Powerful Concepts from Nonstationary Time Series Analysis

David Veitch

University of Toronto Department of Statistical Sciences

May 26 2022

UNIVERSITY OF TORONTO

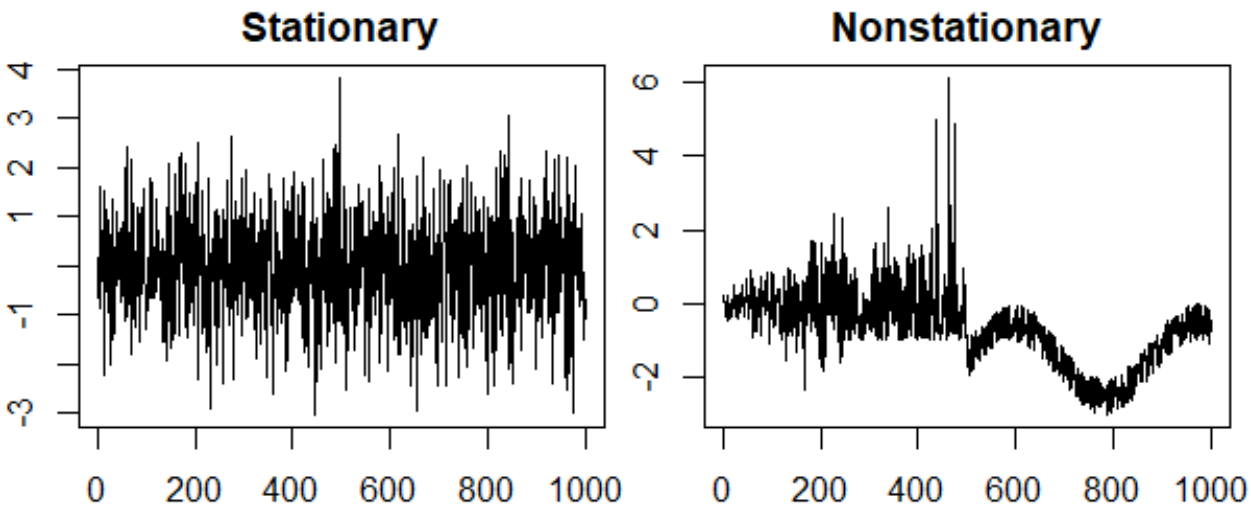
What are Nonstationary Time Series

Time Series: sequence of observations taken over time

(Weakly) Stationary Time Series

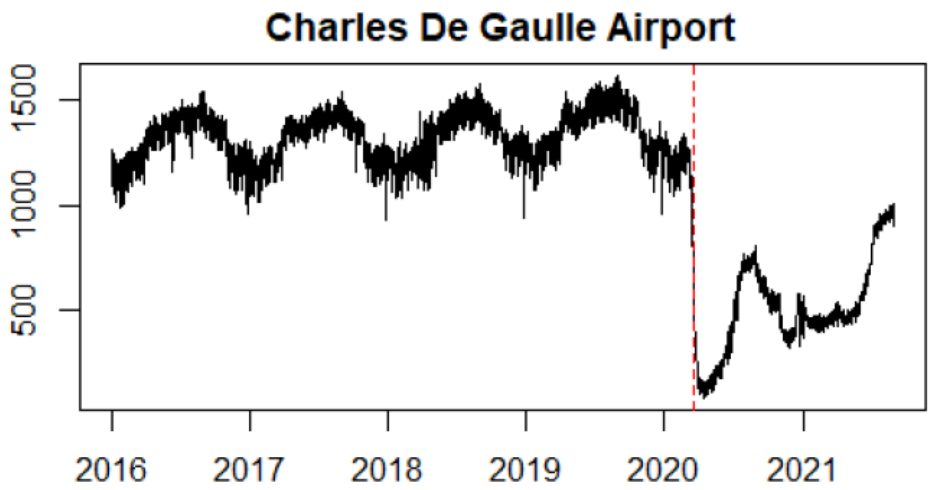
- Constant mean
- Constant autocovariance

Nonstationary Time Series: a time series that is not stationary

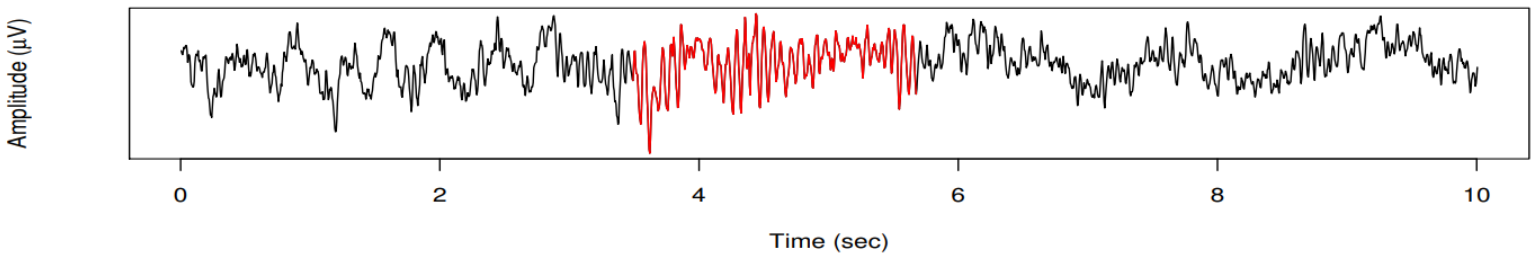


Where are Nonstationary Time Series Found?

Economic Data (e.g. air traffic)



Physiological Data (e.g. sleep EEG [Zhou et al., 2020])



Where are Nonstationary Time Series Found?

Astronomy!

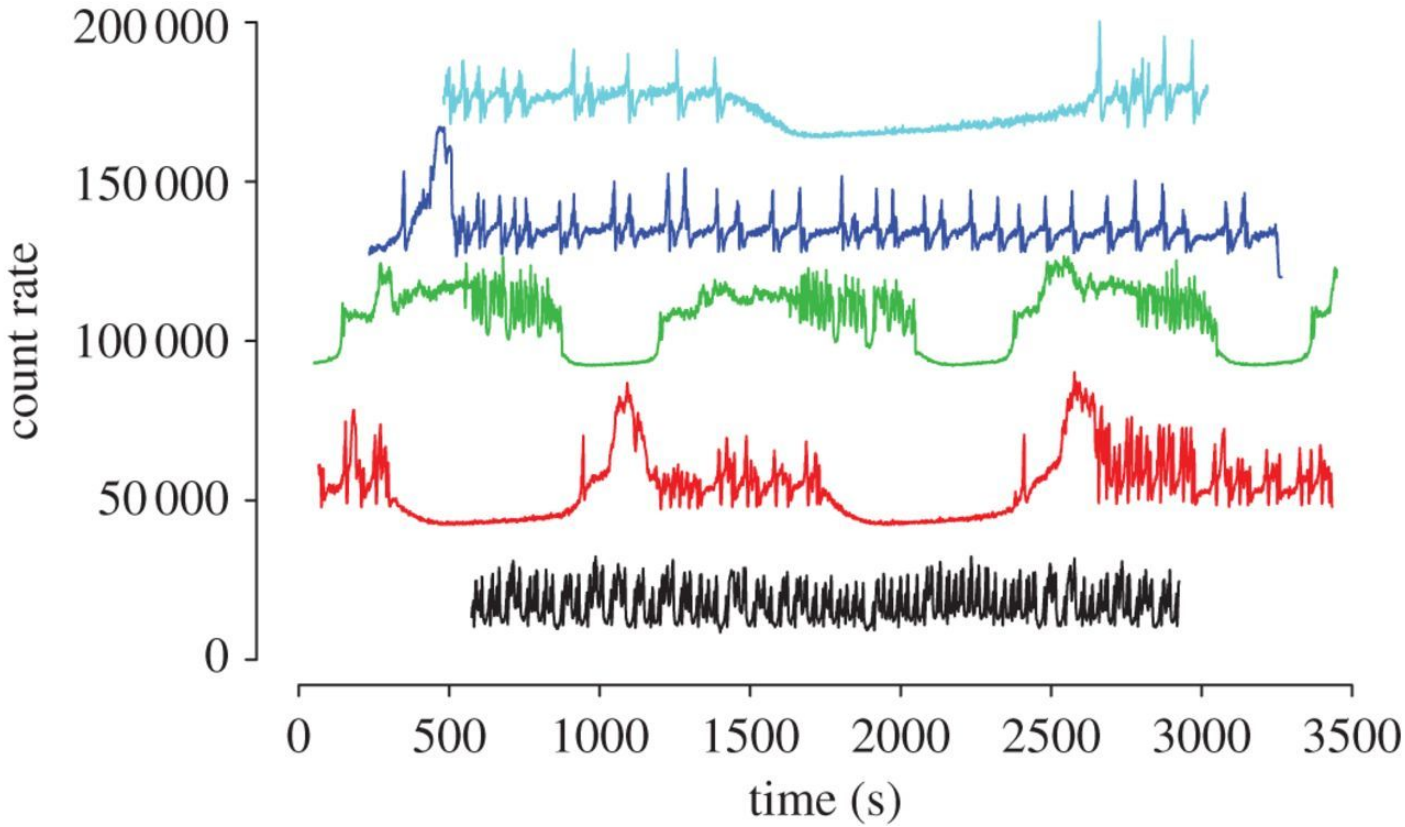


Figure: Example time series of luminous black hole X-ray binary GRS 1915+105. Time series shown are light curves from five different X-ray observations (vertically shifted). [Vaughan, 2013]

Methodology

- Global and/or local tests
- Dependence between tests (no Bonferroni!)
- Utilize max statistics such as $T = \max_{i=1,\ldots,\#\text{ tests}} |\text{TestStat}_i|$

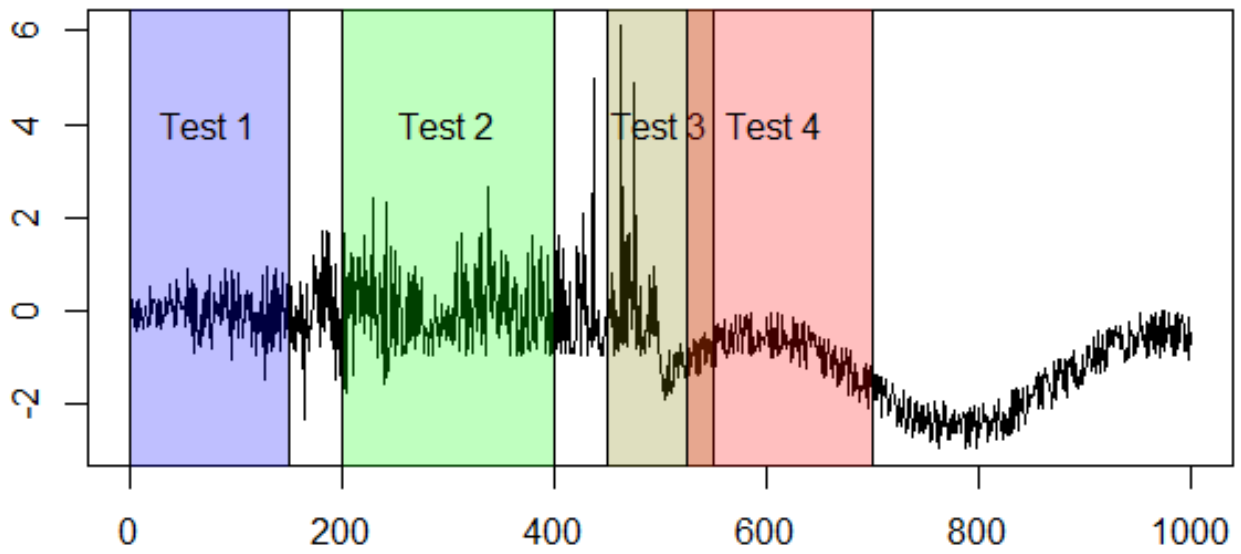


Figure: Example of nonstationary time series testing procedure.

References

Simon Vaughan. Random time series in astronomy. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 371(1984):20110549, 2013. doi: 10.1098/rsta.2011.0549. URL https://royalsocietypublishing.org/doi/abs/10.1098/rsta.2011.0549.

Zhou Zhou, Yang-Guan-Jian Guo, and Hau-Tieng Wu. Frequency detection and change point estimation for time series of complex oscillation, 2020. URL https://arxiv.org/abs/2005.01899.