

# Multi-D optimization problem

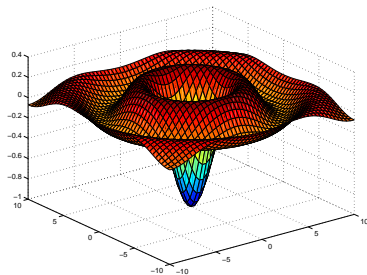
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Lecture 15

# Multi-D optimization



Find  $\vec{x}$  that minimize  $E(\vec{x})$  subject to  $g(\vec{x}) = 0, h(\vec{x}) \leq 0$

$\vec{x}$  design variables

$E(\vec{x})$  merit or objective or fitness or energy function

$g(\vec{x})$  and  $h(\vec{x})$  constrains

Easy to see that maximization problem is the same as minimization once  $E(\vec{x}) \rightarrow -E(\vec{x})$ .

# Solution with Matlab built in Multi-D minimization - fminsearch

```
[x, fval] = fminsearch(fun, x0)
```

**fun** handle to the multi-variable function

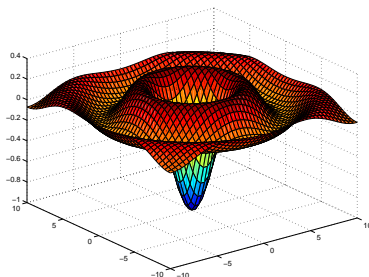
**x0** initial 'guess' (vector)

**x** optimum position vector

**fval** value of the function at the optimum

## Example

```
function ret=fsample_sinc(v)
    x=v(1); y=v(2);
    r=sqrt(x^2+y^2);
    ret= -sin(r)/r;
end
```

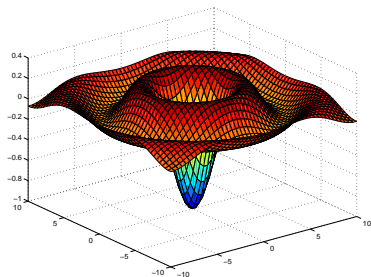


```
x0vec=[0.5, 0.5];
[xResVec,zopt]=fminsearch(@fsample_sinc, x0vec)
xResVec = [0.2852e-4, 0.1043e-4]
zopt = -1.0000
```

# It is easy to miss global minimum

## Example

```
function ret=fsample_sinc(v)
    x=v(1); y=v(2);
    r=sqrt(x^2+y^2);
    ret= -sin(r)/r;
end
```



## Example

```
x0vec=[5, 5];
[xResVec,zopt]=fminsearch(@fsample_sinc, x0vec)
xResVec = [ 5.6560    5.2621 ]
zopt = -0.1284
```

# Sample problem 1

## Problem 1.

Find the minimum of the function

$$F(x, y, z) = 2x^2 + 2y^2 + z^2 + 2xy + 1 - 2y + 2xy$$

Answer:  $[x, y, z] = [-1, 1, 1]$

# Sample problem 2

## Problem 2.

Consider masses  $m_1$  and  $m_2$  suspended by strings with length  $L_1$ ,  $L_2$ , and  $L_3$ .

Find the angles  $\theta_1$ ,  $\theta_2$ , and  $\theta_3$ .

We need to minimize potential energy subject to the length constraints. See merit function in the file 'EconstrainedSuspendedWeights.m'

For the following initial conditions

```
m1=2; m2=2;  
L1=3; L2=2; L3=3;  
Ltot=4; Htot=0;
```

The answer should be close to  $\theta_1 = -1.231$ ;  $\theta_2 = 0$ ;  $\theta_3 = 1.231$ ;

