

## Real-Life Examples of MADM Applications

### Aims:

- To get a feeling for MADM models
- To see the potential of MADM in practice

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## Some Application Areas

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| 1. INFORMATION TECHNOLOGY  | 4. PERSONNEL MANAGEMENT   |
| <ul style="list-style-type: none"><li>evaluation of computers</li><li>evaluation of software</li><li>evaluation of Web portals</li></ul>                   | <ul style="list-style-type: none"><li>personnel evaluation</li><li>selection and composition of expert groups</li><li>evaluation of personal applications</li></ul> |
| 2. PROJECTS  | 5. MEDICINE and HEALTH-CARE   |
| <ul style="list-style-type: none"><li>evaluation of projects</li><li>evaluation of proposal and investments</li><li>product portfolio evaluation</li></ul> | <ul style="list-style-type: none"><li>risk assessment</li><li>diagnosis and prognosis</li></ul>   |
| 3. COMPANIES   | 6. OTHER AREAS  |
| <ul style="list-style-type: none"><li>business partner selection</li><li>performance evaluation of companies</li></ul>                                     | <ul style="list-style-type: none"><li>assessment of technologies</li><li>assessments in ecology and environment</li><li>granting personal corporate loans</li></ul> |

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## Allocation of Housing Loans

- Housing Fund of the Republic of Slovenia: Allocation of housing loans to citizens and nonprofit organizations
- Since 1991: 21 completed floats of loans for citizens (*recurring* decision problem)
- Management decision support system for housing loan allocation
- Evaluation of loan priority: qualitative multi-attribute decision models (DEX)
- 2/3 of housing loans in Slovenia are allocated in this way

M. Bohanec, B. Cestnik, V. Rajkovič, Qualitative Multi-Attribute Modelling and its Application in Housing, *Journal of Decision Systems* 10, 2001.

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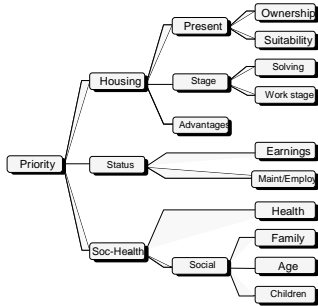
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## Allocation of Housing Loans Multi-Attribute Model Structure



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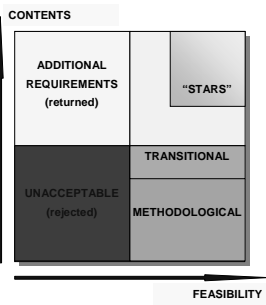
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## Evaluation of R&D Projects Slovenian Ministry of Science and Technology



M. Bohanec, V. Rajkovič, B. Semolič, A. Pogačnik: Knowledge-based portfolio analysis for project evaluation. *Information & Management* 28(5), 1995, 293-302.

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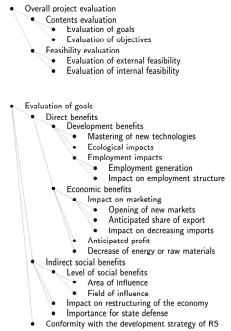
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## Evaluation of R&D Projects Multi-Attribute Model Structure (partial)



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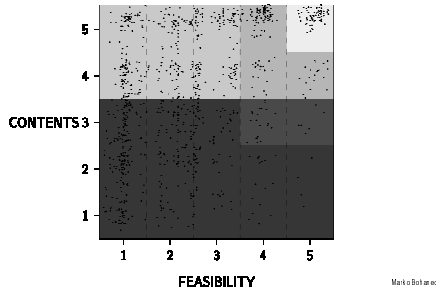
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## Evaluation of R&D Projects

Evaluation of projects in 1992:  
516 projects: 1094 reviews contributed by 90 reviewers




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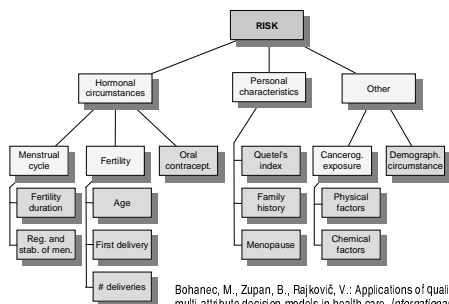
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## Medicine: Breast Cancer Risk Assessment



Bohanec, M., Zupan, B., Rajković, V.: Applications of qualitative multi-attribute decision models in health care, *International Journal of Medical Informatics* 58-59, 191-205, 2000.

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## An Example of Decision Rules

	Fertility duration	Reg. and stabil. of menstruation	Menstrual cycle
1	average	R-28	high risk
2	long	R-28	high risk
3	long	R29+	high risk
4	long	N	high risk
5	short	R-28	moderate risk
6	average	R29+	moderate risk
7	short	R29+	low risk
8	short	N	low risk
9	average	N	low risk

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## Average Importance of Attributes

BREAST CANCER RISK	Regression	Informativity	Gini Index
Hormonal circumstances	158	202	234
Menstrual cycle	125	123	130
Fertility duration	125	128	138
Reg./stab. menstruation	75	72	62
Fertility	111	99	130
Age	97	145	126
First delivery	145	128	145
# deliveries	58	27	29
Oral contraceptives	65	78	41
Personal characteristics	88	56	39
Quetelet's index	29	5	11
Family history	197	183	236
Menopause	74	112	53
Other	55	42	27
Cancerogenic exposure	100	100	100
Physical factors	160	166	179
Chemical factors	40	34	21
Demographical circumst.	100	100	100

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## Evaluation and Analysis of Options

BREAST CANCER RISK	Basic evaluation	Missing data	"What-if" analysis
BREAST CANCER RISK	3	3	2
Hormonal circumstances	2	3/0,5,2/0,5	2
Menstrual cycle	moderate risk	moderate risk	moderate risk
Fertility duration	average	average	average
Reg./stab. menstruation	R29+	R29+	R29+
Fertility	moderate risk	moderate risk	moderate risk
Age	over 40	over 40	over 40
First delivery	29 or younger	29 or younger	29 or younger
# deliveries	up to 4	up to 4	up to 4
Oral contraceptives	no	+	no
Personal characteristics	1	1	1
Quetelet's index	29+	29+	29+
Family history	no	no	no
Menopause	no	no	no
Other	high risk	high risk	moderate risk
Cancerogenic exposure	high risk	high risk	moderate risk
Physical factors	higher	higher	lower
Chemical factors	no	+	no
Demographical circumstances	high risk	high risk	moderate risk

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## Selective Explanation of Options

Reasons FOR higher risk		Reasons AGAINST higher risk	
Age	over 40	Personal characteristics	1
Quetelet's index	29+	Family history	no
Other	high risk	Menopause	no
Cancerogenic exposure	high risk	First delivery	29 or younger
Physical factors	higher	Oral contraceptives	no
Demographic circumst.	high risk	Chemical factors	no

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## Diabetic Foot Risk Assessment

**Who:**

- General Hospital Novo Mesto, Slovenia
- IJS
- Infonet, d.o.o.

**Why:**

- Reduce the number of amputations
- Improve the risk assessment methodology
- Improve the DSS module of clinical information system

**How:**

- Develop multi-attribute risk assessment model
- Evaluate it on patient data (about 3400 patients)
- Integrate into the clinical information system

In: Mladenić, D., Lavač, N., Bohanec, M., Moyle, S. (eds); *Data mining and decision support: Integration and collaboration*. Kluwer Academic Publishers, 2003.

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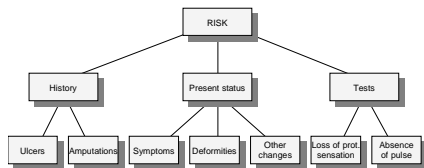
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## Diabetic Foot Risk Assessment

### Risk Assessment Model



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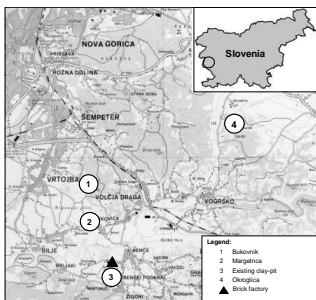
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## Environmental: Clay-Pit Location



Bohanec, M., Rajkovič, V.: Multi-attribute decision modeling: Industrial applications of DEX, *Informatica* 23, 487-491, 1999.

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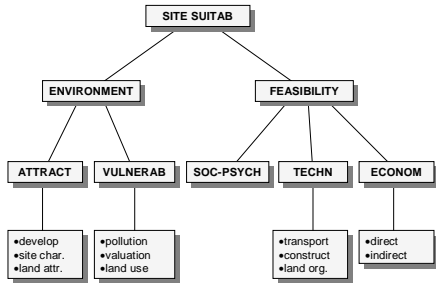
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## Clay-Pit Location Model



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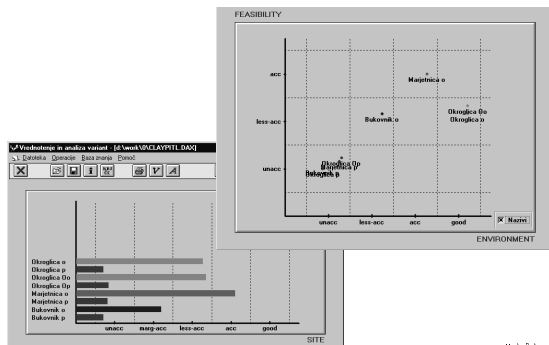
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## Clay-Pit Location Evaluation



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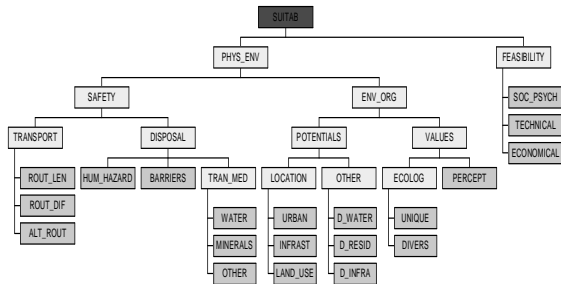
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## Environmental: Location of a Radioactive Waste Repository



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## Advising Children in Choosing Sports



### Talent:

- A knowledge-based computer program
- for advising children in choosing sports
- in primary and secondary schools

Leskošek, B., Bohanec, M., Rajković, V.: The use of expert methods in the orientation of children into different sports, *Acta Universitatis Carolinae, Kineanthropologica* 38(2), 33-44, 2002.

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## Database of Measurements

### GENERAL DATA

	Age
	Gender
	Date of measurement

### MORPHOLOGICAL TESTS

<b>BH</b>	Body height (cm)
<b>BW</b>	Body weight (kg)
<b>SF</b>	Skin fold of the upper arm (mm)

### MOTORIC TESTS

<b>TAP</b>	Taping with hand (number)
<b>SJ</b>	Standing jump (cm)
<b>PB</b>	Polygon backwards (s)
<b>SU</b>	Sit up of the trunk (number)
<b>DB</b>	Deep bend on bench (cm)
<b>BAH</b>	Bent arm hang on horizontal bar (s)
<b>S60</b>	60 m sprint (s)
<b>R600</b>	600 m run (s)

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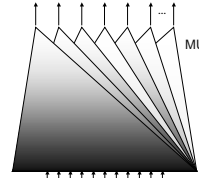
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## Talent: Basics

EVALUATION by sport disciplines



MULTI-ATTRIBUTE  
EVALUATION  
MODELS

### 23 disciplines:

- athletics (5 disciplines)
- swimming (4)
- skiing (3)
- football
- volleyball
- handball
- tennis
- badminton
- ...

"SPORTS-CARD" MEASUREMENT  
3 morphological and 8 motoric tests

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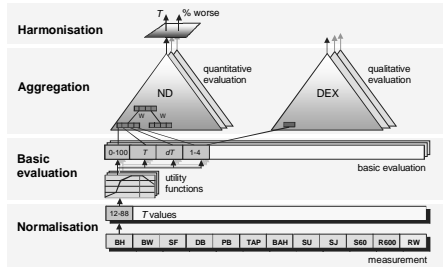
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# Evaluation Models



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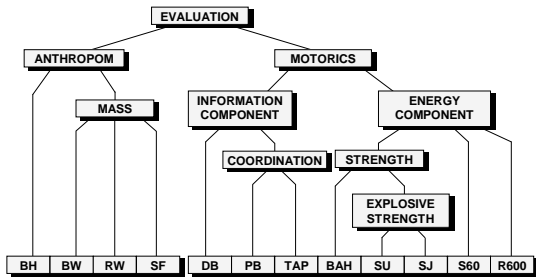
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# Evaluation Model Structure



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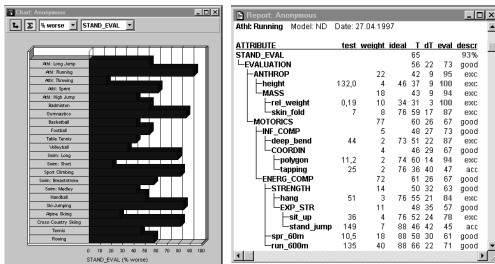
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# Evaluation and Explanation



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## Decision Problem: Housing (1/2)

**Client:**

The Housing Fund of the Municipality of Ljubljana

**Task:**

Support a tender for renovating old denationalized blocks of flats in Ljubljana

**Problem characteristics:**

- one-time problem

In: Mladenić, D., Lavač, N., Bohanec, M., Moyle, S. (eds); *Data mining and decision support: Integration and collaboration*. Kluwer Academic Publishers, 2003.

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## Decision Problem: Housing (2/2)

**Earmarked financial resources:**

600 M SIT (3 M €)

**Timing:** December 1999 – September 2000

**Phases of the project:**

1. application gathering
2. (in)completeness notification
3. application completion
4. loan approval and allocation
5. notifying applicants
6. handling complaints

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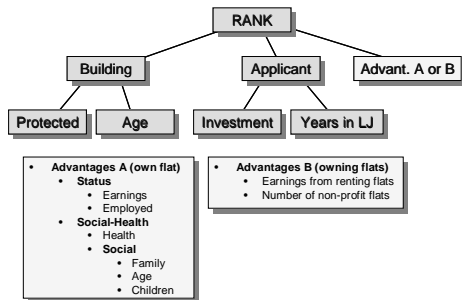
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## DEX Application Ranking Model: Model Structure



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## Banks @ SI Housing Schema

### Who:

- Slovenian Housing Fund
- IJS
- Temida

### What:

- Evaluate and select banks for SHS
- Distribute rights for loan allocation to banks

### Why:

- Difficult and sensitive decision problem

### How:

- Combined quantitative/qualitative modelling

In: Mladenić, D., Lavrač, N., Bohanec, M., Moyle, S. (eds.): *Data mining and decision support: Integration and collaboration*. Kluwer Academic Publishers, 2003.

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## Banks @ SI Housing Schema

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## Assessment of Governmental Life-Event Portals

State/Land-/Province/City	Internet Address
<i>Europe</i>	
France: Service Publique	<a href="http://www.service-public.fr">http://www.service-public.fr</a>
Italy	<a href="http://www.italia.gov.it">http://www.italia.gov.it</a>
Spain	<a href="http://www.administracion.es">http://www.administracion.es</a>
Great Britain: UKonline	<a href="http://www.ukonline.gov.uk">http://www.ukonline.gov.uk</a>
Ireland: Information on the Irish State	<a href="http://www.irigov.gov.ie">http://www.irigov.gov.ie</a>
Austria: Internet Service HELP	<a href="http://www.help.gv.at">http://www.help.gv.at</a>
German Federal Land Rheinland-Pfalz-Lotse:	<a href="http://rip.bund.de/rip-loitse.htm">http://rip.bund.de/rip-loitse.htm</a>
RLP-Lotse	<a href="http://www.rip-buergerservice.de">http://www.rip-buergerservice.de</a>
The city of Bremen (Germany): Bremer-online-service	<a href="http://www.bremer-online-service.de">http://www.bremer-online-service.de</a>
Slovenia: e-Uprava	<a href="http://e-gov.gov.si/e-uprava/index.html">http://e-gov.gov.si/e-uprava/index.html</a>
<i>Rest of the world</i>	
Canada: Government of Canada	<a href="http://canada.gc.ca">http://canada.gc.ca</a>
Singapore: eCitizen	<a href="http://www.ecitizen.gov.sg">http://www.ecitizen.gov.sg</a>
Hong Kong: Government Services	<a href="http://www.info.gov.hk/e/index.htm">http://www.info.gov.hk/e/index.htm</a>

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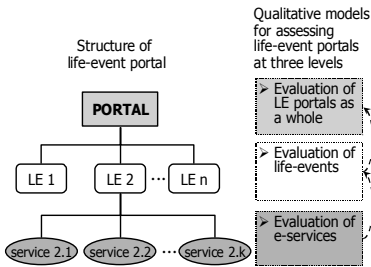
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# Life-Event Portals

## Structure of Models



Qualitative models for assessing life-event portals at three levels

- Evaluation of LE portals as a whole
- Evaluation of life-events
- Evaluation of e-services

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# Life-Event Portals

## Model for Assessment of E-Services

Attribute	Description	Attribute scale
E-service	The final assessment of particular electronic service	unacceptable; acceptable; good; very good; excellent
Clarity of e-Service	Level of e-service clarity	inadequate; partly adequate; adequate
Information	Assessment of provided information about e-service	inadequate; partly adequate; adequate
Inf. Quality	Quality of information	inadequate; partly adequate; adequate
Inf. Accessibility	Accessibility of information	inadequate; partly adequate; adequate
Sophistication	Level of service's on-line sophistication (higher than in)	suitable; partly suitable; suitable; very suitable
Documents	Assessment of documents related to e-service	suitable; partly suitable; suitable; very suitable
Doc. Accessibility	Accessibility of documents related to e-service	inadequate; partly adequate; adequate
Downloadable Doc.	Downloadable documents handling	inadequate; partly adequate; adequate
Download	Download or printing of forms	inadequate; partly adequate; adequate
Send	Documents can be sent by e-mail	inadequate; partly adequate; adequate
Interaction	Interactive document handling	inadequate; partly adequate; adequate
Interactive Forms	Interactive on-line forms	inadequate; partly adequate; adequate
Attachments	Documents can be attached to interactive forms	inadequate; partly adequate; adequate
Authentication	Authentication of e-documents	suitable; partly suitable; suitable; very suitable
Additional Features	Additional features of electronic case handling	inadequate; partly adequate; adequate
Integrating	Notifying about e-service progress in electronic way	inadequate; partly adequate; adequate
E-payment	Electronic payment for service is provided	inadequate; partly adequate; adequate
E-delivering	E-service's results are delivered electronically	inadequate; partly adequate; adequate
E-service Type	Type of e-service	visit; additional

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# Life-Event Portals

## Model for Assessment of Life-Events

Attribute	Description	Attribute scale
Life-event	The final assessment of life-event (LE)	unacceptable; acceptable; good; very good; excellent
Maturity	Level of life-event maturity	unacceptable; acceptable; good; very good; excellent
LE Sophistication	Level of life-event sophistication	unacceptable; acceptable; good; very good; excellent
Scope of LE	How well LE is covered with services	inadequate; partly adequate; adequate
Vital Scope	How well LE is covered with vital services	inadequate; partly adequate; adequate
Additional Scope	How well LE is covered with additional services	inadequate; partly adequate; adequate
LE Coordination	Level of services' coordination within LE	dispersed; one-entry point; step-by-step; one-stop
Use of LE	Elements of LE usage	unsuitable; partly suitable; suitable; very suitable
Access to Services	Access to services within particular LE	unsuitable; partly suitable; suitable; very suitable
Access Instruments	Instruments to access e-services within LE	unsuitable; partly suitable; suitable; very suitable
Entry Steps	List and description of key-steps within LE	inadequate; partly adequate; adequate
Check List	Check list	inadequate; partly adequate; adequate
FAQ	Frequently asked questions	inadequate; partly adequate; adequate
E-guide	Intelligent electronic guide through life-event	inadequate; partly adequate; adequate
Standardisation of Services	Level of services' design standardisation within LE	inadequate; partly adequate; adequate
LE Clarity	How clear LE is presented to the user	inadequate; partly adequate; adequate

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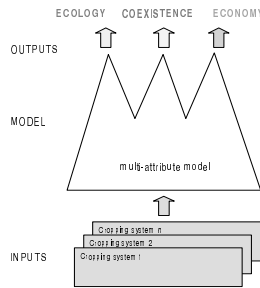
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## ECOGEN and SIGMEA Models

Evaluating cropping systems in terms of *ecology*, *coexistence* and *economy*



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## ECOGEN and SIGMEA Models

1. **“Grignon” model**  
Economic and ecological assessment of GM maize cropping systems
2. **ESQI: ECOGEN Soil Quality Model**  
Assessing the impact of cropping systems on soil quality
3. **SMAC Advisor: SIGMEA Maize Coexistence**  
Decision support software  
Assessing maize coexistence

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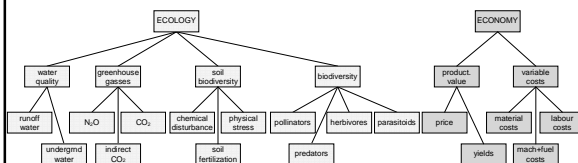
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## “Grignon” Model Model Output: Topmost Levels



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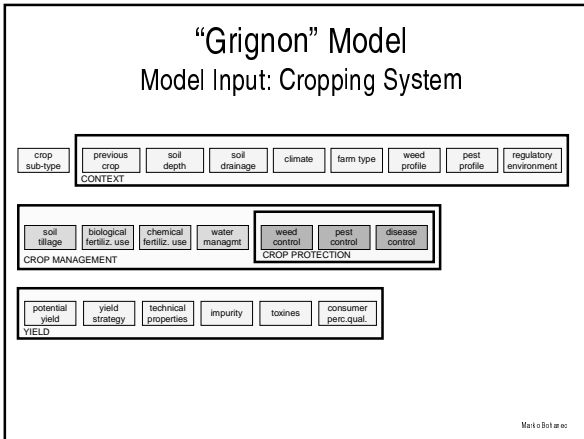
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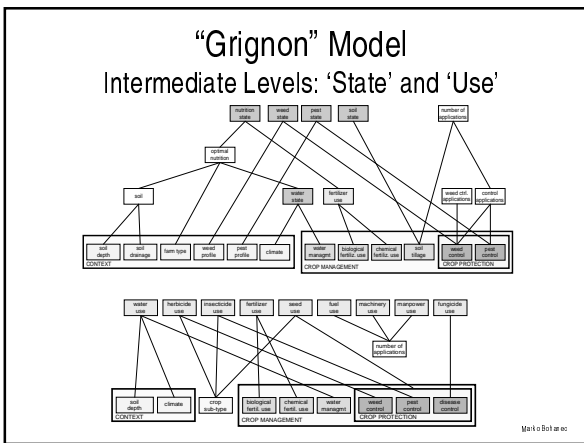
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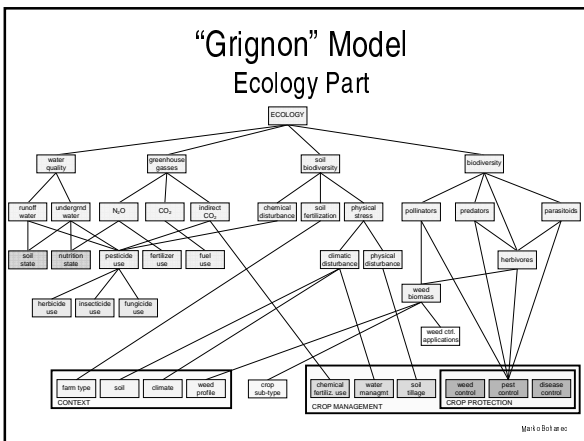
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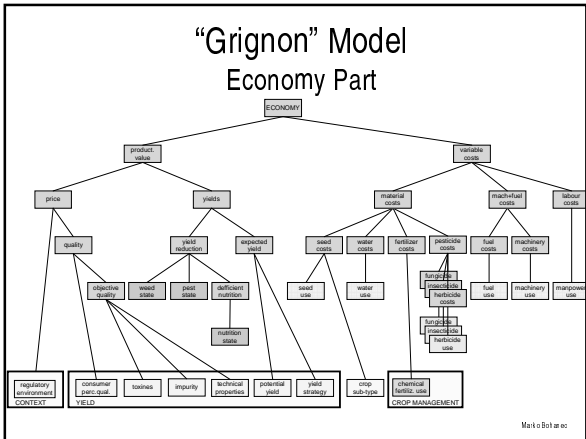
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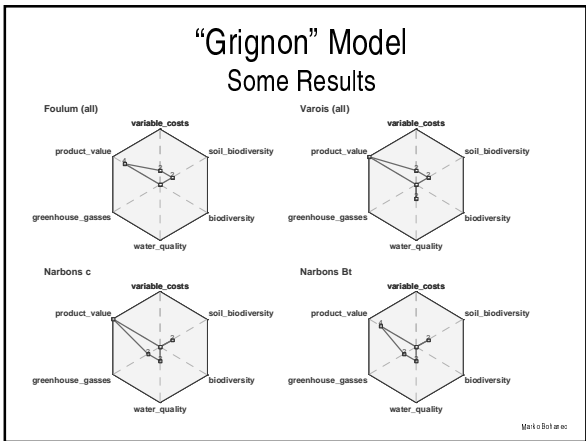
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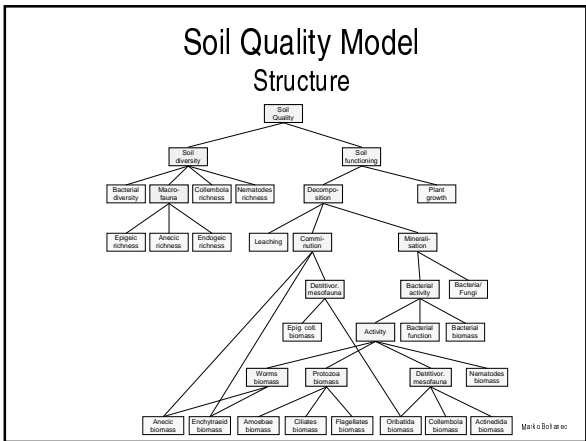
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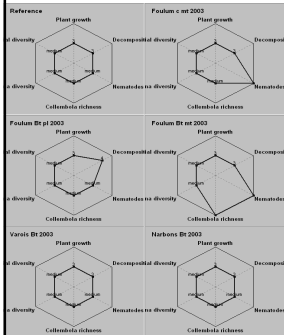
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## Soil Quality Model Assessment of ECOGEN Data



- All the options have the same soil quality value of 3
- The use of **Bt-maize** in **Foulum** positively affects *Soil functioning* (with **ploughing**) and *Soil diversity* (when using **minimum tillage**)
- **Minimum tillage** positively affects *Nematodes richness*, *Detritivorous mesofauna* and *Protozoa biomass*, leading to better *Activity*
- **Bt-maize** reduces *Protozoa biomass*, but improves *Comminution* due to *Anecic earthworm biomass*
- At **Varois** and **Narbons**, **Bt-maize** reduced many faunal populations without affecting the higher level outcomes of *Soil functioning*, *diversity* or *quality*

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## Soil Quality Model ESQI Web Page

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## SMAC Advisor Decision Problem

**Problem:**  
Can GM maize be grown in coexistence with plants on other fields?

**Criterion:**  
Genetic interference (Adventitious Presence)  
Typical target AP: 0.9 %

**Factors:**  
pollen flow, volunteers, feral plants, mixing during harvesting, transport, storage and processing, human error, accidents, ...

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## SMAC Advisor

Decision support software that assesses *the achievable AP* given:

- relation between fields: distance, relative size, wind direction, etc.
- type and characteristics of used seeds
- environmental characteristics (e.g., background GM pollen pressure)
- use of machinery (e.g., sharing with other farmers)
- target AP

... and gives *recommendations*:

- farming allowed
- farming disallowed
- assess risks (coexistence is possibly achievable)
- assess additional measures (coexistence achievable by small changes)

Marko Böhler et al.

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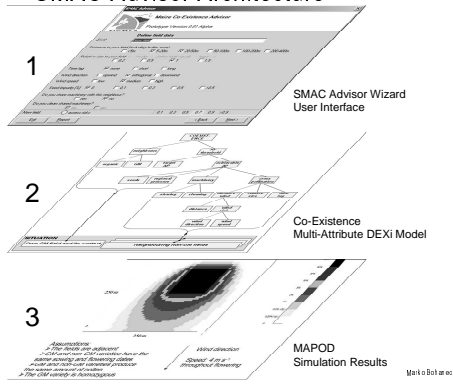
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## SMAC Advisor Architecture




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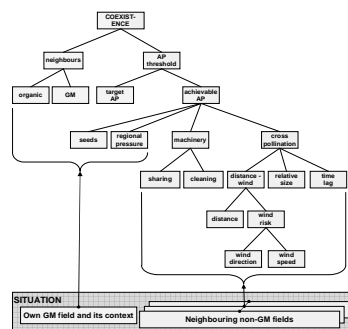
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## SMAC Advisor Level 2: DEXi Model

Qualitative Multi-Attribute Model




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## Summary

1. Loan Allocation
2. Evaluation/Selection of Projects
3. Medicine: Risk Assessment
4. Evaluation/Selection of Locations
5. Advising in Sports
6. Application ranking (in Housing)
7. Business partner selection (in Housing)
8. Assessment of Life-Event Portals

**Other areas:**

- evaluation of technology (cars, computers, software, Web pages and services, ...)
- evaluation of investment proposals, tenders
- production portfolio evaluation
- performance evaluation of companies
- personnel management
- ...

Markus Böhmer

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