

Index

- a posteriori* analysis, 67
- adaptation, 264, 295, 307
- address location, 42
- aggregation, 25, 28, 37, 47, 61, 252, 284
- agriculture, fisheries and forestry (AFF), 235
- air pollution, 232
- airborne emissions, 11
- Alarm function, 309, 310
 - Bayesian, 308
- alternative spatial distribution, 5
- anomalies, 26
- apparent heterogeneity, 63
- approximate methods, 212
- approximations, 61, 200
- arbitrarily bounded subregions, 8
- assessment, 119
- associated-point sampling, 59
- at-risk background population,
 - 45–49, 53, 58, 61, 63, 69, 71, 76, 81, 83, 84, 87, 91, 111, 114, 117, 122, 124, 128, 147, 154, 162, 178, 191, 223, 269
- atomistic fallacy, 6, 247
- augmentation methods, 104
- autocorrelation, 6, 28
- average, 34

- background, 10
 - at risk, 10
- background estimation problem, 52

- bandwidth, 35
- basic reproduction number R_0 , 271
- Bayes models, 218
- Bayesian analysis, 50, 52, 106, 107
- Bayesian approaches, 42
- Bayesian models, 50, 52, 80, 88, 90, 124, 167, 174, 197, 216, 218, 223
- Bayesian residual, 97
- binary labelling, 175
- binary logistic model, 55
- binary regression model, 163
- birth–death algorithm, 302
- bivariate Gaussian kernel, 151
- bivariate kernel density estimate, 71
- bivariate/multivariate models, 53
- Broad Street pump, 69
- bronchitis, 11
- Burkitt’s lymphoma, 18, 136–137
- BYM model, 203, 217, 219, 237, 238

- cancer
 - gastric and oesophageal, 11
 - respiratory, 11
- cartography, 32
- case events, 70, 115, 124, 156, 190
 - fixed time period monitoring, 302
 - location, 94
- Censoring, 100, 288–289
- census tract, 9, 49

- Centers for Disease Control (CDC), 293
- centroid, 10, 59, 120, 190
 - locations, 118
- Change of support, 257
- changepoints, 294, 295, 306
- changes of scale, 25
- choropleth method, 234
- circular clusters, 122
- cluster, 26
 - centres, 51
 - definition, 112
 - distributions, 113
 - function terms, 281
 - modelling, 115
 - size, 116
 - space-time, 118, 124, 127, 137
- cluster centre, 10
- clustering, 10
 - classification, 112
 - focused, 113, 144
 - general, 6, 112, 118, 148
 - hypotheses relating, 114
 - non-focused, 113
 - non-specific, 113
 - space-time, 123–127, 136–140
 - specific methods, 113
- colour schemes, 38
- colour shading, 70
- common control, 177
- complete spatial randomness (CSR), 44
- conditional autoregressive (CAR)
 - models, 51
 - Multivariate, 213
- conditional independence model, 54
- conditional intensity, 95
- conditional likelihood, 45, 177, 281
- conditional likelihood of joint
 - realisation of cases and controls, 48
- conditional predictive ordinates (CPOs), 98
- conditional probability, 281
- conditional standard error surface, 78
- contour plot, 35
- control diseases, 10, 71, 81, 162, 177, 179, 191
- control event, 10
- control limits, 241
- convergence, 130, 263
- coronary heart disease (CHD), 14, 48, 149, 179, 181, 191
- correlated prior distributions, 153
- count data, 8
 - examples, 11
- count data modelling, 227
- counts, 113
 - edge effects in, 99
- covariance matrices, 92, 206
- Cox process, 164
- credible interval, 216, 224, 277
- cross-correlation between diseases, 178
- cross-validation, 48
- crude rates, 190
- Cusum convergence statistic D_T , 134
- cusum, cusum charts, 295
- data, 27, 194
- data availability, 25–29
- data cluster, 51
- data mining, 305
- death certificate, 11, 107
- decoupling, 252
 - approximation, 63
- Delauney triangulation, 75, 148, 164
- DELDIR program, 74
- deletion residuals, 98
- density estimation, 35
- deprivation, 172
 - indicators, 197
 - model, 263
- descriptive methods, 194
- deviance contribution, 166
- deviance residual, 166

- diabetes mellitus
 - incidence, 247
- Diggle and Rowlingson (DR)
 - likelihood, 131
- directional effects, 154
- directional–distance correlation
 - effects, 159
- Dirichlet distribution, 260
- Dirichlet tessellation, 74, 97, 148
- Dirichlet tile, 80, 82, 84, 97, 164, 166, 200, 208, 223
- Dirichlet/Voronoi tessellation, 75
- discrete data, 4
- disease clustering, 5, 6, 25, 37, 69, 85
- disease count, 71
- disease incidence, 38, 189
- disease mapping, 3, 26, 34
- disease mortality, 77
- disease risk, 38, 39
- distance–decline, 159
- distance–risk relations, 155
- district
 - enumeration, 19
 - census, 19
- Ecological
 - aggregation bias, 252–254
- ecological analysis, 5, 26
 - hypothesis tests, 253
- ecological fallacy, 27, 28
- ecological rate ratio, 248
- ecological variables, 220
- edge augmentation, 106
- edge effects, 28, 74
 - weighting schemes, 28
- EM algorithm, 64, 103, 106, 164
- empirical Bayes (EB) analysis, 53
- empirical Bayes (EB) estimators, 200
- empirical Bayes (EB) methods, 77, 90
- empirical Bayes (EB) shrinkage
 - estimation, 151
- epidemic diseases, 7
- epidemiology, 5, 7
- error estimates, 251
- estimation
 - case event data, 164
 - count data, 170, 171
- Euroclus project, 121
- event locations, 162
- excess spatial aggregation, 5
- expectation-maximisation (EM)
 - algorithms, 64, 103, 164
- expected counts, 77, 80, 192
- expected incidence, 10
- expected rates, 5
- exploratory methods, 67–107, 147–153, 193
- exploratory tools, 150
- exposure evidence, 154
- exposure modelling, 154, 158
- exposure patterns, 160
- exposure risk modelling, 159
- extraction mapping, 71
- false discovery rates, 305
- first-order effects, 219–221
- first-order intensity, 279, 284
- focused clustering, 113, 114, 144
- Foot and Mouth disease, 226, 289
- frailty and frailty effects, 90, 91, 94, 159, 198
- frailty models, 47, 51
- frequentist approach, 199
- frequentist paradigm, 89
- $g(x)$ estimation problem, 47–49
- $g(x)$ problem, 47–49
- gamma distribution, 51, 53, 91, 92
- gastric cancer, 13, 19, 20, 105–107, 180
- Gaussian cluster models, 116
- Gaussian prior, 204
- Gaussian prior distribution, 129, 200, 236, 240, 245
- general clustering, 6, 112–114, 120, 150
 - tests, 118–121, 123

- general spatio-temporal Poisson process model, 57
- generalised additive models (GAMs), 300
- generalised least-squares (GLS), 222
- generalised least-squares (GLS)-type estimators, 93, 168
- generalised liner models (GLMs), 63
- Geographical Information Systems (GIS), 80
- geographical representation and mapping, 31–40
- Geographically weighted regression, 210
- georeferenced case events, 222
- geostatistical mapping, 36–43
- geostatistical prediction, 151
- geostatistics, 34
- Geweke's posterior monitoring, 130
- Gibbs sampler, 164, 204
- Gibbs–Metropolis sampling, 103
- goodness-of-fit, 89, 166–167, 173, 251
- guard areas, 28, 79, 100, 102, 103
- hazard exposure risk modelling, 153–161
- health hazard, 4, 46, 47, 52, 85, 91
- health status, 11
- heterogeneity, 113, 114, 120, 121, 158–160, 163, 164, 166, 170, 198, 227, 228, 233, 236
- heterogeneous Poisson process (HEPP), 44, 46, 148, 162, 164
- Hidden Markov mixture model, 56, 218
- hidden structure, 56, 64
- HLA system, 264
- hot-spot clustering, 112
 - space-time clustering, 123–127
 - specific test, 122
- hybrid models, 49
- hyperparameters, 199, 200
- hyperpriors, 204, 207
- hypothesis testing, 67–68, 98–99, 118–123
 - case events, 162–167
 - clusters, 118–123
 - count data, 169–172
 - in disease mapping, 219–222
 - ecological analysis, 252–255, 260
 - pollution aggregates, 155
- image processing, 34, 85, 90
- IMSL library, 70
- incinerators, 175
- inclusion criteria for tracts, 101
- infectious disease modelling, 269–291
 - model development, 270–273
 - SEIR, 270, 283
 - SIR, 270, 271, 276, 280, 283
 - special cases, 280–283
- infective number, 270, 271, 279
- inference problems, 147–153
- influenza, 24, 276, 278
 - culture positive, 276
- insulin dependent diabetes mellitus (IDDM), case study, 263–268
- integrated squared distance (ISD) statistic, 119–120
- intensity function, 124
- Intensity parameterisation, 176–177
- intensity specification, 158, 222, 223, 226
- intensity surface, 191
- interaction, 124, 126
- interpolation, 33–36, 47, 49, 70, 77, 192, 193, 250
- k*-values, 118
- Kelsall–Diggle (KD) estimator, 117
- kernel density estimation, 100
- kernel methods, 250
- kernel regression, 300
- kernel smoothing, 36, 52

- kriging, 36, 151, 153, 250, 257, 261
- Kullback-Leibler distance, 119
- Lag one variance ratios, 300
- Laplace approximation, 213
- large scale, 26
 - disease mapping, 189–245
 - ecological analysis, 247–252
 - surveillance, 293–312
- larynx cancer, 8, 14–18, 73, 148–151
- Lasso parameter, 117, 133
- Lawson–Viel test, 127
- legionnaire’s disease, 184
- leukaemia, 14, 127
- likelihood approximations, 88
- likelihood conditional, 128
- likelihood models, 194–197
- likelihood ratio, 165
- likelihood ratio test, 122
- likelihood-based approaches, 42
- line cluster centres, 116
- link functions, 45, 46, 58
- lip cancer, 21, 232–234, 236–239
- Local likelihood model, 133–138
- location of putative clusters, 121
- log relative risk, 117, 227, 228
- log-likelihood, 178, 287
- log-linear model, 170, 171
- lymphoma, 14, 127
- malaria
 - case study, 263–268
 - prevalence, 249, 251
- map, 31
 - map construction, 32, 34
 - map evolution, 296
 - map hypotheses and modelling
 - approaches, 5–7
 - map resolution, 32
 - maps and mapping, 32–36, 69–70
 - marginal distribution, 73, 74
 - marginal intensity, 64
 - marginal likelihood, 199
- Markov chain Monte Carlo
 - (MCMC) algorithms, 52, 90, 94, 97, 98, 100, 104, 120, 164, 166, 204
- Markov chain Monte Carlo
 - (MCMC) methods, 164, 237, 302
- Markov chain Monte Carlo
 - (MCMC) sampling, 115, 134, 290
- Markov mesh models, 56
- Markov point process, 163
- Markov random field (MRF), 163
- matched case control modelling, 49–58
- Matern covariance, 219
- MATLAB, 75
- maximum *a posteriori* (MAP)
 - estimation, 52, 90, 93, 169, 263
- maximum likelihood (ML)
 - estimates, 80–86, 168, 288
- mean square predictive error
 - (MSPE), 277
- mean variance relationship, 261
- measles epidemic
 - changes of infectivity over time, 285
 - data example, 284–288
 - distribution of susceptibles, 284
 - infectivity pattern, 285, 286
 - model fitting, 286–287
 - revised model, 287–297
- medical mapping, 32
- meningococcal disease, 275
- Metropolis–Hastings (M–H)
 - algorithm, 94, 169, 262, 263
- Metropolis–Hastings (M–H)
 - sampler, 130, 169
- Metropolis–Hastings (M–H)
 - posterior expectation, 169

- Minitab, 60
- minus sampling, 59
- misaligned data, 258
- Misaligned Data Problem, 256–259
- mixture models, 56, 64, 116, 217, 218, 228
- mixture problem, 95
- modal values, 52
- model fitting, measles epidemic, 286
- model performance evaluation, 216–219
- modelling issues, 115–118
- models and applications, 43–44
 - theory, 43
- Modifiable Areal Unit Problem (MAUP), 255
- monochrome thematic maps, 38
- Monte Carlo testing, 80, 127, 165, 171
- Moran's I statistic, 96, 120, 222
- morbidity, 27
- morbidity event, 27
- mortality, 27
- mortality data, 227
 - example, 179–181
- mortality event, 27
- MRF model, 164
- Multilevel modelling, 256
- multilevel monitoring, 258
- multinomial covariance matrix, 120
- multiple disease, 174, 175, 181, 183
 - analysis, 174–183
 - counts, 183, 186
 - incidence, 45, 46, 55, 56
 - study, 11–12
- Multivariate–Multifocus Surveillance, 305–308
- multivariate normal prior distribution, 163
- MVN prior distribution, 168
- Nadaraya–Watson kernel regression smoother, 118
- near-real-time surveillance, 296, 310
- nearest-neighbour, 29
- needle plot, 36, 77, 78
- Negative binomial distribution, 113, 121
- non-focused clustering, 7
- non-parametric density estimation, 119, 240
- non-parametric maximum likelihood (NPML), 202
- non-parametric methods, 202
- non-parametric regression, 36, 70, 71, 78
- non-parametric relative-risk estimation methods, 117
- non-parametric smoothing, 151
- non-spatial random effects, 51
- non-specific, 113
- non-specific clustering, 6
- non-stationarity, 119, 120
- nuisance effects, 158–160
- null hypothesis, 73, 74, 80, 117, 221, 222
- object process, 34
- object process mapping, 34–36
- observed counts, 192
- observed incidence, 191
- oesophageal cancer, 13
- offspring, 10
- optimal surveillance, 309
- outfall patterns, 161
- outfall/risk pattern, 155
- parameter estimation, 80–96, 158
- parametric approach, 94
- parametric bootstrap, 122
- parametric cluster form, 112
- parametric cluster modelling, 116
- parametric empirical Bayes approach, 235–255
- parametric models, 123
- parent, 10
- partition models, 64, 218
- partitioning methods, 116
- Pattern detection, 143, 295, 302

- peakedness, 160
- persistence cluster, 123
- plug-in estimator, 82
- plus sampling, 59
- point cluster centres, 116
- point event data, 166
- point event locations, 191
- point event models, 42–58
- point events, 119
- point process, 28, 29, 71, 79, 144
 - residuals, 166, 167
- Poisson distribution, 121, 252, 254
- Poisson distributional model, 115
- Poisson intensity, 202
- Poisson likelihood, 236, 237
- Poisson likelihood model, 236
- Poisson model, 144
- Poisson point process, 102, 194
- Poisson process, 72–74, 124, 125, 168, 252–254, 281
 - intensity, 252–254
 - likelihood, 167, 168
 - model, 44–49, 60–62, 80–82, 84, 85, 87–98
 - probability, 43, 44, 46, 48–50, 54, 55
- Poisson-gamma model, 217
- pollution
 - air, 12
 - measurements, 258
 - sources, 143, 144, 146, 148, 153–155, 158, 159, 161
 - surrogates, 154, 158
- pollution aggregates, 155
- pollution hazard, 25
- population
 - at risk, 10, 11
- posterior distribution, 129
- posterior sampling, 93, 94, 130
- Potthoff–Whittinghill test, 121
- predictive distributions, 89
- prior beliefs, 178
- prior distributions, 50, 52, 57, 89–91, 93–95, 236, 237, 240
- prior probability distributions, 50
- probability, 43, 44, 46, 48–50, 54, 55, 62
- process control methodology, 294–295
- profile likelihood analysis, 47
- proportional hazards interpretation, 280
- proportional hazards model, 284
- prospective studies, 144–145, 154
- public health surveillance, 232
- putative clusters, 121
- putative hazard, 26
- putative source modelling process, 154
- putative sources of hazard, small scale, 143–187
- quantile–quantile (Q–Q) plotting, 74, 130
- R, 60, 70, 80, 82, 83, 93, 137, 141, 164, 171
- random effects, 50–52, 88, 90, 92–94, 96, 159, 197–202, 236, 245
 - extensions, 63–64
 - modelling, 62, 64, 173
 - non-specific, 113, 114
- random labelling, 117–119
- random-object effects, 50, 51, 94, 96
- rate dependence, 27
- ratio
 - standardised mortality, 10, 14, 21
- ratio extraction surface, 72
- real heterogeneity, 64
- realisations, 41, 43, 44, 54, 73, 80
- regionalisation, 49

- relative risk, 5, 38, 39, 70, 76, 77, 105, 191, 192, 220
 - estimates, 149, 151, 153, 224–226
 - model, 216–219
- REML, 222
- removal, 282, 290
- removal rate, 276, 290
- replication, 146–148
- residual analysis, 166
- residual diagnostics, 96–98
- resolution, 32
- respiratory cancer, 3, 8, 11–13, 15–17, 19, 21, 22, 35, 36, 39, 73, 78, 150, 151, 178–182, 186, 190, 191
- respiratory disease, 153
- retrospective studies, 144–145
- risk
 - air pollution, 11
 - relative, 9
- risk functions, 46
- risk models, 55
- Robbins estimator, 202
- S-Plus, 60, 70, 75, 80
- sampling bias
 - directional, 14
- sampling methods, 41–42, 59
- sampling-importance resampling (SIR), 303
- SatScan, 132
- scales of measurement, 25–29
- score tests, 165, 172
- screening, 293
- second-order covariance and variance effects, 221
- segmentation, 6
- semi-parametric approach, 202
- sequential probability ratio tests (SPRTs), 302
- shared component models, 213, 260
- significant tracts, 122
- simulation envelope p -value surface, 204, 239
- simulation-based evaluation, 217
- simultaneous autoregressive (SAR) models, 51
- skin cancers, 232
- small scale, 26
 - disease clustering, 111–141
 - putative sources of hazard, 143–187
- small-scale modelling, ecological analysis, 252–254
- smoothing, 33–37, 48–50, 52, 70–73, 77–79, 100, 101, 116, 117, 149, 151–153, 192, 193, 217–219, 250
- space-time clustering, 123–127, 184
 - hypothesis testing, 126–127
 - modelling issues, 123–126
- space-time disease mapping, 222–229
- space-time extensions, 56–60, 65–69
- space-time interaction, 126
- space-time modelling, 184
- space-time process, 57
- space-time scan statistic, 126
- spatial censoring, 28, 58
- spatial cluster processes, 44
- spatial cluster testing, 118
- spatial control distributions, 5
- spatial correlation, 251
- spatial dependence cluster function, 282
- spatial distance function, 285, 287
- spatial distribution, 44, 51, 53–55
- spatial ecological bias, 252
- spatial epidemiology, 3, 5
- spatial inhibition processes, 44
- spatial monitoring, 297–304
 - fixed spatial and temporal frame, 297–308
 - fixed spatial frame and dynamic temporal frame, 301–308
- spatial smoothing methods, 100

- spatial structure, 66, 81
- spatially correlated heterogeneity,
 - 50, 203–206
- spatio-temporal censoring, 58
- spatio-temporal interaction model,
 - 284
- SpatStat, 164
- specific cluster, 6
 - locations, 118, 121, 122
 - modelling, 123, 125, 127
 - tests, 118–121, 123
- spline smoothing, 173, 210
- standard deviation, 182
- standard models, 60–62
- standardised mortality/morbidity
 - difference (SMD), 77
- standardised mortality/morbidity
 - ratios (SMRs), 10, 21, 39, 53, 77, 78, 107, 151, 171, 192, 234
- statistical accuracy, 37
- statistical mapping, 31
- statistical maps and mapping, 31, 34
- statistical process control (SPC), 294
- stochastic geometry, 100
- Stone's test, 171, 172
- Strauss inhibition prior distribution,
 - 129
- Strauss prior parameters, 130
- study design, 144–147
- study region design, 145–146
- study region shape, 146
- study region size, 145
- study window, 4, 7–9, 28, 29, 43,
 - 46, 49, 54, 55, 59–61, 65, 70, 77–79, 146, 175
- subgroup modifications, 281–282
- sudden infant deaths (SIDs), 19, 20
- surrogacy, 43, 47, 102, 146, 154
- surrogate measures, 154
- surveillance, large scale, 293–312
- susceptible, 270, 271, 279, 280,
 - 284–285
- susceptible population, 269–272,
 - 279
- symbolic representation, 32
- Syndromic Surveillance, 304–305
- syndromic variables, 305, 308
- Taylor expansion, 168
- temporal cluster function, 282
- temporal dependence, 282
- temporal transmission rate, 284
- thematic maps, 38
- thin plate splines, 36
- TILE algorithm, 75
- time to next event monitoring,
 - 302–308
- toroidal edge correction, 29
- total intensity of cases and controls,
 - 55
- tract counts, 88, 91, 92, 98,
 - 102–105, 115, 120, 183–185, 192–194
 - fixed spatial regions, 298–301
 - fixed time period monitoring, 303–304
- tract integral approximations, 88,
 - 96–103
- transformations, 33, 97, 192, 193
- UMP test, 171
- unconditional likelihood, 45
- uncorrelated heterogeneity, 90–94
- underascertainment, 272, 288–289
- under-reporting rate, 289
- Update
 - Gibbs, 208
 - Metropolis, 94, 208
- variance effects, 219, 221
- variance–covariance matrix, 254
- visual perception, 69
- visual representation, 70
- visualisation, 32, 37, 69
- von Mises density, 161
- von Mises distribution, 156, 157,
 - 161

Weibull density, 161

Weibull model, 157, 161, 230

Weibull–von Mises distribution, 157

weighting schemes, 102–104

WinBUGS, 141, 164, 174, 208, 210,
214, 223, 240, 257, 276,
277

Wishart prior distribution, 216

Wombling, 140–141

zero-inflated Poisson (zip)

regression, 212

zoomed map, 33