Universität Stuttgart
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SPINTERP V2.1
EXAMPLES: REFERENCE RESULTS

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Reference results of the provided examples

In the following, we provide the output of the provided example programs of the software as a reference. The results shown here were computed using MATLAB Version 7.0 running on an AMD Athlon 1.6 GHz PC with a Linux operating system.
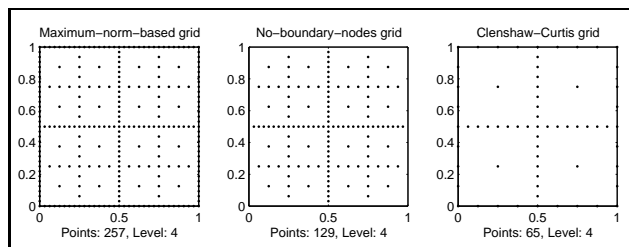
`cmpgrids.m`

Figure 1: Graphical output of `cmpgrids.m`

`spdemo.m`

```
>> spdemo

Sparse grid representation of the function:
z =
            vals: {1x9 cell}
        gridType: 'Clenshaw-Curtis'
               d: 2
           range: [2x2 double]
        maxLevel: 8
      estRelError: 0.0090
       fevalRange: [0.0049 0.9975]
       minGridVal: [1 0]
       maxGridVal: [0.0625 0.6250]
          nPoints: 1537
        fevalTime: 0.0493
```

```
        surplusCompTime: 0.0365
```


Figure 2: Graphical output of `spdemo.m`

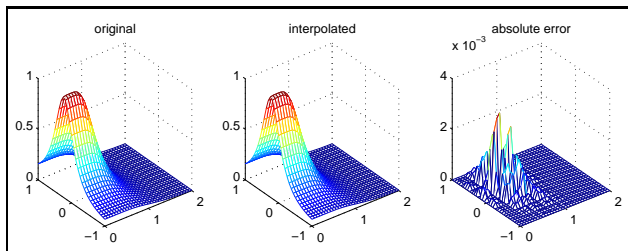## spdemovarout.m

```
>> spdemovarout
ans =

                    vals: {3x6 cell}
                gridType: 'Maximum'
                       d: 2
                   range: [2x2 double]
                maxLevel: 5
              estRelError: 0.0084
               fevalRange: [3x2 double]
               minGridVal: [3x2 double]
               maxGridVal: [3x2 double]
                  nPoints: 577
                fevalTime: 0.4786
          surplusCompTime: 0.1824
             selectOutput: 3
```
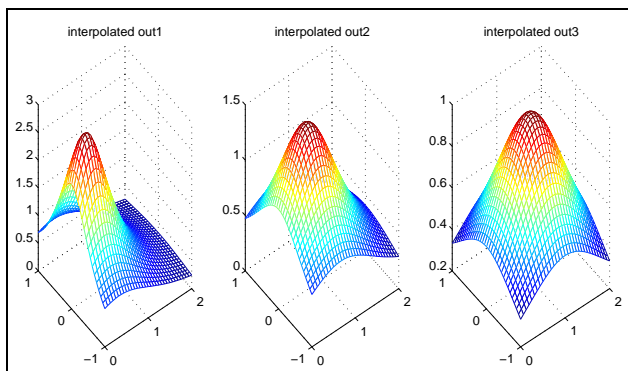

Figure 3: Graphical output of `spdemovarout.m`

spcompare.m

Note: Since the test functions contain random variables, and the interpolation error is approximated using randomly sampled points, MATLAB's random number generator must be initialized as below to obtain the results provided here.

```
>> rand('seed',0); spcompare
Problem dimension: d = 3
```

2

```
Current test function: 1
  nmax=7, Computation time: 5.5298 [s]. (Grid: Maximum)
  nmax=9, Computation time: 3.2299 [s]. (Grid: NoBoundary)
  nmax=11, Computation time: 5.4425 [s]. (Grid: Clenshaw-Curtis)

Current test function: 2
  nmax=7, Computation time: 5.5452 [s]. (Grid: Maximum)
  nmax=9, Computation time: 3.2633 [s]. (Grid: NoBoundary)
  nmax=11, Computation time: 5.4665 [s]. (Grid: Clenshaw-Curtis)

Current test function: 3
  nmax=7, Computation time: 5.5325 [s]. (Grid: Maximum)
  nmax=9, Computation time: 3.2459 [s]. (Grid: NoBoundary)
  nmax=11, Computation time: 5.4328 [s]. (Grid: Clenshaw-Curtis)

Current test function: 4
  nmax=7, Computation time: 5.5506 [s]. (Grid: Maximum)
  nmax=9, Computation time: 3.3055 [s]. (Grid: NoBoundary)
  nmax=11, Computation time: 5.5019 [s]. (Grid: Clenshaw-Curtis)

Current test function: 5
Warning: MaxDepth = 7 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.037765.
> In spvals at 189
  In spcompare at 69
  nmax=7, Computation time: 5.5141 [s]. (Grid: Maximum)
Warning: MaxDepth = 9 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.018901.
> In spvals at 189
  In spcompare at 69
  nmax=9, Computation time: 3.3063 [s]. (Grid: NoBoundary)
Warning: MaxDepth = 11 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.023746.
> In spvals at 189
  In spcompare at 69
  nmax=11, Computation time: 5.5258 [s]. (Grid: Clenshaw-Curtis)

Current test function: 6
Warning: MaxDepth = 7 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.36091.
> In spvals at 189
  In spcompare at 69
  nmax=7, Computation time: 5.5384 [s]. (Grid: Maximum)
  nmax=9, Computation time: 3.3374 [s]. (Grid: NoBoundary)
  nmax=11, Computation time: 5.479 [s]. (Grid: Clenshaw-Curtis)


timespvals.m

>> rand('seed',0); timespvals
Current dim: 1
Current level n = 0...
Warning: MaxDepth = 0 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is Inf.
> In spvals at 189
```
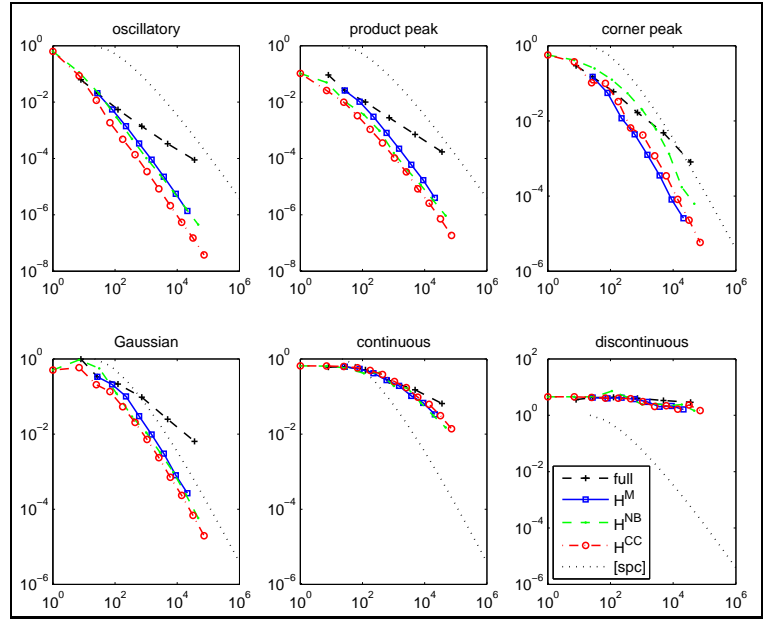
Figure 4: Graphical output of spcompare.m

```
   In timespvals at 45
Computing sparse grid points and evaluating function took 0.002169 [s].
Computing hierarchical surpluses took 0 [s].


Current level n = 1...
Warning: MaxDepth = 1 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.55111.
> In spvals at 189
   In timespvals at 45
Computing sparse grid points and evaluating function took 0.003914 [s].
Computing hierarchical surpluses took 0.000585 [s].


Current level n = 2...
Warning: MaxDepth = 2 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.012876.
> In spvals at 189
   In timespvals at 45
Computing sparse grid points and evaluating function took 0.0066 [s].
Computing hierarchical surpluses took 0.001214 [s].


Current level n = 3...
Computing sparse grid points and evaluating function took 0.00882 [s].
Computing hierarchical surpluses took 0.001994 [s].


Current level n = 4...
Computing sparse grid points and evaluating function took 0.011437 [s].
Computing hierarchical surpluses took 0.003489 [s].


Current level n = 5...
Computing sparse grid points and evaluating function took 0.015369 [s].
Computing hierarchical surpluses took 0.004413 [s].
```

4

```
Current level n = 6...
Computing sparse grid points and evaluating function took 0.011522 [s].
Computing hierarchical surpluses took 0.006019 [s].

Current level n = 7...
Computing sparse grid points and evaluating function took 0.015844 [s].
Computing hierarchical surpluses took 0.008626 [s].

Current level n = 8...
Computing sparse grid points and evaluating function took 0.015233 [s].
Computing hierarchical surpluses took 0.010998 [s].

Current level n = 9...
Computing sparse grid points and evaluating function took 0.016294 [s].
Computing hierarchical surpluses took 0.016976 [s].

Current level n = 10...
Computing sparse grid points and evaluating function took 0.018965 [s].
Computing hierarchical surpluses took 0.023419 [s].

Current level n = 11...
Computing sparse grid points and evaluating function took 0.022425 [s].
Computing hierarchical surpluses took 0.041913 [s].

Current level n = 12...
Computing sparse grid points and evaluating function took 0.023255 [s].
Computing hierarchical surpluses took 0.067003 [s].

Current level n = 13...
Computing sparse grid points and evaluating function took 0.027746 [s].
Computing hierarchical surpluses took 0.1325 [s].

Current level n = 14...
Computing sparse grid points and evaluating function took 0.034719 [s].
Computing hierarchical surpluses took 0.29889 [s].

Current level n = 15...
Computing sparse grid points and evaluating function took 0.051634 [s].
Computing hierarchical surpluses took 0.60223 [s].

Current level n = 16...
Computing sparse grid points and evaluating function took 0.084824 [s].
Computing hierarchical surpluses took 1.379 [s].

Current level n = 17...
Computing sparse grid points and evaluating function took 0.16606 [s].
Computing hierarchical surpluses took 2.8992 [s].

Current dim: 2
Current level n = 0...
Warning: MaxDepth = 0 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is Inf.
> In spvals at 189
```

```
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.00248 [s].
Computing hierarchical surpluses took 0 [s].

Current level n = 1...
Warning: MaxDepth = 1 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.5429.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.008102 [s].
Computing hierarchical surpluses took 0.000646 [s].

Current level n = 2...
Warning: MaxDepth = 2 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.040298.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.007474 [s].
Computing hierarchical surpluses took 0.00139 [s].

Current level n = 3...
Computing sparse grid points and evaluating function took 0.013681 [s].
Computing hierarchical surpluses took 0.002217 [s].

Current level n = 4...
Computing sparse grid points and evaluating function took 0.014655 [s].
Computing hierarchical surpluses took 0.007086 [s].

Current level n = 5...
Computing sparse grid points and evaluating function took 0.021918 [s].
Computing hierarchical surpluses took 0.006448 [s].

Current level n = 6...
Computing sparse grid points and evaluating function took 0.026934 [s].
Computing hierarchical surpluses took 0.009789 [s].

Current level n = 7...
Computing sparse grid points and evaluating function took 0.029885 [s].
Computing hierarchical surpluses took 0.017622 [s].

Current level n = 8...
Computing sparse grid points and evaluating function took 0.038012 [s].
Computing hierarchical surpluses took 0.036794 [s].

Current level n = 9...
Computing sparse grid points and evaluating function took 0.042821 [s].
Computing hierarchical surpluses took 0.088587 [s].

Current level n = 10...
Computing sparse grid points and evaluating function took 0.055059 [s].
Computing hierarchical surpluses took 0.20003 [s].

Current level n = 11...
Computing sparse grid points and evaluating function took 0.06844 [s].
```

6

```
Computing hierarchical surpluses took 0.50127 [s].

Current level n = 12...
Computing sparse grid points and evaluating function took 0.10967 [s].
Computing hierarchical surpluses took 1.2628 [s].

Current level n = 13...
Computing sparse grid points and evaluating function took 0.1698 [s].
Computing hierarchical surpluses took 3.2224 [s].

Current dim: 4
Current level n = 0...
Warning: MaxDepth = 0 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is Inf.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.002696 [s].
Computing hierarchical surpluses took 0 [s].

Current level n = 1...
Warning: MaxDepth = 1 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.53823.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.009732 [s].
Computing hierarchical surpluses took 0.00048 [s].

Current level n = 2...
Warning: MaxDepth = 2 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.037751.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.028605 [s].
Computing hierarchical surpluses took 0.001458 [s].

Current level n = 3...
Computing sparse grid points and evaluating function took 0.05833 [s].
Computing hierarchical surpluses took 0.009588 [s].

Current level n = 4...
Computing sparse grid points and evaluating function took 0.112 [s].
Computing hierarchical surpluses took 0.009406 [s].

Current level n = 5...
Computing sparse grid points and evaluating function took 0.20394 [s].
Computing hierarchical surpluses took 0.029583 [s].

Current level n = 6...
Computing sparse grid points and evaluating function took 0.39362 [s].
Computing hierarchical surpluses took 0.09585 [s].

Current level n = 7...
Computing sparse grid points and evaluating function took 0.54862 [s].
Computing hierarchical surpluses took 0.29699 [s].
```

```
Current level n = 8...
Computing sparse grid points and evaluating function took 0.86703 [s].
Computing hierarchical surpluses took 0.97522 [s].

Current level n = 9...
Computing sparse grid points and evaluating function took 1.3197 [s].
Computing hierarchical surpluses took 3.1959 [s].

Current level n = 10...
Computing sparse grid points and evaluating function took 2.0161 [s].
Computing hierarchical surpluses took 10.0816 [s].

Current dim: 8
Current level n = 0...
Warning: MaxDepth = 0 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is Inf.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.005445 [s].
Computing hierarchical surpluses took 0 [s].

Current level n = 1...
Warning: MaxDepth = 1 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.5278.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.036165 [s].
Computing hierarchical surpluses took 0.000755 [s].

Current level n = 2...
Warning: MaxDepth = 2 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.027811.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.13104 [s].
Computing hierarchical surpluses took 0.002578 [s].

Current level n = 3...
Computing sparse grid points and evaluating function took 0.49938 [s].
Computing hierarchical surpluses took 0.018527 [s].

Current level n = 4...
Computing sparse grid points and evaluating function took 1.5733 [s].
Computing hierarchical surpluses took 0.15524 [s].

Current level n = 5...
Computing sparse grid points and evaluating function took 4.296 [s].
Computing hierarchical surpluses took 1.0154 [s].

Current level n = 6...
Computing sparse grid points and evaluating function took 10.7597 [s].
Computing hierarchical surpluses took 6.0191 [s].
```

```
Current dim: 16
Current level n = 0...
Warning: MaxDepth = 0 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is Inf.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.009512 [s].
Computing hierarchical surpluses took 0 [s].


Current level n = 1...
Warning: MaxDepth = 1 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.51331.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.089804 [s].
Computing hierarchical surpluses took 0.000666 [s].


Current level n = 2...
Warning: MaxDepth = 2 reached before accuracies RelTol = 0.01 or AbsTol = 1e-06 were achieved.
The current estimated relative accuracy is 0.014598.
> In spvals at 189
  In timespvals at 45
Computing sparse grid points and evaluating function took 0.83945 [s].
Computing hierarchical surpluses took 0.010938 [s].


Current level n = 3...
Computing sparse grid points and evaluating function took 5.904 [s].
Computing hierarchical surpluses took 0.29501 [s].


Current level n = 4...
Computing sparse grid points and evaluating function took 32.0927 [s].
Computing hierarchical surpluses took 7.0019 [s].
```
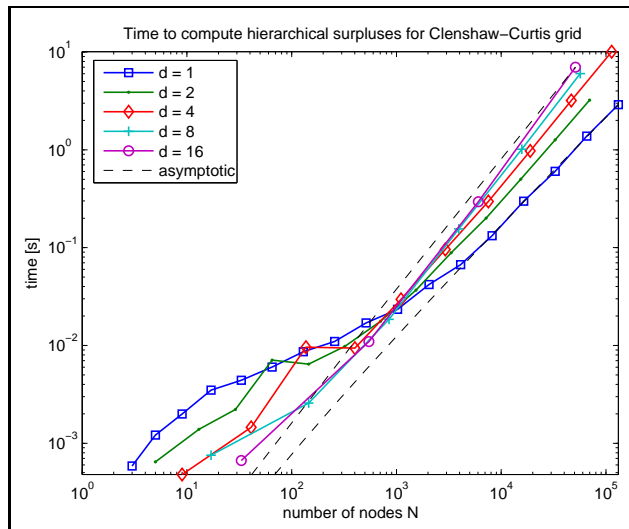

Figure 5: Graphical output of `timespvals.m`

```
timespinterp.m
```

```
>> rand('seed',0); timespinterp
Current dim: 1
Computing sparse grid surpluses up to level 17...
Computing time: 3.1961 [s].
Performing 1000 evaluations for each level...
Done!

Current dim: 2
Computing sparse grid surpluses up to level 13...
Computing time: 3.4674 [s].
Performing 1000 evaluations for each level...
Done!

Current dim: 4
Computing sparse grid surpluses up to level 10...
Computing time: 12.1915 [s].
Performing 1000 evaluations for each level...
Done!

Current dim: 8
Computing sparse grid surpluses up to level 6...
Computing time: 16.7043 [s].
Performing 1000 evaluations for each level...
Done!

Current dim: 16
Computing sparse grid surpluses up to level 4...
Computing time: 39.2443 [s].
Performing 1000 evaluations for each level...
Done!
```
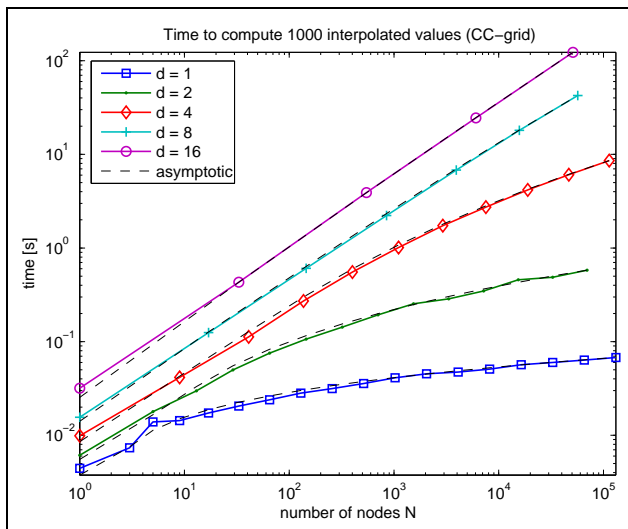

Figure 6: Graphical output of `timespinterp.m`