```
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 =

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

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

x =

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

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

```
x_val = 2×1
     1
     1
```

```
g_val = subs(g, x, x_val)
```

g_val =

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

```
threshhold = 0.001
```

```
threshhold = 1.0000e-03
```

```
for i = 1:2
    d = - g_val
    x_new = x_val + alpha * d

    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
```

```
d =
```

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

```
x_new =
```

$$\begin{pmatrix} 2\,\alpha + 1 \\ 1 - \alpha \end{pmatrix}$$

```
phi =
```

$$10\,\alpha^2 - (2\,\alpha - 1)^2\,(\alpha - 1)$$

```
alpha_vals =
```

$$\begin{pmatrix} 0.1460 \\ 2.8540 \end{pmatrix}$$

```
phi_vals = 2×1
    0.6412
   40.3588
phi_vals = 2×1
    0.6412
   40.3588
alpha_idx = 2×1
     1
     2
```

```
alpha_val =
```

$$0.1460$$

```
x_val =
```

$$\begin{pmatrix} 1.2920 \\ 0.8540 \end{pmatrix}$$

```
g_val =
```

$$\begin{pmatrix} -1.2093 \\ -2.4186 \end{pmatrix}$$

```
d =
```

$$\begin{pmatrix} 1.2093 \\ 2.4186 \end{pmatrix}$$

```
x_new =
```

$$\begin{pmatrix} 1.2093\,\alpha + 1.2920 \\ 2.4186\,\alpha + 0.8540 \end{pmatrix}$$

```
phi =
```

$$10\,(2.4186\,\alpha - 0.1460)^2 + (1.2093\,\alpha - 0.7080)^2\,(2.4186\,\alpha + 0.8540)$$

```
alpha_vals =
```

$$0.0653$$

```
phi_vals = 0.4018
phi_vals = 0.4018
alpha_idx = 1
alpha_val =
```

$$0.0653$$

```
x_val =
```

$$\begin{pmatrix} 1.3710 \\ 1.0120 \end{pmatrix}$$

```
g_val =
```

$$\begin{pmatrix} -1.2731 \\ 0.6366 \end{pmatrix}$$