%% Example of how test are conducted on our (Newton) line search method. We show examples of when only the result is printed, and when we choose a more verbose output.

```
% Performing line search on functions (1-10^a*lambda)^2 for a in [-10, 10]. Only printing results
>> newtonTest(0)
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 10, has
Optimal point: 1.000000e-10
Function value: 4.096000e-15
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 9, has
Optimal point: 1.000000e-09
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 8, has
Optimal point: 1.000000e-08
Function value: 6.103515e-19
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 7, has
Optimal point: 1.000000e-07
Function value: 3.725306e-21
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 6, has
Optimal point: 1.000000e-06
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 5, has
Optimal point: 1.000000e-05
Function value: 5.552958e-25
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 4, has
Optimal point: 1.000000e-04
Function value: 3.371505e-27
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 3, has
Optimal point: 1.000000e-03
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 2, has
Optimal point: 1.000000e-02
```

```
Function value: 1.232595e-30
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 1, has
Optimal point: 1.000000e-01
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = 0, has
Optimal point: 1
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -1, has
Optimal point: 10
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -2, has
Optimal point: 100
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -3, has
Optimal point: 1000
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -4, has
Optimal point: 10000
Function value: 0
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -5, has
Optimal point: 1.000000e+05
Function value: 1.491440e-28
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -6, has
Optimal point: 9.999999e+05
Function value: 5.108799e-15
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -7, has
Optimal point: 1.000161e+07
Function value: 2.592823e-08
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -8, has
```

```
Optimal point: 9.999997e+07
Function value: 7.823388e-14
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -9, has
Optimal point: 1.000000e+09
Function value: 3.882002e-23
Line search finished successfully.
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -10, has
Optimal point: 1.000000e+10
Function value: 1.810054e-13
Line search finished successfully.

% Performing line search on (1-10^a*lambda)^2, a = -10, with verbose output. It
shows the way we choose to handle possible vanishing second-derivatives.
>> newtonTest(1)
-----------------------------------------------------
-----------------------------------------------------
Executing line search...
Computing derivatives...
First attempt: 1st derivative: -2e-10
First attempt: 2nd derivative: 0
--------------------------
Increasing h to 1
Now: 1st derivative: -2e-10
Now: 2nd derivative: 0
Increasing h to 10
Now: 1st derivative: -2e-10
Now: 2nd derivative: -5.5511e-19
--------------------------
After iteration: 1st derivative =-2e-10
After iteration: 2nd derivative = -5.5511e-19,
now using h = 10
--------------------------
Performing line search...
Fp(current_x) = -2e-10
Fpp(current_x) = -5.5511e-19

Fp(current_x) = -2.0721e-10
Fpp(current_x) = 5.5511e-19

Fp(current_x) = -1.9974e-10
Fpp(current_x) = 5.5511e-19

Fp(current_x) = -1.9254e-10
Fpp(current_x) = 5.5511e-19

Fp(current_x) = -1.8561e-10
Fpp(current_x) = 5.5511e-19

Fp(current_x) = -1.7892e-10
Fpp(current_x) = -8.3267e-19

Fp(current_x) = -1.8322e-10
Fpp(current_x) = 2.7756e-19
```

```
Fp(current_x) = -1.7001e-10
Fpp(current_x) = -5.5511e-19

Fp(current_x) = -1.7614e-10
Fpp(current_x) = -5.5511e-19

Fp(current_x) = -1.8249e-10
Fpp(current_x) = -5.5511e-19

Fp(current_x) = -1.8906e-10
Fpp(current_x) = -2.7756e-19

Fp(current_x) = -2.0268e-10
Fpp(current_x) = 0

Second derivative vanishes: recomputing derivatives...
Computing derivatives...
First attempt: 1st derivative: -2.0268e-10
First attempt: 2nd derivative: 0
--------------------------
Increasing h to 1
Now: 1st derivative: -2.0268e-10
Now: 2nd derivative: 0
Increasing h to 10
Now: 1st derivative: -2.0268e-10
Now: 2nd derivative: 0
Increasing h to 100
Now: 1st derivative: -2.0268e-10
Now: 2nd derivative: 3.3307e-20
--------------------------
After iteration: 1st derivative =-2.0268e-10
After iteration: 2nd derivative = 3.3307e-20,
now using h = 100
--------------------------
Fp(current_x) = -8.0977e-11
Fpp(current_x) = 2.0817e-20

Fp(current_x) = -3.1769e-12
Fpp(current_x) = 1.9999e-20

Optimum found
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Details:
Difference in function value from previous point:
delta f = 0.00025231
-----------------------------------------------------
Results:
Function @(lambda,a)(1-10^a*lambda)^2, a = -10, has
Optimal point: 1.000000e+10
Function value: 1.810054e-13
Line search finished successfully.
```