

Lecture 16:

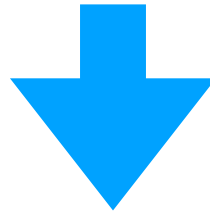
Classification

Professor Ilias Bilonis

Multi-class logistic regression

Recognizing hand-written digits

inputs x =
*matrices,
reshape to
vectors*



labels y = 0 1 2 3 ...

Multi-class logistic regression model

k different labels, $1, 2, \dots, K$

$$p(y=k | \underline{x}, \underline{w}) = \frac{\exp \left\{ \sum_{j=1}^M \underline{w}_{jk} \phi_j(\underline{x}) \right\}}{\sum_{k'=1}^K \exp \left\{ \sum_{j=1}^M \underline{w}_{jk'} \phi_j(\underline{x}) \right\}}$$

(softmax transformation)

looks like single-class logistic regression, but different weights for each input element

normalize: sum over all k (all labels)

$$\underline{w} = (\underline{w}_1, \dots, \underline{w}_K)$$

weight vector for each label,
a vector of vectors

Results

from validation

Prediction: 8



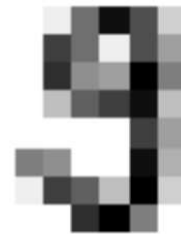
Prediction: 8



Prediction: 4



Prediction: 8



correct

incorrect

Results

Confusion Matrix

