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## Hyndman & Khandakar, 2008: Overview

- ▶ Cited over 5000 times on Google Scholar
- ▶ Motivation for `auto.arima`: thousands of time series to analyze
- ▶ Practical usage: inexperienced time series users just apply it blindly, and call it the “best” model because it is selected by this algorithm.
- ▶ Python port of `auto.arima`: `pmdarima`

## Exponential smoothing (Sec. 2)

- ▶ A standard method in economic forecasting and business
- ▶ May seem ad-hoc until embedded in a dynamic model, i.e., a state space model (SSM) representation, also known as a partially observed Markov process (POMP) or a hidden Markov model (HMM).
- ▶ Eqs (2,3,4) violate the usual POMP assumption that  $Y_n$  is conditionally independent of all other state and observation variables, given  $X_n$ .

## Initial values (Sec. 2.4)

- ▶ Note that initial values have to be estimated,
- ▶ “Most implementations of exponential smoothing use an ad hoc heuristic scheme to estimate  $x_0$ . However, with modern computers, there is no reason why we cannot estimate  $x_0$  along with  $\theta$ , and the resulting forecasts are often substantially better when we do.”

## Why AIC? (Sec. 2.5)

- ▶ “Obviously, other model selection criteria (such as the BIC) could also be used in a similar manner.”
- ▶ Is there anything special about AIC? Not for consistent model selection.

## When does model-based fitting by AIC beat alternatives?

- ▶ Competition results: “The methodology is particularly good at short term forecasts (up to about 6 periods ahead), and especially for seasonal short-term series (beating all other methods in the competitions for these series)”

## On diffuse priors (Sec. 3.1)

- ▶ Claim that the likelihood is not defined for nonzero differencing parameters,  $d$  and  $D$ .
- ▶ R arima attempts to solve this using so-called diffuse priors (Durbin & Koopman, 2001).
- ▶ HK prefer unit root tests.
- ▶ HK note that differencing may produce poor forecasts, but there's no option for a nonlinear trend with ARMA errors .
- ▶ hypothesis testing for differences is contrary to the justification of AIC for order. Could one use AIC for differences?

## Stepwise selection (Sec. 3.2)

- ▶ Compares AIC to neighboring models, with  $+/- 1$  lags for one or two model components.
- ▶ Reject models close to a unit root or having numerical errors

## Comparing exponential smoothing to ARIMA (Sec. 3.3)

- ▶ The larger class does not always do better, particularly for seasonal models (there are dauntingly many choices for SARIMA).

## Software engineering (Sec. 4)

- ▶ S3 classes
- ▶ Presumably, high usage reflects good engineering
- ▶ Success in competitions can demonstrate strong methodology