COMS 4721 Homework 1

Peter Darche pmd2139

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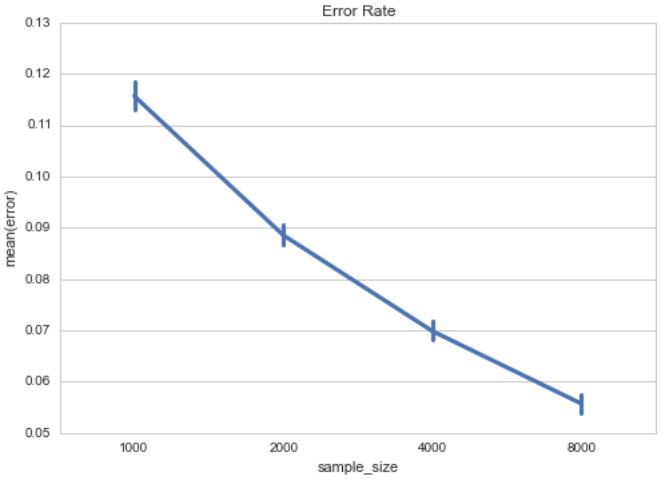
1 Problem 1

Code for this problem is found in the file problem1.py. The program works in the following way: For each sample size $n \in \{100, 2000, 4000, 8000\}$ a list of dictionaries with randomly sampled training data and labels is created. That list is iterated over and the training data is used to predict labels. After a vector of predictions is generated, it's compared to the test labels, generating the error rate for that sample. The error rates for each sample are added to a list of error rates, and that list is added to a final list of errors for each sample size n. Once that 10 x 4 matrix of errors is created, the mean error and sds are computed and plotted. The operative functions are $euclidean_dist$ which takes two positional arguments, X, the matrix of training data, and Y the matrix of test data, and returns a matrix of euclidean distances for each test point to the training points. The learning curve generated:



2 Problem 2

(a) The formula for the MLE of the parameter $\mu_{y,j}$ is:

$$x_j \log(\mu_j) + (1 - x_j) \log(1 - \mu_j)$$

(b) The two functions used to answer this question can be found in the file problem2.py. The first, named 'fit', takes takes two and one keyword argument. The first positional argument X is the matrix of training features, and the second Y is the vector of labels. The keyword argument 'laplace' takes a boolean value and determines whether or not the parameters use Laplace smoothing. The function returns a matrix of parameters. The second function, named 'predict', takes three positional arguments: 'params', the matrix of parameter vectors for each class, 'testdata', the matrix of test vectors to classify, and 'priors' the vector of class priors to use in computing the posteriors. It returns a vector of predicted classes for each test document.

Training the classifier yielded the following error rates on the training and testing datasets:

Training Error	Testing Error
0.21705	0.37868

(c) The top twenty words for for each category were:

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0	vijay	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
1	vijay	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
2	vijay	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
3	vijay	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
4	vijay	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
5	vijay	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
6	archive	iheirent	sinnokf	sheoak	ucnv	redgum	pethybridge	pedantic	psd	sourcing	tranmit	austrailian	mmunic	ation	jaehyung	steenking	corpus	christi	engga	grandfathered
7	etrbo	cleanse	mindless	rewarding	navarro	manzanillo	mockery	maldanado	thon	jaha	fetters	nilsson	reactivated	salty	resigned	winningham	curly	jkik	villanueva	steroids
8	vijay	impotence	klier	harboring	strains	virulent	infected	medications	deltuvia	fungus	coccidiomycosis	steere	substantiating	discoverer	immunizations	bulletins	malaria	breast	akgua	rjb
9	vijay	synergism	caffiene	bbbbb	tiredness	opthamologist	diabetic	prolactin	tsh	julkunen	messi	uku	bilateral	omen	evangelists	adiposity	gains	dieting	ymodem	zmodem
10	vijay	foldable	keytronic	alphanumeric	dragondictate	dragonwriter	lanier	infogrip	chording	scottsdale	backlog	lasser	documention	rearrange	televideo	sinai	iocomm	ono	mandy	rxhfun
11	vijay	photoreceptors	specificity	photons	irrespective	sensitivities	oldish	stimuli	physiol	yau	reponses	barkdoll	reddish	lepomis	starzl	immunology	xanax	turpin	feyerabend	lakatos
12	vijay	muscles	anesthesia	wroth	lopsided	georgec	hdl	triglycerides	lopid	chronically	vertebrae	sacrum	breech	pubic	lumbarized	otc	aches	diuretic	inflammation	jiggers
13	vijay	safekeeping	evaporate	landlords	apartments	preamble	declares	ordained	sawed	inescapable	cation	judiciary	militias	perpetually	debarred	pretense	pamphlets	repealed	keystone	vee
14	vijay	tensor	supposely	integrals	tlx	cla	xpl	cerebral	canard	narcotraficantes	cultivate	pollards	avr	proofing	borut	lavrencic	ijs	ljubljana	slovenia	dolgo
15	archive	urgency	legalization	microscopic	radicals	princes	fortresses	disarming	arming	partisans	disarm	mercenaries	optimism	inhabitants	dissatisfaction	phsyical	peeling	offshore	lokkur	keyspaces
16	vijay	ehd	sara	yonkers	slq	vfw	kyi	pittsfield	newington	hermon	fairground	skeet	telegraph	lpw	babson	wn	albans	hcv	wcsn	cockburn
17	vijay	ftpbk	ftpey	ftpdf	ftpmr	karn	ftppk	pcm	pijnenburg	pcc	infosys	ranum	herndon	lsb	msb	disproves	divisible	factorization	lenstra	arjen
18	archive	discoveries	flake	newage	humanistic	multiplied	embarassed	bonfire	detlef	lannert	tsos	clio	nitpicking	psmith	denninger	bankrupting	mcsnet	vocoders	subunit	csir
19	archive	salle	blanc	rale	jaywalking	allegation	deputy	conspiratorial	lapsed	slogans	shiriff	speculates	arri	invalidated	mutilation	mutilate	authenticators	capita	mite	proviso

3 Problem 3

(a) The region where 1 would be predicted are the x values where

$$c * \pi_0 * N(0,1) > \pi_1 * N(1,1/4)$$

4 Problem 4

(a) The probability that two randomly selected balls have different colors is one minus the probability that any two similarly colored balls are selected. Since the probability of selecting two balls of the same color simultaneously is the $(\frac{n_{color}}{100})^2$, the probability of choosing two similarly colored balls is the probability of selecting two of any of the colors, which is just the sum of the probabilities of any one of the colors. The probability of not getting any two colors is the complement of that, or:

$$P(different) = 1 - \frac{n_r^2 + n_o^2 + n_y^2 + n_g^2 + n_b^2}{100^2}$$

(b) To maximize the probability that two different colors were chosen, I'd ensure that there were equal numbers of each color ball in the urn. More precisely, to maximize

$$P(different) = 1 - \frac{n_r^2 + n_o^2 + n_y^2 + n_g^2 + n_b^2}{100^2}$$

subject to the constraint that $n_r + n_o + n_y + n_g + n_b = 100$, I would use the Lagrangian Multiplier.