Multi-D optimization problem

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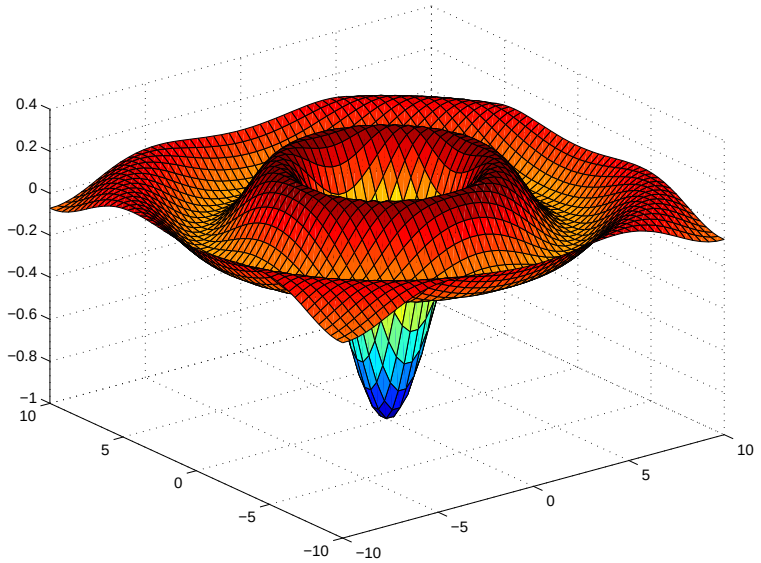
Lecture 15

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

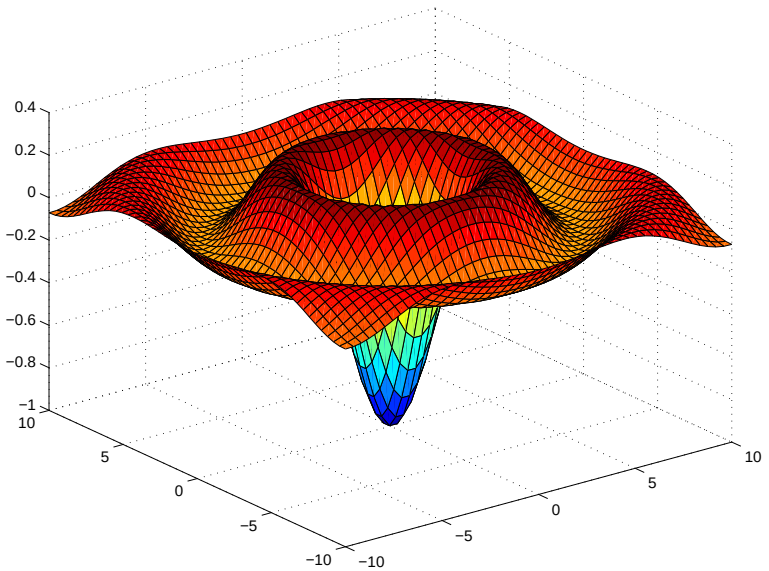
```
[x,fval] = fminsearch(fun,x0)
```

fun	hanldle to the multi-variable function
x0	initial 'guess' (vector)
x	optimum position vector
fval	value of the function at the optimum

fminsearch - usage example

Example

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

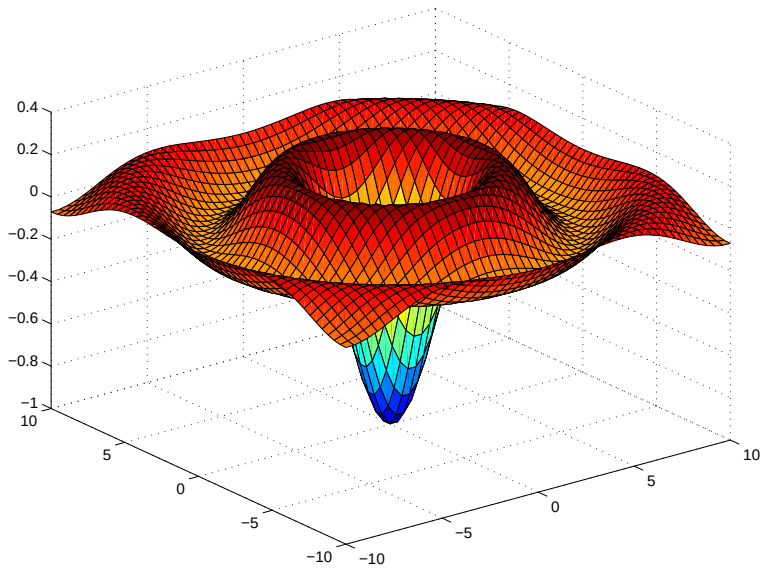



```
x0vec=[0.5, 0.5];
[xResVec,zopt]=fminsearch(@fsample_sinc, x0vec)
  xResVec = [0.2852e-4,    0.1043e-4]
  zopt = -1.0000
```

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.

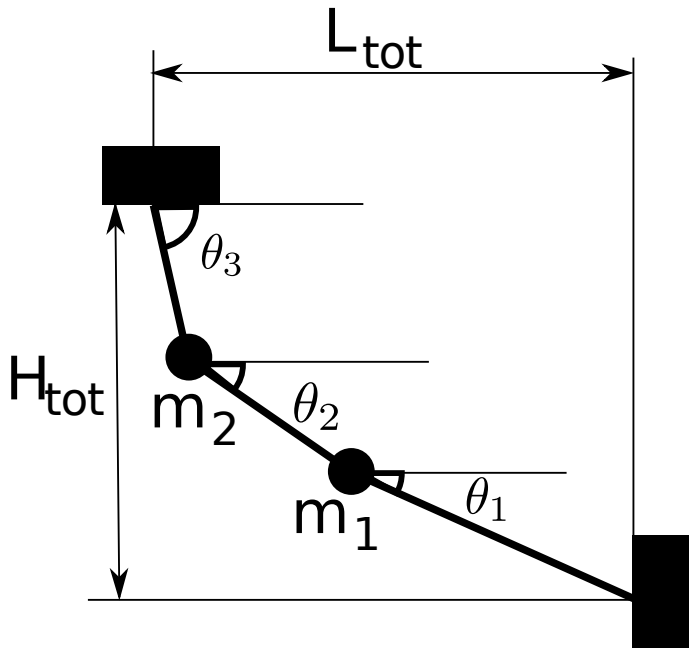
Find the minimum of the function

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

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 θ_1, θ_2, and θ_3.



We need to minimize potential energy subject to the length constrains. 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 $\theta_1 = -1.231; \theta_2 = 0; \theta_3 = 1.231;$