig. 2a. Basic Imputation Techniques

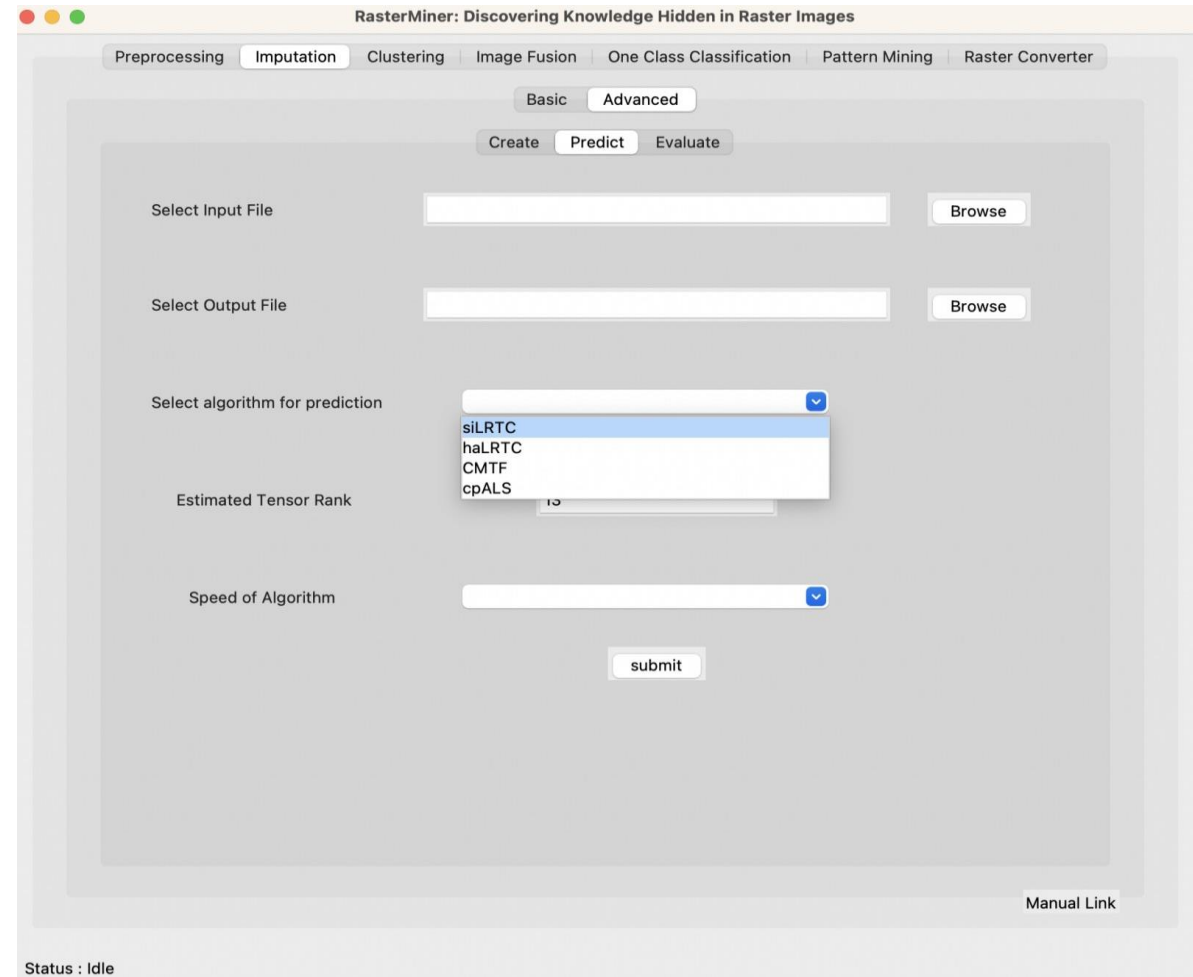


Fig. 2b. Advanced Tensor-based Imputation Techniques

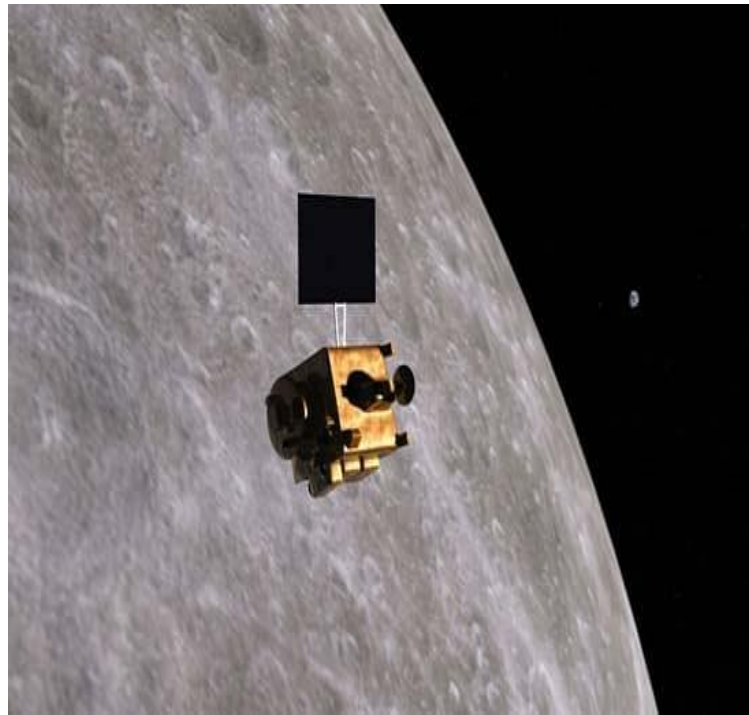
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Introduction: A New Space Race



Kaguya Satellite



Chandrayan-1 Satellite



Chandrayan-2 Satellite

Fig. 1. Satellites Collecting Lunar Surface Data

Introduction: Missing Pixel Data Problem

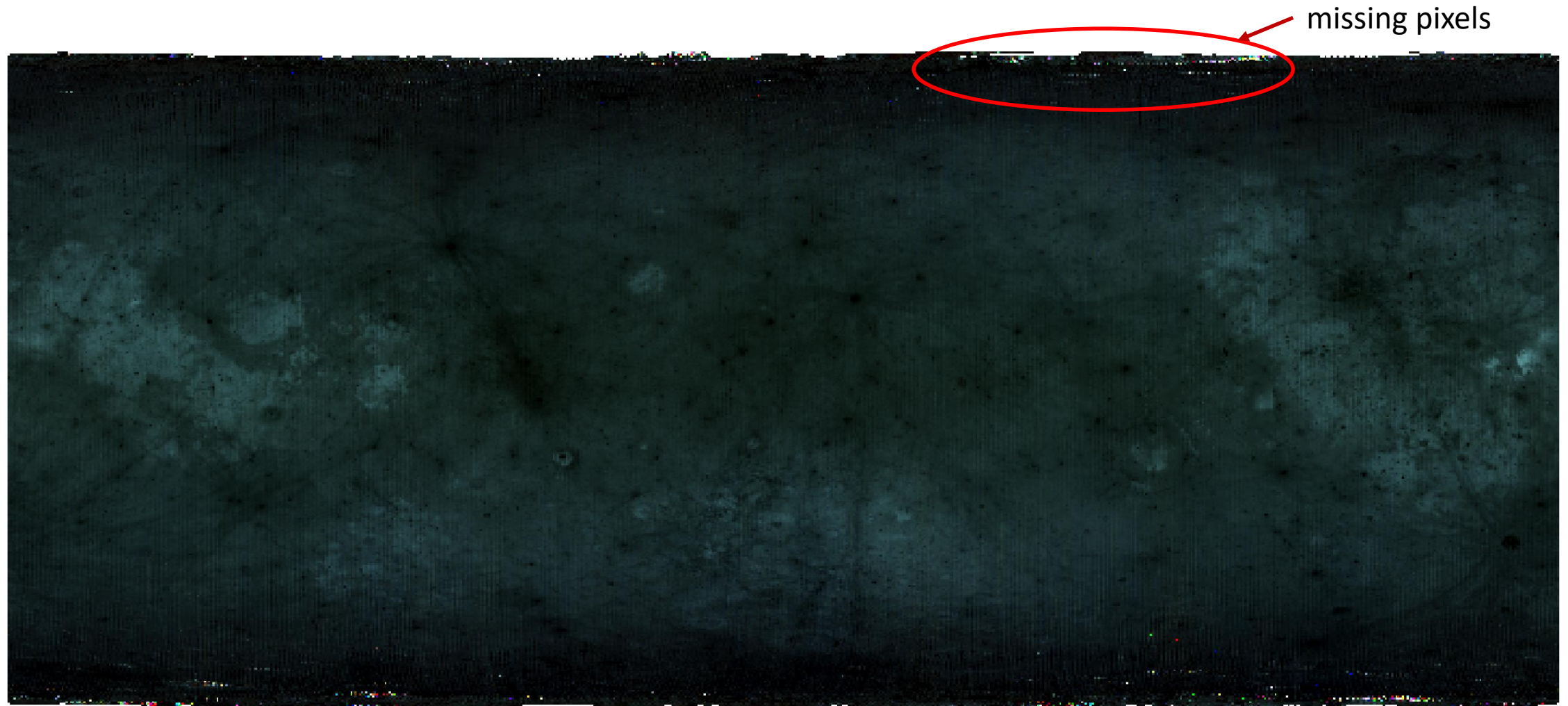
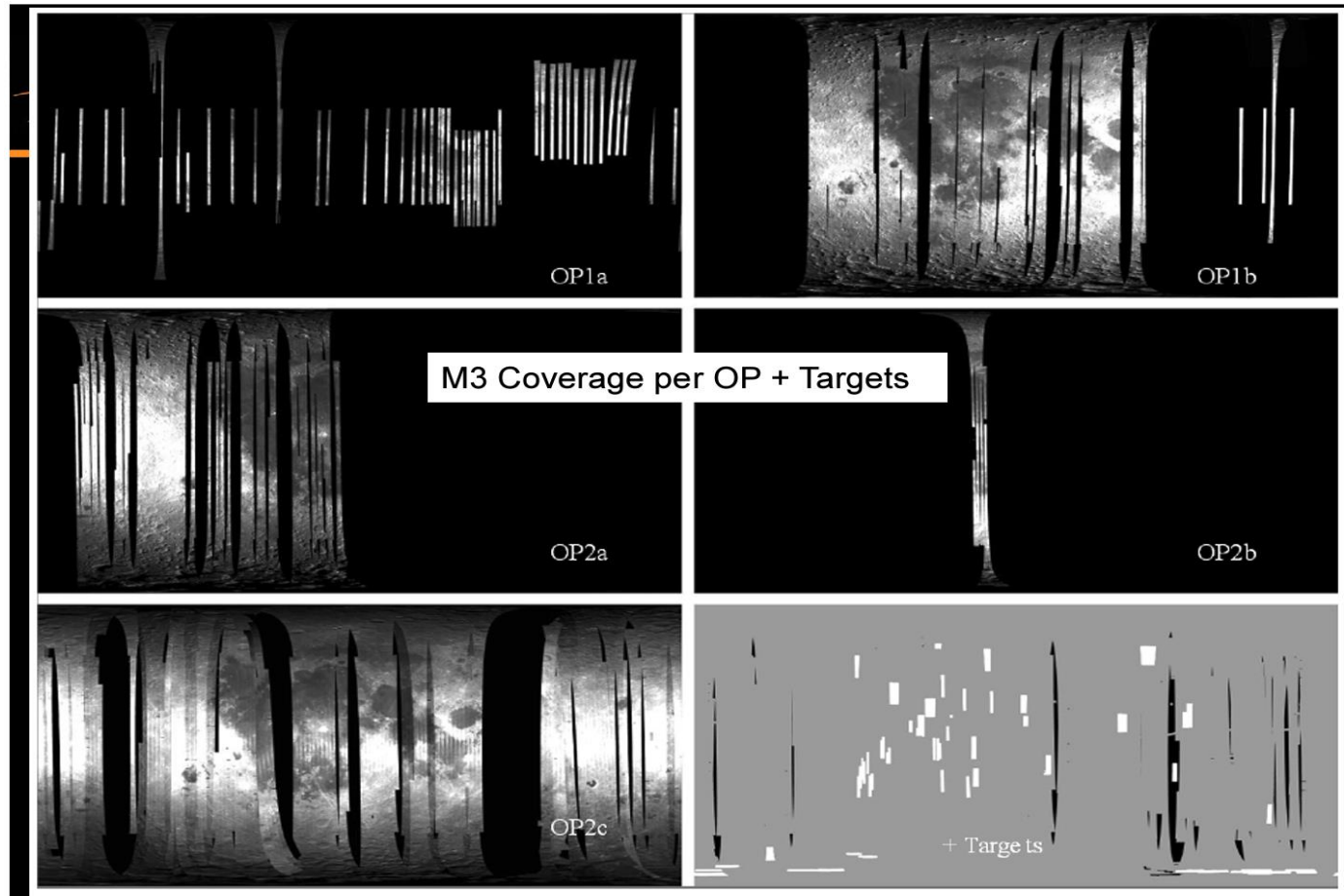


Fig.4. Raster data of Moon's surface gathered by Kaguya Satellite

Introduction: Missing Pixel Data Problem

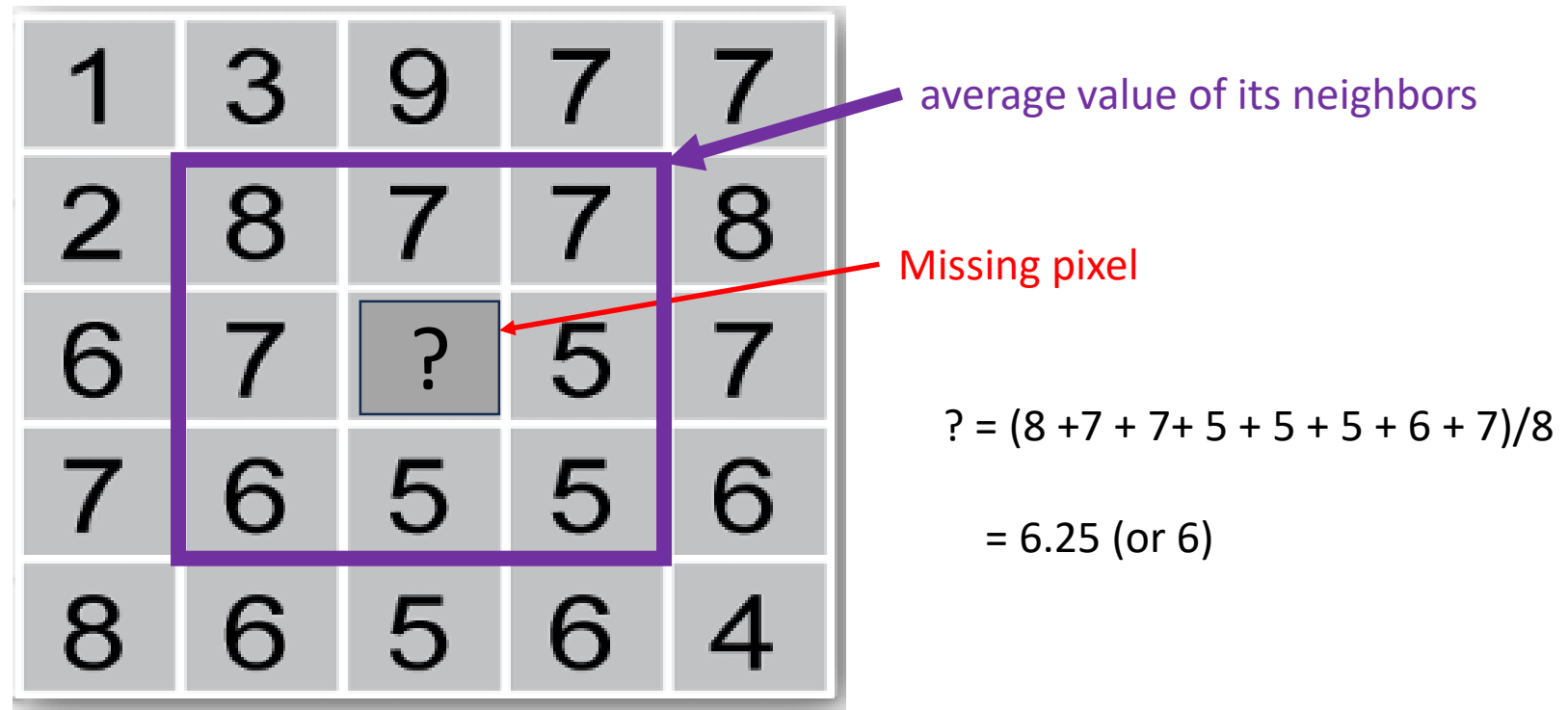


Missing data is shown in black

Fig. 5. Raster data of Moon's surface gathered by Chandrayan Satellite

Introduction: Existing Solutions and Their Limitations

- k-Nearest Neighbors Solution
 - fill in the missing pixel value using its neighbors value



- **Limitation:** Cannot be applied if most of the data is missing

Introduction: Existing Solutions and Their Limitations

- Machine Learning
 - Neural Networks
 - GANs

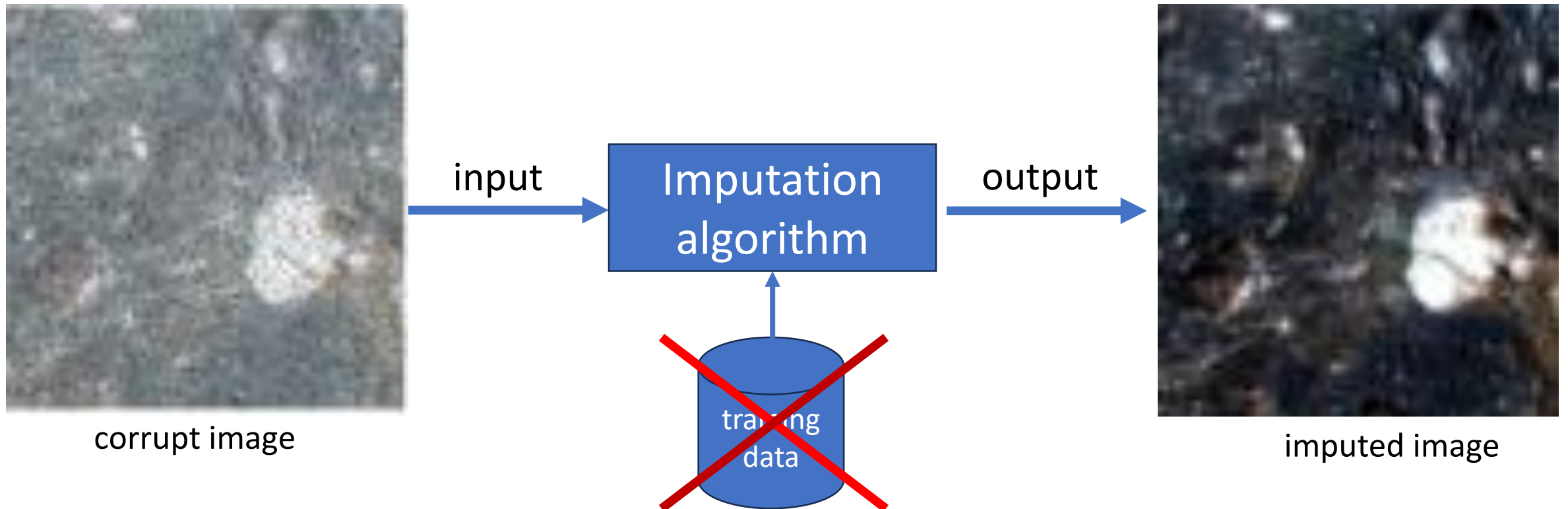
- Limitation:
 - Need much data for model building.
 - Unfortunately, not much data is available

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Problem Definition

- Predict the missing data in a highly corrupt image that has little training data



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Proposed Approach: Tensor Completion

- Idea:

- Model raster image as a tensors using Tucker decomposition and Canonical Polyadic decomposition

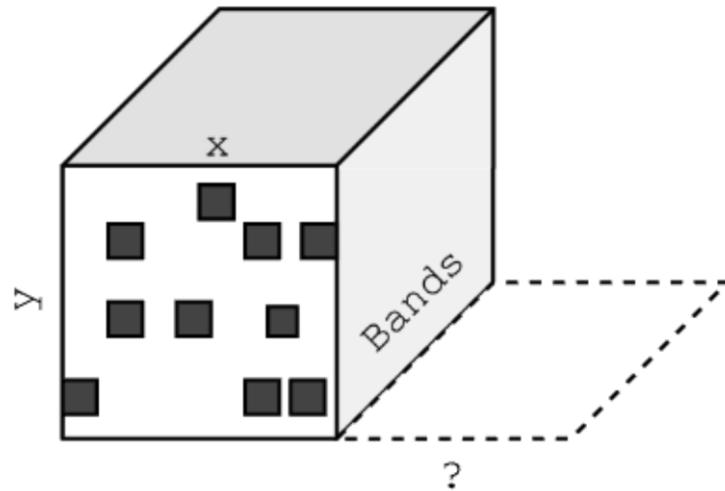
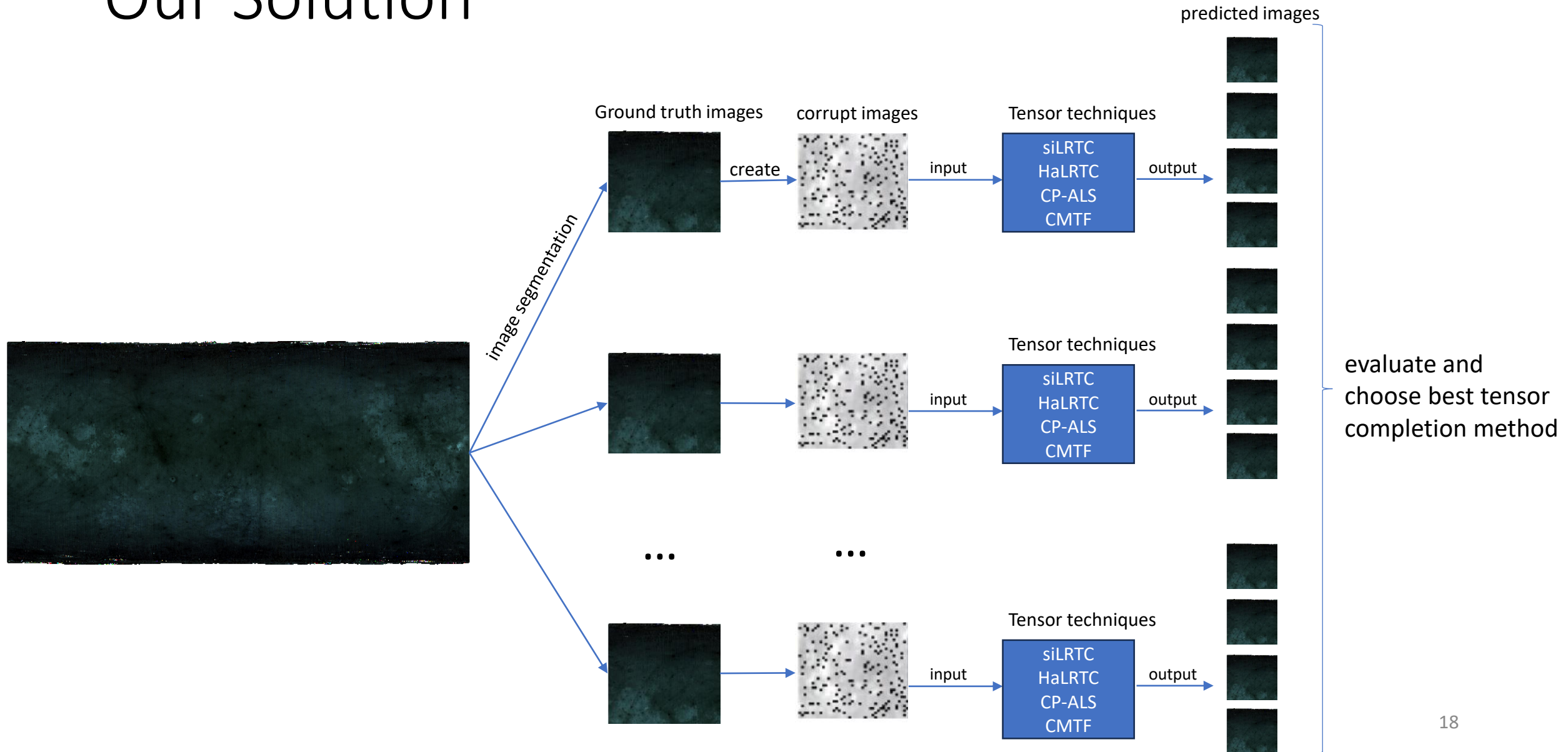


Fig. 6. Raster Data as Tensors

Challenges

- Several Tensor Solutions exists
 - siLRTC (simple Low-Rank Tensor Completion)
 - HaLRTC (High-accuracy Low-Rank Tensor Completion)
 - CP-ALS (Canonical Polyadic - Alternating Least Squares)
 - CMTF-OPT (Coupled Matrix and Tensor Factorization -Optimization)
- No universally accepted best solution exists for predicting missing data for any given dataset

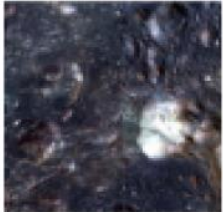


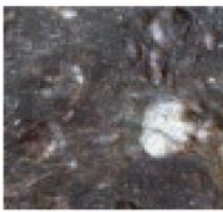


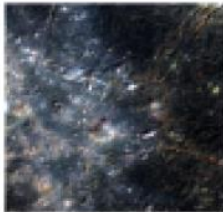



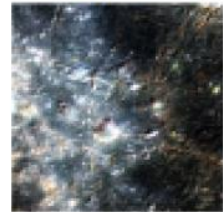
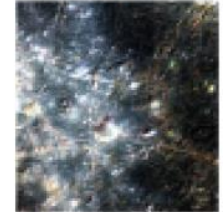
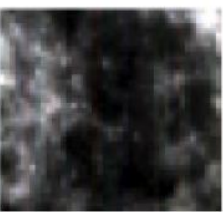
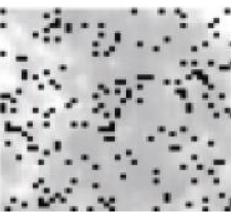
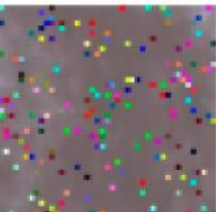

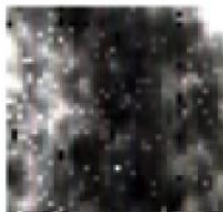


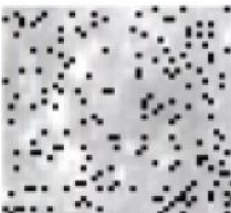
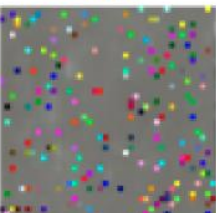



Our Solution



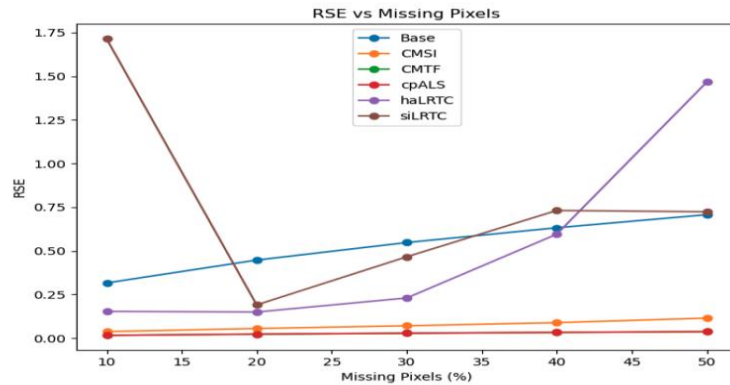
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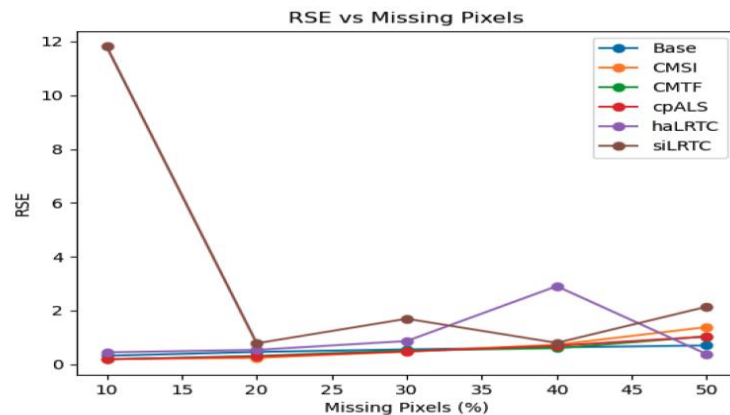
Experimental Results

	Ground Truth	Corrupt Image	siLRTC	haLRTC	CP_ALS	CMTF
Kaguya MI Dataset 1		 0.3164	 1.7139	 0.1535	 0.0163	 0.0377
Kaguya MI Dataset 2		 0.4446	 1.1828	 0.6575	 0.0135	 0.0101
Chandrayan Dataset 1		 0.3183	 11.8124	 0.4644	 0.1857	 0.1826
Chandrayan Dataset 2		 0.3176	 0.2821	 0.1111	 0.0561	 0.0635

Experimental Results

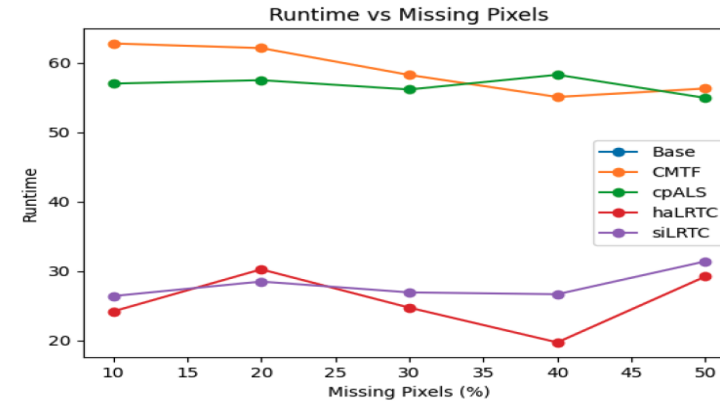


(a) Kaguya Dataset 1

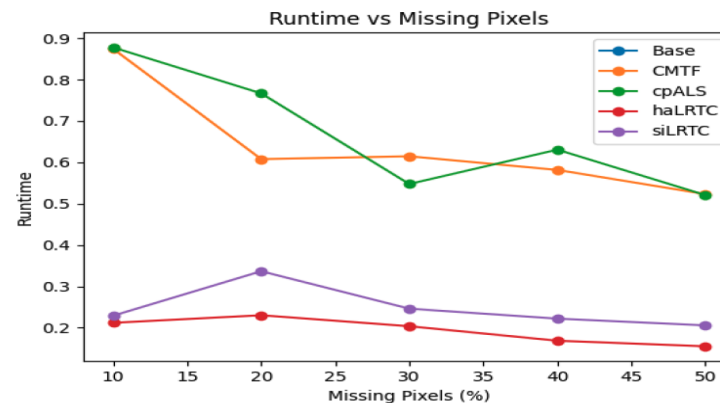


(b) Chandrayan Dataset 1

Fig. 4. Comparison between various approaches on varying the percentage of missing pixels on Kaguya Dataset 1(left) and Chandrayan Dataset 1(right)



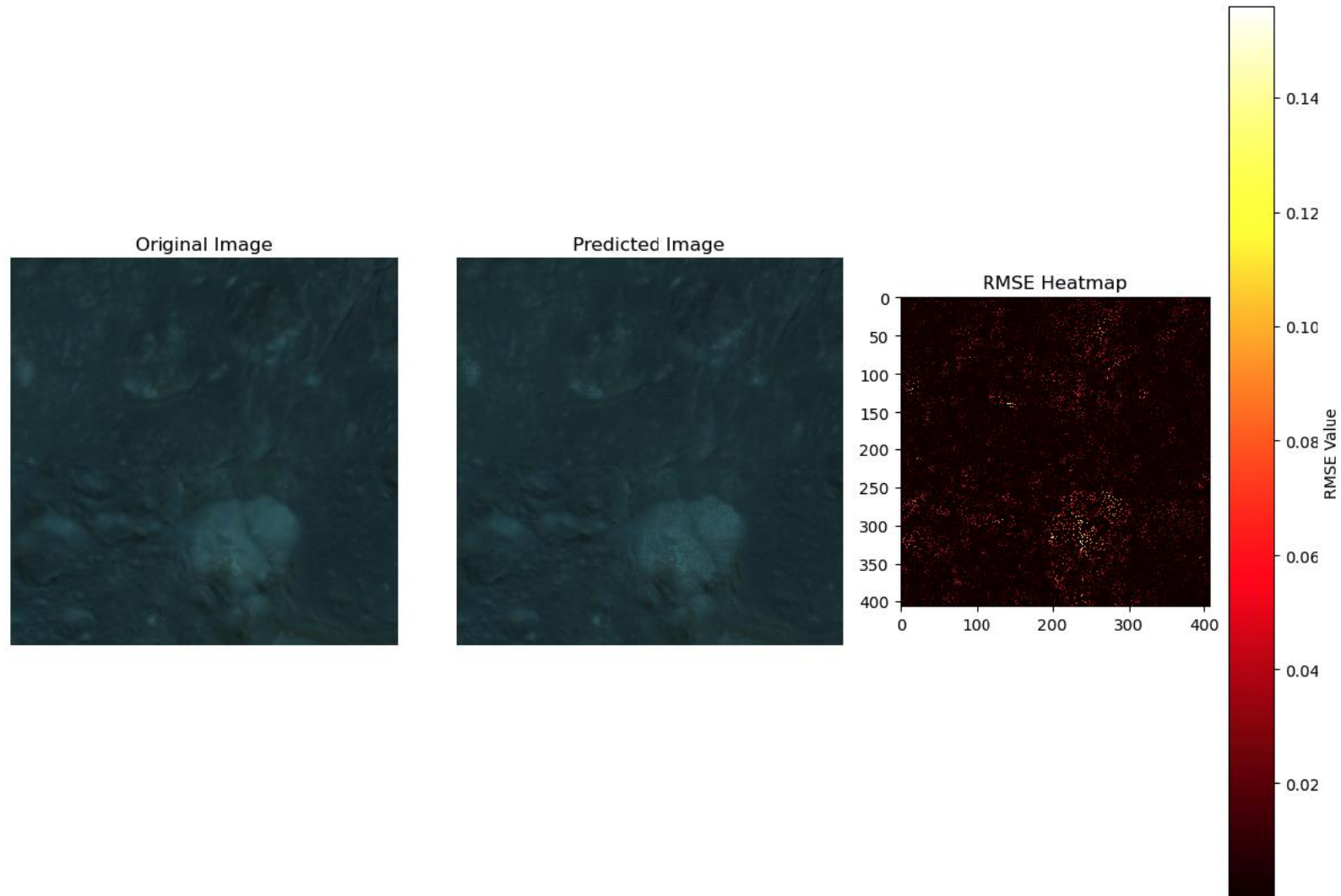
(a) Kaguya Dataset 1



(b) Chandrayan Dataset 1

Fig. 5. Study to compare the run time of different approaches on varying the percentage of missing pixels on Kaguya Dataset 1(left) and Chandrayan Dataset 1(right)

Experimental Results



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Conclusions

- This paper tackled the missing pixel problem in raster images using Tensor Completion Technique.
- Experimental results demonstrate that CMTF-OPT technique performed better against other imputation techniques.
- CMTF-OPT was found to be computationally expensive than most of the tensor-based imputation techniques.

udayRage / icotl23TensorCompletion












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