Learning Analytics Challenges: Trade-offs, Methodology, Scalability

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LAK 2020

Context and Inspiration

- LAK 2020 theme: Shaping the future of the field

  We also invite short papers that explicitly address the theme of this years conference by reflecting on past, present, and future research foci in the field of learning analytics
- LAK 2019 keynote – Ryan Baker's challenges
  - six challenges, focus on clear specification/goals
  - inspired by Hilbert's problems

my argument: we should focus on hard-to-grasp, ill-defined problems

Netflix Prize

- closely related area: recommender systems
- Netflix Prize: 1 million dollars
- well-structured, clearly defined task (improving RMSE by 10%)
- impulse for research, lot of attention
- limited practical impact

Challenges

1. trade-offs
2. methodology
3. scalability

Trade-offs: Examples

- mastery learning thresholds: over-practice vs under-practice
- engagement vs learning
- hints: support for learning vs risk of gaming
- dashboards: focus on comparison with other vs individual results
- interests of students vs researchers
- model accuracy vs implementation simplicity

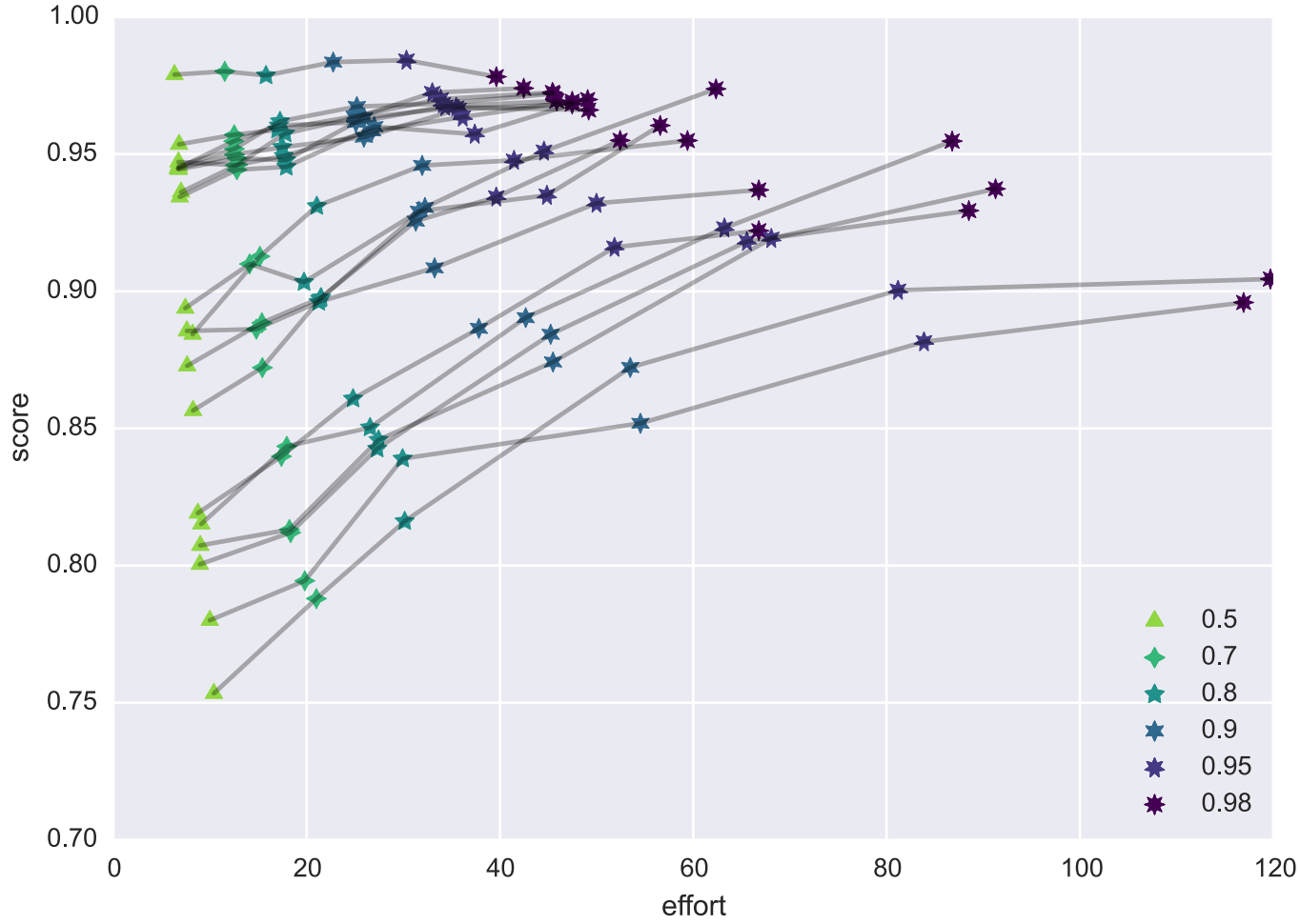
Trade-offs: Research

- hard to perform research studies – evaluation is difficult
- but practically very important

research directions:

- visualization of trade-offs
- exploration using historical data
- optimization with multiple criteria

Visualizing Trade-offs: Mastery Criteria



Methodology

Baker's challenges and typical current research:

- briefly described data
- results for a specific performance metric (e.g., AUC)
- little attention to methodological details

$\Rightarrow$ this can be problematic

Case study: *Deep Knowledge Tracing* paper

Methodological Details Matter

- biases in data
- choice of metric (AUC / RMSE / MAE / ...)
- details of metric computation (averaging)
- train-test set data division

The details matter: methodological nuances in the evaluation of student models. User Modeling and User-Adapted Interaction, 2018

Methodology

challenges, research opportunities:

- clarification of methodological issues
- use of simulated data
- dealing with biases
- "what works when"
  e.g., mapping techniques to Knowledge–Learning–Instruction framework
- systematic replication, reproduction

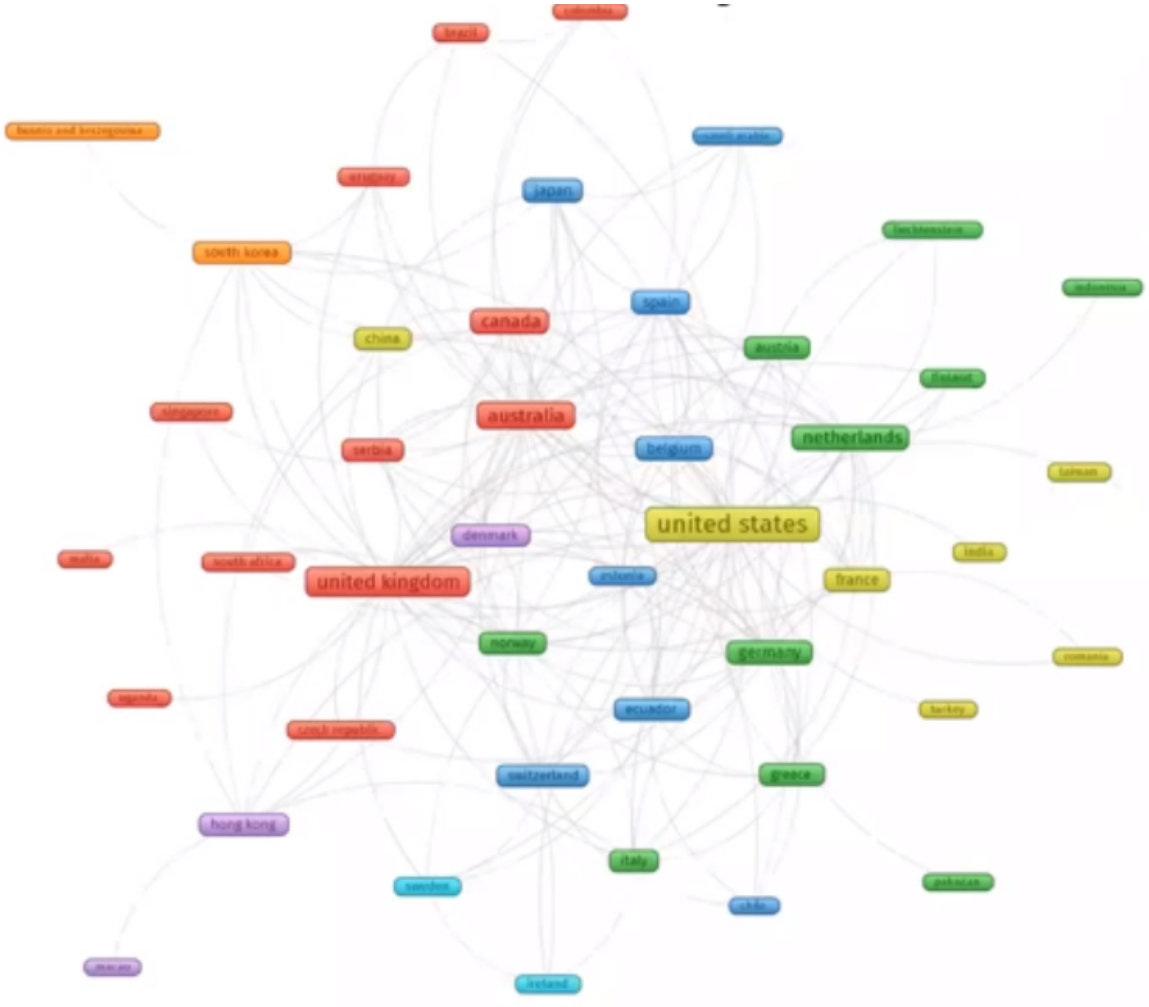
Scalability

- **computational** scalability:
  using techniques on real life traffic / data
- **development** scalability:
  developing systems under real life constraints

My Setting

- `umimeto.org`
- adaptive practice for Czech students (K–12)
- mathematics, Czech, English, programming, ...
- 2 computer scientists + 6 content creators (few hours a week)
- $\sim$ 10 000 students daily

Countries at LAK



Development Scalability

- developing and managing content (tens of thousands of items)
- student models: taking into account implementation simplicity, number of parameters
- "debugging perspective" – identifying most important bugs

Development Scalability: Research Challenges

practical issues – interesting research problems

- item similarity measures
- simple, robust student models
- outlier detection (finding "bugs")
- Q-matrix validation/refinement

Baker's Challenges

1. Transferability: The (learning system) Wall
2. Effectiveness: Differentiating Interventions and Changing Lives
3. Interpretability: Instructors Speak Spanish, Algorithms Speak Swahili
4. Applicability: Knowledge Tracing Beyond the Screen
5. Generalizability: The General-Purpose Boredom Detector
6. Generalizability: The New York City and Marfa Problem

(Dis)Agreements

- common points:
  - research for practical impact
  - high-level goals
- difference:
  - try to clearly specify the goal, focus on techniques to achieve the goal
  - acknowledge that goals are not clear, focus on methodology

Role of Competitions

- competitions = challenges with clearly defined goals
- very good for quick progress in a specific direction
- less suitable for guiding long-term progress

Discussion

- the main point of this paper was meant to stimulate personal discussion at the conference
- let's have it virtually...

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