Homework 4 - BLAS Practice

In this homework, you are required to implement a simple algorithm in C language and compare the performance of different BLAS implementations on your program. Please consider **at least four** of the following BLAS libraries in your report:

- The Netlib BLAS/CBLAS

- Intel MKL

- AMD BLIS

- GotoBLAS

  See the NY Times article.

  This GotoBlas is not actively maintained now, so it's unclear if the code can be easily used or not.

- ATLAS (Its GEMM is used from Kazushige Goto's)

- OpenBLAS (An optimized BLAS library based on GotoBLAS2 1.13 BSD version.)

- Any other implementation listed on the wiki page.

The Power Method

The **power method** is an algorithm for finding the largest eigenvalue of a given matrix. You are required to write a program with the steps:

(1) Generate or read a diagonalizable matrix.

(2) Apply Algorithm 1.

(3) Print the largest eigenvalue.

Algorithm 1 Power method

Require: The input matrix $A \in \mathbb{R}^{d \times d}$, some small tolerance $\epsilon_{\text{tol}} \in \mathbb{R}$

$\quad \boldsymbol{b} \leftarrow \begin{bmatrix} 1 & 1 & \cdots & 1 \end{bmatrix} \in \mathbb{R}^d$

$\quad \epsilon \leftarrow \infty$

$\quad$ **while** $\epsilon > \epsilon_{\text{tol}}$ **do**

$\quad\quad \boldsymbol{b}' \leftarrow \boldsymbol{b}$

$\quad\quad \boldsymbol{b} \leftarrow A\boldsymbol{b}$

$\quad\quad \boldsymbol{b} \leftarrow \frac{\boldsymbol{b}}{\|\boldsymbol{b}\|_2}$

$\quad\quad \epsilon = \|\boldsymbol{b} - \boldsymbol{b}'\|_1$

$\quad$ **end while**

$\quad$ **return** $\|A\boldsymbol{b}\|_2$ $\hspace{4cm}$ ▷ the largest eigenvalue

---

Report Requirement

1. Implement the power method in C and link it with different BLAS implementations that you choosed. Note that you should utilize the functions provided by BLAS when doing matrix and vector computations. Also, you are required to **include your code in the report pdf file**.

   Tip: Most implementation (including Intel MKL, AMD BLIS) supports the CBLAS interface. Therefore, you only need to write one version of code and link it with different implementations.

2. Test the algorithm with a simple matrix. Check the eigenvalue given by your algorithm against the eigenvalue calculated by SciPy or MATLAB to verify the correctness of the algorithm.

3. Compare and discuss the performance of different implementations of BLAS with matrices of different sizes. Are some of the implementations faster? Why? You can cite resources or perform extra experiments to strengthen your argument.

4. You should specify whether your implementation has multi-thread enabled. Furthermore, please provide information of your environment and hardwares.