

# The complexity of exoplanet data can be quantified, and could be used to help search for life in the universe

## Computational Mechanics and Epsilon Machine Reconstruction: A New Approach to Exoplanet Analysis and Biosignatures

Stuart J. Bartlett<sup>1,2</sup>, Lana Sinapayen<sup>3,2</sup>, Vijay Natraj<sup>4,1</sup>, Jonathan Jiang<sup>4,1</sup>, and Yuk L. Yung<sup>1,4</sup>  
 Contact email: [sjb@gps.caltech.edu](mailto:sjb@gps.caltech.edu)

<sup>1</sup>California Institute of Technology, Pasadena, United States;

<sup>2</sup>Earth-Life Science Institute, Tokyo, Japan

<sup>3</sup>Sony Computer Science Laboratories, Tokyo, Japan

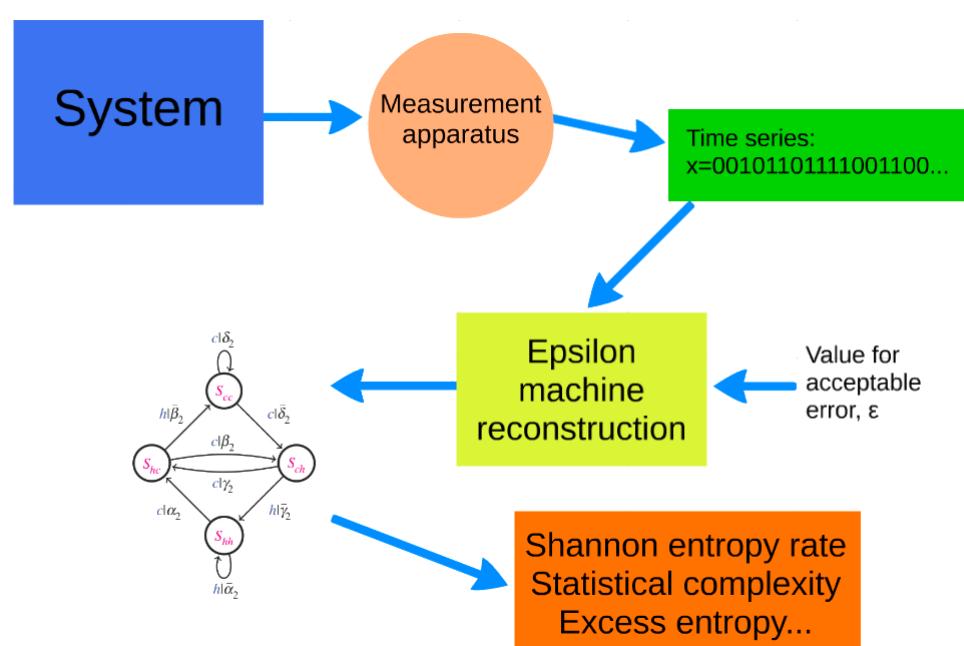
<sup>4</sup>NASA Jet Propulsion Laboratory, Pasadena, United States

### The DSCOVR Mission

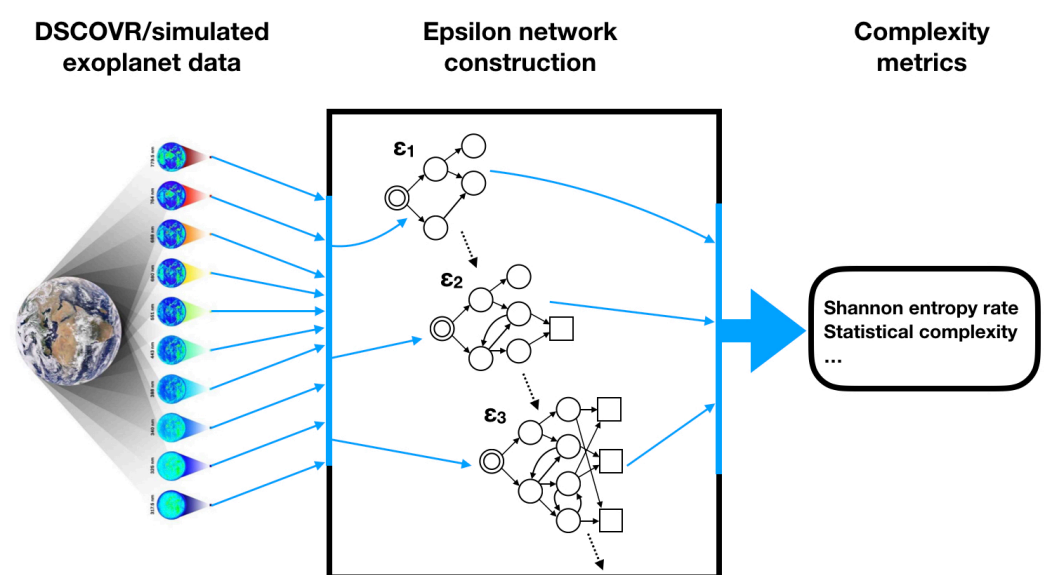
- Earth is being used as a proxy exoplanet to develop life detection techniques
- DSCOVR satellite is situated between Earth and the Sun (1st Lagrangian point)
- EPIC camera measures light reflectance in 10 wavelength bands
- EPIC images were coarse-grained to 1 pixel to emulate a distant exoplanet



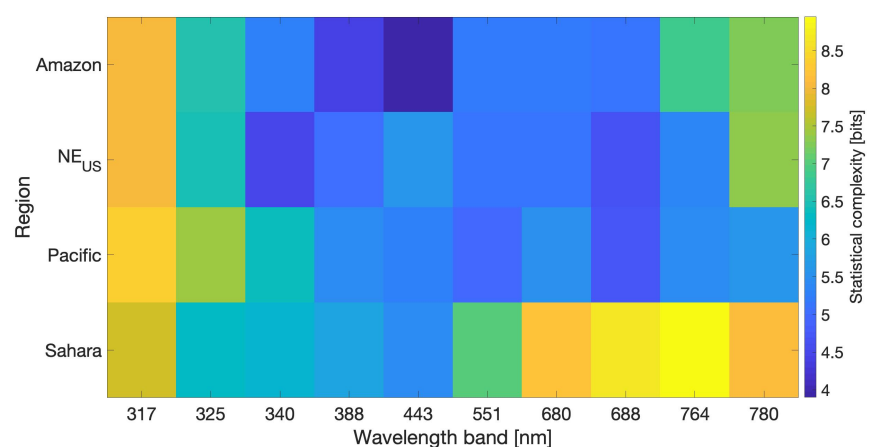
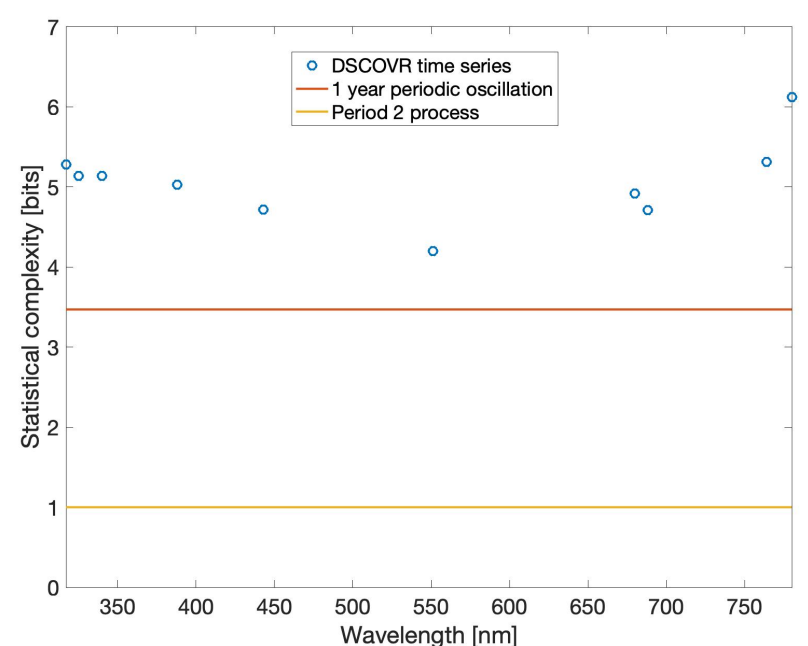
### Computational Mechanics and Epsilon Machines



### Conceptual Approach



### Initial Results



#### References:

- ◆ Brodu, Nicolas. "Reconstruction of epsilon-machines in predictive frameworks and decisional states." *Advances in Complex Systems* 14.05 (2011): 761-794.
- ◆ Crutchfield, James P. "Between order and chaos." *Nature Physics* 8.1 (2012): 17.
- ◆ Jiang, Jonathan H., et al. "Using deep space climate observatory measurements to study the Earth as an exoplanet." *The Astronomical Journal* 156.1 (2018): 26.
- ◆ Sinapayen, Lana, and Takashi Ikegami. "Online fitting of computational cost to environmental complexity: Predictive coding with the  $\epsilon$ -network." *Artificial Life Conference Proceedings* 14. MIT Press, 2017.