Parametric NAFEMS LE10 benchmark with tet elements

Comparison of resource consumption for different FEA programs

Contents

1 Architecture

Date	Thu Sep 28 14:03:11 UTC 2023
Host	Linux ip-172-31-44-208 6.2.0-1012-aws #12~22.04.1-Ubuntu SMP Thu Sep 7 14:01:24 UTC 2023 x86_64 x86_64 x86_64 GNU/Linux
CPU	Intel(R) Xeon(R) Platinum 8259CL CPU @ 2.50GHz
Number	2
Memory	16066232 kB

Figure 1: Architecture from `lstopo`

2 Codes & versions

2.1 aster

```
<INFO> Version exploitation 14.6.0 - 11/06/2020 - rev. b3490fa3b76c
```

2.2 calculix

```


This is Version 2.21
```

2.3 feenox

```
FeenoX v0.3.220-geb7bd44
a cloud-first free no-fee no-X uniX-like finite-element(ish) computational engineering tool

Last commit date   : Thu Sep 28 08:11:45 2023 -0300
Build date         : Thu Sep 28 13:47:20 2023 +0000
Build architecture : linux-gnu x86_64
Compiler version   : gcc (Ubuntu 11.4.0-1ubuntu1~22.04) 11.4.0
Compiler expansion : gcc -Wl,-Bsymbolic-functions -flto=auto -ffat-lto-objects -flto=auto -Wl,-z,relro -I/ ↩
     usr/include/x86_64-linux-gnu/mpich -L/usr/lib/x86_64-linux-gnu -lmpich
Compiler flags     : -O3 -flto=auto -no-pie
Builder            : ubuntu@ip-172-31-44-208
GSL version        : 2.7.1
SUNDIALS version   : N/A
PETSc version      : Petsc Release Version 3.19.5, Aug 30, 2023
PETSc arch         : double-int32-release
PETSc options      : --download-eigen --download-hdf5 --download-hypre --download-metis --download-mumps -- ↩
     download-parmetis --download-scalapack --download-slepc --with-64-bit-indices=no --with-debugging=no -- ↩
     with-precision=double --with-scalar-type=real COPTFLAGS=-O3 CXXOPTFLAGS=-O3 FOPTFLAGS=-O3
SLEPc version      : SLEPc Release Version 3.19.1, unknown
```

2.4 reflex

```
Reflex Version: v1.12.3-1024-ga9e74e0ed
```

2.5 sparselizard

```
v.2022.05-53-g37a9d2b1
```

3 Reference solution

```
$ time feenox le10-ref.fee
sigma_y(D) = -5.3773 MPA (616323 degrees of freedom)
127.19user 3.46system 2:10.86elapsed 99%CPU (0avgtext+0avgdata 3485056maxresident)k
0inputs+0outputs (0major+1815753minor)pagefaults 0swaps
$
```

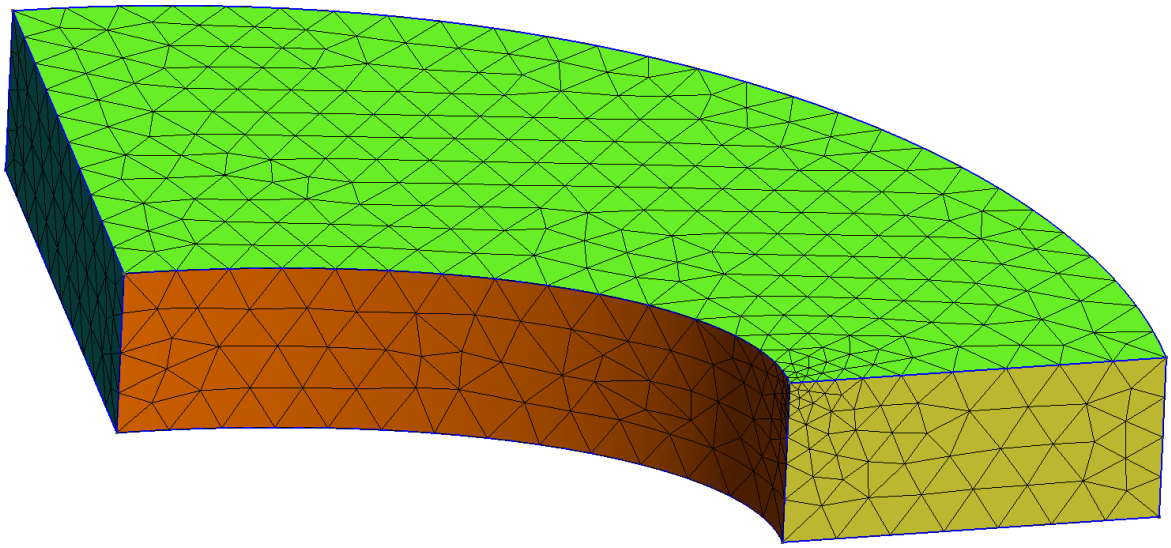
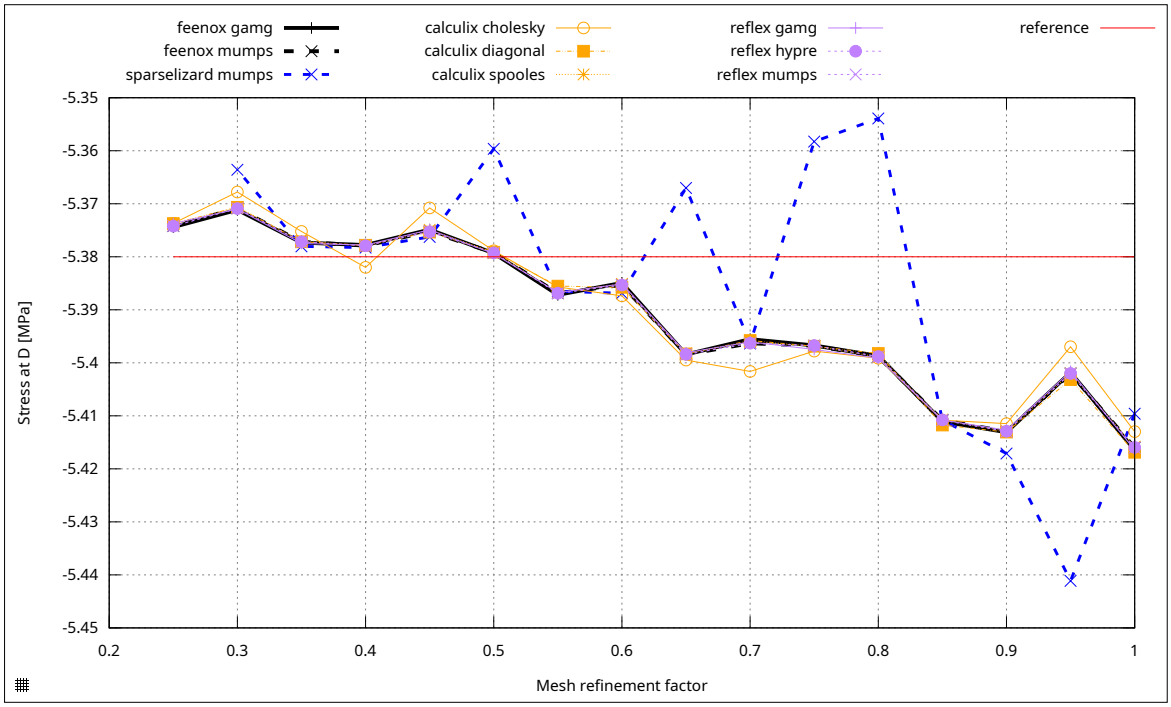
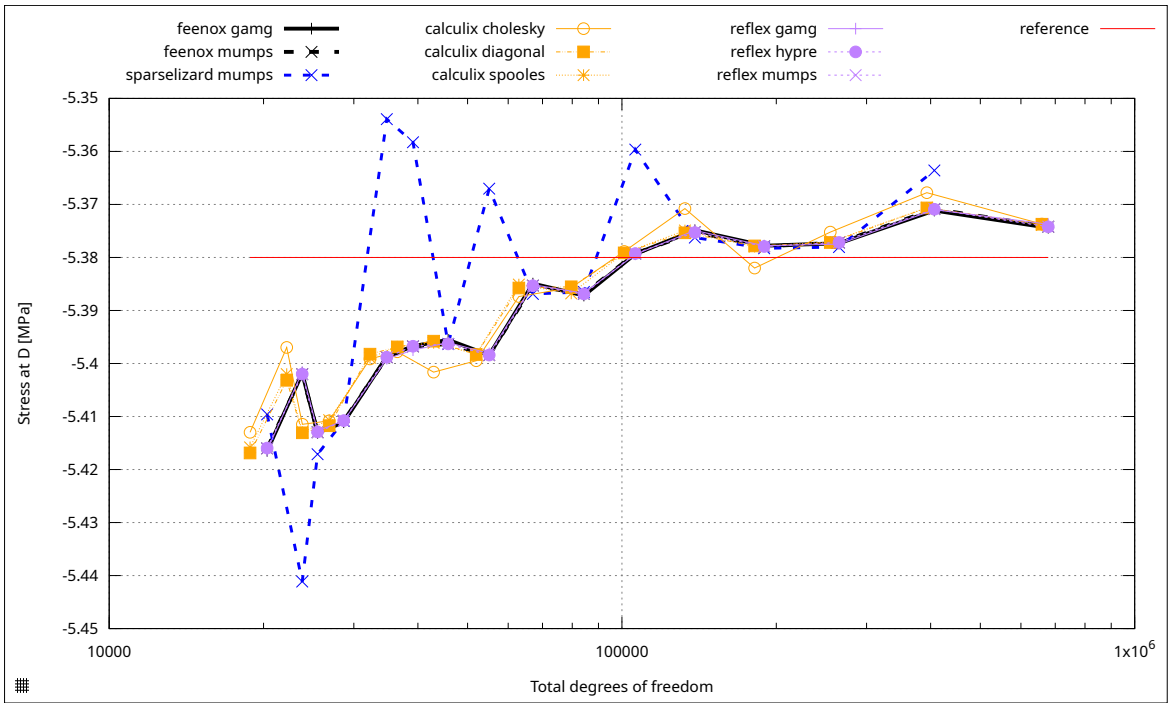


Figure 2: Coarser tet mesh for $c = 1$

4 Figures

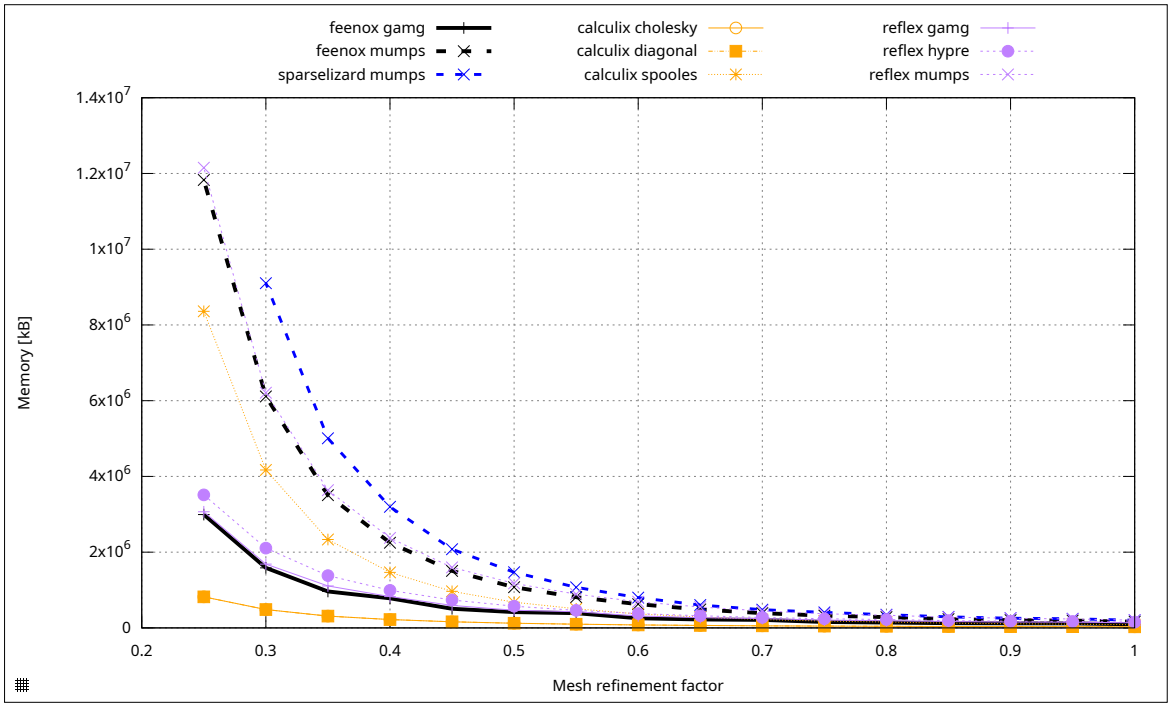


(a)

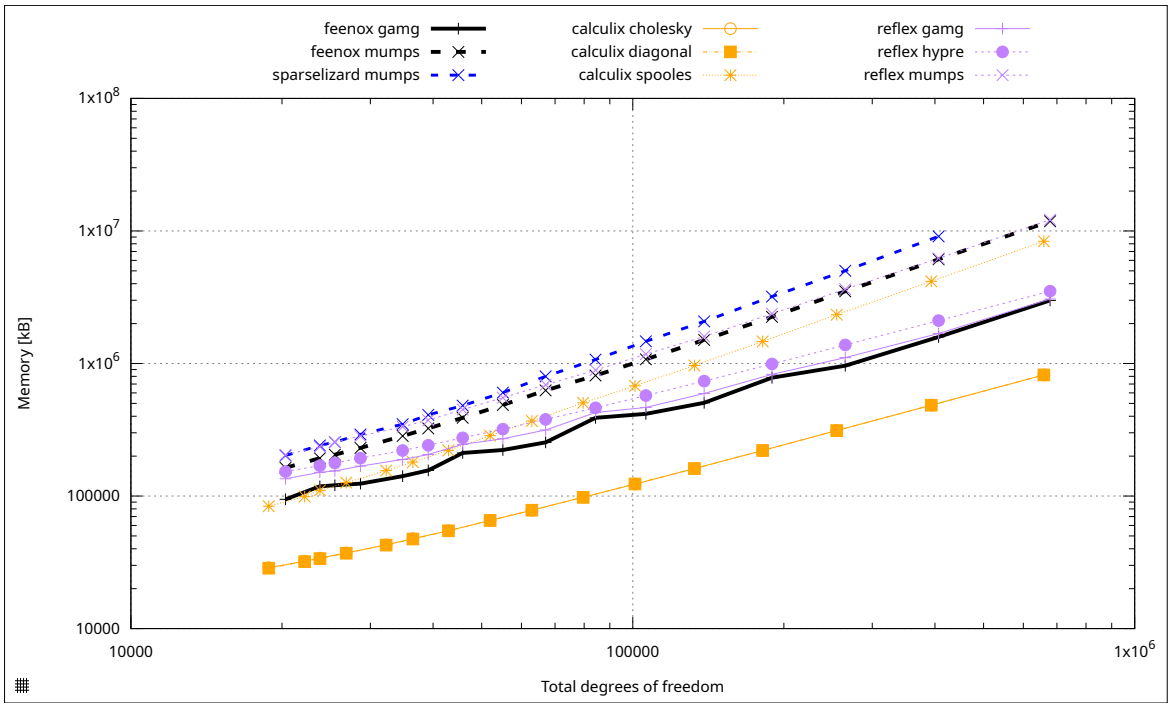


(b)

Figure 3: Stress

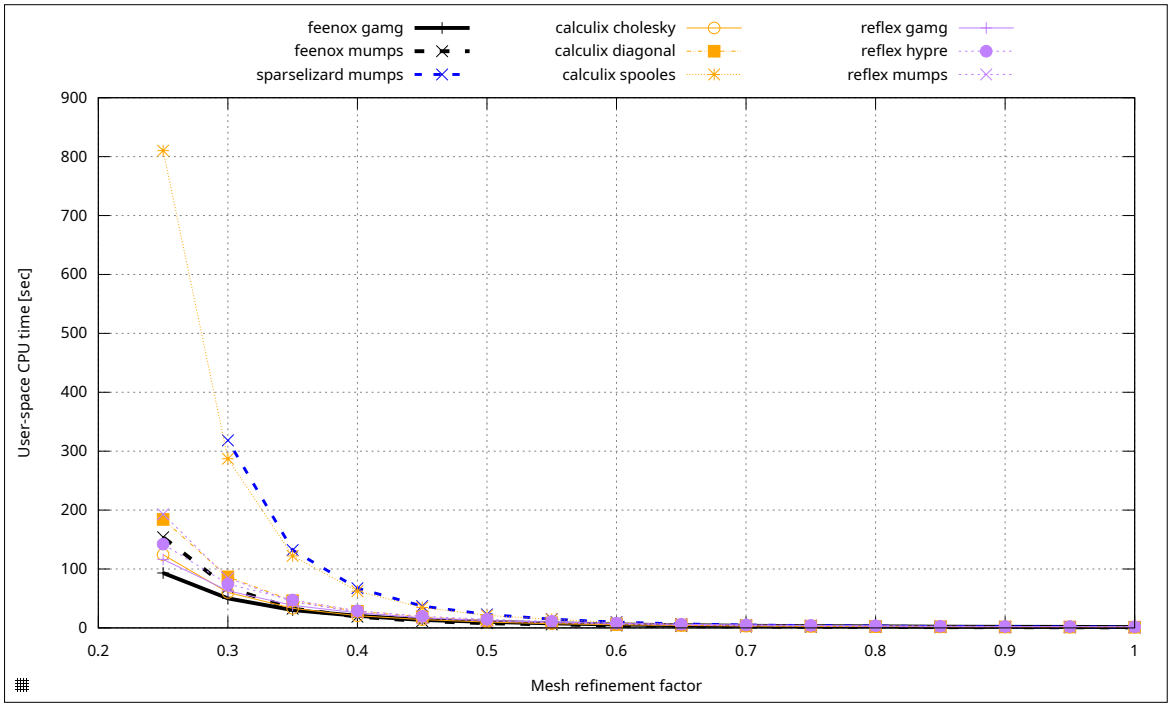


(a)

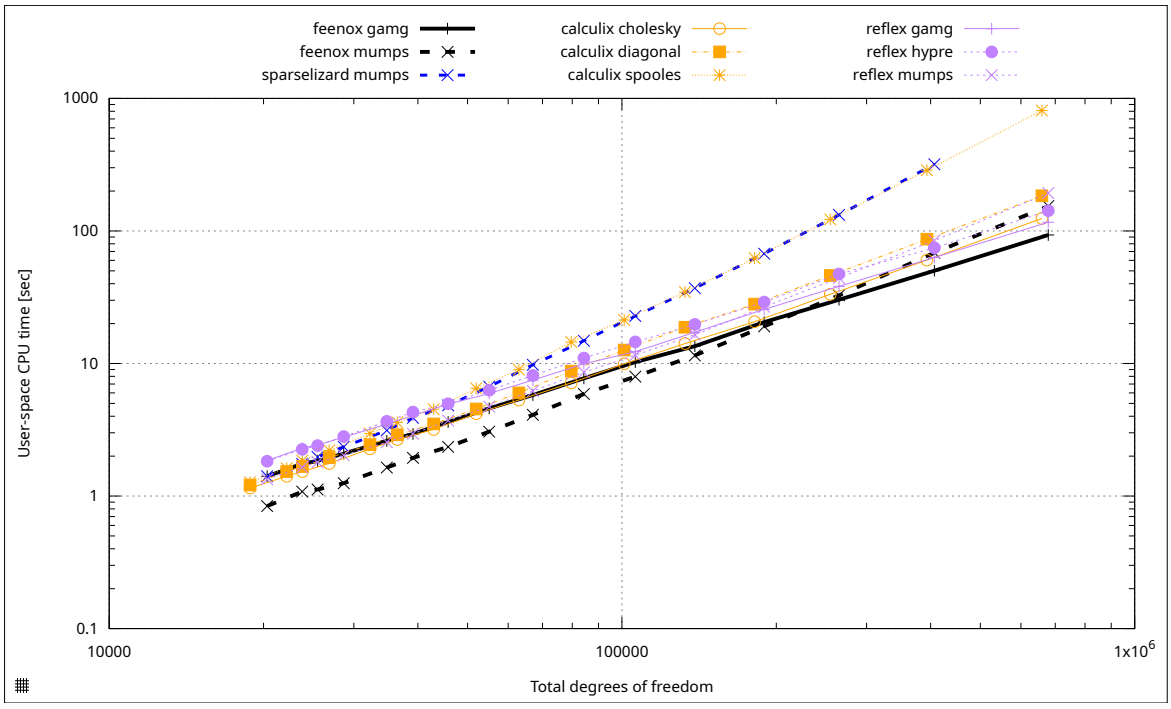


(b)

Figure 4: Memory

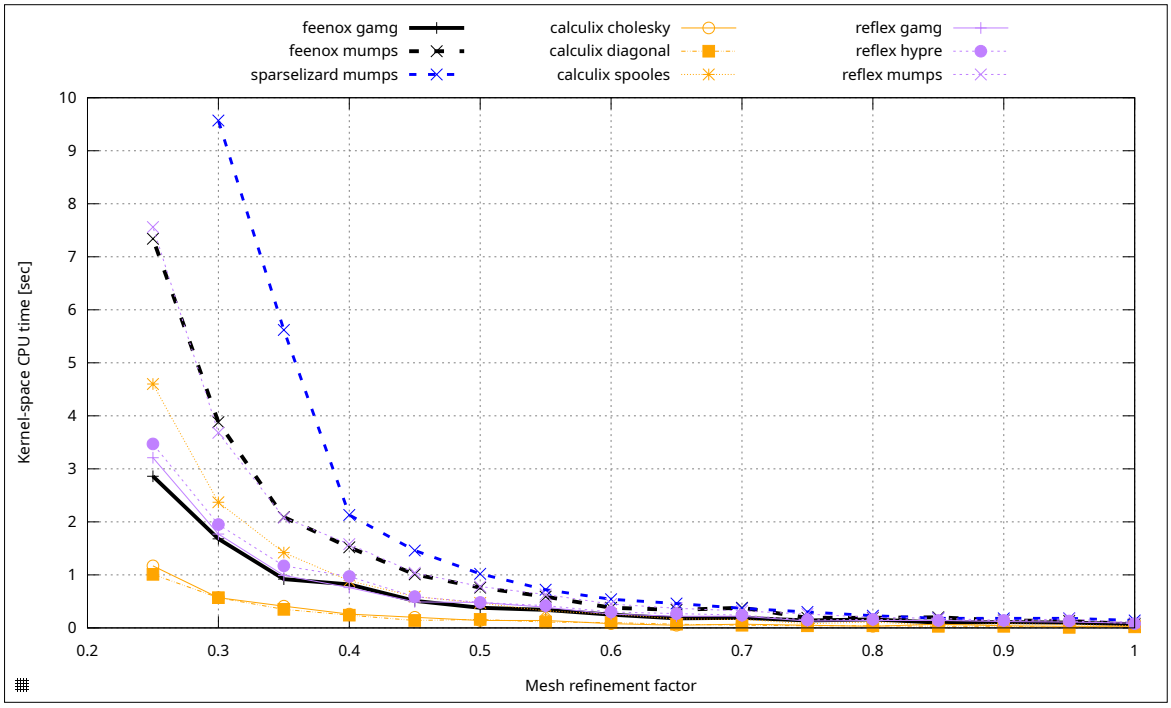


(a)

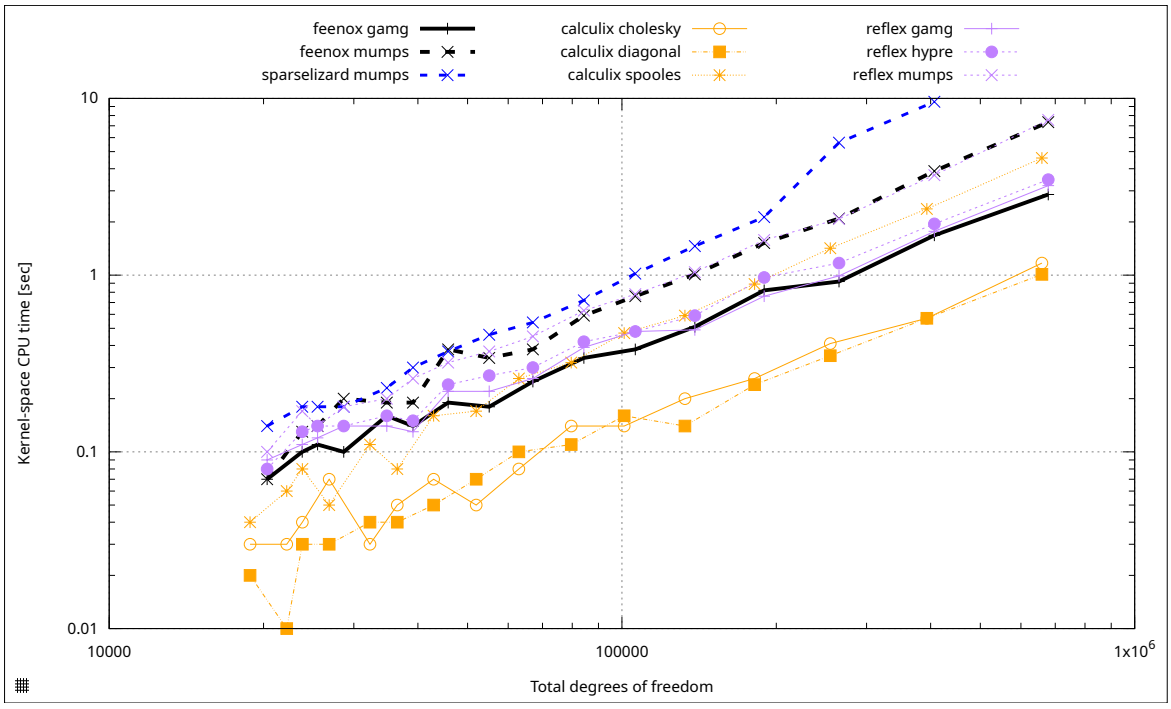


(b)

Figure 5: User



(a)



(b)

Figure 6: kernel

5 Tables

5.1 $c = 1$

Table 2: $c = 1$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	20,325	-5.416	1.1	0.1	0.8	0.16
calculix	cholesky	18,824	-5.413	1.2	0.0	1.1	0.03
calculix	diagonal	18,824	-5.417	1.2	0.0	1.2	0.03
calculix	spooles	18,824	-5.416	1.3	0.0	1.3	0.08
sparselizar	mumps	20,325	-5.410	1.4	0.1	1.4	0.19
reflex	mumps	20,325	-5.416	1.6	0.1	1.3	0.19
feenox	gamg	20,325	-5.416	1.7	0.1	1.4	0.09
reflex	gamg	20,325	-5.416	2.1	0.1	1.9	0.13
reflex	hypre	20,325	-5.416	2.1	0.1	1.8	0.15

Table 3: $c = 1$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	18,824	-5.413	1.2	0.0	1.1	0.03
calculix	diagonal	18,824	-5.417	1.2	0.0	1.2	0.03
calculix	spooles	18,824	-5.416	1.3	0.0	1.3	0.08
feenox	gamg	20,325	-5.416	1.7	0.1	1.4	0.09
reflex	gamg	20,325	-5.416	2.1	0.1	1.9	0.13
reflex	hypre	20,325	-5.416	2.1	0.1	1.8	0.15
feenox	mumps	20,325	-5.416	1.1	0.1	0.8	0.16
reflex	mumps	20,325	-5.416	1.6	0.1	1.3	0.19
sparselizar	mumps	20,325	-5.410	1.4	0.1	1.4	0.19

5.2 $c = 0.95$

Table 4: $c = 0.95$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	22,194	-5.397	1.4	0.0	1.4	0.03
feenox	mumps	23,793	-5.402	1.4	0.1	1.1	0.18
calculix	diagonal	22,194	-5.403	1.6	0.0	1.5	0.03
calculix	spooles	22,194	-5.402	1.7	0.1	1.6	0.09
sparselizar	mumps	23,793	-5.441	1.8	0.2	1.8	0.23
feenox	gamg	23,793	-5.402	2.0	0.1	1.8	0.11
reflex	mumps	23,793	-5.402	2.0	0.2	1.6	0.22

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
reflex	gamg	23,793	-5.402	2.6	0.1	2.3	0.14
reflex	hypre	23,793	-5.402	2.6	0.1	2.2	0.16

Table 5: $c = 0.95$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	22,194	-5.397	1.4	0.0	1.4	0.03
calculix	diagonal	22,194	-5.403	1.6	0.0	1.5	0.03
calculix	spooles	22,194	-5.402	1.7	0.1	1.6	0.09
feenox	gamg	23,793	-5.402	2.0	0.1	1.8	0.11
reflex	gamg	23,793	-5.402	2.6	0.1	2.3	0.14
reflex	hypre	23,793	-5.402	2.6	0.1	2.2	0.16
feenox	mumps	23,793	-5.402	1.4	0.1	1.1	0.18
reflex	mumps	23,793	-5.402	2.0	0.2	1.6	0.22
sparselizar	mumps	23,793	-5.441	1.8	0.2	1.8	0.23

5.3 $c = 0.9$

Table 6: $c = 0.9$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	25,491	-5.413	1.5	0.1	1.1	0.20
calculix	cholesky	23,808	-5.411	1.6	0.0	1.5	0.03
calculix	diagonal	23,808	-5.413	1.7	0.0	1.7	0.03
calculix	spooles	23,808	-5.413	1.9	0.1	1.9	0.11
sparselizar	mumps	25,491	-5.417	2.0	0.2	2.0	0.24
feenox	gamg	25,491	-5.413	2.1	0.1	1.8	0.11
reflex	mumps	25,491	-5.413	2.1	0.1	1.8	0.24
reflex	gamg	25,491	-5.413	2.7	0.1	2.4	0.15
reflex	hypre	25,491	-5.413	2.7	0.1	2.4	0.17

Table 7: $c = 0.9$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	23,808	-5.411	1.6	0.0	1.5	0.03
calculix	diagonal	23,808	-5.413	1.7	0.0	1.7	0.03
calculix	spooles	23,808	-5.413	1.9	0.1	1.9	0.11
feenox	gamg	25,491	-5.413	2.1	0.1	1.8	0.11
reflex	gamg	25,491	-5.413	2.7	0.1	2.4	0.15

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
reflex	hypre	25,491	-5.413	2.7	0.1	2.4	0.17
feenox	mumps	25,491	-5.413	1.5	0.1	1.1	0.20
reflex	mumps	25,491	-5.413	2.1	0.1	1.8	0.24
sparselizar	mumps	25,491	-5.417	2.0	0.2	2.0	0.24

5.4 $c = 0.85$

Table 8: $c = 0.85$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	28,668	-5.411	1.6	0.2	1.2	0.22
calculix	cholesky	26,855	-5.411	1.8	0.1	1.8	0.04
calculix	diagonal	26,855	-5.412	2.0	0.0	1.9	0.04
calculix	spooles	26,855	-5.411	2.3	0.1	2.2	0.12
feenox	gamg	28,668	-5.411	2.4	0.1	2.1	0.12
reflex	mumps	28,668	-5.411	2.4	0.2	2.0	0.27
sparselizar	mumps	28,668	-5.411	2.4	0.2	2.4	0.28
reflex	gamg	28,668	-5.411	3.1	0.1	2.8	0.16
reflex	hypre	28,668	-5.411	3.1	0.1	2.8	0.18

Table 9: $c = 0.85$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	26,855	-5.411	1.8	0.1	1.8	0.04
calculix	diagonal	26,855	-5.412	2.0	0.0	1.9	0.04
calculix	spooles	26,855	-5.411	2.3	0.1	2.2	0.12
feenox	gamg	28,668	-5.411	2.4	0.1	2.1	0.12
reflex	gamg	28,668	-5.411	3.1	0.1	2.8	0.16
reflex	hypre	28,668	-5.411	3.1	0.1	2.8	0.18
feenox	mumps	28,668	-5.411	1.6	0.2	1.2	0.22
reflex	mumps	28,668	-5.411	2.4	0.2	2.0	0.27
sparselizar	mumps	28,668	-5.411	2.4	0.2	2.4	0.28

5.5 $c = 0.8$

Table 10: $c = 0.8$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	34,788	-5.399	2.0	0.2	1.6	0.27

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	32,255	-5.399	2.3	0.0	2.3	0.04
calculix	diagonal	32,255	-5.398	2.5	0.0	2.4	0.04
feenox	gamg	34,788	-5.399	3.0	0.2	2.6	0.13
reflex	mumps	34,788	-5.399	3.0	0.2	2.5	0.32
calculix	spooles	32,255	-5.399	3.1	0.1	3.0	0.15
sparselizar	mumps	34,788	-5.354	3.2	0.2	3.1	0.33
reflex	gamg	34,788	-5.399	3.8	0.1	3.5	0.18
reflex	hypre	34,788	-5.399	4.0	0.2	3.7	0.21

Table 11: $c = 0.8$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	32,255	-5.399	2.3	0.0	2.3	0.04
calculix	diagonal	32,255	-5.398	2.5	0.0	2.4	0.04
feenox	gamg	34,788	-5.399	3.0	0.2	2.6	0.13
calculix	spooles	32,255	-5.399	3.1	0.1	3.0	0.15
reflex	gamg	34,788	-5.399	3.8	0.1	3.5	0.18
reflex	hypre	34,788	-5.399	4.0	0.2	3.7	0.21
feenox	mumps	34,788	-5.399	2.0	0.2	1.6	0.27
reflex	mumps	34,788	-5.399	3.0	0.2	2.5	0.32
sparselizar	mumps	34,788	-5.354	3.2	0.2	3.1	0.33

5.6 $c = 0.75$

Table 12: $c = 0.75$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	39,129	-5.397	2.3	0.2	1.9	0.31
calculix	cholesky	36,462	-5.398	2.7	0.1	2.7	0.05
calculix	diagonal	36,462	-5.397	2.9	0.0	2.9	0.05
feenox	gamg	39,129	-5.397	3.3	0.1	2.9	0.15
reflex	mumps	39,129	-5.397	3.4	0.3	3.0	0.36
calculix	spooles	36,462	-5.397	3.7	0.1	3.6	0.17
sparselizar	mumps	39,129	-5.358	4.0	0.3	3.9	0.39
reflex	gamg	39,129	-5.397	4.4	0.1	4.1	0.20
reflex	hypre	39,129	-5.397	4.7	0.1	4.3	0.23

Table 13: $c = 0.75$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	36,462	-5.398	2.7	0.1	2.7	0.05
calculix	diagonal	36,462	-5.397	2.9	0.0	2.9	0.05
feenox	gamg	39,129	-5.397	3.3	0.1	2.9	0.15
calculix	spooles	36,462	-5.397	3.7	0.1	3.6	0.17
reflex	gamg	39,129	-5.397	4.4	0.1	4.1	0.20
reflex	hypre	39,129	-5.397	4.7	0.1	4.3	0.23
feenox	mumps	39,129	-5.397	2.3	0.2	1.9	0.31
reflex	mumps	39,129	-5.397	3.4	0.3	3.0	0.36
sparselizar	mumps	39,129	-5.358	4.0	0.3	3.9	0.39

5.7 $c = 0.7$

Table 14: $c = 0.7$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	45,822	-5.396	2.9	0.4	2.4	0.37
calculix	cholesky	42,928	-5.402	3.2	0.1	3.2	0.05
calculix	diagonal	42,928	-5.396	3.5	0.1	3.5	0.05
feenox	gamg	45,822	-5.396	4.0	0.2	3.6	0.20
reflex	mumps	45,822	-5.396	4.2	0.3	3.7	0.43
calculix	spooles	42,928	-5.396	4.7	0.2	4.5	0.21
sparselizar	mumps	45,822	-5.396	5.0	0.4	4.8	0.46
reflex	gamg	45,822	-5.396	5.3	0.2	4.9	0.23
reflex	hypre	45,822	-5.396	5.4	0.2	5.0	0.26

Table 15: $c = 0.7$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	42,928	-5.402	3.2	0.1	3.2	0.05
calculix	diagonal	42,928	-5.396	3.5	0.1	3.5	0.05
feenox	gamg	45,822	-5.396	4.0	0.2	3.6	0.20
calculix	spooles	42,928	-5.396	4.7	0.2	4.5	0.21
reflex	gamg	45,822	-5.396	5.3	0.2	4.9	0.23
reflex	hypre	45,822	-5.396	5.4	0.2	5.0	0.26
feenox	mumps	45,822	-5.396	2.9	0.4	2.4	0.37
reflex	mumps	45,822	-5.396	4.2	0.3	3.7	0.43
sparselizar	mumps	45,822	-5.396	5.0	0.4	4.8	0.46

5.8 $c = 0.65$

Table 16: $c = 0.65$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	55,098	-5.398	3.6	0.3	3.1	0.46
calculix	cholesky	51,971	-5.399	4.2	0.1	4.2	0.06
calculix	diagonal	51,971	-5.398	4.6	0.1	4.5	0.06
feenox	gamg	55,098	-5.398	5.0	0.2	4.6	0.21
reflex	mumps	55,098	-5.398	5.3	0.4	4.7	0.53
reflex	gamg	55,098	-5.398	6.4	0.2	5.9	0.26
calculix	spooles	51,971	-5.398	6.7	0.2	6.5	0.27
reflex	hypre	55,098	-5.398	6.8	0.3	6.3	0.30
sparselizar	mumps	55,098	-5.367	6.8	0.5	6.7	0.58

Table 17: $c = 0.65$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	51,971	-5.399	4.2	0.1	4.2	0.06
calculix	diagonal	51,971	-5.398	4.6	0.1	4.5	0.06
feenox	gamg	55,098	-5.398	5.0	0.2	4.6	0.21
reflex	gamg	55,098	-5.398	6.4	0.2	5.9	0.26
calculix	spooles	51,971	-5.398	6.7	0.2	6.5	0.27
reflex	hypre	55,098	-5.398	6.8	0.3	6.3	0.30
feenox	mumps	55,098	-5.398	3.6	0.3	3.1	0.46
reflex	mumps	55,098	-5.398	5.3	0.4	4.7	0.53
sparselizar	mumps	55,098	-5.367	6.8	0.5	6.7	0.58

5.9 $c = 0.6$

Table 18: $c = 0.6$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	67,038	-5.385	4.7	0.4	4.1	0.60
calculix	cholesky	62,943	-5.387	5.4	0.1	5.3	0.07
calculix	diagonal	62,943	-5.386	6.1	0.1	6.0	0.07
feenox	gamg	67,038	-5.385	6.2	0.2	5.8	0.24
reflex	mumps	67,038	-5.385	6.9	0.5	6.2	0.66
reflex	gamg	67,038	-5.385	7.9	0.3	7.5	0.30
reflex	hypre	67,038	-5.385	8.6	0.3	8.1	0.36
calculix	spooles	62,943	-5.385	9.3	0.3	9.0	0.35

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
sparselizar	mumps	67,038	-5.387	9.9	0.5	9.8	0.76

Table 19: $c = 0.6$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	62,943	-5.387	5.4	0.1	5.3	0.07
calculix	diagonal	62,943	-5.386	6.1	0.1	6.0	0.07
feenox	gamg	67,038	-5.385	6.2	0.2	5.8	0.24
reflex	gamg	67,038	-5.385	7.9	0.3	7.5	0.30
calculix	spooles	62,943	-5.385	9.3	0.3	9.0	0.35
reflex	hypre	67,038	-5.385	8.6	0.3	8.1	0.36
feenox	mumps	67,038	-5.385	4.7	0.4	4.1	0.60
reflex	mumps	67,038	-5.385	6.9	0.5	6.2	0.66
sparselizar	mumps	67,038	-5.387	9.9	0.5	9.8	0.76

5.10 $c = 0.55$

Table 20: $c = 0.55$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	84,288	-5.387	6.7	0.6	5.9	0.77
calculix	cholesky	79,636	-5.386	7.3	0.1	7.1	0.09
feenox	gamg	84,288	-5.387	8.3	0.3	7.7	0.37
calculix	diagonal	79,636	-5.386	8.9	0.1	8.8	0.09
reflex	mumps	84,288	-5.387	9.4	0.6	8.6	0.85
reflex	gamg	84,288	-5.387	10.5	0.4	9.9	0.41
reflex	hypre	84,288	-5.387	11.6	0.4	11.0	0.44
calculix	spooles	79,636	-5.387	14.8	0.3	14.5	0.48
sparselizar	mumps	84,288	-5.386	15.1	0.7	14.8	1.02

Table 21: $c = 0.55$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	79,636	-5.386	7.3	0.1	7.1	0.09
calculix	diagonal	79,636	-5.386	8.9	0.1	8.8	0.09
feenox	gamg	84,288	-5.387	8.3	0.3	7.7	0.37
reflex	gamg	84,288	-5.387	10.5	0.4	9.9	0.41
reflex	hypre	84,288	-5.387	11.6	0.4	11.0	0.44
calculix	spooles	79,636	-5.387	14.8	0.3	14.5	0.48

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	84,288	-5.387	6.7	0.6	5.9	0.77
reflex	mumps	84,288	-5.387	9.4	0.6	8.6	0.85
sparselizar	mumps	84,288	-5.386	15.1	0.7	14.8	1.02

5.11 $c = 0.5$

Table 22: $c = 0.5$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	106,185	-5.379	8.9	0.8	8.0	1.02
calculix	cholesky	101,014	-5.379	10.1	0.1	9.9	0.12
feenox	gamg	106,185	-5.379	10.8	0.4	10.2	0.40
reflex	mumps	106,185	-5.379	12.5	0.8	11.6	1.12
calculix	diagonal	101,014	-5.379	12.8	0.2	12.6	0.12
reflex	gamg	106,185	-5.379	13.0	0.5	12.3	0.44
reflex	hypre	106,185	-5.379	15.2	0.5	14.6	0.55
calculix	spooles	101,014	-5.379	21.8	0.5	21.3	0.65
sparselizar	mumps	106,185	-5.360	23.2	1.0	22.8	1.40

Table 23: $c = 0.5$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	101,014	-5.379	10.1	0.1	9.9	0.12
calculix	diagonal	101,014	-5.379	12.8	0.2	12.6	0.12
feenox	gamg	106,185	-5.379	10.8	0.4	10.2	0.40
reflex	gamg	106,185	-5.379	13.0	0.5	12.3	0.44
reflex	hypre	106,185	-5.379	15.2	0.5	14.6	0.55
calculix	spooles	101,014	-5.379	21.8	0.5	21.3	0.65
feenox	mumps	106,185	-5.379	8.9	0.8	8.0	1.02
reflex	mumps	106,185	-5.379	12.5	0.8	11.6	1.12
sparselizar	mumps	106,185	-5.360	23.2	1.0	22.8	1.40

5.12 $c = 0.45$

Table 24: $c = 0.45$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	138,741	-5.375	12.7	1.0	11.5	1.44
feenox	gamg	138,741	-5.375	14.2	0.5	13.5	0.48

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	132,696	-5.371	14.3	0.2	14.1	0.15
reflex	mumps	138,741	-5.375	17.7	1.0	16.5	1.52
reflex	gamg	138,741	-5.375	17.9	0.5	17.2	0.57
calculix	diagonal	132,696	-5.375	18.9	0.1	18.8	0.15
reflex	hypre	138,741	-5.375	20.5	0.6	19.7	0.70
calculix	spooles	132,696	-5.375	35.2	0.6	34.6	0.92
sparselizar	mumps	138,741	-5.376	37.6	1.5	37.0	1.98

Table 25: $c = 0.45$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	132,696	-5.371	14.3	0.2	14.1	0.15
calculix	diagonal	132,696	-5.375	18.9	0.1	18.8	0.15
feenox	gamg	138,741	-5.375	14.2	0.5	13.5	0.48
reflex	gamg	138,741	-5.375	17.9	0.5	17.2	0.57
reflex	hypre	138,741	-5.375	20.5	0.6	19.7	0.70
calculix	spooles	132,696	-5.375	35.2	0.6	34.6	0.92
feenox	mumps	138,741	-5.375	12.7	1.0	11.5	1.44
reflex	mumps	138,741	-5.375	17.7	1.0	16.5	1.52
sparselizar	mumps	138,741	-5.376	37.6	1.5	37.0	1.98

5.13 $c = 0.4$

Table 26: $c = 0.4$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	mumps	189,408	-5.378	20.8	1.5	19.1	2.15
calculix	cholesky	181,449	-5.382	20.9	0.3	20.7	0.21
feenox	gamg	189,408	-5.378	21.5	0.8	20.5	0.75
reflex	gamg	189,408	-5.378	26.6	0.8	25.6	0.79
calculix	diagonal	181,449	-5.378	28.3	0.2	28.1	0.21
reflex	mumps	189,408	-5.378	28.5	1.6	26.7	2.27
reflex	hypre	189,408	-5.378	30.2	1.0	29.1	0.95
calculix	spooles	181,449	-5.378	63.3	0.9	62.4	1.40
sparselizar	mumps	189,408	-5.378	68.3	2.1	67.4	3.05

Table 27: $c = 0.4$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	181,449	-5.382	20.9	0.3	20.7	0.21
calculix	diagonal	181,449	-5.378	28.3	0.2	28.1	0.21
feenox	gamg	189,408	-5.378	21.5	0.8	20.5	0.75
reflex	gamg	189,408	-5.378	26.6	0.8	25.6	0.79
reflex	hypre	189,408	-5.378	30.2	1.0	29.1	0.95
calculix	spooles	181,449	-5.378	63.3	0.9	62.4	1.40
feenox	mumps	189,408	-5.378	20.8	1.5	19.1	2.15
reflex	mumps	189,408	-5.378	28.5	1.6	26.7	2.27
sparselizar	mumps	189,408	-5.378	68.3	2.1	67.4	3.05

5.14 $c = 0.35$

Table 28: $c = 0.35$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	gamg	265,077	-5.377	31.4	0.9	30.3	0.92
calculix	cholesky	254,881	-5.375	33.7	0.4	33.2	0.30
feenox	mumps	265,077	-5.377	35.0	2.1	32.7	3.34
reflex	gamg	265,077	-5.377	39.4	1.0	38.2	1.06
calculix	diagonal	254,881	-5.377	46.4	0.3	46.1	0.30
reflex	mumps	265,077	-5.377	46.5	2.1	44.2	3.47
reflex	hypre	265,077	-5.377	48.7	1.2	47.4	1.32
calculix	spooles	254,881	-5.377	123.7	1.4	122.2	2.23
sparselizar	mumps	265,077	-5.378	136.1	5.6	132.2	4.77

Table 29: $c = 0.35$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	254,881	-5.375	33.7	0.4	33.2	0.30
calculix	diagonal	254,881	-5.377	46.4	0.3	46.1	0.30
feenox	gamg	265,077	-5.377	31.4	0.9	30.3	0.92
reflex	gamg	265,077	-5.377	39.4	1.0	38.2	1.06
reflex	hypre	265,077	-5.377	48.7	1.2	47.4	1.32
calculix	spooles	254,881	-5.377	123.7	1.4	122.2	2.23
feenox	mumps	265,077	-5.377	35.0	2.1	32.7	3.34
reflex	mumps	265,077	-5.377	46.5	2.1	44.2	3.47
sparselizar	mumps	265,077	-5.378	136.1	5.6	132.2	4.77

5.15 $c = 0.3$

Table 30: $c = 0.3$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
feenox	gamg	406,746	-5.371	52.0	1.7	50.1	1.51
calculix	cholesky	393,259	-5.368	60.8	0.6	60.2	0.46
reflex	gamg	406,746	-5.371	65.1	1.8	63.1	1.61
feenox	mumps	406,746	-5.371	72.6	3.9	68.5	5.83
reflex	hypre	406,746	-5.371	76.6	1.9	74.5	2.01
calculix	diagonal	393,259	-5.371	87.2	0.6	86.7	0.46
reflex	mumps	406,746	-5.371	88.5	3.7	84.6	5.92
calculix	spooles	393,259	-5.371	289.6	2.4	287.1	3.98
sparselizar	mumps	406,746	-5.364	325.4	9.6	318.3	8.68

Table 31: $c = 0.3$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	393,259	-5.368	60.8	0.6	60.2	0.46
calculix	diagonal	393,259	-5.371	87.2	0.6	86.7	0.46
feenox	gamg	406,746	-5.371	52.0	1.7	50.1	1.51
reflex	gamg	406,746	-5.371	65.1	1.8	63.1	1.61
reflex	hypre	406,746	-5.371	76.6	1.9	74.5	2.01
calculix	spooles	393,259	-5.371	289.6	2.4	287.1	3.98
feenox	mumps	406,746	-5.371	72.6	3.9	68.5	5.83
reflex	mumps	406,746	-5.371	88.5	3.7	84.6	5.92
sparselizar	mumps	406,746	-5.364	325.4	9.6	318.3	8.68

5.16 $c = 0.25$

Table 32: $c = 0.25$ sorted by wall time

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
sparselizar	mumps	678,393	-nan	49.5	9.6	44.2	3.98
feenox	gamg	678,393	-5.374	96.3	2.9	93.2	2.85
reflex	gamg	678,393	-5.374	119.8	3.2	116.3	2.92
calculix	cholesky	659,302	-5.374	125.4	1.2	124.2	0.78
reflex	hypre	678,393	-5.374	145.9	3.5	142.2	3.35
feenox	mumps	678,393	-5.374	161.5	7.3	153.9	11.28
calculix	diagonal	659,302	-5.374	185.2	1.0	184.2	0.78
reflex	mumps	678,393	-5.374	201.0	7.6	193.0	11.59

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	spooles	659,302	-5.374	814.9	4.6	810.2	7.97

Table 33: $c = 0.25$ sorted by memory

Program	Solver	DOFs	σ_y	Wall [s]	Kernel [s]	User [s]	Memory [Gb]
calculix	cholesky	659,302	-5.374	125.4	1.2	124.2	0.78
calculix	diagonal	659,302	-5.374	185.2	1.0	184.2	0.78
feenox	gamg	678,393	-5.374	96.3	2.9	93.2	2.85
reflex	gamg	678,393	-5.374	119.8	3.2	116.3	2.92
reflex	hypre	678,393	-5.374	145.9	3.5	142.2	3.35
sparselizar	mumps	678,393	-nan	49.5	9.6	44.2	3.98
calculix	spooles	659,302	-5.374	814.9	4.6	810.2	7.97
feenox	mumps	678,393	-5.374	161.5	7.3	153.9	11.28
reflex	mumps	678,393	-5.374	201.0	7.6	193.0	11.59