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Practical Assignment (2)

Terminal

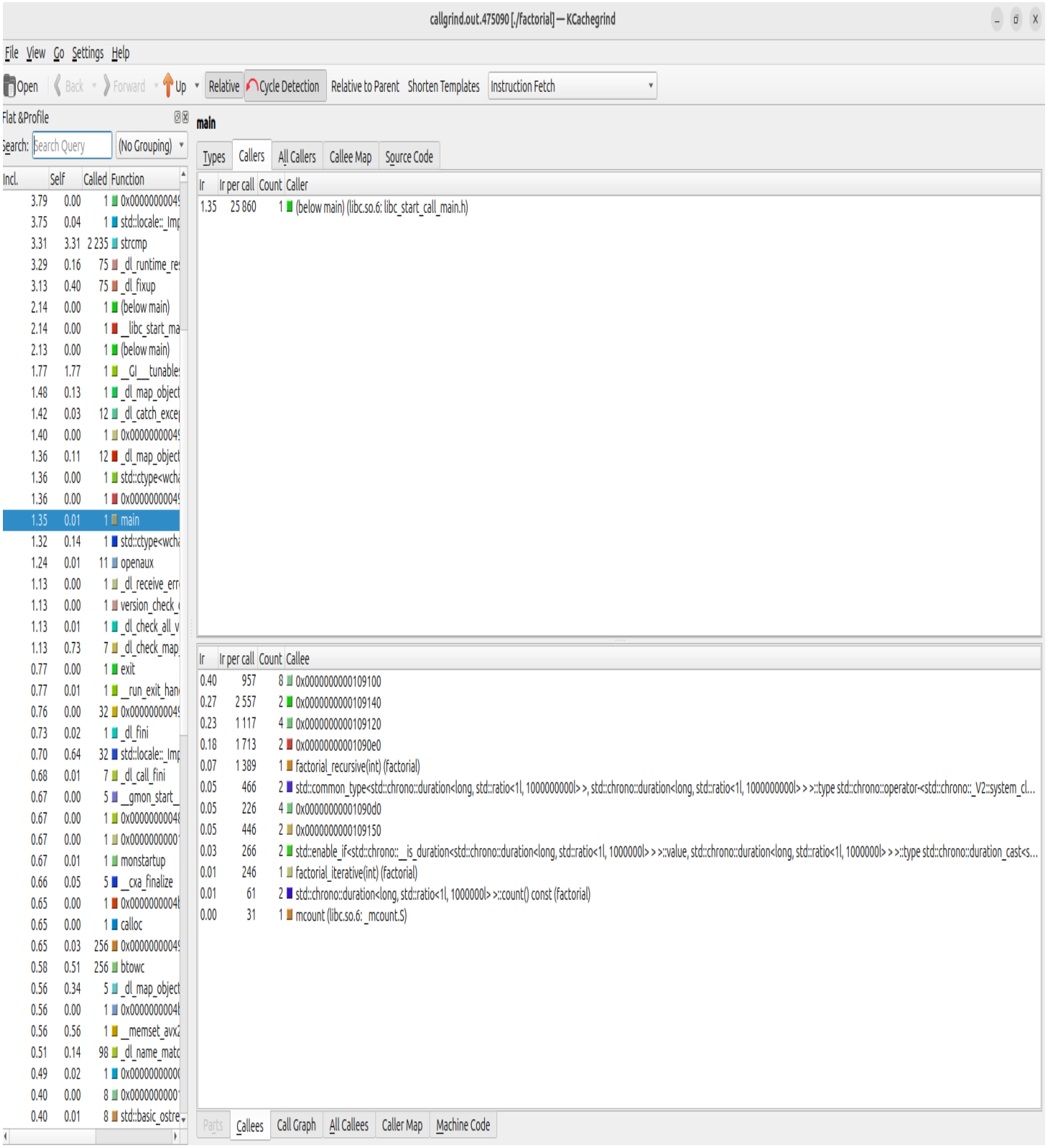
File Edit Options Buffers Tools C++ Help

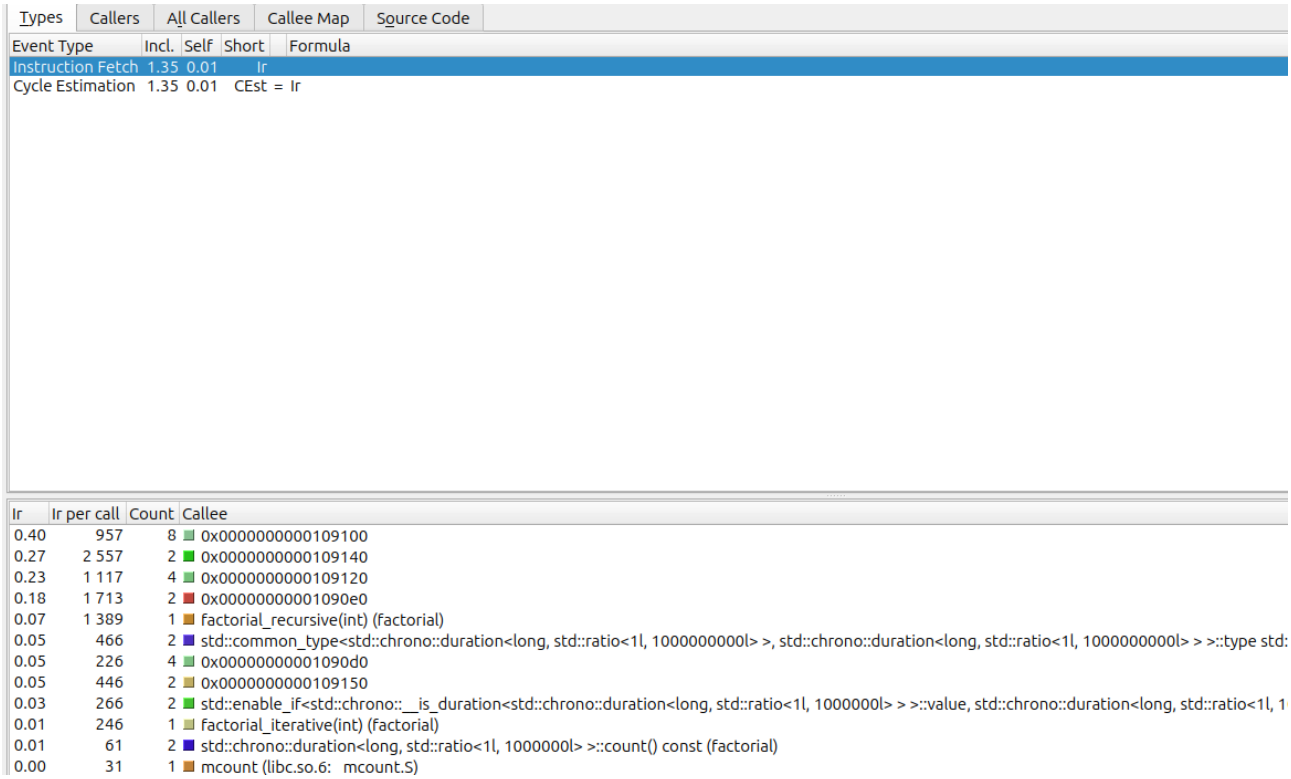
```cpp
#include <iostream>
#include <chrono>

using namespace std;

// Iterative factorial
long long factorial_iterative(int n) {
    long long result = 1;
    for (int i = 1; i <= n; ++i) {
        result *= i;
    }
    return result;
}

// Recursive factorial
long long factorial_recursive(int n) {
    if (n == 0) return 1;
    return n * factorial_recursive(n - 1);
}

int main() {
    int num = 20;

    auto start_iter = chrono::high_resolution_clock::now();
    cout << "Iterative Factorial of " << num << ": " << factorial_iterative(num) << endl;
    auto end_iter = chrono::high_resolution_clock::now();
    cout << "Iterative Execution Time: " << chrono::duration_cast<chrono::microseconds>(end_iter - start_iter).count() << " microseconds" << endl;

    auto start_rec = chrono::high_resolution_clock::now();
    cout << "Recursive Factorial of " << num << ": " << factorial_recursive(num) << endl;
    auto end_rec = chrono::high_resolution_clock::now();
    cout << "Recursive Execution Time: " << chrono::duration_cast<chrono::microseconds>(end_rec - start_rec).count() << " microseconds" << endl;

    return 0;
}
```

```
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ nano factorial.cpp
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ g++ -pg -o factorial factor
ial.cpp
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ ./factorial
Iterative Factorial of 20: 2432902008176640000
Iterative Execution Time: 85 microseconds
Recursive Factorial of 20: 2432902008176640000
Recursive Execution Time: 6 microseconds
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ gprof factorial gmon.out >
analysis.txt
```

```
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ valgrind --tool=callgrind .
/factorial
==475090== Callgrind, a call-graph generating cache profiler
==475090== Copyright (C) 2002-2017, and GNU GPL'd, by Josef Weidendorfer et al.
==475090== Using Valgrind-3.22.0 and LibVEX; rerun with -h for copyright info
==475090== Command: ./factorial
==475090==
==475090== For interactive control, run 'callgrind_control -h'.
Iterative Factorial of 20: 2432902008176640000
Iterative Execution Time: 8258 microseconds
Recursive Factorial of 20: 2432902008176640000
Recursive Execution Time: 369 microseconds
==475090==
==475090== Events    : Ir
==475090== Collected : 1908630
==475090==
==475090== I   refs:      1,908,630
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ kcachegrind callgrind.out.*
```

```
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ kcachegrind callgrind.out.*
Selected  "main"
^C
ali@Ali:~/Desktop/Projects/#03 WasReleasedToday/SPE$ kcachegrind callgrind.out.4
75090
Selected  "main"
```


callgrind.out.475090 [./factorial] — KCachegrind
File View Go Settings Help
Open Back Forward Up Relative Cycle Detection Relative to Parent Shorten Templates Instruction Fetch
Flat &Profile
Search: Search Query (No Grouping)
Incl. Self Called Function
3.79 0.00 1 0x00000000049
3.75 0.04 1 std::locale::_Imp
3.31 3.31 2 235 strcmp
3.29 0.16 75 _dl_runtime_re
3.13 0.40 75 _dl_fixup
2.14 0.00 1 (below main)
2.14 0.00 1 __libc_start_ma
2.13 0.00 1 (below main)
1.77 1.77 1 __GI__tunable
1.48 0.13 1 _dl_map_object
1.42 0.03 12 _dl_catch_excep
1.40 0.00 1 0x00000000049
1.36 0.11 12 _dl_map_object
1.36 0.00 1 std::ctype<wcha
1.36 0.00 1 0x00000000049
1.35 0.01 1 main
1.32 0.14 1 std::ctype<wcha
1.24 0.01 11 openaux
1.13 0.00 1 _dl_receive_err
1.13 0.00 1 version_check_
1.13 0.01 1 _dl_check_all_v
1.13 0.73 7 _dl_check_map_
0.77 0.00 1 exit
0.77 0.01 1 __run_exit_han
0.76 0.00 32 0x00000000049
0.73 0.02 1 _dl_fini
0.70 0.64 32 std::locale::_Imp
0.68 0.01 7 _dl_call_fini
0.67 0.00 5 __gmon_start__
0.67 0.00 1 0x00000000046
0.67 0.00 1 0x0000000000
0.67 0.01 1 monstartup
0.66 0.05 5 __cxa_finalize
0.65 0.00 1 0x00000000046
0.65 0.00 1 calloc
0.65 0.03 256 0x00000000049
0.58 0.51 256 btowc
0.56 0.34 5 _dl_map_object
0.56 0.00 1 0x00000000046
0.56 0.56 1 __memset_avx2
0.51 0.14 98 _dl_name_matc
0.49 0.02 1 0x0000000000
0.40 0.00 8 0x0000000000
0.40 0.01 8 std::basic_ostre
main
Types Callers All Callers Callee Map Source Code
Ir Ir per call Count Caller
1.35 25 860 1 (below main) (libc.so.6: libc_start_call_main.h)
Ir Ir per call Count Callee
0.40 957 8 0x0000000000109100
0.27 2 557 2 0x0000000000109140
0.23 1 117 4 0x0000000000109120
0.18 1 713 2 0x00000000001090e0
0.07 1 389 1 factorial_recursive(int) (factorial)
0.05 466 2 std::common_type<std::chrono::duration<long, std::ratio<1l, 1000000000l> >, std::chrono::duration<long, std::ratio<1l, 1000000000l> > >::type std::chrono::operator-<std::chrono::_V2::system_cl...
0.05 226 4 0x00000000001090d0
0.05 446 2 0x0000000000109150
0.03 266 2 std::enable_if<std::chrono::__is_duration<std::chrono::duration<long, std::ratio<1l, 1000000l> > >::value, std::chrono::duration<long, std::ratio<1l, 1000000l> > >::type std::chrono::duration_cast<s...
0.01 246 1 factorial_iterative(int) (factorial)
0.01 61 2 std::chrono::duration<long, std::ratio<1l, 1000000l> >::count() const (factorial)
0.00 31 1 mcount (libc.so.6: _mcount.S)
Parts Callees Call Graph All Callees Caller Map Machine Code



Types | Callers | All Callers | Callee Map | Source Code

Event Type	Incl.	Self	Short	Formula
Instruction Fetch	1.35	0.01		Ir
Cycle Estimation	1.35	0.01	CEst	= Ir

Ir	Ir per call	Count	Callee
0.40	957	8	0x0000000000109100
0.27	2 557	2	0x0000000000109140
0.23	1 117	4	0x0000000000109120
0.18	1 713	2	0x00000000001090e0
0.07	1 389	1	factorial_recursive(int) (factorial)
0.05	466	2	std::common_type<std::chrono::duration<long, std::ratio<1l, 1000000000l> >, std::chrono::duration<long, std::ratio<1l, 1000000000l> > >::type std:
0.05	226	4	0x00000000001090d0
0.05	446	2	0x0000000000109150
0.03	266	2	std::enable_if<std::chrono::__is_duration<std::chrono::duration<long, std::ratio<1l, 1000000l> > >::value, std::chrono::duration<long, std::ratio<1l, 1
0.01	246	1	factorial_iterative(int) (factorial)
0.01	61	2	std::chrono::duration<long, std::ratio<1l, 1000000l> >::count() const (factorial)
0.00	31	1	mcount (libc.so.6: mcount.S)