

Bayesian Decision Making

a part of Edukalibre teaching project

M. Karny, I. Nagy, L. Pavelkova,
E. Suzdaleva, J. Homolova

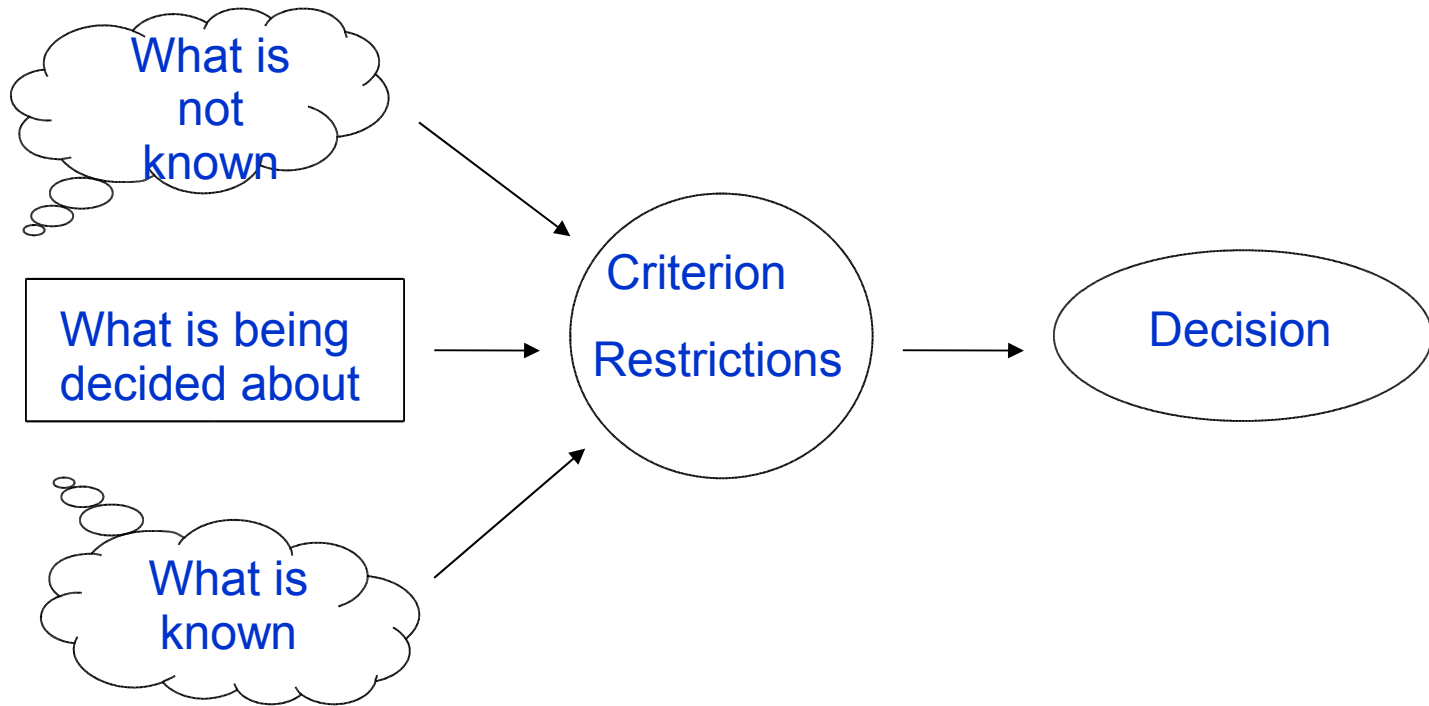


Decision Making (DM)

Model

Design (optimization)

Result



Bayesian DM Elements

- Model of the system
 - conditional prob. distribution
function („of what“ | „depending on“)
 - equivalent to model equation + noise
- Restrictions (causality, reality)
- Loss function – preferences for the design
- Type of decision



DM Tasks

- Parameter estimation
- Output prediction
- Testing of hypotheses
- State filtration
- Optimal control

All can be static or dynamic



Package for DM teaching

- Text with DM theory
 - general theory
 - application to normal and discrete models
- Examples
 - example description (references to theory)
 - example program code (termbase)

Theory description

- General theory
 - Underlying theory
 - Decision making tasks
 - Evaluation techniques
- Theory for discrete distribution (CCM)
- Theory for normal distribution (1st order)
 - Introduction
 - Decision making tasks
 - Appendix (special formulas)

Examples

- Introduction to each example (.pdf)
 - Hyperlinks to the main text
 - Running m-file in OCTAVE
 - Editing of m-file (possible restoration)
 - Back to the list of examples
- m-file (program – ascii code)
 - Dialogue about variables (check of validity)
 - Running the program (in time loop)
 - Options, what to do next

Text to example

1.2.1 Testing of Hypotheses about CT - three fix values

Aim:

This example concerns Coin Tossing (CT). It relates properties of Bayesian hypothesis testing to the parameter values specifying them and to the information content of data that is changed by the amount of data processed. See [CT model](#), [CCM hypotheses](#).

Description:

The considered [CT \(coin tossing\) model](#) describes a simplified CCM experiment. The tosses of the coin are supposed to be mutually independent and uncontrolled. The data generating mechanism is modelled by unequal probabilities of respective *outputs* $y \in \{1, 2\}$. Thus, single *parameter* $\theta = f(y_t = 1 | y(t-1), \theta)$ – the probability of the event $y_t = 1$ – describes the experiment. Three hypotheses $H_1 : \theta = \theta_1$, $H_2 : \theta = \theta_2$ and $H_3 : \theta = \theta_3$ about the unknown model parameter θ are tested. The posterior probabilities of respective hypotheses are fully determined by the number of processed data *ndat* and by the key *test statistic* ρ , which is relative frequency of event $y = 1$ units observed up to time $\hat{t} \equiv \text{ndat}$. For complementary information, see [CT model](#), [CT parameter](#), [CCM hypotheses](#).

Specification:

System: uncontrolled, memoryless with two-valued scalar output

Decision: acceptance of hypothesis $\hat{H} \in \{H_1, H_2, H_3\}$ about the value of parameter θ by the generalized Bayesian test of hypothesis evaluating the $f(H|\rho, \hat{t})$ on $H^* \equiv \{H_1, H_2, H_3\}$

Experience: the test statistic ρ and the number of processed data records *ndat*

Ignorance: validity of the hypothesis

Admissible strategy: causal $\rho, \hat{t} \rightarrow \hat{H}$

Loss function: zero for $\hat{H} = H$ and positive constant for $\hat{H} \neq H$.

Text to example, (cont.)

Recommended experiments:

1. *Change number of data records* [ndat](#) .

The amount of information gained through the measured data influences the accuracy of the decisions. The more data is incorporated into the decision making the more resolute the decisions are.

2. *Change the values of the parameters defining the hypotheses* [th](#) .

The mutual distribution of the parameter values tested shows the sensitivity of the testing (how clearly near values can be distinguished).

[Run Example](#)

[Edit m-file](#)

[Restore m-file](#)

[Contents](#)

m-file to example

```
TESTING OF HYPOTHESES ABOUT FIXED PARAMETER VALUES
  th=th(1) or th=th(2) or th=th(3)
```

```
=====
```

```
I n p u t   v a r i a b l e s
```

```
Number of data records      ->  ndat  = 10;
```

```
Parameters defining hypotheses ->  th   =
```

```
          H1  ->  th(1) = 0.2
```

```
          H2  ->  th(2) = 0.5
```

```
          H3  ->  th(3) = 0.7
```

```
-----
any changes ? ENTER = no, or type a command: >
```

```
That's the END! What do you want to do now?
```

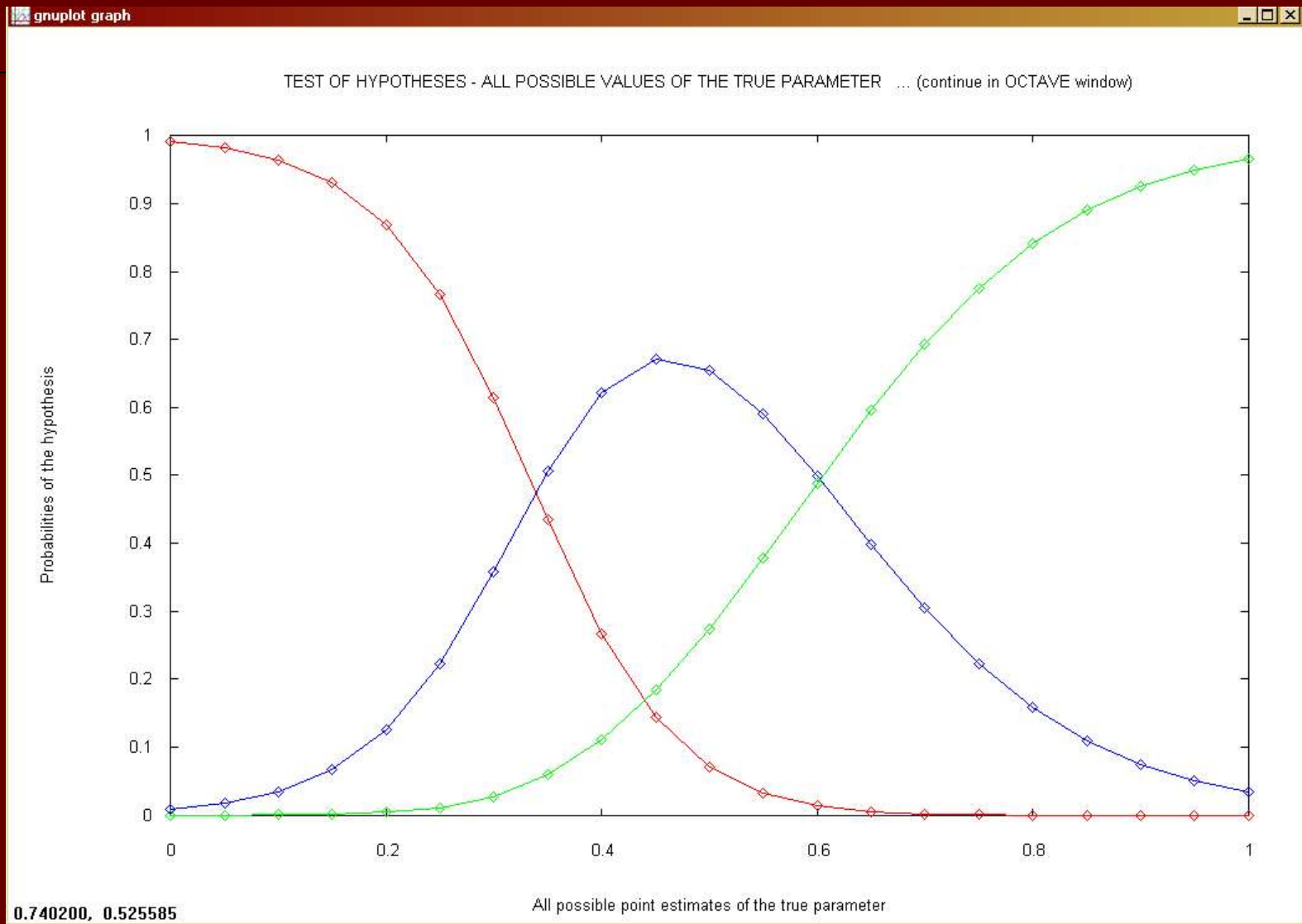
```
ENTER = continue with current values
```

```
I      = continue with initial values
```

```
S      = stop this experiment
```

```
> █
```

Example of result



DM and Edukalibre

- **Demo version** – on web (texts to DM, texts to examples, references to theory and termbase)
<http://moodle.utia.cas.cz>
- **Full version** – both on web and UTIA svn repository
 - read documentation and install Octave
 - download packages for your OS
 - run examples in full (texts and programs)

Bayesian Decision Making: Theory and Examples

You are logged in as: Guest User (Logout)

MoUTIA » DecMak

People

- Participants
- Edit profile

Search

My courses

- Bayesian Decision Making: Theory and Examples

All courses...

Topic outline

- Introduction

1 Demo of BDM examples

Attention: "Run example" for start Octave and a task is **not** available in demo (see full version in Download).

Open Demo:Examples. Choose the example, you are interested in. Each decision making task offers its description, specification (see [Introduction](#)) and recommended experiments.

- Demo: Examples
- Demo: Theory
- Glossary of Bayesian decision making

2 Download

- documentation
- If you don't have Octave at your computer, click here and install it
- download for linux
- download for windows

Calendar

<< July 2005 >>

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Global events Course events

Online Users

(last 5 minutes)

None

Conclusions

- The task is not a typical e-learning one due to the necessity of running programs
- We tried to push it as far as possible
 - All can be found on web (but not fully run)
 - All is based on free software (needs running of another program)
 - The content is a teaching material (aiming at Ph.D. students)