111-2 DBMS Final Project: ECSQL

Access databases with one button

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ABSTRACT

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• Software and its engineering~Software notations and tools~Formal language definitions~Semantics

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KEYWORDS

Insert keyword text, Insert keyword text, Insert keyword text, Insert keyword text

ACM Reference format:

FirstName Surname, FirstName Surname and FirstName Surname. 2018. Insert Your Title Here: Insert Subtitle Here. In *Proceedings of ACM Woodstock conference (WOODSTOCK’18). ACM, New York, NY, USA, 2 pages.* https://doi.org/10.1145/1234567890

2  PRIOR WORK

2.2 PCA

While PCA has been widely used and well-established, the prior work also recognized certain limitations. For instance, the interpretability of the resulting principal components and their relationship to the original features has been a subject of interest. Researchers have sought to develop techniques to better understand and interpret the meaning and contribution of individual features in the reduced-dimensional space.

Additionally, the state of the art acknowledged the need for exploring alternative dimensionality reduction techniques beyond PCA. Researchers have investigated methods such as t-SNE, LLE, and ISOMAP, among others, aiming to address specific challenges and provide complementary approaches to dimensionality reduction.

3  SOLUTION

3.2 PCA

In this study, we employed Principal Component Analysis (PCA), a statistical method widely utilized for dimensionality reduction in data analysis, to address the challenges associated with high-dimensional data. High-dimensional data often poses various difficulties, including feature correlation, computational costs, and overfitting problems.

Feature correlation is a common issue in high-dimensional data, where certain features exhibit strong correlations with each other, leading to problems such as multiple solution ambiguity and redundancy. To mitigate this challenge, PCA examines the data comprising multiple variables, identifies correlations between these variables, and determines the optimal combination of values that effectively captures the differences in the results. By employing these combined feature values, PCA facilitates the construction of a more concise feature space.

Furthermore, computational costs can be a significant concern when dealing with large sample sizes and a high number of features. Excessive features demand increased memory requirements, thereby reducing operational efficiency. PCA addresses this challenge by reducing the dimensionality of the data, allowing for more efficient storage and processing.

Additionally, high-dimensional data can make training models more susceptible to overfitting issues. With numerous complex features, models tend to capture excessive noise and detail, hindering their ability to generalize to new data. PCA aids in overcoming this problem by extracting the most informative components, ensuring that the retained principal components represent the essential underlying structure of the original data.

In our project, we applied the PCA function to our dataset, which initially consisted of 13 dimensions. Through PCA, we were able to retain three principal components that captured the maximum variability in the original data. The concept of explained variance ratio was utilized to measure the contribution of each principal component to the overall variability of the original data.

By employing PCA as a dimensionality reduction technique, we effectively addressed the challenges posed by high-dimensional data in our analysis. The retained principal components provided a compact and informative representation of the original data, enabling us to better understand its underlying structure and facilitate subsequent analysis and interpretation.

4  RESULT

4.2 PCA

The analysis of Table 1 reveals that a significant portion of the data variability (99.81%) can be effectively captured by the first principal component alone. The second and third principal components, although less easily interpretable, exhibit variations that are specific to different datasets, making them valuable and reserved for future utilization.

Moreover, scatterplot matrices serve as intuitive visualization tools, enabling the observation of correlations between variables, scatter patterns, and potential trends. The scatterplot matrix analysis further supports the effectiveness of the principal components. Specifically, combinations that incorporate the first principal component tend to provide superior discrimination between the three distinct data labels when represented in a two-dimensional plot. Conversely, combinations that do not include the first principal component fail to achieve a clear resolution of the different data labels.

These findings emphasize the importance of the first principal component in capturing the most significant variability within the data. Leveraging this principal component in combination with others, when necessary, enhances the distinction between data labels and facilitates a comprehensive understanding of the dataset's underlying structure. The scatterplot matrix analysis serves as an additional validation of the effectiveness and utility of the selected principal components in enhancing data visualization and interpretation.

Table 1. The explained variance ratio is the percentage of variance that is attributed by each of the selected components

|  |  |  |  |
| --- | --- | --- | --- |
| Principal Components | PC1 | PC2 | PC3 |
| Explained Variance Ratio (%) | 99.81 | 0.17 | 0.01 |

5  CRITIQUE

5.2 PCA

We provided a clear and concise explanation of PCA and its relevance in reducing the dimensionality of data while retaining maximum variability. We effectively highlighted the specific challenges of feature correlation, computational costs, and overfitting problems in high-dimensional datasets, establishing a strong foundation for the necessity of employing PCA as a solution.

Furthermore, we successfully communicated our methodology and its implementation in the project. Our decision to retain three principal components from the original 13 dimensions of data was appropriately justified. We utilized the concept of explained variance ratio to measure each principal component's contribution to the overall variability of the data. By incorporating these details, we demonstrated a robust approach to dimensionality reduction and the selection of informative components.

6  POSSIBLE EXTENSION

Some potential extensions that can be explored based on the findings and methodology presented in this project are:

1. Feature Importance and Interpretability: While PCA effectively reduces the dimensionality of the data, the resulting principal components may lack direct interpretability. To address this, future research could focus on exploring techniques to assess the importance of individual features within each principal component and their contribution to the overall variability. Methods such as feature loading analysis or correlation analysis between the original features and principal components could be employed to gain insights into the significance and interpretability of the features in the reduced-dimensional space. This extension would enhance the understanding of the relationship between the original features and the principal components obtained through PCA.
2. Application to Different Datasets: Extending the analysis to different datasets and domains would provide a broader perspective on the applicability and effectiveness of PCA. Investigating how PCA performs on diverse datasets with varying characteristics and complexities would highlight its strengths and limitations in different contexts. This extension could involve applying PCA to datasets from various domains, such as healthcare, finance, or image analysis, and evaluating its performance in terms of dimensionality reduction, information retention, and subsequent analysis. By examining the behavior of PCA across different datasets, a more comprehensive understanding of its generalizability and utility can be gained.

Exploring these potential extensions would contribute to the advancement of knowledge in the field of dimensionality reduction and provide valuable insights into the interpretability of principal components as well as the applicability of PCA across diverse datasets and domains.

ACKNOWLEDGMENTS

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REFERENCES

[1] Zoomer Analytics, L. (2023). API Reference - xlwings Documentation. https://docs.xlwings.org/zh\_TW/latest/api/index.html

[2]

UPDATED PRESENTATION VIDEO

WORK ASSIGNMENT TABLEConference Name:ACM Woodstock conference

|  |  |
| --- | --- |
| Member | Work |
| LIN BO-YONG | Organize meetings and project information, implement PCA method, map workflows |
| KUO, TING-YI |  |
| TSENG YU-HSUAN |  |
| ZHANG, YU-JIE |  |

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