

Data Mining and Analytics in Realizeit

November 4, 2013 Dr. Colm P. Howlin

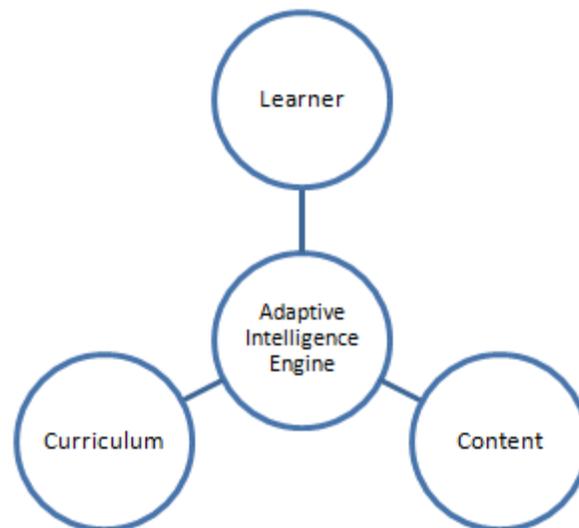
Data mining is the process of discovering patterns in large data sets. It draws on a wide range of disciplines, including statistics, artificial intelligence and machine learning. The goal is to discover previously unknown relationships and information hidden within the data, and to make them available for use and interpretation through appropriate models, metrics and visualizations.

As individual learners interact with Realizeit a vast wealth of deeply granular data is collected. This data provides evidence on learner attainment and learning behaviors, as well as the effectiveness of the content and curriculum. This evidence drives the intelligence and adaptivity of Realizeit, and ultimately the learning.

The core of Realizeit's decision making capabilities is built upon data mining techniques allowing it to automatically uncover relationships, patterns and learner preferences hidden in the data. The reporting and analytical review interfaces to Realizeit allow faculty and administrators to mine the data and to manually and automatically extract information and insights from learner data. In addition to this, Realizeit allows both the data and insights to be easily extracted for use in third-party data mining and business intelligence tools.

Educational data mining in Realizeit

At the centre of the Realizeit approach is the separation of content and curriculum. The curriculum is represented as a set of connected and related concepts, and is used to drive the direction of the learning. It is the content which delivers the learning to the individual. Just as a teacher can teach the same concept in many different ways, Realizeit can have multiple pieces and types of content available to it for each concept in the curriculum.



In a learning environment, to present a learner with a situation where they must both navigate a curriculum and select content would place an enormous additional cognitive load on them. Realizeit avoids this by using the Adaptive Intelligence Engine to assist in decision making and to guide the learner on an individual learning pathway.

The Adaptive Intelligence Engine bridges the gap between the curriculum and the content using models and algorithms from the fields of data mining and machine learning. While there are separate components which are tasked with learning, understanding and adapting to a specific part of the learning process, these components are highly connected and rely intimately upon each other.

To aid the system in its decision making process, Realizeit can incorporate data from existing data sources such as student information systems. This data can provide Realizeit with a head start in deriving the necessary information on each individual to develop a deep understanding of all elements of their learning needs and requirements. Realizeit is built using a generic data model. This allows any institution-specific or third-party data elements (for example surveys) to be ingested and utilized within the system.

Adaptive Intelligence Engine

The main goal of the Realizeit Adaptive Intelligence Engine is to manage the interaction between the curriculum, the content and the learner in order to provide an effective, efficient and personalized learning experience for each individual.

The Adaptive Intelligence Engine in Realizeit is built from multiple components, each of which controls a specific task within the engine. The more fundamental of these are tasked with assessing all data generated by the learner, in order to measure ability and progress, and to determine factors which influence learner success. Additional elements are tasked with monitoring and evaluating the performance of instructional material, content and resources.



In addition to the metrics derived by these components, Realizeit also maintains all evidence generated by the learner, including the length of time spent learning, the number of attempts and outcome of each question, the number and types of interactions between the instructor and the learner, as well as any recorded interventions external to Realizeit. All data collected on each individual is available within the reporting and analysis sections of Realizeit, and for extraction from the system in order to support educational research and evaluation.

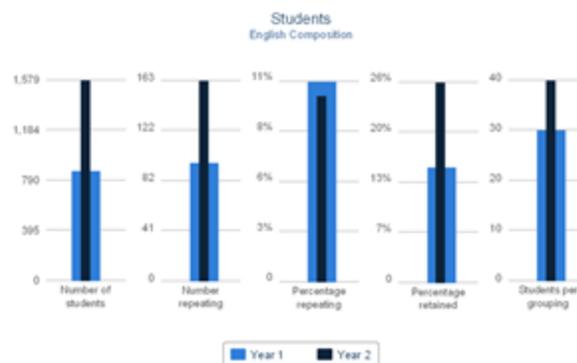
A key requirement of the engine is that it must be able to improve its accuracy, efficiency and effectiveness as data is collected. To achieve this, the Adaptive Intelligence Engine begins by gathering any prior knowledge that is available regarding the content, curriculum or learners. The engine uses this prior knowledge in conjunction with the adaptive processes to make its initial decisions. As the learners interact with the content, curriculum and system all available evidence is collected. The machine learning and data mining processes of the intelligence engine use this evidence to update and supplement their current knowledge of the content, curriculum and learners. This new knowledge replaces the prior knowledge when the adaptive processes are making their decisions. This process is repeated throughout the learning cycle to improve the interaction between the learner and Realizeit; it ensures continuous improvement in the accuracy and effectiveness of the learning, and allows further development and enhancement of the instruction and the associated materials and resources.

Reports and Analytics

The adaptive intelligence engine uses data mining techniques to aid Realizeit in its decision making process. The reporting and analytics interface allows instructors, faculty and administrators to mine the available data within the system, enabling them to evaluate the performance of instructional resources, courses, and programs, and to evaluate learner success factors.

Reports

The Reports interface allows users to explore the data held within the system. This data exposes both the low level data as it is collected and the high level outcomes from the data mining activities of the Adaptive Intelligence Engine.



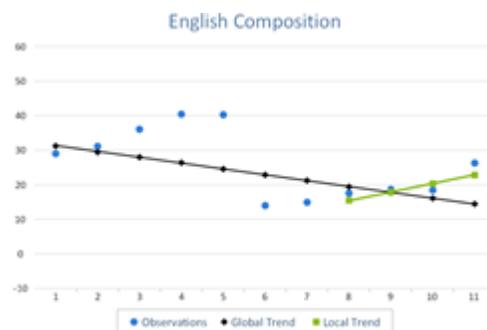
There are multiple reports available within the system, each of which covers an aspect of the learning process. While there are many different reports available some of the key ones include:

- Objective Data: This report can be used during a course/session to examine the learner ability and attainment data for the weeks that have passed.
- Objective Trends: This can be used to examine more detailed information on the changes in learner ability and attainment throughout the life of a course/session.
- Learning Usage: This report allows the engagement level of learners to be examined.
- Interventions: This report can be used to examine the level and scope of interaction between instructors and learners.

Within each of these reporting options a wide and varied range of possible breakdown factors is available.

Analytical Reviews

While the Reports interface exposes both the raw and derived data so that it can be manually mined, the Analytical Reviews interface automatically mines the data and searches for specific relationships. If relationships are found, the data is further analyzed to find all information within the data that may be correlated with the observed relationship. The analytical reviews generate visualizations and dashboards which allow the relationships and derived information to be easily digested.



There are four analytical review interfaces within Realizeit:

- Overall review – this considers data across all courses and sessions within the system for an institution
- Course review – this is similar to the above review but is restricted to all instances of a single course
- Instructor review – this review looks at instructor performance
- Course Development review – this review considers the learning material and resources available with the system

The insights gained through the analytics provided by the system are critical in the continuous evolution of courses in order to improve the learning experience of every learner.



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Colm is the Principal Investigator of the research team at Realizeit. He has a background in Applied Mathematics and has carried out research at several Universities worldwide. He has several years of experience in Teaching & Research at University level. He has spent time as a Consultant Statistician and is a specialist in the areas of modeling and data mining. Colm holds a Bachelors Degree in Applied Mathematics & Computing, a PhD in Applied Mathematics from the University of Limerick and was a Research Fellow at Loughborough University. He is the receiver of an Advance Scholar Award (University of Limerick) and was awarded a Scholarship by the Irish Research Council for Science, Engineering and Technology (IRCSET).