Index

accuracy, 82, 103, 178	image data, 112
activation function, 137, 140, 146, 178, 202	text data, 109
adjustable basis, see basis	data generating function, 53, 107, 131, 166
automated medical diagnosis, 11, 186	dimension reduction techniques, 245
automatic feature design, see feature	discrete cosine transform (DCT), see basis
	discrete cosine transform (2 C 1), see casis
back-propagation, 146, 178, 202	edge detection, 14, 113
backtracking line search, 226, 236	eigenvalue, 25, 276
bag of words (BoW), 109	eigenvalue, 23, 270
basis	face detection, 10, 186
adjustable basis, 136, 141	
discrete cosine transform basis, 254	features
fixed basis, 135, 141, 174	knowledge-driven feature design, 51, 104
Fourier basis, 136	automatic feature design/learning, 131, 166
neural network basis, 136, 140, 202	feature transformation/map, 51, 104
orthogonal basis, 158	histogram features, 107
polynomial basis, 135	first order condition for optimality, 22
bounded curvature, see curvature	fixed basis, see basis
buffer zone, see margin perceptron	Fourier basis, see basis
butter zone, see margin perception	function approximation
chain rule, 202, 269	continuous function approximation, 134
classification	discrete function approximation, 133
classification accuracy, see accuracy	indicator function approximation, 170
classification boundary, 178	piecewise continuous function approximation,
ideal classification scenario, 166	166
linear classification, 73	universal approximator, 165
multiclass classification, 95, 179	fusion rule, 99, 179
nonlinear classification, 166	
real classification scenario, 171	Galileo's ramp experiment, 12, 53, 155
clustering, see K-means	genome-wide association (GWA), 8
convex function, 24	gradient descent
convolutional neural network, 188	gradient descent with adaptive step length, 226
cost function, 15	gradient descent with fixed step length, 29, 219
cross-validation	gradient descent with momentum, 206
	stochastic gradient descent, 229
hold out cross-validation, 149, 182	gross domestic product (GDP), 47
k-fold cross-validation, 152, 184	gross domestic product (GDT), 17
leave-one-out cross-validation, 155	handwritten digit recognition, 96
12 regularized cross-validation, 209	Hessian matrix, 22, 268
counting cost, 83	
curse of dimensionality, 134	Hilbert matrix, 160
curvature, 22, 241	hinge cost, 75
1-4-4	histogram of oriented gradients (HoG), 115
data types	hold out cross-validation, <i>see</i> cross-validation
audio data, 115	hyperbolic tangent function, 137

image compression, 254	squared margin perceptron, 81
indicator function, 168	polynomial basis, see basis
	population growth modeling, 56
k-fold cross-validation, see cross-validation	positive (semi)-definite matrix, 25
K-means clustering, 246	
K-nearest neighbors, 192	radial basis function, see kernel
Kepler's law, 67	recommender system, 256
kernel	rectified linear unit, 137
kernelization cost functions, 197	regression
polynomial kernel, 199	ideal regression scenario, 131
Fourier kernel, 200	linear regression, 45
radial basis function (RBF) kernel, 201	nonlinear regression, 56, 131
Kleiber's law, 62	real regression scenario, 141
11101001 5 1441, 02	regularization
ℓ_2 norm, 59	ℓ_2 regularization, 56, 95, 208
learning rate, see step length	revenue forecasting, 8
least squares, 47	revenue forecasting, o
leave-one-out, see cross-validation	saddle point, 26
linear classification, see classification	second order definition of convexity, 25
linear regression, see regression	sentiment analysis, 11, 110
Lipschitz constant, 223, 241	similarity matrix, 201
logistic regression, 56, 86	singular value decomposition (SVD), 274
logistic sigmoid function, 56	spam detection, 111
loss, see cost function	speech recognition, 117
1055, SEE COST TUILCHOIL	softmax cost, 76, 101
matrix completion 257	softmax function, 75
matrix completion, 257	
matrix factorization, 245, 274	spectrogram, 117
mean squared error (MSE), 50	step function, 87
minimum	step length
global minimum, 24	fixed step length rule, 219
local minimum, 24	adaptive step length rule, 226
Moore's law, 65	step length for stochastic gradient, 233
multiclass classification, see classification	steepest descent, see gradient descent
multiclass softmax classifier, 99	stochastic gradient descent, <i>see</i> gradient descent
1 . 1 . 1	stopping condition, 27
neural network, see basis	student loan debt, 7, 49
Newton's method, 33	stationary point, 23
nonlinear classification, see classification	support vector machine (SVM)
nonlinear regression, see regression	hard-margin SVM, 93
numerical optimization, see optimization	log-loss SVM, 95
11 . 1 . 2 . 10 114	soft-margin SVM, 93
object detection, 10, 114	T 1 1 2 21
Occam's razor, 148	Taylor series approximation, 21
Ohm's law, 66	testing phase
one-versus-all (OvA) classifier, 96, 179	testing error, 152
optimization, 15, 21, 219	testing set, 4, 151
outliers, 90	training phase
overfitting, 147, 149, 181, 209	training error, 152
	training set, 1, 151
principal component analysis (PCA), 250	transformed feature space, 52, 55, 107
perceptron	1 6 1 147 140 101
basic perceptron, 73	underfitting, 147, 149, 184
margin perceptron, 78	universal approximator, see function approximation