Psychology and the internet: An European Perspective

Computerized Adaptive Psychological Testing
A Personalisation Perspective

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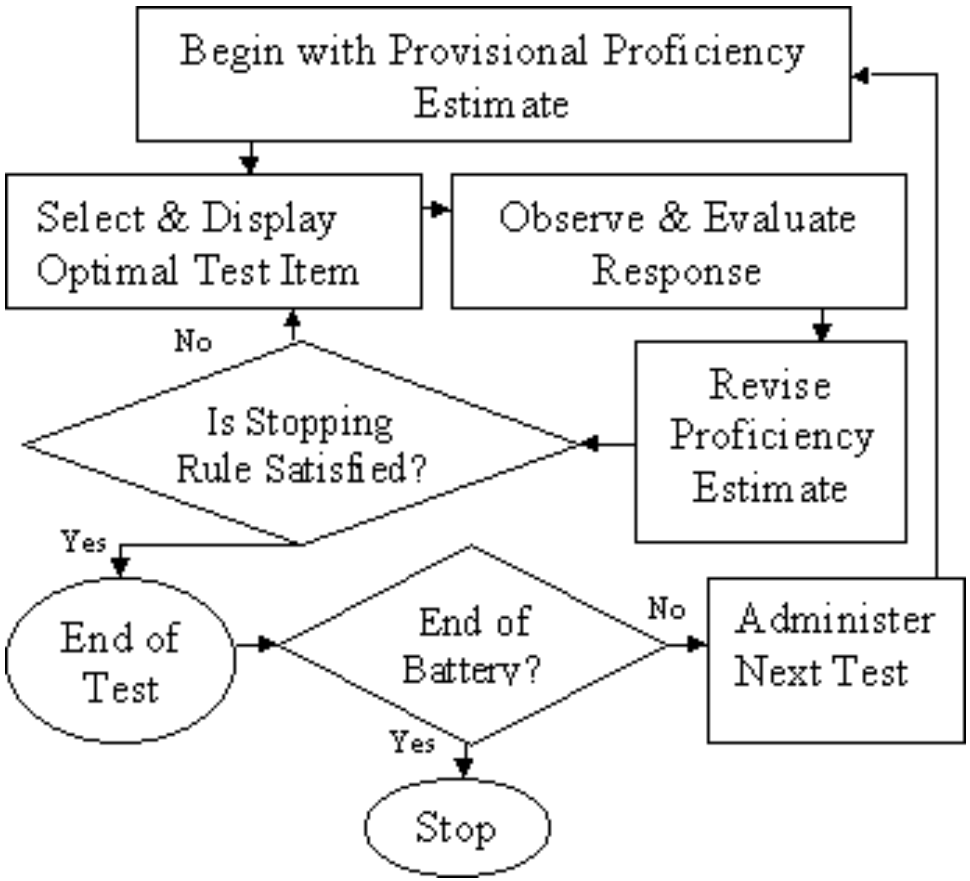
Introduction

- **Mixed Model of IRT and ES**
  - ES
  - IRT-based CAT
  - Manage the selection of test questions according to both ES rules and IRT parameters with priority to the first ones
  - Main benefit

Basic CAT Algorithm



Logic:

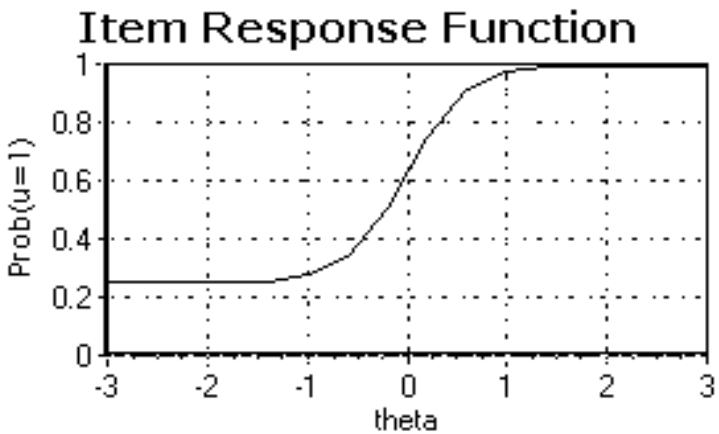
- ✓find out the “best” next item
- ✓administer the "best" next item and get the examinee’s respond
- ✓a new ability estimate is computed based on the responses to all of the administered items
- ✓steps 1 through 3 are repeated until a stopping criterion is met

IRT-model

$$I_i(\Theta) = \frac{P_i'(\Theta)^2}{P_i(\Theta)(1 - P_i(\Theta))}$$

$$P(\Theta) = c + \frac{1 - c}{1 + \exp(-a(\Theta - b))}$$

$$\hat{\Theta}_{s+1} = \hat{\Theta}_s + \frac{\sum S_i(\hat{\Theta}_{s+1})}{\sum I_i(\hat{\Theta}_{s+1})}$$



$$S_i(\Theta) = (u_i - P_i)\frac{P_i'}{P_i(1 - P_i)}$$

Computer Adaptive Testing

- Key Technical and Procedural Issues
  - Balancing content
  - Administering items belong to sets
  - Examinee Considerations
  - Item exposure
  - Item pool size
  - Shifting parameter estimates
  - Stopping rules

Computer Adaptive Testing

➢ Potential

- Significantly less time both for examinee and administrator is needed since fewer items are needed to achieve acceptable accuracy
  - CATs can reduce testing time by more than 50% while maintaining the same level of reliability
  - fatigue reducing
- CATs can provide accurate scores over a wide range of abilities while traditional tests are usually most accurate for average examinees

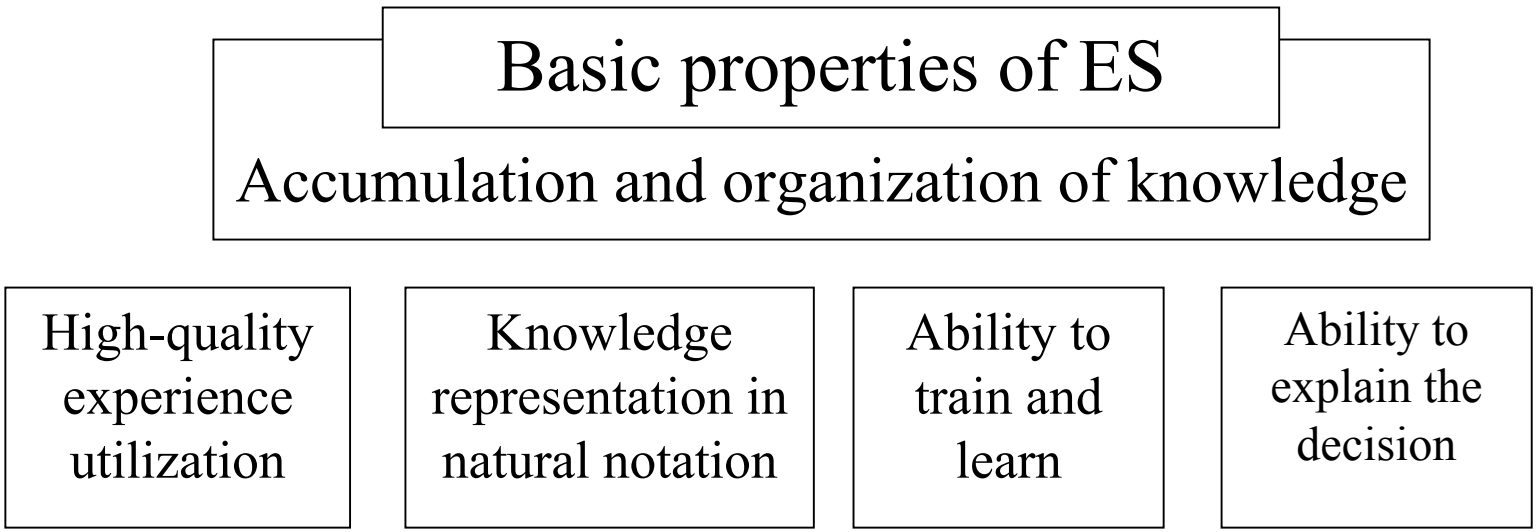
Computer Adaptive Testing

➢ Limitations

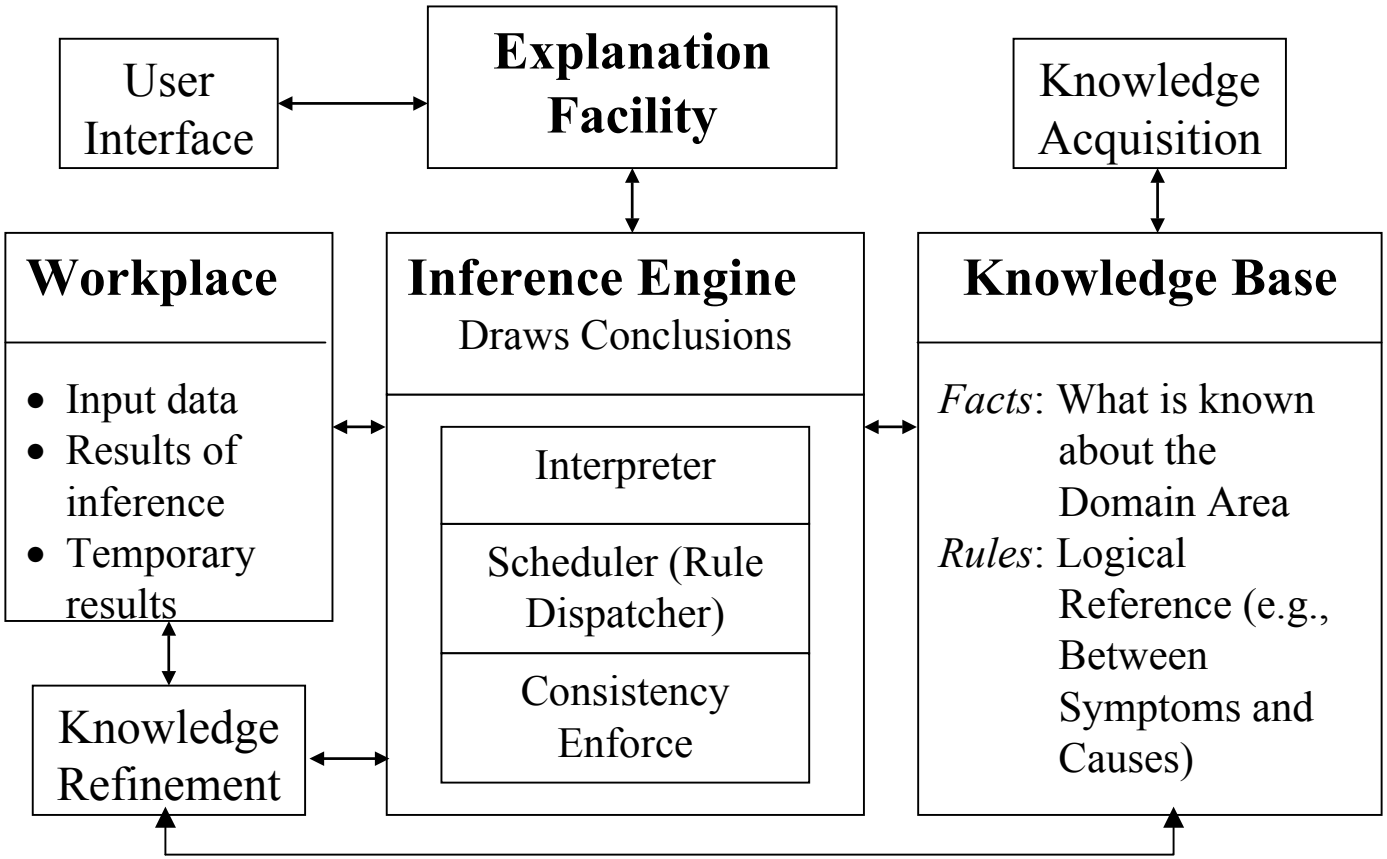
- CATs are not applicable for all subjects and skills.
- CATs require careful item calibration.
- With each examinee receiving a different set of questions, there can be perceived inequities.
- Examinees are not usually permitted to go back and change answers.
- The answers of an examinee are analysed only according to their accuracy that imply a lack of personalisation

Expert System

- ES as a tool of Artificial Intelligence
- Knowledge accumulation
- IF-THEN rules



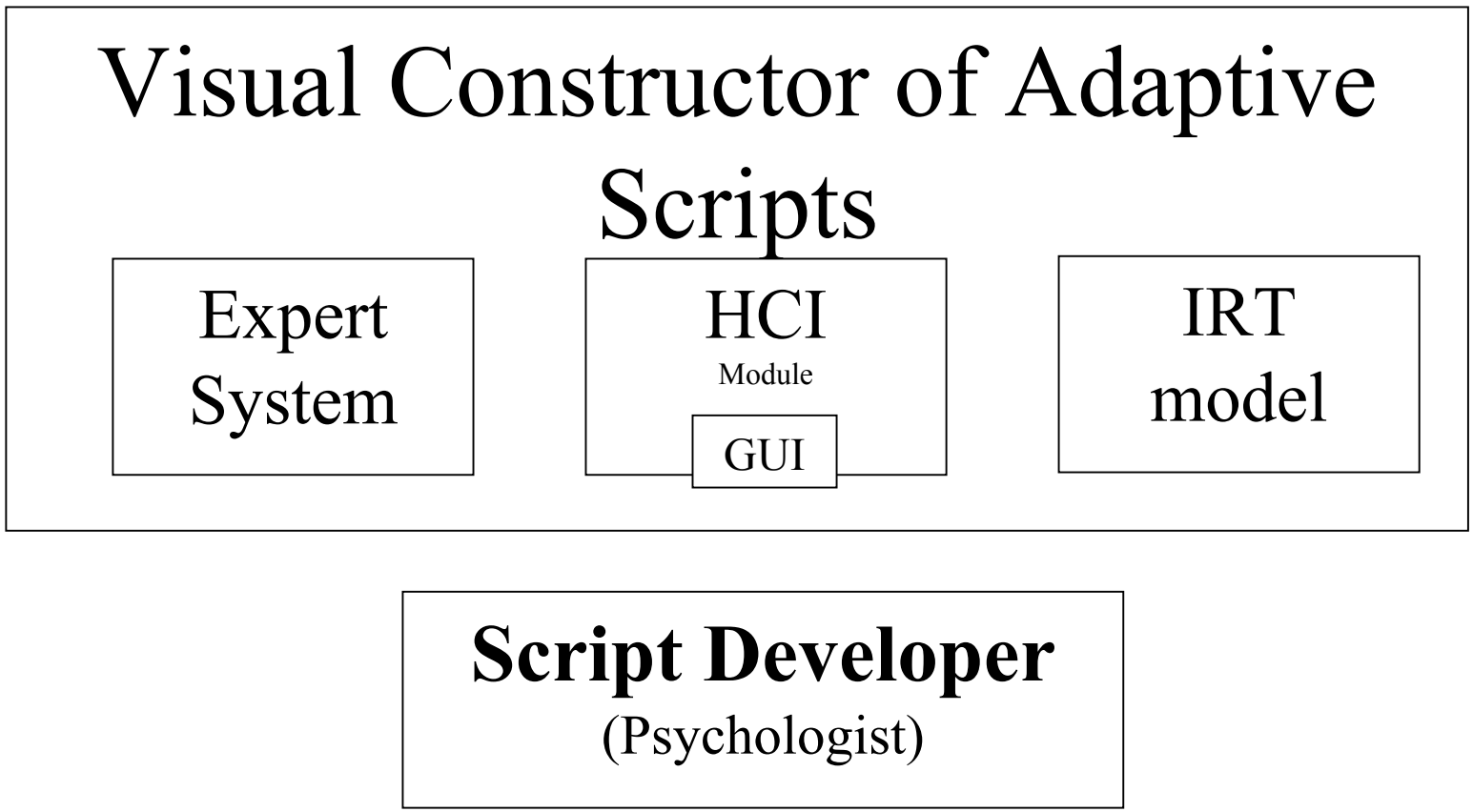
Basic Structure of an Expert System



Mixed Model of IRT and ES

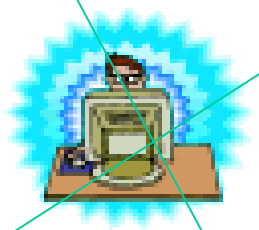
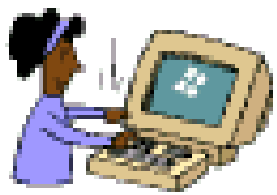
- Manage the selection of test questions according to both ES rules and IRT parameters with priority to the first ones

Basic Model of VCAS



GUI of VCAS

- Possibilities to:
  - create IF-THEN rules;
  - manage with IRT model
  - visualise tree-structure of cards when such structure exists


Advantages of the Mixed Model

- Aggregation of benefits from ES and CAT and overcoming of CAT limitations
  - analysing the answers not only according to their accuracy benefits
  - more sophisticated test script personalisation to an examinee, comparing to conventional CAT systems

Examples of ES & battery

- Use ES rules to define the problem and then provide an IRT-based test battery
- by switching between IRT and rules

Patterns of dissociation between operations predicted by the triple-code model of number processing (Cohen & Dehaene, 2000)

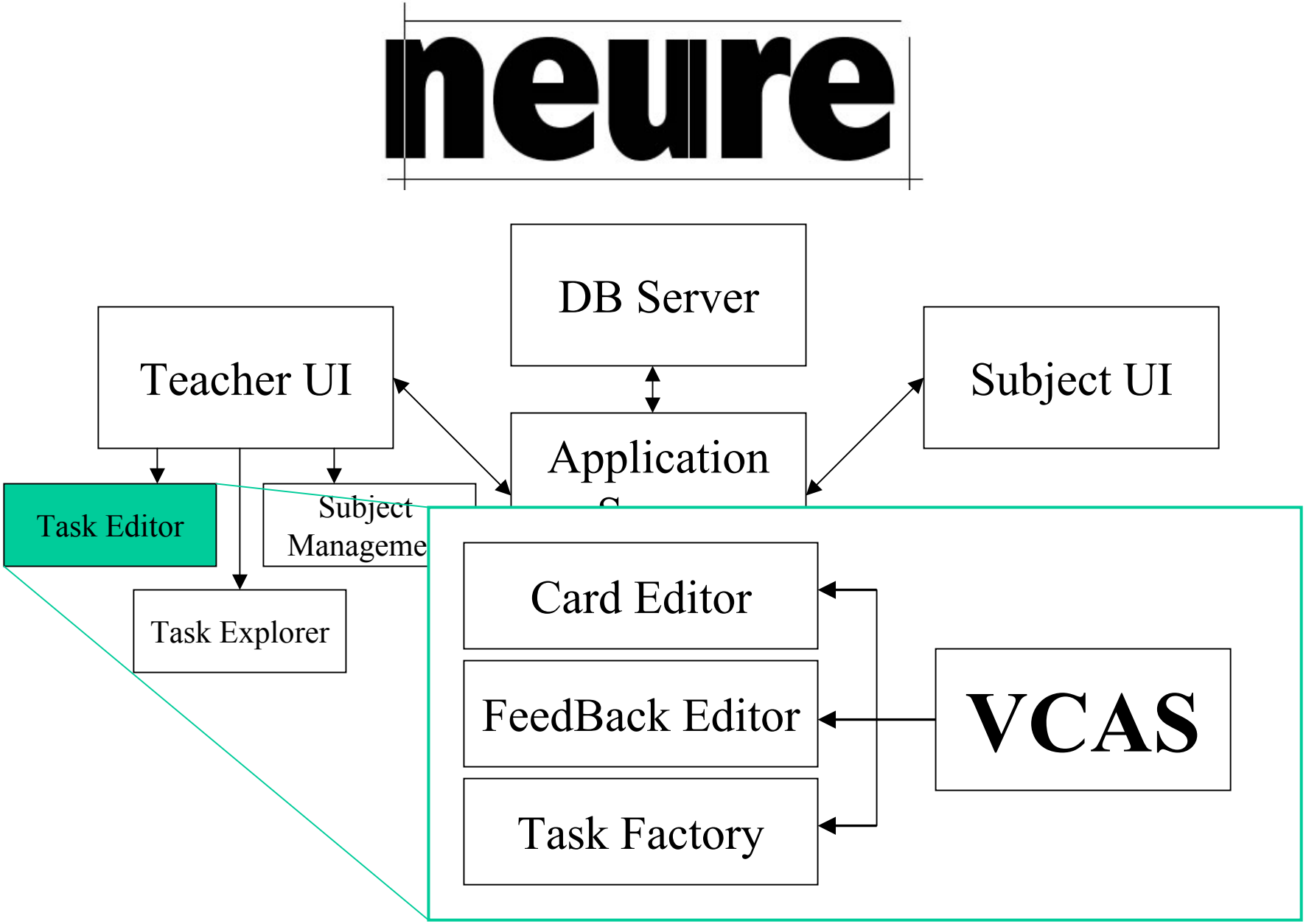
Multiplication	*Addition*	*Subtraction*	*Commentary*
×	–	–	Impaired rote verbal memory
–	–	×	Impaired quantity manipulations
×	×	–	Impaired rote verbal memory + reliance on rote memory for addition
–	×	×	Impaired quantity manipulations + reliance on quantity manipulations for addition
×	×	×	Global acalculia
×	–	×	Impossible pattern
–	×	–	Impossible pattern

Description of the patterns by the set IF-THEN rules in an Expert System

IF *Problems in*	THEN *Provide test*
Multiplication	Impaired rote verbal memory
Subtraction	Impaired quantity manipulations
Multiplication **AND** *Addition*	Impaired rote verbal memory **AND** reliance on rote memory for addition
Addition **AND** *Subtraction*	Impaired quantity manipulations + reliance on quantity manipulations for addition
Multiplication **AND** *Addition* **AND** *Subtraction*	Global acalculia
(*Multiplication* **AND** *Subtraction*) **OR** *Addition*	**ERROR** in the set of facts in the working memory of ES: Impossible pattern

Application to NEURE

- What is NEURE?
  - Netexperimental generation tool
  - Tool for computer-aided assessment and rehabilitation at developmental disorders, namely learning disorders and cognitive disabilities in perception
- Why to NEURE?
- Where to NEURE?


neure
DB Server
Teacher UI
Subject UI
Application
Task Editor
Subject
Manageme
Task Explorer
Card Editor
FeedBack Editor
Task Factory
VCAS

Preliminary results

- Mixed model is implemented with Java programming tools
- Integration process with NEURE, namely with TaskEditor part is going on

Future work: Main Focus

- Problems of classification, feature extraction, etc.
- Neural Networks as a tool for run-time data processing
- Adaptive selection of a tool to provide an improved script adaptiveness

Extended conceptual VCAS Model