Data Types and Precision vs. Significance:

Mathematical models can help quantify the precision and significance of data. For instance, regression models can be used to understand how precise certain variables (like historical demand data) are in predicting future demand.

2. Demand Data

Forecasting Models:

- **Time Series Analysis**:
  - Model: yt=α+βt+γyt−1+ϵty_t = \alpha + \beta t + \gamma y_{t-1} + \epsilon_tyt=α+βt+γyt−1+ϵt
  - Description: Predicts future demand yty_tyt based on past demand data, time trend, and error term.
- **Exponential Smoothing**:
  - Model: St=αyt+(1−α)St−1S_t = \alpha y_t + (1-\alpha) S_{t-1}St=αyt+(1−α)St−1
  - Description: Averages past data with more weight on recent observations.

3. Transportation Costs

Cost Calculation:

- **Total Transportation Cost (TTC)**:
  - Model: TTC=∑i=1n(Fi+ViQi)\text{TTC} = \sum_{i=1}^{n} (F_i + V_i Q_i)TTC=∑i=1n(Fi+ViQi)
  - Description: Sum of fixed costs FiF_iFi and variable costs ViV_iVi multiplied by the quantity transported QiQ_iQi.

4. Data Aggregation

Aggregation Levels:

- **Weighted Sum**:
  - Model: A=∑i=1nwixiA = \sum_{i=1}^{n} w_i x_iA=∑i=1nwixi
  - Description: Aggregating data xix_ixi with weights wiw_iwi.

5. Data Analysis

Advanced Analytics:

- **Regression Analysis**:
  - Model: y=β0+β1x1+β2x2+...+βnxn+ϵy = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n + \epsilony=β0+β1x1+β2x2+...+βnxn+ϵ
  - Description: Predicts dependent variable yyy based on independent variables xix_ixi and error term ϵ\epsilonϵ.

6. Date of Optimization Fixing

Rolling Horizon:

- **Dynamic Programming**:
  - Model: Vt(x)=maxu{Rt(x,u)+βVt+1(f(x,u))}V_t(x) = \max_{u} \{ R_t(x, u) + \beta V_{t+1}(f(x, u)) \}Vt(x)=maxu{Rt(x,u)+βVt+1(f(x,u))}
  - Description: Optimizes decisions over a rolling horizon.

7. Decision Making in Supply Chain Management

Scenario Analysis:

- **Monte Carlo Simulation**:
  - Model: Uses random sampling to simulate various scenarios and their outcomes.

8. Dedicated Fleet

Fleet Optimization:

- **Vehicle Routing Problem (VRP)**:
  - Model: min∑k=1m∑i=1n∑j=1ncijxijk\min \sum_{k=1}^{m} \sum_{i=1}^{n} \sum_{j=1}^{n} c_{ij} x_{ijk}min∑k=1m∑i=1n∑j=1ncij xijk
  - Constraints: ∑k=1mxijk=1\sum_{k=1}^{m} x_{ijk} = 1∑k=1mxijk=1 for all iii, ensuring each customer is visited exactly once.
  - Description: Minimizes total routing cost cijc_{ij}cij while ensuring all customers are served.

9. Differing Service Level Requirements

Service Level Agreements (SLAs):

- **Service Level Calculation**:
  - Model: SL=Orders Delivered On TimeTotal Orders×100%SL = \frac{\text{Orders Delivered On Time}}{\text{Total Orders}} \times 100\%SL=Total OrdersOrders Delivered On Time×100%
  - Description: Measures the percentage of orders delivered on time.

10. Product Modelling

Bill of Materials (BOM):

- **Product Structure Tree**: Represents the hierarchy of components in a product.

11. Disruption Costs

Risk Management:

- **Expected Loss**:

- Model: EL=∑i=1npiLiEL = \sum_{i=1}^{n} p_i L_iEL=∑i=1npiLi
- Description: Sum of probabilities pip_ipi of disruptions and their respective losses LiL_iLi.

12. Capacity Modelling

Dynamic Capacity Planning:

- **Queuing Theory**:
  - Model: L=λWL = \lambda WL=λW
  - Description: Relates average number of items in the system LLL to the arrival rate λ\lambdaλ and average waiting time WWW.

13. Constraints in Optimization

Soft Constraints:

- **Penalty Function**:
  - Model: minf(x)+∑i=1nλigi(x)\min f(x) + \sum_{i=1}^{n} \lambda_i g_i(x)minf(x)+∑i=1nλigi(x)
  - Description: Objective function f(x)f(x)f(x) plus penalty for constraint violations gi(x)g_i(x)gi(x).

14. Distribution Network Analysis

Network Simulation:

- **Discrete Event Simulation (DES)**:
  - Model: Simulates the operation of a system as a discrete sequence of events over time.

15. Evaluating Supply Chain Network Design

Multi-Criteria Decision Analysis (MCDA):

- **Weighted Sum Model**:
  - Model: Score=∑i=1nwici\text{Score} = \sum_{i=1}^{n} w_i c_iScore=∑i=1nwici
  - Description: Aggregates criteria cic_ici with weights wiw_iwi.

16. Geocoding

Spatial Analysis:

- **Distance Calculation**:
  - Model: d=(x2−x1)2+(y2−y1)2d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}d=(x2−x1)2+(y2−y1)2
  - Description: Euclidean distance between two geographic points.

17. Geography in Supply Chain

Geopolitical Factors:

- **Trade Model**:
    - Model: C=∑i=1ntiQiC = \sum_{i=1}^{n} t_i Q_iC=∑i=1ntiQi
    - Description: Cost CCC based on tariffs tit_iti and quantities QiQ_iQi.

18. Baseline in Supply Chain Modelling

Benchmarking:

- **Performance Benchmark**:
    - Model: P=Current PerformanceBenchmark Performance×100%P = \frac{\text{Current Performance}}{\text{Benchmark Performance}} \times 100\%P=Benchmark PerformanceCurrent Performance×100%
    - Description: Compares current performance to a benchmark.

19. Labor and Sensitivity Analysis

Labor Productivity:

- **Productivity Calculation**:
    - Model: P=OutputLabor InputP = \frac{\text{Output}}{\text{Labor Input}}P=Labor InputOutput
    - Description: Measures output per labor unit.

20. Infeasible Solutions

Feasibility Checks:

- **Constraint Satisfaction**:
    - Model: If gi(x)≤0, solution is feasible.\text{If } g_i(x) \leq 0 \text{, solution is feasible.}If gi(x)≤0, solution is feasible.
    - Description: Checks if constraints gi(x)g_i(x)gi(x) are satisfied.

21. Per Unit Cost

Activity-Based Costing (ABC):

- **Cost Allocation**:
    - Model: C=∑i=1nAiCiC = \sum_{i=1}^{n} A_i C_iC=∑i=1nAiCi
    - Description: Allocates costs CCC based on activities AiA_iAi.

22. Weighted Average Location and Position

Centroid Method:

- **Optimal Location**:

- Model: Latitudeoptimal=∑i=1nLatitudei×Demandi∑i=1nDemandi\text{Latitude}_{\text{optimal}} = \frac{\sum_{i=1}^{n} \text{Latitude}_i \times \text{Demand}_i}{\sum_{i=1}^{n} \text{Demand}_i}Latitudeoptimal =∑i=1nDemandi∑i=1nLatitudei×Demandi
- Description: Finds the optimal latitude considering demand weights.

23. What-If Scenarios

Scenario Planning:

- **Linear Programming**:
  - Model: max∑i=1ncixi\max \sum_{i=1}^{n} c_i x_imax∑i=1ncixi
  - Constraints: ∑j=1maijxj≤bi\sum_{j=1}^{m} a_{ij} x_j \leq b_i∑j=1maijxj≤bi
  - Description: Maximizes objective cixic_i x_icixi subject to constraints aija_{ij}aij.

. Data Processing Algorithms

- **Outlier Detection**: DBSCAN (Density-Based Spatial Clustering of Applications with Noise), Z-Score Method.
- **Missing Value Imputation**: K-Nearest Neighbors (KNN), Mean/Median Imputation.

2. Demand Forecasting Algorithms

- **Time Series Forecasting**: ARIMA (AutoRegressive Integrated Moving Average), SARIMA (Seasonal ARIMA), Prophet.
- **Exponential Smoothing**: Holt-Winters Method, Simple Exponential Smoothing.

3. Transportation Optimization Algorithms

- **Cost Minimization**: Linear Programming (LP), Mixed-Integer Programming (MIP).
- **Vehicle Routing Problem (VRP)**: Clarke-Wright Savings Algorithm, Genetic Algorithms (GA), Ant Colony Optimization (ACO).

4. Data Aggregation Algorithms

- **Weighted Average**: Weighted Moving Average, Aggregation Functions in SQL.

5. Data Analysis Algorithms

- **Regression Analysis**: Ordinary Least Squares (OLS), Ridge Regression, Lasso Regression.
- **Machine Learning**: Random Forest, Support Vector Machines (SVM), Gradient Boosting Machines (GBM).

6. Optimization Algorithms for Rolling Horizon

- **Dynamic Programming**: Bellman's Equation, Policy Iteration.
- **Stochastic Programming**: Two-Stage Stochastic Programming.

7. Scenario Analysis Algorithms

- **Monte Carlo Simulation**: Monte Carlo Sampling, Random Walks.

8. Dedicated Fleet Optimization Algorithms

- **Vehicle Routing Algorithms**: Genetic Algorithm (GA), Ant Colony Optimization (ACO), Tabu Search.

9. Service Level Optimization Algorithms

- **Multi-Objective Optimization**: Goal Programming, Multi-Criteria Decision Analysis (MCDA).

10. Product Modelling Algorithms

- **Bill of Materials (BOM) Optimization**: Mixed-Integer Linear Programming (MILP), Constraint Programming (CP).

11. Disruption Costs Algorithms

- **Risk Management**: Decision Trees, Bayesian Networks, Value-at-Risk (VaR).

12. Capacity Modelling Algorithms

- **Queuing Theory**: M/M/1 Queue Model, G/G/1 Queue Model.
- **Capacity Planning**: Linear Programming, Integer Programming.

13. Constraint Handling Algorithms

- **Penalty Methods**: Penalty Function Method, Interior Point Methods.

14. Distribution Network Analysis Algorithms

- **Shortest Path**: Dijkstra's Algorithm, A* (A-Star) Algorithm.
- **Network Flow**: Ford-Fulkerson Algorithm, Edmonds-Karp Algorithm.

15. Evaluating Supply Chain Network Design Algorithms

- **Multi-Criteria Decision Analysis (MCDA)**: Analytic Hierarchy Process (AHP), Weighted Sum Model.

16. Geocoding Algorithms

- **Geocoding**: Geospatial Indexing, Reverse Geocoding Algorithms.

17. Geography and Risk Analysis Algorithms

- **Trade and Tariff Models**: Equilibrium Models, Gravity Models.

18. Baseline in Supply Chain Modelling Algorithms

- **Benchmarking**: Data Envelopment Analysis (DEA), Performance Benchmarking Models.

19. Labor and Sensitivity Analysis Algorithms

- **Sensitivity Analysis**: Tornado Diagrams, Partial Derivatives.

20. Feasibility Checking Algorithms

- **Feasibility Algorithms**: Feasibility Pump, Interior Point Methods.

21. Per Unit Cost Calculation Algorithms

- **Activity-Based Costing**: ABC (Activity-Based Costing) Algorithms.

22. Weighted Average Location and Position Algorithms

- **Location Optimization**: Centroid Method, Median of Means.

23. What-If Scenarios Algorithms

- **Scenario Planning**: Monte Carlo Simulation, Scenario Tree Analysis.