Title: Matrices

M7

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Application of matrices in computer graphics

Matrix Transformations

Matrices are frequently used in computer graphics and matrix transformations are one of the core mechanics of any 3D graphics. the chain of matrix transformations allows to render a 3D object on a 2D monitor.

Scaling matrices

given $\vec{K} = (K_i, k_j, k_z)$ is a 3D vector that represent the scale along each axis.

$$S(\vec{K}) = \begin{bmatrix} k_x & 0 & 0 & 0 \\ 0 & k_y & 0 & 0 \\ 0 & 0 & k_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The scaled vector will be

$$p' = S(\vec{K})p$$

Rotation matrices

In ~~8~~ 3D, a rotation matrix can be used to rotate the image 90° counter clockwise.

$$~~R~~ = R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix}$$

$$R_y(\theta) = \begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix}$$

$$R_z(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Translation matrix

With a 4x4 matrix, we can also express translation as a matrix multiplication that represents the position where we want ~~our~~ to move our space to, in which we can use to head move the camera or to move ~~set~~ objects.

$$T(\vec{v}) = \begin{bmatrix} 1 & 0 & 0 & d_x \\ 0 & 1 & 0 & d_y \\ 0 & 0 & 1 & d_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

∴ Such matrices are used to change or manipulate the size of the image in computer graphics.

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Application of matrices in Machine learning

1. Data Representation :-

In machine learning, from datasets to images all ~~p~~ are often represented as matrices. Datasets are represented where each row corresponds to an instance or sample, and each column represents a feature or attribute of the data. This tabular representation allows efficient storage and processing of large datasets.

2. Dot product :-

Dot products are extensively used in machine learning. In algorithms like gradient descent, the dot product is used to calculate the gradient of the loss function with respect to the model parameters. The dot product ~~is~~ between the gradient and the input vector determines the step direction and magnitude in the parameter update. And the most important use is in neural networks, specifically in the computation of weighted sums in the hidden layers.

3. Feature Extraction:-

Matrices are employed in feature extraction techniques such as Principal Component Analysis and Singular value Decomposition. These methods transform high-dimensional data into lower-dimensional space using matrix operations, facilitating data compression and mass reduction.

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MATRICES.

STATISTICS APPLICATION.

Statistics heavily relies on matrices for various tasks such as data organization, analysis and modeling. Matrices offer a concise and efficient way to represent and manipulate data sets, making them indispensable in statistical computations. Lets delve into how matrices are applied in statistics, elucidated with an example

APPLICATION OF MATRICES IN STATISTICS.

1. DATA REPRESENTATION:

Matrices are used to represent data sets in statistics. In many real-world scenarios, data can be organized into matrices where each row represents an observation or data point, and each column represents a variable. For instance, in a survey where respondents rate multiple products on various criteria, the data can be structured into a matrix where each row corresponds to a respondent and each column corresponds to a product or a criterion.

2. LINEAR REGRESSION:

Linear regression is a fundamental statistical technique used to model the relationship between a dependent variable and one or more independent variables. Matrices play a crucial role in the formulation and solution of linear regression models. The relationship between variables is expressed using matrix operations and the coefficient of the regression model are estimated through matrix operations.

Example:

Lets consider a simple example of using matrices in Statistics: calculating the covariance matrix for a set of variables. Suppose we have a data set consisting of observations on 3 variables: X, Y & Z. We organise this data into a matrix X, where each row represents an observation and each column represents a variable.

$$X = \begin{bmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & x_{22} & x_{23} \\ x_{31} & x_{32} & x_{33} \end{bmatrix} \qquad X^* = \begin{bmatrix} x_{11}-x_1 & x_{12}-x_2 & x_{13}-x_3 \\ x_{21}-x_1 & x_{22}-x_2 & x_{23}-x_3 \\ x_{31}-x_1 & x_{32}-x_2 & x_{33}-x_3 \end{bmatrix}$$

Next, we compute the covarience matrix Σ using the formula $\Sigma = \frac{1}{n} x^{T} \cdot x^{*}$ ∴ Where n is the number of observations. After performing the matrix operations, we obtain covariance matrix.

$$\Sigma = \begin{bmatrix} \sigma^2 x & \sigma xy & \sigma xz \\ \sigma yx & \sigma^2 y & \sigma yz \\ \sigma zx & \sigma zy & \sigma^2 z \end{bmatrix}$$

Here $\sigma^2 x$, $\sigma^2 y$ and $\sigma^2 z$ are the variances of variables X, Y and Z respectively while σ_{xy}, σ_{xz} and σ_{yz} are the covariances between variables X and Y, X and Z and Y & Z respectively.

This examples illustrates how matrices are used in statistics to compute and analyze important quantities such as covariance matrices, which provide insights into the relationships between variables in a data set

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Application of Matrices in Data Science:

Matrices are fundamental in data science, serving as a cornerstone for various mathematical operations & algorithms. Here's how matrices are applied in data science

1. Data Representation:
Matrices are used to represent datasets where each row corresponds to an observation (e.g., a sample or an instance) & each column represents a feature or attribute of the observation.
for e.g.: in a dataset of housing prices, each row represents a house, & columns represents features like size, location, & price.

2. Linear Algebra Operations:
Matrices enable various linear algebra operations commonly used in data science, such as addition, subtraction, multiplication, & inversion. These operations are vital for tasks like regression analysis, dimensionality reduction, & solving systems of linear equations.

3. Matrix Decompositions:
Techniques like Singular Value Decomposition (SVD) & Eigenvalue Decomposition are applied to matrices for tasks such as Principal Component Analysis (PCA), which is used for dimensionality reduction, & recommendation systems like collaborative filtering

4 Machine Learning Algorithms:
Matrices play a crucial role in machine learning algorithms. Algorithms like linear regression & logistics regression utilize matrices for parameter

estimation & prediction.

5. Graph Representation:

Matrices are used to represent graphs in data science. For instance, the adjacency matrix represents the connections between nodes in a ~~graph~~ graph, enabling graph-based algorithms like PageRank for ranking web pages or community detection in social networks.

6. Text Processing:

In natural language processing (NLP), matrices are used to represent text data using techniques like Term-Document Matrix (TDM) or Term frequency-Inverse Document Frequency (TF-IDF). These representations enable tasks like sentiment analysis, documentation classification, & topic modeling.

Example: Consider a dataset containing housing info:

$$X = \begin{bmatrix} 1 & 2000 & 3 \\ 1 & 1500 & 2 \\ 1 & 2500 & 4 \end{bmatrix}$$

Each row represents a house with features: intercept (1), size (in square feet), & number of bedrooms. To predict house prices y, we have: $y = X\theta + \varepsilon$

where θ is the vector of coefficient, & ε is the error term. By solving the equation using techniques like Ordinary Least Squares (OLS), we estimate the parameters θ to make predictions ~~of~~ on the house prices.

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MINI PROJECT

Application Of Matrices In Finance

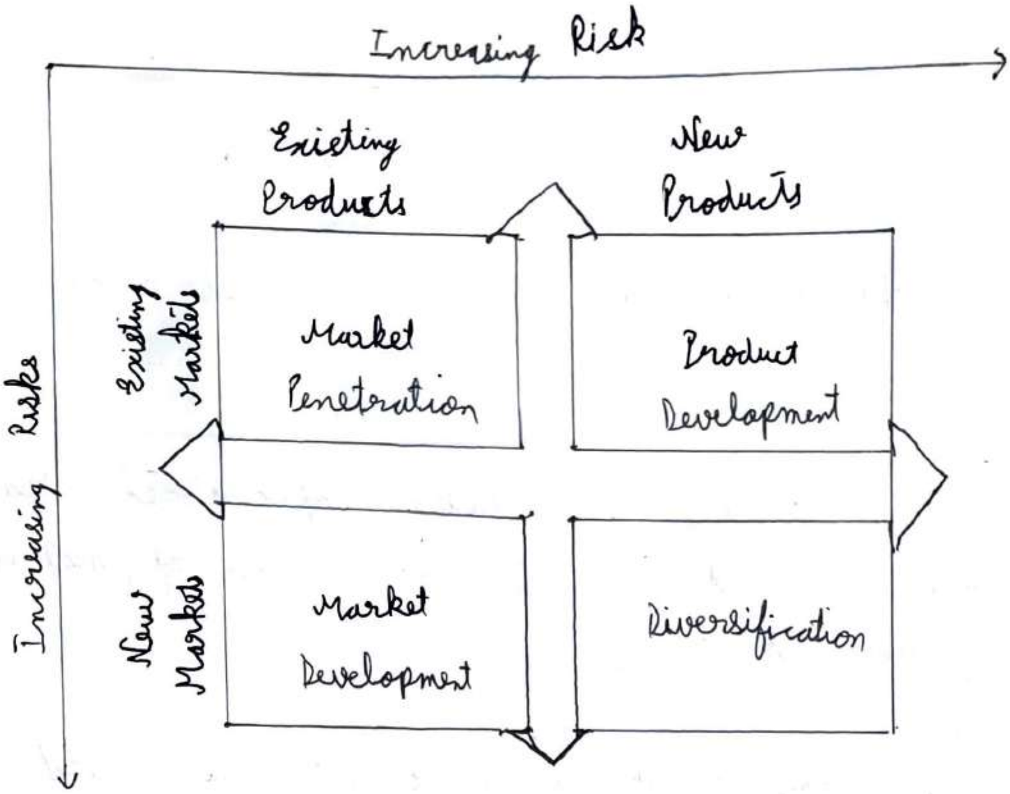
Matrix algebra is a highly specialized branch of mathematics that deals with the study of matrices and their properties. ~~A~~

Matrix algebra is an important tool used in finance and accounting, as it can be used to calculate various financial ratios, such as profitability ratios, liquidity ratio and efficiency ratio. Besides, it is also used to analyse and interpret accounting data such as balance sheets, income statements and cash flow statements. By applying matrix algebra, businesses can make informed decisions about investments and portfolio management.

Matrix algebra can be used to calculate returns on investments. It can also be used to calculate the cost of capital and assess risk of investments. It is also used to compare and contrast different investments.

Matrix algebra is also used to measure performance of a company. It can be used to calculate various financial ratios such as return on investments and

Equity.



Business Application Of Matrix Algebra

Matrix algebra can also be used to forecast future trends in the financial markets. It can be used to analyse historical data and make predictions about future stocks prices, interest rates and currency exchange rates.

Overall matrix algebra is an important tool used in finance and accounting. It enables businesses to make better decisions, assess risk and measure performance. Matrix algebra is an essential tool for anyone involed in the finance and accounting industry.

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