

軟體分析與最佳化 HW3

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Execution environments

- CPU information

```
ashen@Stephanie-Lin:~$ lscpu
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Address sizes:          39 bits physical, 48 bits virtual
Byte Order:             Little Endian
CPU(s):                 12
  On-line CPU(s) list:  0-11
Vendor ID:              GenuineIntel
Model name:             11th Gen Intel(R) Core(TM) i5-11500 @ 2.70GHz
CPU family:             6
Model:                  167
Thread(s) per core:     2
Core(s) per socket:     6
Socket(s):              1
Stepping:               1
CPU max MHz:            4600.0000
CPU min MHz:            800.0000
BogoMIPS:               5424.00
```

- Memory

```
ashen@Stephanie-Lin:~$ free -h
               total        used        free      shared  buff/cache   available
Mem:           31Gi        4.2Gi        12Gi        1.8Gi        14Gi        24Gi
Swap:          2.0Gi          0B         2.0Gi
```

- OS version

```
ashen@Stephanie-Lin:~$ lsb_release -a
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 22.04.2 LTS
Release:        22.04
Codename:       jammy
```

- GCC version

```
ashen@Stephanie-Lin:~$ gcc --version
gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0
Copyright (C) 2021 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

- ICC version

```
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW2$ icc --version
icc: remark #10441: The Intel(R) C++ Compiler Classic (ICC) is deprecated and will be removed from
product release in the second half of 2023. The Intel(R) oneAPI DPC++/C++ Compiler (ICX) is the rec
ommended compiler moving forward. Please transition to use this compiler. Use '-diag-disable=10441'
to disable this message.
icc (ICC) 2021.10.0 20230609
Copyright (C) 1985-2023 Intel Corporation. All rights reserved.
```

Compile nsieve.c

```
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW3$ gcc -DUNIX -g -O0 nsieve.c -o nsieve_O0_gcc
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW3$ gcc -DUNIX -g -O3 nsieve.c -o nsieve_O3_gcc
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW3$ icc -DUNIX -g -O0 nsieve.c -o nsieve_O0_icc
icc: remark #10441: The Intel(R) C++ Compiler Classic (ICC) is deprecated and will be removed from product release
half of 2023. The Intel(R) oneAPI DPC++/C++ Compiler (ICX) is the recommended compiler moving forward. Please
this compiler. Use '-diag-disable=10441' to disable this message.
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW3$ icc -DUNIX -g -Ofast nsieve.c -o nsieve_Ofast_icc
icc: remark #10441: The Intel(R) C++ Compiler Classic (ICC) is deprecated and will be removed from product release
half of 2023. The Intel(R) oneAPI DPC++/C++ Compiler (ICX) is the recommended compiler moving forward. Please
this compiler. Use '-diag-disable=10441' to disable this message.
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW3$ icx -DUNIX -g -O0 nsieve.c -o nsieve_O0_icx
nsieve.c:151:1: warning: return type of 'main' is not 'int' [-Wmain-return-type]
void main()
^
nsieve.c:151:1: note: change return type to 'int'
void main()
^
int
nsieve.c:282:5: warning: a function definition without a prototype is deprecated in all versions of C and is
x [-Wdeprecated-non-prototype]
int SIEVE(n,n,p)
^
nsieve.c:454:5: warning: a function definition without a prototype is deprecated in all versions of C and is
x [-Wdeprecated-non-prototype]
int dtm(p)
^
3 warnings generated.
ashen@Stephanie-Lin:~/Documents/Software_Analysis-git/HW3$ icx -DUNIX -g -Ofast nsieve.c -o nsieve_Ofast_icx
nsieve.c:151:1: warning: return type of 'main' is not 'int' [-Wmain-return-type]
```



nsieve.c



nsieve_O0_gcc



nsieve_O0_icc



nsieve_O0_icx



nsieve_O3_gcc



nsieve_Ofast_icc



nsieve_Ofast_icx

Vtune profiler

1. gcc -DUNIX -g -O0 nsieve.c

- CPU time: 1.760 s
- Instructions retired: 9,566,100,000
- CPI: 0.673

Elapsed Time: 1.787s

CPU Time	1.760s
Instructions Retired:	9,566,100,000
Microarchitecture Usage	41.8% of Pipeline Slots
Total Thread Count:	2
Paused Time	0s

Top Hotspots

This section lists the most active functions in your application. Optimizing these hotspot functions typically results in improving overall application performance.

Function	Module	CPU Time	% of CPU Time
SIEVE	nsieve_O0_gcc	1.727s	98.1%
native_sched_clock	vmlinux	0.003s	0.2%
native_irq_return_iret	vmlinux	0.003s	0.2%
__mod_memcg_lruvec_state	vmlinux	0.002s	0.1%
clear_page_erms	vmlinux	0.002s	0.1%
[Others]	N/A*	0.023s	1.3%

*N/A is applied to non-summable metrics.

2. gcc -DUNIX -g -O3 nsieve.c

- CPU time: 1.174 s
- Instructions retired: 5,983,200,000
- CPI: 0.770

Elapsed Time: 1.239s

- CPU Time: 1.174s
 - Instructions Retired: 5,983,200,000
- Microarchitecture Usage: 38.3% of Pipeline Slots
 - CPI Rate: 0.770
 - Total Thread Count: 2
 - Paused Time: 0s

Top Hotspots

This section lists the most active functions in your application. Optimizing these hotspot functions typically results in improving overall application performance.

Function	Module	CPU Time	% of CPU Time
SIEVE	nsieve_O3_gcc	1.142s	97.3%
__memset_evex_unaligned_erms	libc.so.6	0.007s	0.6%
sync_regs	vmlinux	0.003s	0.3%
__mod_lruvec_page_state	vmlinux	0.002s	0.2%
__handle_mm_fault	vmlinux	0.002s	0.2%
[Others]	N/A*	0.018s	1.5%

*N/A is applied to non-summable metrics.

3. icc -DUNIX -g -O0 nsieve.c

- CPU time: 2.307 s
- Instructions Retired: 18,098,100,000
- CPI Rate: 0.561

Elapsed Time: 2.363s

- CPU Time: 2.307s
 - Instructions Retired: 18,098,100,000
- Microarchitecture Usage: 46.7% of Pipeline Slots
 - CPI Rate: 0.561
 - Total Thread Count: 2
 - Paused Time: 0s

Top Hotspots

This section lists the most active functions in your application. Optimizing these hotspot functions typically results in improving overall application performance.

Function	Module	CPU Time	% of CPU Time
SIEVE	nsieve_O0_icc	2.270s	98.4%
native_irq_return_iret	vmlinux	0.005s	0.2%
native_write_msr	vmlinux	0.005s	0.2%
rmqueue_bulk	vmlinux	0.003s	0.1%
native_sched_clock	vmlinux	0.002s	0.1%
[Others]	N/A*	0.022s	0.9%

*N/A is applied to non-summable metrics.

4. icc -DUNIX -g -Ofast nsieve.c

- CPU Time: 1.221s
- Instructions Retired: 5,305,500,000
- CPI Rate: 1.117

Elapsed Time: 1.320s

- CPU Time: 1.221s
 - Instructions Retired: 5,305,500,000
- Microarchitecture Usage: 29.0% of Pipeline Slots
 - CPI Rate: 1.117
 - Total Thread Count: 2
 - Paused Time: 0s

Top Hotspots

This section lists the most active functions in your application. Optimizing these hotspot functions typically results in improving overall application performance.

Function	Module	CPU Time	% of CPU Time
SIEVE	nsieve_Ofast_icc	1.195s	97.9%
__intel_avx_rep_memset	nsieve_Ofast_icc	0.003s	0.2%
__rcu_read_unlock	vmlinux	0.003s	0.2%
exc_page_fault	vmlinux	0.002s	0.2%
sync_regs	vmlinux	0.001s	0.1%
[Others]	N/A*	0.017s	1.4%

*N/A is applied to non-summable metrics.

5. icx -DUNIX -g -O0 nsieve.c

- CPU Time: 2.009s
- Instructions Retired: 16,497,000,000
- CPI Rate: 0.601

Elapsed Time [Ⓢ]: 2.240s

CPU Time [Ⓢ] :	2.009s
Instructions Retired:	16,497,000,000
Microarchitecture Usage [Ⓢ] :	36.1% [Ⓢ] of Pipeline Slots
CPI Rate [Ⓢ] :	0.601
Total Thread Count:	2
Paused Time [Ⓢ] :	0s

Top Hotspots

This section lists the most active functions in your application. Optimizing these hotspot functions typically results in improving overall application performance.

Function	Module	CPU Time [Ⓢ]	% of CPU Time [Ⓢ]
SIEVE	nsieve_O0_icx	1.971s	98.1%
irqentry_nmi_enter	vmlinux	0.003s	0.1%
sync_regs	vmlinux	0.003s	0.1%
native_irq_return_iret	vmlinux	0.003s	0.1%
native_write_msr	vmlinux	0.003s	0.1%
[Others]	N/A*	0.026s	1.3%

*N/A is applied to non-summable metrics.

6. icx -DUNIX -g -Ofast nsieve.c

- CPU Time: 1.392s
- Instructions Retired: 10,276,200,000
- CPI Rate: 0.478

Elapsed Time [Ⓢ]: 1.477s

CPU Time [Ⓢ] :	1.392s
Instructions Retired:	10,276,200,000
Microarchitecture Usage [Ⓢ] :	64.3% [Ⓢ] of Pipeline Slots
CPI Rate [Ⓢ] :	0.478
Total Thread Count:	2
Paused Time [Ⓢ] :	0s

Top Hotspots

This section lists the most active functions in your application. Optimizing these hotspot functions typically results in improving overall application performance.

Function	Module	CPU Time [Ⓢ]	% of CPU Time [Ⓢ]
SIEVE	nsieve_Ofast_icx	1.357s	97.5%
__intel_avx_rep_memset	nsieve_Ofast_icx	0.009s	0.6%
charge_memcg	vmlinux	0.004s	0.3%
try_charge_memcg	vmlinux	0.002s	0.1%
_raw_spin_trylock	vmlinux	0.002s	0.1%
[Others]	N/A*	0.018s	1.3%

*N/A is applied to non-summable metrics.