SELECTING MARTIAN LANDING SITES

INDEX

INTRODUCTION AND PROJECT AIM

- Landing on Mars is extremely difficult due to its thin atmosphere and rough terrain.
- The goal of this project is to simulate NASA’s process of selecting safe landing zones.
- We focus on identifying areas near the equator with:

1. Low elevation (for better atmospheric drag)
2. Flat terrain (for safe landings)

WHY LOW AND FLAT ZONES MATTER?

- Mars’ atmosphere is ~1% as dense as Earth’s.
- Low elevation = more atmospheric drag = safer landings.
- Flat terrain = reduced risk of damage and better solar panel performance.
- Two key smoothness metrics:

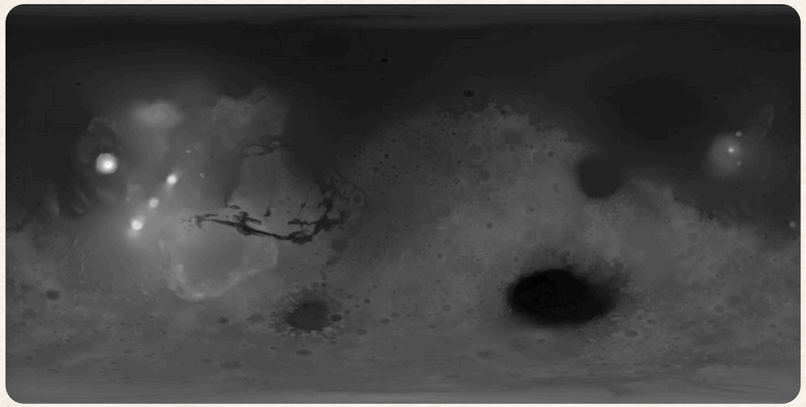
1. Standard Deviation (StD): Measures terrain flatness.
2. Peak-to-Valley (PtV): Measures elevation range in a region.

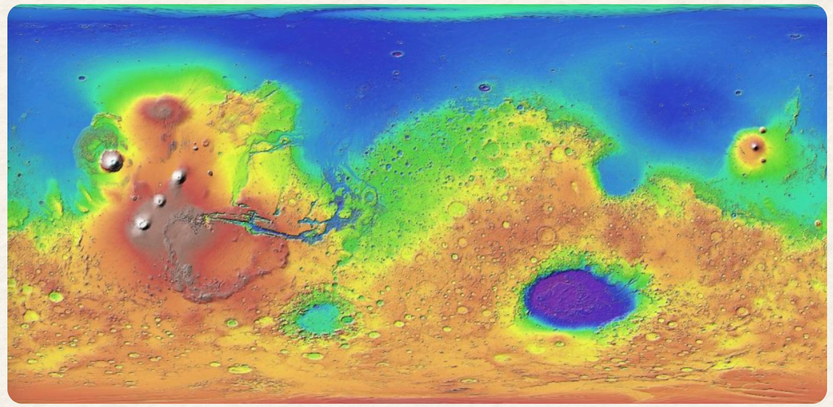
LOADING AND PREPARING THE MARTIAN DATA

- We used two images from the MOLA mission:

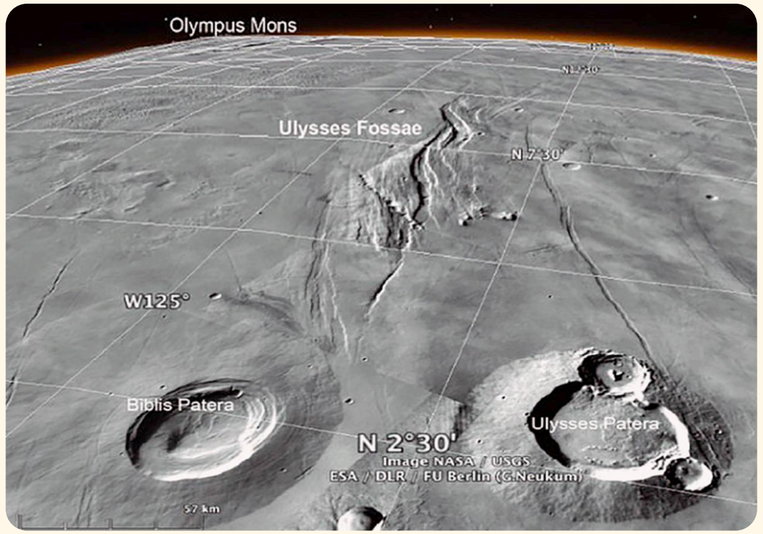
1. Grayscale elevation map for calculations
2. Color shaded relief map for visualization

- Images were loaded into NumPy arrays using OpenCV
- Map dimensions were converted from kilometers to pixels
- Each search zone is 670 km × 335 km





REGION ANALYSIS



- THE GRAYSCALE IMAGE IS SCANNED WITH OVERLAPPING RECTANGLES.
- EACH RECTANGLE IS ANALYZED ONLY IF ITS MEAN ELEVATION IS BELOW A THRESHOLD.
- FOR VALID REGIONS, WE CALCULATE:
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  - STANDARD DEVIATION (STD)
  - PEAK-TO-VALLEY (PTV)
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- OVERLAPPING HELPS AVOID MISSING IMPORTANT ZONES.

FILTERING AND RANKING

- All valid rectangles are sorted by:
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  - Standard Deviation (StD) → flatter regions
  - Peak-to-Valley (PtV) → less elevation variation
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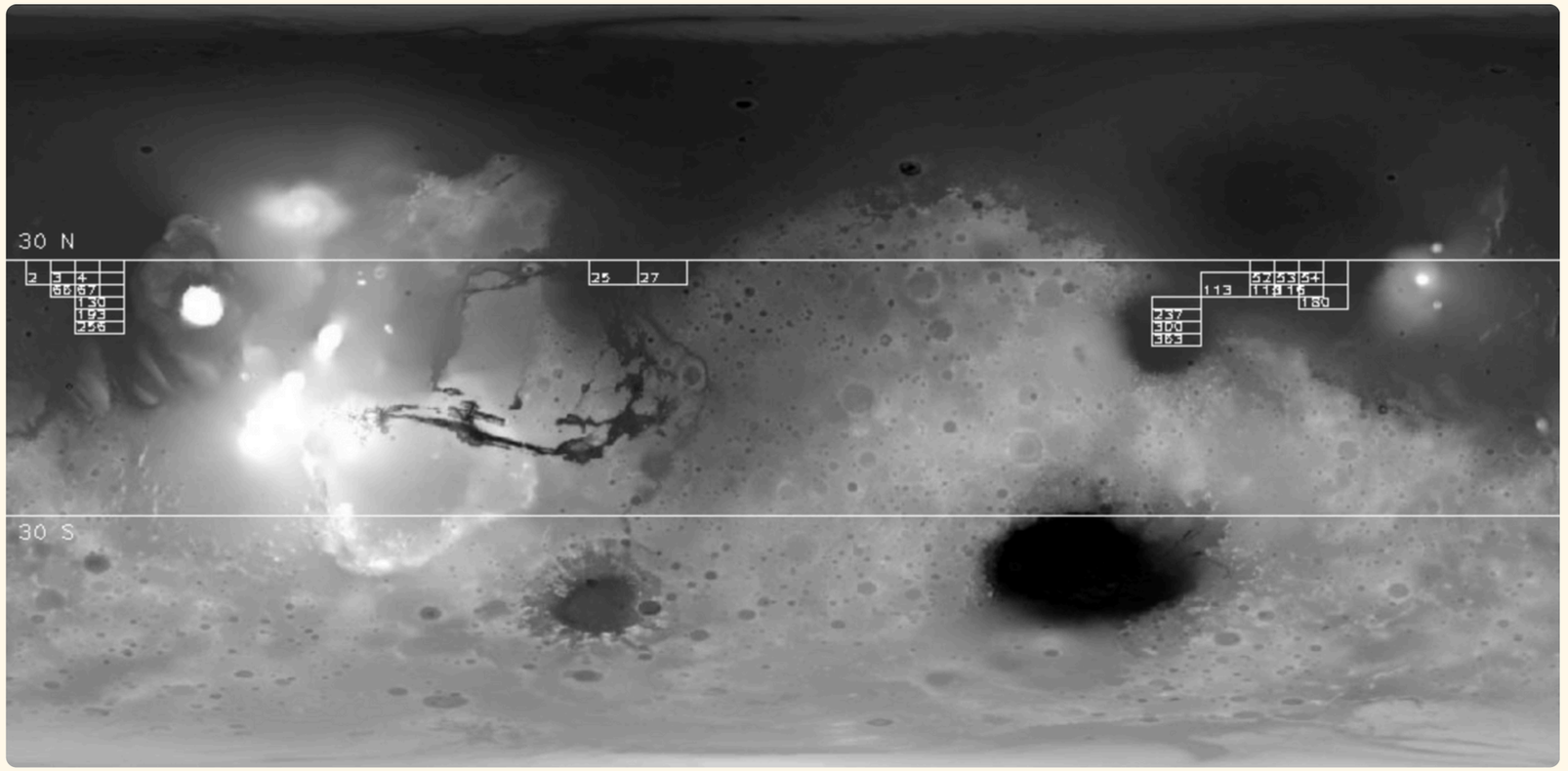
- The top 20 regions are selected from each list.
- Only regions that appear in both rankings are kept.
- This ensures the final candidates are both low and flat.

VISUALIZATION

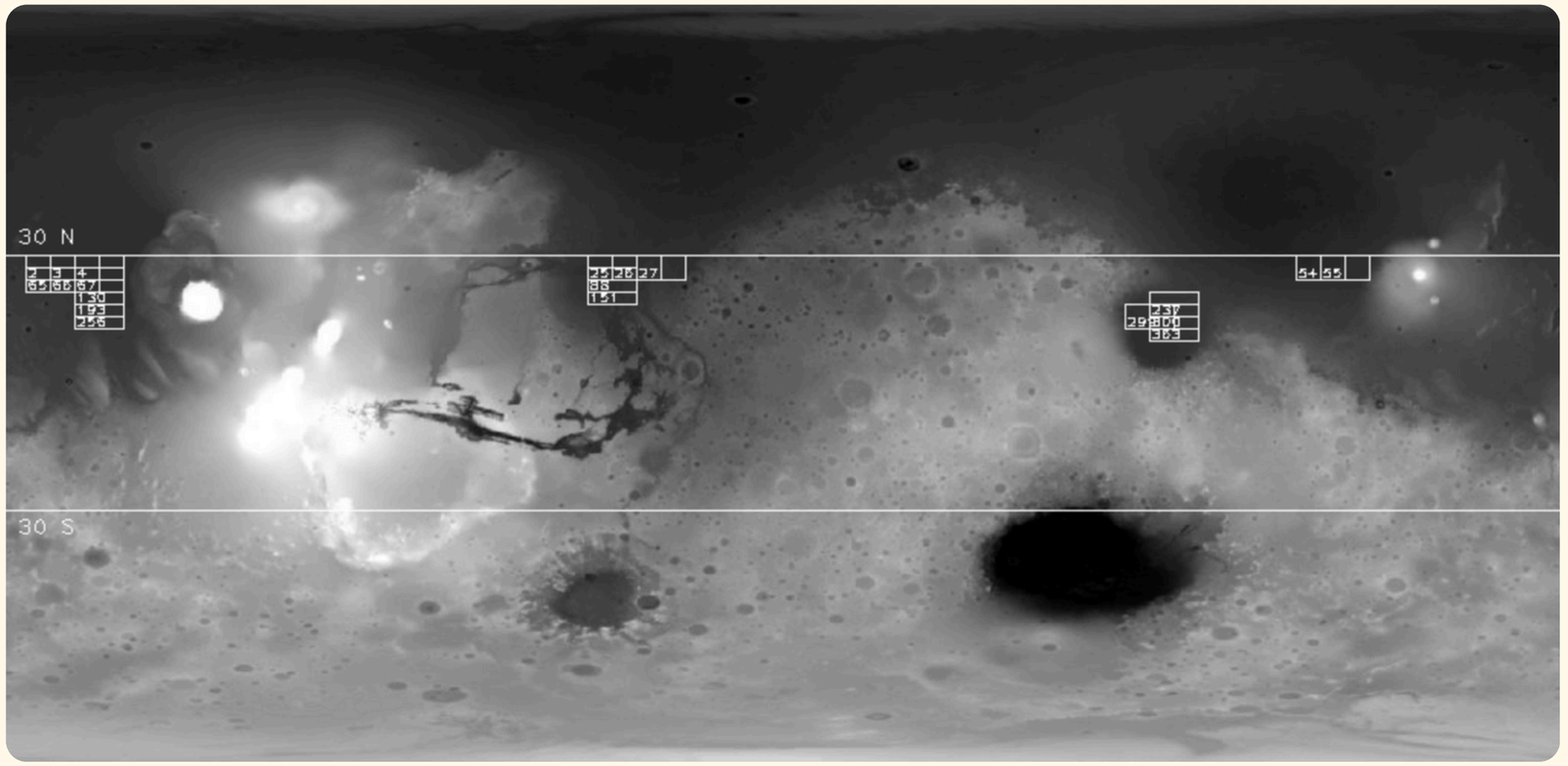
- A Tkinter GUI displays the final landing zones.
- The color MOLA map is used as a background.
- Each selected region is highlighted with a rectangle.
- Annotations show the region’s:
  a. Number
  b. Mean elevation
  c. Standard Deviation
  d. Peak-to-Valley
- The interface helps easily verify and compare results.

CONLCUSIONS



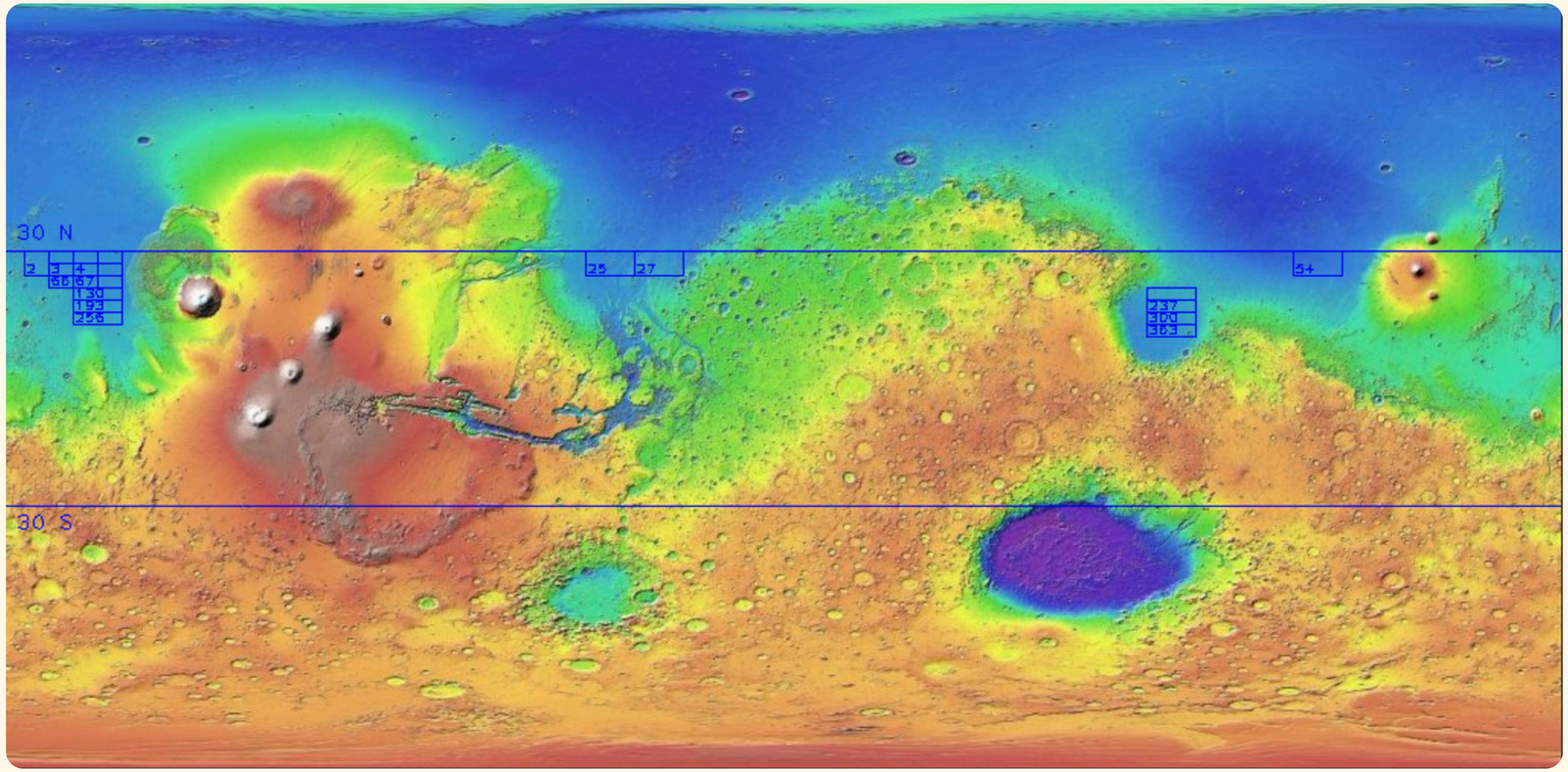
Sorted by ptp

CONCLUSIONS



Sorted by std

CONLCUSIONS



Std and Ptp

THE END