MULTI-KERNEL, DEEP NEURAL NETWORK AND HYBRID MODELS FOR PRIVACY PRESERVING MACHINE LEARNING

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Introduction and Motivation

- The advent of IOT and Big Data creates privacy concerns.
- The threat to privacy motivates the Principle of Least Privilege to be applied to Big Data.
- We consider the application of privacy preserving classification.
- We look for data representations that are helpful with the utility, but nothing else.
- We perform lossy compression in the private sphere, before the data is released.

Method

Our methodology combines two regimes; Kernel Based Learning and Deep Learning.

Step 1: Kernel Based Compression

We apply the utility maximizing lossy compression method called KDCA [1]. A KDCA projection can be derived via the optimization:

$$A_{KDCA} = \text{argmax}_A \text{trace}(A^T K_B A)$$

where $K$ is the centered kernel matrix and $K_B$ is the kernel between-class scatter matrix. The projection obtained from $N$ training samples can then be applied to the data via the kernel trick:

$$\Phi = A^T (I - \frac{1}{N} 11^T) K.$$

For classification with $L$ classes, $L - 1$ dimensional projections can capture all the discriminant power, allowing for a high compression rate.

Step 2: Kernel Selection

To select the best kernels for the utility, we perform a filtering procedure based on the Discriminant Information (DI) metric [2,3]:

$$DI = \text{trace}((\bar{S} + \rho I)^{-1} S_B)$$

where $\bar{S}$ and $S_B$ are the centered and the between class scatter matrices.

Since KDCA captures the utility information, combining KDCA projections with kernel selection has an effect of utility-maximizing space mining.

Step 3: Deep Learning Based Compression

To distill the utility information further, we utilize a DNN with a narrow, funnelling layer. The DNN processes multiple KDCA projections to form a Compressive Hybrid.

Experimental Results

- Multi-KDCA with kernel selection achieves the best utility performances, demonstrating the importance of the space mining process.
- Multi-Kernel and Deep Learning based compression can effectively remove private information, while maintaining high utility.

Conclusion

References


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