Learning Analytics and Recommendations for Learning Objects

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Learning Analytics

Definition:

Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs. (LAK 2011)
Vision of Learning Analytics

- **Provide access to data**
- **Extract/Identify relevant information from data**
- **Visualize relevant information for teachers and learners**
- **Provide personalized education for learners**
- **Provide individual recommendations for learners and teachers**
- **Help teachers understand what is going on in their courses**
- **Help teachers understand (un)successful teaching strategies**
- **Support collaborative learning**
- **Motivate students through providing information**
- **Identify at-risk students**
- **Help teachers understand when and in which context students are learning**
- **Visualize relevant information for teachers and learners**
- **Provide access to data**
- **…**
- **Algorithms**
- **Student Modelling**
- **Context Modelling**
- **Visualization Techniques**
- **Personalization**
- **Recommender Systems**
- **Adaptive Learning Systems**
- **Context Awareness**
- **Artificial / Computational Intelligence**
- **Intelligent Systems**
- **…**
- **Data Mining**
- **Provide access to data**
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A Rule-based Recommender System (RUBARS) and its Visualization and Analytics Tool (VAT-RUBARS)
Motivation

Learner-centered learning has many advantages such as

- enabling students to focus on their interest
- empowering learners on how and what to learn
- motivating learners
- promoting active learning
- enhancing learners performance
Motivation

- One way of providing students with a learner-centered approach is to allow them to choose which tasks of an assignment they do

- Accordingly, learners can choose, for example, to do many easy tasks or only a few difficult tasks (in order to achieve full marks)

- While having choice is a great motivator for students, it sometimes might be difficult for students to actually make a meaningful selection of tasks
Research Question

How to support students in selecting appropriate tasks of assignments in a learner-centered approach?

- Consider what students would select
- Consider what worked well for other students with similar characteristics
- Consider students’ performance on previous assignments

→ Build a recommender system
→ Integrate the recommender system into an LMS
Architecture

![Diagram showing the architecture model]

- Rule repository
  - Neighborhood Generation Module
    - Recommendation Generation Module
    - Recommendation Display Module
  - Learner Model
    - Learner Modelling Module
    - Learning Management System
- Data Repository

Learner
Learner Modelling Module

- Responsible for gathering information about the learner:
  - Learning styles
  - Prior knowledge
  - Expertise level
  - Performance
Neighborhood Generation Module

- Responsible for finding out who the “neighbors” of a particular learner are
- Neighbors are considered students who have similar characteristics
- Euclidean Distance is used to measure how similar the characteristics are
Recommendation Generation Module

- Responsible for generating the recommendations
- Each task can have one of three difficulty levels (easy, moderate, difficult)
- Recommendations depend on:
  - the target learner’s previous performance on tasks of each difficulty level within the whole course,
  - the average performance of the neighbor learners on tasks of each difficulty level in the unit where a recommendation has to be provided and
  - the selection of learning tasks proposed by the target learner to complete within the unit where a recommendation has to be provided
Recommendation Generation Module

How to build recommendations

1. **Ranking of preferred difficulty levels** based on rules considering the target learner’s performance (in the whole course) and the neighbor learners’ performance (in the respective unit)

2. **Selection of learning tasks** based on those rankings using rules considering the average performance of neighbor learners on a task and whether or not a task has been selected by the target students
Hello Mary! You are about to start Unit 2. Your previous performance shows that you did great in moderate tasks. Students similar to you, have performed better in moderate tasks in this unit. Based on that, you are recommended to attempt moderate tasks first, then easy and then challenging tasks. This will help you to perform better.

Your recommended plan for this unit is generated as follows:

**Your Plan**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Level</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>Moderate</td>
<td>4–6</td>
</tr>
<tr>
<td>2.4</td>
<td>Challenging</td>
<td>5–7</td>
</tr>
<tr>
<td>2.5</td>
<td>Challenging</td>
<td>5–7</td>
</tr>
<tr>
<td>2.6</td>
<td>Challenging</td>
<td>5–7</td>
</tr>
</tbody>
</table>

Total Marks >= 22

**Recommended Plan**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Level</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>Moderate</td>
<td>4–6</td>
</tr>
<tr>
<td>2.3</td>
<td>Moderate</td>
<td>4–6</td>
</tr>
<tr>
<td>2.7</td>
<td>Moderate</td>
<td>4–6</td>
</tr>
<tr>
<td>2.1</td>
<td>Easy</td>
<td>2–4</td>
</tr>
</tbody>
</table>

Total Marks >= 22
Visualization and Analytics Tool for RUBARS

- While a learner-centered approach has a lot of advantages for students, it makes it difficult for teachers to understand what is going on in their courses and to monitor what their students are doing.

- VAT-RUBARS aims at providing teachers with such information.
Demo ...
Incorporating Motivational Techniques into Learning Management Systems
Motivation

- Motivation is the reason that someone engages in a certain behaviour
- Motivation is a key factor in education
- Lot of research has been done by educational psychological researchers on motivational aspects in the educational domain
- These researches resulted in several theories and models
- Based on such theories and models, learning systems have been developed that use particular motivational techniques
- However, most systems include only one or few such techniques and typically they assume that the technique(s) are motivational for all learners alike
Motivation

- However, learners are motivated differently and what is motivational for one learner can be demotivational for another learner.
- We aim at providing personalization based on motivational aspects.
- The first step in doing so is to develop a framework of motivational techniques that can be used in learning systems.
Aim

How to build a framework of motivational techniques that can be easily integrated into different learning systems?

- The framework should
  - Include many diverse motivational techniques in order to motivate different learners
  - Include motivational techniques that are domain-independent and course-independent in order to make it easy to integrate them into existing systems and courses
Framework for Incorporating Motivational Techniques

- Selected 11 motivational techniques
- Techniques are not new
- Techniques are based on motivational theories and models and most of them have already been successfully implemented in learning systems
- Techniques have been selected based on literature review and with respect to their capabilities to motivate learners
- Technique has to be domain-independent and course-independent
- Looked into the relationships of these techniques
Selected Techniques

- Progress Timeline
- Progress Annotations
- Rankings
- Awards/Achievements
- Goal Setting
- Communications
- Forum Discussions
- Posting Solutions
- Emoticons/Emotions
- Caring Agent
- Knowledge Agent
Relationships between Techniques

- Communications
- Discussion Forum
- Progress Annotation
- Posting Solutions
- Progress Timeline
- Awards and Achievements
- Goal Setting
- Ranking
- Knowledge Agent
- Emoticons/Emotions
- Caring Agent
Progress Timeline

Aim:
1. Provide learners with information about their progress in the course based on pre-defined milestones (e.g., assignments, quizzes, exams, projects, etc).
2. Show them their progress in relation to progress on the class (anonymous and accumulated).

Why motivational?
- assist with time management → increases confidence
- motivate learners to learn in the same (or quicker) pace as the overall class
Progress Timeline

- When can this technique be demotivational?
  - If learners have fallen behind, they might get impression that they cannot catch up
  - If too many milestones are remaining for them to complete
  - If nobody is at the same level as the learner

- Requirements for course and system:
  - Measurable milestones
  - Tracking of learners’ completion of milestones
  - Access to start and end date of all learners
Progress Timeline

The horizontal axis represents the important milestones in this course. The vertical axis represents the week in which the milestone should be completed.
Progress Annotation

- **Aim:**
  - Display to the learner their progress through the course content:
    1. Allow learners to tag their active position in the course content
    2. Allow learners to tag the completed content

- **Why motivational?**
  Learners can view and track their progress
  Helps in time management
  \(\rightarrow\) increases confidence and satisfaction on achievements

- **When can this technique be demotivational?**
  - If learners feel they are not progressing fast enough, even though they put in a lot of effort

- **Requirements for course and system**
  - Course must have content
Progress Annotation

This pie-chart shows the fraction of learning objects completed, in progress and not started yet.
Ranking

- **Aim:**
  - Rank learners based on certain criteria (e.g., performance, participation, etc.)

- **Why motivational?**
  
  Show statistics and allow learners to compare themselves
  \( \rightarrow \) Increases satisfaction

  Some learners will use this information to continually improve
Ranking

- When can this technique be demotivational?
  - If learners feel they should be doing better than they are
  - If they don’t feel as though they have a sense of control
  - Since each ranking can be motivational for some learners but demotivational for others, personalization is an important issue

- Requirements for course and system:
  - There must be a minimum number of people enrolled
  - Criteria to use for ranking and track the respective achievements of learners based on the criteria
Ranking

- Grades of assignments
- Grades of quizzes
- Overall grades
- Total number of awards achieved
- Overall time online
- Time online in current month
- Overall number of posts submitted
- Number of posts submitted in current month
- Overall post ratings
- Post ratings in current month
- Overall reading of all posts
- Reading of all posts in current month
- Amount of time it took to reach each milestone
- Pace to complete milestones
Rankings - Time Online in Current Month

You are logged in as Sally (Logout)

Rankings for the time spent online in the current month.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>Time online</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sally</td>
<td>1h 45min</td>
</tr>
<tr>
<td>2</td>
<td>Thomas</td>
<td>28 min</td>
</tr>
<tr>
<td>3</td>
<td>Richard</td>
<td>8 min</td>
</tr>
<tr>
<td>4</td>
<td>Jane</td>
<td>4 min</td>
</tr>
</tbody>
</table>
Awards and Achievements

- **Aim:**
  - Provide learners with incentives and/or recognition
  - Based on achievements, scales or levels (e.g., different types of forum users)

- **Why motivational?**
  - rewards the learner and provide recognition to the learner → increases satisfaction

- **When can this technique be demotivational?**
  - If the learner finds flaws in the methodology
  - If the learner does not get the recognition that he/she believes to deserve

- **Requirements for course and system:**
  - Components that associate awards/achievements with them
Awards and Achievements

- Grades of assignments
- Grades of quizzes
- Overall grades
- Completed course milestones within a time period
- Overall time online
- Time online in current month
- Overall number of posts submitted
- Number of posts submitted in current month
- Overall post ratings
- Post ratings in current month
- Overall reading of all posts
- Reading of all posts in current month
Awards and Achievements

Awards - Overall number of posts submitted

Awards for overall number of posts submitted award with a breakdown by month. Total is calculated with a weighting of Gold = 3, Silver = 2 and Bronze = 1.

<table>
<thead>
<tr>
<th>Name</th>
<th>Active</th>
<th>Total</th>
<th>June (current)</th>
<th>May</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sally</td>
<td>x</td>
<td>4</td>
<td>Silver</td>
<td>Silver</td>
<td></td>
</tr>
<tr>
<td>Jane</td>
<td>x</td>
<td>2</td>
<td>Bronze</td>
<td>Bronze</td>
<td></td>
</tr>
<tr>
<td>Richard</td>
<td>x</td>
<td>1</td>
<td>Bronze</td>
<td>Bronze</td>
<td></td>
</tr>
<tr>
<td>Thomas</td>
<td>x</td>
<td>1</td>
<td>Bronze</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Providing Easy Access to Complex Educational Data
Motivation

- In online education, educators and learning designers typically don’t get much feedback on what students are actually doing in a course and whether or not their teaching strategies and course designs are successful/helpful for students.

- Learning Management Systems (LMSs) generate a lot of data

- However, when looking at the data in the database, it is very difficult to get anything useful out of these data
General Aim of AAT

- Provide users with easy and comprehensive access to complex educational log data
  - Easy: Users do not need to have computer science knowledge
  - Comprehensive: users should have access to anything they are interested in

General design decisions:
- Allow users to ask “questions” to the data
- Allow users to start with easy queries and then build upon them
- Allow users to get information across courses and departments/faculties
- Work for different LMS and different versions of LMSs
- Work with several databases
Benefits

- Help to get better understanding on what students are actually doing in a course
- Facilitate learning about teaching strategies and learning designs
Procedure

Building a profile

- Select a learning system to connect to
- Create/Select a **data set** (courses)
- Create/Select **patterns** (queries)

Profiles

- Which LMS?
- Which courses?
- Which questions?

<table>
<thead>
<tr>
<th>User ID</th>
<th>Assignment Description</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>3957</td>
<td>TMA 1: Group project</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>TMA 2: Reflection</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>TMA 3: Final Report</td>
<td>94</td>
</tr>
<tr>
<td>3958</td>
<td>TMA 1: Group project</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>TMA 2: Reflection</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>TMA 3: Final Report</td>
<td>76</td>
</tr>
<tr>
<td>3959</td>
<td>TMA 1: Group project</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>TMA 2: Reflection</td>
<td>91</td>
</tr>
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Demo
Questions

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