Mathematical Foundations for Computer Vision and Machine Learning

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Assignment 09

Jupyter Notebook

- Create a new notebook for Python 3
- Include your name and the student ID in the notebook
- Write python 3 codes for the given assignment
- Try to separate the codes into meaningful blocks
- Write a comment for each block of codes
- Plot the important intermediate results
- Write a short description for each graphical result
- Use LaTeX for mathematical comments in the notebook
- Save the notebook file as assignment09.ipynb
- Download the notebook as a PDF file assignment09.pdf

Assignment 09

github

- Start a project or a directory for the assignment09
- Include the link to the giuhub for the assignment in the notebook
- Upload the notebook assignment09.ipynb to the github after the deadline (Note that your github project is visible to public)

Assignment 09

Submission to *eclass*

- Submit the PDF file assignment09.pdf to eclass
- Deadline is 11:59 pm on next Thursday. No extension
- Score ranges from 0 to 5

Assignment 09

Score Table

- The results should be correct
- The codes should be written in a modulated way
- The comment should be made for each block of the codes
- The important intermediate results should be presented
- The link to the github project should be included

Assignment 09

Build a binary classifier

- Define a linear bi-partitioning function $\tilde{f}$ to classify digit '0' against all the other digits '1', '2', '3', '4', '5', '6', '7', '8', '9' using the training data at MNIST dataset
- Define the classifier $\hat{f}(x) = \mathrm{sign}(\tilde{f}(x))$ using the sign function:

$$\mathrm{sign}(x) = \begin{cases} +1 & \text{if } x \geq 0 \\ -1 & \text{if } x < 0 \end{cases}$$

- Evaluate the performance of the classifier $\hat{f}$ using the testing data at MNIST dataset based on TP(True Positive), FP(False Positive), TN(True Negative) and FN(False Negative)

Assignment 09

Build a binary classifier

- Let $x = (x_1, x_2, \cdots, x_{784})$ be a vector that represent an image of the size 28×28 (vectorised by column-wise)
- Let f_i be a feature function such tat $f_i : \mathbb{R}^{784} \to \mathbb{R}$:

$$f_i(x) = r_i^T x, \quad r_i \sim \mathcal{N}(0, \sigma), \quad r_i \in \mathbb{R}^{784}$$

  where r_i denotes a random vector drawn from a normal distribution. (function: numpy.random.normal)
- The partitioning function $\tilde{f} : \mathbb{R}^{784} \to \mathbb{R}$ is defined by:

$$\tilde{f}(x; \theta) = \theta_1 f_1(x) + \theta_2 f_2(x) + \cdots + \theta_p f_p(x)$$

  where $\theta = (\theta_1, \theta_2, \cdots, \theta_p)$ denotes the model parameters

Assignment 09

Essential Visualisation

- Try with varying the number of parameters p with the standard deviation $\sigma = 1$ of the random feature vector r
- Present the best F_1 score among the results with different number of parameters p
- Plot the average image (28×28) of True Positive
- Plot the average image (28×28) of False Positive
- Plot the average image (28×28) of True Negative
- Plot the average image (28×28) of False Negative

Assignment 09

F_1 score $= 2 \cdot \frac{\text{precision}\cdot\text{recall}}{\text{precision}+\text{recall}}$