How Can AI help MOOCs?

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#Southampton

The slides can be downloaded at http://keg.cs.tsinghua.edu.cn/jietang
Big Data in MOOC

- **149 partners**
- **2000+ courses**
- **24,000,000 users**

- **110 partners**
- **1,270 courses**
- **10,000,000 users**
- **10+ MicroMaster**

- **1,000+ courses**
- **8,000,000 users**
- **Chinese EDU association**

- **~10 partners**
- **40+ courses**
- **1.6 million users**
- **“nanodegree”**

- **host >1,000 courses**
- **millions of users**
launched in 2013
Some exciting data…

• Every day, there are 5,000+ new students
• An MOOC course can reach 100,000+ students
• >35% of the XuetangX users are using mobile
• traditional->flipped classroom->online degree
Some exciting data…

• Every day, there are 5,000+ new students
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• >35% of the XuetangX users are using mobile
• traditional->flipped classroom->online degree
• “Network+ EDU” (O2O)
  – edX launched 10+ MicroMaster degrees
  – Udacity launched NanoDegree program
  – GIT+Udacity launched the largest online master
  – Tsinghua+XuetangX will launch a MicroMaster soon
However…

• only ~3% certificate rate
  - The highest certificate rate is 14.95%
  - The lowest is only 0.84%

• Can AI help MOOC and how?
MOOC user = Student?

How to learn more effectively and more efficiently?

- **Who is who?** background, where from?
- **Why MOOC?** motivation? degree?
- **What is personalization?** preference?
MOOC course = University course?

How to discover the prerequisite relations between concepts and generate the concept graph automatically?

Thousands of Courses

How to leverage the external knowledge?
However to improve the engagement?
LittleMU (小木)

LittleMU: Intelligent Interaction

1. User analysis
   - Behavior logs
   - Behavior modeling
   - User Profiling

2. Course analysis
   - Incentive analysis
   - Course recommendation
   - Automated video navigation
   - Question answering

3. Concept extraction
   - Prerequisite relation mining

Knowledge base

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What is the complexity of Bubble sort?
It has a $O(n^2)$ complexity.
How about the best case?
The best case is $O(n)$, but average case is $O(n^2)$.
Then how about the space complexity?
What is LittleMU(“小木”)  

• Not a Chatbot  
  – “Good morning”, “did you have the breakfast?”—NO  
• Not a teacher/TA  
  – “Can you explain the equation for me?” —NO  
• Instead, “小木” is more like a learning peer  
  – Tell you some basic knowledge in her mind  
  – Tell you what the other users are thinking/learning  
  – Try to understand your intention  
  – Teach “小木” what you know
What is LittleMU(“小木”)
What is LittleMU(“小木”)

小木机器人是你的智能学习助理，由学堂在线和清华大学联合研发，集知识查询、学习问答、学习管理、机器人客服于一身。目前，小木可以解答一部分课程学习疑问、平台使用疑问；小木会给你提问引导你的学习（试验中，部分课程可见）；小木会作诗逗你开心~~~更多的功能敬请期待噢~~️

来自问答库
二叉树:
在计算机科学中，二叉树是每个节点最多有两个子树的树结构。通常子树被称作“左子树”（left subtree）和“右子树”（right subtree）。二叉树常被用于实现二叉查找树和二叉堆。二叉树的每个结点至多只有二棵子树（不存在度大于2的结点），二叉树的子树有左右之分，次序不能颠倒。二叉树的第i层至多有2^i-1个结点；深度为k的二叉树至多有2^k-1个结点；对任何一棵二叉树T，如果其总结点数为n，度为2的结点数为n2，则n_0=n_2+1。一棵深度为k，且有2^k-1个结点的二叉树称之为满二叉树；深度为k，有n个结点的二叉树，当且仅当每一个结点都与深度为k的满二叉树中，序号为1至n的结点对应时，称之为完全二叉树。

5. 二叉树 (e4) 层次遍历
Acrostic Poem: 小木作诗

小木作诗

部分课程可见：小木合作诗逗你开心～～更多功能敬请期待！

来自同济库

part of the course visible: Xiaomu cooperation poetry amuses you～～more functions敬请期待！

来自同济库

进退华年事事幽
制衣由非自优游
转蓬山色侵书剑
换骨吾辈上钓舟
再来一首

In the years of elegance, everything is幽
Clothes made by others enjoy leisure
The color of the wandering cloud invades the book and sword
Change the bone, we fish with the boat
Come again

动摇碧落步崔嵬
态度西风万壑雷
规矩自从来天下事
划然一叶作龙媒
再来一首

Wobble碧落步崔嵬
Attitude of the West Wind万壑雷
Rules come from the past events in the world
Sudden, one leaf to be a dragon媒
Come again

计日经纶济世才
算来心事转堪哀
横眉不及山河恨
型在天南万里开
再来一首

Number days, plan and resolve to help the world's talents
Counted the heart affairs are so sad
The eyebrows do not exceed the hatred of the mountains and rivers
Model in the south of the sky opening a万里
Come again

冒雪峰峦万里开
泡流浮动水云来
排空一阵东风紧
序齿双黄绝世埃
再来一首

With snow mountain range a万里 open
Water and cloud floating flow
A gust of the east wind tight
Order the teeth of the double yellow绝世埃
Come again

05E4-1 次序

小木提问：什么是层次遍历？（2个同学已问过类似问题）

小木提问：What is depth-first search？（Two students have asked similar questions）

5. 二叉树

(e4) 层次遍历

5. Binary Tree

(e4) Level-order traversal

下载字幕 .txt
LittleMU (小木)

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3. Prerequisite relation mining
   - Concept extraction

Behavior logs

Knowledge base

User Modeling

Intervention

Content Analysis
LittleMU (小木)

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Behavior logs

Knowledge base
Dynamic Factor Graph Model

Model: incorporating “embedding” and factor graphs

Prediction labels:
Activities we are interested in, e.g., assignments performance and getting certificates.

\[ Y^t(i) = [Y_{t,i,0}, Y_{t,i,1}, \ldots, Y_{t,i,n-1}]^T \]

Latent learning states
Every student’s status in at time t is associated with a vector representation

\[ Z^t(i) = [Z_{t,i,0}, Z_{t,i,1}, \ldots, Z_{t,i,m-1}]^T \]

All features: time-varying attributes:
1. Demographics
2. Forum Activities
3. Learning Behaviors

\[ X^t(i) = [X_{t,i,0}, X_{t,i,1}, \ldots, X_{t,i,d-1}]^T \]

Certificate Prediction

<table>
<thead>
<tr>
<th>Category</th>
<th>Method</th>
<th>AUC</th>
<th>Precision</th>
<th>Recall</th>
<th>F1-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>LRC</td>
<td>92.13</td>
<td>83.33</td>
<td>46.51</td>
<td>59.70</td>
</tr>
<tr>
<td></td>
<td>SVM</td>
<td>92.67</td>
<td>52.17</td>
<td>83.72</td>
<td>64.29</td>
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<tr>
<td></td>
<td>FM</td>
<td>94.48</td>
<td>61.54</td>
<td>74.42</td>
<td>67.37</td>
</tr>
<tr>
<td></td>
<td>LadFG</td>
<td><strong>95.73</strong></td>
<td><strong>73.91</strong></td>
<td><strong>79.07</strong></td>
<td><strong>76.40</strong></td>
</tr>
<tr>
<td>Non-Science</td>
<td>LRC</td>
<td>94.16</td>
<td>76.93</td>
<td>89.20</td>
<td>82.57</td>
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<tr>
<td></td>
<td>SVM</td>
<td>93.94</td>
<td>76.96</td>
<td>88.60</td>
<td>82.37</td>
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<tr>
<td></td>
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<td>94.87</td>
<td>80.22</td>
<td>86.23</td>
<td>83.07</td>
</tr>
<tr>
<td></td>
<td>LadFG</td>
<td><strong>95.54</strong></td>
<td><strong>79.76</strong></td>
<td><strong>89.01</strong></td>
<td><strong>84.10</strong></td>
</tr>
</tbody>
</table>

- LRC, SVM, and FM are different baseline models
- LadFG is our proposed model
Predicting more

• **Dropout**
  – KDDCUP 2015, 1,000+ teams worldwide

• **Demographics**
  – Gender, education, etc.

• **User interests**
  – computer science, mathematics, psychology, etc.

• ...
LittleMU (小木)

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User Modeling

Intervention

Content Analysis
Knowledge Graph

- How to extract concepts from course scripts?
- How to recognize (prerequisite) relationships between concepts?

[1] Liangming Pan, Chengjiang Li, Juanzi Li, and Jie Tang. Prerequisite Relation Learning for Concepts in MOOCs. ACL'17.
LittleMU (小木)

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Knowledge base
• Let start with a simple case
  – *Course recommendation* based on user interest
Course Recommendation

Course Recommendation:
Guess you like

课程  院校   广场   学堂云   雨课堂   App下载

公司金融学
7 天前开课 422人

管理会计学
5 天前开课 328人

大学计算机教程
9 个月前开课 14267人

IC设计与方法
3 个月前开课 818人

托福考试准备：来自考试举办方的指导

水力学
9 个月前开课 2349人

孝亲之礼
9 个月前开课 499人

陆游词鉴赏
8 个月前开课 850人

贞观之治
4 个月前开课 214人

IELTS雅思考试备考

Course Recommendation:  
Guess you like

决胜移动互联网：创业者的商业模式课（2017春）
3 个月前开课 3083人

u.lab 0x: 基于觉察的系统创变：感知和共创未来生活... 8 个月前开课 5132人

金融工程导论
3 个月前开课 1492人

分布式计算与数据管理（微慕课）
5 个月前开课 1099人

现代生活美学(2017春)
3 个月前开课 2907人
Online A/B Test

Top-k recommendation accuracy (MRR)
Comparison methods:
HCACR – Hybrid Content-Aware Course Recommendation
CACR – Content-Aware Course Recommendation
IBCF – Item-Based Collaborative Filtering
UBCF – User-Based Collaborative Filtering

Online Click-through Rate
Comparison methods:
HCACR – Our method
Manual strategy
• Let start the simplest case
  – Course recommendation based on user interest
• What can we else?
  – Interaction when watching video?
Smart Jump
—Automated suggestion for video navigation

Let's begin with …
The example is that …
First, we introduce …
Next … capital assets … investment property …
Average Jump

Let's begin with...

First, we introduce... The example is that... Next... capital assets... investment property...

On Average: 2.6 Clicks = 5 seconds
Two Numbers

According to what we have discussed we find that the fifth activity belongs to cash outflow of a business activity.

\[ 5S \times 8,000,000 \text{ users} = 1.3 \text{ years} \]
More

• Let start the simplest case
  – Course recommendation based on user interest

• What can we else?
  – Interaction when watching video?
  – Interaction->intervention
Active Question

Question: What is **time complexity**?
Active Question

Question: What is Random Vector?
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Course Content

Knowledge base

User Modeling
Intervention
Content Analysis
Recent Publications

- Liangming Pan, Chengjiang Li, Juanzi Li, and Jie Tang. Prerequisite Relation Learning for Concepts in MOOCs. In ACL'17.
- Xia Jing, Jie Tang, Wenguang Chen, Maosong Sun, and Zhengyang Song. Guess You Like: Course Recommendation in MOOCs. WI'17.
- Jie Tang, Tracy Xiao Liu, Zhenyang Song, Xiaochen Wang, Xia Jing, Jiezhong Qiu, Zhenhuan Chen, Chaoyang Li, Han Zhang, Liangmin Pan, Yi Qi, Xiuli Li, Jian Guan, Juanzi Li, and Maosong Sun. LittleMU: Enhancing Learning Engagement Using Intelligent Interaction on MOOCs. submitted to KDD.
- 薛宇飞, 敬峡, 裘捷中, 唐杰, 孙茂松. 一种在线课程中的作业互评方法：中国，201510531490.2.（中国专利申请号）
- 唐杰, 张茜, 刘德兵. 用户退课行为预测方法及装置. 201610292389.0 （中国专利申请号）
Thank you!

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Jie Gong (**NUS**), Jimeng Sun (**GIT**)
Wendy Hall (**Southampton**)
Maosong Sun, Tracy Liu, Juanzi Li (**THU**)
Xia Jing, Zhenhuan Chen, Liangmin Pan, Jiezhong Qiu, Han Zhang, Zhengyang Song, Xiaochen Wang, Chaoyang Li, Yi Qi (**THU**)

Download all data & Codes,

- [http://keg.cs.tsinghua.edu.cn/jietang](http://keg.cs.tsinghua.edu.cn/jietang)
- [http://arnetminer.org/data](http://arnetminer.org/data)