Lab8

电脑硬件配置如下：


```
wyo@PC: ~                    ×   +   ∨
/home/wyo/.hushlogin file.
wyo@PC:~$ lscpu
Architecture:              x86_64
CPU op-mode(s):            32-bit, 64-bit
Byte Order:                Little Endian
Address sizes:             39 bits physical, 48 bits virtual
CPU(s):                    20
On-line CPU(s) list:       0-19
Thread(s) per core:        2
Core(s) per socket:        10
Socket(s):                 1
Vendor ID:                 GenuineIntel
CPU family:                6
Model:                     154
Model name:                12th Gen Intel(R) Core(TM) i7-12700H
Stepping:                  3
CPU MHz:                   2687.999
BogoMIPS:                  5375.99
Virtualization:            VT-x
Hypervisor vendor:         Microsoft
Virtualization type:       full
L1d cache:                 480 KiB
L1i cache:                 320 KiB
L2 cache:                  12.5 MiB
L3 cache:                  24 MiB
Vulnerability Itlb multihit:     Not affected
Vulnerability L1tf:              Not affected
Vulnerability Mds:               Not affected
Vulnerability Meltdown:          Not affected
Vulnerability Mmio stale data:   Not affected
```

CPU Specifications

Total Cores ?	14
# of Performance-cores	6
# of Efficient-cores	8
Total Threads ?	20
Max Turbo Frequency ?	4.70 GHz
Intel® Turbo Boost Max Technology 3.0 Frequency ‡ ?	4.70 GHz
Performance-core Max Turbo Frequency ?	4.70 GHz
Efficient-core Max Turbo Frequency ?	3.50 GHz
Cache ?	24 MB Intel® Smart Cache
Processor Base Power ?	45 W
Maximum Turbo Power ?	115 W
Minimum Assured Power	35 W

Advanced Technologies

Intel® Gaussian & Neural Accelerator ?	3.0
Intel® Thread Director ?	Yes
Intel® Image Processing Unit ?	6.0
Intel® Smart Sound Technology ?	Yes
Intel® Wake on Voice ?	Yes
Intel® High Definition Audio ?	Yes
MIPI SoundWire* ?	1.2
Intel® Deep Learning Boost (Intel® DL Boost) ?	Yes
Intel® Adaptix™ Technology ?	Yes
Intel® Speed Shift Technology ?	Yes
Intel® Turbo Boost Max Technology 3.0 ‡ ?	Yes
Intel® Hyper-Threading Technology ‡ ?	Yes
Instruction Set ?	64-bit
Instruction Set Extensions ?	Intel® SSE4.1, Intel® SSE4.2, Intel® AVX2
Thermal Monitoring Technologies ?	Yes
Intel® Flex Memory Access ?	Yes
Intel® Volume Management Device (VMD) ?	Yes

不同指令集每核心每时钟周期的单精度、双精度浮点运算次数说明			
	instruction set（指令集）	每时钟周期的单精度运算次数	每时钟周期的双精度运算次数
Nehalem	SSE（128-bits）	8	4
Sandy Bridge	AVX（256-bits）	16	8
Haswell	AVX2（256-bits）	32	16
Pueley	AVX512（512-bits）	64	32（FMA=2） 16（FMA=1）@DinqYi

根据以上表可知，电脑核数为 14，6 个 Performance-cores，8 个 Efficient-cores，其中 Performance-cores 单核主频为 4.70GHz，Efficient-cores 单核主频为 3.50GHz，指令集为 AVX2，对应每时钟周期的双精度运算次数为 16
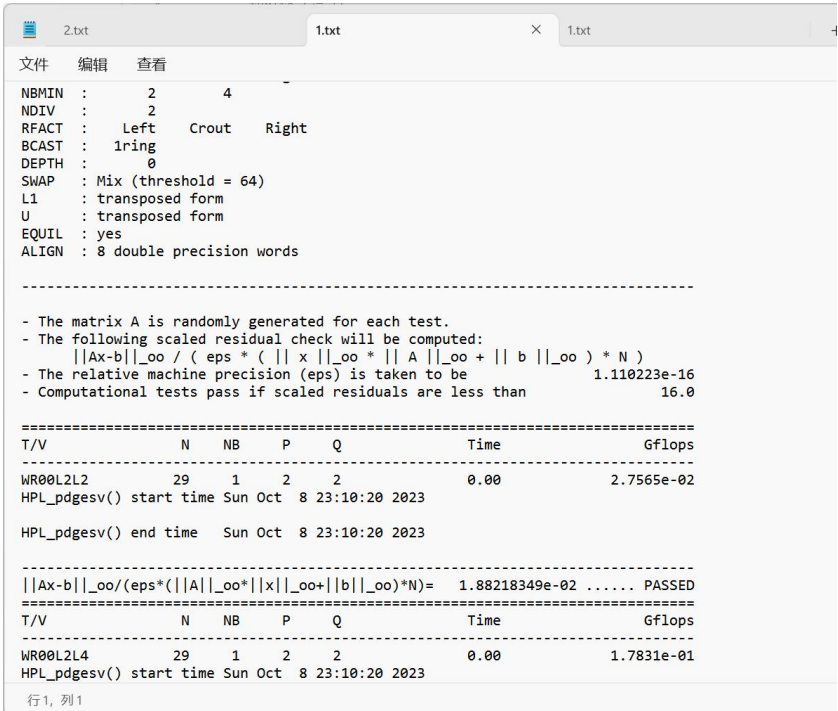
CPU 理论峰值=（6*4.70+8*3.50）*16=899.2GFLOPS

软件依赖：

gcc version 9.4.0

Open MPI: 4.0.3

安装好 hpl 环境后，用默认值测试得到下表


```
📋   2.txt                          1.txt              ×    1.txt                    +

文件   编辑   查看
        NBMIN   :       2       4
        NDIV    :       2
        RFACT   :     Left     Crout    Right
        BCAST   :     1ring
        DEPTH   :       0
        SWAP    : Mix (threshold = 64)
        L1      : transposed form
        U       : transposed form
        EQUIL   : yes
        ALIGN   : 8 double precision words

        ----------------------------------------------------------------

        - The matrix A is randomly generated for each test.
        - The following scaled residual check will be computed:
            ||Ax-b||_oo / ( eps * ( || x ||_oo * || A ||_oo + || b ||_oo ) * N )
        - The relative machine precision (eps) is taken to be          1.110223e-16
        - Computational tests pass if scaled residuals are less than           16.0

        ================================================================
        T/V              N    NB     P     Q          Time          Gflops
        ----------------------------------------------------------------
        WR00L2L2        29    1      2     2          0.00          2.7565e-02
        HPL_pdgesv() start time Sun Oct  8 23:10:20 2023

        HPL_pdgesv() end time   Sun Oct  8 23:10:20 2023

        ----------------------------------------------------------------
        ||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)=   1.88218349e-02 ...... PASSED
        ================================================================
        T/V              N    NB     P     Q          Time          Gflops
        ----------------------------------------------------------------
        WR00L2L4        29    1      2     2          0.00          1.7831e-01
        HPL_pdgesv() start time Sun Oct  8 23:10:20 2023

行1，列1
```

可以看到结果不甚理想。于是在自动调参网站输入以下数据，调整了 HPL.dat

Tuning HPL can be a long and difficult process. Once you've found the pe
architecture, now you need to create a perfect HPL.dat file. Use the form
output file as a starting point on getting the best GFLOP number you can

Input

Nodes:

1

Cores per Node:

10

Memory per Node (MB):

7065.6

Block Size (NB):

192

Go!

经过调整后，数据如下表


```
L1      : transposed form
U       : transposed form
EQUIL   : yes
ALIGN   : 8 double precision words

--------------------------------------------------------------------------------

- The matrix A is randomly generated for each test.
- The following scaled residual check will be computed:
      ||Ax-b||_oo / ( eps * ( || x ||_oo * || A ||_oo + || b ||_oo ) * N )
- The relative machine precision (eps) is taken to be            1.110223e-16
- Computational tests pass if scaled residuals are less than           16.0

================================================================================
T/V               N    NB     P     Q             Time           Gflops
--------------------------------------------------------------------------------
WR11C2R4      28416   192     2     5           441.66          3.4638e+01
HPL_pdgesv() start time Mon Oct  9 22:06:10 2023

HPL_pdgesv() end time   Mon Oct  9 22:13:32 2023

--------------------------------------------------------------------------------
||Ax-b||_oo/(eps*(||A||_oo*||x||_oo+||b||_oo)*N)=   9.84141128e-04 ...... PASSED
================================================================================

Finished      1 tests with the following results:
              1 tests completed and passed residual checks,
              0 tests completed and failed residual checks,
              0 tests skipped because of illegal input values.
--------------------------------------------------------------------------------

End of Tests.
================================================================================
```

推测离理论峰值仍有距离的原因一是 wsl 系统内存小于本身系统内存，二是 14 个核工作能力不一样，难以测出理想的结果