Problem5

November 5, 2016

```
In [3]: mysecondorder = (x,h) -> (f(x+h) - 2.0*f(x) + f(x-h))/(h^2.0)
        ddf = x -> -1.0*sin(x)
        f = x -> sin(x)
```

```
Out[3]: (anonymous function)
```

```
In [4]: x = pi/6.0
        for i=1:16
            h=10.0^(-i)
            addf = mysecondorder(x,h)
            err = abs(addf - ddf(x))
            @printf("%.8e  %.16f  %.5e\n", h, addf, err)
        end
```

```
1.00000000e-01  -0.4995834721974234  4.16528e-04
1.00000000e-02  -0.4999958333473664  4.16665e-06
1.00000000e-03  -0.4999999583255033  4.16745e-08
1.00000000e-04  -0.4999999969612645  3.03874e-09
1.00000000e-05  -0.5000005964816977  5.96482e-07
1.00000000e-06  -0.4999334279887080  6.65720e-05
1.00000000e-07  -0.4940492459581947  5.95075e-03
1.00000000e-08  -1.1102230246251563  6.10223e-01
1.00000000e-09  55.5111512312578199  5.60112e+01
1.00000000e-10  0.0000000000000000  5.00000e-01
1.00000000e-11  0.0000000000000000  5.00000e-01
1.00000000e-12  0.0000000000000000  5.00000e-01
1.00000000e-13  5551115123.1257820129394531  5.55112e+09
1.00000000e-14  -555111512312.5782470703125000  5.55112e+11
1.00000000e-15  0.0000000000000000  5.00000e-01
1.00000000e-16  -5551115123125783.0000000000000000  5.55112e+15
```

```
In [5]: @show mysecondorder(x,0.2)
        @show mysecondorder(x,0.1)
        @show mysecondorder(x,0.05)
        ;
```

```
mysecondorder(x,0.2) = -0.49833555396895646
mysecondorder(x,0.1) = -0.4995834721974234
mysecondorder(x,0.05) = -0.4998958420134868
```

```
In [7]: h0=0.2

        h1=h0/2.0
        rho0 = mysecondorder(x,h0)
        rho1 = mysecondorder(x,h1)
```

```
        addf0 = (4/3)*rho1 - (1/3)*rho0
        err = abs(addf0 - ddf(x))
        @printf("%.8e  %.16f  %.5e\n", h0, addf0, err)
        h0=h1

        h1=h0/2.0
        rho0 = mysecondorder(x,h0)
        rho1 = mysecondorder(x,h1)
        addf1 = (4/3)*rho1 - (1/3)*rho0
        err = abs(addf1 - ddf(x))
        @printf("%.8e  %.16f  %.5e\n", h0, addf1, err)
        h0=h1

        addf2 = (16/15)*addf1 - (1/15)*addf0
        err = abs(addf2 - ddf(x))
        @printf("Combination     %.16f  %.5e\n", addf2, err)
```

```
2.00000000e-01  -0.4999994449402457  5.55060e-07
1.00000000e-01  -0.4999999652855079  3.47145e-08
Combination     -0.4999999999751921  2.48078e-11
```

```
In [8]: using ApproxFun
```

```
In [9]: x=pi/6.0
        f = Fun(x->sin(x))
        aprox = f''(x)
        err = abs(aprox - ddf(x))
        @printf("%.16f  %.5e\n", aprox, err)
```

```
-0.4999999999999885  1.14908e-14
```

```
In [ ]:
```