Multimedia Data Mining Concept

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INTRODUCTION

The development of information technology is particularly noticeable in the methods and techniques of data acquisition, high-performance computing, and bandwidth frequency. According to a newly observed phenomenon, called a storage low (Fayyad & Uthurusamy, 2002), the capacity of digital data storage is doubled every 9 months with respect to the price. Data can be stored in many forms of digital media, for example, still images taken by a digital camera, MP3 songs, or MPEG videos from desktops, cell phones, or video cameras. Such data exceeds the total cumulative handwriting and printing during all of recorded human history (Fayyad, 2001). According to current analysis carried out by IBM Almaden Research (Swierzowicz, 2002), data volumes are growing at different speeds. The fastest one is Internet-resource growth: It will achieve the digital online threshold of exabytes within a few years (Liautaud, 2001). In these fast-growing volumes of data environments, restrictions are connected with a human's low data-complexity and dimensionality analysis. Investigations on combining different media data, multimedia**,** into one application have begun as early as the 1960s, when text and images were combined in a document. During the research and development process, audio, video, and animation were synchronized using a time line to specify when they should be played (Rowe & Jain, 2004). Since the middle 1990s, the problems of multimedia data capture, storage, transmission, and presentation have extensively been investigated. Over the past few years, research on multimedia standards (e.g., MPEG-4, X3D, MPEG-7) has continued to grow. These standards are adapted to represent very complex multimedia data sets; can transparently handle sound, images, videos, and 3-D (three-dimensional) objects combined with events, synchronization, and scripting languages; and can describe the content of any multimedia object. Different algorithms need to be used in multimedia distribution and multimedia database applications. An example is an image database that stores pictures of birds and a sound database that stores recordings of birds (Kossmann, 2000). The distributed query that asks for "top ten different kinds of birds that have black feathers and a high voice" is described there by Kossmann (2000, p.436).

One of the results of the inexorable growth of multimedia data volumes and complexity is a data overload problem. It is impossible to solve the data overload issue in a human manner; it takes strong effort to use intelligent and automatic software tools for turning rough data into valuable information and information into knowledge.

Data mining is one of the central activities associated with understanding, navigating, and exploiting the world of digital data. It is an intelligent and automatic process of identifying and discovering useful structures in data such as patterns, models, and relations. We can consider data mining as a part of the overall knowledge discovery in data processes. Kantardzic (2003, p.5) defines data mining as "a process of discovering various models, summaries, and derived values from a given collection of data.". It should be an iterative and carefully planned process of using proper analytic techniques to extract hidden, valuable information.

The article begins with a short introduction to data mining, considering different kinds of data, both structured as well as semistructured and unstructured. It emphasizes the special role of multimedia data mining. Then, it presents a short overview of goals, methods, and techniques used in multimedia data mining. This section focuses on a brief discussion on supervised and unsupervised classification, uncovering interesting rules, decision trees, artificial neural networks, and rough-neural computing. The next section presents advantages offered by multimedia data mining and examples of practical and successful applications. It also contains a list of application domains. The following section describes multimedia data-mining critical issues and summarizes main multimedia data-mining advantages and disadvantages.

NEED FOR MULTIMEDIA DATA MINING

Data mining is essential as we struggle to solve data overload and complexity issues. With the fastest acceleration of off-line data resources on the Internet, the WWW (World Wide Web) is a natural area for using data-mining techniques to automatically discover and extract actionable information from Web documents and services. These techniques are named Web mining. We also consider text mining as a data-mining task that helps us summarize, cluster, classify, and find similar text documents in a set of documents. Due to advances in informational technology and high-performance computing, very large sets of images such as digital or digitalized photographs, medical images, satellite images, digital sky surveys, images from computer simulations, and images generated in many scientific disciplines are becoming available. The method that deals with the extraction of implicit knowledge, image data relationships, and other patterns not explicitly stored in the image databases is called image mining (Zhang, Hsu, & Li Lee, 2001a). A main issue of image mining is dealing with relative data, implicit spatial information, and multiple interpretations of the same visual patterns. We can consider the application-oriented functional approach and the image-driven approach. In the latter, one the following hierarchical layers are established (Zhang, Hsu, & Li Lee, 2001b): the lower layer that consists of pixel and object information, and the higher layer that takes into consideration domain knowledge to generate semantic concepts from the lower layer and incorporates them with related alphanumerical data to discover domain knowledge.

The main aim of the multimedia data mining is to extract interesting knowledge and understand semantics captured in multimedia data that contain correlated images, audio, video, and text.

Multimedia databases, containing combinations of various data types, could be first integrated via distributed multimedia processors and then mined, or one could apply data-mining tools on the homogenous databases and then combine the results of the various data miners (Thuraisingham, 2002).

GOALS, METHODS, AND TECHNIQUES USED IN MULTIMEDIA DATA MINING

One of the most popular goals in data mining is ordering or dissecting a set of objects described by high-dimensional data into small comprehensive units, classes, substructures, or parts. These substructures give better understanding and control, and can assign a new situation to one of these classes based on suitable information, which can be classified as supervised or unsupervised. In the former classification, each object originates from one of the predefined classes and is described by a data vector (Bock, 2002). But it is unknown to which class the object belongs, and this class must be reconstructed from the data vector. In unsupervised classification (clustering), a new object is classified into a cluster of objects according to the object content without a priori knowledge. It is often used in the early stages of the multimedia data-mining processes.

If a goal of multimedia data mining can be expressed as uncovering interesting rules, an association-rule method is used. An association rule takes a form of an implication $X \Rightarrow Y$, where X denotes antecedent of the rule, Y denotes the consequent of the rule, X and Y belong to the set of objects (item set) I, $X \cap Y = \Phi$, and D denotes a set of cases (Zhang et al., 2001a). We can determine two parameters named support, s, and confidence, c. The rule $X \Rightarrow Y$ has support s in D, where s% of the data cases in D contains both X and Y, and the rule holds confidence c in D, where c% of the data cases in D that support X also support Y. Association-rule mining selects rules that have support greater than some user-specified minimum support threshold (typically around 10^{-2} to 10^{-4}), and the confidence of the rule is at least a given (from 0 to 1) confidence threshold (Mannila, 2002). A typical association-rule mining algorithm works in two steps. The first step finds all large item sets that meet the minimum support constraint. The second step generates rules from all large item sets that satisfy the minimum confidence constraints.

A natural structure of knowledge is a decision tree. Each node in such a tree is associated with a

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