Personal Attributes & Application Metadata

Choosing the Best Method of Storing and Sharing Descriptive Data within Your Users' MARi Accounts

Summary

MARi-enabled applications often draw conclusions or make predictions about the level of expertise that their users can display in specific domains. By agreeing to be part of the MARi ecosystem, these applications agree to share information about each user's knowledge, competencies, experiences, and personal traits. However, participating applications do not necessarily agree to share information about how those conclusions or predictions have been reached, or what methods were employed to make the various observations that are at the heart of any such conclusions. The internal workings of each application are strictly the concern of the application's developers, and is generally of little use to other applications that the same user may choose to execute. Therefore, MARi provides two distinct types of data storage: 1) Personal Attributes, which are shared by multiple applications, and 2) Application Metadata which is generally private and only used to store internal user model data that is of interest to the application that stored the data. This paper compares the two data storage components and shows examples that demonstrate what type of data is stored in each.

Introduction

MARi™ provides support services for managing two distinct types of user data: Personal Attributes (PAs) and Application Metadata. PAs are at the core of MARi's existence and represent an observable characteristic about a user. As such, a PA should be application-independent and convey some meaningful descriptive information about the user that might be of interest to another. Conversely, application metadata is focused on the user model data that actually drives your application and is dependent on the context and internal structure of your application.

Examples

Perhaps the best way to illustrate the difference between Personal Attributes and Application Metadata is by presenting some examples that show how different systems might separate the two types of data. Each of the following scenarios describes a potential MARi-enabled application along with the data they use for internal purposes and the data they might choose to share with other applications in the form of Personal Attributes.

Scenario 1

A physics tutor is teaching concepts related to acceleration and velocity of objects due to gravitational forces. The tutor displays educational material on the topic and then presents a series of formula-based questions and word-problem questions to the learner. As the learner progresses through the assessment material, the tutor automatically supplies needed scaffolding, hits, and prompts. The difficultly of the presented assessment material is automatically adjusted based on the amount of assistance that the learner requires. At the end of the tutoring session, the tutor software presents the learner with an overall score that indicates how well the learner has mastered the underlying concepts of acceleration and velocity of objects under the influence of gravitational fields.

Application Metadata

The tutor captures and processes information about the following points of interest:

- Learner's answers to each presented question
- Ratio of correct answers to incorrect answers
- Total amount of time to complete all problems
- Amount of time to complete each individual problem
- Number of hints and prompts required to complete each problem
- Progress trend indicating whether the number of required hints and prompts is increasing or decreasing from problem to problem

MARi Personal Attributes

At the end of the tutoring session, the tutoring software is able to draw conclusions about the individual learner based on the overall performance within the tutoring software. The following PAs may be written into the learner's MARi account:

- Understand the equation for velocity
- Understand the equation for acceleration
- Understand the use of force vectors
- Add 2-dimensional vectors
- Subtract 2-dimensional vectors
- Add 3-dimensional vectors
- Subtract 3-dimensional vectors

Scenario 2:

A student is assigned an ASSISTment™ Skill Builder math assignment, in which the student is presented with a series of questions on one specific skill. The student must answer three questions correctly in a row to complete the assignment. If the student runs into trouble or needs help, the ASSISTments software provides methods of receiving progressively more specific hints about the question or guidance on how to "Break this Problem Into Steps" to help guide the student toward discovery of the solution. However, if the student using the tutoring hints or problem breakdown tools on a question, that question will be marked as incorrect. The student must answer three questions in a row correctly to get credit for the skill builder. The student receives immediate feedback on whether each question was answered correctly. If the student requests hints but is still unable to figure out the correct solution, the ASSISTments software will exhaust all available hints and then finally simply give the correct answer to the student in an effort to explain the proper solution.

Application Metadata

ASSISTments might capture and process information about the following points of interest:

- Student's answer to each question
- Number of hints requested for each question
- Amount of thought (linger) time between the moment a question is presented and the moment an answer is provided by the student
- Effectiveness of each hint or step breakout, based on number of correct answers provided after each hint or step breakout is provided

MARi Personal Attributes

At the end of the tutoring session, the ASSISTments software is able to draw conclusions about the individual student based on the overall performance within the tutoring software and whether the student was able to correctly complete three questions in a row. The following PAs may be written into the student's MARi account:

- Understand the specific topic being assessed, including both a proficiency score within the specific assessment and a confidence estimate that together indicate the likelihood that the student will correctly answer similar questions
- (There would be one PA for each Skill Builder skill)

Scenario 3:

A student is asked to play the qualitative physics game Newton's Playground, in which the student must apply basic knowledge of physical objects such as inclined planes (ramps), pendulums, levers, and springboards to move a ball toward a balloon while navigating various obstacles. Students are allowed to create new objects and apply pivot points to create moving mechanisms to move the ball in desired ways. All objects that are placed in Newton's Playground automatically follow basic Newtonian physics principles. By correctly moving the ball so that it eventually strikes the balloon, the student demonstrates practical knowledge of the basic laws of physics and an understanding of Newton's three laws of motion.

Application Metadata

As the student plays Newton's Playground, the software keeps track of the student's actions and records a series of events in a log file. This log file contains time series data that describe the student's gameplay in terms of:

- time spent on a particular level
- number of restarts required for the level
- total number of objects used to solve the problem
- number of erased from the level
- number of pins uses
- the position and trajectory of objects
- total amount of time it took to complete the level
- amount of pause time (presumably used to think about the problem)
- whether the student actually solved the problem

Application Metadata (Continued)

Each of these pieces of data are of great interest to the inner workings of the game, but none of them are of much use to other applications that need to know something about the student's ability to understand the basic laws of physics. Consequently, these items should be stored as Application Metadata within the student's MARi account.

MARi Personal Attributes

On the other hand, the Newton's Playground software is capable of interpreting its log files to draw conclusions about the student's understanding of the laws of physics, as well as certain behavioral traits like perseverance in the face of challenging situations, or imaginative problem solving based on prior research efforts. These conclusions can then be shared with other applications that would benefit from knowing the student's level of understanding about basic physics, even if those other applications do not have the ability to assess that knowledge themselves. Newton's Playground may be able to contribute values to the following PAs, among others:

- Understand the use of an inclined plane to lift an object vertically
- Understand the use of a pendulum to transfer energy and motion by striking an object
- Understand the use of a springboard to move an object vertically
- Understand the effect of mass on springboard effectiveness
- Understand the effect of fulcrum placement on generated leverage
- Understand the effect of gravity on objects of varying mass
- Understand the conservation and transfer of momentum

Comparison

	Personal Attribute	Application Metadata
Sharing	Generally available to any entity (subject to permission constraints)	Generally for the private use of the application that originally generated the data, but permissions can be set to allow shared access with a finite set of named entities
Format	Time series event entry which includes the attribute ID, time of observation, assessment value, observation method (direct or predicted), and a confidence factor	Either time series event entry with arbitrary content, or SQL-based relational structures
Curated	Yes – MARi maps each PA request to the best fit among all existing PAs, and ensures that all new PA definitions are properly structured for global use	No – The source application may store data in any manner

Terms

Term	Definition
Data Owner	The organization, researcher, or individual that originally created a MARi account
Organization	A public or private entity, such as a school system or corporation, that sponsors one or more MARi-enabled applications and retains persistent access to their constituents' MARi data that is generated by those sponsored applications
Researcher	Academic partners who have access to anonymous MARi data for the purpose of conducting research on large data sets and creating predictive models based on those large data sets
Individual	The actual person that is described by the data stored in a single MARi account
Entity	A generic name for any interested party, including organizations, researchers, developers, applications, and individuals

