Mathnal
DECISIONS FROM EVIDENCE

Supply Chain Optimization
for the Modern Enterprise

12 Weeks Duration	**96 Hours** Total Hours
8 Modules Core Topics	**Python** Powered

Certified Supply Chain Optimization Professional

CSCOP Program

"Decisions from Evidence"

Python · PuLP · OR-Tools · NumPy · Scikit-learn · Industry Case Studies

What We'll Cover Today

01 **Program Overview**

Goals, structure, and what you'll build

02 **8-Module Deep Dive**

From LP foundations to AI-powered optimization

03 **Technology Stack**

Python, PuLP, OR-Tools, Scikit-learn

04 **Industry Case Studies**

Amazon, Walmart, DHL, Maersk, P&G

05 **Capstone Project**

Real-world problem solving with Python

06 **Assessment & Outcomes**

Grading, certification, and career paths

Program At a Glance

96	12	8	30+	15+
Total Hours	Weeks	Modules	Python Labs	Case Studies

Format	Instructor-led lectures + Hands-on Python labs + Industry case studies
Language	Python 3.10+ | PuLP · OR-Tools · NumPy · SciPy · Pandas · Scikit-learn
Audience	Freshers (Data/Engineering) and Working Professionals in Supply Chain / Analytics
Outcome	CSCOP Certificate + Python optimization portfolio + Job-ready skills

Who Is This Program For?

Fresh Graduates

B.E/B.Tech/MBA

Engineers and management graduates looking to break into supply chain analytics, data science, or operations research roles at top companies.

Working Professionals

2–8 Yrs Exp.

Supply chain managers, procurement analysts, and logistics professionals upgrading from Excel to Python-powered optimization.

Data Scientists

Analytics Background

Data/ML professionals wanting to apply Python skills specifically to supply chain and operations research problems.

Consultants

Strategy/Ops Roles

Consultants in operations or strategy practices who want to add quantitative optimization capabilities to their toolkit.

12-Week Learning Roadmap

M1	M2	M3	M4	M5	M6	M7	M8
SC Foundations	Math Optimization	Procurement	Inventory	Transportation	Network Design	Risk Modeling	Advanced AI
Wk 1–2	Wk 3–4	Wk 5	Wk 6–7	Wk 8–9	Wk 10	Wk 11	Wk 12

CAPSTONE PROJECT (Weeks 13–14)

Teams build a complete Python optimization model and present to industry panel. 4 tracks: FMCG Distribution | Airline Spare Parts | E-Commerce Fulfilment | Supplier Risk

Every Week:

- **Concept Lecture** — 2 hrs
- **Mathematical Modeling** — 2 hrs
- **Python Lab** — 2 hrs
- **Case Study** — 2 hrs

Mathnal
DECISIONS FROM EVIDENCE

01

MODULE 01

Supply Chain Analytics Foundations

Weeks 1–2 | 16 Hours | Build Business Context Before Optimization

Module 1 — Supply Chain Analytics Foundations

SC Fundamentals

Procurement · Inventory structures · Transport networks · SC risk taxonomy

Analytics Tiers

Descriptive vs Predictive vs Prescriptive · Optimization vs Simulation

Key KPIs

Fill Rate · OTIF · Inventory Turns · Total Landed Cost · Service Level

Python Setup

NumPy · SciPy · PuLP · OR-Tools · Pandas · Matplotlib

Lab

Import SC datasets · Build cost models · Data cleaning & transformation

Case Study

Amazon-style fulfillment network overview and KPI analysis

Mathnal
DECISIONS FROM EVIDENCE

02

MODULE 02

Mathematical Optimization Foundations

Weeks 3–4 | 16 Hours | The Mathematical Language of Supply Chain Decisions

Module 2 — Three Pillars of Optimization

LP

Linear Programming

- Min Z = $c^T x$ s.t. $Ax \leq b, x \geq 0$
- Simplex & interior-point algorithms
- Procurement cost minimization
- Transportation cost minimization
- Shadow prices & sensitivity analysis

Tool: PuLP

MIP

Mixed Integer Programming

- Binary yes/no decisions ($y \in \{0,1\}$)
- Facility location (open/close)
- Supplier selection problems
- Branch-and-bound solver approach
- Big-M constraint formulation

Tool: PuLP + CBC

NLP

Nonlinear Programming

- Nonlinear objective or constraints
- Price break optimization
- Capacity scaling problems
- SciPy minimize() framework
- Gradient-based & heuristic solvers

Tool: SciPy.optimize

Mathnal
DECISIONS FROM EVIDENCE

03

MODULE 03

Procurement Optimization

Week 5 | 8 Hours | How Companies Choose Optimal Suppliers

Module 3 — Procurement Optimization

Procurement MIP Model

MINIMIZE	Purchase Cost + Transport Cost + Risk Penalty + Fixed Supplier Cost
SUBJECT TO	Demand Fulfillment Supplier Capacity MOQ Constraints Diversification Limit
VARIABLES	x_i = Qty from supplier i y_i ∈ {0,1} = Selected?

Case: Automotive OEM · Electronics global sourcing

Key Topics & Outcomes

1. Multi-supplier sourcing strategy & Total Cost of Ownership (TCO)
2. MOQ constraints, price break optimization (nonlinear NLP)
3. Supplier risk scoring: financial, quality, delivery, geopolitical
4. Python lab: full procurement MIP with PuLP
5. Case Study: Automotive OEM (India) — 6 suppliers, 180k units/yr
6. Case Study: Electronics industry global sourcing strategy

Mathnal
DECISIONS FROM EVIDENCE

04

MODULE 04

Inventory Optimization

Weeks 6–7 | 16 Hours | From EOQ to Multi-Echelon Systems

EOQ Formula

$$Q^* = \sqrt{(2 \times D \times S / H)}$$

D=Demand · S=Ordering Cost · H=Holding Cost/unit/yr

Safety Stock: $SS = z \times \sqrt{(L \times \sigma^2_D + D^2 \times \sigma^2_L)}$

Service Level → Z-Score

SL	90%	95%	97%	99%
z	1.28	1.65	1.88	2.33
SS eg.	72u	103u	124u	164u

Classic EOQ

Optimal order qty minimizing ordering + holding cost. Full sensitivity analysis.

Safety Stock

Service-level buffer. z-score for 90–99% SL. Demand & LT uncertainty.

Multi-Echelon

Supplier→Plant→DC→Store positioning. Bullwhip mitigation.

Mathnal
DECISIONS FROM EVIDENCE

05

MODULE 05

Transportation Optimization

Weeks 8–9 | 16 Hours | VRP, Routing Algorithms & Google OR-Tools

Module 5 — Transportation Optimization

Variant	Full Name	Key Constraint	OR-Tools Support
CVRP	Capacitated VRP	Vehicle load capacity	Full support
VRPTW	VRP + Time Windows	Customer time windows	Full support
MDVRP	Multi-Depot VRP	Multiple depots	Full support
PDVRP	Pickup & Delivery	Paired pickup/delivery	Full support
EVRP	Electric VRP	Battery range + charging	Partial

Algorithms:

PATH_CHEAPEST_ARC | GUIDED_LOCAL_SEARCH | LNS | SAVINGS | SWEEP

Google OR-Tools

World-class combinatorial optimization library. VRP, Scheduling, Network Flow, Constraint Programming. Free & open-source.

Mathnal
DECISIONS FROM EVIDENCE

06

MODULE 06

Supply Chain Network Design

Week 10 | 8 Hours | Where to Locate Facilities, How to Route Flows

CFLP — Capacitated Facility Location Problem

DECISION	$y_j \in \{0,1\}$ Open warehouse j? $x_{ij} \in \{0,1\}$ Assign customer i to j?
MINIMIZE	$\Sigma f_j \cdot y_j$ (fixed) $+ \Sigma c_{ij} \cdot x_{ij} \cdot d_i$ (shipping)
SUBJECT	Each customer → 1 facility Capacity: $\Sigma x_{ij} \cdot d_i \leq Cap_j \cdot y_j$
RESULT	Optimal locations + assignments + total network cost

Case: P&G $1.5B redesign · 65 plants · 80 countries

Network Design Decisions

How many?	Number of warehouses/DCs to operate in the network
Where?	Optimal locations minimising weighted delivery cost
How big?	Capacity at each facility vs. regional demand forecasts
What flows?	Multi-commodity routing from each facility
What modes?	Intermodal: road/rail/air/sea per lane
What risk?	Dual-sourcing nodes, backup facilities, buffer

Mathnal
DECISIONS FROM EVIDENCE

07

MODULE 07

Supply Chain Risk Modeling

Week 11 | 8 Hours | Monte Carlo · Markov Chains · Disruption Quantification

Risk Category Matrix

Supplier Risk	Medium	High	Multi-sourcing, audits
Transport Risk	Medium	Medium	Mode diversification
Demand Risk	High	Medium	Safety stock, flex contracts
Geopolitical	Low	Very High	Nearshoring, regional hubs
Nat. Disaster	Very Low	Catastrophic	Redundancy, insurance
Cyber Risk	Low	High	Security, backups

Monte Carlo Simulation

Run 100,000 scenarios with randomised demand, lead time & disruption inputs to build a probability distribution of total cost.

VaR 95%	Max cost at 95% confidence
CVaR 95%	Expected cost in worst 5%
Stockout P	Probability of stockout
E[Cost]	Mean scenario cost

Case Study: COVID-19 Supply Chain Disruptions
Dual-sourcing ROI, Monte Carlo, Markov disruption analysis

Mathnal
DECISIONS FROM EVIDENCE

08

MODULE 08

Advanced Algorithms & AI in Supply Chains

Week 12 | 8 Hours | Metaheuristics · ML Forecasting · AI Risk Prediction

Module 8 — Advanced Algorithms & AI

GA Genetic Algorithm

Darwinian evolution. Population evolves via crossover and mutation. Best for large-scale VRP.

Best for: Large-scale VRP, network design

SA Simulated Annealing

Metallurgy-inspired hill-climbing with cooling schedule. Escapes local optima.

Best for: TSP, facility location

TS Tabu Search

Memory-based local search. Tabu list prevents revisiting recent solutions.

Best for: Job scheduling, constrained VRP

Machine Learning for Supply Chain

XGBoost

Demand Forecasting

Tabular data, promotions, seasonality. Typical MAPE: 8–12%

LSTM/TFT

Deep Learning TS

Complex temporal patterns. Used by Walmart & Amazon.

Prophet

Seasonal Forecasting

Trend + seasonality + holidays. Robust to missing data.

Scikit-learn

Risk Classification

Supplier risk scoring, anomaly detection, lead time prediction.

Technology Stack — Python & OR Libraries

Python 3.10+

All optimization models, scripts, data pipelines, and ML models.

PuLP

Linear and Mixed Integer Programming. Procurement, transportation, network design.

OR-Tools

Google's VRP, scheduling, and constraint programming solver.

NumPy

Matrix operations, Monte Carlo simulation, EOQ models.

SciPy

NLP solvers (minimize), statistical distributions, LP via linprog.

Pandas

SC data import, cleaning, KPI calculation — OTIF, fill rate, turns.

Scikit-learn

Demand forecasting, supplier risk classification, anomaly detection.

Matplotlib

Cost curves, network maps, sensitivity plots, executive dashboards.

Industry Case Studies — Learn from the Best

AMAZON

Fulfillment Network Design

FC placement MIP, inventory positioning, Prime routing

M1, M6

WALMART

Inventory & VMI Optimization

Continuous replenishment, cross-docking, OTIF tracking

M4

DHL

VRP Last-Mile Routing

Dynamic routing, time windows, 25-stop CVRP lab

M5

MAERSK

Container Network Flow

Repositioning MIP, vessel speed opt., port sequencing

M5,M6

P&G

Global Network Redesign

$1.5B savings using MIP · 65 plants · multi-commodity flow

M6

COVID-19

Risk & Disruption Modeling

Monte Carlo stress test, dual-sourcing ROI, Markov analysis

M7

Case Study Deep Dive — Amazon Fulfillment Network

Amazon by the Numbers

200+
Fulfillment Centers (US)

FC placement MIP model

400M
sq ft Warehouse Space

Predictive inventory positioning

75%
US pop within 25 miles

3-tier last-mile structure

40%
Delivery cost reduction

Prime routing algorithms

Lab: FC placement MIP for 20 Indian cities.
Cover 70% demand within 50km at min cost.

Optimization Layers in Amazon's SC

Strategic

Network Design MIP

Decide FC count + locations annually using demand forecasts

Tactical

Inventory Positioning

Pre-stock SKUs in nearest FC using ML models 6–8 weeks ahead

Operational

VRP Routing

Daily re-optimization of 1,000+ routes per metro, 2-hour windows

Real-time

Dynamic Re-routing

Re-route as traffic, cancellations, and conditions change

Capstone Project — Build Something Real

TRACK A

FMCG Distribution Optimization

- Network design MIP (8 DCs, 3 plants, 450 outlets)
- Last-mile VRP optimization
- Inventory policy at each node
- Cost savings dashboard

Python + Jupyter + PuLP/OR-Tools

TRACK B

Airline Spare Parts Inventory

- EOQ / safety stock per SKU
- Multi-echelon policy design
- Service level vs. cost frontier
- Cannibalization modeling

Python + Jupyter + PuLP/OR-Tools

TRACK C

E-Commerce Fulfillment Network

- FC location MIP for next-day delivery
- Inventory positioning model
- Delivery promise optimization
- What-if scenario analysis

Python + Jupyter + PuLP/OR-Tools

TRACK D

Supplier Risk Mitigation

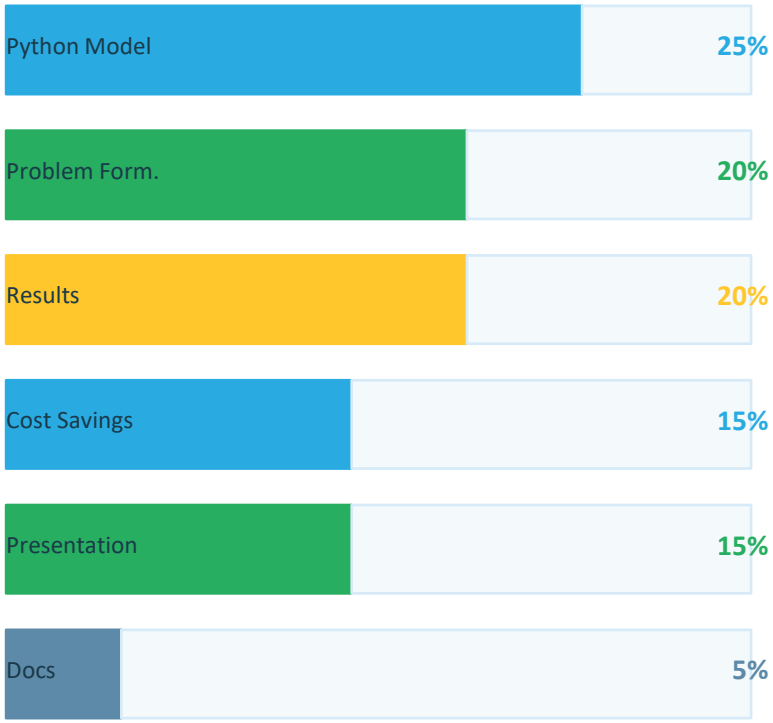
- Supplier risk scoring model
- Monte Carlo disruption sim
- Dual-sourcing optimization
- Risk-cost Pareto analysis

Python + Jupyter + PuLP/OR-Tools

Capstone Deliverables & Evaluation

Deliverable	Description
Python Optimization Model	Complete, documented PuLP / OR-Tools model solving the chosen problem
Jupyter Notebooks	Step-by-step notebooks with formulation, solution, and sensitivity analysis
Cost Savings Analysis	Quantified business impact vs. baseline; ROI calculation; implementation effort
Executive Dashboard	Plotly / Matplotlib dashboard showing KPIs, optimization results, and scenarios
Presentation Deck	Executive-level 10-slide deck presented to faculty and guest industry panel

Evaluation Weights



Assessment Structure & Grading

Component	When	Weight	Description
Weekly Lab Submissions	Wks 1–10	30%	Python notebooks auto-graded + instructor review
Module Quizzes (×4)	Wks 4,7,10,12	15%	Online MCQ + formulation questions (30 min each)
Mid-Program Assignment	End Wk 6	15%	Individual optimization project: procurement or inventory
Case Study Analyses	Wks 5,7,9,11	10%	Written analysis + model replication for each case study
Capstone Project	Wks 13–14	25%	Team project + Python model + executive presentation
Participation	Throughout	5%	Forum contributions, peer reviews, in-class Q&A

Grading Scale:

A+	A	B+	B	C	F
90–100	80–89	70–79	60–69	50–59	<50
Distinction	Merit	Pass	Pass	Conditional	Re-exam

Career Outcomes — Where CSCOP Graduates Work

Supply Chain Analyst

Key Employers:

Amazon, Flipkart, Walmart

₹6–10 LPA

OR Analyst

Key Employers:

McKinsey, BCG, Deloitte

₹10–18 LPA

SC Data Scientist

Key Employers:

Maersk, DHL, Siemens

₹12–20 LPA

Logistics Opt. Engineer

Key Employers:

Swiggy, Zomato, Dunzo

₹10–16 LPA

Procurement Analytics Mgr

Key Employers:

TCS, Infosys, Accenture

₹14–22 LPA

SCM Consultant

Key Employers:

Big 4, Boutique firms

₹15–30 LPA

Skills Employers Are Actively Hiring For:

- Python Optimization
- Operations Research
- SC Analytics
- VRP / Routing
- Demand Forecasting
- Risk Modeling

What Every Student Receives

30+

Python Notebooks

Python Notebooks

One notebook per lab, fully documented with comments, formulations, and outputs.

15+

Industry Case Studies

Industry Case Studies

Adapted real problems from Amazon, Walmart, DHL, Maersk, P&G, and more.

8

Optimization Templates

Optimization Templates

Reusable PuLP/OR-Tools templates for LP, MIP, VRP, network design, and risk.

5

Real-World Datasets

Real-World Datasets

Cleaned SC datasets for procurement, inventory, transport, and demand.

1

GitHub Repository

GitHub Repository

Personal project repo with all labs, capstone code, and portfolio notebooks.

∞

Community Access

Community Access

Lifetime access to Mathnal Alumni Network, job boards, and future cohort recordings.

Mathnal
DECISIONS FROM EVIDENCE

Certified Supply Chain Optimization Professional

"Decisions from Evidence"

Start Your Journey

in Supply Chain Optimization

- 12 weeks · 96 hours · 8 Modules
- Python + OR-Tools + PuLP + ML
- 15+ industry case studies (Amazon, P&G, DHL...)
- 4 Capstone project tracks
- CSCOP Certificate + Portfolio
- Roles: ₹6–30 LPA | Fortune 500 to Startups

Register now or enquire at:

krishnaidu@mathnal.tech | +91-7993651356 I www.mathnal.tech