STAT 720 sp 2019 Projects

Written part due on Wednesday, April 24th, 2019
Presentations to be made on Wednesday, April 24th and Monday, April 29th, 2019

Project options

Choose from among the following projects (each project can only be chosen by one student):

1. **Moving-blocks bootstrap:** Implement on a real data set and study the performance on simulated data sets of the moving blocks bootstrap. See Künsch (1989) and Lahiri et al. (1999) and the references therein.

2. **Lobato's test of uncorrelatedness:** Implement on a real data set and study the performance on simulated data sets of the test for uncorrelatedness proposed in Lobato (2001).

3. **Spectral-density driven bootstrap:** Implement on a real data set and study the performance on simulated data sets of the spectral-density driven bootstrap proposed by Krampe et al. (2018), under which one estimates the spectral density function with a lag-window estimator and then generates bootstrap samples of the time series from the estimated spectral density.

4. **Time-varying autoregressive model:** Discuss an estimator for the model

$$X_t = \phi(t/n)X_{t-1} + \sigma(t/n)Z_t, \quad \{Z_t, t \in \mathbb{Z}\} \sim \mathrm{IID}(0, 1)$$

   where ϕ, and σ are functions on $[0, 1]$ which we wish to estimate. This model is an $\mathrm{AR}(1)$ model for which the parameters may change over time. Implement and study the performance on simulated data sets of an estimator for the model. See in particular Section 2 of Dahlhaus (2011) as well as Haslbeck et al. (2017), Rao (1970) and Dahlhaus et al. (1999) and the references therein.

5. **Change-point detection:** Implement on a real data set and study the performance on simulated data sets of at least two change-point detection methods. See Zeileis et al. (2003) and the references therein.

6. *Or a project of your own that I have approved.*

Project requirements

The project entails a written component and a presentation to the class.

Written component

All projects must include the following key components.

- An explanation of the methods and the ideas behind them so that the class can understand (1–2 pages).

- A simulation study which evaluates the performance of the method; this could be in terms of the power and maintenance of nominal size of some tests of hypotheses using the method, the coverage of confidence intervals when estimating parameters, or of the mean squared error of estimation achieved by an estimator. Be creative and include some figures and tables (2–3 pages).
- An illustration of one or more methods on one or more real data sets (2–3 pages).

The written part of the project must be typeset using R markdown or LaTex. All R code must be included; if using LaTex, you must put the R code into the document, for example using the `verbatim` environment (you may not just print it on separate paper).

In-class presentation

Each student will give a *20-minute* presentation to the class. Make some nice slides which take the class through the content of your written work. Having 20 minutes will allow you to be fairly detailed. Some use the rule of thumb of one slide per minute; according to this rule you should have around 20 slides.

Guidelines for the presentation:

- You may not put more than 6 lines of text or formulas on any slide (slides become too cluttered if there is too much information).
- Do not read your slides word-for-word to the class. Avoid putting complete sentences in your slides (I almost never put complete sentences in slides). If you put complete sentences, you will be tempted to read your slides word-for-word, and this is very boring to an audience. Also, your audience does not want to read long sentences.
- Use the `beamer` document class in LaTex to make your presentation. There are numerous templates online which you can use.
- Do not write on the chalkboard during your presentation (unless it is to answer an unexpected question). If something is important enough to present, then it belongs in your prepared slides.

References

Dahlhaus, R. (2011). Locally stationary processes. *arXiv preprint arXiv:1109.4174* .

Dahlhaus, R., Neumann, M. H., Von Sachs, R., et al. (1999). Nonlinear wavelet estimation of time-varying autoregressive processes. *Bernoulli* **5,** 873–906.

Haslbeck, J., Bringmann, L. F., and Waldorp, L. J. (2017). How to estimate time-varying vector autoregressive models? a comparison of two methods. *arXiv preprint arXiv:1711.05204* .

Krampe, J., Kreiss, J.-P., and Paparoditis, E. (2018). Estimated wold representation and spectral-density-driven bootstrap for time series. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* **80,** 703–726.

Künsch, H. R. (1989). The jackknife and the bootstrap for general stationary observations. *The annals of Statistics* pages 1217–1241.

Lahiri, S. N. et al. (1999). Theoretical comparisons of block bootstrap methods. *The Annals of Statistics* **27,** 386–404.

Lobato, I. N. (2001). Testing that a dependent process is uncorrelated. *Journal of the American Statistical Association* **96,** 1066–1076.

Rao, T. S. (1970). The fitting of non-stationary time-series models with time-dependent parameters. *Journal of the Royal Statistical Society: Series B (Methodological)* **32,** 312–322.

Zeileis, A., Kleiber, C., Krämer, W., and Hornik, K. (2003). Testing and dating of structural changes in practice. *Computational Statistics & Data Analysis* **44,** 109–123.