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SOFTWARE REVIEW
AUTOBOX AND ITS USE IN DENDROECOLOGY

JULIA RAUCHFUSS

Mid Sweden University, Department of Natural Sciences, Engineering and Mathematics, SE-851 70 Sundsvall, Sweden

Autobox software, developed by Automatic Forecasting Systems, P.O. Box 563, Hatboro, PA 19040, USA, 1-215-675-0652, http://www.autobox.com/, retail prices for interactive version: $800 (Pro), $1,400* (Pro+), $2,400* (Enterprise), $6,000* (Enterprise+) [*20% annual usage fee required]

The software Autobox from Automatic Forecasting Systems (2007) has been developed for economic data with the main purpose being automatic and non-automatic forecasting, *e.g.* what supplies are needed over the coming holiday weekend. The program mainly models time-series with intervention detection to forecast (Reilly 1984). Initially proposed by Box and Tiao (1975), intervention analysis has been used to model both environmental and economic data. It is my impression that Autobox has not been developed for analyzing environmental data. Nevertheless, this program and its forerunners have been used, for example, in dendroecology to reconstruct canopy-disturbance histories (*e.g.* Druckenbrod 2005).

Canopy-disturbance histories have long been reconstructed from tree rings (Henry and Swan 1974; Oliver and Stephens 1977). However, an objective method to differentiate between growth releases, *i.e.* abrupt and sustained increases, and non-releases, in a tree-ring series was not published until 1989 when Lorimer and Frelich (1989) published their seminal paper. Since then, many methods have been suggested and used (Rubino and McCarthy 2004; Rauchfuss, manuscript). Advances in the objective reconstruction of canopy-disturbance histories are, for example, species-specific thresholds when attempting to classify the magnitude of releases (*e.g.* Fraver and White 2005), or the use of programs that were developed by authors of different methods (*e.g.* Black and Abrams 2003, 2004).

Druckenbrod (2005), as the first one to reconstruct unknown disturbances with Freefore (a forerunner of Autobox), concludes that "[t]ime-series analysis offers an alternative approach for identifying prior forest disturbances via tree rings based on statistical methods applicable *across species and disturbance regimes*" (emphasis added). Reconstructing disturbance regimes with one method and without species-specific thresholds (Black and Abrams 2003, 2004; Fraver and White 2005) is very desirable, because it is not always possible to get enough data for a species-specific threshold for certain species (Black and Abrams 2009). Druckenbrod (2005) did not, however, compare his method with other methods of reconstructing disturbance events as was suggested by Fraver and White (2005). Following that suggestion, I compared several methods of reconstructing canopy-disturbance histories, *e.g.* intervention analysis and visual assessment (*i.e.* visually assessing the cores and tree-ring graphs for abrupt and sustained increases in ring width) (Rauchfuss, manuscript).

There are several advantages of intervention analysis and the program Autobox: (1) intervention analysis with Autobox can potentially be used in a variety of forest types and species, (2) autocorrelation is removed using the ARIMA process (Druckenbrod 2005), which has advantages for identifying the correct starting dates of a release, (3) the magnitude of the interventions (releases and suppression periods) is given, which has the benefit of checking how pronounced the releases were, (4) in the program, significance levels can be chosen, which helps identify releases on different levels (*e.g.* conservative *vs.* moderate), and (5) Automatic Forecasting Systems has very good customer service in my personal experience.

Disadvantages of the program Autobox are: (1) ring-width measurements in one series (core) and/or interventions (releases and suppressions) that are detectable might be limited based on the version of Autobox, (2) the analysis of ring-width measurements to reconstruct canopy-disturbances needs to be followed up with the visual detection method to ensure that only 'real' releases are identified as releases, which should be, however, the procedure for every method of reconstructing disturbance histories (Rauch-

fuss, manuscript), (3) to collect all the interventions from the output (with one intervention file per tree-ring series) is somewhat cumbersome (however, customer service is very keen on improving the program for its users and they gladly create an output file that suits the customer), (4) I think that some versions of Autobox may be expensive for reconstructing disturbance histories alone (even though universities get a 20% discount), especially because other programs (*e.g.* Rodionov 2007) are available, which calculate disturbance histories just as well or even better (Rauchfuss, manuscript).

Three different features in Autobox should be considered, which determine the price of the program. First, Automatic Forecasting Systems has several versions of Autobox for purchase and different versions allow for a certain amount of historical data (*i.e.* different length of a tree-ring series) to serve as program input. The cheapest version (Pro) allows for 100 ring-width measurements in one series, which frequently will not be enough as many trees might be older than 100 years. Other versions allow 300, 1,000, and 10,000 ring-width measurements.

Second, intervention analysis is a major component of Autobox, and the number of interventions that can be identified varies among the versions. Autobox Pro and Pro+ can identify five interventions plus one causal variable, which is the ring-width series, per data series. These five interventions include releases as well as suppression periods. In addition, different kinds of interventions are identified, *e.g.* pulse interventions (releases and suppressions that are not sustained) or level interventions (sustained releases and suppression periods). For the purpose of reconstructing canopy-disturbance histories, only sustained releases, *i.e.* level interventions, are of interest. Therefore, Autobox Pro and Pro+ might not have enough intervention spots available to identify all sustained releases and Autobox Enterprise might be necessary.

Third, all four versions of Autobox (Pro, Pro+, Enterprise, Enterprise+) can come as interactive, batch, or combined (interactive and batch) versions. The interactive versions have extra features that the batch versions do not have, *e.g.* Monte-Carlo simulations. The disadvantage of the interactive version is that only one series can be processed at a time. The batch version was developed to analyze several tens to hundreds to thousands of data series without having to manually upload the series.

In conclusion, Autobox might be an exceptional program for automatic and non-automatic forecasting, and it could also be used in dendroecology to reconstruct canopy-disturbance histories. However, Autobox would not be my first choice of programs as other programs can be used to reconstruct canopy-disturbance histories and may be available free, *e.g.* Rodionov's (2007) regime-shift detector.

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