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Software Review: ITSM 2000 Professional Version 6.0.

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ITSM 2000 Professional Version 6.0, developed by Peter J. Brockwell and Richard A. Davis, B&D Enterprises, Inc., Copyright 1999. The Student Version is included in *Introduction to Time Series and Forecasting*, 1996, Springer-Verlag New York Inc. (ISBN: 0387947191). The Professional Version is obtainable from pbrockwell@compuserve.com. Web Page of the author: <http://www.stat.colostate.edu/~pjbrock/>

1. INTRODUCTION AND OVERVIEW

Perhaps the most popular time series textbooks during the past years for graduate students and specialists in statistics, mathematics, econometrics, and other related areas may be the books written by Peter Brockwell and Richard Davis (B&D): *Time Series: Theory and Methods*, 1991, and *Introduction to Time Series and Forecasting*, 1996, published by Springer-Verlag. Many people are familiar with the software designed to accompany these books. *ITSM (Interactive Time Series Modelling)* 6.0 is an interactive Windows based menu-driven software for time series modeling and forecasting. The empirical examples in the B&D books were created using the *ITSM* software. The software is not designed to perform a wide array of estimation and testing procedures relating to multiple regressions. Instead, the *ITSM* software is designed for the user engaged in time series analysis and forecasting that desires an easy to use “cookbook” of estimation and graphics. The software will be useful to practitioners in the private sector, government, and academics. In terms of teaching level, the software is most suitable for students at the advanced undergraduate and graduate levels.¹

The *ITSM* software has evolved from the program PEST and earlier versions *ITSM41* and *ITSM50*. While the earlier versions often crashed, *ITSM 6.0* for Windows runs smoothly under Windows 95, Windows 98, Windows ME or Windows 2000 Professional NT. The new version has a variety of menus that permit easy execution of data processing, graphical display, estimation, and diagnostic testing for univariate and multivariate time series models in the time and frequency domains. Perhaps the most important feature of *ITSM*, compared to other software, is the provision of easy to use estimation and forecasting tools for spectral analysis. The software provides easy to use graphic output of the periodogram, smoothed periodogram, cross-spectrum, and cumulative spectrum. In particular, the dynamic graphics allow the user to instantly see the effect of data transformations and model changes on a wide variety of features such as the sample, residual, and model autocorrelation functions and spectra.

2. STATISTICAL AND ECONOMETRICS CAPABILITIES

ITSM is an integrated package containing eight different modules previously developed in the DOS environment. Compared to previous versions, all modules are now contained in one package. The modules include:

PEST (basic program for identifying and estimating ARMA models)

SPEC (spectral estimation)

SMOOTH (smoothing techniques used in the time and frequency domain)

TRANS (cross-correlation and transfer function analysis)

ARVEC (estimating vector autoregressive models with Yule-Walker equations)

BURG (estimating vector autoregressive models with Burg's algorithm)

ARAR (ARARMA forecasting methodology of Newton and Parzen)

LONGMEM (estimating and forecasting fractionally integrated ARMA models)

2.1. Estimation of ARMA models and diagnostic checks

ITSM is primarily suited for estimating ARMA models. Once the data has been examined, an ARMA model can be specified. It is often desirable, however, to first transform the time series by differencing, or other means, to achieve stationarity. This can easily be performed from menu-driven commands. A Box-Cox transformation using suitable values of the transformation parameters can be selected to correct for non-linearity. Various transformations are provided to eliminate trend and seasonal components. To identify the ARMA model, a variety of preliminary analyses can be easily performed, such as examining the autocorrelation and partial autocorrelation function and the sample and smoothed spectrum. After estimating the model, a variety of diagnostic checks can be performed on the residuals. These functions can be initiated from menus or by clicking on small icons. In addition, *ITSM* easily calculates Fisher's cumulative periodogram goodness-of-fit statistic and the associated p -value to test the null hypothesis that the original series, or residuals from the estimated model, is Gaussian white noise. The ARMA model is estimated by either least squares or maximum likelihood.

2.2. Filtering and smoothing

ITSM offers moving average smoothing, exponential smoothing, and spectral smoothing methods. For the first two methods, *ITSM* provides only one simple technique with one parameter for each. It does not provide options that include more than one parameter or other smoothing or filtering methods, such as X-11 and Hodrick-Prescott. However, *ITSM* does provide spectral smoothing, which can be employed to remove high frequency components in the frequency domain. This feature is not normally found in other software.

2.3. Long memory models

One salient noteworthy feature of *ITSM* is the simulation, estimation, and prediction by long-memory models included in the class of fractionally integrated processes known as ARFIMA processes. For a given ARIFIMA(p, d, q) model specification, *ITSM* produces the maximum likelihood estimate of the parameter d , which takes the whole value $-0.5 \leq d \leq 0.5$, along with other coefficient estimates. More precise estimates can be obtained by varying the step-size in the optimization procedure. The AIC statistic is provided for model specification. After estimating the fractionally integrated model, various diagnostic checks can be performed on the residuals, in the same manner as when estimating ARMA models.

2.4. Forecasting

As expected, the *ITSM* software permits easy execution of ARMA forecasting. By selecting options from the Forecast menu, *ITSM* can easily provide out of sample forecasts along with prediction bounds at a pre-specified confidence level. In calculating the forecast, *ITSM* performs inverse transformations that take into account all previous smoothing, including differencing and fractional integration, Box-Cox transformation, and estimated trend and seasonal components. *ITSM* additionally offers other forecasting methods such as ARAR based on the ARARMA algorithm of Parzen and Newton, Holt-Winters, and seasonal Holt-Winters.

2.5. Estimation and analysis of multivariate autoregressive models

ITSM provides extensive tools for estimating and testing multivariate autoregressive models. *ITSM* provides the option of using either the Burg algorithm or Yule-Walker equations for estimating a stationary multivariate VAR(p) model of any order up to $p=20$ in a m -variate series ($m < 6$). The program has a built-in option to automatically choose the value of p by minimizing the AIC statistic. Forecasting and simulation using the fitted model can then be carried out. For preliminary and diagnostic procedures, *ITSM* allows examination of the cross-correlation and cross-spectrum using both numbers and graphics. In analyzing the cross-spectrum, *ITSM* produces an array of graphics showing the phase spectrum and estimates of the squared coherency.

2.6. Transfer function modeling and intervention analysis

ITSM provides easy estimation tools for transfer function analysis. Given two input and output time series, the software allows us to obtain estimates of transfer coefficients and plots of sample cross correlations. One may check on the model specification by plotting residuals and their ACFs. The software also permits forecasting from the estimated transfer function model. When the input series is captured as a deterministic process, the intervention analysis model of Box and Tiao (1975) can be easily performed. As with transfer function analysis, estimation and diagnostic procedures for intervention analysis are undertaken by selecting options from a menu.

2.7. Other features

ITSM allows investigating properties of a pure ARMA model without having to analyze the data. Once parameter values are specified, *ITSM* can check if the specified model is causal and invertible, calculate AR and MA coefficients in their infinite representations, and simulate data from the specified model. In addition, all graphs and data can be conveniently copied onto a clipboard and pasted into other Windows applications.

A new feature of *ITSM* is the ability to perform maximum Gaussian likelihood regression with ARMA or FARIMA errors. The regressors can be polynomials, sine waves or data stored in a file. We have learned from the author that the forthcoming *ITSM2000, Version 7.0*, includes ARCH and GARCH modeling and an AUTOFIT feature which fits maximum likelihood ARMA(p, q) models for specified ranges of p and q and selects the model with smallest AIC value.

3. BERK'S CRITERIA

Berk (1987) suggests a number of criteria for any software review. We briefly examine each of these below.

- *Documentation*: contrary to earlier versions of the *ITSM* software, version 6.0 does not (yet) have a manual to accompany. However, the Help menu provides extensive information, including many examples showing application windows and graphics. Included throughout the Help topics are references to the Brockwell and Davis textbooks with appropriate page numbers.
- *Language*: the language throughout the Help menu is user-friendly.
- *Installation*: the software is easy to install. Once all files are decompressed and copied into a directory, the software is ready to use. The CD-ROM version of the software can also be run directly from the CD-ROM.
- *Data handling and manipulation*: Upon opening, one is first asked to create a project. Any ASCII data file can be easily imported as the new project. The project is saved as a file having the suffix.TSM. All TSM files are in the ASCII format. Unlike most new software, *ITSM* does not provide a spreadsheet-type window to add or revise the data. However, the Export button allows data, residuals, spectra, autocorrelations, etc. to be copied to the Clipboard and pasted into an Excel spreadsheet for easy manipulation. Editing can also be performed with a text editor such as Notepad.² When an ASCII data file is imported or an existing project is opened, *ITSM* immediately provides a plot of the time series in one window and descriptive statistics with default white noise model in another. *ITSM* can handle up to 10 projects with no limitation on the series length.³
- *Graphics*: the graphics are user-friendly and dynamic and can be easily imported to the clipboard and pasted into other Windows applications. Fig. 1 provides an example of the graphics.

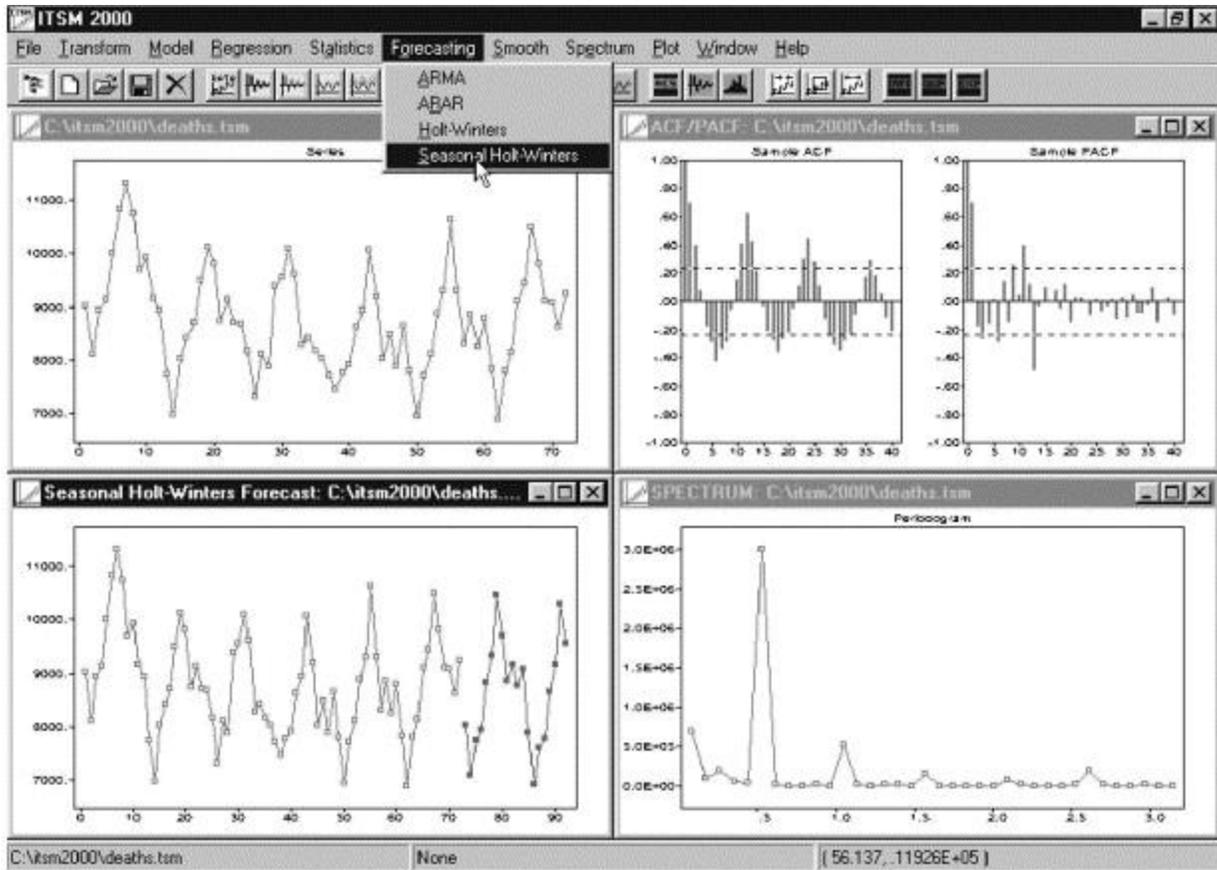


Fig. 1. Sample of Graphics

- *Procedures*: as noted above, the software has many useful procedures for estimation and forecasting of ARMA type models. Some of these procedures are automated. The random number generator is not documented, so we cannot comment on the algorithm.
- *Output*: output can be easily printed or saved to file or clipboard. Test statistics are accompanied by appropriate p -values.
- *Customizing*: the software does not allow customizing of the icons or menus.
- *Support*: we do not know if telephone and/or email support is available from the software providers.
- *Overview*: the software is most appropriate to accompany the Brockwell and Davis textbooks (and similar books). Specialists engaged in time series analysis and/or forecasting should also find the software advantageous.

4. Conclusion

Overall, the *ITSM* software version 6.0 can be described as a user-friendly and well-designed package to accompany the Brockwell and Davis textbooks (and similar books). The software will additionally be of interest to those engaged in time series analysis and forecasting. The many menu-driven features make examining, estimating, and analyzing various ARMA type models quick and easy. Once a model is selected, forecasting can be performed quickly from the menus. Nice graphics can be easily created throughout. The addition of easy to use features for spectral analysis is an especially attractive feature of this software. While the *ITSM* software provides exceptional user-friendly tools for time series analysis and forecasting, some advanced users may find the software in the cookbook realm.

REFERENCES

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NOTES

1. This is based on experience by the first author using earlier versions to accompany the Brockwell and Davis textbooks while teaching graduate courses in Time Series Econometrics at Vanderbilt University and University of Central Florida.
2. Once saved, editing the project file in TSM format must be done with great care so as not to introduce inconsistencies in the saved project since saved projects contain coded model information as well as the data. This makes it difficult to revise or extend the data in the TSM file. It appears that updating the data file with a text editor program and importing it into a new project file is much easier. Further, *ITSM* can read any ASCII file having other suffixes, such as TXT or PRN, as TSM files. In this regard, there is no merit in saving the project file with a TSM suffix except to distinguish files which may contain model as well as data information.
3. We tried time series having 100,000 observations in length and had no problem. We were unable to open a series having 1,000,000 observations in length, but this may be due to our own computer hardware limitations.