ECSE 4320/6320 Project A1: Advanced OS and CPU Feature Exploratio

Generated: 2025-12-13 18:21:30

Environment summary (auto-collected; edit README for full details):

uname:
Linux LAPTOP-MKR8JNGQ 6.6.87.2-microsoft-standard-WSL2 #1 SMP PREEMPT_DYNAMIC Thu Jun 5 18:30:46 UTC 2025 x86_64 x86_64 x86_64 GNU/Linux

lscpu (top):
Architecture: x86_64
CPU op-mode(s):   32-bit, 64-bit
Address sizes: 48 bits physical, 48 bits virtual
Byte Order: Little Endian
CPU(s):   16
On-line CPU(s) list: 0-15
Vendor ID: AuthenticAMD
Model name: AMD Ryzen 7 PRO 5850U with Radeon Graphics
CPU family: 25
Model: 80
Thread(s) per core: 2
Core(s) per socket: 8
Socket(s):   1
Stepping: 0
BogoMIPS: 3792.77
Flags: fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush mmx fxsr sse sse2 ht syscall nx mmxext fxsr_opt pdpe1gb rdtscp lm constant_tsc rep_good nopl tsc_reliable nonstop_tsc cpuid extd_apicid tsc_known_freq pni pclmulqdq ssse3 fma cx16 sse4_1 sse4_2 movbe popcnt aes xsave avx f16c rdrand hypervisor lahf_lm cmp_legacy svm cr8_legacy abm sse4a misalignsse 3dnowprefetch osvw topoext perfctr_core ssbd ibrs ibpb stibp vmmcall fsgsbase bmi1 avx2 smep bmi2 erms invpcid rdseed adx smap clflushopt clwb sha_ni xsaveopt xsavec xgetbv1 xsaves clzero xsaveerptr arat npt nrip_save tsc_scale vmcb_clean flushbyasid decodeassists pausefilter pfthreshold v_vmsave_vmload umip vaes vpclmulqdq rdpid fsrm
Virtualization: AMD-V
Hypervisor vendor: Microsoft
Virtualization type: full
L1d cache: 256 KiB (8 instances)
L1i cache: 256 KiB (8 instances)
L2 cache: 4 MiB (8 instances)
L3 cache: 16 MiB (1 instance)
NUMA node(s):   1
NUMA node0 CPU(s):   0-15

WSL indicator:
Linux version 6.6.87.2-microsoft-standard-WSL2 (root@439a258ad544) (gcc (GCC) 11.2.0, GNU ld (GNU Binutils) 2.37) #1 SMP PREEMPT_DYNAMIC Thu Jun 5 18:30:46 UTC 2025

perf:
perf version 5.15.189

compiler:
g++ (Ubuntu 11.3.0-1ubuntu1~22.04) 11.3.0

Methodology

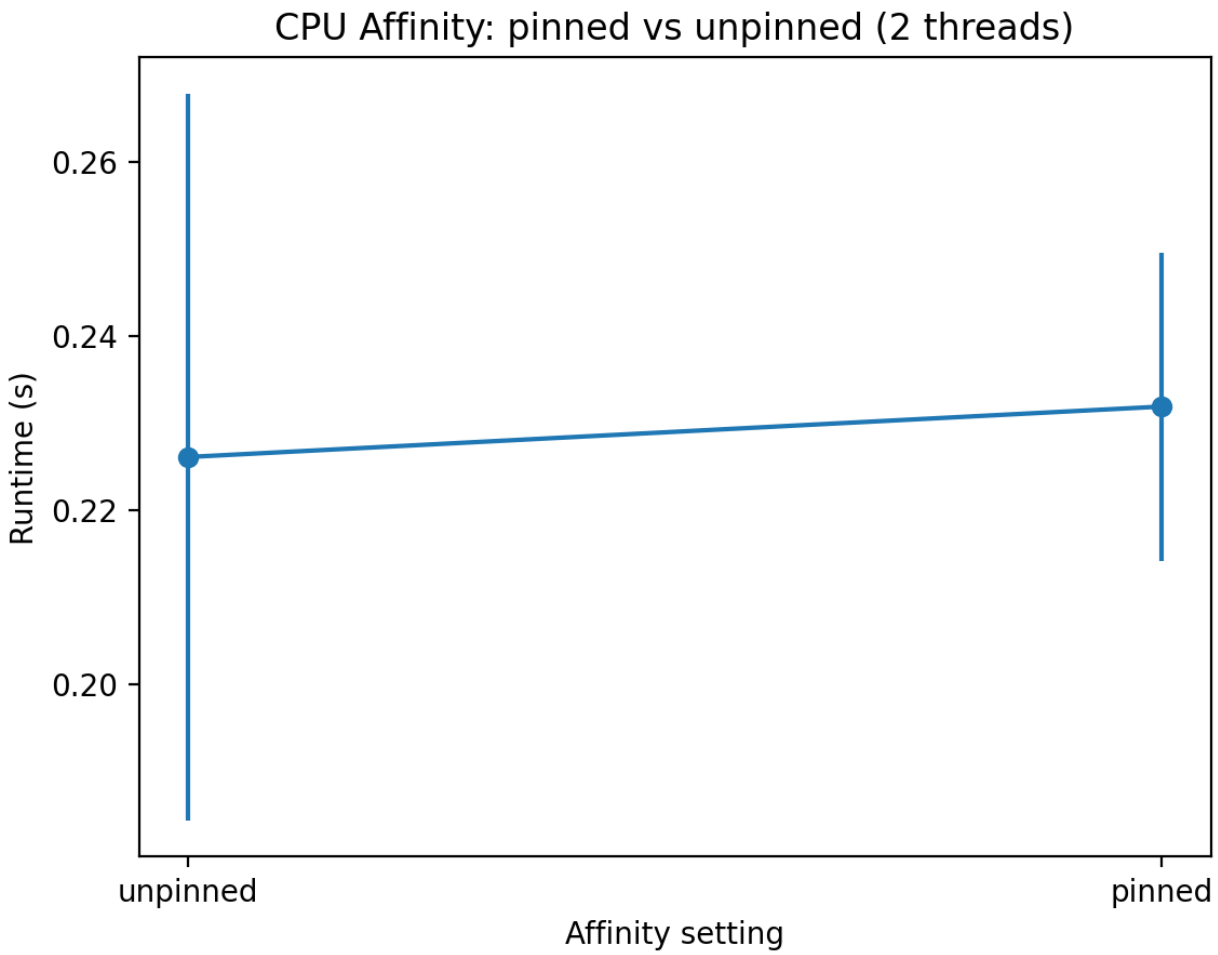
We implemented microbenchmarks targeting four OS/CPU features and executed each configuration multiple times to reduce noise. We report mean and standard deviation for runtime or throughput.

WSL Notes: Under WSL2, some perf hardware events (e.g., LLC-load-misses) may be unavailable. This report records cycles when supported and documents unsupported events as NA. Where CPU affinity is not honored, the benchmark prints a warning.

Raw results CSV (preview)

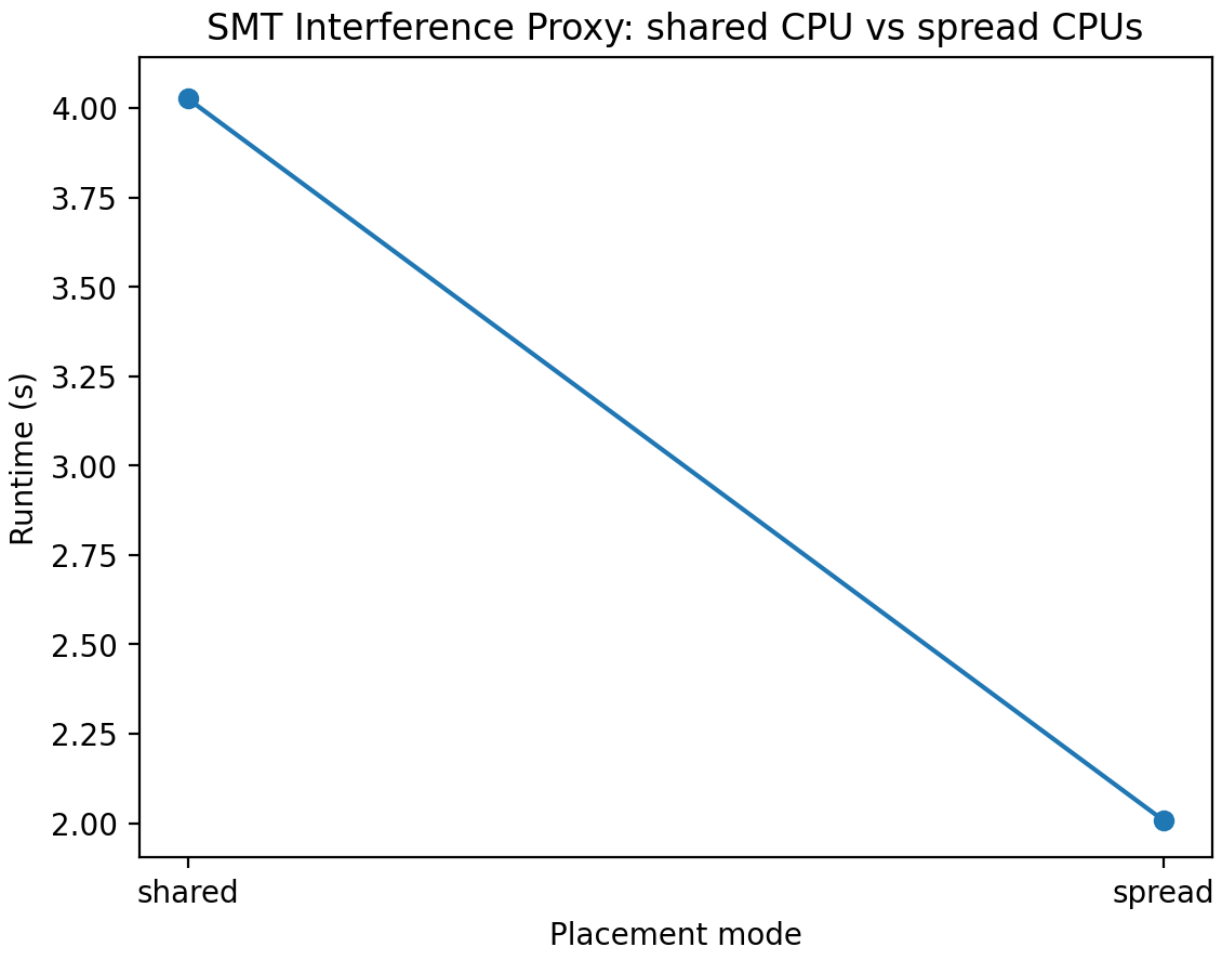
```
experiment,pinned,feature,threads,iters,seconds,seconds_mean,seconds_sd,cyc
les_mean,cycles_sd,perf_elapsed_mean,perf_elapsed_sd,stderr_note,mode,cpuA,
cpuB,stride_elems,thp,mb,reps,touches,touches_per_s,touches_per_s_mean,touc
hes_per_s_sd,pattern,accesses,accesses_per_s,accesses_per_s_mean,accesses_p
er_s_sd
affinity,0,affinity,2,300000000,0.219692,0.226083,0.04171820787937404,79561
7583.3333334,134113120.43002166,0.251212211,0.04510576209207509,,,,,,,,,,
,,,,,
affinity,1,affinity,2,300000000,0.206916,0.23187933333333333,0.017691949361
84881,729881222.3333334,50844147.79332891,0.21733765866666666,0.01344217659
4777328,,,,,,,,,,,,,,,,
smt_proxy,,smt_proxy,,300000000,4.04518,4.025856666666667,0.013886555448426
482,7219173344,1937010.6145770084,4.0623194536666665,0.008389097883968088,,
shared,0,0,,,,,,,,,,,
smt_proxy,,smt_proxy,,300000000,2.00855,2.00829,0.003116279833390986 4,72219
08090.333333,492108.78252159746,2.030112423,0.003235871084459365 7,,spread,0
,1,,,,,,,,,,,
mmu,,mmu,,,0.142824,0.0978446,0.03180771308011104,278352855,50676661.487551
45,0.6651229576666666,0.05137377022517585,,,,,16,always [madvise]
never,256,5,20971520,1.46835e+08,234488333.33333334,61997592.20235,,,,,
mmu,,mmu,,,0.0347797,0.034742866666666664,3.65179712227042e-
05,122265044,1437942.6109531168,0.47180362233333334,0.000724873784995392,,,
,,64,always [madvise]
never,256,5,5242880,1.50746e+08,150905666.66666666,158644.95649790516,,,,,
mmu,,mmu,,,0.0120696,0.011512533333333333,0.0006387237761522758,79203880,73
5171.4424654066,0.45033041933333334,0.0016774578244717689,,,,,256,always
[madvise]
never,256,5,1310720,1.08597e+08,114216333.33333333,6574440.677519436,,,,,
mmu,,mmu,,,0.00571354,0.005451566666666667,0.00018602597476935525,69052291.
66666667,1350858.2677765356,0.44732810266666667,0.005537256335922888,,,,,10
24,always [madvise]
never,256,5,327680,5.73515e+07,60175966.666666664,2006925.9832445795,,,,,
prefetch,,prefetch,,,0.0313368,0.03649333333333333,0.006038789965621332,915
08969.33333333,430257.3982322158,0.2676397973333333,0.003420149682920346,,,
,,,,128,1,,,,,seq,33554432,1.07077e+09,942792666.6666666,141109885.36440513
prefetch,,prefetch,,,1.01323,1.007897,0.012588355915951362,1906467886.33333
33,41749336.927421995,1.2758867446666666,0.030251430299491497,,,,,,,128,1,,
,,,rand,33554432,3.31164e+07,33296800.0,418838.1389829091
```

Results: CPU Affinity



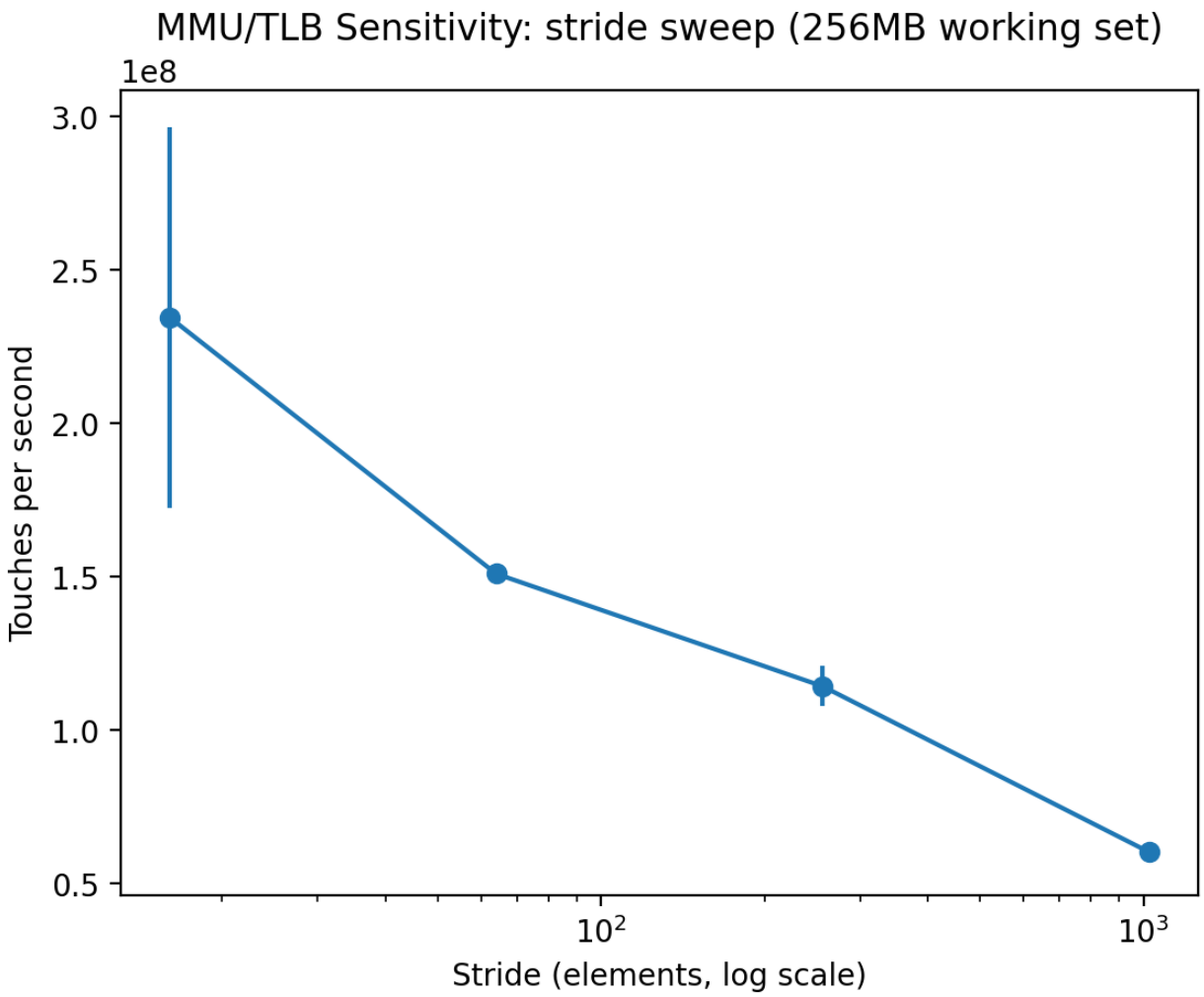
Caption guidance: state the independent variable(s), dependent metric, and the key effect. Tie the trend to OS/CPU mechanisms (contention, scheduling, TLB pressure, prefetch efficiency).

Results: SMT Interference Proxy



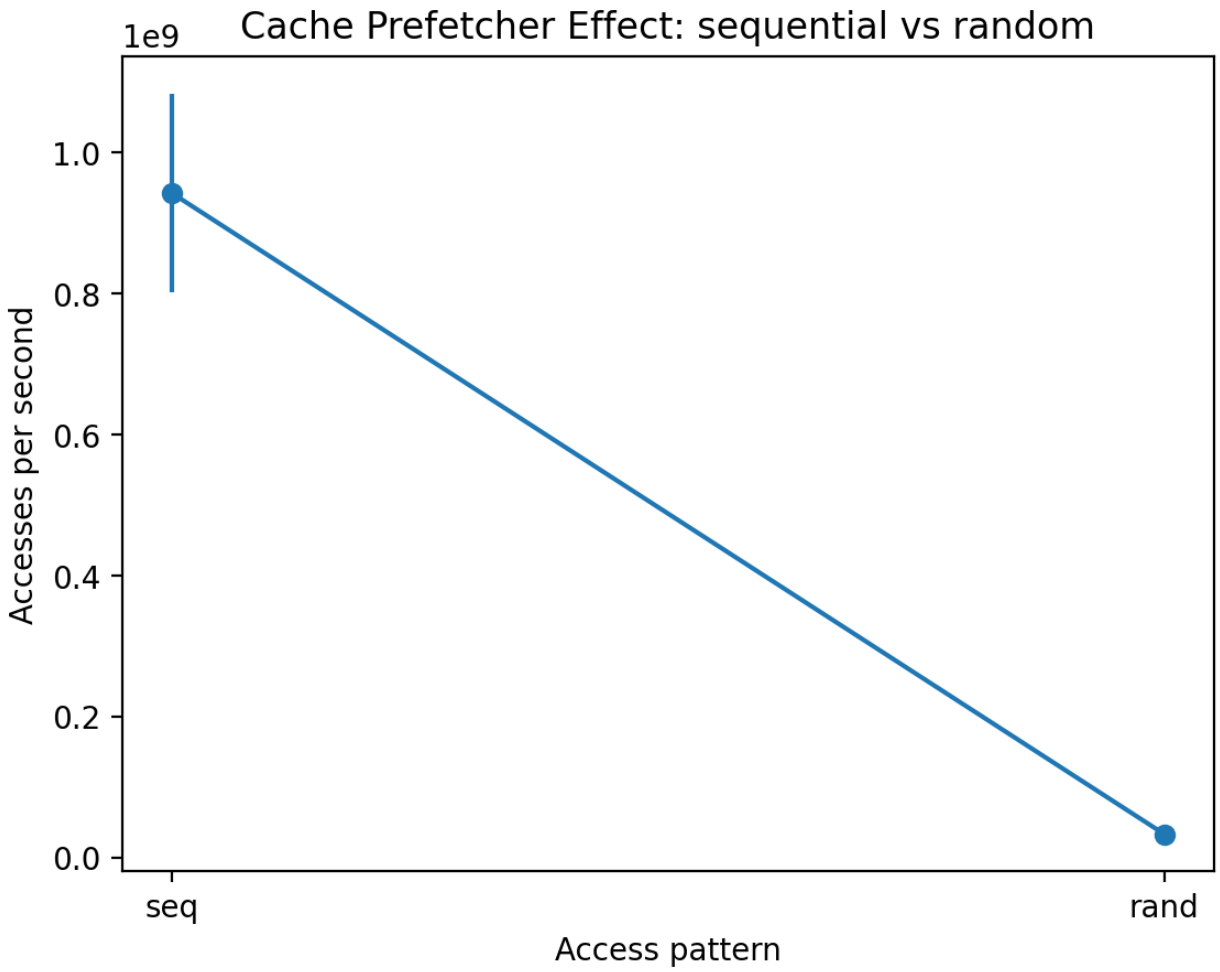
Caption guidance: state the independent variable(s), dependent metric, and the key effect. Tie the trend to OS/CPU mechanisms (contention, scheduling, TLB pressure, prefetch efficiency).

Results: MMU / Stride Sensitivity



Caption guidance: state the independent variable(s), dependent metric, and the key effect. Tie the trend to OS/CPU mechanisms (contention, scheduling, TLB pressure, prefetch efficiency).

Results: Prefetcher Effect



Caption guidance: state the independent variable(s), dependent metric, and the key effect. Tie the trend to OS/CPU mechanisms (contention, scheduling, TLB pressure, prefetch efficiency).