

Matrix Sparsity Calculation using Multithreading: OpenMP vs PThreads

Overview

This project aims to calculate the sparsity (the ratio of zero-valued elements) of a square matrix using multithreading. The matrix sparsity calculation is implemented using both OpenMP and PThreads, with three different parallelization techniques: Chunk, Mixed, and Dynamic. The program compares the performance of these techniques by measuring the time taken for different matrix sizes, thread counts, sparsity values, and row increments.

Files and Structure

The project directory contains the following files:

Source Code Files

- `Assgn2-Chunk-OpenMP-C022BTECH11006.cpp`
- `Assgn2-Chunk-PThreads-C022BTECH11006.cpp`
- `Assgn2-Dynamic-OpenMP-C022BTECH11006.cpp`
- `Assgn2-Dynamic-PThreads-C022BTECH11006.cpp`
- `Assgn2-Mixed-Chunk-OpenMP-C022BTECH11006.cpp`
- `Assgn2-Mixed-Chunk-PThreads-C022BTECH11006.cpp`
- `Assgn2-Mixed-OpenMP-C022BTECH11006.cpp`
- `Assgn2-Mixed-PThreads-C022BTECH11006.cpp`

Other Files

- `Makefile`: Script to compile all programs using the `make` command.
- `input.txt`: Sample input file for running the programs.
- `Figure_1.png`, `Figure_2.png`, `Figure_3.png`, `Figure_4.png`: Graphs for performance analysis.

Compilation and Execution

Compilation

To compile the programs, use the provided `Makefile`. Run the following command in the terminal:

```
make
```

This will generate the following executables:

- **chunk-omp**: Chunk method using OpenMP.
- **mixed-omp**: Mixed method using OpenMP.
- **dynamic-omp**: Dynamic method using OpenMP.
- **mixedchunk-omp**: Mixed-Chunk method using OpenMP.
- **chunk**: Chunk method using PThreads.
- **mixed**: Mixed method using PThreads.
- **dynamic**: Dynamic method using PThreads.
- **mixedchunk**: Mixed-Chunk method using PThreads.

Manual Compilation

You can also manually compile individual files. Below are example commands to compile each file separately:

For OpenMP versions:

```
g++ -fopenmp Assgn2-Chunk-OpenMP-CO22BTECH11006.cpp -o chunk-omp
g++ -fopenmp Assgn2-Mixed-OpenMP-CO22BTECH11006.cpp -o mixed-omp
g++ -fopenmp Assgn2-Dynamic-OpenMP-CO22BTECH11006.cpp -o dynamic-omp
g++ -fopenmp Assgn2-Mixed-Chunk-OpenMP-CO22BTECH11006.cpp -o mixedchunk-omp
```

For PThreads versions:

```
g++ -pthread Assgn2-Chunk-PThreads-CO22BTECH11006.cpp -o chunk
g++ -pthread Assgn2-Mixed-PThreads-CO22BTECH11006.cpp -o mixed
g++ -pthread Assgn2-Dynamic-PThreads-CO22BTECH11006.cpp -o dynamic
g++ -pthread Assgn2-Mixed-Chunk-PThreads-CO22BTECH11006.cpp -o mixedchunk
```

Input

The program reads matrix data and parameters from **input.txt**. The structure of the input file is as follows:

- **N**: Matrix size (NxN).
- **S**: Sparsity percentage (amount of zero values in the matrix).
- **K**: Number of threads to use.
- **rowInc**: Row increment for dynamic scheduling.
- **Matrix**: The NxN matrix values in row-major order.

An example of the **input.txt** file is provided in the project directory.

Execution

After compiling, you can run the executables as follows:

For OpenMP versions:

```
./chunk-omp  
./mixed-omp  
./dynamic-omp
```

For PThreads versions:

```
./chunk  
./mixed  
./dynamic
```

Output

The output will be written to **output.txt** and will contain:

- Time taken to compute the matrix sparsity.
- Total number of zero-valued elements.
- Number of zero-valued elements counted by each thread.

Contact

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