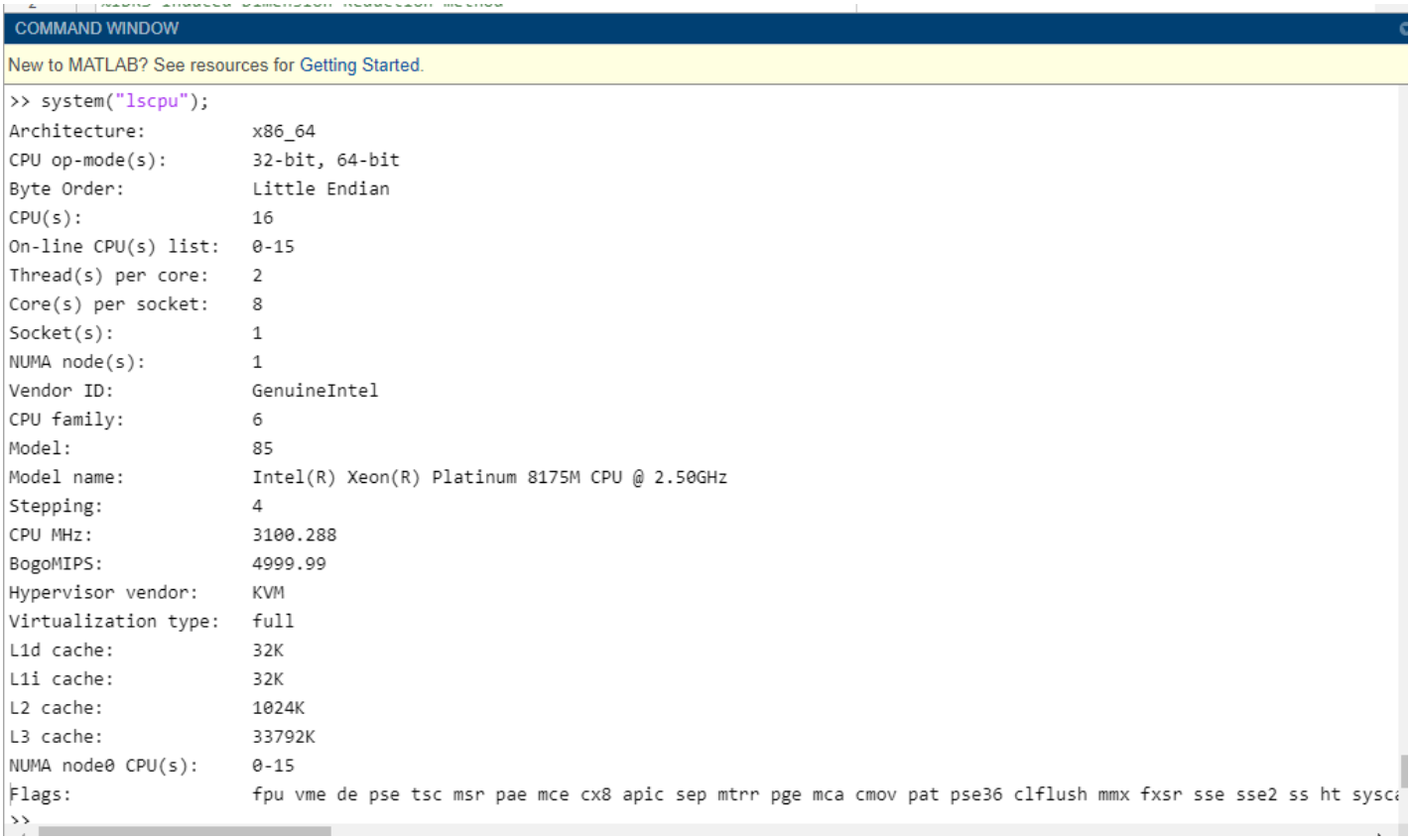
Comparison of execution time of IDR(s)-biortho in Matlab (original implementation by Martin van Gijzen, Version August 31, 2010) and Project Code for various values of shadow space number for various Matrices from SuiteSparse Matrix Collection.

Specification of system on which **online Matlab** was run.



Project code was run on **Tesla K20Xm GPU** which has peak performance of 1312 GFlop per second (double precision). CPU model: Intel(R) Xeon(R) CPU E5-2670 v2

IDR(s) is run for 100 iterations with smoothing enabled and identity preconditioner.

Matrix	IDR(s)	Runtime(s) :		Performance (Gflop/s): Project code
		Matlab	Project code	
airfoil_2d	IDR(1)	0.094	0.067	5.835
	IDR(4)	0.153	0.076	6.310
	IDR(8)	0.221	0.092	6.652
Trefethen_20000	IDR(1)	0.196	0.087	8.133
	IDR(4)	0.326	0.096	8.636
	IDR(8)	0.298	0.113	8.982
pwtk	IDR(1)	2.194	0.644	18.902
	IDR(4)	2.425	0.693	19.439
	IDR(8)	2.764	0.753	20.560
inline_1	IDR(1)	6.656	1.665	21.668
	IDR(4)	7.274	1.768	22.108
	IDR(8)	8.244	1.911	22.888
bone010	IDR(1)	10.020	3.147	22.339
	IDR(4)	10.919	3.346	22.771
	IDR(8)	16.009	3.643	23.418

airfoil_2d matrix

Matlab Runtime:

```
COMMAND WINDOW
New to MATLAB? See resources for Getting Started.
>>
>>
>>
>>
>> A = mmread("airfoil_2d.mtx");
>> [m , n] = size(A);
>> b = ones(m,1);
>> x0 = zeros(n,1);
>> options.smoothing = 1;
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.094848 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.094168 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.093224 seconds.
>>
```

```
>>
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.162143 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.151888 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.144223 seconds.
>>
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.200759 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.279846 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.183289 seconds.
>>
```

Project Code Runtime:

s = 1

```
[iaggarwal@fineci Build]$
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/airfoil_2d.mtx


----------------------------------Solver info:----------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:92.0319
init_residual:119.222
final_residual:92.0319
runtime in milliseconds:67.0618
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:50
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on an average(ran 10 times): 67.4298 ms

s = 4

```
[iaggarwal@fineci Build]$
[iaggarwal@fineci Build]$
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/airfoil_2d.mtx


----------------------------------Solver info:----------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:75.8781
init_residual:119.222
final_residual:75.8781
runtime in milliseconds:75.6412
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:20
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on an average(ran 10 times): 75.9873 ms.

s = 8

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/airfoil_2d.mtx


----------------------------------Solver info:----------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:83.5312
init_residual:119.222
final_residual:83.5312
runtime in milliseconds:91.2463
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:11
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on an average(ran 10 times):91.824 ms

Trefethen_20000

Matlab Runtime:

```
>> A = mmread("Trefethen_20000.mtx");
>> [m , n] = size(A);
>> b = ones(m,1);
>> x0 = zeros(n,1);
>> options.smoothing = 1;
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.239189 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.182585 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.166297 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.196040 seconds.
>>
>>
```

```
>>
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.229786 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.565048 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.296384 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.212425 seconds.
>>
```

```
>>
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.307535 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.282091 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.286509 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 0.314427 seconds.
>>
```

Project Code Runtime:

s = 1

```
[iaggarwal@fineci Build]$
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/Trefethen_20000.mtx


---------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:4.71712
init_residual:141.421
final_residual:4.71712
runtime in milliseconds:87.1494
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:50
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 86.8734 ms

s = 4

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/Trefethen_20000.mtx


---------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:3.09123
init_residual:141.421
final_residual:3.09123
runtime in milliseconds:95.6364
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:20
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 95.6411 ms

s = 8

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/Trefethen_20000.mtx


---------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:3.31581
init_residual:141.421
final_residual:3.31581
runtime in milliseconds:112.652
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:11
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 112.527 ms

pwtk

Matlab Runtime:

```
COMMAND WINDOW
New to MATLAB? See resources for Getting Started.
>>
>>
>> A = mmread("IDR_Test_Matrices/pwtk.mtx");
>> [m , n] = size(A);
>> b = ones(m,1);
>> x0 = zeros(n,1);
>> options.smoothing = 1;
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.154046 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.275379 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.154025 seconds.
>>
```

```
>>
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.450075 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.401427 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.423523 seconds.
>>
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.723249 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.778735 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 2.788524 seconds.
>>
```

Project Code Runtime:

s = 1

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/pwtk.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:436.909
init_residual:466.817
final_residual:436.909
runtime in milliseconds:642.522
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:50
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 644.026 ms

s = 4

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/pwtk.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:389.405
init_residual:466.817
final_residual:389.405
runtime in milliseconds:692.122
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:20
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 693.134 ms

s = 8

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/pwtk.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:413.245
init_residual:466.817
final_residual:413.245
runtime in milliseconds:754.195
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:11
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 753.248 ms

inline_1

Matlab Runtime:

COMMAND WINDOW

New to MATLAB? See resources for Getting Started.

```
>>
>> A = mmread("inline_1/inline_1.mtx");
>> [m , n] = size(A);
>> b = ones(m,1);
>> x0 = zeros(n,1);
>> options.smoothing = 1;
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 6.610308 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 6.654219 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 6.679556 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 6.790067 seconds.
>>
```

```
>>
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 7.315361 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 7.230891 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 7.275952 seconds.
>>
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 8.416752 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 8.201703 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 8.112334 seconds.
>>
```

Project Code Runtime:

s = 1

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/inline_1.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:706.281
init_residual:709.727
final_residual:706.281
runtime in milliseconds:1665.89
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:50
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 1665 ms

s = 4

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/inline_1.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:696.91
init_residual:709.727
final_residual:696.91
runtime in milliseconds:1769.01
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:20
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 1767.87 ms

s = 8

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/inline_1.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:697.601
init_residual:709.727
final_residual:697.601
runtime in milliseconds:1895.58
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:11
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 1910.97 ms

bone010

Matlab Runtime:

```
COMMAND WINDOW
New to MATLAB? See resources for Getting Started.

      986703

>> A = mmread("bone010/bone010.mtx");
>> [m , n] = size(A);
>> b = ones(m,1);
>> x0 = zeros(n,1);
>> options.smoothing = 1;
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 10.874136 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 9.592225 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 9.327519 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 9.645012 seconds.
>> [x] = idrs(A,b,1,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 10.661340 seconds.
>>
```

```
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 11.654247 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 10.749667 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 10.910712 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 10.482129 seconds.
>> [x] = idrs(A,b,4,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 10.799458 seconds.
>>
```

```
>>
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 16.707842 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 16.205631 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 16.012832 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 15.861589 seconds.
>> [x] = idrs(A,b,8,1e-04,100,speye(m),speye(m),x0,options);
Elapsed time is 15.257086 seconds.
>>
```

Project Code Runtime:

s = 1

```
[iaggarwal@fineci Build]$
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/bone010.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:990.808
init_residual:993.329
final_residual:990.808
runtime in milliseconds:3141.01
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:50
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 3147.34 ms

s = 4

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/bone010.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:986.659
init_residual:993.329
final_residual:986.659
runtime in milliseconds:3348.17
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:20
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 3346.35ms

s = 8

```
[iaggarwal@fineci Build]$ ./biorthoIDR ../../IDR-Test_Matrices/bone010.mtx


----------------------------------Solver info:------------------------------------------------------------
info: SLOW_CONVERGENCE
iter_resdidual:984.826
init_residual:993.329
final_residual:984.826
runtime in milliseconds:3635.81
max_iter: 100
spmv_count:100
num_iter:100
full_cycle:11
rtol:0.0001
atol:1e-28
Generating a log.txt file containing the iteratively computed residuals along with the timings at which they are computed.
```

Runtime on average(ran 10 times): 3643.09 ms
