Table of Contents

Preface	1 chemiest requirement
Chapter 1: Introduction to Time Series Analysis	and R
Technical requirements	essent to setudnitis of 1 - 7
Time series data	8 anna amir ajanavtilina
Historical background of time series analysis	
Time series analysis	no local paragraph and the control of the control o
Learning with real-life examples	12
Getting started with R	poissoud worsely act. 14
Installing R	15
A brief introduction to R	and the second s
R operators	10
Assignment operators	o aim bas ai gaisilsus v 16
Arithmetic operators	and have adversely and
Logical operators	18
Relational operators	agazinad circulaci en 19
The R package	20
Installation and maintenance of a package Loading a package in the R working environment	os rutw gridioW sa resque 21 22
The key packages	momentuper Isolande 22
Variables	24
Importing and loading data to R	satuditha asslo oos arti 25
Flat files	do oor and to xabril ant 1 26
Web API	il bns atab rillw gribhovi 27
R datasets	toelde pos a gnilserió 28
Working and manipulating data	nit elgillum nilw prizhow 29
Querying the data	essio six en la 31
Help and additional resources	aetudithe assio arx eri i 34
Summary	villenoilanut aix en l 35
Chapter 2: Working with Date and Time Objects	naido est costableixaM 37
Technical requirements	edo etxus onitisedus 37
The date and time formats	38
Date and time objects in R	40
Creating date and time objects	ewobniw prilici 43
Importing date and time objects	ansi poliseno 44
Reformatting and converting date objects	one posterio nilapendo A 44
Handling numeric date objects	do etx bas our control 48
Reformatting and conversion of time objects	molionul oex Joie an 50
Time zone setting	notion of stx tolo enil 53
Creating a date or time index	o doldw - Ri to got six 54

M	anipulation of date and time with the lubridate p Reformatting date and time objects – the lubridate way	ackage	55 56
1	Utility functions for date and time objects		59
S	ummary		6
Char	ter 3: The Time Series Object		63
T	echnical requirement		64
	ne Natural Gas Consumption dataset		
	ne attributes of the ts class		64
	Multivariate time series objects		68
	Creating a ts object		70
	Creating an mts object		75
	Setting the series frequency		76
D	ata manipulation of ts objects		80
	The window function		80
	Aggregating ts objects		82
	Creating lags and leads for ts objects		83
Vi	sualizing ts and mts objects		84
	The plot ts function		85
	The dygraphs package		87
81	The TSstudio package		90
S	ummary		92
Chap	ter 4: Working with zoo and xts Objects		93
	echnical requirement		93
	ne zoo class		
35	The zoo class attributes		94 95
	The index of the zoo object		96
	Working with date and time objects		97
	Creating a zoo object		99
	Working with multiple time series objects		103
: TI	ne xts class		104
	The xts class attributes		105
	The xts functionality		105
	The periodicity function		106
	Manipulating the object index		106
D/I	Subsetting an xts object based on the index properties		107
o IVI	anipulating the zoo and xts objects		108
	Merging time series objects Rolling windows		109
	Creating lags		111
	Aggregating the zoo and xts objects		113
PI	otting zoo and xts objects		113
50	The plot.zoo function		114
	The plot.zeo function		115
xt	s, zoo, or ts – which one to use?		116
276	-,,		122

Summary Summar	123
Chapter 5: Decomposition of Time Series Data	125
Technical requirement	125
The moving average function	126
The rolling window structure	
The average method	128
The MA attributes	129
The simple moving average	132
Two-sided MA	137
A simple MA versus a two-sided MA	140
The time series components	142
The cycle component	143
The trend component	145
The seasonal component	147
The seasonal component versus the cycle component	150
White noise nousiums	152
The irregular component	156
The additive versus the multiplicative model	156
Handling multiplicative series	158
The decomposition of time series	160
Classical seasonal decomposition	161
Seasonal adjustment	165
Summary anodomuses 2.10 sriT	166
Chapter 6: Seasonality Analysis	167
Technical requirement	167
Seasonality types	168
Seasonal analysis with descriptive statistics	171
Summary statistics tables	171
Seasonal analysis with density plots	180
Structural tools for seasonal analysis	185
Seasonal analysis with the forecast package	185
Seasonal analysis with the TSstudio package	187
Summary	195
and successful the total management of the second control of the s	407
Chapter 7: Correlation Analysis Technical requirement	197
Tooline and an one of the control of	101
	100
Lags analysis	200
The autocorrelation function	202
The partial autocorrelation function	
Lag plots	
Causality analysis	
Causality versus correlation	211

The cross-correlation function	213
Summary	218
Chapter 8: Forecasting Strategies	219
Technical requirement	219
The forecasting workflow	220
Training approaches	222
Training with single training and testing partitions	222
Forecasting with backtesting	225
Forecast evaluation	229
Residual analysis	229
Scoring the forecast Forecast benchmark	232
	235
Finalizing the forecast	238
Handling forecast uncertainty	240
Confidence interval and allowed the second s	240
Horse race approach	241 243
Summary	243
and the second s	245
Chapter 9: Forecasting with Linear Regression	247
Technical requirement	247
The linear regression	248
Coefficients estimation with the OLS method	250
The OLS assumptions	252
Forecasting with linear regression	253
Forecasting the trend and seasonal components	253
Features engineering of the series components	255
Modeling the series trend and seasonal components	259
The tslm function	270
Modeling single events and non-seasonal events	271
Forecasting a series with multiseasonality components – a case	ITT 8
study The UKgrid period	273
The UKgrid series	274
Preprocessing and feature engineering of the UKdaily series Training and testing the forecasting model	276
Model selection	280 284
Residuals analysis	286
Finalizing the forecast	287
Summary	289
	209
Chapter 10: Forecasting with Exponential Smoothing Models	291
Technical requirement	291
Forecasting with moving average models	292
The simple moving average	292
Weighted moving average	299

Forecasting with exponential smoothing	301
Simple exponential smoothing model	301
Forecasting with the ses function	306
Model optimization with grid search	309
Holt method	311
Forecasting with the holt function	313
Holt-Winters model	318
Summary	328
Chapter 11: Forecasting with ARIMA Models	329
Technical requirement	330
The stationary process	330
Transforming a non-stationary series into a stationary series	334
Differencing time series	335
Log transformation	337
The random walk process	338
The AR process	341
Identifying the AR process and its characteristics	344
The moving average process	346
Identifying the MA process and its characteristics	348
The ARMA model	349
Identifying an ARMA process	352
Manual tuning of the ARMA model	353
Forecasting AR, MA, and ARMA models	357
The ARIMA model	358
Identifying an ARIMA process	359
Identifying the model degree of differencing	359
The seasonal ARIMA model	364
Tuning the SARIMA model	365
Tuning the non-seasonal parameters	365
Tuning the seasonal parameters	365
Forecasting US monthly natural gas consumption with the SARIMA model -	
a case study	366
The auto.arima function	377
Linear regression with ARIMA errors	379
Violation of white noise assumption	379
Modeling the residuals with the ARIMA model	382
Summary	387
Chapter 12: Forecasting with Machine Learning Models	389
Technical requirement	389
Why and when should we use machine learning?	390
Why h2o?	391
Forecasting monthly vehicle sales in the US – a case study	392
Exploratory analysis of the USVSales series	392
The series structure	392

X	427
er Books You May Enjoy	423
ummary	421
	419
	416
	413
	406
	405
	403
	402
Training, testing, and model evaluation	401
Feature engineering	399
Exploratory analysis – key findings	397
	396
	394 395
	Feature engineering Training, testing, and model evaluation Model benchmark Starting a h2o cluster Training an ML model Forecasting with the Random Forest model Forecasting with the GBM model Forecasting with the AutoML model Selecting the final model ummary