Stata goes BUGS (via R)

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press "ctrl + l" to start presentation

Problem 1

Problem

You are a Stata user . . .

- and have a complicated likelihood function hard (or impossible) to maximize, or . . .
- have not enough number of observations for a large amount of parameters to estimate.

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One possible solution

- You forget the maximization (at a moment or forever) and take the Bayesian methods.

Bayesian Methods

Another philosophy

- observed data: fixed; unknown parameters: random
- MCMC (Markov Chain Monte Carlo) provides estimated distribution of interested parameters.

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Some practical advantages

- Fitting a wider range of models
  - Modelling latent variables
  - Estimation of hierarchical models
- Analyzing a wider range of data
  - Analyzing small samples
  - Treating missing data properly
- Systematic incorporation of your prior knowledge
- Intuitive interpretation of results

Problem 2

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Solution?

BUGS: Bayesian updating using Gibbs sampling

- WinBUGS (for Windows)
- OpenBUGS (for Linux)
- JAGS (platform independent)

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No interface for WinBUGS is available in Stata.

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Solution?

R

- is well equipped with interfaces to Stata as well as WinBUGS.
- can be used as interface betwenn Stata and WinBUGS.

Stata goes BUGS

Stata goes BUGS step by step

1. You call R from inside Stata.

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Stata goes BUGS

Stata goes BUGS via R step by step

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2. R reads, transforms, and hands your data to WinBUGS
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Setting up

Software to install

- `R` and `R2WinBUGS` (Additional Package)
- WinBUGS
  (should be installed in "c:/Programme/WinBUGS14")

Files

- `GoWinBUGS.R` (You don't have to edit it.)
- `GoWinBUGSModel.bug` (your model code)

To run WinBUGS

You need ...

model (including priors)	You specify it in `GoWinBUGSModel.bug`.
data file	`R` transforms your data in Stata into the WinBUGS format.
initial values	You specify it in the preamble of `GoWinBUGSModel.bug` and `R` translates it into WinBUGS.

How to go WinBUGS

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- Run following command:

```
shell "C:/Programme/R/R-2.2.1/bin/R.exe" CMD BATCH
"GoWinBUGS.R"
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- Run following command:
  `shell "C:/Programme/R/R-2.2.1/bin/R.exe" CMD BATCH "GoWinBUGS.R"`
- You will have following output files in your working directory:
  - dataFromR.dta: Posterior distribution in Stata Format
  - bugOutput1.pdf and bugOutput2.pdf: some graphics
  - GoWinBUGS.Rout: log of R

Example 1

Simulated data based on a probit model

$$Pr(y_i = 1) = F(\beta_1 + \beta_2 x_i) \quad (1)$$

F is here the probit CDF transformation.

your do-file

GoWinBUGS.do

```
clear
cd "c:/Konferenzen/StataMeeting"

/* setting parameters */
set obs 100                    /* setting the number of obs.*/
scalar beta1=5                 /* constant */
scalar beta2=7                 /* coef for x */
scalar wt=3                    /* weight of error term */

/* generating data */
gen x =uniform()*2 -1                  /* generating independent variable */
gen e = invnorm(uniform())             /* generating error term */
gen y = beta1+beta2*x+wt*e             /* generating latent variable */
replace y =0 if y<=0.5
replace y =1 if y>0.5
```

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your do-file

GoWinBUGS.do

```
/* probit analysis */
probit y x

/* going BUGS */
keep y x                                  /* keep only variables for WinBUGS */
save dataToR,replace                      /* save data set */
shell "C:/Programme/R/R-2.2.1/bin/R.exe" CMD BATCH "GoWinBUGS.R"

/* getting results from R */
use dataFromR, clear
/* summary statistics of posterior distribution */
sum, detail
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Model

GoWinBUGSModel.bug (preamble: not read by WinBUGS, but by R)

```
# #
# # interested parameters: beta
# # initial values: beta=0,3      ←initial values; Comma (,) between values
# # n.burnin: 5000                ←length of burn in
# # n.iter: 10000                 ←no of iterations
# # n.thin: 1                     ←thinning rate
# # N (no. of rows)?: yes
# # J (no. of cols)?: no
# # debug?: no                    ←if yes, you can inspect results in WinBUGS.
# #
# # binary probit
# #
```

Model

GoWinBUGSModel.bug (model)

```
model{
    for (i in 1:N){
        mu[i] <- beta[1] + beta[2]* x[i];
            # # the trick from Jackman (2000)
            # # otherwise WinBUGS would give an error
        ystar[i] ~ dnorm(mu[i],1)I(lo[y[i]+1],up[y[i]+1]);
        probit(p[i]) <- ystar[i];
    }
    lo[1] <- -50; up[1] <- 0;          # # interval for ystar | y=0
    lo[2] <- 0; up[2] <- 50;           # # interval for ystar | y=1
    # # priors
        beta[1] ~ dnorm(0,0.0001)  ←Here you can
        beta[2] ~ dnorm(0,0.0001)  ← change priors.
}
```

Ideological Positions of Political Actors

Relevant for Analysis of . . .

- Voting behavior
- Party competition
- Coalition building
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- etc.

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Data source

- Expert Survey
- Mass Survey
- Party Manifesto
- Recorded vote, or "roll call vote"

Item-Response Theory

Applying Item-Response Theory

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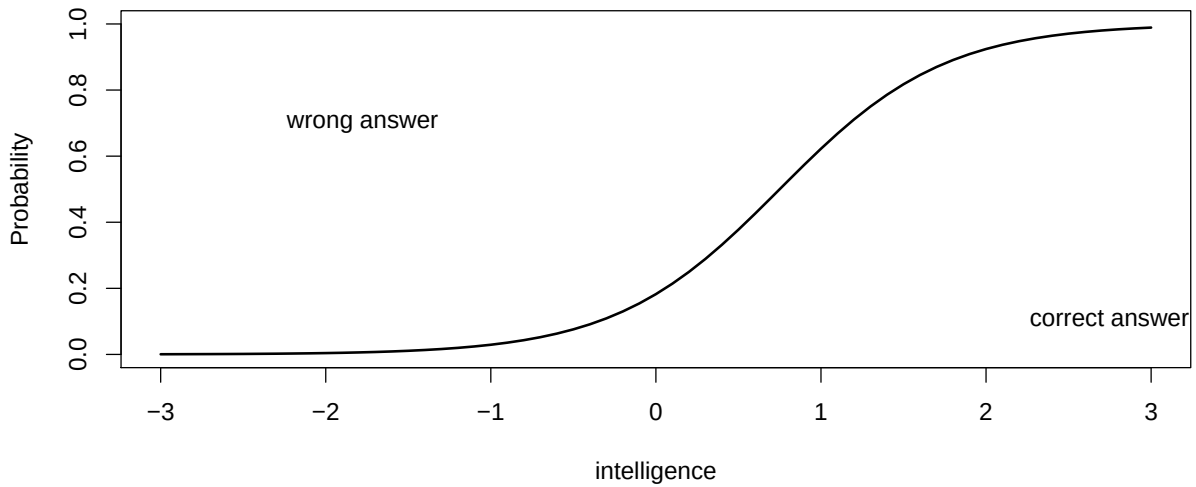

skip caricature

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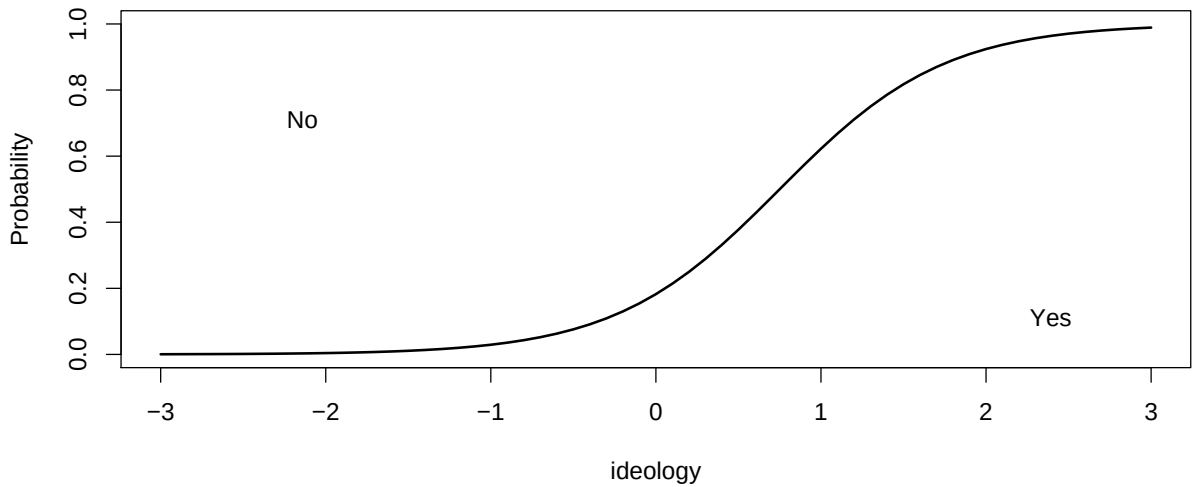
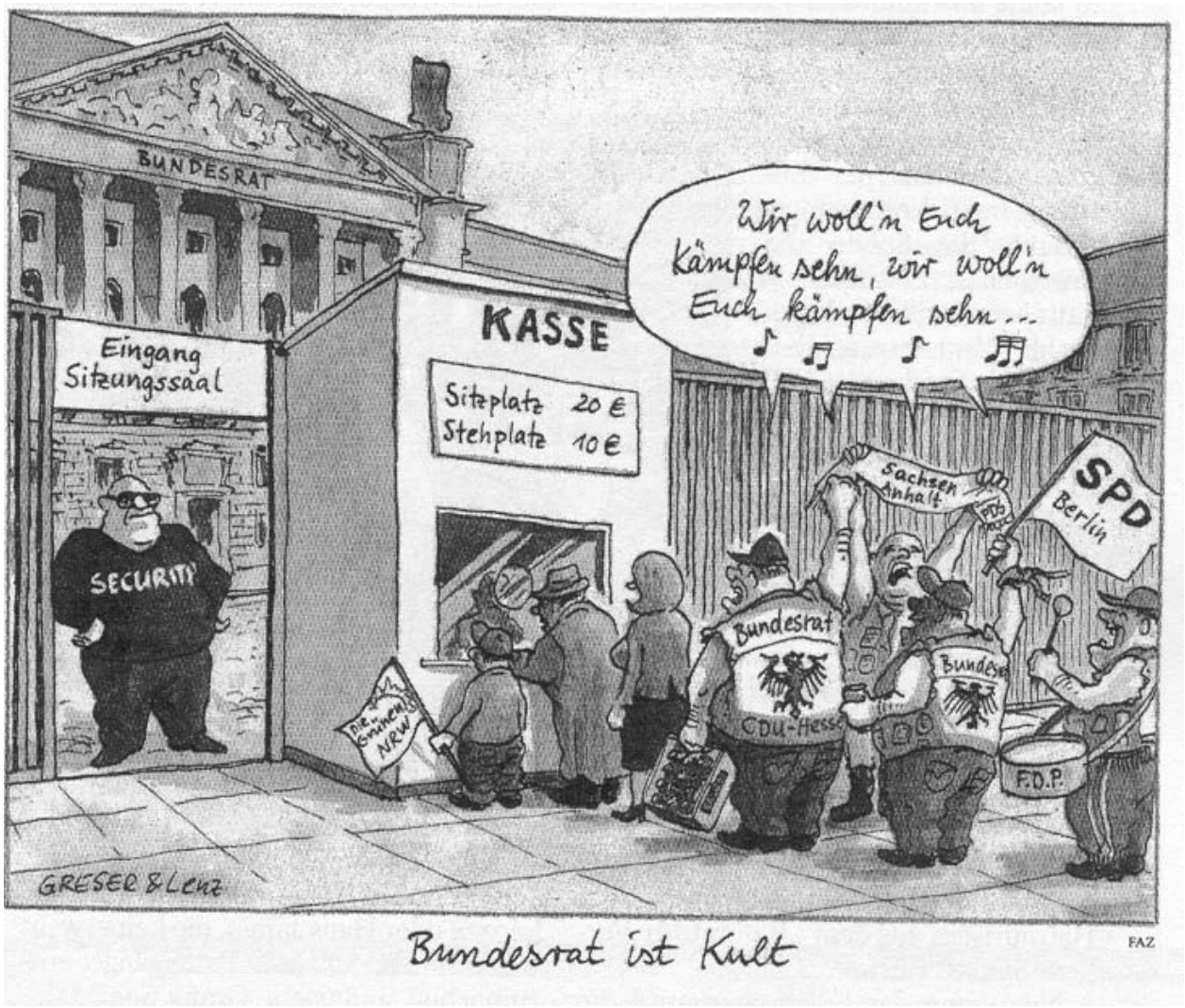


skip caricature

Ideological Position of German Federal States



Source: Frankfurter Allgemeine Zeitung

Roll calls in German Bundesrat

Bundesrat

- The second chamber consisted of the representatives of 16 state governments
- The representatives of a state vote unanimously.

Data

- 729.-813. Session (1998-2005; during the red-green government)
- J= 20 (all but unanimous roll calls); N=16

Roll calls in German Bundesrat

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	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18	v19	v20
BW	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1
BY	1	0	0	0	0	0	0	1	0	1	1	0	0	1	1	1	1	1	1	1
BE	1	0	0	0	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	1
BB	1	0	1	1	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	1
HB	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1
HH	1	0	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1
HE	1	0	1	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1
MV	1	0	1	0	1	1	1	0	1	0	0	1	1	1	0	0	0	0	0	0
NI	1	0	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	0	1	1
NW	1	0	1	1	0	1	1	0	1	0	0	1	1	1	0	0	0	0	0	1
RP	1	0	0	0	1	1	1	0	1	0	0	1	1	1	1	0	0	0	0	1
SL	1	0	1	1	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1
SA	1	1	0	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1
ST	1	0	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1
SH	1	0	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	0	0	1
TH	1	1	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1

Roll calls in German Bundesrat

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Challenge

- With 16×20 data
- 20 (γ) + 20 (β) + 16 (x) parameters to estimate

Model

GoWinBUGSModel.bug (preamble: not read by WinBUGS, but by R)

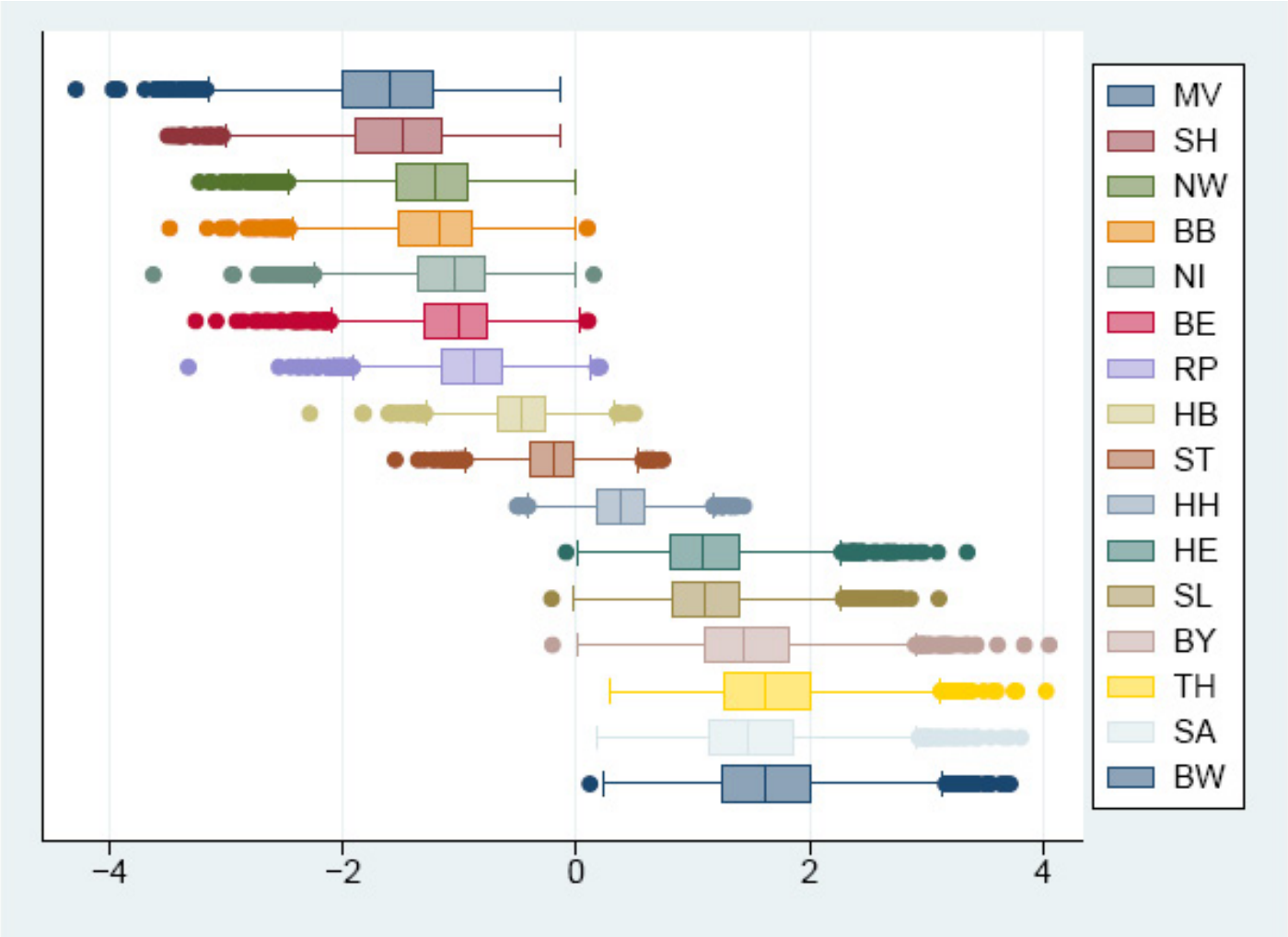
```
# # interested parameters: beta, gamma, x
# # initial values: beta=3,-3,-3,-1,3,2,3,3,2,1,-1,-3,-2,1,-1,3,-1,-1,
1,0;gamma=0,0,0,-3,-1,-1,-1,-1,-1,-3,-1,-2,-1,-1,-3,0,-1,0,
1,-2;x=1,1,-1,-1,0,0,1,-1,0,-1,-1,1,1,0,-1,1     ←; between parameters.
# # n.burnin: 5000
# # n.iter: 10000
# # n.thin: 1
# # N (no. of rows)?: yes
# # J (no. of cols)?: yes
# # Matrix? : yes                          ←Data are read as matrix y[,]
# # debug?: no
# # IRT
# #
```

Model

GoWinBUGSModel.bug (model)

```
model{
    for (i in 1:N){ # # loop over federal states
        for (j in 1:J) { # # loop over issues
            logit(p[i,j]) <- gamma[j] - beta[j] * x[i] ;
            y[i,j] ~ dbern(p[i,j]);
        }
    }
    # # prior
    for (i in 1:N){
        x[i] ~ dnorm(0,1) # # prior for ideal points
    }
    for (j in 1:J){
        gamma[j] ~ dnorm(0,0.25)
        beta[j] ~ dnorm(0,0.25)
    }
}
```

Estimation results for x



Further possibilities

- Change of government - Introducing missing values

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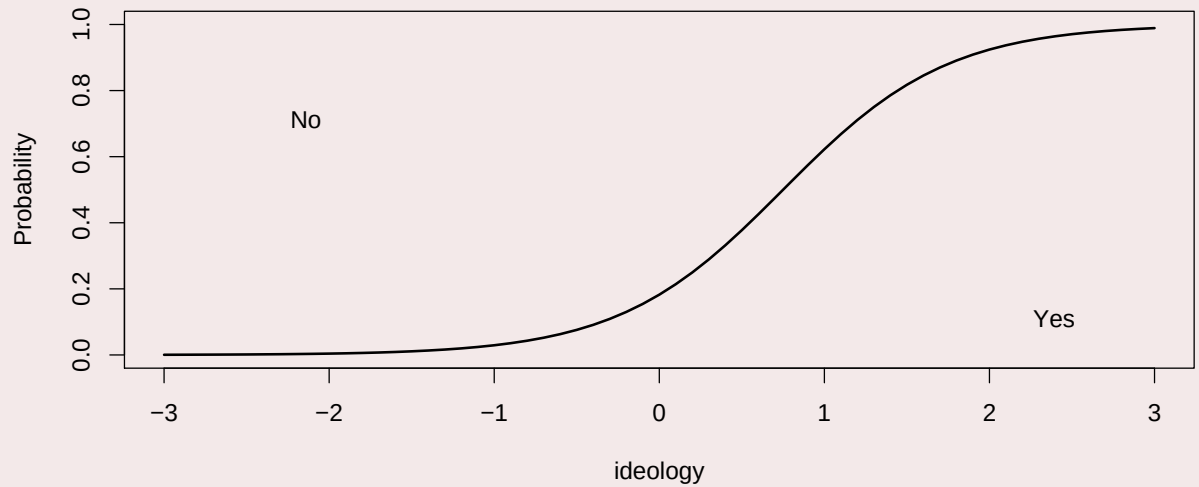

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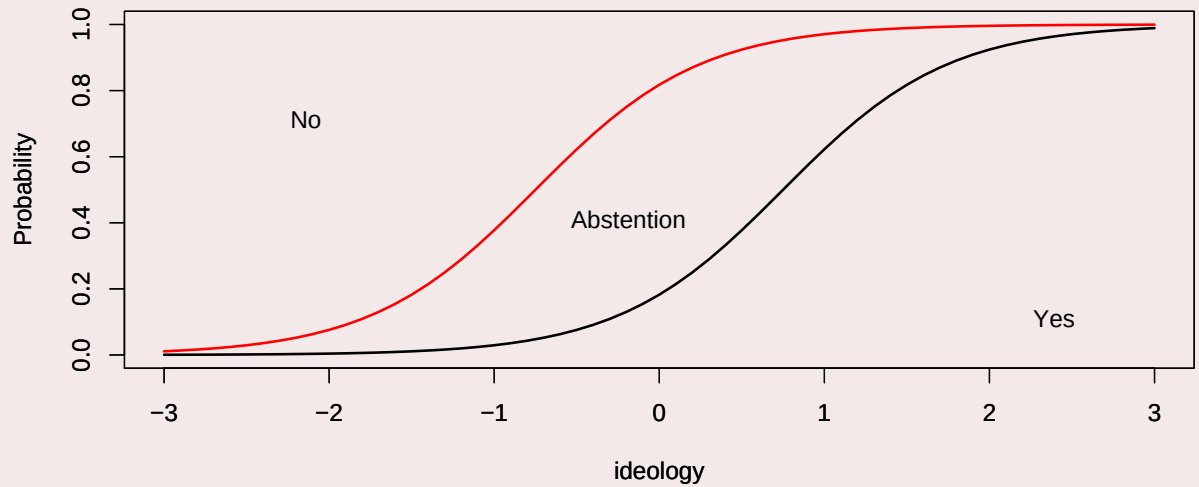

Conclusion

Main messages

- Stata user can now use MCMC.

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- but, still in a roundabout way.

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- Stata user can now use MCMC.
- but, still in a roundabout way.
- Why not its own implementation or, at least, an interface to WinBUGS?

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FAQ, or frequently heard arguments

1. MCMC is a technique only for hard core scientists. Demands for MCMC are limited.

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1. MCMC is a technique only for hard core scientists.
   Demands for MCMC are limited.
   Development of technology and software can encourage a wider range of users to applicate MCMC.

Conclusion

FAQ, or frequently heard arguments

1. MCMC is a technique only for hard core scientists. Demands for MCMC are limited.
2. Why Stata? You can use R or learn WinBUGS.

Conclusion

FAQ, or frequently heard arguments

1. MCMC is a technique only for hard core scientists. Demands for MCMC are limited.
2. Why Stata? You can use R or learn WinBUGS.
   - Same answer to point 1.
   - Teaching

Conclusion

FAQ, or frequently heard arguments

1. MCMC is a technique only for hard core scientists. Demands for MCMC are limited.
2. Why Stata? You can use R or learn WinBUGS.
3. Writing model for themselves is also painful.

Conclusion

FAQ, or frequently heard arguments

1. MCMC is a technique only for hard core scientists. Demands for MCMC are limited.
2. Why Stata? You can use R or learn WinBUGS.
3. Writing model for themselves is also painful.
   - Problem specific packages (IRT, MNP, etc.)
   - Writing own model is didactically meaningful.

Acknowledgements

Special thanks to Alex Herzog for his advices in Stata.

Disclaimer

- Programs presented here are downloadable under:
  http://webrum.uni-mannheim.de/sowi/shikanos/#software
- They were written for relatively simple models.
- Choose your initial values carefully. If your choice is bad, WinBUGS can go on strike.

Useful Links

- `http://www.mrc-bsu.cam.ac.uk/bugs/winbugs/contents.shtml`
  Homepage of WinBUGS
- `http://www.r-project.org/`
  Homepage of R
- `http://cran.r-project.org/src/contrib/Descriptions/R2WinBUGS.html`
  R2WinBUGS (also can be installed per internet from inside R)

Literature

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- Jackman, Simon. Estimation and inference via Bayesian simulation: An introduction to Markov Chain Monte Carlo. American Journal of Political Science. 2000; 44(2):369-98.
- Gill, Jeff. Bayesian methods: a social and behavioral sciences approach. Chapman & Hall/CRC; 2002.