HOMEWORK 5 - CARMA models

The Astrophysical Journal, 788:33 (18pp), 2014 June 10 doi:10.1088/0004-637X/788/1/33

FLEXIBLE AND SCALABLE METHODS FOR QUANTIFYING STOCHASTIC VARIABILITY IN THE ERA OF MASSIVE TIME-DOMAIN ASTRONOMICAL DATA SETS

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Received 2014 February 24; accepted 2014 April 25; published 2014 May 19

ABSTRACT

We present the use of continuous-time autoregressive moving average (CARMA) models as a method for estimating the variability features of a light curve, and in particular its power spectral density (PSD). CARMA models fully account for irregular sampling and measurement errors, making them valuable for quantifying variability, forecasting and interpolating light curves, and variability-based classification. We show that the PSD of a CARMA model can be expressed as a sum of Lorentzian functions, which makes them extremely flexible and able to model a broad range of PSDs. We present the likelihood function for light curves sampled from CARMA processes, placing them on a statistically rigorous foundation, and we present a Bayesian method to infer the probability distribution of the PSD given the measured light curve. Because calculation of the likelihood function scales linearly with the number of data points, CARMA modeling scales to current and future massive time-domain data sets. We conclude by applying our CARMA modeling approach to light curves for an X-ray binary, two active galactic nuclei, a long-period variable star, and an RR Lyrae star in order to illustrate their use, applicability, and interpretation.

Key word: methods: statistical

Online-only material: color figures

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