Health Economics at UCL

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UCL Health Economics Network Event
University College London
London, 18 November 2016
Who are we?

http://www.ucl.ac.uk/statistics/research/statistics-health-economics/

Statistics for Health Economic Evaluation

Group profile
The Statistics for Health Economic Evaluation Group, led by Dr Gianluca Baio, is a research group based in the Department of Statistical Science. Our activity revolves around the development and application of Bayesian statistical methodology for health economic evaluation, e.g. cost-effectiveness or cost-utility analysis.

We work in close collaboration with academics both within UCL and at other institutions, including MRC Biostatistics Unit Cambridge, University of Sheffield and University of Rome, as well as with partners in the private sector. We have received a five-year research grant from Mapa, a consultancy company working in the area of economic evaluation. This creates exciting opportunities to develop new methodologies for problems that are relevant to real, practical applications.

Our activities include a series of seminars aimed at statisticians, health economists and clinicians working in health economic evaluations. We also aim at seeking potential areas of commonality with other research groups within the department of Statistical Science and statisticians in general.
Who are we?

- 5 members of staff — working across a wide range of methodology and application areas
  - Bayesian modelling
  - Biostatistics
  - Functional analysis
  - General statistical methodology

- 10 PhD students/postdoctoral researchers

- “Affiliates”
  - Co-supervisors (mainly within UCL)
  - Public sector (eg NICE or other institutions)
  - Private sector (eg consultancy companies)
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• A few sources of funding
  – Industry (research grant funded by Mapi + studentship from Bresmed & support from Amaris)
  – RCs (through PhD studentships + research grants)
  – Teaching (eg training events)
A wide range of research projects
(mainly concerned with HTA/cost-effectiveness and based on Bayesian approach)

- **Expected value of information** (Anna Heath + Ioanna Manolopoulou)
- **Single arm trials** (Anthony Hatswell + Nick Freemantle)
- **Missing data in cost-effectiveness analysis** (Andrea Gabrio + Rachael Hunter & Alexina Mason)
- **Epidemiology & economic burden of PCOS** (Christina Tao + Irene Petersen & Paul Hardiman)
- **Assessing uncertainty in utility scores** (Spyros Poulimenos + Jeff Round)
- **Economic evaluation of Human Papilloma Virus vaccination** (Katrin Haeussler + Ardo van den Hout)
- **Network meta-analysis in longitudinal studies** (Andreas Karabis + Maria De Iorio + Marta Tallarita)
- **Regression discontinuity design in epidemiology** (Federico Ricciardi + Aidan O’Keeffe & others)
- **R tools for health economic evaluation** (mainly GB harassing people to do these...)

http://www.ucl.ac.uk/statistics/research/statistics-health-economics/current-projects
Some ongoing projects...
- Economic evaluation of Cochlear implant strategies in the UK (UCL Brain Sciences)
- Issues with survival analysis in cost-effectiveness modelling (Mapi)
- ...
Collaborations (present & future?)

- Some ongoing projects...
  - Economic evaluation of Cochlear implant strategies in the UK (UCL Brain Sciences)
  - Issues with survival analysis in cost-effectiveness modelling (Mapi)
  - ... 

- Possible areas of collaboration?
  - Methodological support in modelling (eg for RCT data with HE component)
  - Statistical methodology for causal inference from observational data
  - Computational issues (eg EVPPI/EVSI; standardising output of cost-effectiveness analysis; etc)
BCEAweb provides a web interface to the R package BCEA, designed to post-process the results of a statistical model and standardize health economic evaluations, as described in the following graph.

First, a statistical model is constructed and fitted to estimate relevant population parameters (the red rounded box). These are then fed to an economic model (the grey box), which combines them to obtain suitable summaries that quantify the incremental population average for clinical benefits (e.g. QALYs) and costs (e.g. £). These are the fundamental quantities used to make the decision analysis (orange box). And this is the process that BCEA and BCEAweb can perform, by producing standardised output to aid in the assessment of the economic evaluation. In addition, provided suitable data are provided by the user, BCEAweb can also perform Probabilistic Sensitivity Analysis i.e. the process of analysing the impact of (parameter or model) uncertainty on the results of the decision analysis (the olive box).

BCEAweb assumes that the results of the statistical model are available in the form of a large number of simulations for all the relevant model parameters. These can be stored and uploaded by the user using three different formats:

1. A spreadsheet, in .csv format, e.g. a file produced by MS Excel. Download an example here;
2. Files in 'coda' format. These are typically saved as the results of running MCMC software such as OpenBUGS. Coda produces an 'index' file and one output file for each Markov Chain used in the analysis. Download a .zip file with an example here.
3. A .rds file containing a data frame with the simulated values for the quantities of interest. This is created directly from R. Download an example here.

The parameters simulations are uploaded at the 'check assumptions' tab. Once the simulations are uploaded, BCEAweb will produce graphical summaries and tables so that the user can assess whether the results are consistent with the assumptions or, in the case of a full Bayesian analysis, analysis convergence of the MCMC process through suitable diagnostics. BCEAweb assumes that the user has saved simulations for the measures of effectiveness and costs for each of the interventions being assessed in a .csv file. The order of the variables in this file needs to be like in the following picture (e.g. effectiveness and costs for each intervention, in sequence).
R applications/packages:
https://egon.stats.ucl.ac.uk/projects

bmeta is a web application for the R package bmeta, designed to use Bayesian meta-analytic methods for evidence synthesis.

Meta-analysis is a commonly used statistical approach for evidence synthesis by integrating results from independent studies and is considered to play a fundamental role in evidence-based medicine. Most applied implementations of meta-analysis are conducted under the fixed-effects paradigm. However, it is often the case that using a Bayesian approach can be beneficial in the context of meta-analysis. The main advantage is that Bayesian methods allow for a formal representation of prior belief in the model and uncertainties related to both parameters and model can be better accounted for. The bmeta is easy and straightforward to use. First, users need to specify a Bayesian meta-analytic model to fit the observed data. The types of outcomes for selection include binary, continuous and count and then, users need to decide whether to use a meta-analysis or a meta-regression accounting for moderator effects and specify the type of models (i.e. fixed- or random-effects model) to be performed. Finally, users can select the prior to be included in the model designed for a specific type of outcome. These are the pre-steps required by bmeta before automatically performing the analysis and producing standardised output based on the Bayesian meta-analytic methods. In addition, bmeta can also save the model template selected by the user. These templates can be modified easily to fit other scenarios or saved for future reference.

bmeta assumes that the studies included only have two arms comparing a single intervention and users must provide essential information of the two arms for comparison. For example, for the binary data, users must provide the sample size of both case and control arm and the events observed in the two arms. If meta-regression models are selected, users need to pay special attention to the format of covariates which are categorical and this includes specifying a binary category and stratifying each of the rest categories into dummy variables. For example, if different studies report using population of distinct ethnic groups—White, Black, Asian. Then users need to select a baseline group, suppose we use Asian here, and then for White and Black, dummy variables need to be created to indicate whether the study used a certain ethnic group or not. Therefore, in this case, in this meta-regression model, two covariates need to be used, each representing the incremental effects of ethnicity in comparison to the baseline group (Asian). These observed data need to be formatted properly and uploaded by the user in MS Excel format: a spreadsheet in .csv format, e.g., a file produced by MS Excel. Download an example here.

The observed data are uploaded at the ‘Load data and model selection’ tab. Once the user specifies a desired model and uploads the spreadsheet, the analysis will be automatically run. bmeta assumes that the user has saved all the observed data in an appropriate manner for each of the studies being assessed in a .csv file. The variables in this file need to be like in the following pictures. The first picture presents the spreadsheet template for binary data (i.e. y1 and y0: number of events in case and control arm; n1 and n0: total sample size of case and control arm). The next two pictures show the template for continuous data as it is assumed that there are two types of studies. The first type of study provides detailed information of both case and control arm (i.e. y1 and y0: mean of the case and control arm; s1 and s0: standard error of case and control arm) whereas the second-type study only report mean difference between the two arm (y) and the variance (var). Notice that the variance is computed as the sum of variances of the two arms. The last graph illustrates the template for count data (y1 and y0: total number of events in the follow-up period for case and control arm; p1 and p0: total follow-up person years—computed as the total number of patients times the total number of follow-up time). It should also be noted that users need to save the covariates (i.e. X1, X2,...,X) starting from the 7th column except for the second type of continuous data (studies reporting mean difference between the two arms and the variance) where covariates start from the 5th column. The study characteristics such as author name and year of publication need to be named as ‘study’ and ‘year’ (notice the first letter of these variable names is not capital).
BCEA: An R package to perform Bayesian Cost-Effectiveness Analysis

BCEA is a library specifically designed to post-process the result of a Bayesian health economic evaluation. Typically, this consists in the estimation of a set of relevant parameters that can be combined to produce an estimation of suitable measures of cost (c) and clinical benefits (e) associated with an intervention. Within the Bayesian framework, this amounts to estimating a posterior distribution for the pair (e,c).

Health economic evaluations then proceed by computing some relevant summaries of the resulting decision process: is the innovative intervention $e_1$ more “cost-effective” than the standard intervention $e_2$? BCEA provides a set of functions that can be used to produce a standardised analysis. The package has been created to complement my [book](http://www.statistica.it/gianluca/BCEA) on Bayesian methods in health economics where it features heavily (some discussion of the package in blog can be found [here](http://www.statistica.it/gianluca/BCEA), [here](http://www.statistica.it/gianluca/BCEA), [here](http://www.statistica.it/gianluca/BCEA) and [here](http://www.statistica.it/gianluca/BCEA)). A discussion of the changes in release 2.0 is [here](http://www.statistica.it/gianluca/BCEA).

A stable version 2.2-4 is now available on CRAN; a beta release 2.2-5 (including some features under testing) can be downloaded [here](http://www.statistica.it/gianluca/BCEA).

BCEA produces a synthesis of the decision process given the current evidence and uncertainty, as well as several indicators that can be used to perform Probabilistic Sensitivity Analysis to parameter and model uncertainty. These include the Cost-Effectiveness Acceptability Curve and the analysis of the Expected Value of Information, that can be used to prioritize research. Examples of the output of the function are given below:

```r
> library(BCEA)
> data(fictitious)
> i <- c("Standard care","Vaccination")
> m <- bcea(e,f,i,ref=2,interventions=i)
> summary(m)

Cost-effectiveness analysis summary
Reference intervention: Vaccination
Comparator intervention: Standard care

Optimal decision: choose Standard care for k=20000 and Vaccination for k=26000

Analysis for willingness to pay parameter k=25000

<table>
<thead>
<tr>
<th>Expected utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard care</td>
</tr>
<tr>
<td>Vaccination</td>
</tr>
</tbody>
</table>

BCEA is now available from CRAN - to install type `install.packages("BCEA")` in your R terminal! Follow this space - more examples & tutorials coming! The development version is available for download from

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Teaching/training

- We are actively involved in the set up of UCL new MSc in Health Economics and Decision Science
  - GB is a co-director, together with Jolene Skordis-Worrall & Marcos Vera Hernandez
  - We will contribute to the syllabus with a few core modules, including Medical Statistics and Bayesian Methods in Health Economics
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- We also organise short courses/summer schools
  - Bayesian Methods in Health Economics + Statistical Methods for Value of Information Analysis (merged into a summer school in Florence in June 2017: http://www.statistica.it/gianluca/bayes-hecours)
  - Workshop “Infectious Disease Modelling in Public Health Policy: Current status and challenges”
  - Workshop “NICE and the cost-effectiveness thresholds: Can good intentions compensate for bad practice?”
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- We also run a regular-ish series of seminars
  - http://www.ucl.ac.uk/statistics/research/statistics-health-economics/seminars


Thank you!