

Contents

List of Figures	XIII
List of Tables	XVII
List of Abbreviations	XIX
1 Introduction	1
1.1 Motivation	2
1.2 Objectives and Research Questions	4
1.3 Research Design and Thesis Structure	5
2 Theoretical and Conceptual Foundations	9
2.1 Data Foundation	10
2.1.1 Experimental versus Observational Data	10
2.1.2 Independent and Identically Distributed Data	13
2.2 Causal Inference	17
2.2.1 Statistical Approaches	24
2.2.2 Graphical Approaches	28
2.2.3 Deep Learning Approaches	32
2.2.4 Assumptions for Causal Inference	34
2.3 Causal Analysis for E-Commerce Issues	37
2.3.1 Explainable Artificial Intelligence	40
2.3.2 Causal Inference in E-Commerce	41
2.3.3 Analyzing Human Behavior in E-Commerce	45
2.4 Related Work	46
2.4.1 Foundations of Causality	46
2.4.2 Existing Methods for Causal Inference	47
2.5 Interim Conclusion	51
3 Causal Inference on Observational Data	53
3.1 Goal Definition and Methodology	54
3.2 Data Foundation	56
3.2.1 Data Selection	57
3.2.2 Internal Data Sources	60
3.2.3 External Data Sources	63
3.2.4 Data Preprocessing	64

3.3	Combinatorial Approach	66
3.4	Structure Learning	68
3.4.1	Methodology	69
3.4.2	Model Output	73
3.5	Structure Refinement	75
3.5.1	Methodology	78
3.5.2	Model Output	82
3.6	Structure Quantification	85
3.6.1	Methodology	86
3.6.2	Model Output	89
3.7	Model Evaluation	90
3.7.1	Evaluation of Causal Relations for Single Timelags	92
3.7.2	Comparison of Evaluation Metrics across Timelags	102
3.7.3	Causal Relations between Interventions and Target	103
3.8	Interim Conclusion	106
4	Causal Intelligent Scenario Planner	109
4.1	Objective and Methodology	110
4.2	Requirements	111
4.2.1	Functional Requirements	111
4.2.2	Non-functional Requirements	113
4.3	System Components	115
4.3.1	Overview	115
4.3.2	Causal Modeling	117
4.3.3	Database	118
4.3.4	Data Configuration	120
4.3.5	Visualization Configuration	121
4.3.6	Intervention Management	122
4.3.7	Causal Inference	123
4.3.8	Graph Visualization	125
4.3.9	Effect Visualization	127
4.4	Architecture and Workflow	129
4.4.1	System Architecture	129
4.4.2	Software Architecture	130
4.4.3	Data Model	132
4.4.4	Use Case	133
4.5	Evaluation and Restrictions	136
4.5.1	Study Guidelines	136
4.5.2	Study Design	137
4.5.3	Results	141
4.6	Interim Conclusion	150
5	Conclusions	153
5.1	Discussion	154
5.1.1	Developed Models	155

<i>CONTENTS</i>	XI
5.1.2 Prototype	156
5.2 Implications	157
5.2.1 Implications for Research	157
5.2.2 Implications for Practice	158
5.3 Limitations and Future Research	160
References	XXIII
Appendix A Data Dictionary	XLVII
Appendix B Causal Structure	LI
Appendix C Evaluation	LXXIII
Appendix D Questionnaire	LXXV