

Thilaksha Tharanganie & Rob J. Hyndman, Monash University

Density forecasting using a functional data approach

Abstract

We consider the problem of forecasting a time series of density functions, with an estimated density function at each time period.

A data set comprising many observations is recorded at each time period, and the associated probability density function is to be estimated for each time period. A logspline approach is applied to each data set separately where each estimated density has common knots but different coefficients. These estimated densities form a “functional time series”. We forecast future densities by decomposing the functional time series into orthonormal functional principal components and their uncorrelated principal component scores. Different sets of future densities are forecasted using univariate time series models applied to the scores obtained from various decomposition algorithms: functional principal component analysis, and eight projection pursuit algorithms for robust principal component analysis.

We apply our methods to two simulated data sets (unimodal and bimodal) and four real data sets. The four real data sets comprise UK and Australian income and age data over many years with thousands of observations per year. We evaluate the calibration of our density forecasts using a form of probability integral transforms. Proper scoring rules are then used to evaluate the relative sharpness of the density forecasts. We conclude that two of the projection pursuit algorithms produce relatively good forecast densities.