

Contents

1	Introduction to Music Similarity and Retrieval	1
1.1	Music Information Retrieval	2
1.2	MIR from an Information Retrieval Perspective	3
1.2.1	Retrieval Tasks and Applications in MIR	4
1.2.2	Browsing Interfaces in MIR	6
1.2.3	Recommendation Tasks and Applications in MIR	9
1.2.4	MIR Beyond Retrieval, Browsing, and Recommendation	10
1.3	Music Similarity	12
1.3.1	Computational Factors of Music Similarity	13
1.3.2	Music Features	14
1.4	Contents of this Book	18
1.5	Evaluation of Music Similarity Algorithms	19
1.5.1	Evaluation Using Prelabeled Data	20
1.5.2	Evaluation Using Human Judgments	24
1.5.3	Evaluation Using Listening Histories	26
1.5.4	Music Collection and Evaluation in this Book	26
1.6	Further Reading	30

Part I Content-Based MIR

2	Basic Methods of Audio Signal Processing	33
2.1	Categorization of Acoustic Music Features	33
2.2	Simplified Scheme of a Music Content Feature Extractor	36
2.2.1	Analog–Digital Conversion	37
2.2.2	Framing and Windowing	39
2.2.3	Fourier Transform	40
2.3	Common Low-Level Features	41
2.3.1	Time Domain Features	43
2.3.2	Frequency Domain Features	47
2.4	Summary	49
2.5	Further Reading	50

- 3 Audio Feature Extraction for Similarity Measurement** 51
 - 3.1 Psychoacoustic Processing 51
 - 3.1.1 Physical Measurement of Sound Intensity 52
 - 3.1.2 Perceptual Measurement of Loudness 52
 - 3.1.3 Perception of Frequency 53
 - 3.2 Frame-Level Features and Similarity 55
 - 3.2.1 Mel Frequency Cepstral Coefficients 55
 - 3.2.2 Statistical Summarization of Feature Vectors 58
 - 3.2.3 Vector Quantization 58
 - 3.2.4 Gaussian Mixture Models 60
 - 3.2.5 Single Gaussian Model 65
 - 3.3 Block-Level Features and Similarity 67
 - 3.3.1 Fluctuation Pattern 68
 - 3.3.2 Logarithmic Fluctuation Pattern 70
 - 3.3.3 Spectral Pattern 71
 - 3.3.4 Correlation Pattern 74
 - 3.3.5 Similarity in the Block-Level Feature Framework 77
 - 3.4 Hubness and Distance Space Normalization 78
 - 3.5 Summary 81
 - 3.6 Further Reading 83
- 4 Semantic Labeling of Music** 85
 - 4.1 Genre Classification 86
 - 4.2 Auto-tagging 90
 - 4.2.1 Differences to Classification 90
 - 4.2.2 Auto-Tagging Techniques 91
 - 4.3 Mood Detection and Emotion Recognition 94
 - 4.3.1 Models to Describe Human Emotion 94
 - 4.3.2 Emotion Recognition Techniques 99
 - 4.4 Summary 102
 - 4.5 Further Reading 103

Part II Music Context-Based MIR

- 5 Contextual Music Meta-data: Comparison and Sources** 107
 - 5.1 Web-Based Music Information Retrieval 108
 - 5.1.1 The Web as Source for Music Features 108
 - 5.1.2 Comparison with Content-Based Methods 110
 - 5.1.3 Applications Using Web Data 111
 - 5.2 Data Formats for Web-Based MIR 112
 - 5.3 Tags and Annotations 114
 - 5.3.1 Expert Annotations 115
 - 5.3.2 Collaborative Tagging 115
 - 5.3.3 Games with a Purpose 117

5.4	Web Texts	119
5.4.1	Web Pages Related to Music	120
5.4.2	Biographies, Product Reviews, and Audio Blogs	126
5.4.3	Microblogs	127
5.5	Lyrics	128
5.5.1	Analysis of Lyrics on the Web	128
5.5.2	Retrieval and Correction	129
5.6	Summary	131
5.7	Further Reading	132
6	Contextual Music Similarity, Indexing, and Retrieval	133
6.1	Text-Based Features and Similarity Measures	133
6.1.1	Vector Space Model	134
6.1.2	Latent Semantic Indexing	139
6.1.3	Applications of Latent Factor Approaches	142
6.2	Text-Based Indexing and Retrieval	144
6.2.1	Pseudo Document Indexing	145
6.2.2	Document-Centered Rank-Based Scoring	146
6.2.3	Auto-Tag Indexing	147
6.3	Similarity Based on Co-occurrences	148
6.4	Combination with Audio Content Information	151
6.4.1	Combined Similarity Measures	151
6.4.2	Contextual Filtering	153
6.4.3	Combined Tag Prediction	154
6.5	Stylistic Analysis and Similarity	155
6.6	Summary	156
6.7	Further Reading	157

Part III User-Centric MIR

7	Listener-Centered Data Sources and Aspects: Traces of Music Interaction	161
7.1	Definition and Comparison of Listener-Centered Features	161
7.2	Personal Collections and Peer-to-Peer Network Folders	163
7.3	Listening Histories and Playlists	164
7.4	User Ratings	169
7.5	Modeling User Context	170
7.5.1	Sensor Data for Modeling User Context	170
7.5.2	Social Networks and User Connections	173
7.6	Factors of User Intentions	174
7.7	Summary	176
7.8	Further Reading	177
8	Collaborative Music Similarity and Recommendation	179
8.1	Similarity Estimation via Co-occurrence	180
8.2	Graph-Based and Distance-Based Similarity	182

8.3	Exploiting Latent Context from Listening Sessions	186
8.3.1	Latent Dirichlet Allocation	186
8.3.2	Case Study: Artist Clustering from Listening Events	187
8.3.3	Music Recommendation	190
8.4	Learning from Explicit and Implicit User Feedback	191
8.4.1	Memory-Based Collaborative Filtering	192
8.4.2	Model-Based Collaborative Filtering	194
8.5	Multimodal Combination	198
8.5.1	Hybrid Recommender Systems	198
8.5.2	Unified Metric Learning	205
8.6	Summary	208
8.7	Further Reading	210

Part IV Current and Future Applications of MIR

9	Applications	215
9.1	Music Information Systems	215
9.1.1	Band Members and Their Roles	216
9.1.2	Artist's or Band's Country of Origin	216
9.1.3	Album Cover Artwork	217
9.1.4	Data Representation	218
9.2	User Interfaces to Music Collections	218
9.2.1	Map-Based Interfaces	218
9.2.2	Other Intelligent Interfaces	230
9.3	Automatic Playlist Generation	233
9.4	Music Popularity Estimation	239
9.4.1	Popularity Estimation from Contextual Data Sources	240
9.4.2	Comparison of Data Sources	244
9.5	Summary	245
10	Grand Challenges and Outlook	247
10.1	Major Challenges	247
10.1.1	Methodological Challenges	248
10.1.2	Data-Related Challenges	249
10.1.3	User-Centric Challenges	250
10.1.4	General Challenges	251
10.2	Future Directions	252
A	Description of the Toy Music Data Set	255
A.1	Electronic Music	255
A.2	Classical Music	257
A.3	Heavy Metal	259
A.4	Rap	261
A.5	Pop	263
	References	266
	Index	293