

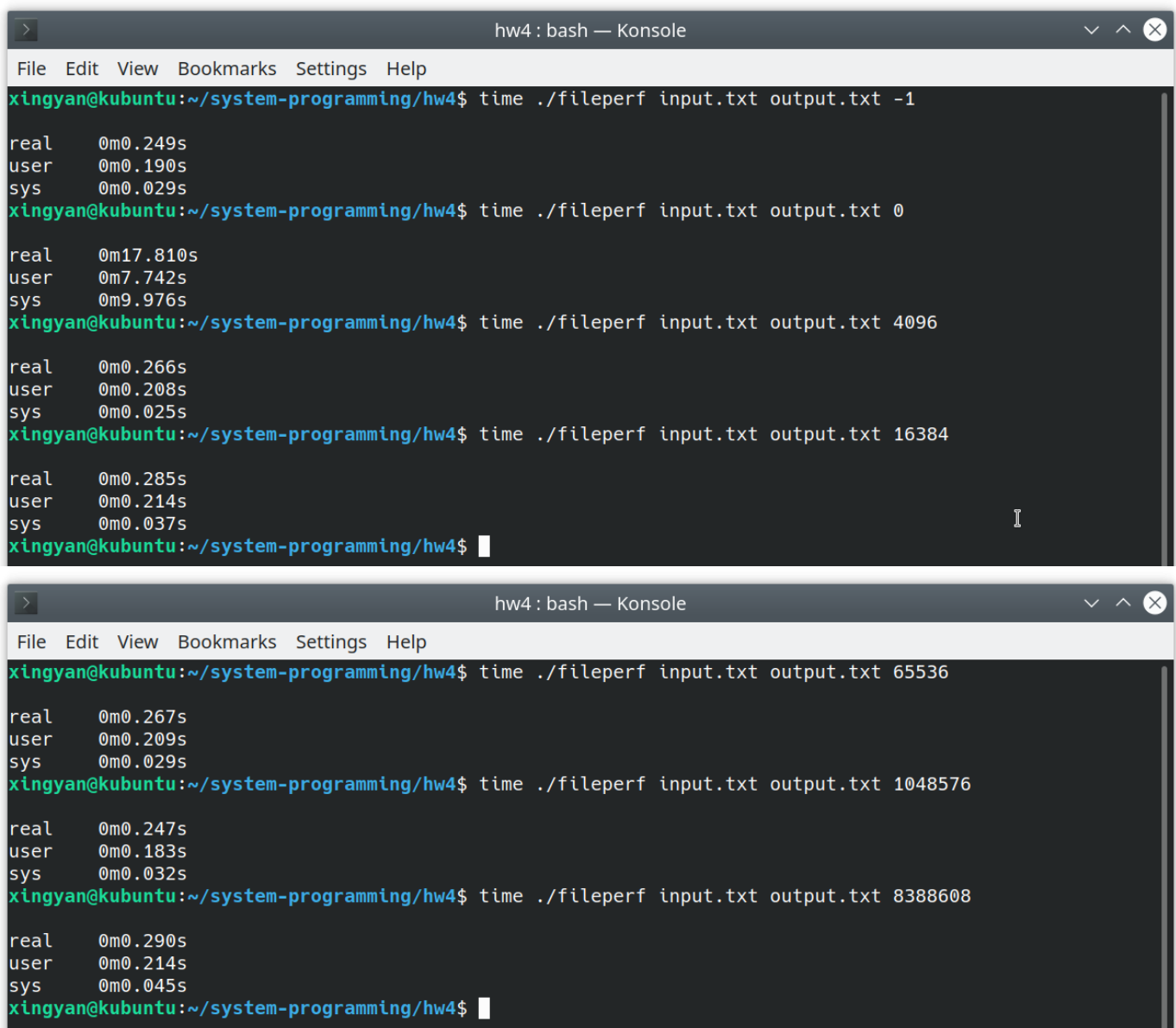
System Programming Homework #4

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0. 按照題目要求撰寫程式 fileperf.c，詳細內容寫在註解。

測試：

1. 使用 setvbuf 設定輸入輸出檔案的 buffer 大小，並使用 time 分別測試 0 -1 4KB 16KB 64KB 1MB 8M 緩存所使用的時間。



The image shows two screenshots of a terminal window titled 'hw4: bash — Konsole'. The terminal displays the execution of the fileperf program with various buffer sizes. The first screenshot shows results for buffer sizes -1, 0, 4096, and 16384. The second screenshot shows results for buffer sizes 65536, 1048576, and 8388608. Each execution shows three timing metrics: real, user, and sys time.

```
hw4: bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt -1
real    0m0.249s
user    0m0.190s
sys     0m0.029s
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt 0
real    0m17.810s
user    0m7.742s
sys     0m9.976s
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt 4096
real    0m0.266s
user    0m0.208s
sys     0m0.025s
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt 16384
real    0m0.285s
user    0m0.214s
sys     0m0.037s
xingyan@kubuntu:~/system-programming/hw4$

hw4: bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt 65536
real    0m0.267s
user    0m0.209s
sys     0m0.029s
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt 1048576
real    0m0.247s
user    0m0.183s
sys     0m0.032s
xingyan@kubuntu:~/system-programming/hw4$ time ./fileperf input.txt output.txt 8388608
real    0m0.290s
user    0m0.214s
sys     0m0.045s
xingyan@kubuntu:~/system-programming/hw4$
```

上圖結果顯示出當使用 linebuffer 時速度最快，並且沒有 buffer 時速度明顯下降很多，也可觀察到當 buffer 大小到達一定的大小後繼續增加 buffer 不見得能夠提升效，甚至可因下降。

2. 使用 ltrace 來觀察程式呼叫 function 的情況。

```
hw4: bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt -1
% time      seconds  usecs/call   calls      function
-----
26.30      0.000187    187          1          fopen
20.39      0.000145    145          1          setvbuf
12.94      0.000092    92           1          atoi
12.52      0.000089    89           1          getc
11.11      0.000079    79           1          malloc
8.58       0.000061    61           1          fputs
8.16       0.000058    58           1          putc
-----
100.00     0.000711    7 total
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt 0
% time      seconds  usecs/call   calls      function
-----
25.26      0.001304    1304         1          fopen
18.95      0.000978    978          1          putc
18.36      0.000948    948          1          malloc
11.76      0.000607    607          1          fputs
10.23      0.000528    528          1          atoi
10.05      0.000519    519          1          getc
5.39       0.000278    278          1          setvbuf
-----
100.00     0.005162    7 total
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt 4096
% time      seconds  usecs/call   calls      function
-----
28.57      0.000180    180          1          fopen
16.83      0.000106    106          1          atoi
13.17      0.000083    83           1          getc
13.02      0.000082    82           1          malloc
9.52       0.000060    60           1          setvbuf
9.52       0.000060    60           1          putc
9.37       0.000059    59           1          fputs
-----
100.00     0.000630    7 total
xingyan@kubuntu:~/system-programming/hw4$

hw4: bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt 16384
% time      seconds  usecs/call   calls      function
-----
48.02      0.000449    449          1          fopen
11.12      0.000104    104          1          getc
9.63       0.000090    90           1          atoi
8.66       0.000081    81           1          fputs
7.91       0.000074    74           1          putc
7.70       0.000072    72           1          malloc
6.95       0.000065    65           1          setvbuf
-----
100.00     0.000935    7 total
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt 65536
% time      seconds  usecs/call   calls      function
-----
23.75      0.001245    1245         1          setvbuf
22.91      0.001201    1201         1          fopen
14.38      0.000754    754          1          getc
12.09      0.000634    634          1          malloc
11.54      0.000605    605          1          putc
8.78       0.000460    460          1          atoi
6.54       0.000343    343          1          fputs
-----
100.00     0.005242    7 total
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt 1048576
% time      seconds  usecs/call   calls      function
-----
43.48      0.000637    637          1          getc
14.54      0.000213    213          1          malloc
13.11      0.000192    192          1          fopen
10.03      0.000147    147          1          putc
6.89       0.000101    101          1          atoi
6.69       0.000098    98           1          fputs
5.26       0.000077    77           1          setvbuf
-----
100.00     0.001465    7 total
xingyan@kubuntu:~/system-programming/hw4$

hw4: bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ ltrace -c ./fileperf input.txt output.txt 8388608
% time      seconds  usecs/call   calls      function
-----
72.95      0.005968    5968         1          getc
15.30      0.001252    1252         1          fopen
4.06       0.000332    332          1          atoi
3.98       0.000326    326          1          malloc
1.45       0.000119    119          1          setvbuf
1.34       0.000110    110          1          fputs
0.90       0.000074    74           1          putc
-----
100.00     0.008181    7 total
xingyan@kubuntu:~/system-programming/hw4$
```

3. 使用 strace 觀察程式呼叫 system call 的情況。

```
hw4 : bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ strace -c ./fileperf input.txt output.txt -1
% time      seconds  usecs/call   calls   errors syscall
-----
70.71      0.012467      3       3390         write
29.29      0.005164      1       3347         read
0.00      0.000000      0         2         close
0.00      0.000000      0         4         fstat
0.00      0.000000      0         7         mmap
0.00      0.000000      0         4         mprotect
0.00      0.000000      0         1         munmap
0.00      0.000000      0         3         brk
0.00      0.000000      0         6         pread64
0.00      0.000000      0         1         1 access
0.00      0.000000      0         1         execve
0.00      0.000000      0         2         1 arch_prctl
0.00      0.000000      0         4         openat
-----
100.00      0.017631             6772         2 total
xingyan@kubuntu:~/system-programming/hw4$ strace -c ./fileperf input.txt output.txt 0
% time      seconds  usecs/call   calls   errors syscall
-----
70.84      48.076467      3 13699328         read
29.14      19.775749      7 2629854         write
0.02      0.011947     2986         4         openat
0.00      0.000000      0         2         close
0.00      0.000000      0         2         fstat
0.00      0.000000      0         7         mmap
0.00      0.000000      0         4         mprotect
0.00      0.000000      0         1         munmap
0.00      0.000000      0         3         brk
0.00      0.000000      0         6         pread64
0.00      0.000000      0         1         1 access
0.00      0.000000      0         1         execve
0.00      0.000000      0         2         1 arch_prctl
-----
100.00      67.864163     16329215         2 total
xingyan@kubuntu:~/system-programming/hw4$
```

```
hw4 : bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ strace -c ./fileperf input.txt output.txt 4096
% time      seconds  usecs/call   calls   errors syscall
-----
41.46      0.013873      4       3390         write
34.86      0.011664     2916         4         openat
17.60      0.005890      1       3347         read
2.90      0.000970     970         1         execve
1.01      0.000339     48         7         mmap
0.75      0.000251     62         4         mprotect
0.48      0.000160     26         6         pread64
0.25      0.000085     85         1         munmap
0.22      0.000072     24         3         brk
0.13      0.000044     22         2         fstat
0.13      0.000043     21         2         close
0.11      0.000037     37         1         1 access
0.11      0.000036     18         2         1 arch_prctl
-----
100.00      0.033464             6770         2 total
xingyan@kubuntu:~/system-programming/hw4$ strace -c ./fileperf input.txt output.txt 16384
% time      seconds  usecs/call   calls   errors syscall
-----
53.01      0.004815      5       848         write
24.25      0.002203     550         4         openat
18.75      0.001703      2       839         read
2.00      0.000182     182         1         execve
0.57      0.000052      7         7         mmap
0.36      0.000033      8         4         mprotect
0.31      0.000028      4         6         pread64
0.20      0.000018     18         1         munmap
0.15      0.000014      4         3         brk
0.11      0.000010      5         2         fstat
0.10      0.000009      4         2         close
0.10      0.000009      4         2         1 arch_prctl
0.08      0.000007      7         1         1 access
-----
100.00      0.009083             1720         2 total
xingyan@kubuntu:~/system-programming/hw4$
```

```
hw4 : bash — Konsole
File Edit View Bookmarks Settings Help
xingyan@kubuntu:~/system-programming/hw4$ strace -c ./fileperf input.txt output.txt 1048576
% time      seconds   usecs/call   calls   errors syscall
-----
55.80 0.010867    2716        4         0 openat
22.51 0.004384     274       16         0 read
16.65 0.003242     231      14         0 write
1.90 0.000370      41        9         0 mmap
0.88 0.000172      43        4         0 mprotect
0.86 0.000167      27        6         0 pread64
0.41 0.000080       80        1         0 munmap
0.25 0.000048      24        2         0 fstat
0.24 0.000046      15        3         0 brk
0.22 0.000043      21        2         0 close
0.18 0.000036       36        1         0 access
0.10 0.000019        9        2         0 arch_prctl
0.00 0.000000        0        1         0 execve
-----
100.00 0.019474        65        2 total
xingyan@kubuntu:~/system-programming/hw4$ strace -c ./fileperf input.txt output.txt 8388608
% time      seconds   usecs/call   calls   errors syscall
-----
54.54 0.020577    5144        4         0 read
24.46 0.009230    2307        4         0 openat
20.79 0.007843    3921        2         0 write
0.21 0.000078        8        9         0 mmap
0.00 0.000000        0        2         0 close
0.00 0.000000        0        2         0 fstat
0.00 0.000000        0        4         0 mprotect
0.00 0.000000        0        1         0 munmap
0.00 0.000000        0        3         0 brk
0.00 0.000000        0        6         0 pread64
0.00 0.000000        0        1         0 access
0.00 0.000000        0        1         0 execve
0.00 0.000000        0        2         0 arch_prctl
-----
100.00 0.037728       41        2 total
xingyan@kubuntu:~/system-programming/hw4$
```

可以觀察到 buffer 越大，一次讀取和輸出的量越大，因此呼叫的 read write 次數越少。