Massive Open Online Courses (MOOCs)

- Education available to everyone
- Ease of access
- Efficient learning

Goals
- Predict students' performance
- Analyze student performance
- Provide personalized feedback to students
- Provide feedback to the course instructor

Challenges
- Large number of students
- Hard to track individual performance

Main Idea
- Find underlying hidden groups of students
- Find predictive covariates
- Reduce dimensionality by latent variable modeling algorithms

Conditional Latent Tree Model (CLTM)

Combination of Conditional Random Fields (CRFs) and latent tree graphical models

Conditional Random Fields (CRFs)
- Relevant covariates affect student learning performance
  - Previous time observations
  - History of observations
  - Knowledge Components
  - Seasonality (day of week)

Latent Tree Graphical Models
- Shared underlying groups of students
- Students are not conditionally independent
- Latent trees are scalable and tractable

\[
Pr(Z|X, \theta) = \exp \left( \sum_{i \in Z} \phi_i(X, \theta) + \sum_{i \in Z} \phi_i(X, \theta) | z_i - A(X, \theta) \right)
\]

Learning CLTMs

Structure Learning
- Unsupervised learning
- Chow-Liu Recursive Grouping algorithm (CLRG)
- Consider conditional information distances in CLRG

Parameter Estimation
- Exponential family distribution with latent variables
- Expectation Maximization (EM) algorithm

Two phase model learning description for MOOCs

Steps
- Learn latent tree over knowledge components (KCs)
- Use graph partitioning on the learned latent tree to cluster KCs
- Use the cluster information as well as other relevant covariates to learn a CLTM for the students

Data set Description

Student interactions with Stanford OLI in a Psychology course offered in Spring 2013
- Data available on CMU Datashop
- 5,615 students
- 266 knowledge components
- 1,493,612 interaction records
- 60 train and 30 test data instances

Project Page

Visit our project page: [http://newport.eecs.uci.edu/anandkumar/Lab/Lab_sub/CLTM.html](http://newport.eecs.uci.edu/anandkumar/Lab/Lab_sub/CLTM.html)

Conclusions

- Applicability of CLTM to student performance prediction
- Ability of giving qualitative analysis on student performance
- Groups of students learn differently