Relational and Non-relational Program Independent Schemas:

Supporting arbitrary archaeological data models

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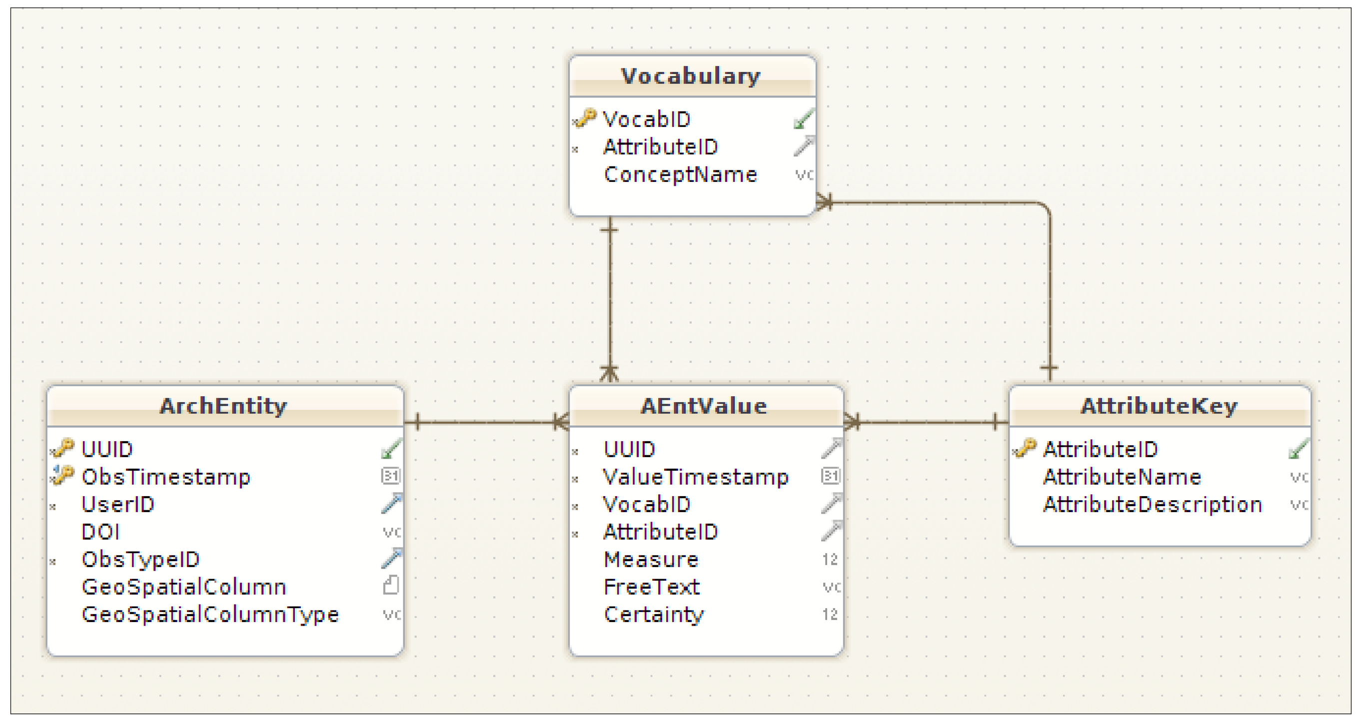
Introduction

Archaeologists employ different research strategies. No single data structure can satisfy such diverse requirements without being so general that it loses utility as a way to organise and manipulate data. As a result, we have chosen to mimic "NoSQL" key-value stores. We implement this approach through a Domain-Key Normal Form relational database (Fagin 1981), as newer NoSQL data stores were either not well supported on Android or were incompatible with GIS software, which generally expects tabular or relational data. After considering the available options available for Android, we chose SQLite with SpatiaLite spatial extensions as our data store.



The essential four tables of the DKNF append-only database demonstrating an ArchEnt implementation.

Data Structure Description

Our central data structure is comprised of four tables: ArchEntity, AEntValue, AttributeKey, and Vocbaulary. It is best thought of, however, as a single, virtual table. Imagine a spreadsheet with the top row and the first column locked. The unique identifier for an Archaeological Entity (ArchEnt) resides In the first column, designating a row that will contain all of the information about that entity:

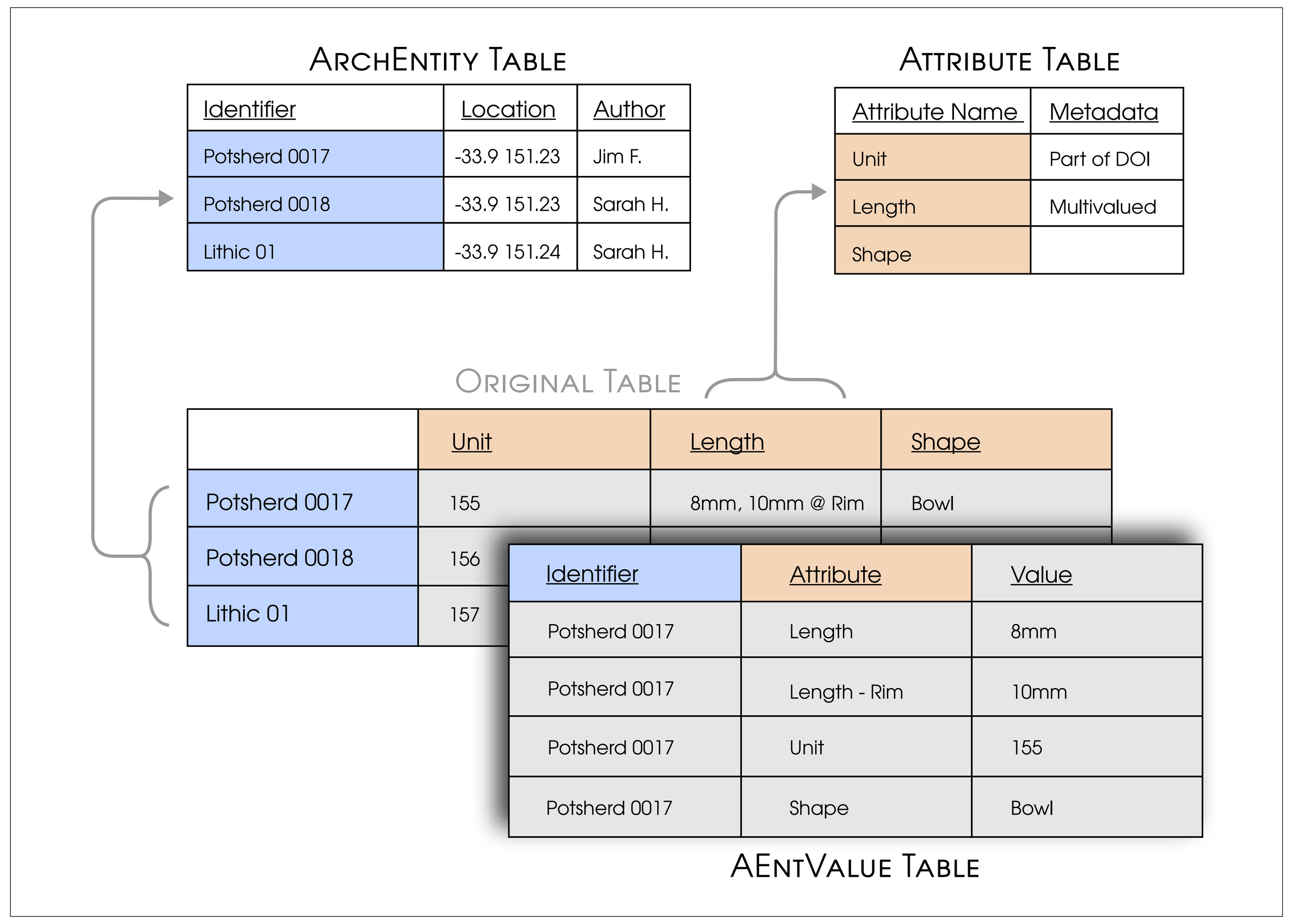
- The "ArchEntity" table acts as the first column, providing an identifier (along with identifier-specific metadata) to all information about that archaeological entity.
- The "AttributeKey" table provides a constrained set of attributes concerning the entity. It can be thought of as the frozen row at the top of the sheet with column names representing the things you want to record about an object.
- The "AEntValue" table represents the data held in the body of the table (each cell being an intersection of an "ArchEntity" row and the "AttributeKey" column; a unique record is identified by the triple determinant of UUID, Timestamp, and Attribute ID).

The relationship between these three tables provides a flexible data schema that does not need to be altered within the database to meet a wide range of use scenarios. Only values contained in the ArchEntity and AttributeKey tables need to be specified in order to define the ArchEnts being recorded along with all of their possible attributes; no aspect of the database structure or associated logic needs to be altered. The supporting table, "Vocabulary" underpins the Arch16n process that links local terminology to core archaeological concepts.

Append-only Datastore

We intend to never lose data. To achieve that goal, we have instituted an append-only data store, a method modeled on Google's Protobuffs (Chang et. al. 2008:7). Only writes are allowed to the database; updates and deletions are simulated through inserts. The current records are merely the set of all values with the latest timestamp for a given Universally Unique Identifier and Attribute pair.

The queries we have designed for normal access to the database will simply disregard all records with an old timestamp or a deleted boolean set to "true", but the deleted or modified records will remain in the database. This approach makes it trivial to review changes and recover data, as no data is ever deleted or changed.



A tabular data transformation into DKNF.

References

- Chang, F. et al., 2008. Bigtable. ACM Transactions on Computer Systems, 26(2), pp.1–26.
- Fagin, Ronald, 1981. "A Normal Form for Relational Databases That Is Based on Domains and Keys". ACM Transactions on Database Systems 6, pp.387–415.

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