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Comprehensive Overview of DM Applications in SHM on the Basis of the Preceding Literature on DM

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Description

Data Mining (DM) is one of the novel and rapidly developing computer science technologies. Civil engineers are gradually coming to recognize this method as a potent tool for a variety of applications, including the prediction of structures' dynamic behavior, the most effective design of vibration control systems, and the identification of structural damage. In addition, Data Mining (DM) is a method for investigating large datasets to discover hidden relationships between raw data in the form of patterns or models and, ultimately, make predictions based on these models. Civil engineers have attempted to improve their computer skills over the past few decades in order to use DM techniques (DMTs). As a result, DMTs have been utilized in a variety of civil engineering applications across a variety of domains, including Structural Health Monitoring (SHM), structural engineering, the structural control system, and construction materials.

DM and its Sensitivity to Detection and Problem Resolution

In order to make decisions that are satisfactory regarding structural maintenance, repair, and retrofitting, SHM systems have been utilized to guarantee the safe operation of infrastructure. In a similar vein, an appealing solution to a variety of SHM issues, particularly in data inverse analysis, has been provided by combining DM and SHM. One of the most recent SHM schemes, for instance, has two modules: 1) a system based on a sensor network to collect structural responses; and 2) DM as a method of knowledge extraction to identify the structural health condition. In 1937, the Golden Gate Bridge in San Francisco also saw the first bridge health monitoring. Similarly, direct use of DM in the identification of structural damage has begun since 2014. One common tool for knowledge discovery is conventional approaches such as classical mathematical-statistical methods. However, they are time-consuming, difficult to make assumptions that meet the needs of the real world, and only focus on simplified quantitative analysis, which cannot address real-world issues. It should also be noted that they lack precise language and are poorly defined. Additionally, if a large amount of data is collected, additional issues with accuracy reduction may arise. As a result, conventional methods, such as traditional mathematical-statistical techniques, are relatively ineffective. To solve these issues, sophisticated computing technologies and tools, like the DM approach, can be used to extract useful information from a large amount of data. This is due to the fact that DM is well-defined and includes a variety of models and tools. In addition, it produces precise results and can be utilized in the real world. Wu et al. state that along the same lines, DMTs are designed to discover tomorrow's success clues, whereas traditional mathematical statistical techniques were designed to summarize previous success rules. As a result, it is confirmed that the DM is one of the novel computer science topics that can link the data management, statistics, and machine learning fields. This study provides a comprehensive overview of DM applications in SHM on the basis of the preceding literature on DM and its sensitivity to detection and problem resolution, particularly in SHM.

Effectiveness of the Utilized DM Technique

Several scientific articles on DMTs applications in civil engineering have been identified using online databases to support the goal. As a result, the structure of this paper is as follows: It is essential to draw attention to a fundamental aspect of knowledge discovery before delving into the specifics of DM. To this end, the term data refers to any information that can be processed by a computer, such as text, numbers, or facts. In addition, the following is a list of DM definitions. In a variety of studies, DMTs have been used to extract useful information from SHM. In the subsequent sub-sections, DM applications in SHM developed by a number of researchers will be briefly introduced and reviewed. Based on the DM technique used, each application is categorized separately. The effectiveness of the utilized DM technique is then demonstrated through the presentation of a number of inspiring application examples for each technique. DMTs have been used for a variety of purposes in the field of structural health monitoring, including structural damage detection and the determination of modal parameters like the natural frequencies of structures, the intensity of

vibration, and damping coefficients. In accordance with evolving DM techniques, it has been crucial to employ various software programs written in appropriate programming languages. Consequently, a variety of software and programming languages have been utilized for the numerical analysis of DM methods in civil engineering fields. The most important reasons to choose a particular DM technique for a number of distinct applications are its fundamental assumptions and limitations. Numerous criteria, including their function, adaptability, complexity, autonomy, capacity for optimization, and accuracy, are the subject of extensive research on DMTs. The task that each technique is responsible for is indicated by its function. In a variety of civil structures, ANNs have received a lot of attention from academic as well as industrial sectors. However, they are unsure how to weight connections between layers, which can lower the results' reliability. Metaheuristic optimization-based methods must be used in the ANN learning process to overcome this limitation. A powerful computing technique known as Data Mining (DM) is used to estimate the potential for future application in a variety of fields and uncover the hidden relationship between data. It has the potential to establish a strong connection between civil engineering and computer science in order to formulate knowledge-driven findings.