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Course: Optimization and Numerical Probability

Projected Gradient Method with four variables

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```
format short;
clc;clear;
syms x_1 x_2 x_3 x_4;
```

Ojective function

```
f = (x_1+x_2)^2+(x_3+x_4)^4+3*(x_1-2)^2+ (2*x_3+1)^2+2*(x_4-0.5)^2+1
```

f =

$$3\,(x_1-2)^2+2\left(x_4-\frac{1}{2}\right)^2+(2\,x_3+1)^2+(x_1+x_2)^2+(x_3+x_4)^4+1$$

```
p_f = 0.5*[(x_1-x_2),(x_2-x_1),(x_3-x_4),(x_4-x_3)]
```

p_f =

$$\left(\frac{x_1}{2}-\frac{x_2}{2}\quad\frac{x_2}{2}-\frac{x_1}{2}\quad\frac{x_3}{2}-\frac{x_4}{2}\quad\frac{x_4}{2}-\frac{x_3}{2}\right)$$

initial guess

```
xo = [1 -1 1 -1]
```

xo = 1×4

1	-1	1	-1

```
e = 0.01;
```

```
i = 1;
```

gradient

```
g_func = gradient(f);
grad = (subs(g_func,[x_1,x_2,x_3,x_4],[xo(1),xo(2),xo(3),xo(4)]));
xk = xo
```

xk = 1×4

1	-1	1	-1

```
%x_k = subs(p_f,[x_1,x_2,x_3,x_4],[xo(1),xo(2),xo(3),xo(4)]);
```

projected gradient descent

```
while norm(grad)>e
    w(i) = xk(1);x(i) = xk(2);y(i) = xk(3);z(i) = xk(4);
    I = [w(i),x(i),y(i),z(i)];
    x1 = I(1) - 0.2*grad(1);
    x2 = I(2) - 0.2*grad(2);
    x3 = I(3) - 0.2*grad(3);
    x4 = I(4) - 0.2*grad(4);
    J = [x1, x2, x3, x4];
```

Updating the gradient

```
    xk = subs(p_f,[x_1,x_2,x_3,x_4],[J(1),J(2),J(3),J(4)]);
    grad = (subs(g_func,[x_1,x_2,x_3,x_4],[xk(1),xk(2),xk(3),xk(4)]));
    f_x(i) = subs(f,[x_1,x_2,x_3,x_4], [xk(1),xk(2),xk(3),xk(4)]);
    i = i + 1;
end
```

Representing the final outcome as a Table

```
itr = 1:i-1;
f_xk = f_x';
f_xk  = round(double(f_xk),10);
x_1 = w';x_2 = x';x_3 = y';x_4 = z';
iterations = itr';
T = table(x_1,x_2,x_3,x_4,f_xk,iterations)
```

T = 7×6 table

	x_1	x_2	x_3	x_4	f_xk	iterations
1	1.0000	-1.0000	1.0000	-1.0000	2.0200	1
2	1.6000	-1.6000	-0.8000	0.8000	1.0984	2
3	1.8400	-1.8400	-0.4400	0.4400	1.0132	3
4	1.9360	-1.9360	-0.5120	0.5120	1.0020	4
5	1.9744	-1.9744	-0.4976	0.4976	1.0003	5
6	1.9898	-1.9898	-0.5005	0.5005	1.0001	6
7	1.9959	-1.9959	-0.4999	0.4999	1.0000	7