An Application of FCA to the Analysis of Aeronautical Incidents

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Abstract. This paper illustrates how a new clustering process dedicated to the analysis of anecdotal reports of aviation incidents has been designed and tested thanks to an FCA tool called *Kontex*. Special attention has been given to the necessary transcription of the data from the initial relational database to an FCA context. The graphical interface for *Kontex*, which has been specially implemented for this study, is also presented.

The study presented in this paper validates the process adopted and highlights the use of FCA to help the expert to mine the database without previous knowledge of the searched concepts. The work brought original ideas to the aviation safety community by the development of an incident model and the notion of scenario. For the FCA community, one interesting aspect of this work lies on the use of a first-order context (given by a relational database) and its translation into a classical context.

1 Introduction

1.1 Scope of This Paper

This paper describes an experiment that has been realized cooperatively by ONERA and NASA. Its aim was to test a new clustering methodology dedicated to the analysis of textual reports of aviation incidents. A Formal Concept Analysis (FCA) tool has been developed and used for this work.

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After a short overview of incident analysis, the paper describes briefly the FCA tool (*Kontex*) in section 2. Then a simplified view of the incident model and the definition of the clustering methodology are given in section 3. Finally, the experiment and a summary of the results given by the use of the FCA tool are presented in section 4.

1.2 ONERA-NASA Cooperation

Since 1995, ONERA and NASA Ames Research Center have conducted collaborative research on the analysis of aeronautical incident reports. The aim is to develop methodologies and tools that allow the experts to identify causal factors and human-factor-related issues. The ASRS[1] database [1], [2] is used as a representative data resource for this study even though the approach adopted is not designed to fit any specific incident reporting systems.

Several codification processes that have been developed and tested on ASRS reports [3] were evaluated. Then the effort have focused on the design of a new clustering process. In 2003, an experiment validating the methodology was completed [4] and is the subject of this paper. It was based on the use of the FCA tool *Kontex* (developed by ONERA) with a limited set of selected ASRS reports. Other experiments based on statistical methods are now under study.

1.3 Applicative Background

Even though air transportation is the safest mode of travel, improving the level of security is a major concern for the aeronautical community. The airlines and the authorities would like to have a proactive management of safety risk from a system-wide prospective. Such a process involves identifying hazards, evaluating causes, assessing risks and implementing appropriate solutions. It is a non-trivial task that relies on the capability of continuously monitoring the system's performance.

Some airlines have already developed quality-control strategies in which they analyze routinely their performance data. Their safety programs rely mainly on two types of data sources: (1) flight-recorded data [5], and (2) incident-reporting systems. Other techniques such as in-flight audit (LOSA) [6] are emerging but are not widely used yet[2]. While flight-data analysis provides an objective understanding of "what" happened during operations, it gives little information about the " why". This distinction between the "what" and the "why" of an incident is discussed further in the discussion of the notion of scenario in Section 3.2. An understanding of the causal factors of why an incident occurred is essential

[1] The ASRS (Aviation Safety Reporting System) managed by NASA and funded by the FAA Office of System Safety since 1976, is one of the world's best-known and most highly regarded repositories of safety information. The ASRS database is a collection of nearly 112,000 narratives of aviation safety incidents that have been voluntarily submitted by reporters across the aviation industry.

[2] At least when measured on the basis of the extent of the ongoing collection of data.