Convex Optimization for Machine Learning

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Cs 460 - Machine learning
Poster Presentation

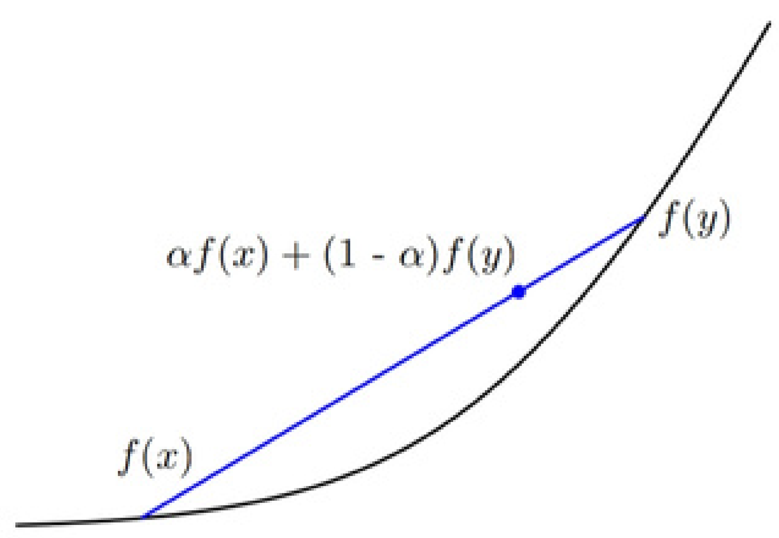
Guide :- Dr. Subhankar Mishra

what is optimization ?

Finding the minimizer of a function subject to constraints :
minimize f(x)
s.t. fi(x) <= 0 , i = {1,2,....,k}
hj(x) = 0 , j ={1,2,....,l}

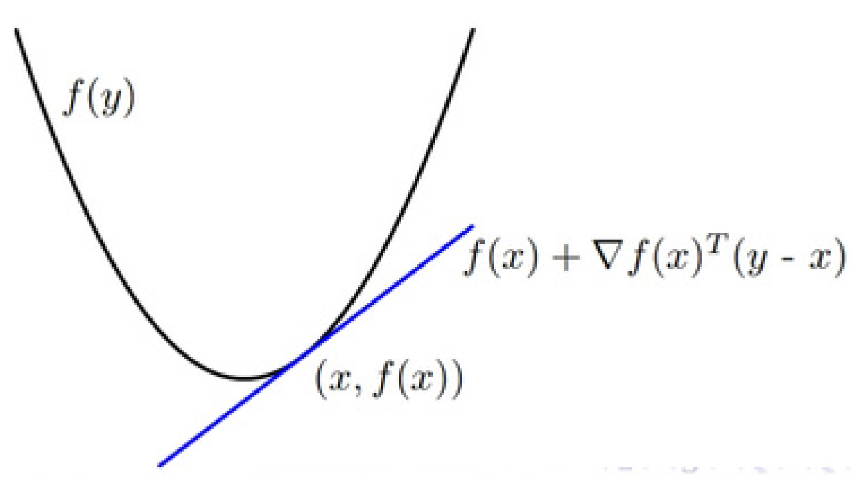
Convex Functions

A function f: R^n -----> R is convex if for x,y belonging to domain of f and any a belonging to [0,1] ,
f(ax+(1-a)y)<=af(x)+(1-a)f(y)

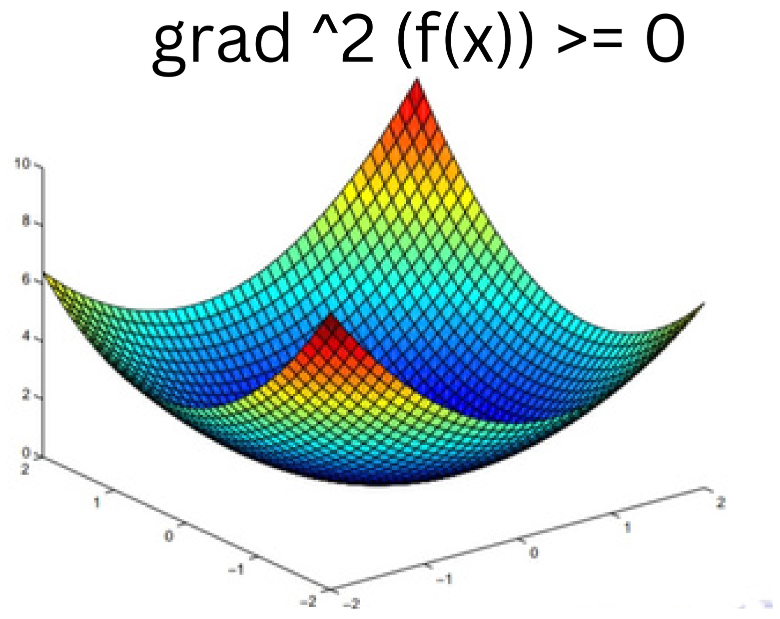


Convexity conditions

First order convexity condition
Theorem:- suppose f:R^n---->R is differentiable. Then f is convex iff for all x,y belonging to domain of f ,we have
f(y) >= f(x) + grad (f(x) ^T)(y-x)

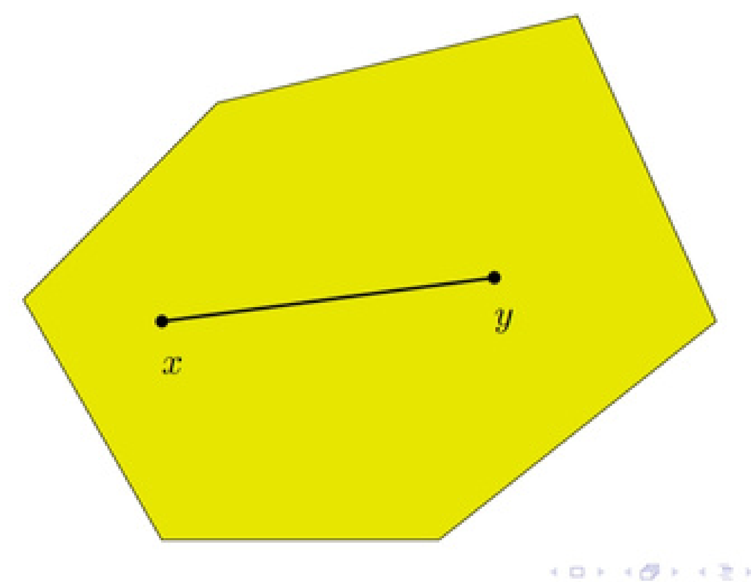


Second order convexity condition
Theorem:- suppose f: R^n ---> R is twice differentiable .
Then f is convex iff for all x belonging to domain f we have
grad ^2 (f(x)) >= 0

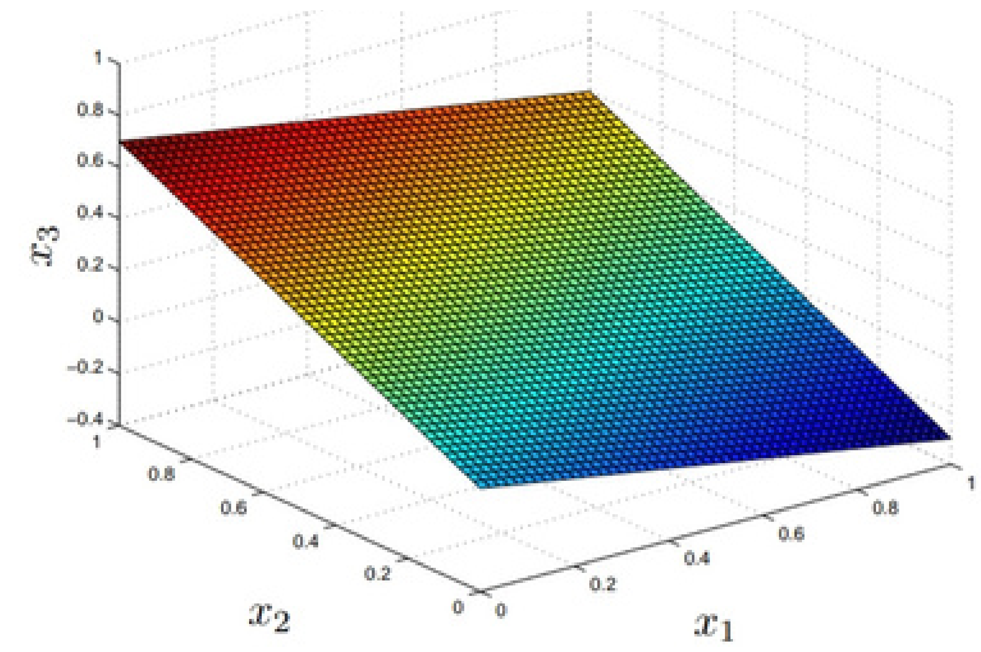


Convex Sets

A set C is a subset of R^n is convex if for
x,y belonging to C and any a belonging to [0,1] ,
ax + (1-a)y belongs to C



Example :- Affine Subspaces : Ax = b , Ay = b , then
A(ax+(1-a)y) = aAx+(1-a)Ay=ab+(1-a)b=b



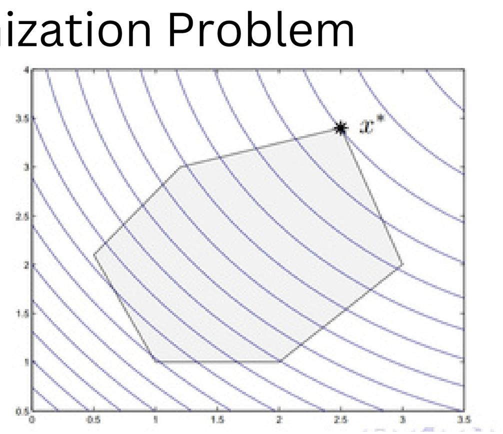
Convex Optimization Problem

A optimization problem is convex if it's objective is a convex function, the inequality constraints fi are convex , and the equality constraints hj are affine

	minimize f(x)	(convex function)
s.t.	fi(x) <= 0.	(Convex sets)
	hj= 0.	(affine)

Some important results

#. If x* is a local minimizer of a convex Optimization Problem then it is a global minimizer



##. Gradient of f(x) = 0 iff x is a global minimizer of f(x)