

---

# Contents

---

<b>Foreword</b> . . . . .	ix
<b>Preface</b> . . . . .	xiii
<b>Introduction</b> . . . . .	xvii
<b>Chapter 1. Seismicity and Earthquake Catalogues Described as Point Processes</b> . . . . .	1
1.1. The Gutenberg–Richter law . . . . .	2
1.2. The time-independent Poisson model . . . . .	5
1.3. Occurrence rate density as a space–time continuous variable . . . . .	7
1.4. Time-independent spatial distribution . . . . .	9
1.5. Clustered seismicity . . . . .	10
1.6. Epidemic models . . . . .	13
<b>Chapter 2. The Likelihood of a Hypothesis</b> . . . . .	15
2.1. The Bayes theorem . . . . .	15
2.2. Likelihood function . . . . .	18
2.3. Alternative formulations . . . . .	20
2.4. Likelihood ratio . . . . .	22
<b>Chapter 3. The Likelihood for a Model of Continuous Rate Density Distribution</b> . . . . .	25
3.1. The limit case of regions of infinitesimal dimensions . . . . .	25
3.2. The case of discrete regions . . . . .	27

3.3. The case of time independence . . . . .	27
3.4. The likelihood of an epidemic model in a 4-D space of parameters . . . . .	29
<b>Chapter 4. Forecast Verification Procedures . . . . .</b>	<b>31</b>
4.1. Scoring procedures . . . . .	34
4.2. The binary diagrams . . . . .	35
4.2.1. The ROC diagrams . . . . .	36
4.2.2. Molchan's error diagram . . . . .	38
4.2.3. Probability gain . . . . .	39
4.2.4. R-score . . . . .	40
4.3. Statistical tests implemented within CSEP . . . . .	41
4.3.1. Number test or N-test . . . . .	42
4.3.2. Data-consistency test or L-test . . . . .	43
4.3.3. S(pace)-test or S-test . . . . .	44
4.3.4. M(agnitude)-test or M-test . . . . .	44
<b>Chapter 5. Applications of Epidemic Models . . . . .</b>	<b>45</b>
5.1. Declustering a catalogue through an epidemic model . . . . .	45
5.2. Earthquake forecasting . . . . .	50
5.3. Seismic hazard maps for short-term forecast . . . . .	55
<b>Chapter 6. Long-term Earthquake Occurrence Models . . . . .</b>	<b>59</b>
6.1. The empirical Gutenberg–Richter law and the time-independent model under the Poisson hypothesis . . . . .	60
6.2. Statistics of inter-event times . . . . .	63
6.3. The truncated magnitude distribution . . . . .	64
6.4. Earthquake rate assessment under a renewal time-dependent model . . . . .	66
6.4.1. Exponential distribution (under the time-dependent hypothesis). . . . .	68
6.4.2. Log-normal distribution . . . . .	69
6.4.3. Gamma distribution . . . . .	69
6.4.4. Weibull distribution . . . . .	70
6.4.5. Double-exponential distribution . . . . .	70
6.4.6. BPT distribution . . . . .	71

6.5. Validation and comparison of renewal time-dependent models . . . . .	72
6.5.1. The likelihood ratio . . . . .	72
6.5.2. Long-term earthquake records . . . . .	73
6.5.3. Application of a Monte Carlo procedure . . . . .	74
6.5.4. Concluding remarks . . . . .	78
6.6. The Cornell method for time-independent seismic hazard assessment . . . . .	80
6.7. Acknowledgments . . . . .	82
<b>Chapter 7. Computer Programs and Examples of their Use . . . . .</b>	<b>83</b>
7.1. PDE2REC, ZMAP2REC . . . . .	83
7.2. REC2PDE . . . . .	88
7.3. SMOOTH . . . . .	90
7.4. LIKELAQP . . . . .	94
7.5. LIKSTAQP . . . . .	103
7.6. BPT . . . . .	117
<b>Bibliography . . . . .</b>	<b>121</b>
<b>Index . . . . .</b>	<b>137</b>

