Autonomous lineament detection in Galileo images of Europa

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Find my abstract here:

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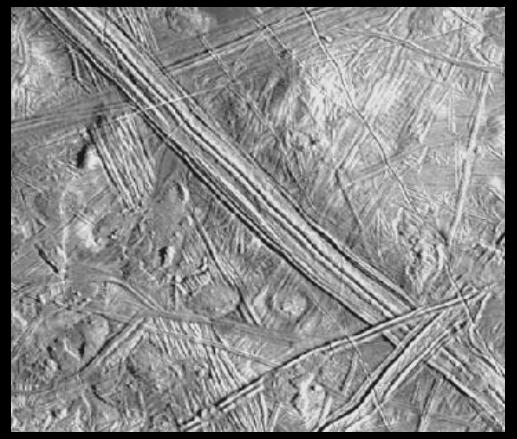
PlanetS

National Centre of Competence in Research

Introduction – surface features on Europa

double ridge
(most common)

ridge complex



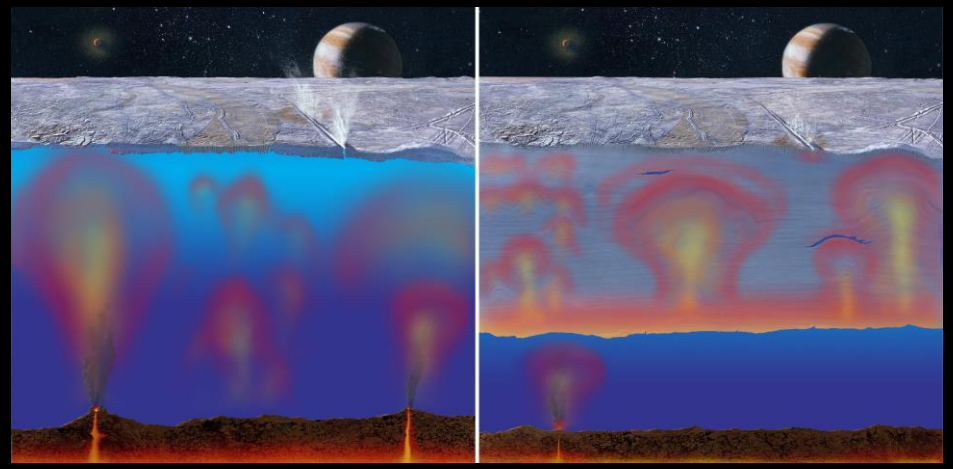
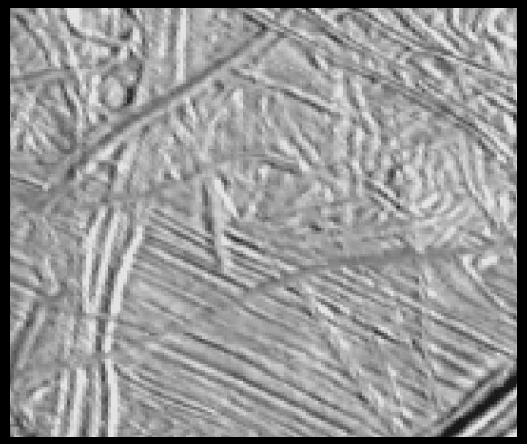


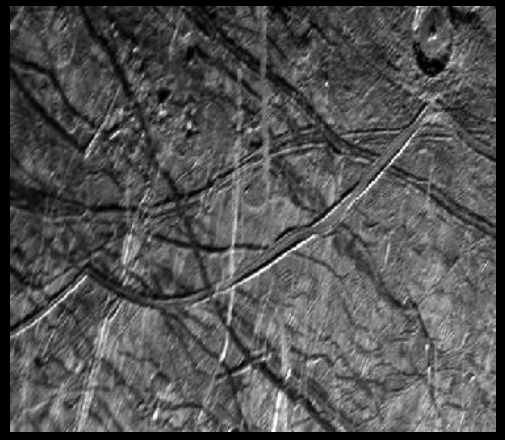
Image credits: NASA/JPL/Michael Carroll

ridged plains
Undifferentiated lineae



band

cycloid



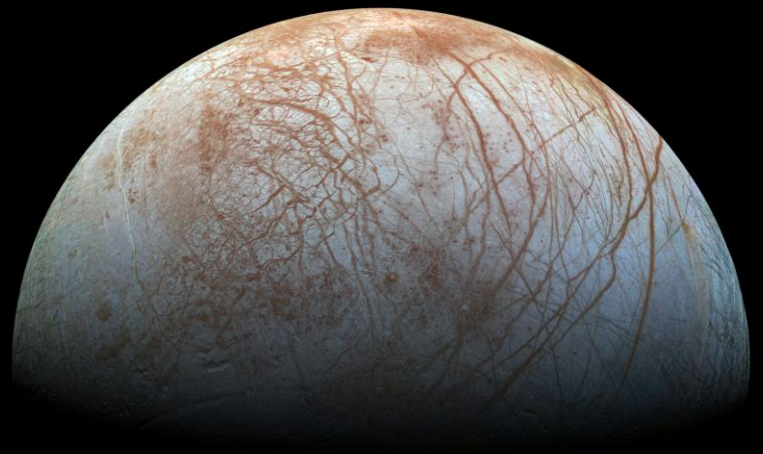
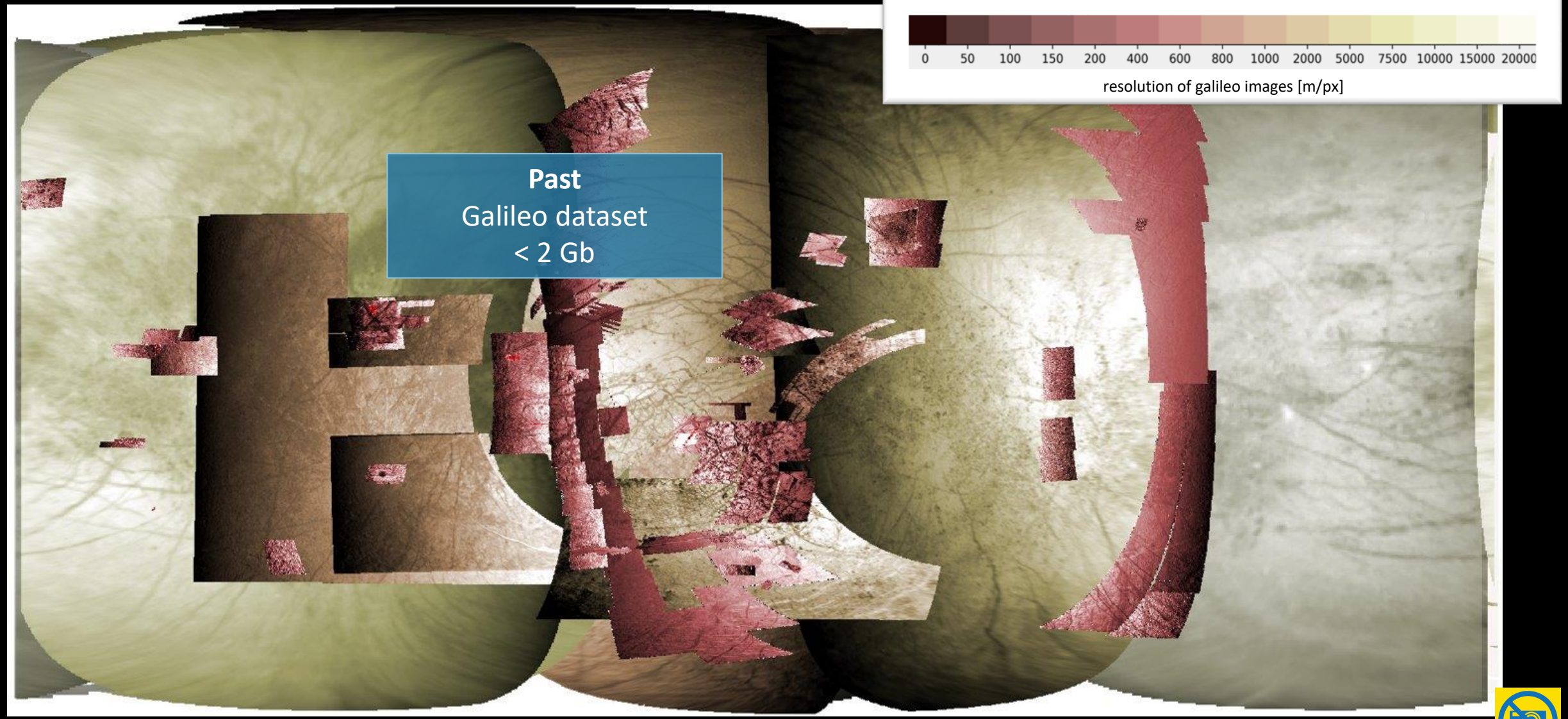


Image credits: https://pds-imaging.jpl.nasa.gov/data, Bland et al. 2021

Image credits: NASA/JPL-Caltech/SETI Institute

Motivation for automatic detection of linear surface features



Map based on data from Bland et al. 2021

Motivation for automatic detection of linear surface features

Past
Galileo dataset
< 2 Gb

Human work
Manual mapping of lineaments

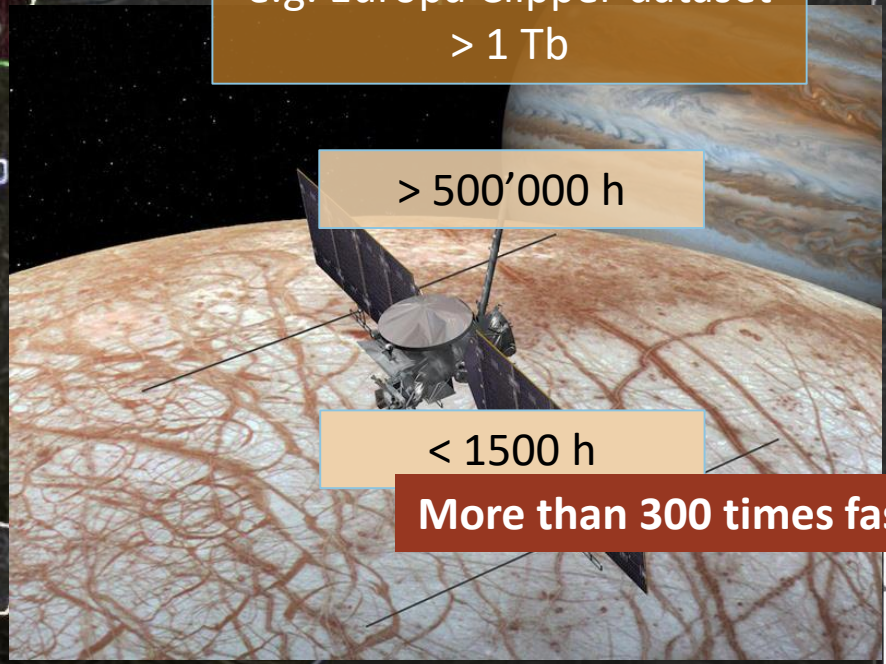
> 1’000 h

Computer work
Automatic lineament segmentation algorithm

< 3 h

We want that!

Future
e.g. Europa Clipper dataset
> 1 Tb



> 500’000 h

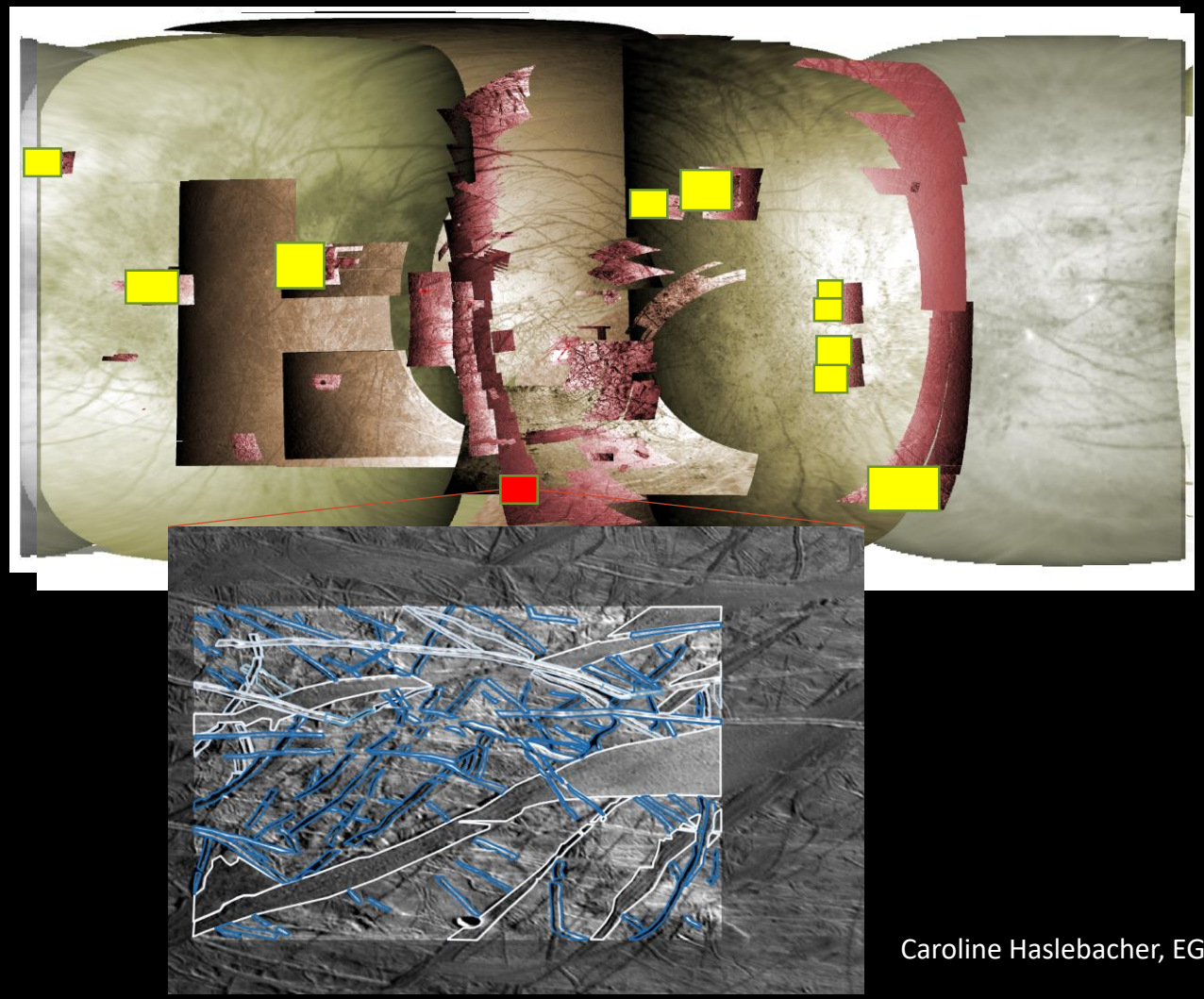
< 1500 h

More than 300 times faster

Map based on data from Bland et al. 2021

Methodology – Mask R-CNN (He et al. 2018)

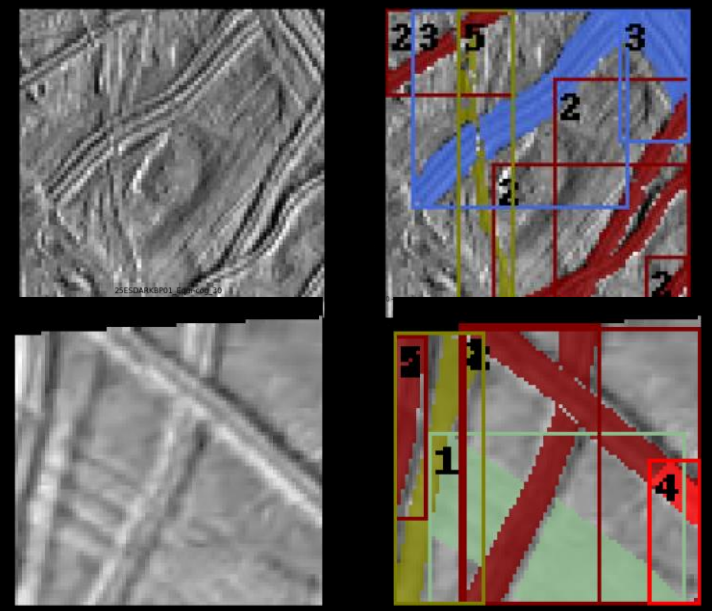
Image selection
Resolution of 180 – 600 m/px



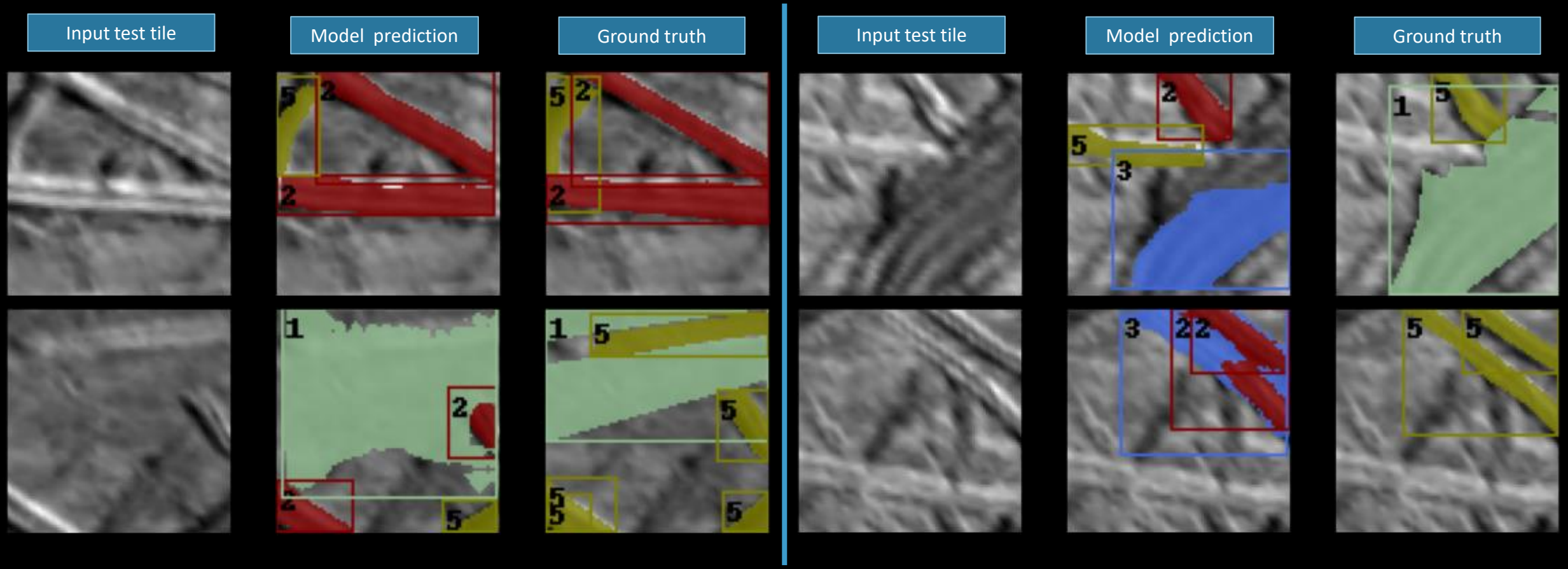
Manually segmented dataset
- guideline
- 80x80 px images

Training tile

Ground truth segmentation



Results – Mask R-CNN on Galileo data

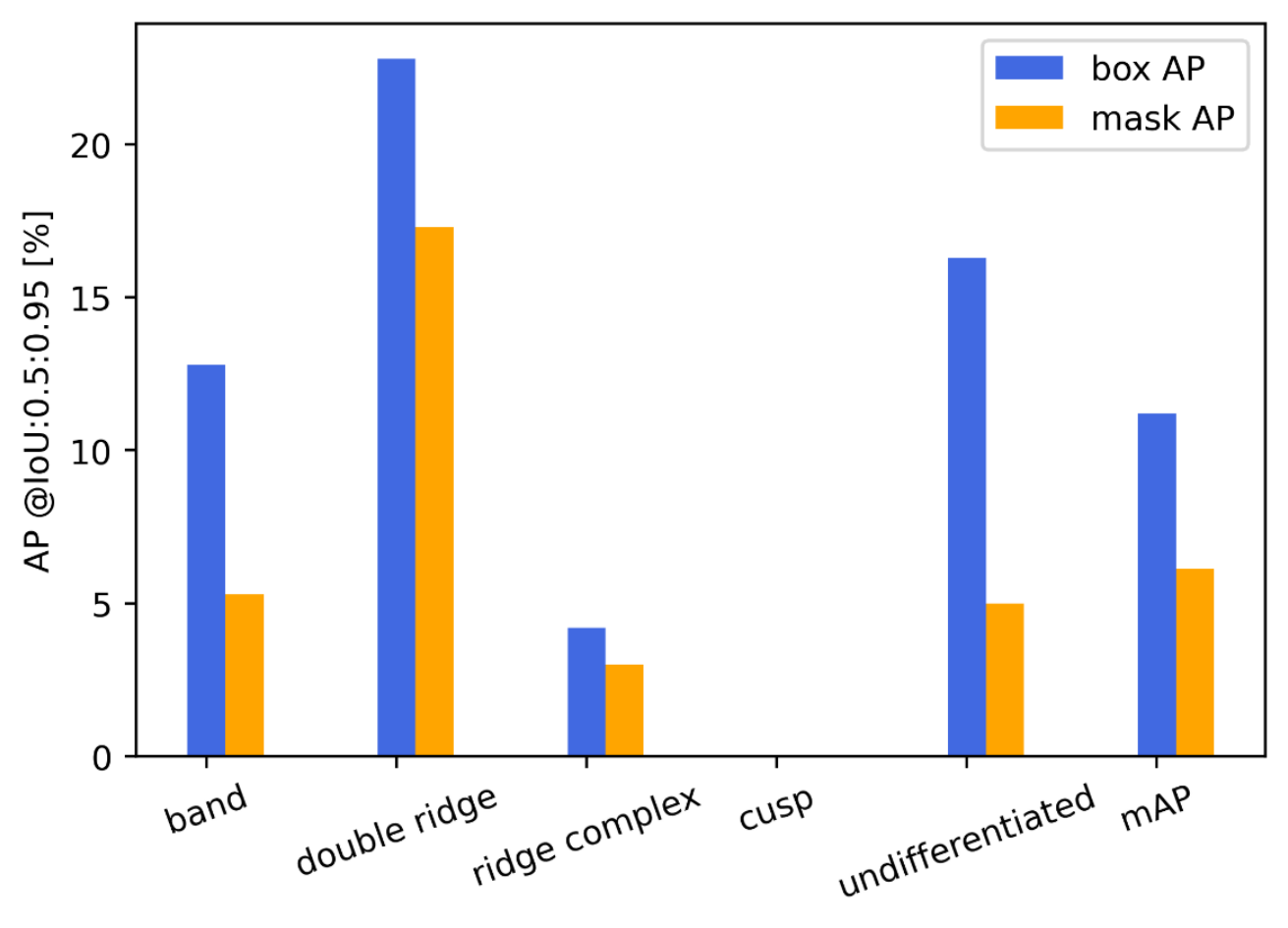


The trained Mask R-CNN produces reasonable and ‘intelligent’ predictions.

Work in progress

Results – Mask R-CNN on Galileo data

Quantitative metrics: average precision



Conclusion

Deep learning is a promising method for instance segmentation of linear surface features

Outlook: Ganymede (JUNO)

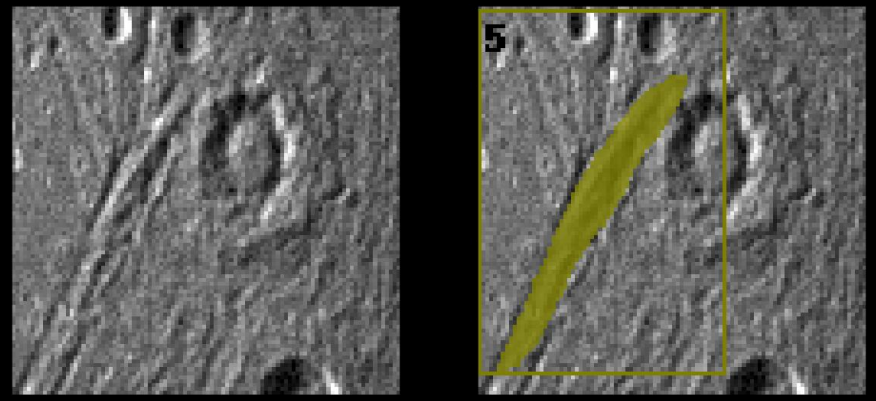
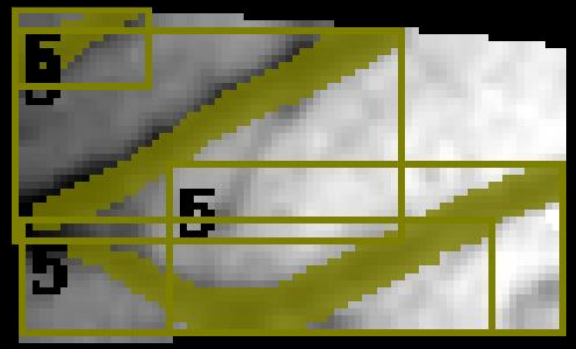


Image credit: Credit: NASA/JPL-Caltech/SwRI

Outlook: spectral images (Galileo NIMS)



https://pds-imaging.jpl.nasa.gov/data/

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Caroline Haslebacher, EGU 2022

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