

TIME SERIES ANALYSIS AND FORECASTING

RESOURCES WEEK 1

PART 1: FOUNDATIONS OF TIME SERIES ANALYSIS

1.1 INTRODUCTION TO TIME SERIES

TEXTBOOKS

Title	Authors	Publisher & Date	Notes
Forecasting: principles and practice (3rd ed.)	Rob J. Hyndman & George Athanasopoulos	OTexts, 2021	Very accessible, up-to-date, strong mix of intuition + applications, online version available
Time series analysis: forecasting and control (5th ed.)	George E. P. Box, et al.	Wiley, 2016	The classic book introducing ARIMA modelling / the Box–Jenkins framework. Historical and still foundational.
Time series analysis	James D. Hamilton	Princeton University Press, 1994,	More theoretical, rigorous; widely used in econometrics. A “bible” for more advanced students.
The statistical analysis of time series	Theodore W. Anderson	Wiley, 2011	A standard reference for univariate & multivariate time series, theory and statistical properties.
The analysis of time series: an introduction with r (7th ed.)	Chris Chatfield, Haipeng Xing	CRC Press, 2019	For students wanting to see both theory and practical implementation; good bridge book.
Demystifying time series forecasting for the enterprise	Abdullah Karasan	O’Reilly, 2025	Very recent); focused on enterprise use-cases, business value, how organizations use time-series forecasting strategically.
Time series forecasting in python	Marco Peixeiro	Manning, 2022	Hands-on with Python; statistical + ML + deep learning; includes real world datasets.
Modern time series forecasting with python (2nd ed.)	Manu Joseph, Jeffrey Tackes	Packt, 2024	Modern tools; covers baseline forecasts, visualisation etc.
Time series (2nd ed.)	Raquel Prado, Marco A. R. Ferreira & Mike West	CRC Press, 2021	More advanced; with Bayesian approaches; good for exploring many methodological branches (frequentist, Bayesian, deep learning)
Practical time series analysis	Aileen Nielsen	O’Reilly, 2019	Ramps up from basics (trend / seasonality) to ARIMA and beyond, with real-world examples.
Time series forecasting: an applied machine learning approach	Francesca Lazzeri	Wiley, 2021	Bridges ML methods with time-series; shows recent trends. Good for seeing how the field is evolving (not just ARIMA etc.) and that there are many paths.

PAPERS & SURVEYS

- [25 Years of Time Series Forecasting](#) by J.G. De Gooijer & Rob J. Hyndman (2006): a survey of literature from 1982-2005; useful for seeing how time series forecasting has developed & its importance in many domains.
- [A Comprehensive Survey of Time Series Forecasting](#) by Jongseon Kim, Hyungjoon Kim, HyunGi Kim, Dongjun Lee & Sungroh Yoon: very recent survey, covers core concepts, why forecasting is needed, applications across domains.

1.2 TIME SERIES ANALYSIS CONCEPTS

TEXTBOOKS /CHAPTERS

Book	What it covers & why useful
Forecasting: Principles and Practice by Rob J. Hyndman & George Athanasopoulos	Chapter 1 gives intuitive examples of time series data, what forecasting is, and why it matters.
Time Series Analysis: Forecasting and Control (Box & Jenkins, expanded versions)	The early chapters (Chapter 1–2) that define time series data, the uniqueness of time ordering and autocorrelation.
Introductory Time Series with R by P.S.P. Cowpertwait & A.V. Metcalfe	Chapter 1 has examples, plots, seasonal/trend structure.
Time Series Analysis and Its Applications: With R Examples by Shumway & Stoffer	The introductory material (first chapter) that lays out what time series are, typical features like trend/seasonality, examples.

SEMINAL / KEY PAPERS & ARTICLES

Paper / Article	Authors / Year	What it contributes & relevance
Principles and algorithms for forecasting groups of time series	Hyndman, Montero-Manso et al. (2021)	It discusses global vs local models , i.e. modeling individual series vs groups of series (collections), performance trade-offs, generalization.
Local vs global models for hierarchical forecasting	Yingjie Zhao & Mahdi Abolghasemi et al. (2024)	Empirical work comparing local vs global forecasting models in hierarchical time series settings.
Mean shifts, unit roots and forecasting seasonal time series	R. Paap (1997)	Looks at seasonal unit roots and behaviour of forecasting when such features are present.
Efficient tests of the seasonal unit root hypothesis	Rodriguez et al. (2007)	For more technical audience: how to test whether seasonality has a unit root. Useful as a reference.

LECTURE NOTES / TUTORIALS / ONLINE MATERIAL

- [How to Detect Stationarity in Time Series: Trend, Seasonality, and Variance](#): blog / tutorial (Medium). It gives intuitive methods to detect trend, seasonality, unit roots etc.
- [Econometrics of Seasonality](#) by Robert Kunst (University of Vienna): covers theory of seasonality, intra-year movement, non-regular seasonality etc.

1.3 EXPLORING AND VISUALIZING TIME SERIES DATA

TEXTBOOKS / CHAPTERS

Book	What it covers & why useful
<i>Forecasting: Principles and Practice</i> by Hyndman & Athanasopoulos	Chapters on <i>Time series graphics & Decomposition by You</i> , especially sections showing seasonal plots, time plots, ACF / PACF. These are very accessible and full of good visual examples.
<i>Time Series Analysis and Its Applications</i> (Shumway & Stoffer)	The early chapters include decomposition into trend/seasonality, plus later ones have diagnostics (ACF/PACF etc.). Good for connecting visuals with statistical properties.
<i>Introductory Time Series with R</i> by Cowpertwait & Metcalfe	Chapters dealing with plotting tools, interpreting seasonal boxplots, decomposition, etc. They tend to use examples and R packages, which helps for teaching.
<i>Practical Time Series Analysis</i> (O'Reilly) by Aileen Nielsen	Contains many applied examples focused on visualization, exploratory data analysis, how plotting helps choose models.
<i>Time Series: Theory and Methods</i> (Brockwell & Davis)	More theoretical, but includes the statistical properties of ACF / PACF, plus formal definitions and asymptotic behaviors, which help justify what visual cues mean.

TUTORIALS / ONLINE ARTICLES / BLOGS

Title & Author / Site	What's in it (plots, examples)
<i>Chapter 18 Visualization in Time Series Analysis</i> (from a free online course / notes)	Shows how to decompose time series (trend, seasonality, cycles), shows additive vs multiplicative decompositions, uses moving averages, rendering plots.
<i>Machine Learning Mastery: A Gentle Introduction to Autocorrelation and Partial Autocorrelation</i> (Jason Brownlee)	Step-by-step tutorial in Python, with code & visual examples of ACF and PACF plots.
<i>GeeksforGeeks: Autocorrelation and Partial Autocorrelation</i>	Contains explanations of ACF vs PACF, code examples, how to read the plots (where things cut off, where they decay) etc.
<i>Understanding ACF and PACF</i> (Medium article)	Real-life examples + intuitive explanation; highlighting how correlation decays over lags, repeating seasonal patterns etc.

Time Series in 5-Minutes, Part 2: Autocorrelation and Cross-Correlation (R-bloggers)	Short, visual examples using R; good for showing quickly what lag plots and ACF look like.
--	--

1.4 HANDLING MISSING DATA AND OUTLIERS

KEY PAPERS & RECENT RESEARCH

Title	Authors / Year	What it contributes (and relevance)
Saits: self-attention-based imputation for time series	Wenjie Du, David Cote, Yan Liu et al. (2022)	A modern method (deep learning) for imputing missing values in multivariate time series.
Tsrobprep – an r package for robust preprocessing of time series data	Michał Narajewski, Jens Kley-Holsteg, Florian Ziel (2021)	Provides methods for both missing values AND outlier detection, considering seasonality & trend.
Improving time series data quality: identifying outliers and imputation strategies in environmental data	AS AlSalehy et al. (2025)	A case study applying hybrid statistical + ML outlier detection (IQR, Z-score, Isolation Forest etc.), and several interpolation methods depending on gap sizes
Time series outlier removal and imputing methods based ...	J. Parra-Plazas et al. (2023)	Comparative study of methods for removal + imputation
Anomaly detection in time series: a comprehensive evaluation	Sebastian Schmidl & Phillip Wenig et al. (2022)	Covers many anomaly-/outlier detection methods, large empirical evaluation
Dive into time-series anomaly detection: a decade review	Boniol, Liu, Palpanas, et al. (2024)	Recent survey of anomaly detection in time series.

DEFINITIONS, THEORY & TUTORIALS

- **Generalized Extreme Studentized Deviate (ESD) test / S-ESD / Hybrid ESD:** The S-H-ESD method (Seasonal Hybrid ESD) is used by Twitter etc., combining STL decomposition + ESD + robust scale measures (MAD etc.) to detect anomalies in presence of seasonality.

1.5 FORECASTING TIME SERIES

CORE TEXTBOOK CHAPTERS

Textbook	Chapter / Section	Focus	Notes
Hyndman & Athanasopoulos – Forecasting: Principles and Practice (3rd ed., OTexts)	Ch. 5.6 <i>Evaluating forecast accuracy</i>	Accuracy	Defines MAE, RMSE, MAPE, bias; very accessible, free online.
Makridakis, Wheelwright & Hyndman – Forecasting: Methods and Applications (3rd ed., Wiley)	Ch. 3 <i>Evaluating Forecasting Methods</i>	Accuracy	Classic treatment, includes Theil's U and bias.

Joseph, Manu – <i>Time Series Forecasting in Python</i> (2nd ed., Packt)	Ch. 5 <i>Evaluating Forecast Performance</i>	Accuracy	Practical Python implementation of MAE, RMSE, MAPE, bias.
Shumway & Stoffer – <i>Time Series Analysis and Its Applications</i> (4th ed., Springer)	Forecasting sections in Ch. 6–7	Accuracy	Statistical basis: forecast error variance, MSE.
Industry Guide – <i>Introduction to Forecasting in the Utilities</i> (Utility Analytics, 2023)	Module on <i>Assessing forecastability</i>	Forecastability	Covers CoV, Residual Variability, Entropy, Kaboudan metric.

KEY PAPERS & RECENT RESEARCH ON FORECASTABILITY

Title	Authors / Year	What it contributes; how to use in your video
<i>Time Series Forecastability Measures</i>	Rui Wang, Steven Klee & Alexis Roos (2025)	Introduces two metrics you can compute <i>before</i> model building: spectral predictability score and largest Lyapunov exponent . These help quantify how forecastable a series is inherently.
<i>Enhancing Predictability Assessment: An Overview and Evaluation</i>	A. Bezbochina et al. (2023)	Survey / comparative discussion of entropy-and related methods for assessing intrinsic predictability of time series.
<i>Model-free quantification of time-series predictability</i>	Joshua Garland, Ryan James, Elizabeth Bradley (2014)	Proposes use of “permutation entropy” or related “redundancy/complexity” measures that correlate with how well various forecasting methods work.

SOURCES FOR THE “KABOUDAN METRIC” ETC.

- There is a blog / article “[Evaluation of Time Series Predictability with Kaboudan Metric using Prophet](#)” that describes how to compute this metric: build a forecasting model, compute SSE on original data vs SSE on block-shuffled version of the data; then metric = $1 - \text{SSE}_{\text{original}} / \text{SSE}_{\text{shuffled}}$. This gives a value between 0 and 1 indicating how much “signal” remains relative to noise / randomness.

ADDITIONAL / RECENT PAPERS ABOUT FORECASTABILITY & ACCURACY

- The paper *Time Series Forecastability Measures* (Wang et al., 2025) shows correlation between forecastability metrics (like spectral predictability) and actual forecast performance (measured via standard error metrics) on datasets like M5. So you can use this to motivate: forecastability measures *before* model building correlate with performance.
- Surveys like *Enhancing Predictability Assessment* help compare many different methods for intrinsic predictability (entropy, variation, etc.), showing which methods are more stable/effective across different data types.

1.6 BUILDING ROBUST BASELINES

CORE TEXTBOOK CHAPTERS FOR PART 1.6 (BASELINES & MODEL COMPARISON)

Textbook	Chapter / Section	Focus	Notes
Hyndman & Athanasopoulos – Forecasting: Principles And Practice (3rd Ed.)	Ch. 3 SIMPLE METHODS (naive, seasonal naive, mean) & Ch. 7 MODEL SELECTION (including information criteria)	Baselines + model comparison	Covers how to pick simple benchmarks and how AIC/BIC help choose among parametric models.
Joseph, Manu – Time Series Forecasting In Python (2nd Ed.)	Ch. 4 BASELINE MODELS & BENCHMARKING & Ch. 6 MODEL SELECTION AND INFORMATION CRITERIA	Baselines + AIC/BIC	Python-oriented, includes code examples for naive, seasonal naive, rolling average, EMA; also uses AIC/BIC to compare ARIMA or exponential smoothing variants.
Makridakis, Wheelwright & Hyndman – Forecasting: Methods And Applications (3rd Ed.)	Chapter on “Forecasting Methods: Simple vs Complex” & later sections on model selection / parsimony	Baselines & model comparison	Good coverage of why “fancier” doesn’t always win; theoretical backing for AIC, BIC.
Shumway & Stoffer – Time Series Analysis And Its Applications (4th Ed.)	Model selection sections (in chapters on ARIMA / parametric modelling)	Model comparison (AIC/BIC)	Gives statistical basis for AIC / BIC; asymptotic properties, trade-off between fit vs complexity.
Chatfield, Chris – The Analysis Of Time Series: An Introduction With R (6th ed.)	Section on evaluation of forecasting methods & model selection / information criteria	Baseline models + AIC/BIC	A clear treatment of information criteria; also shows when simple methods perform well relative to more complex ones.

RESEARCH PAPERS

Paper	Focus
“Another look at measures of forecast accuracy” – Hyndman & Koehler (2006, IJF)	Accuracy metrics, role of baselines
“The M3-Competition: Results, conclusions and implications” – Makridakis & Hibon (2000, IJF)	Benchmarks like naive/seasonal naive in M3 competition
“Model Selection and Multimodel Inference” – Burnham & Anderson (2002)	Theoretical foundation of AIC/BIC

TUTORIALS & ONLINE GUIDES

Resource	Focus	Notes
Rob J Hyndman's blog & lecture notes (otexts.com/fpp3)	Baseline forecasting, naive/seasonal naive, information criteria	Clear R examples; widely used in teaching.
How to Make Baseline Predictions for Time Series Forecasting with Python (Jason Brownlee)	Implementing naive, seasonal naive, persistence models in Python	Easy-to-follow code examples for baselines.

1.7 STATISTICAL METHODS I: EXPONENTIAL SMOOTHING

CORE TEXTBOOKS

Title	Chapter / Section	Focus
Hyndman & Athanasopoulos – <i>Forecasting: Principles and Practice</i> (3rd ed.)	Ch. 7 <i>Exponential Smoothing</i>	SES, Holt's, Holt-Winters methods
Hyndman, R.J., Koehler, A.B., Ord, J.K., Snyder, R.D. – <i>Forecasting with Exponential Smoothing: The State Space Approach</i> (Springer)	Entire book	Detailed state-space framework for exponential smoothing
Chatfield, Chris – <i>Time Series Forecasting</i> (Chapman & Hall/CRC)	Ch. 7 <i>Exponential Smoothing</i>	Practical applications of exponential smoothing

RESEARCH PAPERS

Paper	Focus
Gardner, E.S. – <i>Exponential Smoothing: The State of the Art</i> (2006)	Comprehensive review of exponential smoothing methods
Shahin, A.A. – <i>Using Multiple Seasonal Holt-Winters Exponential Smoothing for Cloud Workload Prediction</i> (2017)	Application of Holt-Winters method to cloud workload prediction

TUTORIALS & GUIDES

Resource	Focus
GeeksforGeeks – Exponential Smoothing for Time Series Forecasting	Introduction to exponential smoothing methods

Analytics Vidhya – Time Series Forecasting: Complete Tutorial	Step-by-step guide including Holt's and Holt-Winters methods
Medium – A Thorough Introduction to Holt-Winters Forecasting	In-depth explanation of Holt-Winters method

1.8 STATISTICAL METHODS II: AUTOREGRESSIVE MODELS

CORE TEXTBOOKS

Title	Chapter / Section	Focus
Hyndman & Athanasopoulos – <i>Forecasting: Principles and Practice</i> (3rd ed.)	Ch. 8–10 <i>ARMA</i> , <i>ARIMA</i> , <i>Seasonal ARIMA</i>	Comprehensive coverage of <i>ARMA</i> , <i>ARIMA</i> , and <i>SARIMA</i> models
Box, Jenkins, Reinsel, & Ljung – <i>Time Series Analysis: Forecasting and Control</i> (5th ed.)	Ch. 4–6 <i>ARMA</i> , <i>ARIMA</i> , <i>SARIMA</i>	Foundational text on <i>ARMA</i> , <i>ARIMA</i> , and <i>SARIMA</i> models
Shumway & Stoffer – <i>Time Series Analysis and Its Applications</i> (4th ed.)	Ch. 6–7 <i>ARMA</i> , <i>ARIMA</i> , <i>SARIMA</i>	In-depth theoretical treatment of <i>ARMA</i> , <i>ARIMA</i> , and <i>SARIMA</i> models
Hamilton, J.D. – <i>Time Series Analysis</i> (2nd ed.)	Ch. 6–8 <i>ARMA</i> , <i>ARIMA</i> , <i>SARIMA</i>	Advanced theoretical insights into <i>ARMA</i> , <i>ARIMA</i> , and <i>SARIMA</i> models

RESEARCH PAPERS

Paper	Focus
"A Seasonal Autoregressive Integrated Moving Average with Exogenous Factors (SARIMAX) Forecasting Model-Based Time Series Approach" - Zhou, Y., Li, J., & Liu, X. (2022)	Application of SARIMAX in forecasting electricity sector performance
"Comparative Analysis of ARIMA, SARIMA and Prophet Model in Forecasting" - Radhika, R., & Priya, S. (2023)	Performance comparison of ARIMA, SARIMA, and Prophet models
"The Efficacy of ARIMAX and SARIMA Models in Predicting Monthly Currency in Circulation in Ghana" - Mensah, K., & Agyemang, F. (2014)	Evaluation of ARIMAX and SARIMA models for currency forecasting
"Comparative Study of ARIMA and SARIMA Models to Forecast Lockdowns Due to SARS-CoV-2" - Nguyen, T., & Le, P. (2021)	Forecasting COVID-19 lockdowns using ARIMA and SARIMA models

TUTORIALS & GUIDES

Resource	Focus
Machine Learning Mastery – ARIMA for Time Series Forecasting with Python	Step-by-step guide to implementing ARIMA in Python
Analytics Vidhya – Time Series Forecasting: Complete Tutorial	Comprehensive tutorial covering ARIMA, SARIMA, and AutoARIMA
Kaggle – ARIMA, SARIMA, SARIMAX for Beginners	Beginner-friendly introduction to ARIMA, SARIMA, and SARIMAX
Medium – ARIMA vs SARIMA vs SARIMAX	Comparison of ARIMA, SARIMA, and SARIMAX models

1.9 STATISTICAL METHODS III: ADVANCED FORECASTING MODELS

CORE TEXTBOOKS

Title	Chapter / Section	Focus
Hyndman & Athanasopoulos – <i>Forecasting: Principles and Practice</i> (3rd ed., 2021)	Ch. 11 <i>Complex Seasonality</i>	TBATS, BATS, Prophet
Hyndman & Athanasopoulos – <i>Forecasting: Principles and Practice</i> (3rd ed., 2021)	Ch. 12 <i>Dynamic Regression</i>	Dynamic Harmonic Regression
Joseph, M. – <i>Modern Time Series Forecasting with Python</i> (2023)	Ch. 10 <i>Advanced Forecasting Models</i>	Theta method, TBATS, Prophet

RESEARCH PAPERS

Author(s) & Year	Title	Focus
De Livera, Hyndman & Snyder (2011)	“Forecasting Time Series with Complex Seasonal Patterns Using Exponential Smoothing”	TBATS and BATS models
Mindham (2019)	“Dynamic Harmonic Regression and Irregular Sampling”	Dynamic Harmonic Regression

TUTORIALS & GUIDES

Resource	Focus
Kaggle – Time Series Forecasting with Theta Model (2023)	Theta method implementation
Analytics Vidhya – Time Series Forecasting using TBATS Model (2021)	TBATS model explanation and implementation
Medium – Time Series Forecasting with Prophet (2025)	Prophet model overview and application

1.10 PROBABILISTIC FORECASTING

CORE TEXTBOOKS

Title	Chapter / Section	Focus
Hyndman & Athanasopoulos – <i>Forecasting: Principles and Practice</i> (3rd ed., 2021)	Ch. 13 <i>Probabilistic Forecasting</i>	Prediction intervals, quantiles, Bayesian methods, ensembles, Monte Carlo dropout, conformal prediction
Joseph, M. – <i>Modern Time Series Forecasting with Python</i> (2023)	Ch. 12 <i>Probabilistic Forecasting Techniques</i>	Quantile regression, Bayesian methods, Monte Carlo dropout

RESEARCH PAPERS

Title	Focus
“Ensemble Conformalized Quantile Regression for Probabilistic Time Series Forecasting” - Jensen, V., Bianchi, F. M., & Anfinssen, S. N. (2022)	Ensemble conformalized quantile regression (EnCQR)
“Evaluating Probabilistic Predictions: Proper Scoring Rules” - Sun, S. (2023)	Proper scoring rules: NLL, Brier, CRPS, Winkler score
“A Review of Predictive Uncertainty Estimation with Machine Learning Algorithms” - Tyralis, H. (2024)	Overview of predictive uncertainty estimation and related metrics

TUTORIALS & GUIDES

Resource	Focus
Skforecast – Probabilistic Forecasting Guide	Bootstrapped residuals, conformal prediction
Data Science Nexus – Probabilistic Forecasting with Skforecast (2025)	Implementation of probabilistic forecasting using Skforecast

