Final Project

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1 Introduction

2 Problem Statement

The database is a set of noisy recordings, which have poor quality for further usage. So it make sense to improve them. In order to remove the noisy, we propose to use online dictionary learning.

3 Algorithm

3.1 Data Preparation

We use librosa to prepare our data.

3.2 Sparse Coding

Using LARS to calculate

$$\alpha_t \triangleq \arg\min_{\alpha \in R^k} \frac{1}{2}\|\boldsymbol{x}_t - \boldsymbol{D}_{t-1}\alpha\|_2^2 + \lambda\|\alpha\|_1$$

where $\boldsymbol{x} \in \mathbb{R}^{50}, \boldsymbol{D} \in \mathbb{R}^{50\times 500}$ and $t \leq T$(maximum number of iterations)
Then Updating $\boldsymbol{A}, \boldsymbol{B}$ by

$$\boldsymbol{A}_t \leftarrow \boldsymbol{A}_{t-1} + \alpha_t \alpha_t^T$$
$$\boldsymbol{B}_t \leftarrow \boldsymbol{B}_{t-1} + \boldsymbol{x}_t \alpha_t^T$$

3.3 Dictionary Update

$$\boldsymbol{D}_t \triangleq \arg\min_{\boldsymbol{D}\in C} \frac{1}{t}\sum \frac{1}{2}\|\boldsymbol{x}_i - \boldsymbol{D}\alpha_i\|_2^2 + \lambda\|\alpha\|_1$$

Where $C \triangleq \boldsymbol{D} \in \mathbb{R}^{50\times 500}$ s.t. $\forall j = 1, ..., k, \boldsymbol{d}_j^T \boldsymbol{d}_j \leq 1$ to ensure the convex.
Using block-coordinate descent to update dictionary Extracting columns of $\boldsymbol{A}$ and $\boldsymbol{B}$

$$\boldsymbol{A} = [\boldsymbol{a}_1, ..., \boldsymbol{a}_k] \in \mathbb{R}^{500\times 500}$$

$$\boldsymbol{B} = [\boldsymbol{b}_1, ..., \boldsymbol{b}_k] \in \mathbb{R}^{500 \times 500}$$

for each column from $j = 1 \Rightarrow k$

$$\boldsymbol{u_j} \leftarrow \frac{1}{A[j,j]}(\boldsymbol{b}_j - \boldsymbol{D}\boldsymbol{a}_j) + \boldsymbol{d}_j$$

$$\boldsymbol{d}_j \leftarrow \frac{1}{\max(\|\boldsymbol{u}_j\|_2, 1)}\boldsymbol{u}_j$$

return $\boldsymbol{D}$ for next iteration

4 Experiments