Training Course on Advanced Time Series Analysis and Forecasting In Data Science

Professional Development Training Course Outline

Category	Data Science	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

In today's data-driven world, the ability to accurately predict future trends is a critical competitive advantage for businesses and researchers alike. Training Course on Advanced Time Series Analysis & Forecasting delves into the sophisticated methodologies of **Advanced Time Series Analysis & Forecasting**, equipping participants with the essential skills to unlock profound insights from sequential data. We will explore classical statistical techniques like **ARIMA models**, alongside modern, flexible approaches such as Facebook's **Prophet** and cutting-edge **Neural Networks for time series**, empowering data professionals to build robust predictive models for diverse applications.

This program goes beyond foundational concepts, focusing on practical implementation and real-world problem-solving. Through a blend of theoretical understanding and hands-on exercises, participants will master the art of **time series decomposition**, **stationarity testing**, **model selection** , and **forecast evaluation**. The curriculum is designed to provide a comprehensive toolkit for anyone seeking to enhance their **predictive analytics capabilities** and drive data-informed decision-making across industries, from finance and retail to healthcare and supply chain management.

Programme Curriculum

Training Course on Advanced Time Series Analysis & Forecasting in Data Science: ARIMA, Prophet, Neural Networks for time series

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Course Objectives

Upon completion of this comprehensive training, participants will be able to:

1. Comprehend core concepts, components (trend, seasonality, cyclic, irregular), and characteristics of **time series data**.
2. Apply advanced visualization techniques and statistical methods for initial **time series data exploration**.
3. Implement differencing and transformation techniques to ensure **data stationarity** for classical models.
4. Build, interpret, and diagnose **ARIMA (Autoregressive Integrated Moving Average)** models for univariate forecasting.
5. Extend ARIMA to **SARIMA (Seasonal ARIMA)** to effectively capture and forecast seasonal patterns.
6. Understand and implement various **Exponential Smoothing (ETS)** techniques for different time series patterns.
7. Employ the **Prophet forecasting model** for robust and scalable business forecasting, handling trends, seasonality, and holidays.
8. Understand the architecture and application of **Recurrent Neural Networks (RNNs)**, including **LSTMs (Long Short-Term Memory)**, for complex time series forecasting.
9. Develop advanced **feature engineering** strategies specific to time series data for improved model performance.
10. Critically assess and compare forecasting model performance using key **accuracy metrics** (MAE, RMSE, MAPE).
11. Gain an introduction to **Vector Autoregression (VAR)** and other methods for forecasting multiple interdependent time series.
12. Tackle issues like **missing data imputation**, **outlier detection**, and **interventions** in time series.
13. Effectively present and interpret forecasting results to technical and non-technical stakeholders, highlighting **business impact**.

Organizational Benefits

- Improve the precision of demand forecasting, sales predictions, financial projections, and resource allocation.

- Streamline inventory management, production planning, and supply chain operations through better predictive insights.
- Proactively identify and respond to potential market shifts, financial volatility, and operational disruptions.
- Empower teams with the analytical capabilities to make informed strategic and tactical decisions.
- Leverage advanced analytical techniques to outperform competitors in market responsiveness and foresight.
- Encourage the adoption of cutting-edge machine learning and statistical methods for predictive intelligence.
- Optimize staffing, budget allocation, and infrastructure planning based on reliable future predictions.

Target Audience

This course is designed for:

1. Data Scientists and Analysts.
2. Business Intelligence Professionals
3. Financial Analysts & Quants.
4. Supply Chain and Operations Managers.
5. Researchers and Academics.
6. Software Engineers.
7. Marketing & Sales Professionals.
8. Students & Aspiring Data Professionals.

Modules with Case Studies

Module 1: Introduction to Time Series Analysis & Forecasting Foundations (5 hours)

- Understanding Time Series Data: Definition, characteristics, types.
- Components of Time Series: Trend, Seasonality, Cyclical, Irregular.
- Time Series Visualization: Line plots, seasonal plots, autocorrelation plots.
- Key Concepts: Stationarity, Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF).
- Data Preprocessing for Time Series: Handling missing values, outliers, transformations.
- **Case Study**: Analyzing historical retail sales data to identify trends and seasonality for a consumer electronics company.

Module 2: Classical Forecasting Methods (5 hours)

- Naive Methods: Simple, Seasonal Naive, Drift.
- Moving Averages & Weighted Moving Averages.
- Exponential Smoothing (ETS): Simple, Holt's, Holt-Winters.
- Choosing the Right ETS Model: Additive vs. Multiplicative, damping.
- Evaluating Forecast Accuracy: MAE, MSE, RMSE, MAPE.
- **Case Study**: Forecasting monthly electricity consumption for a utility company using Holt-Winters exponential smoothing.

Module 3: ARIMA Models: The Box-Jenkins Methodology (6 hours)

- Introduction to ARIMA (Autoregressive Integrated Moving Average).
- Stationarity Testing: Augmented Dickey-Fuller (ADF) test, KPSS test.
- Differencing to Achieve Stationarity.

- Identifying ARIMA(p,d,q) Orders: Using ACF and PACF plots.
- Model Fitting, Diagnosis, and Forecasting with ARIMA.
- **Case Study**: Predicting daily stock prices for a specific company using ARIMA models, analyzing residuals for white noise.

Module 4: Seasonal ARIMA (SARIMA) (4 hours)

- Understanding Seasonality in ARIMA: Seasonal components (P, D, Q, S).
- SARIMA Model Identification: Interpreting seasonal ACF/PACF.
- Fitting and Forecasting with SARIMA Models.
- Comparing ARIMA and SARIMA for Seasonal Data.
- Advanced SARIMA Diagnostics.
- **Case Study**: Forecasting quarterly GDP growth for a national economy using SARIMA, accounting for economic cycles.

Module 5: Facebook Prophet for Business Forecasting (6 hours)

- Introduction to Prophet: Strengths, assumptions, and use cases.
- Additive Model Decomposition: Trend, seasonality, holidays.
- Handling Trends: Piecewise linear and logistic growth.
- Managing Seasonality: Annual, weekly, daily seasonality.
- Incorporating Holidays and Special Events: Custom regressors.
- **Case Study**: Forecasting web traffic for an e-commerce platform, integrating promotions and holiday effects using Prophet.

Module 6: Advanced Prophet Techniques & Customization (5 hours)

- Changepoint Detection and Adjustment.
- External Regressors (Exogenous Variables) in Prophet.
- Cross-Validation and Hyperparameter Tuning for Prophet.
- Uncertainty Intervals and Forecast Visualization.
- Limitations and Best Practices for Prophet Implementation.
- **Case Study**: Predicting product demand for a fast-moving consumer goods (FMCG) company, incorporating marketing spend as an external regressor with Prophet.

Module 7: Introduction to Neural Networks for Time Series (6 hours)

- Recurrent Neural Networks (RNNs): Architecture and backpropagation through time.
- Challenges with Vanilla RNNs: Vanishing/exploding gradients.
- Long Short-Term Memory (LSTM) Networks: Gate mechanisms, memory cells.
- Gated Recurrent Units (GRUs): Simplified alternative to LSTMs.
- Implementing RNNs/LSTMs/GRUs for Time Series Forecasting in Python (Keras/TensorFlow).
- **Case Study**: Forecasting energy consumption in a smart grid using LSTM networks to capture complex, non-linear patterns.

Module 8: Advanced Neural Network Architectures for Time Series (5 hours)

- Stacked LSTMs and Bidirectional LSTMs.
- Convolutional Neural Networks (CNNs) for Time Series (TCNs).
- Encoder-Decoder Architectures for Sequence-to-Sequence Forecasting.
- Attention Mechanisms in Time Series Forecasting.
- Hybrid Models: Combining statistical and neural network approaches.

- **Case Study**: Predicting financial market volatility using a combination of CNN and LSTM layers to identify intricate patterns in high-frequency data.

Module 9: Feature Engineering for Time Series & Exogenous Variables (4 hours)

- Lagged Features: Autoregressive features.
- Rolling Statistics: Moving averages, standard deviations, min/max.
- Time-Based Features: Day of week, month, quarter, year, holidays.
- Seasonal Decomposition Features.
- Incorporating Exogenous Variables: Impact and selection.
- **Case Study**: Enhancing a sales forecasting model by generating new features from calendar data and past promotional activities.

Module 10: Model Selection, Evaluation, and Comparison (5 hours)

- Advanced Evaluation Metrics: MASE, R-squared, directional accuracy.
- Walk-Forward Validation vs. Block Time Series Cross-Validation.
- Residual Analysis: Diagnosing model shortcomings.
- Comparing Forecasts from Different Models (ARIMA, Prophet, NN).
- Ensemble Forecasting Techniques.
- **Case Study**: Comparing the forecasting performance of ARIMA, Prophet, and LSTM models for airline passenger numbers, identifying the most suitable model.

Module 11: Multivariate Time Series Analysis (5 hours)

- Introduction to Vector Autoregression (VAR) Models.
- Granger Causality Testing.
- Cointegration and Error Correction Models (ECM).
- Impulse Response Functions (IRFs) and Forecast Error Variance Decomposition (FEVD).
- Implementing VAR models in Python.
- **Case Study**: Analyzing and forecasting the interdependent relationship between inflation, interest rates, and unemployment using VAR models.

Module 12: Anomaly Detection in Time Series (4 hours)

- Statistical Methods for Anomaly Detection (e.g., control charts).
- Machine Learning Approaches for Anomaly Detection.
- Time Series Decomposition for Anomaly Identification.
- Impact of Anomalies on Forecasting.
- Strategies for Handling Anomalies.
- **Case Study**: Detecting unusual server load patterns in IT infrastructure time series data to prevent outages.

Module 13: Time Series for Causal Inference & Intervention Analysis (4 hours)

- Understanding Causality in Time Series.
- Intervention Analysis: Quantifying the impact of specific events.
- Counterfactual Forecasting.
- Quasi-Experimental Designs for Time Series.
- Practical Applications in Policy and Marketing.
- **Case Study**: Assessing the impact of a new marketing campaign on sales performance using intervention analysis techniques.

Module 14: Deploying Time Series Models & MLOps Considerations (4 hours)

- Model Deployment Strategies: Batch vs. Real-time forecasting.
- Monitoring Model Performance in Production.
- Retraining Strategies for Time Series Models.
- Version Control for Models and Data.
- Scalability and Performance Optimization.
- **Case Study**: Developing a deployment strategy for a daily demand forecasting model, ensuring continuous accuracy and retraining.

Module 15: Advanced Topics & Future Trends (3 hours)

- Bayesian Time Series Forecasting.
- Probabilistic Forecasting & Quantile Regression.
- Generative Models for Time Series (e.g., GANs).
- Explainable AI (XAI) for Time Series Models.
- Big Data Time Series & Distributed Computing (e.g., Spark).
- **Case Study**: Exploring advanced techniques for generating probabilistic forecasts of renewable energy output for grid management.

Training Methodology

This training course employs a highly **interactive and practical methodology** to ensure maximum learning and skill acquisition. The approach combines:

- **Expert-Led Lectures**: Clear and concise explanations of complex theoretical concepts.
- **Hands-on Coding Sessions**: Extensive practical exercises using **Python** with popular libraries like **Pandas, NumPy, Scikit-learn, Statsmodels, Prophet, Keras, and TensorFlow**.
- **Real-World Case Studies**: Application of learned techniques to diverse industry scenarios, fostering problem-solving skills.
- **Live Demonstrations**: Step-by-step walkthroughs of model building, evaluation, and interpretation.
- **Interactive Discussions**: Encouraging participants to share insights, ask questions, and collaborate on solutions.
- **Group Activities & Challenges**: Reinforcing understanding and promoting teamwork in applying concepts.
- **Q&A Sessions**: Dedicated time for addressing individual queries and clarifying doubts.
- **Upcoming Scheduled Sessions**

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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