Business Rules Forum
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Applying
Constructivist
Knowledge Engineering
for Building a Rule-Based System

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Parts

- Part 1 - ATA Case Study: How business rules automation is being used in a Tax Return Assessment (TRA) automation project (8 slides).
- Part 2 - Business Rules Automation
  Applications that put lot of knowledge to work require *knowledge models*, which can be better implemented with business rules automation rather than with conventional technologies (8 slides).
- Part 3 - Constructivist Knowledge View
  Foundations of the constructivist theory of knowledge
- Part 4 - Constructivist Knowledge Engineering (CoKE): How CoKE has been applied to model and implement the knowledge of assessment experts for building the ATA system

TRA Problem at STV-BL
(TRA = Tax Return Assessment)

- *STV-BL*: Internal Revenue Service, Ministry of Finance, Canton of „Baselland“
- 70 assessors in ca. 50 branches
- Change: assessment period reduced from 2- to 1-year (by 2001).
- Volume new: increase by 30%
- Limits of Tax Return Processing (TRP) software currently used by assessors

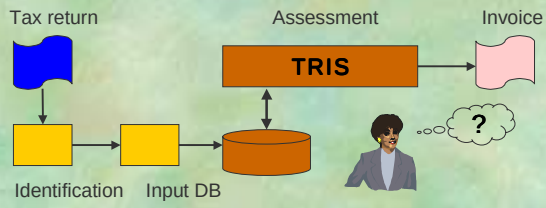
TRA Automation: Objectives

- Assess increased returns/year volume
- Staff: no recruiting, same costs
- Quality: same (or better)
- Quickly put to work changed regulations
- Investment < $500,000
- Release: December 31, 2001

TRA Automation: Requirements

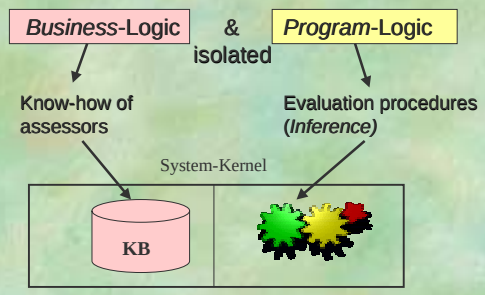
- Assess employed & unemployed individuals (State & Confederation taxes)
- Automatically approve or refer *routine* tax returns
- Show reasons that caused referral
- Maintenance by assessors
- Batch processing
- Evolution to on-line processing, self-employed individuals

Tax Return Assessment: manual



Assessment = does the case comply with regulations ?

Business Rules Automation



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Allegro Tax Assistant (ATA)

- Task: Automated tax return assessment
- Technology: Rule-based, object-oriented
- Tool: Aion 8 by Computer Associates
- Productive prototype & system
- 450 expert rules / 800 system rules
- Scope: employed and unemployed (retired) individuals (with or without real estate)

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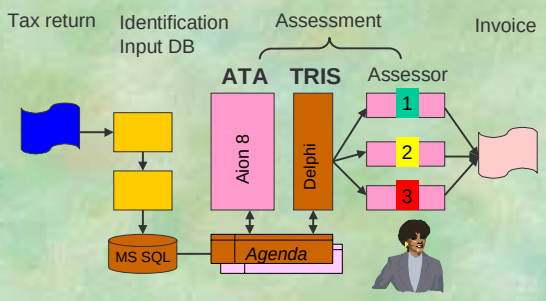
TRA Workflow with ATA



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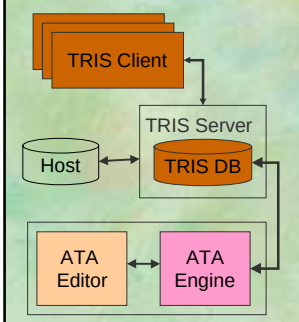
ATA Architecture: Integration



Tax Return Information System (TRIS)
- Identification
- Data Entry
- Assessment
- Special taxes

ATA Expert System
- Automated Assessment of Routine Cases
- Engine Maintenance Without Programming

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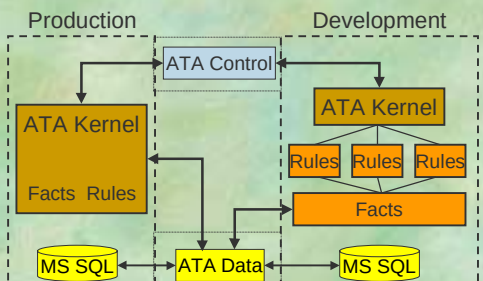
ATA Engine: Production & Development



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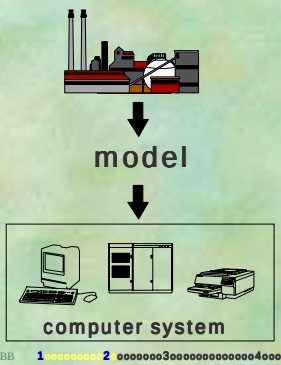
Automated Problem Solving



K. Dittrich, 1994

The Knowledge Principle

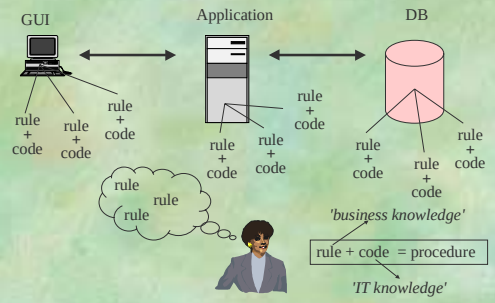
"A system exhibits intelligent understanding and action at a high level of competence primarily because of the *knowledge* that it can bring to bear: the concepts, facts, representations, methods, metaphors and heuristics of its domain of endeavour".

Edward Feigenbaum, 1991

Knowledge Models with Flow-Based SW: Properties

- Knowledge cast into procedures
- Knowledge & Program: interwoven
- Knowledge modeling: complication
- Knowledge formalisms: cryptic
- Knowledge organisation: dispersed
- Knowledge redundant, inconsistent

Conventional IT-Systems: *flow-based (procedural)*



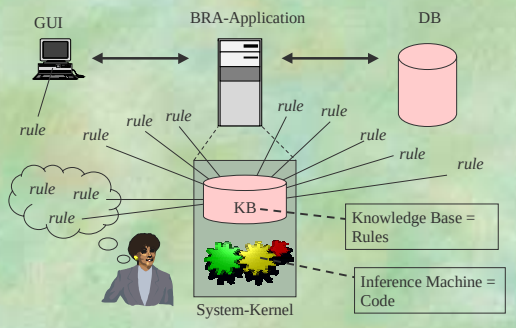
Knowledge Models with Flow-Based SW: Problems

- Expert & developer: communication gap
- Specification & model: organisation gap
- Specification & code: language gap
- Find knowledge
- Extend and maintain knowledge
- Reuse knowledge

Business Rules Autmation (BRA): 4 Basic Principles

- *Isolation*: Separation of knowledge and program
- *Deduction*: Dynamic generation of solution paths
- *Emulation*: Adaptation of knowledge organisation to human thinking
- *Abstraction*:Adaptation of knowledge formalisms to human language

BRA-Systems: *rule-based*



Business Rules Autmation : Benefits

- Quicker reactions to changes
- Improved participation of business people
- Improved knowledge sharing
- Knowledge maintenance by users
- Knowledge reuse, extension, migration (technical independence)
- Improved quality assurance, training, application development

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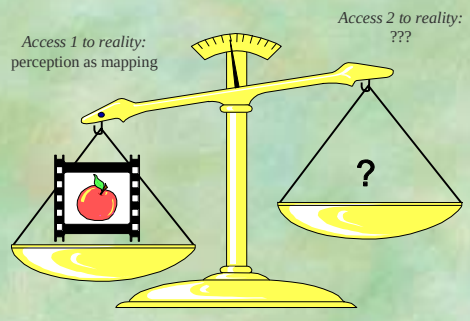
Knowledge modeling for IT

- *Find objects*
- *Choose concepts or predicates*
- *Validate objects & concepts*
- *What is modeled ?*
- *What is an object ?*
- *What is a concept ?*
- *What is a model ?*
- *What does a model represent?*
- *What do we do in modeling ?*
- *How do we do it ?*

Knowledge modeling as ‚*mapping*‘

Modeling tasks	Knowledge as mapping
Find objects	Are ready-made
Choose concepts or predicates	Are evident / Informally / Invent
Validate objects & concepts	Compare them with reality
What is modeled ?	Reality
What is an object ?	A thing
What is a concept ?	A list of attributes
What is a model ?	A surrogate that matches reality
What does a model represent?	Reality
What do we do in modeling ?	We map reality onto concepts
How do we do it ?	We analyse reality and extract knowledge (mining)

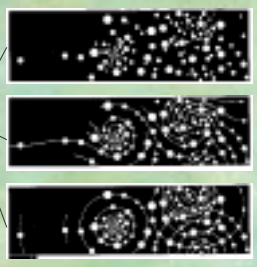
Knowledge as mapping: dilemma



How can we carry out this comparison ?

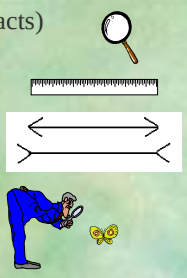
Multiple perceptions *instead of* unique mapping

We must become aware ... of the possibility to have multiple perceptions, all equally valid.
(de Bono, 1998, p. 75)

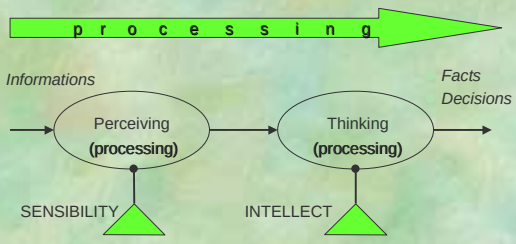


Perception neglected: facts

- Emphasis given to analysis (facts) and understanding (decisions)
- Interest directed to „what is“
- Perception conceived as untruthful pre-processing
- Scientist seen as discoverer, not as inventor



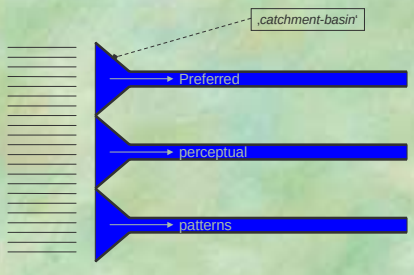
Perception neglected: cognition as ‚information processing‘



Perception neglected: Why?

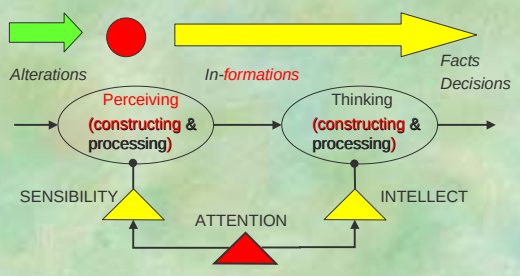
- Perplexity caused by the uncertainty of perception
  - optical illusions: obstacle or curiosity
- **Main strength of the brain: ‘*efficiency principle*‘**
  - to see anything in terms of past experiences
  - preference for available patterns

Preferred paths or patterns

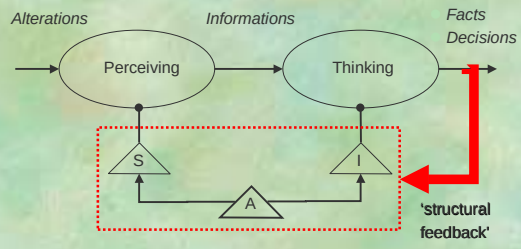


(adapted from: de Bono, 1998, p. 14)

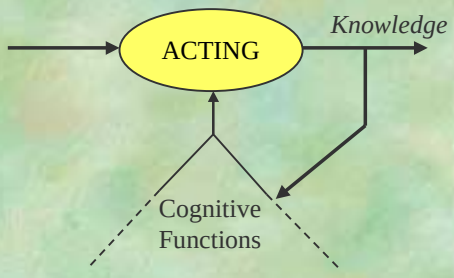
Perception revaluated: ‚attentional system‘



Perception revaluated: ‚attentional organism‘



Anatomy of Knowledge: Result & Instrument of Acting



Anatomy of knowledge: two states

explicit

tacit

Picture: Ronald Kramer, NL

explicit knowledge
- Manuals, Laws
- Reports, DB
- Diagrams, Drawings

tacit knowledge
- Heuristics (thumb rules)
- Experiences
- Skills
- Cases, Analogies
- Attitudes, Values

What do we do in modeling?

Modelling tasks	Knowledge as mapping	**Knowledge as constructing**
Find objects	Are ready-made	**We determine them tacitly**
Choose concepts or predicates	Are evident / Informally / Invent	**We choose according to schemata and principles**
Validate objects & concepts	Compare them with reality	**We compare them with other objects & concepts**
What is modeled ?	Reality	**Sensation and experience**
What is an object ?	A thing	**The unity of our synthesis**
What is a concept ?	A list of attributes	**A pattern of activity**
What is a model ?	A surrogate that matches reality	**A construction that fits (is viable in) reality**
What does a model represent?	Reality	**Specific experiences**
What do we do in modeling ?	We map reality onto concepts	**We construct generalizations of experiences**
How do we do it ?	We analyse reality and extract knowledge (mining)	**We synthesize knowlege that is viable**

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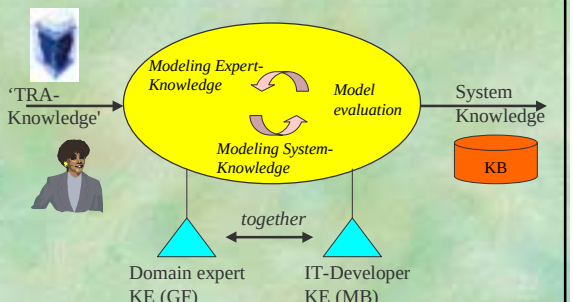
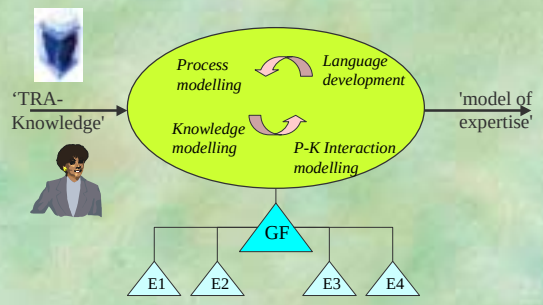
Knowledge Engineering: Process



Modelling Expert-Knowledge



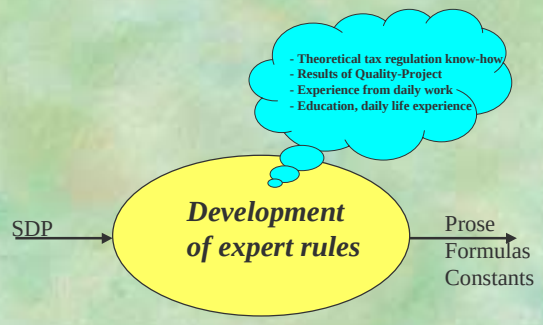
'Model of expertise': Position 25

- System-, Data- & Process-Model
- Knowledge-Model of domain expert
- Problem solving strategy
- Analysis of constraints (Covela, Host)
- Modify, test strategy
- Develop dependency formula
- Test strategy, develop expert rules
- Pos. 25(97) S *a_025 = Pos. 25 (97) C

Dok

Dok

Expert-Knowledge modeling



System-, Data- & Process-Model

- Increase of *AHV-/IV*-pensions
- System-Model: Gris ↔ Covela ↔ Host
- Data-Model:
  - current declaration in DB
  - assessed declaration of prior tax year
  - Gris-Tables
- Process-Model: Assessment activity

Problem solving strategy: specify rules by prose, formulas and parameters

25	*25,01*	*A self-hiring value must be equal to the GRIS value (State tax)*
	25,02	*A self-hiring value must be the same in both years (State tax)*
	25,03	*A self-hiring value must be the same as in the prior tax period (State tax)*
	25,04	*A land-register value of the building (Pos. 101) must be the same as in the prior tax year*

25	**25,01**	**Pos. 25 (97) = s_025a**
	25,02	**Pos. 25 (97) = Pos. 25 (98)**
	25,03	**Pos. 25 (97) = Pos. 25 (96)**
	25,04	**Pos. 101 (97) = Pos. 101 (95)**

s_025a	Sum 025a = all "self_hiring_value_sst" in Tab gris_emw
s_025b	Sum 025b = all "self_hiring_value_bst"in Tab gris_emw

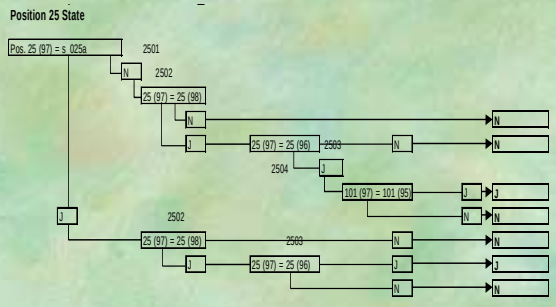
Test problem solving strategy

- Applying the rules produced assessment errors in more than 30% of the cases
- Error analysis pointed to host data errors
- Host DB for real estate data was inconsistent with manually assessed tax returns
  - Why this difference ?

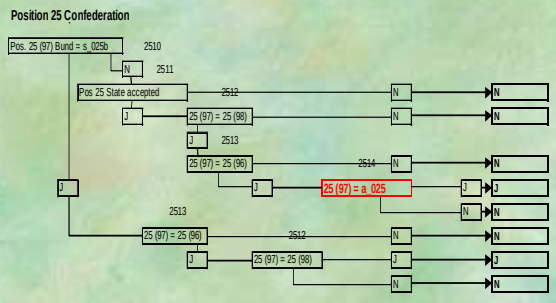
Analysis of constraints

- Missing data of real estate DB (Gris)
- Gris-Data < > assessed real estate data
- Court decision ‚collective property' was still not implemented in the system
- County of ‚Laufental' assigned to the canton of Baselland: errors in data transfer and in handling of modified or new properties

Modify and test strategy, specify rules by Decision Tree (1)



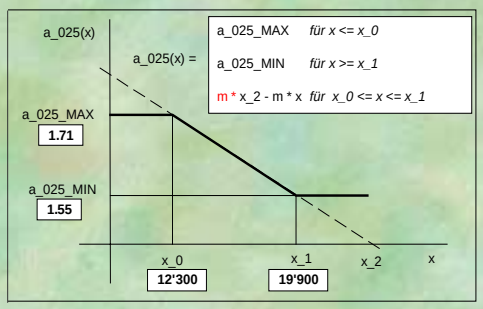
Modify and test strategy(2)



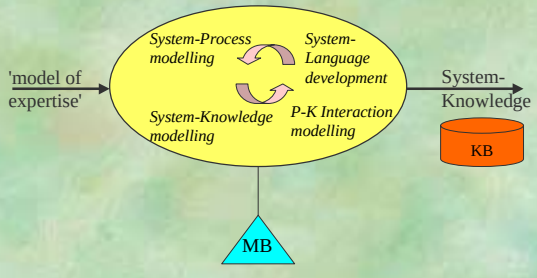
Development of a functional relation

- Up to a land-register value of Fr. 204‘800 (self-hiring value Fr. 12‘300) the surcharge for confederation taxes amounts at 71%
- For a land-register value between Fr. 204‘900 and Fr. 340‘800 (self-hiring value between Fr. 12‘400 and Fr. 19‘900) the surcharge for confederation taxes decreases linerly from 71% to 55%
- For land-register value higher than Fr. 340‘800 the surcharge for confederation taxes amounts at 55%

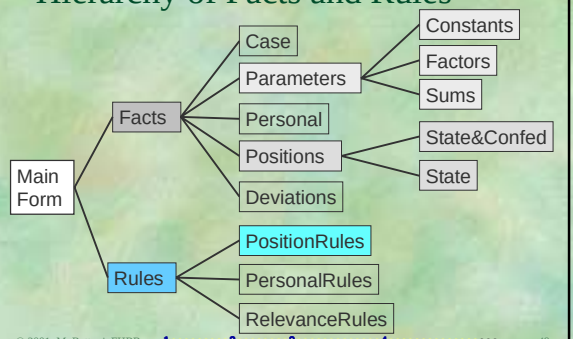
Pos. 25(97) S *a_025 = Pos. 25 (97) C



Modelling System-Knowledge



ATA Knowledge Model: Hierarchy of Facts and Rules



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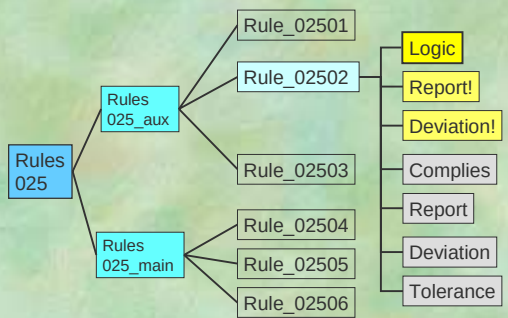
ATA Knowledge Model: Rule-Classes & Rule-Objects



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Constructive Knowledge Engineering - CoKE (1)

- Constructivist Theory of Knowledge
- Anatomy of Knowledge
- Domain Expert KE & IT-Developer KE
- Domain Expert must be free in modelling
- IT-Developer: Methods & Technology (constraints)
- evolutionary-explorative planning
- Connect modelling & development

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Constructive Knowledge Engineering - CoKE (2)

- Prototyping
- Development-Prototype
- Integrated Prototype
- Prototype in productive use
- Focus on Routine-Knowledge
- Analysis follows Modelling
- Experiments as Sources of Knowledge

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