Notation & Setup

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Hey, Let's use the following notation in our writeups and code ?

The first primal objective is,

$$F_1(\boldsymbol{\alpha}) = \frac{1}{2n}\|Y - \sum_{j=1}^{M} K^{(j)}\alpha^{(j)}\|_2^2 + \frac{\lambda}{M}\sum_{j=1}^{M}\sqrt{\alpha^{(j)^\top}K^{(j)}\alpha^{(j)}}$$

Let the Cholesky decomposition of $K^{(j)}$ be, $K^{(j)} = L^{(j)}L^{(j)^\top}$ where $L^{(j)}$ is lower triangular[1]. Let $\beta_j = L^{(j)^\top}\alpha^{(j)}$. Then, we can write the above objective as,

$$F_2(\boldsymbol{\beta}) = \frac{1}{2n}\|Y - \sum_{j=1}^{M} L^{(j)}\alpha^{(j)}\|_2^2 + \frac{\lambda}{M}\sum_{j=1}^{M}\|\beta^{(j)}\|_2$$

Coding

Lets use the following standards, its basically what we are using right now.

- Maintain $\boldsymbol{\alpha}$ as an $\mathbb{R}^{n \times M}$ matrix. Each column corresponds to an $\alpha^{(j)}$.
- Maintain all the Kernel matrices in a $\mathbb{R}^{n \times n \times M}$ tensor K, where K(:,:,j) is $K^{(j)}$.
- Same for all the $L^{(j)}$'s.

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[1]Matlab's `chol` gives the upper triangular matrix, but my wrapper `stableCholesky` takes care of it. It also, takes care of numerical issues in PSD matrices but be careful when using a non-PSD matrix with it.