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BACTERIA, GEOGRAPHY, AND STATISTICS: HOW DO THEY WORK TOGETHER?

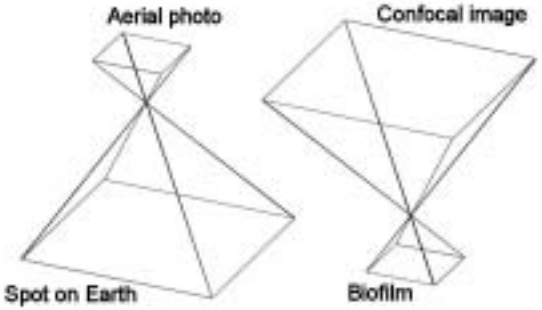
Alexandru I. Petrisor, MSPH
Tomohiro Kawaguchi, PhD
Alan W. Decho, PhD

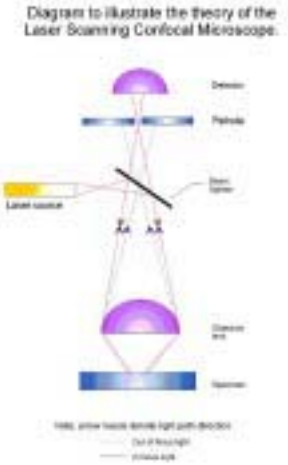
Department of Environmental Health
Norman J. Arnold School of Public Health
University of South Carolina

Basic Principle

Aerial Photography

Two types of remote sensing

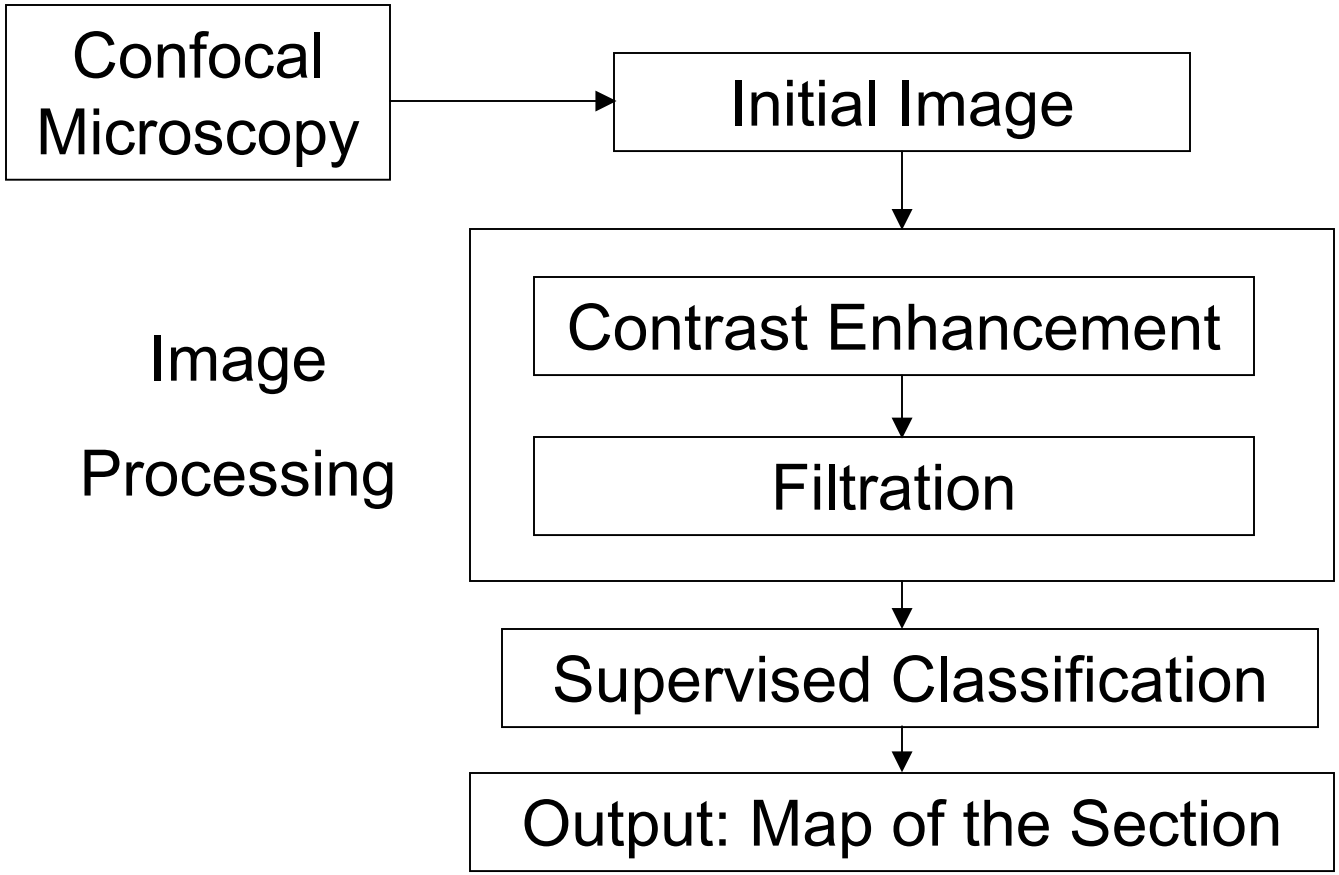




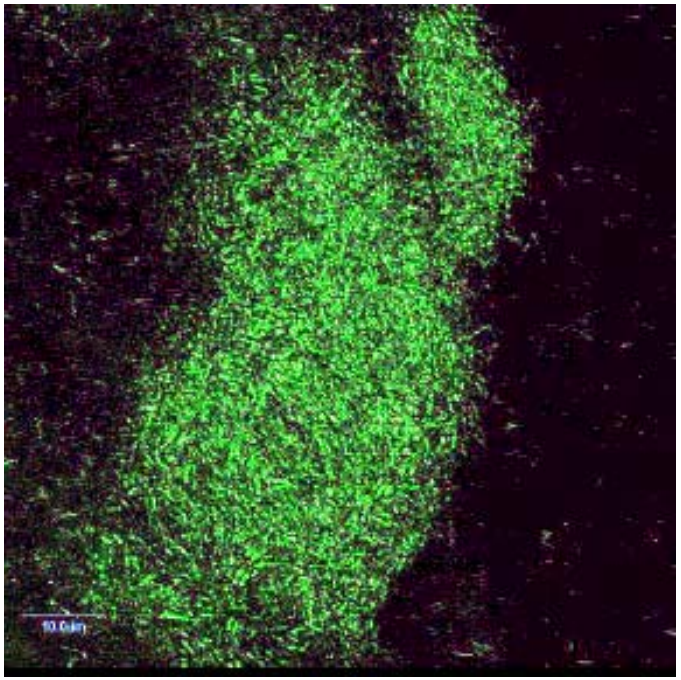
Confocal Microscopy Image

Scale makes the difference!

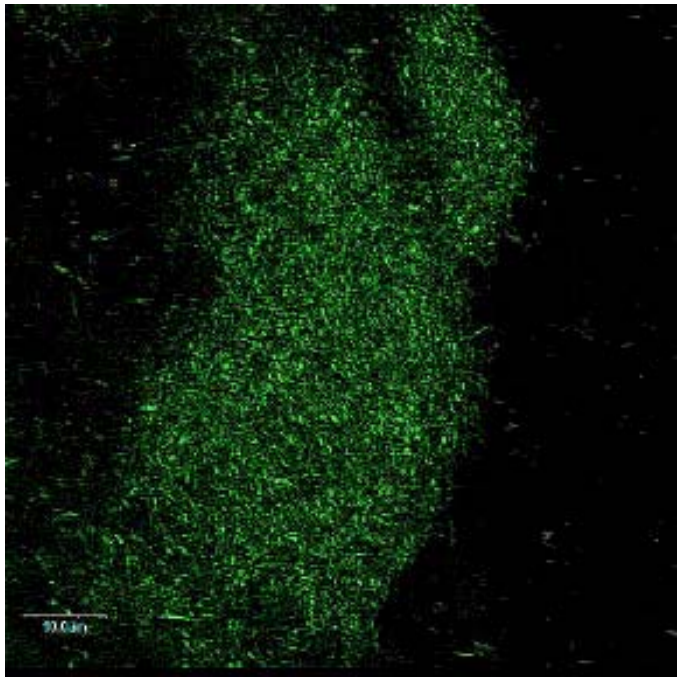
Methodology



Example: Comparison between the Initial and the Enhanced Contrast Image

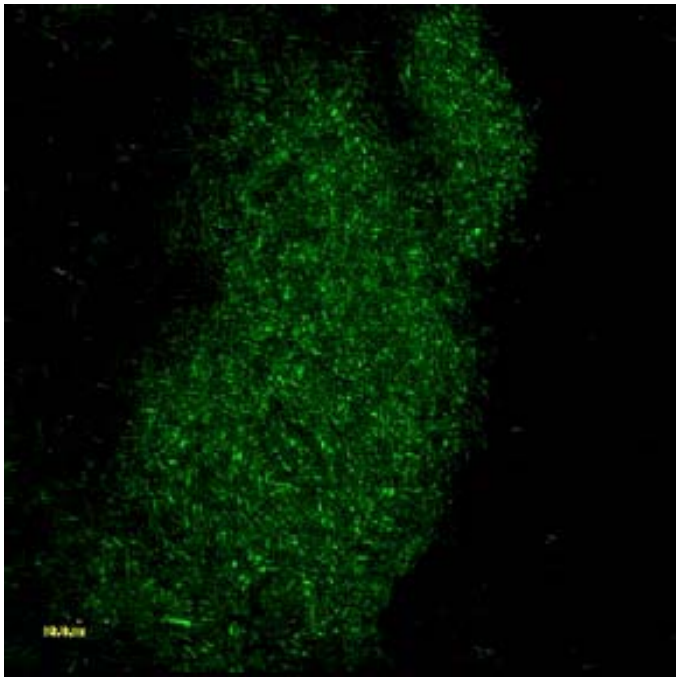


Initial Image

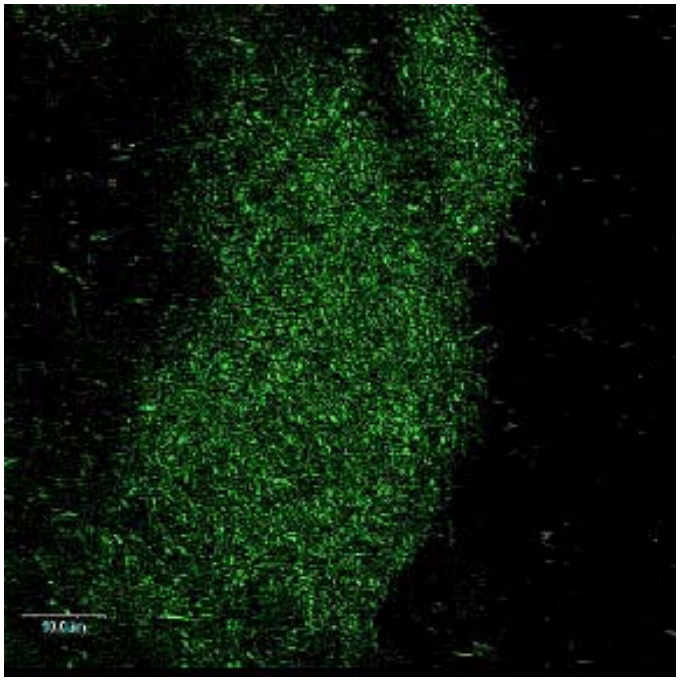


Enhanced Contrast

Example (continued): Comparison between the Enhanced Contrast Image and the Filtered Image

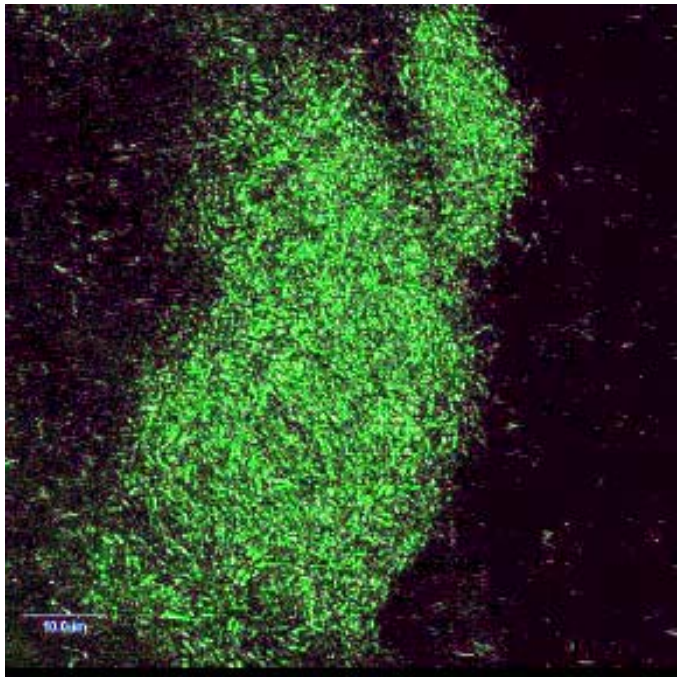


Enhanced Contrast

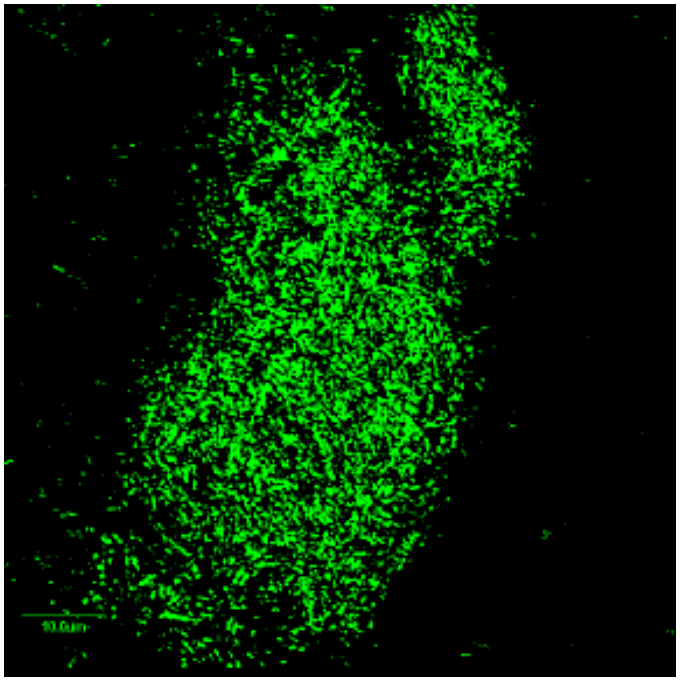


Filtered Image

Example (continued): Comparison between the Initial Image and the Classified Image



Initial Image

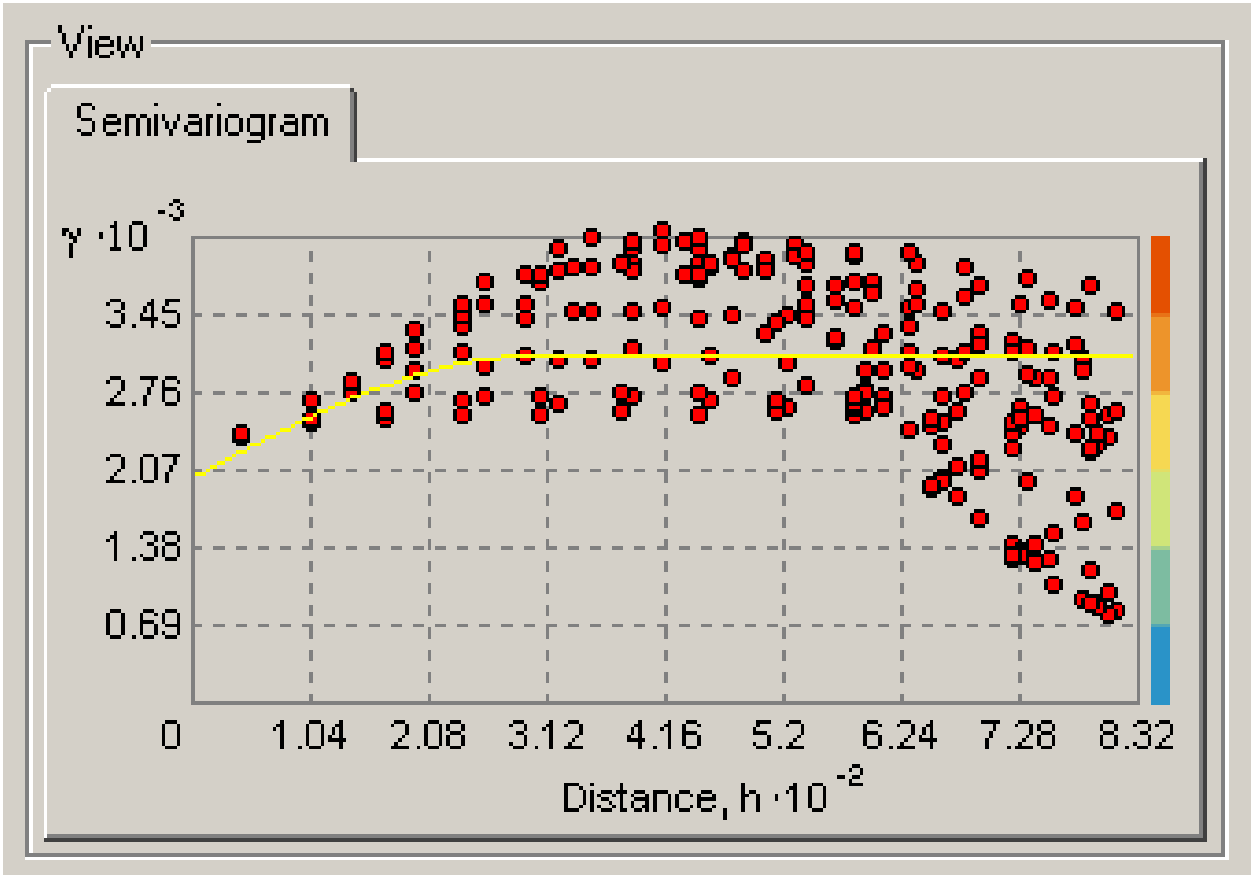


Classified Image

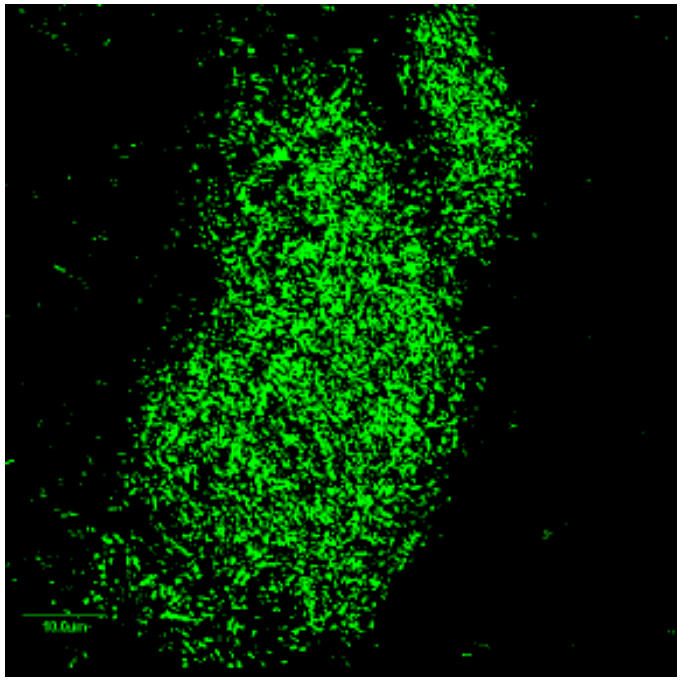
Using Spatial Statistics

- Kriging
  - Named after mining geologist D. G. Krige
  - Spatial stochastic interpolation technique used in obtaining estimates of surface elevation using known elevation at specific points and semivariograms as weighting functions
  - Simple kriging assumes that the true mean of the data is constant and known

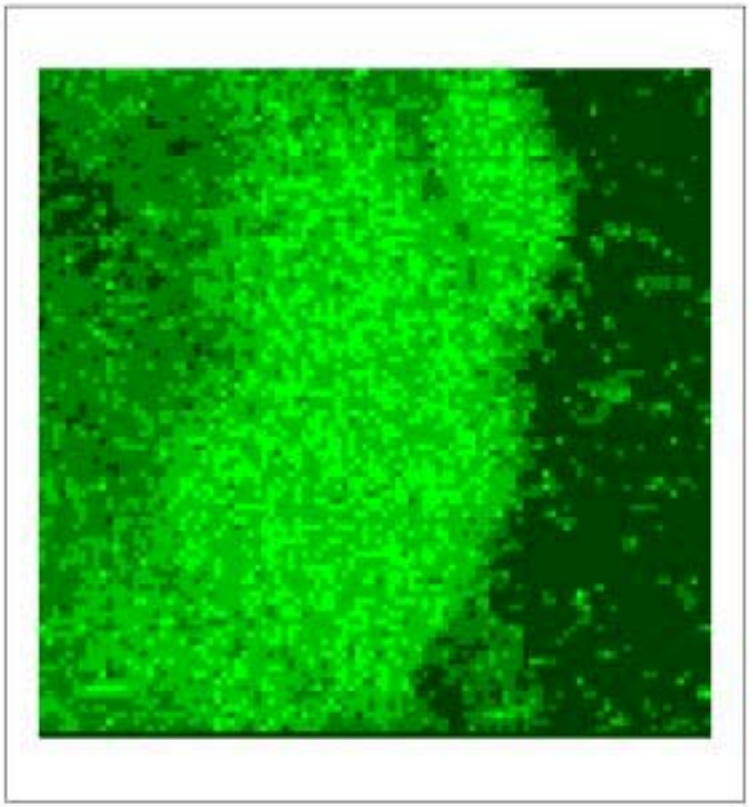
Using Spatial Statistics: Semivariogram Corresponding to the Classified Map



Using Spatial Statistics: Results of Kriging



Classified Image



Simple Kriging: Prediction Map for Biofilm Image

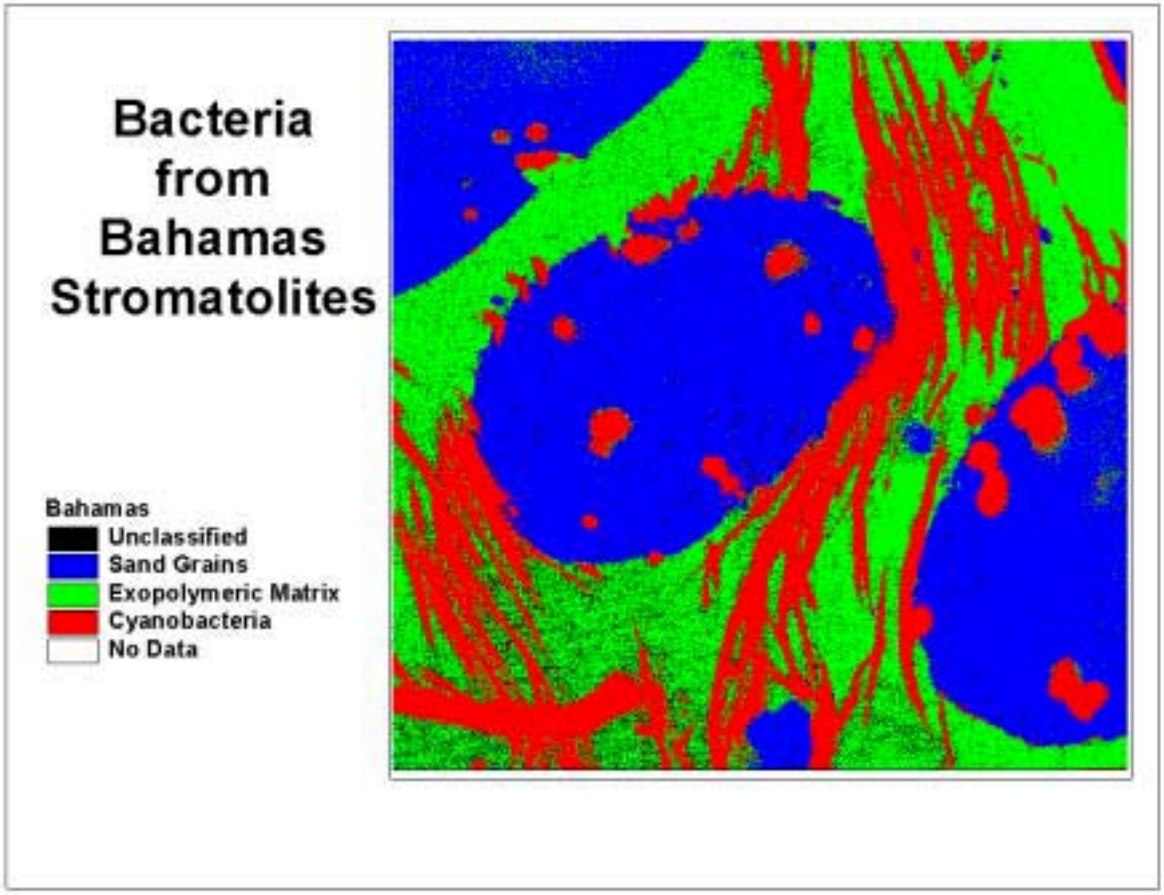
Stromatolites

- Oldest known fossils, dating back more than 3 billion years
- Form nowadays in Bahamas and Australia
- Built mainly by cyanobacteria

Stromatolites. Courtesy of OAR/National Undersea Research Program

- Bacteria dig canals through the sand grains and re-precipitate calcium carbonate elsewhere

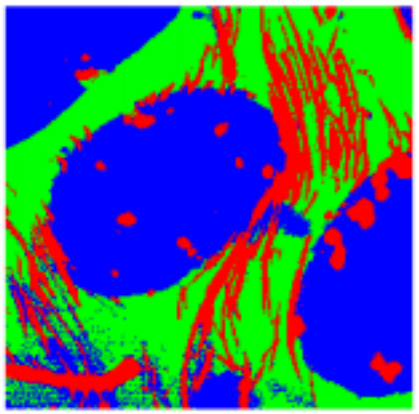
Future Directions: Classified Image of a Section through a Bahamas Stromatolite



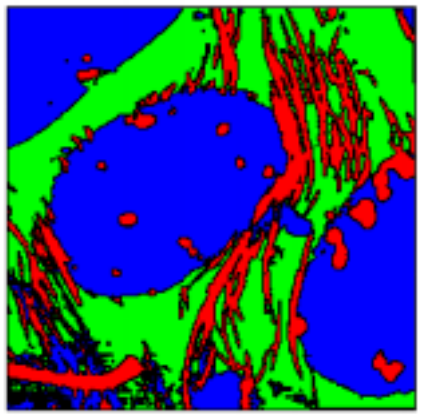
Hypothesis: in some regions of the stromatolite, bacteria dig more canals than in the others.

Verify hypothesis using the method presented before.

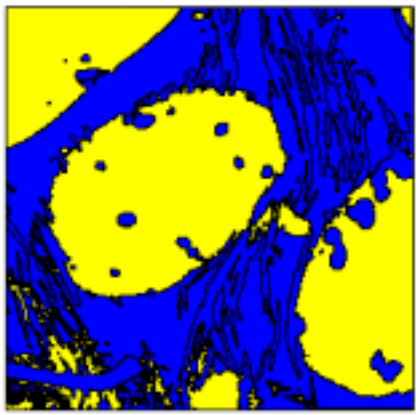
Future Directions (Continued)



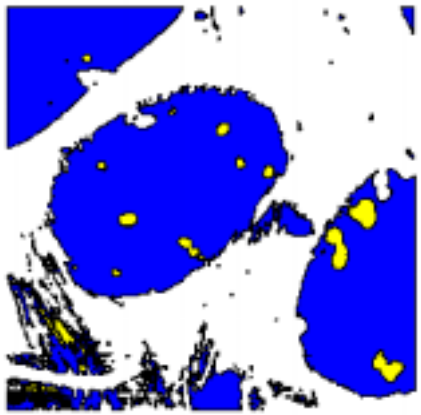
Classified Image



Additional Filtering

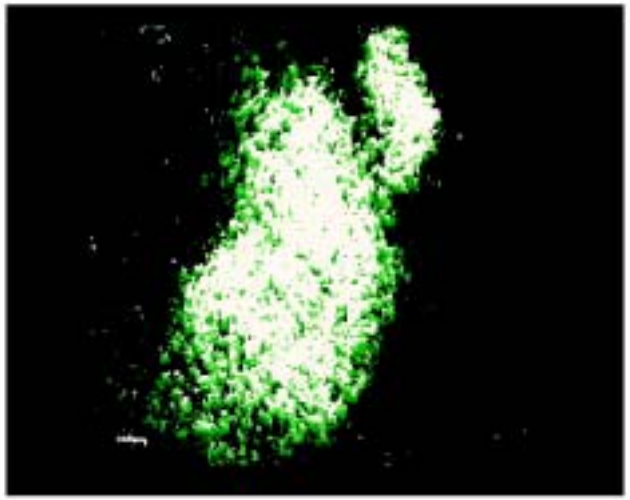


Reclassification

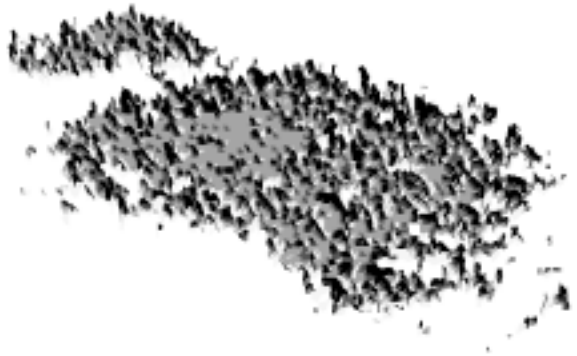


Separation of components

Future Directions (Continued)



Five overlaid sections through a biofilm. Three-dimensional aspect suggested through shading intensity



Three-dimensional reconstitution of the biofilm volume based on five sections

Three-Dimensional Extension of Our Approach

Conclusion

Our methodology permits studying spatial variability within biofilms. The question remains: “How does it compare with other approaches?”

Any questions?