```
syms x [1 2]
syms alpha
```

```
f = x2 * (x1 - 2)^2 + 10 * (x2 - 1)^2
```

f = $x_2\,(x_1-2)^2+10\,(x_2-1)^2$

```
g = gradient(f, x)
```

g =

$$\begin{pmatrix} x_2\,(2\,x_1-4) \\ 20\,x_2+(x_1-2)^2-20 \end{pmatrix}$$

```
h = hessian(f)
```

h =

$$\begin{pmatrix} 2\,x_2 & 2\,x_1-4 \\ 2\,x_1-4 & 20 \end{pmatrix}$$

```
x = transpose(x)
```

x =

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

```
x_val = [1;1]
```

```
x_val = 2×1
     1
     1
```

```
for i = 1:2
    h_val = subs(h, x, x_val)
    g_val = subs(g, x, x_val)

    d_val = - inv(h_val) * g_val

    x_new = x_val + alpha * d_val

    phi = subs(f, x, x_new)

    alpha_vals = solve([gradient(phi) == 0, alpha >= 0], alpha)
    phi_vals = double(subs(phi, alpha, alpha_vals))
    [phi_vals, alpha_idx] = sort(phi_vals)

    alpha_val = alpha_vals(alpha_idx(1))
```

```
    x_val = subs(x_new, alpha, alpha_val)
    g_val = subs(g, x, x_val)
end
```

h_val =

$$\begin{pmatrix} 2 & -2 \\ -2 & 20 \end{pmatrix}$$

g_val =

$$\begin{pmatrix} -2 \\ 1 \end{pmatrix}$$

d_val =

$$\begin{pmatrix} 1.0556 \\ 0.0556 \end{pmatrix}$$

x_new =

$$\begin{pmatrix} 1.0556\,\alpha + 1 \\ 0.0556\,\alpha + 1 \end{pmatrix}$$

phi = $(1.0556\,\alpha - 1)^2\,(0.0556\,\alpha + 1) + 0.0309\,\alpha^2$

alpha_vals = 0.9230

```
phi_vals = 0.0270
phi_vals = 0.0270
alpha_idx = 1
```

alpha_val = 0.9230

x_val =

$$\begin{pmatrix} 1.9743 \\ 1.0513 \end{pmatrix}$$

g_val =

$$\begin{pmatrix} -0.0540 \\ 1.0263 \end{pmatrix}$$

h_val =

$$\begin{pmatrix} 2.1026 & -0.0514 \\ -0.0514 & 20 \end{pmatrix}$$

g_val =

$$\begin{pmatrix} -0.0540 \\ 1.0263 \end{pmatrix}$$

d_val =

$$\begin{pmatrix} 0.0244 \\ -0.0512 \end{pmatrix}$$

x_new =

$$\begin{pmatrix} 0.0244\,\alpha + 1.9743 \\ 1.0513 - 0.0512\,\alpha \end{pmatrix}$$

phi = $10\,(0.0512\,\alpha - 0.0513)^2 - (0.0512\,\alpha - 1.0513)\,(0.0244\,\alpha - 0.0257)^2$

alpha_vals =

$$\begin{pmatrix} 586.2227 \\ 1.0017 \end{pmatrix}$$

phi_vals = 2×1

```
10^3 ×
    3.0670
    0.0000
phi_vals = 2×1
10^3 ×
    0.0000
    3.0670
alpha_idx = 2×1
     2
     1
alpha_val = 1.0017
x_val =
```

$$\begin{pmatrix} 1.9988 \\ 0.9999 \end{pmatrix}$$

```
g_val =
```

$$\begin{pmatrix} -0.0024 \\ -0.0012 \end{pmatrix}$$