

Using Machine Learning to Analyze Earth's First Reefs

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Motivation



NOAA

Cambrian Explosion

4.5 billion years ago: Earth's formation



3.7 billion years ago: First life

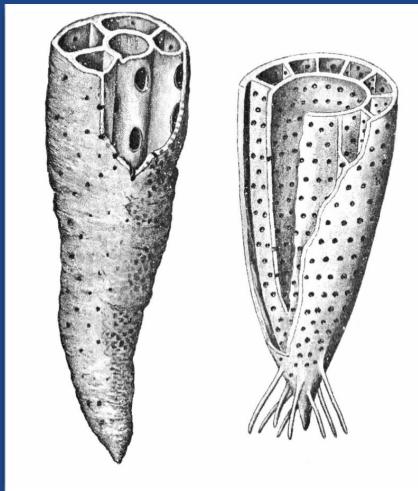


800 million years ago:
Animals first evolve



Today

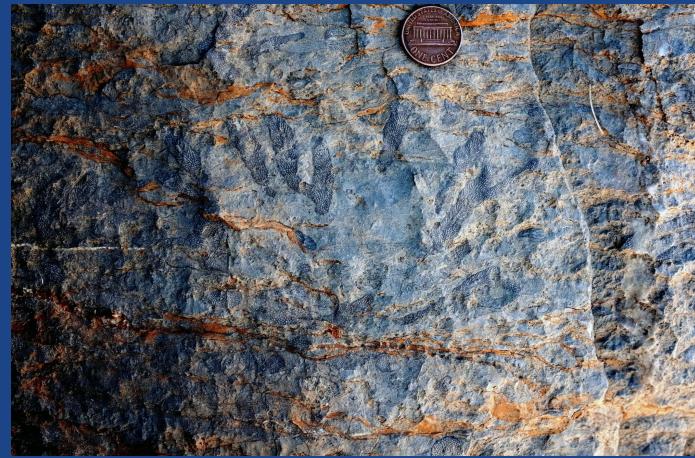
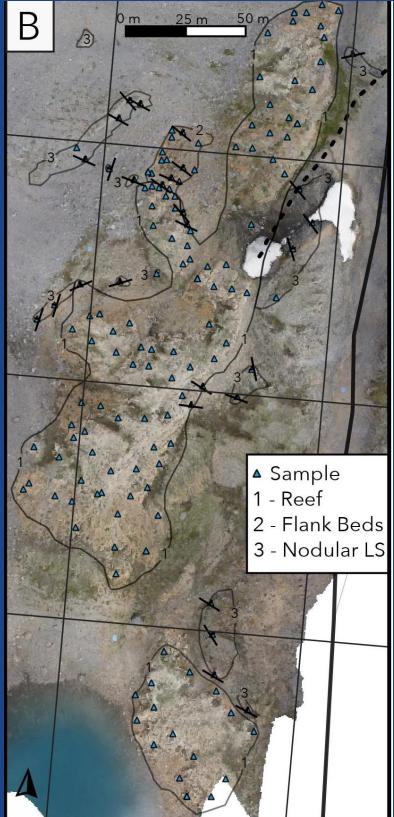
Archaeocyathid



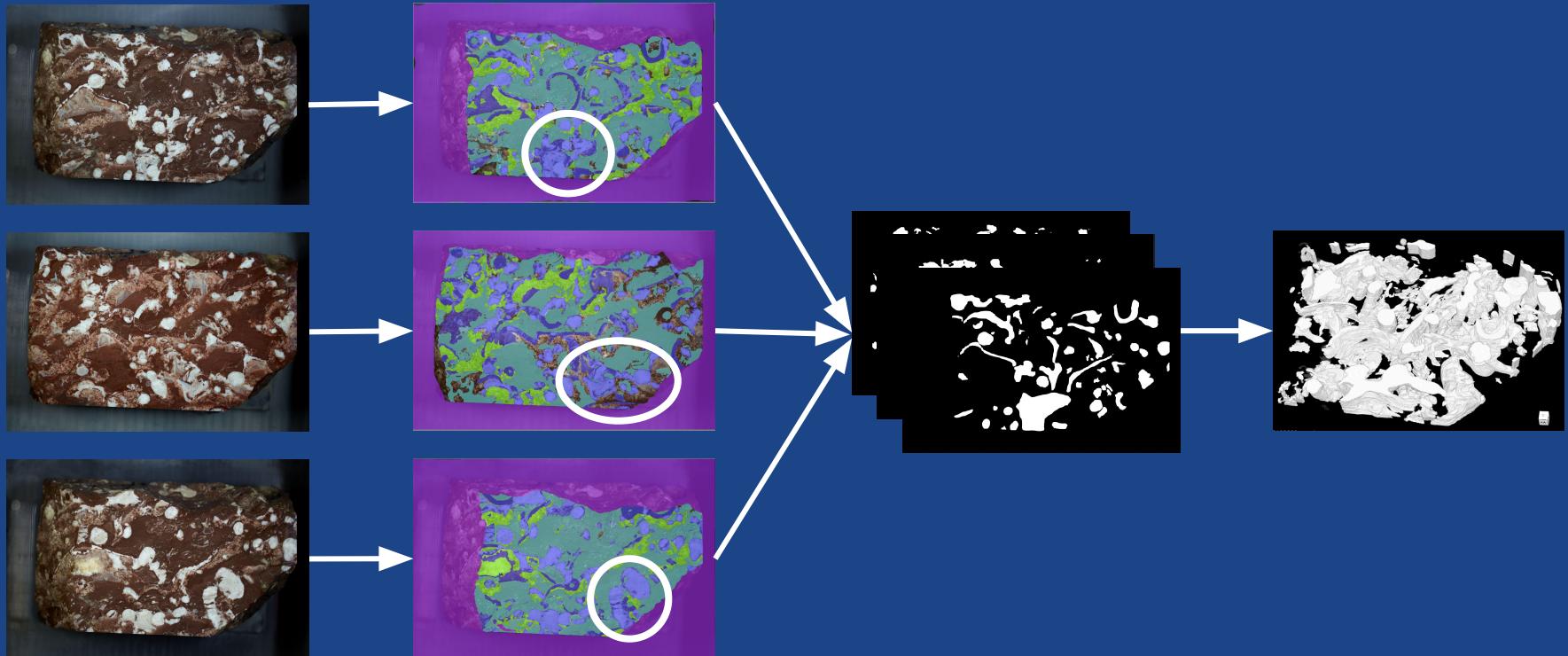
500 million years ago:
Animals proliferate-The Cambrian Explosion



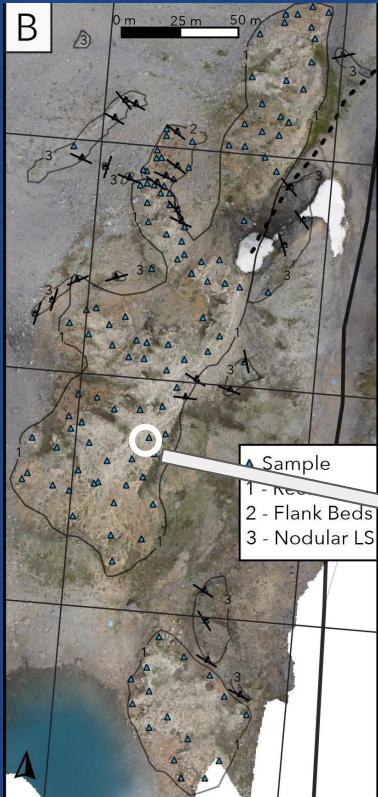
Overarching Objective



Objective #1



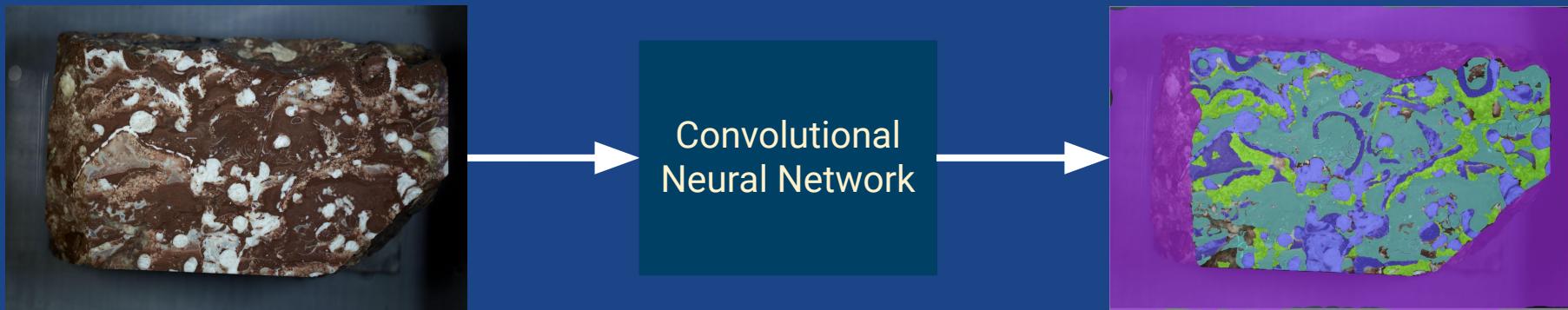
Objective #2: Thin Sections



- Rock samples obtained from Yukon territory in Canada
- Identify presence/concentration of archaeocyathids and diversity of other sediments in various samples
- Eventually analyze spatial/temporal trends

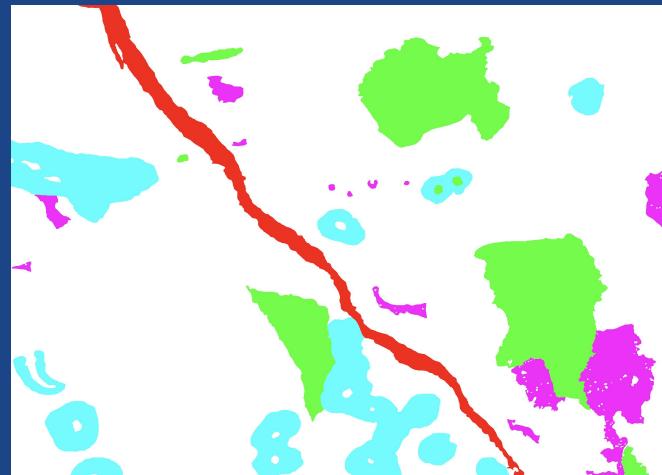
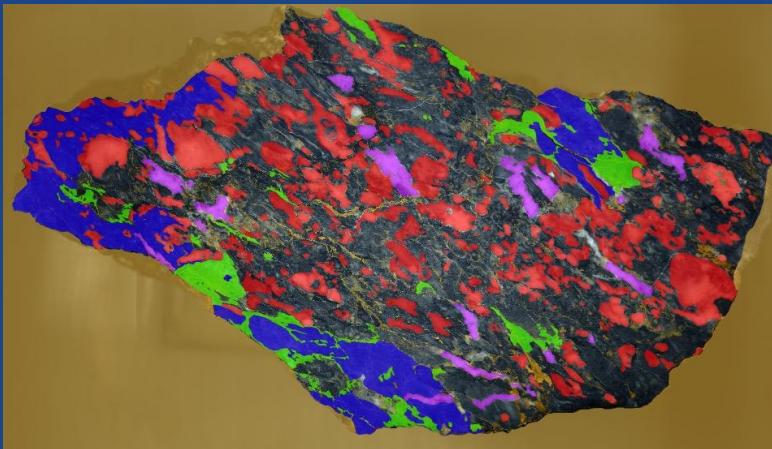


Convolutional Neural Networks (CNN)



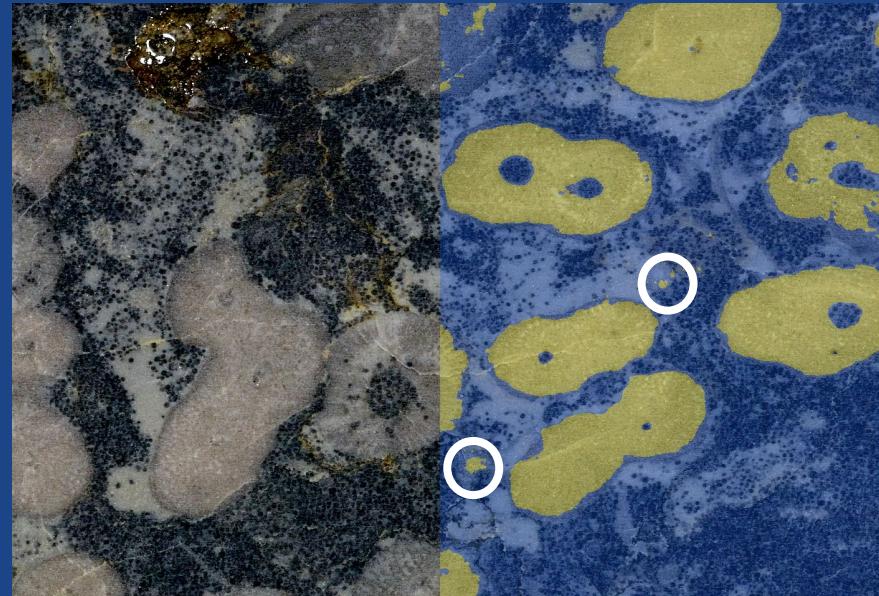
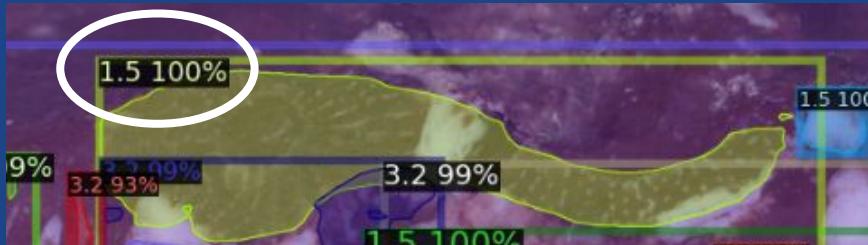
Training Data

- Create training data in the COCO format
 - 1. Convert old data in the lab
 - Mask images
 - Photoshopped images
 - 2. Manually trace and label



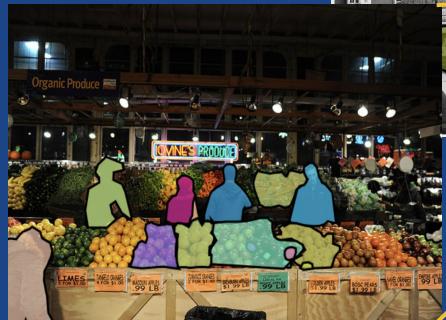
Mask R-CNN¹

- Remove masks with lower confidence
- No spurious pixels



¹ Wu, Y., Kirillov, A., Massa, F., Lo, W.-Y., & Girshick, R. (2019). *Detectron2*.

Pretrained



Mask R-CNN

Fine-tune



COCO Images Source: <https://cocodataset.org/#explore>

Experimentation

- Backbone networks
- Data augmentations
- Combinations of datasets
- Combining classes
- Learning rates
- Batch size
- Training steps

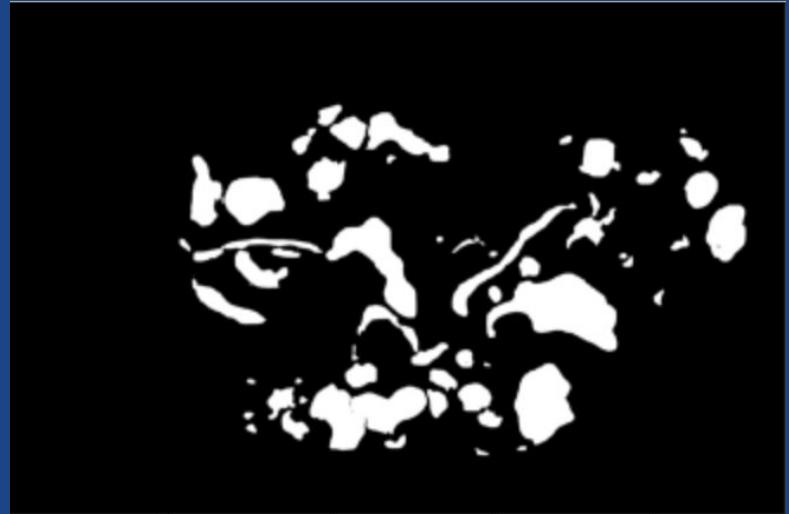


Image-by-image Labrador results

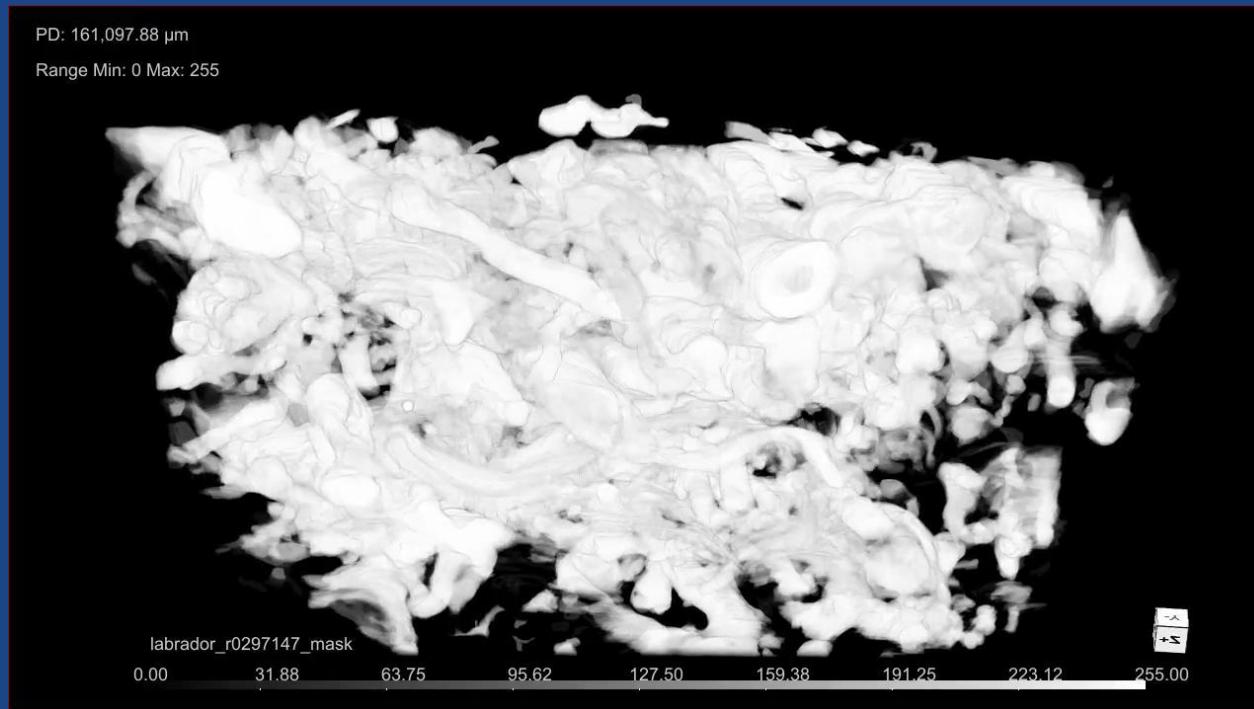
Ground Truth



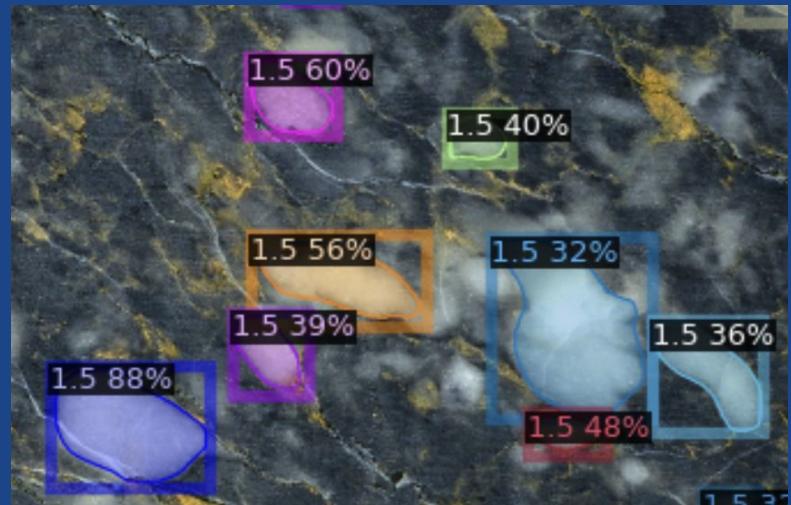
Predicted



Resulting 3D model for Labrador



Ketza Results



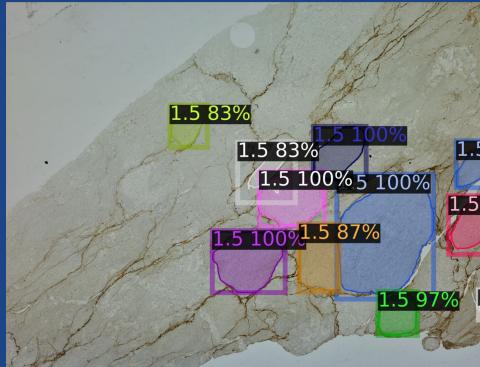
Sample Predictions

Results for Thin Sections

Raw Image



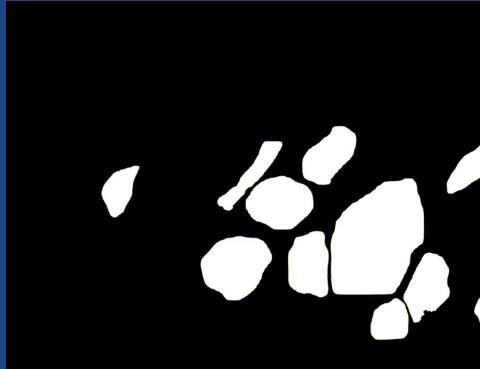
Prediction



Ground Truth



Prediction

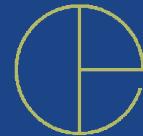


Conclusions/Future Directions

- decent accuracy achieved
- struggles with non-oval shapes
- we can learn from the model

Personal Reflections

Thank you!



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