

Programming Assignment 4

Issued: Tuesday 27th November, 2018

Due: Monday 3rd December, 2018

4.1. Suppose we are given a dataset $\{(x^{(i)}, y^{(i)}) : i = 1, 2, \dots, N\}$. $x^{(i)}$ belongs to discrete finite set $\mathcal{X} = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$, $y^{(i)}$ belongs to discrete finite set $\mathcal{Y} = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14\}$.

- (a) (10 points) The given data num.npy is a 10×15 matrix, each entry of this matrix represents the number of corresponding pairs occur in the given dataset. i.e. num(0, 1) is the number of pair $(x^{(i)} = 0, y^{(i)} = 1)$ occurs in the given dataset. Implement ACE algorithm to calculate $g(y)$ and second singular value of B matrix in the given dataset, refer to your class notes for the definition of B matrix.

Algorithm 2 ACE Algorithm with Finite Samples

Require: training samples $\{(x_i, y_i) : i = 1, \dots, N\}$

1. Initialize: randomly pick $g(y)$, $y \in \mathcal{Y}$

repeat: pick a subset of n samples

2a. $f(x) \leftarrow \hat{\mathbb{E}}_n[g(Y)|X = x]$, $\forall x \in \mathcal{X}$

2b. $g(y) \leftarrow \hat{\mathbb{E}}_n[f(X)|Y = y]$, $\forall y \in \mathcal{Y}$

2c. Regularize: $g(y) \leftarrow g(y) - \hat{\mathbb{E}}_n[g(Y)]$, $\forall y \in \mathcal{Y}$

$g(y) \leftarrow g(y) / \sqrt{\hat{\mathbb{E}}_n[g^2(Y)]}$, $\forall y \in \mathcal{Y}$

until $\hat{\mathbb{E}}_n[f(X)g(Y)]$ stops to increase

Pa4_2018.py will walk you through this exercise.

Notice:

- Submit your .py file only.
- Please solve the question following the provided ACE algorithm, other ways are not accepted.
- Use whole dataset instead of a subset of n samples in this problem.
- np.linalg.svd(), np.linalg.eig() or other matrix decomposition methods are forbidden.
- Using matrix manipulation and numpy broadcasting for efficiency.
- If your codes are right, the result will be like one of those:

