$$\arg\min_x E(x)$$

$$Ax \geq 0$$

$$\arg\min_{x,y} E(x) + I(y)$$

$$Ax - y = 0$$

$$I(y) = \begin{cases} +\infty & y < 0 \\ 0 & y \geq 0 \end{cases}$$

$$\arg\max_u \min_{x,y} E(x) + I(y) + \frac{\rho}{2}(\|Ax - y + u\|_2^2 - \|u\|_2^2)$$

$k \leftarrow 0$
$x^k \leftarrow 0, \qquad y^k \leftarrow 0, \qquad u^k \leftarrow 0$
LOOP until convergence
$\qquad x^{k+1} \leftarrow \arg\min_x E(x) + \frac{\rho}{2}\|Ax - y^k + u^k\|_2^2, \qquad$ (Primal Descent 1)
$\qquad y^{k+1} \leftarrow \max(0, Ax^{k+1} + u^k), \qquad\qquad$ (Primal Descent 2)
$\qquad u^{k+1} \leftarrow u^k + Ax^{k+1} - y^{k+1}, \qquad\qquad$ (Dual Ascent)
$x^* \leftarrow x^k$

$$g(x) = \frac{\partial E(x)}{\partial x}, \qquad h(x) = \frac{\partial^2 E(x)}{\partial x^2}$$

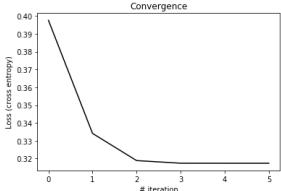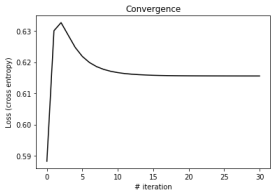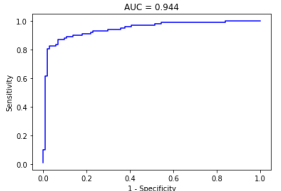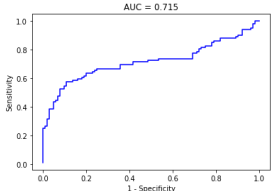$$x_{\text{Newton}}^{k+1} = (h + \rho A^T A)^{-1}\left(g + \rho A^T(Ax^k - y^k + u^k)\right)$$

$$E(x) = \sum_{i=1}^{N} \left(l_i \log \sigma(f_i^T x) + (1 - l_i) \log \left(1 - \sigma(f_i^T x)\right) \right)$$

$$g(x) = \frac{\partial E(x)}{\partial x} = \sum_{i=1}^{N} f_i \left(\sigma(f_i^T x) - l_i\right)$$

$$h(x) = \frac{\partial^2 E(x)}{\partial x^2} = \sum_{i=1}^{N} f_i \left(\sigma(f_i^T x) \left(1 - \sigma(f_i^T x)\right)\right) f_i^T$$

$$A = \text{diag}\{1,1,1,\dots,1\}$$

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

	Unconstrained	Constrained
Regression weight (x^*)	[[-2.816e+00] [-2.185e-01] [3.583e-01] [-1.272e-02] [-1.724e-01] [1.750e+00] [1.979e-02] [1.803e-03] [-8.547e-01] [-7.706e-02]]	[[1.133e-04] [9.864e-05] [1.293e-01] [6.451e-02] [9.399e-05] [5.835e-01] [2.215e-01] [4.573e-01] [9.647e-05] [1.009e-04]]
$E(x)$ vs. Iter		
Confusion $\begin{bmatrix} TN & FP \\ FN & TP \end{bmatrix}$	[[93 8] [13 86]]	[[73 28] [33 66]]
Precision	0.915	0.702
Recall	0.869	0.667
ROC		
AUC	0.944	0.715