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```
% Cory Wolfe
f = @(x) x^5-x^2+4;
```

Manual evaluation

```
x = 4; h = .5;
df_f_c = (f(x+h)-f(x))/h % forward
df_b_c = (f(x)-f(x-h))/h % backward
h = .25;
df_f_f = (f(x+h)-f(x))/h % forward finer
df_b_f = (f(x)-f(x-h))/h % backward finer
h = 0.5;
df_f2_c = (-f(x+2*h)+4*f(x+h)-3*f(x))/(2*h) % Forward O(h2)
df_b2_c = ( 3*f(x)-4*f(x-h)+f(x-2*h))/(2*h) % Backward O(h2)
df_c2_c = ( f(x+h)-f(x-h))/(2*h) % Centered O(h2)
h = 0.25;
df_f2_f = (-f(x+2*h)+4*f(x+h)-3*f(x))/(2*h) % Forward O(h2)
df_b2_f = ( 3*f(x)-4*f(x-h)+f(x-2*h))/(2*h) % Backward O(h2)
df_c2_f = ( f(x+h)-f(x-h))/(2*h) % Centered O(h2)
```

```
df_f_c =
   1.6341e+03
df_b_c =
  990.0625
df_f_f =
   1.4421e+03
df_b_f =
   1.1219e+03
df_f2_c =
   1.1761e+03
df_b2_c =
   1.2061e+03
df_c2_c =
   1.3121e+03
df_f2_f =
   1.2501e+03
df_b2_f =
   1.2538e+03
df_c2_f =
   1.2820e+03
```

Truncation Error

```
exact = 1272;
```

```
E_f_c = abs(exact-df_f_c);
E_f_f = abs(exact - df_f_f);
E_f2_c = abs(exact - df_f2_c);
E_f2_f = abs(exact - df_f2_f);
fprintf('True Error\n')
fprintf('          O(h)     O(h2)\n')
fprintf('Coarse  %.2f     %.2f\n',E_f_c,E_f2_c)
fprintf('Fine    %.2f     %.2f\n',E_f_f,E_f2_f)
fprintf('\nTrue Relative Error\n')
fprintf('         O(h)     O(h2)\n')
fprintf('Coarse   %.2f     %.2f\n',E_f_c/exact,E_f2_c/exact)
fprintf('Fine     %.2f     %.2f\n',E_f_f/exact,E_f2_f/exact)
```

```
True Error
          O(h)     O(h2)
Coarse  362.06     95.88
Fine    170.07     21.93

True Relative Error
         O(h)     O(h2)
Coarse   0.28     0.08
Fine     0.13     0.02
```

Using derfun

```
df_f_c
derfun(f,4,.5,1,'f')
df_b2_c
derfun(f,4,.5,2,'b')
df_c2_f
derfun(f,4,.25,2,'c')
help derfun
```

```
df_f_c =
   1.6341e+03
ans =
   1.6341e+03
df_b2_c =
   1.2061e+03
ans =
   1.2061e+03
df_c2_f =
   1.2820e+03
ans =
   1.2820e+03
  derfun: Numerical calculation of first derivative
    df = derfun(f,x,h,O,dir)

  inputs:
    f = function to differentiate
    x = location where to evaluate derivative
    h = step size
    O = order of accuracy (1, 2 or 4)
    dir = string indicating direction, 'f' 'b' 'c'
```

```
  outputs:
    df = numerical estimation of the derivative
```

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