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REPAIRING DISENGAGEMENT

Based on the paper
"Repairing Disengagement With Non-Invasive Interventions"
by Ivon Arroyo et al. (2007)

Motivation

- We have
  - Students using a tutoring system
  - Decrease in motivation (= disengagement)
- We want to
  - Detect disengagement
  - Adapt to disengaged behavior by providing "something useful"

→ Machine learning

Machine learning with data

- Adapt to new circumstances automatically
  1. Learn engagement state
  2. Dynamically react on current engagement

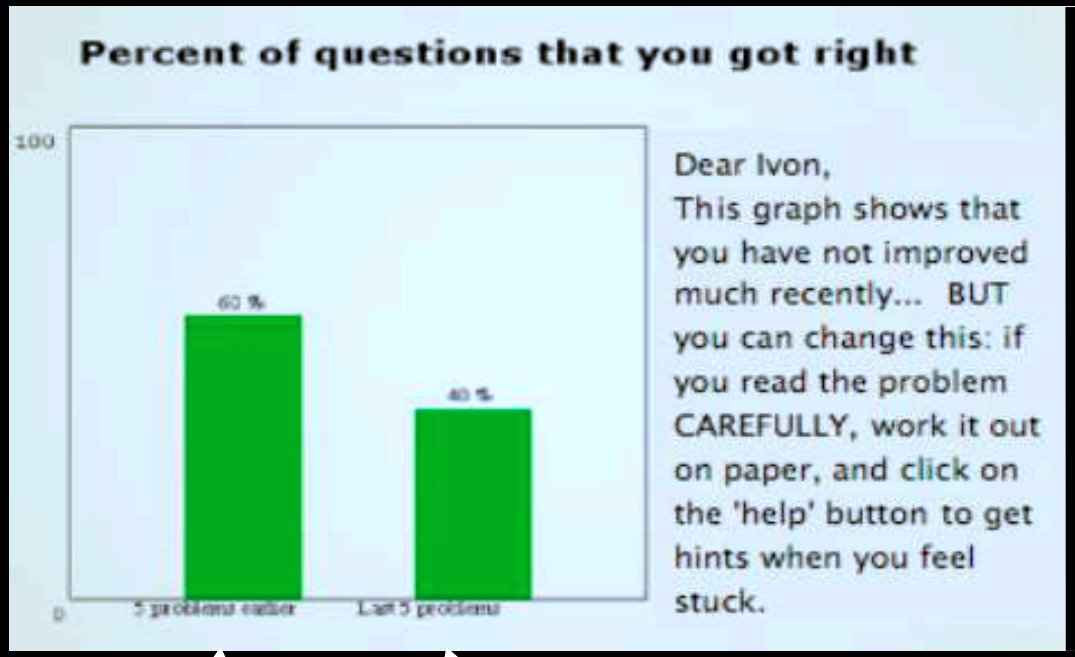
- How to learn the engagement state?
  1. Collect data (→ Data acquisition)
  2. Process data
     (predict engagement state by using special techniques to "calculate" the engagement state)

Data acquisition

Students after logon pseudo-randomly assigned to

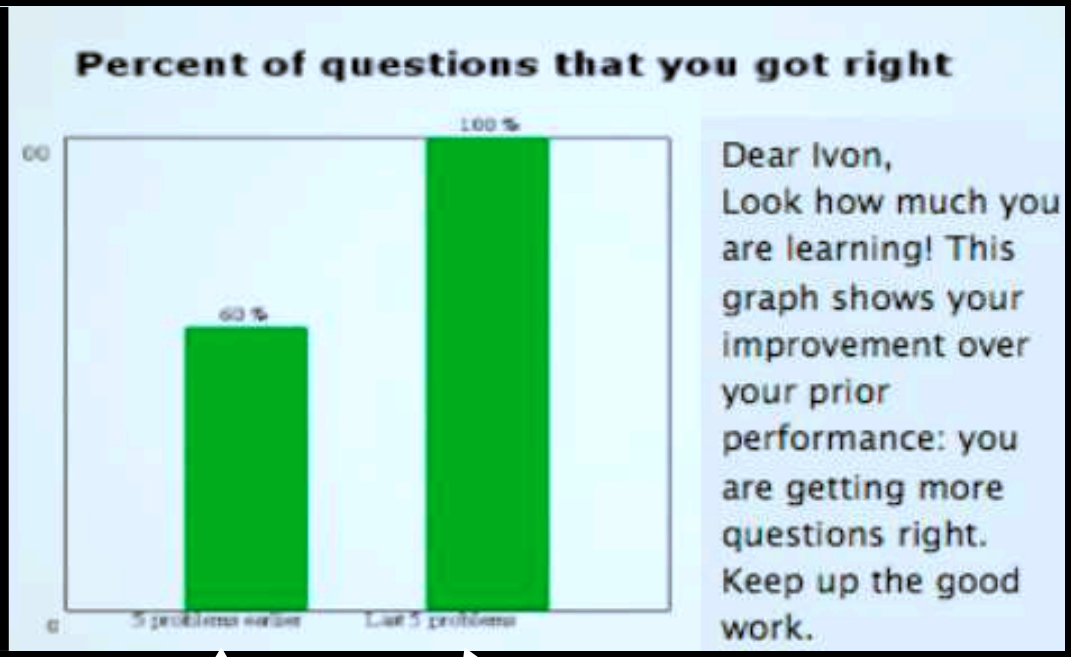
- Tutor Control Group
  - Traditional Wayang: Possibility to click on help button which provides multimedia hints
- Experimental (Interventions) Group
  - Receiving intervention screens at fixed intervals of 6 problems

Performance Graphs



5 problems earlier

Last 5 problems



5 problems earlier

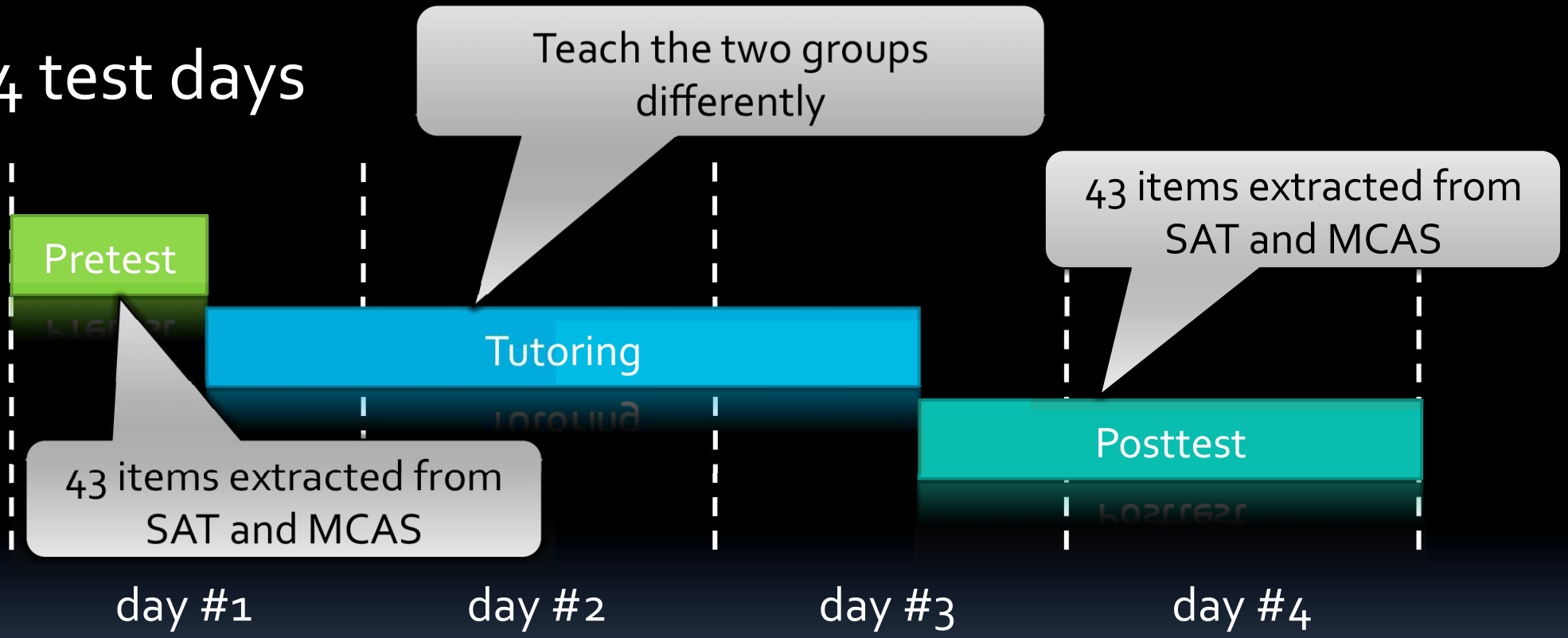
Last 5 problems

Tips

- Suggest a productive learning behavior
- Tip-read-carefully
  - Slow down, read problem carefully, read provided hints carefully
- Tip-make-guess
  - Think about the problem, make a guess, if guess is wrong then ask for hints

Data acquisition (2)

- 4 test days



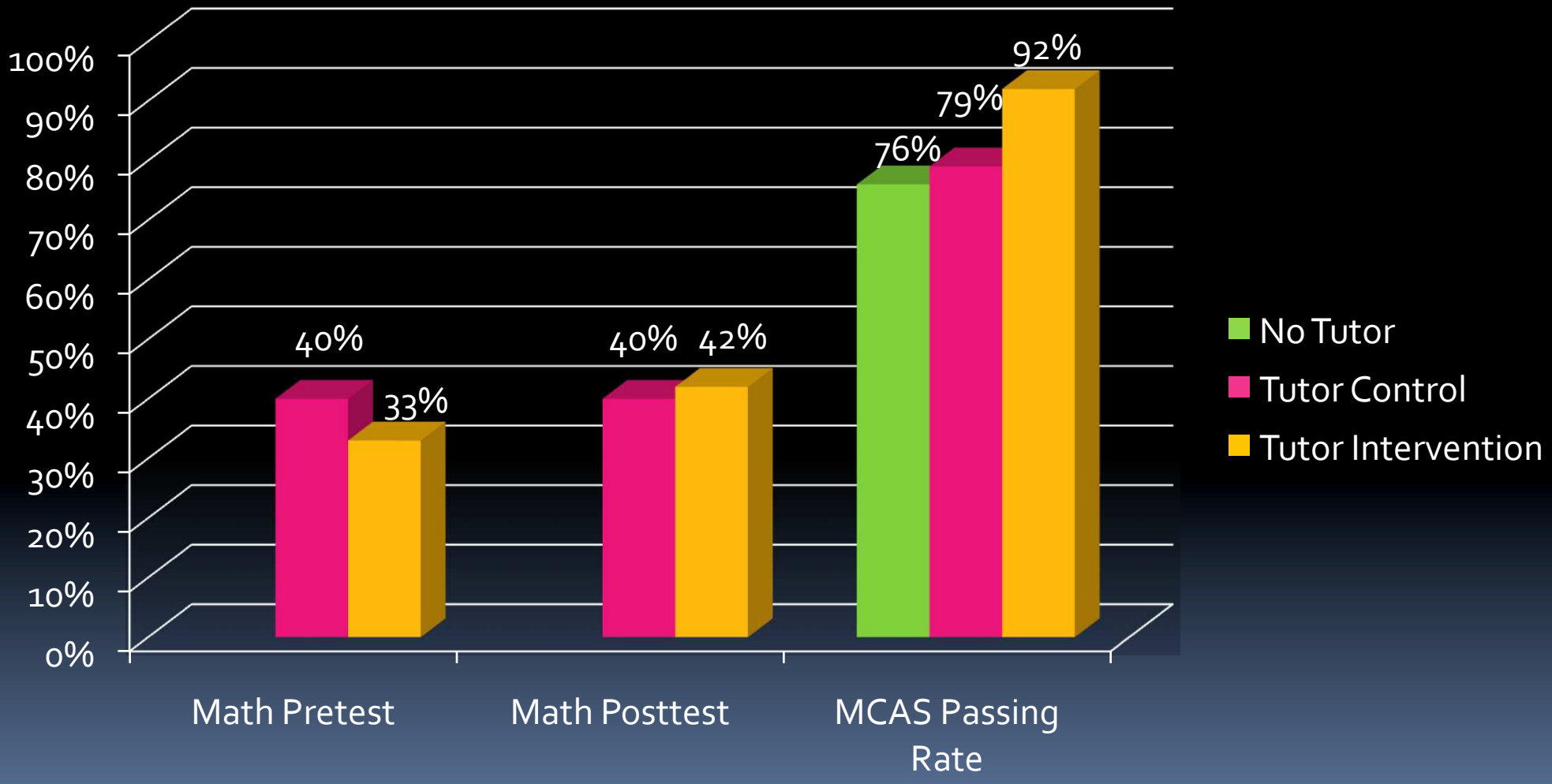
- Now we want to analyze this data…

Data analysis

1. Do interventions help (at all)?
2. What type of interventions help?
3. Whom do interventions help?
4. How can you predict whether an intervention helps at a certain point?

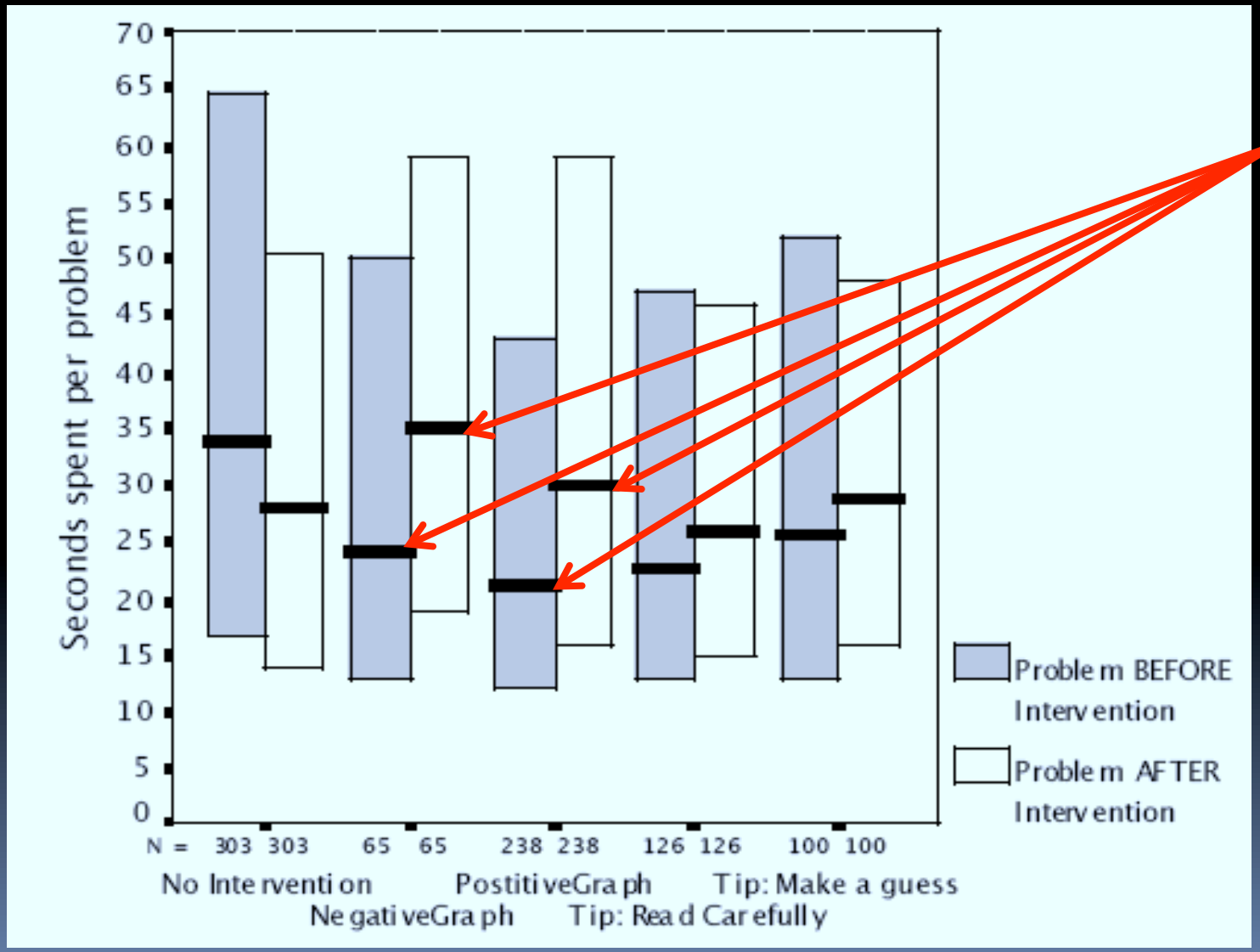
Data analysis: step 1

Do interventions help (at all)?



Data analysis: step 2

What type of interventions help?



Increase of median time spent in the problem after seeing an intervention.

Significant difference in time spent for Graphs, but not for Tips.

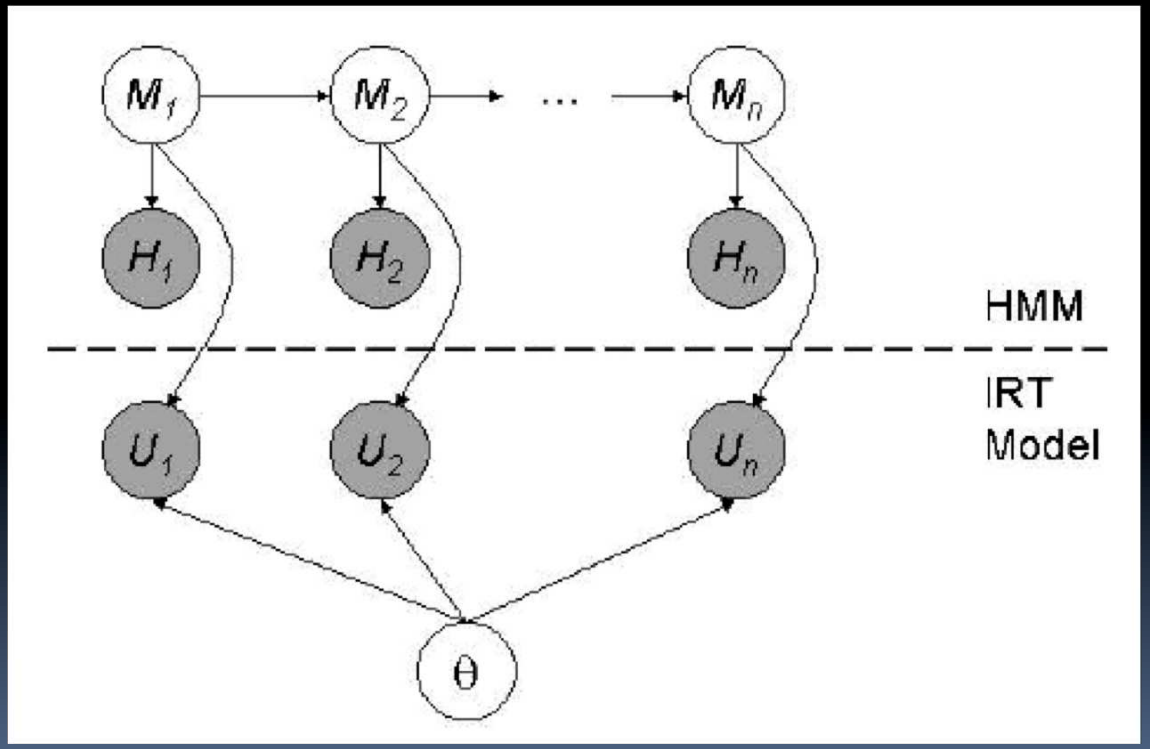
N: number of random pairs of subsequent problems

Data analysis: step 3
Whom do interventions help?

- Help for disengaged students!
- Problem: How to detect disengaged students?
- Solution: Dynamic Mixture Model-IRT (based on *Hidden Markov Models* and *Item Response Theory*)

Data analysis

- Dynamic Mixture Model-IRT (= IRT + HMM)



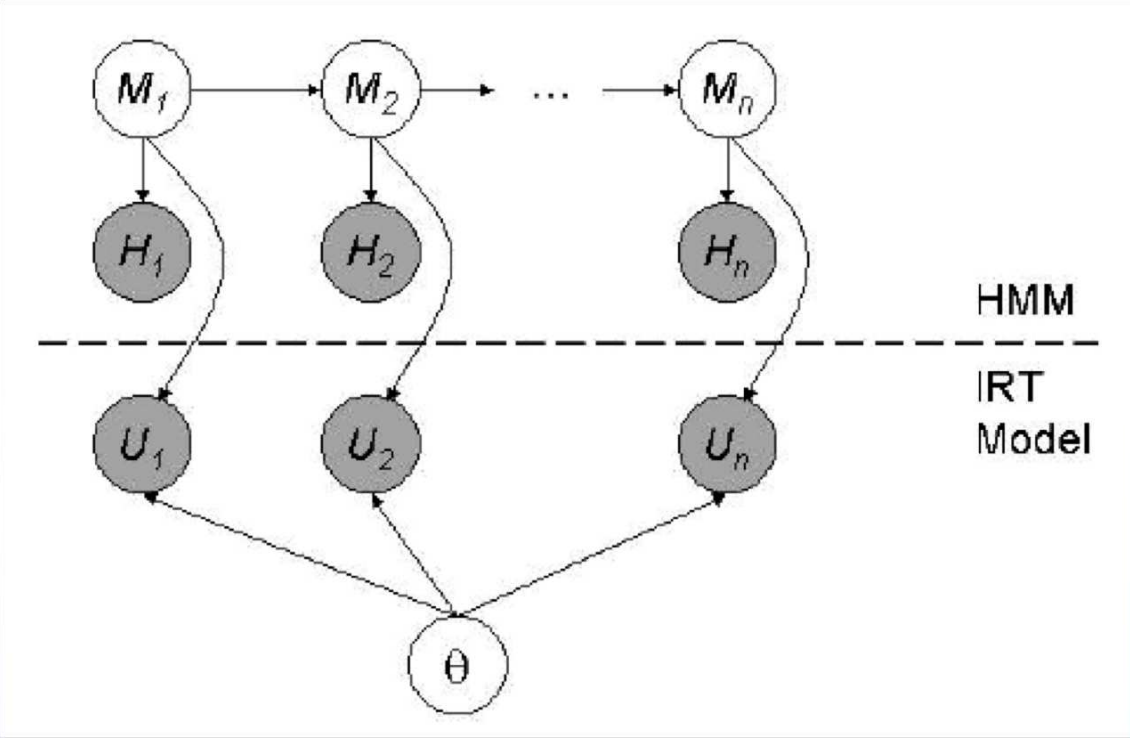
i: current problem
M_i: motivation
H_i: evidence of motivation
U_i: (initial) response of user
θ: proficiency

Source:
J. Johns et al. "A Dynamic Mixture Model to Detect Student Motivation and Proficiency"

Data analysis: step 4

How can you predict whether an intervention helps at a certain point?

- Dynamic Mixture Model-IRT (= IRT + HMM)



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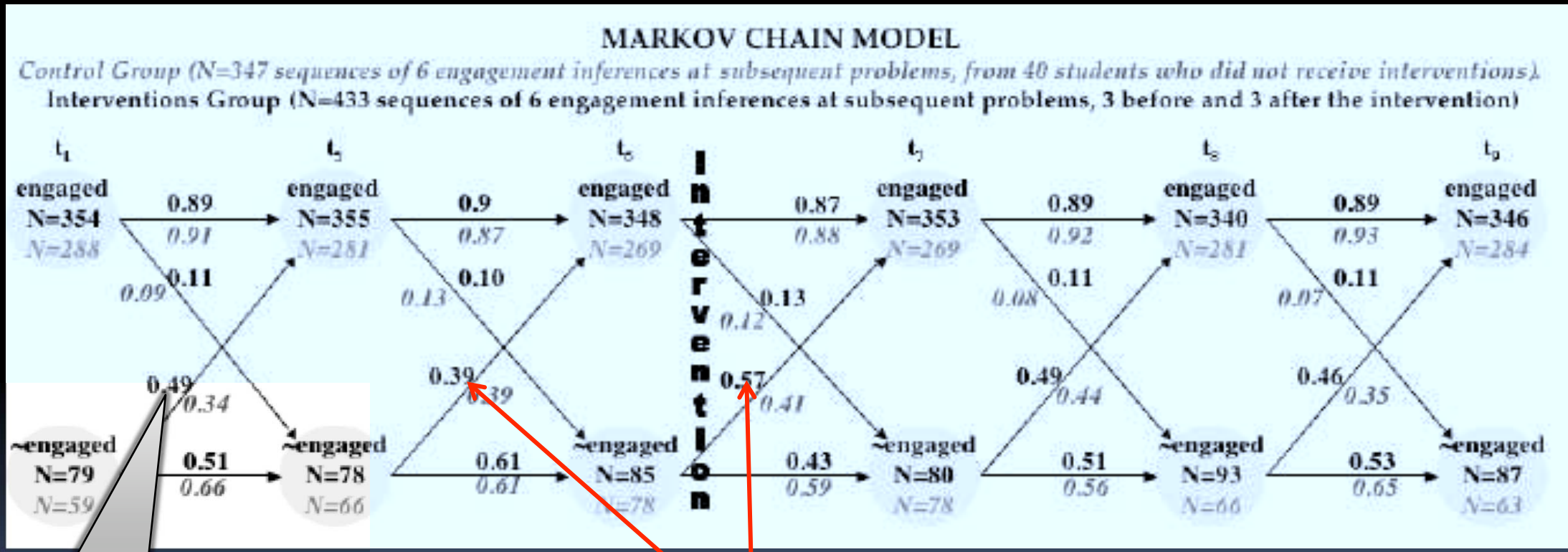
Engaged or not engaged, that is the question...



$P(E_{t5}|\sim E_{t4}) = 0.49$

Interventions help disengaged students!

N: number of students

Summary

- The “winner”: Interventions group.

Summary

- The “winner”: Interventions group. Why?
  - Lower pre-test scores, but higher post-test scores
  - Higher passing rates in standardized tests
- Conclusion: Presented data mining helps to detect disengagement and react on it
- How can we use such data mining in ActiveMath?

How to use such data mining in ActiveMath?

- Present (non-invasive) interventions
  - based for example on Dynamic Mixture Model-IRT to predict engagement state (for which students?)
  - adapted to the user's engagement state (which interventions? / when?)
  - maybe with additional information such as
    - feedback on planning how to solve a specific kind of problem
    - individual hints based on user's profile

THANK YOU!

QUESTIONS?