BHARATHIDASAN UNIVERSITY

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Programme: MBA (Financial Management)

Course Title : R and Python for Finance (NSE)

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Unit IV : Mathematical Tools

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Mathematical Tools for Finance

This presentation explores key mathematical tools used in finance, including approximation, regression, interpolation, optimization, and symbolic computation.

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Approximation: Estimating the Unknown

Purpose

Simplify complex data or functions, provide predictions for unobserved data points, and understand relationships between variables.

Example

Estimating the value of a stock based on historical data using a regression model.

Regression: Modeling Relationships

1 Linear Regression

Models the relationship between two variables by fitting a straight line.

2 Polynomial Regression

Fits a polynomial curve to the data, useful when the relationship between variables is non-linear.

3 Multiple Linear Regression

Extends linear regression to multiple independent variables.

4 Logistic Regression

Used when the dependent variable is categorical, models the probability of a certain class or event.

Applications of Regression

Predictive Analysis

Forecasting future trends based on past data, such as sales predictions.

Relationship Analysis

Understanding how changes in one variable affect another, such as the impact of interest rates on stock prices.

Optimization

Finding the best values of parameters for a process or system, such as optimizing portfolio allocation.

Interpolation: Filling in the Gaps

Linear Interpolation

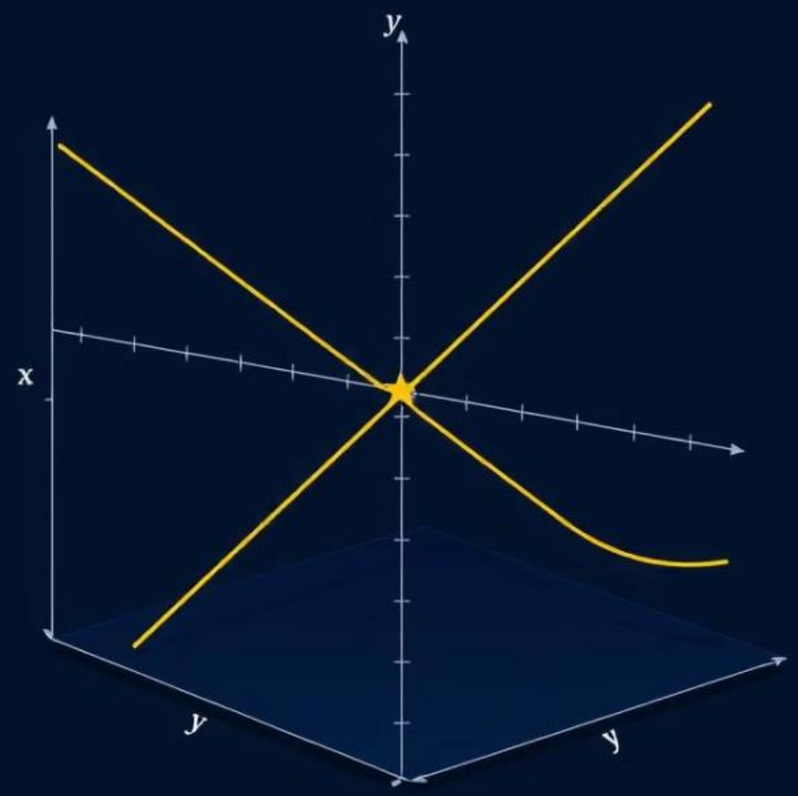
Connects known data points with straight lines.

Polynomial Interpolation

Fits a polynomial through the data points.

Spline Interpolation

Uses piecewise polynomials for a smoother fit.



Convex Optimization: Finding the Best Solution

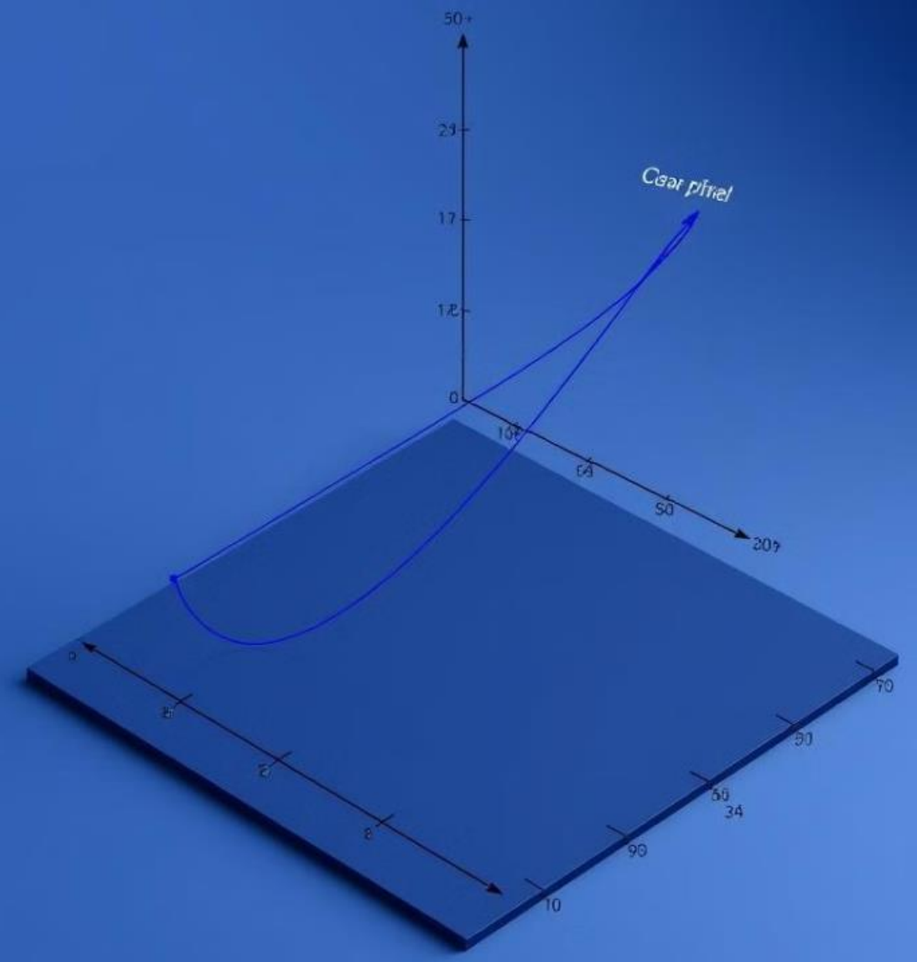
Convex optimization involves solving mathematical optimization problems where the objective function is convex, and the feasible region is defined by convex constraints.

Applications include portfolio optimization, resource allocation, and machine learning.

Global Optimization: Exploring the Entire Solution Space

Global optimization aims to find the absolute minimum or maximum of a function over a given domain, even when the function is non-convex or has multiple local optima.

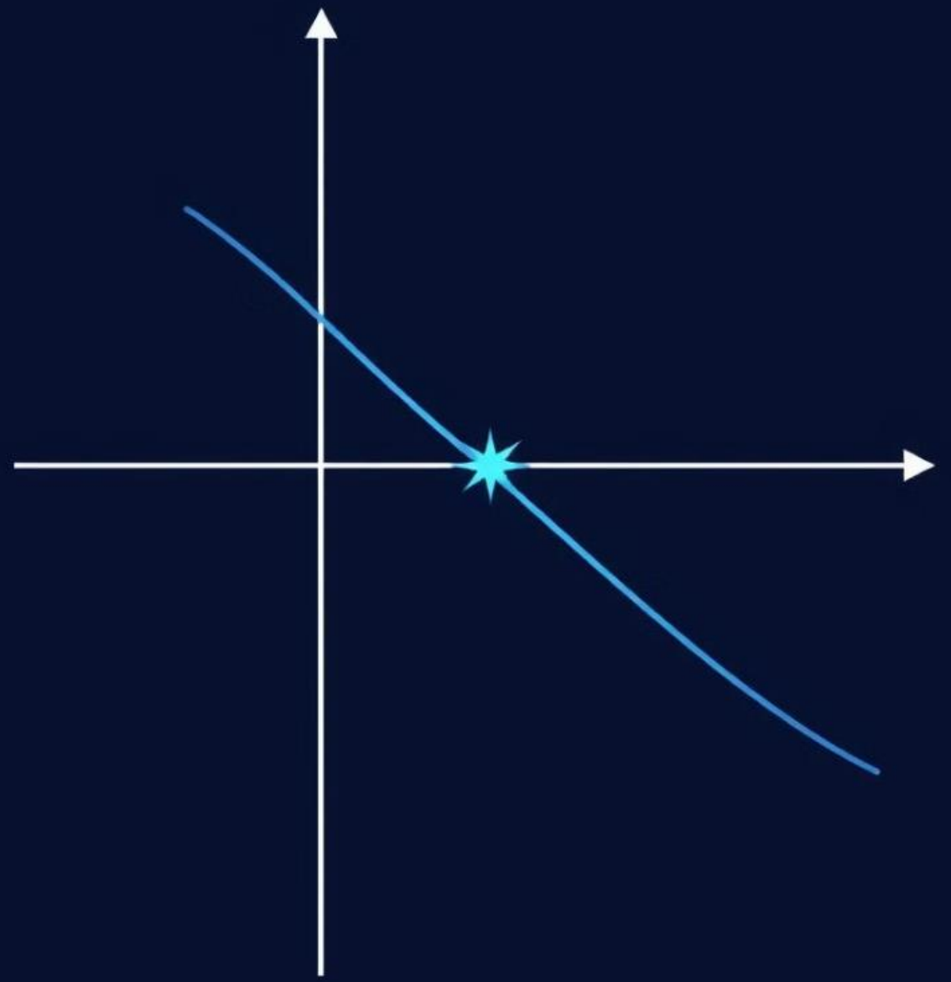
Applications include energy systems, logistics, chemical engineering, healthcare, and finance.



Local Optimization: Improving Within a Neighborhood

Local optimization involves finding a local minimum or maximum of a function using numerical methods.

Example: Portfolio optimization, where the goal is to allocate investments across different assets to minimize risk while achieving a target return.



Numerical Integration in Finance

1 Option Pricing

Pricing exotic options using continuous-time models like Black-Scholes.

2 Risk and Portfolio Analysis

Calculating expected returns or risk metrics involving complex probability distributions.

3 Present Value of Cash Flows

Estimating the net present value (NPV) for irregular cash flows or complex discount functions.

4 Probability Estimation

Integrating probability density functions (PDFs) for specific financial models.

Symbolic Computation: Manipulating Expressions Symbolically

Symbolic computation involves manipulating mathematical expressions symbolically rather than numerically.

Key applications in finance include option pricing, bond pricing, and portfolio optimization.