Multiclass SVM

Vladimir Ventaniuc

Multiclass Classification

- Multiclass classification is classification task with more than two classes. Multi-class classification makes the assumption that each sample is assigned to one and only one label.
- General strategies:

1. One-versus-rest classifiers

2. One-versus-one classifiers

MNIST dataset

- The MNIST database (Modified National Institute of Standards and Technology database) is a large database of handwritten digits converted into 28x28 pixel pictures that is commonly used for training various image processing systems.

Pegasos algorithm

INPUT: S, λ, T

INITIALIZE: Set $\mathbf{w}_1 = 0$

FOR $t = 1, 2, \ldots, T$

Choose $i_t \in \{1, \ldots, |S|\}$ uniformly at random.

Set $\eta_t = \frac{1}{\lambda t}$

If $y_{i_t} \langle \mathbf{w}_t, \mathbf{x}_{i_t} \rangle < 1$, then:

Set $\mathbf{w}_{t+1} \leftarrow (1 - \eta_t \lambda)\mathbf{w}_t + \eta_t y_{i_t} \mathbf{x}_{i_t}$

Else (if $y_{i_t} \langle \mathbf{w}_t, \mathbf{x}_{i_t} \rangle \geq 1$):

Set $\mathbf{w}_{t+1} \leftarrow (1 - \eta_t \lambda)\mathbf{w}_t$

[Optional: $\mathbf{w}_{t+1} \leftarrow \min \left\{ 1, \frac{1/\sqrt{\lambda}}{\|\mathbf{w}_{t+1}\|} \right\} \mathbf{w}_{t+1}$]

OUTPUT: $\mathbf{w}_{T+1}$

Results

Epochs	λ	Error	Classificator	Error for classificator
200	2^{-5}	0.124	0	0.0879
			1	0.0465
			2	0.2151
			3	0.1538
			4	0.0777
			5	0.2447
			6	0.0435
			7	0.1282
			8	0.1136
			9	0.1569
	2^{-4}	0.276	0	0.3187
			1	0.1473
			2	0.3118
			3	0.3187
			4	0.2039
			5	0.3723
			6	0.0761
			7	0.2393
			8	0.3636
			9	0.4608
	2^{-3}	0.288	0	0.3407
			1	0.155
			2	0.3226
			3	0.3297
			4	0.2039
			5	0.4043
			6	0.0761
			7	0.2479
			8	0.3864
			9	0.4706

Epochs	λ	Error	Clasificator	Error for clasificator
500	2^{-5}	0.125	0	0.0989
			1	0.0465
			2	0.2151
			3	0.1538
			4	0.0583
			5	0.2553
			6	0.0435
			7	0.1368
			8	0.1136
			9	0.1569
	2^{-4}	0.287	0	0.3187
			1	0.1473
			2	0.3118
			3	0.3077
			4	0.2136
			5	0.3723
			6	0.0761
			7	0.265
			8	0.4318
			9	0.4804
	2^{-3}	0.3	0	0.3187
			1	0.155
			2	0.3333
			3	0.3297
			4	0.2233
			5	0.4043
			6	0.0761
			7	0.2735
			8	0.4545
			9	0.4902