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2. Given

$$J(\theta) = \frac{1}{N}\sum_{i=1}^{N}\left(\theta^T x^{(i)} + by^{(i)}\right) + \frac{1}{2}\theta^T A\theta$$

(a) $$\frac{\partial J(\theta)}{\partial \theta} = \frac{1}{N}\sum_{i=1}^{N}\frac{\partial}{\partial \theta}\left(\theta^T x^{(i)} + by^{(i)}\right) + \frac{1}{2}\frac{\partial}{\partial \theta}\left(\theta^T A\theta\right)$$

$$= \frac{1}{N}\sum_{i=1}^{N}\left(x^{(i)}\right) + \frac{1}{\cancel{2}}\left(\cancel{2}A\right)$$

$$\boxed{\frac{\partial J(\theta)}{\partial \theta} = \frac{1}{N}\sum_{i=1}^{N} x^{(i)} + A}$$

(b) Closed form

$$\frac{\partial J(\theta)}{\partial \theta}$$

(c) Given $Ax = \lambda x$

$(\lambda = \text{scalar})$

Multiply A,

$$A^2x = A\lambda x = \lambda Ax = \lambda^2 x$$

Multiply A,

$$A^3x = A\lambda^2 x = \lambda^2 Ax$$
$$= \lambda^3 x$$

⋮

k times

⋮

$$A^k x = \lambda^k x$$

$\therefore$ x is eigen vector for A^k

Also $A^k x = \lambda^k x$

where λ^k is eigen value

for eigen vector x

for A^k