

# Index

- Affine transformation, 65
- AFNI, 9, 14
- Amplitude of a complex number, 193–194
- Analysis of variance, 101–102, 167, 176–177, 289
- Analyze data format, 13
- ANOVA. *See* Analysis of variance
- ART, 68
- Atlas, brain, 64
- Autocorrelation function, 188–190
- Autoregressive model, 221
  - order of, 221, 233
- Balloon model, 25, 35, 293
- Bayesian information criterion, 233
- Bayesian statistics, 294–295
- Between-subject variance, 164, 175–178
- Bilinear models of neural activation, 293–294
- Bit of information, 267
- Block design, 6, 97–99, 113–114
  - percent signal change, 119–120
  - power analysis, 180–183
  - preprocessing considerations, 42, 75–76
- BOLD signal, 3, 17–42
- Bonferroni correction, 129–130, 145–146
- Boxcar model, 23, 26, 92–93
- Brain Voyager, 8–9
- Canonical correlation, 292
- Causality, 211–219, 226–231, 242–243
- Central limit theorem, 69, 263
- Characteristic equation, 311
- Chi-square map, 116–117, 137, 153
- Cholesky factorization, 265
- Cluster, 147
- Cluster height, 153–156
- Cluster-based approaches to the multiple comparisons problem, 147–156
- Cocktail-party problem, 257–258
- Coherence analysis, 185–219, 242–243
- Coherency, 210
- Commutative property, 298–299
- Complex number, 193–194
- Computational neuroscience, 22–23, 294
- Confirmatory data analysis, 219, 293
- Conformable matrices, 298
- Connectivity analysis, 185
- Consistent linear equations, 306–310
- Contour of equal likelihood, 246, 317–318
- Convolution integral, 20–21
- Coordinate system, MRI 4–5, 52–53
- Coregistration, 58–63
- Correlation coefficient, 60, 188, 197, 262, 316
- Correlation model, 81, 91–99, 123–125, 163, 287–289
- Covariance, 188
- Cross-correlation function, 190–192
- Cross-power spectrum, 197, 214
- Cross-spectral density, 196–197
- CT scanning, 2
- Deconvolution, 22–24
- Degrees of freedom
  - chi-square map, 116–118
  - GLM, 105, 112–113, 124
  - group analysis, 166, 168–171, 173, 176
  - power analysis, 179, 183
- Delta function, 18–20, 32–33, 82
- Design matrix, 88, 99–100, 102
- Determinant, 303
- Diagonal matrix, 297
- DICOM data format, 11–13
- DICOM to MINC conversion, 15
- DICOM to NIfTI conversion, 14
- Diffusion tensor imaging, 5
- Distortion correction, 78–79
- Dynamic causal modeling, 293–294
- Eigenvalue, 104–105, 246–248, 310–314
- Eigenvector, 104, 246–248, 310–314
- Empirical Bayesian methods, 294–295
- Entropy. *See* Information
- Error variance, 41, 89–90, 103, 105, 226–230
- Euler characteristic, 134–138, 149
- Euler’s formula, 193

- Even function, 194
- Event-related design, 6–7, 42, 75, 81–97, 120–123
  - rapid, 6–7
  - slow, 6, 33, 292
- Excel, 30
- Excursion set, 134
- Expectation-maximization algorithm, 295
- Exploratory data analysis, 219, 289, 293
  
- False discovery rate, 141–146
- False positive rate, 127
  - experiment-wise, 128, 141
  - single test, 128
- FastICA, 270, 285–287
- FBR model, 81–91, 123–125, 287–289
- Field map, 5, 79
- Finite BOLD response model. *See* FBR model
- FIR model. *See* Hrf
- Fixed effects model, 164–170, 175–176
- Fixed factor, 162–170
- F-map, 137, 153
- Fourier transform, 24, 26, 45–46, 193, 215
- FSL, 8, 11, 13–14, 16, 75, 79, 106, 117, 283–286, 295
  - FNIRT, 68
  - FSLUTILS, 14–15
  - MELODIC, 283
- Full width at half maximum. *See* FWHM
- FWHM, 70–71, 132
  
- Gaussian kernel. *See* Kernel
- Gaussian random field, 130–141, 147–156
- Gauss-Markov theorem, 103, 105
- Generalized inverse, 310
- General linear model, 87–90, 100–118, 231–232
- Geometric distribution, truncated, 85–86
- Global normalization, 79
- Grand mean scaling, 79–80
- Granger causality, 222–243
  - conditional, 235–242
- Group map, 160–161, 175
- Group variance. *See* Between-subject variance
  
- Hanning window, 46–48
- Header component, 12–13
- Head motion correction, 51–58
- Hemodynamic response function. *See* Hrf
- Homogeneity of variance, 103, 106, 166
- Hemoglobin, 3
- Hrf, 20–33, 47–51, 92–93, 125
  - basis function model, 30–33, 96, 113–117
  - difference of gamma functions, 30, 47–51
  - FIR model, 32–33, 81–82, 87, 125
  - gamma function, 25–26, 28–29
  - parameter estimation, 29–30
  - temporal derivative, 47–51
- Hypothesis testing
  - in coherence analysis, 207
  - in Granger causality, 234–235
  - in ICA, 283–285
  - in the GLM, 107–118
- Identity matrix, 301
- Image component, 12–13
- Impulse response function, 20–21
- Inconsistent linear equations, 306–310
- Independence, statistical, 106–107, 261–263, 268, 273–274, 315–316
- Infomax, 272–277
- Infomax learning algorithm, 274–277
- Information, 60, 266–271
- Interpolation, 43–47, 66
  - linear, 43–44
  - sinc, 45–47
  - spline, 44
- IRTK, 68
  
- Jittering, 7, 84–86, 104–105
- Joint information, 267, 271, 273
- Joint probability density function, 315
  
- Kernel, 69–73, 77, 132–134
- Knot, 44
- Kurtosis, 262, 269
  
- Laplace distribution, 263–264
- Landmark identification, 59, 63–64
- Least squares parameter estimation, 103
- Leptokurtic distributions, 263, 269
- Linear interpolation. *See* Interpolation
- Linear system, 17–21
- Linearly independent, 304
- Local field potential, 3, 17
- Localizer, 4
- Logistic distribution, 272–275
- Low-pass filter, 205
  
- Machine learning, 291–292
- Macrolinearity, 86–87, 95, 123
- Magnetic field inhomogeneities, 5
- Marginal distribution, 315
- Matched filter theorem, 71
- MATLAB, 15–16, 20–21, 24, 56, 103, 198, 207, 216, 297–314
  - conv, 21
  - fft, 24
  - ifft, 24
  - optimization toolbox, 30, 56
  - signal processing toolbox, 198, 216
- Matrix, 297
  - addition, 298
  - diagonal form, 104
  - ill-conditioned, 105
  - inverse, 302–304
  - multiplication, 298–299
  - nonsingular, 303–304
  - orthogonal, 253, 265–266, 271

- rank, 304–306
- singular, 303
- transpose, 299–300
- Maximum likelihood parameter estimation, 105
- Maximum likelihood ICA, 271–277
- Mean-centered data, 188, 249, 263–264
- Mean vector, 316–317
- Microlinearity, 86–87, 92, 95, 124, 198, 201
- MINC data format, 14
- Minimum variance unbiased estimator, 103
- Mixed effects model, 171
- Mixing matrix, 261
- Mixture of normal distributions, 284–285
- Modulus of a complex number, 193–194
- Moments, 262–263, 269
- MNI atlas, 64
- MNI software, 14
- Multi-level group analysis, 175–178
- Multiple factor experiments, 176–178
- Multivariate normal distribution, 316–319
  - Gaussian random fields, 130–131
  - GLM, 88, 101
  - ICA, 257, 281–283
  - PCA, 246–248, 251
- Multivariate statistics, 81, 245, 287, 289, 292–293
- Mutual information, 60, 268, 270–271, 273
  
- Naïve Bayes classifier, 292
- Negentropy, 269–271, 285
- NIfTI data format, 13–14
- Noise, 7–8, 41, 263
  - coherence, effects on, 198
  - GLM model of, 87, 106, 124
  - Granger causality, effects on, 230
  - PCA to reduce, 251–255
  - preprocessing steps to reduce, 69, 71–77
- Noise reduction with PCA, 251–255
- Noise, effects on correlation, 186–187
- Noisy ICA model, 281–285
- Noninformative prior, 294
- Nonlinear BOLD response, 33–39
- Nonlinear registration, 66–68
- Nonlinear transformation, 65
- Non-normality in ICA, 263, 269–271
- Nonparametric methods, 118–119, 156–157
- Normal equations, 32, 103, 231–232
- Normalization, 63–68
- Nyquist-Shannon sampling theorem, 46, 73, 75, 218
  
- Order of a matrix, 297
- Order of a statistic, 262
  
- Parameter estimation, 103–107, 231–233
- Partial coherence, 209–211
- Partial correlation, 210
- Partial least squares, 292–293
- Partial trials design, 91
- Pattern classifiers, 291–292
  
- Percent signal change, 119–123, 180
- Permutation methods, 118–119, 156–157
- PET scanning, 2, 79
- Phantoms, 78
- Phase of a complex number, 194
- Phase spectrum, 211–219
- Platykurtic distributions, 269
- Positive definite, 314
- Positive semi-definite, 247, 314
- Postprocessing, 8
- Power analysis, 178–183
- Power spectrum, 193–196
- Preprocessing, 8, 41–80
- Preprocessing pipeline, 80
- Prewhitening, 106
- Principle components analysis, 246–257, 265, 285–287, 292–293, 314
- Prior distribution, 294
- Probability density function, 315
- Probabilistic ICA. *See* Noisy ICA
- Proportional scaling, 79
  
- Quality assurance, 78
  
- Radial basis function, 66
- Random effects model, 163–165, 170–176
- Random factor, 162–165
- Random field, 130. *See also* Gaussian random field
- Random vector, 315
- Region of interest, 113, 119, 136, 138, 205
- Regression model, 102, 231
- Resel, 132, 138–141
  
- Satterthwaite approximation, 118
- Scalar, 298
- Scalar multiplication, 299
- Scanner drift, 75–79, 88–89
- Seed region, 205–207
- Shimming, 5, 78
- Sidak correction, 128–130
- Signal-to-noise ratio, 69, 71–72, 106
- Sinc function, 45
- Sinc interpolation. *See* Interpolation
- Singular-value decomposition, 293
- Skewness, 262
- Slice-timing correction, 42–51, 57–58
- Smoothing, spatial, 68–73
- Spatial extent, 147, 150–156
- Spatial ICA, 258–261
- Spline interpolation. *See* Interpolation
- SPM, 8, 11, 13–14, 16, 45–46, 75, 79, 99–100, 106, 113, 295
  - DARTEL, 68
- Square matrix, 297
- Stationarity, 289
- Statistical parametric map, 107–118, 127, 131, 147, 159
- Structural equation modeling, 292, 294

- Structural scan, 4
- Super-Gaussian distributions, 263, 269, 274, 284
- Superposition principle, 18, 20, 33–34, 82, 86, 198, 201
- Support vector machine, 292
- SyN, 68
  
- Talairach atlas, 64
- Temporal correlation, 106–107, 117–118
- Temporal derivative. *See* Hrf
- Temporal filtering, 73–77
- Temporal ICA, 258–260
- Testable hypothesis, 110–111
- Testing set, 292
- Time-invariant linear system, 20–21
- T-map, 112–115, 136–137, 153, 180
- TR, 4
- Tractography, 5
- Training set, 292
- Type I error, 113, 118, 127, 178
- Type II error, 178
  
- Uncertainty. *See* Information
- Uniform distribution, 273
- Univariate statistics, 81, 245, 287
- Unmixing matrix, 261
  
- Variance-covariance matrix, 246, 316–317
  - diagonal representation, 246–247, 314
- Vector, 298
- Voodoo correlations, 157–158
- Volterra series model, 35–39
- Voxel, 4–5
- Voxel size, 5, 58–59
  
- Whitening, 263–266, 270
- Within-subject variance, 163–167, 170–171, 175–178
  
- Z-map, 131, 136