## Contents

Acknowledgments ix

1 Introduction 1
   1.1 Toward Simplicity 1
   1.2 Our Perspective and Aims 1
   1.3 Strategies for Applying a Technology 3
   1.4 Relevance of the Disciplines 3
   1.5 Human or Artificial Intelligence? 4
   1.6 Advantages of Artificial Neural Networks 5
   1.7 Illustrative Examples 6
   1.8 Motivation and Morphology 11
   1.9 Book Map 11
   Summary 12
   Exercises 13
   References 13

2 Neural Networks: Methods and Algorithms 15
   Motivation 15
   2.1 Five Steps of Neural Network Design 15
   2.2 Neural Networks as Systems 18
   2.3 Backpropagation Networks 19
   2.4 Kohonen Network and Feature Mapping 26
   2.5 Hopfield Networks 30
   2.6 Radial Basis Function Network 31
   2.7 Building Complex Networks 33
   2.8 History 33
   Summary 36
   Exercises 37
   References 38

3 Training Set and Input Representation 41
   Motivation 41
   3.1 Generalization Properties 41
   3.2 Computer Generation of Training Sets 45
   3.3 Causes of Slow Training 45
   3.4 Feature Extraction and Preprocessing 46
   3.5 Performance Evaluation 53
Contents

Summary 55
Exercises 56
References 57

4 Optimal Groundwater Remediation 59
Motivation 59
Morphology 59
4.1 Hydrogeologic Background 60
4.2 Example Problem 72
Summary 81
Exercises 81
References 89

5 Discriminating Natural Earthquakes from Underground Nuclear Explosions 93
Motivation 93
Morphology 93
5.1 Background 94
5.2 Neural Network Discrimination 97
5.3 Performance of the Neural Network 103
5.4 Discussion 106
Summary 108
Exercises 108
References 108

6 Automated Monitoring of Seismic, Acoustic, and Biomedical Signals 111
Motivation 111
Morphology 111
6.1 Characteristics of Seismic Data 112
6.2 Interpretation of Continuous Waveform Data 113
6.3 Time-Frequency Distributions: Spectrograms 115
6.4 Self-Organizing Neural Networks 116
6.5 Seismic Interpretation Parameters 119
6.6 Results and Discussion 120
6.7 Conclusions 123
Summary 124
Exercises 125
References 125

7 Strength Estimation of Seismic Sources 127
Motivation 127
Morphology 127
7.1 Seismic Methods 128
7.2 F-Value Scale 130
7.3 Hydrodynamic Method 131
7.4 Future Research 154
7.5 Conclusions 156
Summary 156
Exercises 156
References 156

vi Contents
# Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Spatial Estimation for Geologic Characterization</td>
<td>159</td>
</tr>
<tr>
<td>9</td>
<td>Lithology Prediction for Geologic Characterization</td>
<td>173</td>
</tr>
<tr>
<td>10</td>
<td>Forecasting or Early Warning of Earthquakes</td>
<td>185</td>
</tr>
<tr>
<td>11</td>
<td>Climate Changes</td>
<td>199</td>
</tr>
<tr>
<td>12</td>
<td>Full Circle</td>
<td>209</td>
</tr>
</tbody>
</table>

## 8 Spatial Estimation for Geologic Characterization
- Motivation: 159
- Morphology: 159
- Geostatistical Background: 160
- Example Problem: 163
- Summary: 168
- Exercises: 172
- References: 172

## 9 Lithology Prediction for Geologic Characterization
- Motivation: 173
- Morphology: 173
- Background: 173
- Example Problem: 176
- Summary: 180
- Exercises: 180
- References: 182

## 10 Forecasting or Early Warning of Earthquakes
- Motivation: 185
- Morphology: 186
- Background: 186
- Seismicity Forecasting Using ANNs: 187
- Hayward Fault Seismicity: 188
- Synthetic Seismicity: 190
- Network Architecture: 191
- Earthquake Warning Systems: 192
- Summary: 194
- Exercises: 194
- References: 197

## 11 Climate Changes
- Motivation: 199
- Morphology: 199
- Background: 199
- Example Problem: 201
- Summary: 205
- Exercises: 205
- References: 208

## 12 Full Circle
- Summary: 209
- Advantages and Limitations: 209
- Troubleshooting: 210
- Future Directions: 210

Appendix | 213
Index | 237