

DATASET VERSIONING THROUGH CHANGELOG ANNOTATION

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ACKNOWLEDGMENT

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ABSTRACT

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CHAPTER 1

INTRODUCTION

Dataset versioning tracks and documents the changes which occur in datasets. Version numbers are commonly seen in relation to new releases of software such as MATLAB or R, but current version naming schemes borrow from software contexts. While it may have been possible to manually manage the changes to data when datasets were relatively small, research centers must now supervise on the order of tens of millions of files with changes being made at rates of thousands of processing jobs per day.

Versioning information is widespread across devices and software in the modern world. From the numbering of the latest smart phone to the patch number of the newest release of MATLAB, scientists must deal with a range of labels and formats when performing their research. Science data, likewise, also has a tendency to change. Datasets are subjected to data audits and error corrections regularly to maintain a level of data quality.

Agencies and research groups have collected new data at an incredible rate. The amount of data housed by NASA quadrupled from 2001 to 2004 [4] and high energy physics labs can generate on the order of 4000 new datasets every day [5].

1.1 Provenance

In a number of papers, authors describe models or systems that track changes in the workflow and how modifications to the flow would then generate new versions of datasets. The information that details the activities and agents involved in generating a data entity is known as provenance. Barkstrom identifies times when new versions should be generated by locating changes in provenance (specifically calibrations, scripts, and input data) at different levels of data processing in NASA remote sensing workflows. Software revision management tools such as Git and SVN also keep track of provenance information when logging new commits to a project. Since it plays a significant role in triggering new version generations, provenance is often

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<code>table</code>	environment	command.

conflated with versioning by scientists. However, it does not sufficiently characterize a versioning event.

Provenance is the data used to describe the origin of an object (Merrium Webster). In the field of semantic technologies, the W3C recommendation, PROV provides a data model to encode provenance information so that the lineage of data products can be traced. However, PROV expresses relationships between versions with the `wasRevisionOf` or `alternateOf` property. The properties do not allow for more elaboration as to what changes were made to transform version one into its alternate, nor should it. Explicitly itemizing the changes is unnecessary in order to communicate the provenance relationship between the two versions. That there exists an association is sufficient. This gap illustrates why versioning information is necessary because itemization allows data consumers to determine the significance of changing to version two.

1.2 Types of Change

1.3 Changelogs

1.4 RDFa

1.5 Why Semantic Technologies?

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CHAPTER 2

PREVIOUS WORK

PROV is a W3C recommendation that deliniates a method to express data prove-nance with semantic technologies. Using the model of relating activities, agents, and entities, data managers can express the origins of their datasets. However, when an entity is revised, the PROV data model can only express the relationship as a revision or that the new dataset was derived from the original. This leaves

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²Here's the text of the footnote.

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CHAPTER 3

CONCEPTUAL MODEL

The conceptual model used within this thesis is built around the expression of three core versioning operations: addition, invalidation, and modification. These three activities can be represented by interacting with three types of concepts: versions, attributes, and changes. Versions represent the data entities being compared. These could be two different editions of a book or versions of software. It is important to understand that a version is an abstraction as it can be represented by multiple physical files. In the sections that follow, operations will only consider the interaction between two versions and will be explained later in the chapter. Versions then contain attributes representing a quantity being modified. Specifically for tabular data, attributes would correspond to an identifier that refers to particular rows or columns within the data. Attributes of the two versions are then connected by a change. This link functions as a very general concept which can be subclassed into more informative types such as unit changes, improving the expressiveness of the model beyond PROV's revisionOf concept.

3.1 ADDITION

When a change adds a new attribute to a version, it only needs to refer to version two and its corresponding attribute. The reasoning should be fairly obvious as the attribute never existed in version one, and therefore, there is nothing to refer to and no need to form a relationship between the change and version one. However, by linking the addition change to version one, we address a difficulty with comparing provenance graphs. When two data objects have identical structures, it is difficult to determine what time the objects were added to the dataset and which version they belong to. As a result, determining the compatibility of the two objects becomes difficult. The change contributions to the dataset evolution appears naturally using this construction. The resulting model can be seen in Figure 3.1.

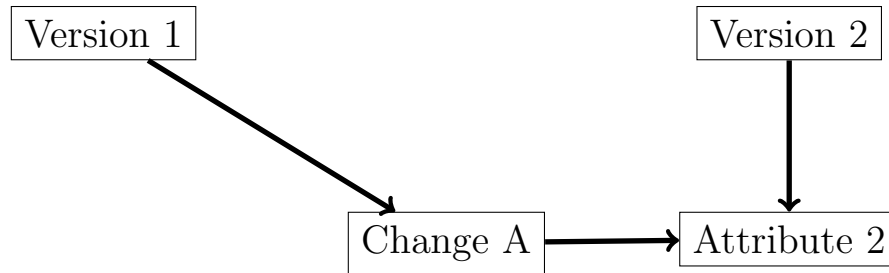


Figure 3.1: Model of the relationships between Versions 1 and 2 when adding an Attribute 2 to Version 2 as a result of Change A

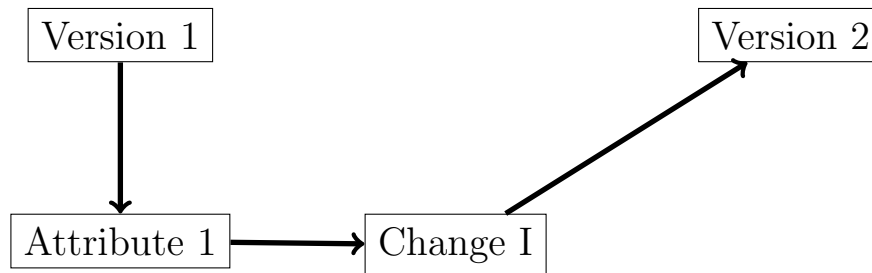


Figure 3.2: Model of the relationships between Versions 1 and 2 when invalidating Attribute 1 from Version 1 as a result of Change I

3.2 INVALIDATION

The Invalidation operation corresponds to the delete concept found in other applications. The choice of invalidation over delete results from the policy that data is never deleted.

3.3 MODIFICATION

3.4 MULTIPLE LINKED VERSIONS

REFERENCES

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- [3] Another item in the Bibliography.
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- [5]

APPENDIX A

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A.1 A Section Heading

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$$x^2 + y^2 = z^2 \tag{A.1}$$

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APPENDIX B

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