

# Choosing a Student Model for a Real World Application

**Jiří Řihák**, Radek Pelánek

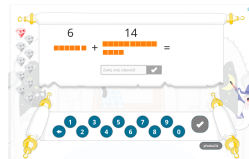
Masaryk University Brno



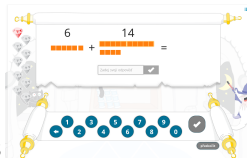
Development of applications: [matmat.cz](http://matmat.cz), [outlinemaps.org](http://outlinemaps.org), ...

- What student model we should select?
- What features of the model we should focus on?
- How many answers the model needs?
- ...

- online, free, without ads
- basic arithmetic -  $+$ ,  $-$ ,  $\times$ ,  $\div$
- 150 000 answers, 2 000 items
- adaptive practice
- importance of response time

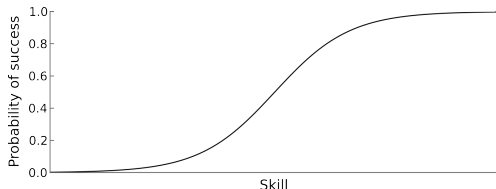


- online, free, without ads
- basic arithmetic -  $+$ ,  $-$ ,  $\times$ ,  $\div$
- 150 000 answers, 2 000 items
- adaptive practice
- importance of response time
  - correct answer to  $3 \times 5$  in **2** seconds
  - correct answer to  $3 \times 5$  in **14** seconds



# Adaptability

- selection of question - targeting 75% success rate
- model parameters - **difficulties** of items and **skills** of learners
- domain model - several skills per learner
- use of response time



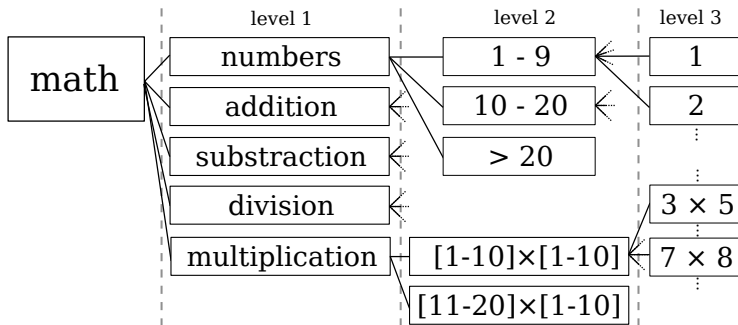
What aspects of student modeling  
are most important?

# Aspects to Compare

Three aspects of student modeling

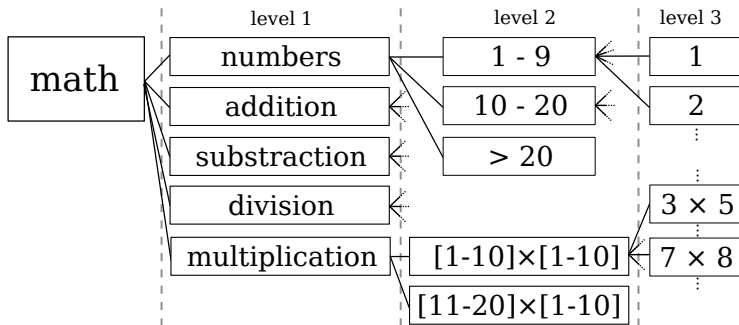
- domain modeling
- response times utilization
- missing answers utilization

# Domain Modeling





# Domain Modeling

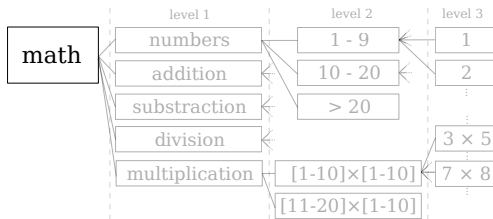


Too complicated?

- Item average - no skill

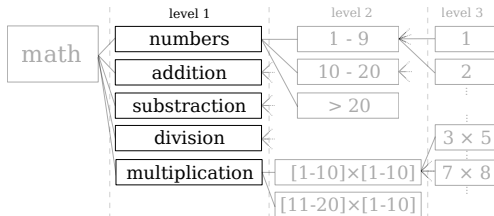
# Domain Modeling

- Item average - no skill
- Basic model - one global skill



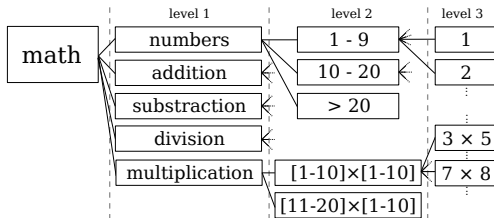
# Domain Modeling

- Item average - no skill
- Basic model - one global skill
- Concepts model - 5 skills



# Domain Modeling

- Item average - no skill
- Basic model - one global skill
- Concepts model - 5 skills
- Hierarchical model

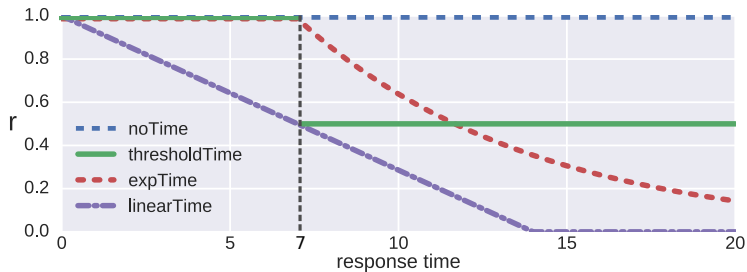


# Response Times

- classic response:
  - $r = 0$  - wrong answer
  - $r = 1$  - correct answer
- use of response time:
  - $r = 0$  - wrong answer
  - $r \in [0, 1]$  - correct answer

# Response Times

- no time
- threshold time
- exponential time
- linear time



# Wrong Answers

- many missing answers - skips
- long sequences of missing answers
  - adults trying system
  - gaming system
- simple model extension:
  - probability of missing next answer
  - based on number of previous missing answers

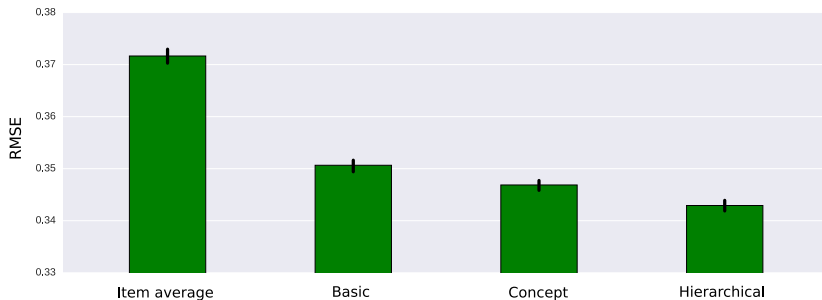


# Aspects to Compare

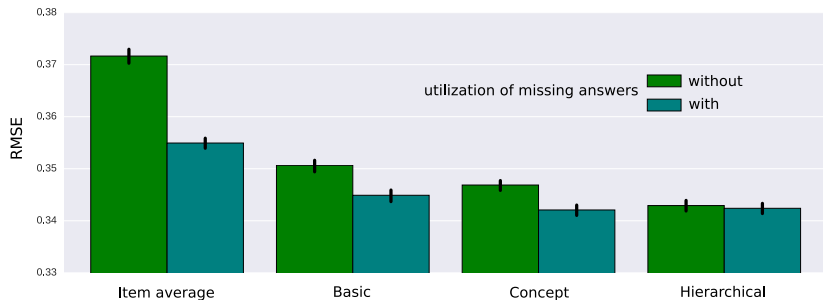
Three aspects of student modeling

- domain models - 4
- response times uses - 4
- missing answers - with and without

# Prediction Accuracy



# Prediction Accuracy



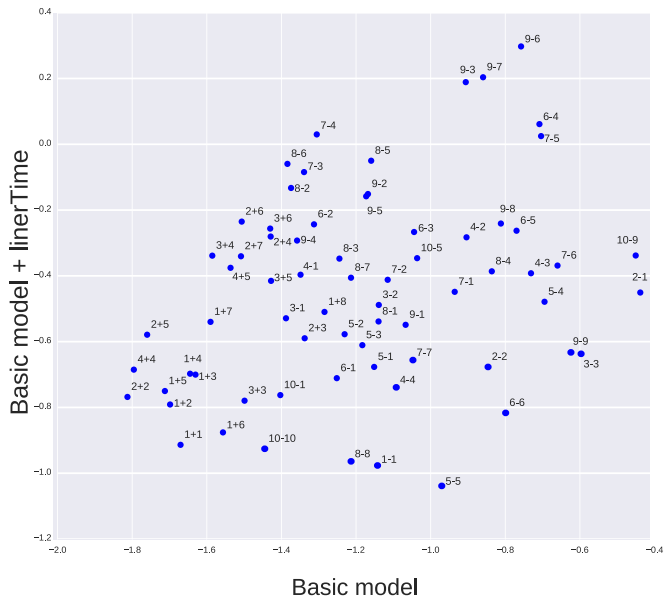
- 1 Large improvement over baseline does not mean usefulness for more complex models.

# Prediction Accuracy - Time

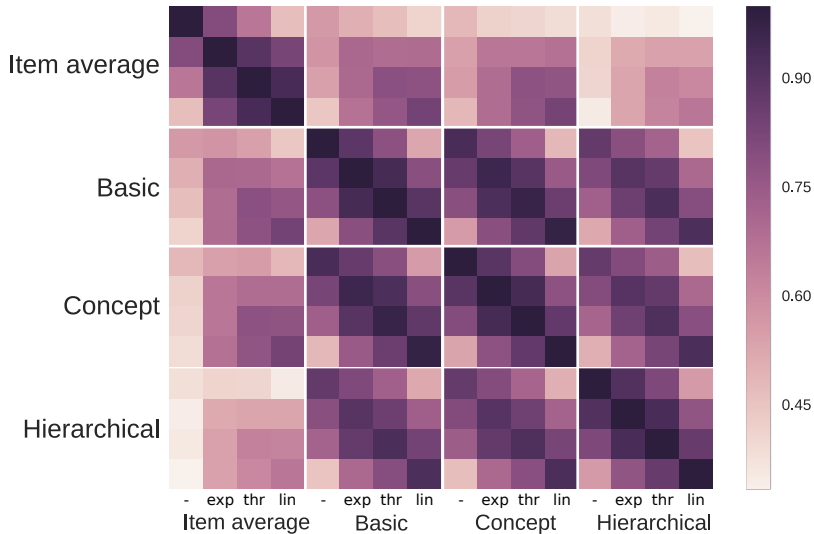
Comparing models with different time utilization

- models are trained to predict different absolute values
- direct comparison is not possible

# Estimated Parameters - Difficulties

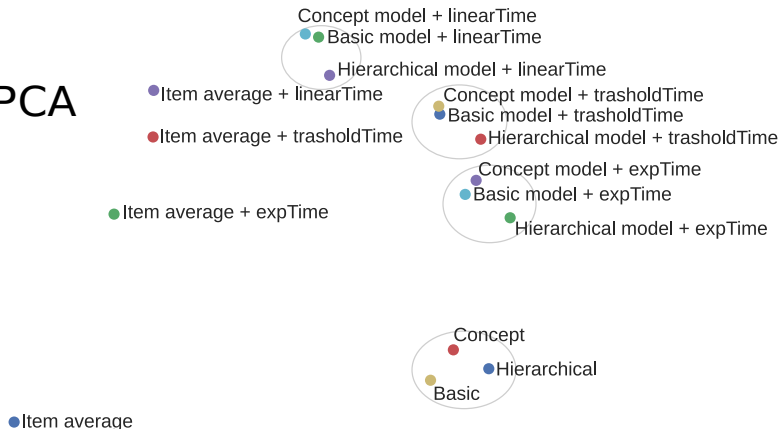


# Correlations of Estimated Parameters



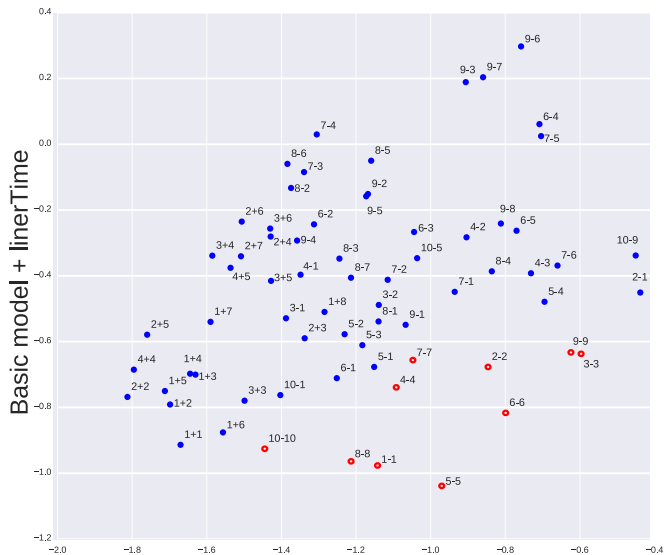
# Correlations of Estimated Parameters

PCA



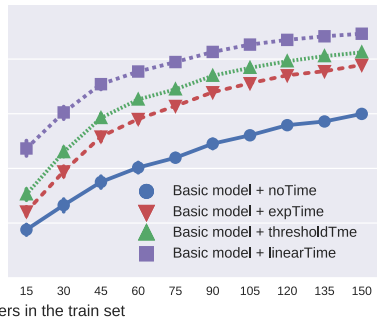
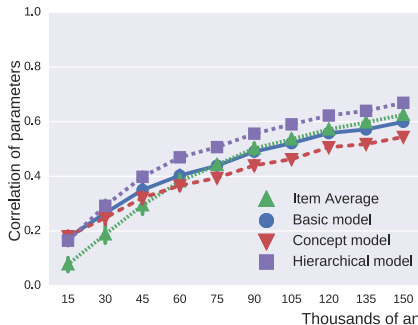
- 2 Response time utilization have larger impact on trained parameters that domain modeling.

# Estimated Parameters





# Estimated Parameters - Stability



- 3 Utilization of response time have large impact on model stability.

# Conclusion

- ❶ Large improvement over baseline does not mean usefulness for more complex models.
- ❷ Response time utilization have larger impact on trained parameters than domain modeling.
- ❸ Utilization of response time have large impact on model stability.

Incorporation of different aspects of student modeling may be more important than detailed modeling of one particular aspect.