

workshop优化

fork

优化

fork

```
1  git clone https://github.com/xingfeng2510/workshop.git
2  cd workshop
3  make
4
5  ./workshop
```

```
ubuntu@VM-0-11-ubuntu:~/workshop$ sudo time ./workshop
Matrix multiply iteration 1: cost 35.525 seconds
Matrix multiply iteration 2: cost 36.618 seconds
Matrix multiply iteration 3: cost 33.435 seconds
Matrix multiply iteration 4: cost 33.503 seconds
Matrix multiply iteration 5: cost 33.881 seconds
Matrix multiply iteration 6: cost 34.330 seconds
Matrix multiply iteration 7: cost 34.003 seconds
Command terminated by signal 9
535.10user 2.40system 4:34.00elapsed 196%CPU (0avgtext+0avgdata 263356maxresident)k
0inputs+0outputs (0major+360406minor)pagefaults 0swaps
ubuntu@VM-0-11-ubuntu:~/workshop$
```

原始程序在第7次迭代后因内存超限被 `signal 9(SIGKILL)` 终止。平均在34.4s

优化

1、`main.c` 中 `Multiplyonce` 函数调用了 `ParallelMultiply`，后者通过多线程执行 `mul` 函数。

矩阵乘法本身是三重循环，是计算密集型。

2、

- 循环顺序：原代码中循环顺序是 `i-j-k`，即外层循环是行 `i`，中层是列 `j`，内层是累加 `k`。这种顺序可能导致对内存的非连续访问，降低缓存效率。
- 额外操作：每次计算完 `c[i][i]` 后调用 `vector_append`，但这个向量未被使用。
- 未初始化内存：`c` 数组在计算前未清零。

```
mul.c Shell |
1 void mul(int msize, int tidx, int numt, Vector *vec, TYPE a[][NUM], TYPE b
  [][NUM], TYPE c[][NUM], TYPE t[][NUM]) {
2     int i, j, k;
3     for (i = tidx; i < msize; i += numt) {
4         // 初始化c[i][j]为0
5         for (j = 0; j < msize; j++) {
6             c[i][j] = 0.0;
7         }
8         // 调整循环顺序为i-k-j
9         for (k = 0; k < msize; k++) {
10            // 缓存a[i][k]减少重复访问
11            TYPE a_ik = a[i][k];
12            for (j = 0; j < msize; j++) {
13                c[i][j] += a_ik * b[k][j];
14            }
15        }
16    }
17 }
```

3、在 `thrmode1.c` 的线程参数中，每个线程通过 `vector_create()` 创建了 `Vector` 对象，但未调用 `vector_destroy()` 释放内存。注：

```
thrmodel.c Shell |
1 // destroy vector here 33line
2 vector_destroy(par->vec); //34 line
```

4、`-O3` 会开启 `-O2` 所包含的所有优化，提高程序的运行性能。编译时间的增加不再考虑范围内。

```
Makefile Shell |
1 # CFLAGS = -g -O2 -fno-asm
2 CFLAGS = -g -O3 -fno-asm
```

-O3的优化结果在3.96 s 左右，-O2的优化结果在4.47 s 左右。

```
Matrix multiply iteration 90: cost 3.939 seconds
Matrix multiply iteration 91: cost 3.956 seconds
Matrix multiply iteration 92: cost 3.936 seconds
Matrix multiply iteration 93: cost 3.965 seconds
Matrix multiply iteration 94: cost 3.977 seconds
Matrix multiply iteration 95: cost 3.977 seconds
Matrix multiply iteration 96: cost 3.964 seconds
Matrix multiply iteration 97: cost 3.977 seconds
Matrix multiply iteration 98: cost 3.966 seconds
Matrix multiply iteration 99: cost 3.966 seconds
Matrix multiply iteration 100: cost 3.957 seconds
ubuntu@VM-0-11-ubuntu:~/workshop$
```

(a) O3

```
Matrix multiply iteration 91: cost 4.470 seconds
Matrix multiply iteration 92: cost 4.498 seconds
Matrix multiply iteration 93: cost 4.488 seconds
Matrix multiply iteration 94: cost 4.507 seconds
Matrix multiply iteration 95: cost 4.462 seconds
Matrix multiply iteration 96: cost 4.479 seconds
Matrix multiply iteration 97: cost 4.490 seconds
Matrix multiply iteration 98: cost 4.474 seconds
Matrix multiply iteration 99: cost 4.471 seconds
Matrix multiply iteration 100: cost 4.458 seconds
ubuntu@VM-0-11-ubuntu:~/workshop$
```

(b) O2

优化倍数分别是： $34.4/3.96 \approx 8.67$

$34.4/4.47 \approx 7.69$

附CPU利用率 [http](#)

