20BCE1550
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CSE4001 Lab 07
Profiling

Matrix Multiplication

Nested parallelism is not supported in ompP, so the 'collapse' keyword has been used.

Code:

```
#include <stdio.h>

#include <stdlib.h>
#include <omp.h>

typedef int ** matrix;
#define N 1100 // the size of the matrices

void multiply(matrix A, matrix B, matrix ans, int numThreads) {
int i = 0, j = 0, k = 0;
#pragma omp parallel shared(A, B, ans) private(i, j, k) num_threads(numThreads)
{
#pragma omp for collapse(3)
for (i = 0; i < N; i++) {
for (j = 0; j < N; j++) {
for (k = 0; k < N; k++) {
ans[i][j] += A[i][k] * B[k][j];
}
}
}
}
}

int main(int argc, char *argv[]) {
int numThreads = atoi(argv[1]);
matrix A, B, C;

A = (int **)calloc(N, sizeof(int*));
B = (int **)calloc(N, sizeof(int*));
C = (int **)calloc(N, sizeof(int*));

for (int i = 0; i < N; i++) {
A[i] = (int *) calloc(N, sizeof(int));
B[i] = (int *) calloc(N, sizeof(int));
C[i] = (int *) calloc(N, sizeof(int));
for (int j = 0; j < N; j++) {
A[i][j] = rand() % 10;
```

```
B[i][j] = rand() % 10;
C[i][j] = 0;
}
}

double t = omp_get_wtime();

multiply(A, B, C, numThreads);

t = omp_get_wtime() - t;

printf("took %f seconds\n", t);

for (int i = 0; i < N; i++) {
free(A[i]);
free(B[i]);
}
free(A);
free(B);
free(C);

printf("\n");
return 0;
}
```

OmpP Profiler Output:

```
--------------------------------------------------------------------------------
---------ompP General Information----------------------------------
--------------------------------------------------------------------------------
Start Date      : Thu Sep 15 21:31:53 2022
End Date        : Thu Sep 15 21:31:56 2022
Duration        : 2.94 sec
Application Name: unknown
Type of Report  : final
User Time       : 11.24 sec
System Time     : 0.00 sec
Max Threads     : 8
ompP Version    : 0.8.99
ompP Build Date : Sep 13 2022 10:59:18
PAPI Support    : not available

--------------------------------------------------------------------------------
---------ompP Region Overview--------------------------------------
--------------------------------------------------------------------------------
PARALLEL: 1 region:
 * R00001 q1.c (10-20)

LOOP: 1 region:
 * R00002 q1.c (12-19)
```

```
---------------------------------------------------------------------------
---  ompP Flat Region Profile (inclusive data)  ---------------
---------------------------------------------------------------------------
R00001 q1.c (10-20) PARALLEL
 TID       execT       execC       bodyT    exitBarT   startupT   shutdwnT       taskT
   0        2.94           1        2.94        0.00       0.00       0.00        0.00
   1        2.94           1        2.94        0.00       0.00       0.00        0.00
   2        2.94           1        2.94        0.00       0.00       0.00        0.00
   3        2.94           1        2.94        0.00       0.00       0.00        0.00
   4        0.00           0        0.00        0.00       0.00       0.00        0.00
   5        0.00           0        0.00        0.00       0.00       0.00        0.00
   6        0.00           0        0.00        0.00       0.00       0.00        0.00
   7        0.00           0        0.00        0.00       0.00       0.00        0.00
 SUM       11.77           4       11.77        0.00       0.00       0.00        0.00

R00002 q1.c (12-19) LOOP
 TID       execT       execC       bodyT    exitBarT       taskT
   0        2.94           1        2.87        0.08        0.00
   1        2.94           1        2.80        0.14        0.00
   2        2.94           1        2.74        0.20        0.00
   3        2.94           1        2.94        0.00        0.00
   4        0.00           0        0.00        0.00        0.00
   5        0.00           0        0.00        0.00        0.00
   6        0.00           0        0.00        0.00        0.00
   7        0.00           0        0.00        0.00        0.00
 SUM       11.77           4       11.34        0.42        0.00
```

```
---  ompP Callgraph Region Profiles (incl./excl. data)  -------
---------------------------------------------------------------------------

[*00] unknown
[+01] R00001 q1.c (10-20) PARALLEL
 TID       execT       execC     bodyT/I     bodyT/E    exitBarT   startupT   shutdwnT       taskT
   0        2.94           1        2.94        0.00        0.00       0.00       0.00        0.00
   1        2.94           1        2.94        0.00        0.00       0.00       0.00        0.00
   2        2.94           1        2.94        0.00        0.00       0.00       0.00        0.00
   3        2.94           1        2.94        0.00        0.00       0.00       0.00        0.00
   4        0.00           0        0.00        0.00        0.00       0.00       0.00        0.00
   5        0.00           0        0.00        0.00        0.00       0.00       0.00        0.00
   6        0.00           0        0.00        0.00        0.00       0.00       0.00        0.00
   7        0.00           0        0.00        0.00        0.00       0.00       0.00        0.00
 SUM       11.77           4       11.77        0.00        0.00       0.00       0.00        0.00

[*00] unknown
[+01] R00001 q1.c (10-20) PARALLEL
[=02] R00002 q1.c (12-19) LOOP
 TID       execT       execC     bodyT/I     bodyT/E    exitBarT       taskT
   0        2.94           1        2.87        2.87        0.08        0.00
   1        2.94           1        2.80        2.80        0.14        0.00
   2        2.94           1        2.74        2.74        0.20        0.00
   3        2.94           1        2.94        2.94        0.00        0.00
   4        0.00           0        0.00        0.00        0.00        0.00
   5        0.00           0        0.00        0.00        0.00        0.00
   6        0.00           0        0.00        0.00        0.00        0.00
   7        0.00           0        0.00        0.00        0.00        0.00
 SUM       11.77           4       11.34       11.34        0.42        0.00
```

```
---------------------------------------------------------------------
---  ompP Overhead Analysis Report  ---------------------------
---------------------------------------------------------------------
Total runtime (wallclock)  : 2.94 sec [8 threads]
Number of parallel regions  : 1
Parallel coverage          : 2.94 sec (99.97%)

Parallel regions sorted by wallclock time:
        Type                          Location      Wallclock (%)
R00001  PARALLEL                   q1.c (10-20)      2.94 (99.97)
                                              SUM     2.94 (99.97)

Overheads wrt. each individual parallel region:
        Total      Ovhds (%)  =   Synch  (%)  +  Imbal   (%)  +   Limpar (%)   +    Mgmt (%)
R00001  23.54    0.42 ( 1.80)   0.00 ( 0.00)   0.42 ( 1.80)   0.00 ( 0.00)   0.00 ( 0.00)

Overheads wrt. whole program:
        Total      Ovhds (%)  =   Synch  (%)  +  Imbal   (%)  +   Limpar (%)   +    Mgmt (%)
R00001  23.54    0.42 ( 1.80)   0.00 ( 0.00)   0.42 ( 1.80)   0.00 ( 0.00)   0.00 ( 0.00)
  SUM   23.54    0.42 ( 1.80)   0.00 ( 0.00)   0.42 ( 1.80)   0.00 ( 0.00)   0.00 ( 0.00)
```