

WORKSHOP

Bayesian Regression Analysis Using WINBUGS



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Summary

Use of Bayesian methods is becoming increasingly widespread in many areas of research for analysing data with complex structure – for example, hierarchical data, spatial and temporal dependence, measurement error and so on. However, very few data analysts have any formal training in Bayesian methods. This five-day seminar aims to introduce quantitative researchers to the basic principles of Bayesian inference and simulation-based methods for estimating Bayesian models, to highlight some of the potential benefits that a Bayesian approach can offer and then to focus specifically on Bayesian methods for regression analysis and modelling of data, and how to implement these methods using the most popular WinBUGS software. There is a large practical component to this seminar with time for hands-on data analysis using a variety of examples from many different areas. By the end of the seminar participants will be able to understand the philosophy of Bayesian statistical modeling and Bayesian models for numerous common data analysis situations, including prior elicitation, to apply Markov Chain Monte Carlo techniques (MCMC) to Bayesian statistical modeling using WinBUGS software and to understand basic principles of both conjugate analyses and MCMC-based Bayesian analyses. Participants will also learn how to implement linear regression (normal and t errors), poisson and loglinear regression, and binary/binomial regression and to estimate parameters of regression models using WinBUGS.

Aim

Our first objective is for the participants to experience first-hand how a Bayesian approach to data analysis can improve inference and increase understanding. Our second objective is for you to obtain practical experience with WinBUGS, an easy-to-use computer program that allows the user to implement all kinds of Bayesian regression models.

Target Audience

Statisticians, data analysts and quantitative researchers, working in any application area, who are interested in finding out what Bayesian methods are all about, and how to implement some simple Bayesian regression models using the WinBUGS software. The seminar would also be of interest to researchers with experience of multiple regression modelling using likelihood-based methods who wish to find out more about fitting and interpreting Bayesian versions of multiple regression models. No previous experience of Bayesian methods or WinBUGS is necessary, although familiarity with standard statistical terminology and a good grasp of the basic principles of standard (maximum likelihood-based) linear and generalised linear regression models will be assumed. Participants will also be expected to be familiar with some common probability distributions (normal, binomial, Poisson). All participants will be required to use their own laptop. If you do not have a laptop we can always pair you up with someone that does. If you can bring your own laptop, it would save time if you could download and install WinBUGS version 1.4.3 software beforehand, which can be downloaded from the WinBUGS website:

<http://www.mrc-bsu.cam.ac.uk/software/bugs/the-bugs-project-winbugs/>

which also contains instructions for installation. You will need to download and install the main WinBUGS 1.4 package, and then the patch to upgrade this to 1.4.3 and the key file to allow unrestricted use. Participants will receive written seminar notes and WINBUGS example codes.

WINBUGS Programı ile Bayesian Regression Analysis Workshop Program

Sunday October 6

- 09:00 - 11:00** : Introduction to Bayesian methodology
Comparison of Bayesian approach with frequentist approach
Bayes' theorem; The likelihood, The nature of priors; The posterior distribution.
Priors (conjugate, noninformative, vague, reference)
Conjugate Bayesian inference for binary, count and continuous data
Introduction to Monte Carlo simulation methods and MCMC
- 11:00- 12:00** : Introduction to WinBUGS: Model syntax, compiling the model, initial values, updating, monitoring. WinBUGS data inputs, convergence checks, obtaining summaries
Conjugate Priors and Conjugate Derivation Example (Beta/Binomial and Gamma/Poisson), Normal Model (mean unknown, variance known)
Conjugate analysis of binary, Poisson and Normal data using WinBUGS
- 13:00 - 14:00** : Bayesian Inference for Simple Linear Regression Models
Robust Bayesian methods
Multivariate regression methods
Bayesian linear regression modelling using WinBUGS
- 14:00- 15:00** : Logistic regression for binary and binomial responses; using other links
Poisson regression
Log linear models for contingency tables
- 15:00 - 16:00** : Introduction to Bayesian hierarchical models for count and continuous data
Bayesian methods for repeated measures (time permitting)

Computers

All workshop participants should bring their own laptop with WinBUGS pre-installed and ready to be used. Internet access will be available in the seminar venue.

INSTALLATION

Although we will be running through how to obtain and install the WINBUGS software during the workshop, it would be very useful if participants could try and install the software before the day.

Installing WinBUGS in Windows

(from the WinBUGS website:

<http://www.mrc-bsu.cam.ac.uk/software/bugs/the-bugs-project-winbugs/>)

Quick start

- Download and install WinBUGS14.exe
- If installing on a 64-bit machine, or if the installer doesn't work for any other reason, you should download a zipped version of the whole file structure and unzip it into Program Files or wherever you want it. This includes the key for unrestricted use.
- Download and install the patch for 1.4.3
- Get the free key for unrestricted use by clicking [here](#) - this can be used for multiple installations.
- See the main BUGS page for a summary of the different versions of BUGS available.

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- [What else is available?](#)

Introduction to WinBUGS

WinBUGS is part of the BUGS project, which aims to make practical MCMC methods available to applied statisticians. See the main BUGS page for a summary of the different versions of BUGS available.

WinBUGS can use either a standard 'point-and-click' windows interface for controlling the analysis, or can construct the model using a graphical interface called DoodleBUGS. WinBUGS is a stand-

alone program, although it can be called from other software. For a version that BUGS (BRugs) that sits within the R statistical package, see the [OpenBUGS site](#).

In the past, we have required that users register with us to obtain unrestricted use, in particular to give us some idea of the intended use of the program. This information has provided valuable feedback to ourselves and our funders. However, we no longer require users to register and the key for unrestricted use (of WinBUGS 1.4.x) can be downloaded from [here](#).

Watch [WinBUGS - The Movie!](#) for a short Flash illustration of the basic steps of running WinBUGS. (This movie features WinBUGS 1.3 - when you've watched it you will understand why WinBUGS 1.4 includes scripts to avoid all the clicking and pointing!).

All the documentation specific to WinBUGS is available on-line and is packaged with the program.

Pdf versions of both the [WinBUGS 1.4 manual](#) (which DOES NOT include features in the 1.4.3 patch) and the [GeoBUGS manual](#) (which DOES feature the 1.4.3 patch) can now be downloaded, as can PDF versions of [Volume 1](#), [Volume 2](#), and [Volume 3](#) of the examples.

Obtaining the File(s)

Please read the [LICENCE AGREEMENT](#) for WinBUGS, before downloading anything.

The files you need are [WinBUGS14.exe](#) (selecting the link will yield a dialog box inviting you to save the file onto your system) and the [key for unrestricted use](#), which is free.

[WinBUGS 1.1](#) and [WinBUGS 1.2](#) are still available for those with historical interests. [WinBUGS 1.3](#) and its [key](#) are also available and may still be useful if problems are obtained with WinBUGS 1.4 and for running PKBUGS Version 1 (see below).

Installing WinBUGS 1.4 in Windows

For installation, run the file WinBUGS14.exe. One way to do this is as follows:

1. Exit all other programs currently running (particularly if using Windows XP)
2. Copy WinBUGS14.exe to your computer
3. Go into Explore and double click on WinBUGS14.exe
4. Follow the instructions in the dialog box
5. You should have a new directory called WinBUGS14 within Program Files
6. Inside the WinBUGS14 directory is a program called WinBUGS14.exe
7. Right-click on the pretty WinBUGS icon, select 'create shortcut', then drag this shortcut to the desktop.
8. Double click on WinBUGS14.exe to run WinBUGS14.

If you have problems after installation, check again that you did not have programs running. You could also try disabling any virus checker.

Note: There appears to be a problem with installing WinBUGS and/or various patches in Windows Vista. Vista doesn't seem to like anyone overwriting files in the "C:\Program Files" directory (regardless of permissions). Hence we recommend that WinBUGS be installed elsewhere, e.g. "C:\".

If all else fails (for example with a 64-bit machine), you can download a [zipped version of the whole file structure](#) and unzip it into Program Files or wherever you want it. WinBUGS makes no changes to the Registry.

Obtaining the key for unrestricted use

WinBUGS is free, but has absorbed a lot of time and grant money over the last two decades. We have tried to keep our employers happy with our time spent on the project by keeping track of how many people are downloading it and where they come from. It has also been very helpful to have an idea of what it is being used for. This information has, in the past, been collected via a registration process whereby users enter their details and a key for unrestricted use of the software has been sent to them via email (free of charge). However, as development shifts more and more towards [OpenBUGS](#), we have decided that it is time to do away with this registration process and simply allow direct access to the key (which will no longer expire at the end of each year)...

Please click [here](#) to download the key for unrestricted use. After following the instructions given in the key, check that the **Keys.ocf** file in `..\WinBUGS14\Bugs\Code\` has been updated. (Some people have found they need to re-boot the machine to complete installation of the key.)

Upgrade to version 1.4.3

A free patch for upgrading to version 1.4.3 is now available. Click [here](#) to obtain a full description and the patch file.

Some problems reported in WinBUGS 1.4

Some models that run in 1.3 are running slowly or not at all. Please let us have examples. This may be due to the change in the update order to graphical order, which has sorted out problems with forward sampling, but has introduced some new difficulties. We shall probably need to make adjustments to the adaptive slice sampler. (If your Trap message complains of problems with DFreeARS (Distribution-free adaptive rejection sampling), you could try changing to slice sampling for log-concave distributions - see manual for instructions.)

Etienne Rivot has pointed out that after a Trap, you can 'Save States' (model Menu), then reinitialise the model with these states. There may then, with luck, be a helpful proper error message!

Additions/corrections to WinBUGS 1.4 manual

- **Model specification/Formatting of data:** When importing matrix data from Splus version 6 or above using the ``dput'` command, you will need to replace Splus's ``nrow'` and ``ncol'` by a ``.Dim'` statement. The ordering of the dimensions remains as in the manual. The procedure for arrays remains as in the manual, except that Splus's inverted commas and ``.Dimnames'` statement should be removed.
- **An ``inprod2'` function** has been added in 1.4.3 - use this instead of ``inprod'` to speed up runs.

Instructor



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Mehmet Ziya FIRAT currently holds an appointment in the Department of Animal Science, Faculty of Agriculture at Akdeniz University and has been teaching various statistical courses including Bayesian Data Analysis, Experimental Design, Nonlinear Models, Applied Multivariate Analysis and Linear Models to graduate and post-graduate students for 16 years. His courses have evolved over time; during the last ten years it has emphasized likelihood-based and Bayesian methods for model-data assimilation. He has also taught short courses. He delivered two well-attended workshops on Bayesian Methods using WINBUGS in 2014 and 2016. With a formal background in both animal science (BS) and statistics (MSc and PhD), he has a unique perspective on statistical pedagogy, having taught for many different audiences from different home departments himself (i.e., Econometrics, Agriculture, Business Administration, etc.).