



# IA353A - Neural Networks EC1

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## Question 1

## Question 2

$$\|Ax - b\|_P^2 + \|x - x_0\|_Q^2$$

Since we are searching for  $x$  that minimizes the previous expression, we will calculate the derivative with relation to  $x$  and set it equal to zero:

$$\frac{d}{dx}(\|Ax - b\|_P^2 + \|x - x_0\|_Q^2) = 0$$

**Property used:**  $\|x\|_Q^2 = x^T Q x$

$$\frac{d}{dx} \left[ \overbrace{(Ax - b)^T P (Ax - b)}^{\|Ax - b\|_P^2} + \overbrace{(x - x_0)^T Q (x - x_0)}^{\|x - x_0\|_Q^2} \right] = 0$$

**Property used:**  $(M + N)^T = M^T + N^T$

$$\frac{d}{dx} \{ [(Ax)^T - b^T] P (Ax - b) + (x^T - x_0^T) Q (x - x_0) \} = 0$$

**Property used:**  $(MN)^T = N^T M^T$

$$\frac{d}{dx} \{ [x^T A^T - b^T] P (Ax - b) + (x^T - x_0^T) Q (x - x_0) \} = 0$$

$$\frac{d}{dx} [(x^T A^T P A x - x^T A^T P b - b^T P A x + b^T P b) + (x^T Q x - x^T Q x_0 - x_0^T Q x + x_0^T Q x_0)] = 0$$

**Properties used:**

- $\frac{d}{dy}(y^T M y) = M^T y + M y.$
- $\frac{d}{dy}(y^T M y) = 2 M y$ , if  $M = M^T$  (i.e.  $M$  is simetric)
- $\frac{d(Ax)}{dx} = A$
- $\frac{d(x^T A)}{dx} = A^T$
- obs.:  $A^T P A$  is simetric, since  $(A^T P A)^T = (P A)^T (A^T)^T = A^T P^T A$ , but  $P^T = P$ , since  $P$  is simetric. Then  $A^T P A = (A^T P A)^T$

**Using the previous properties, we have:**

$$\frac{d}{dx} [(x^T A^T P A x - x^T A^T P b - b^T P A x + b^T P b) + (x^T Q x - x^T Q x_0 - x_0^T Q x + x_0^T Q x_0)] = 0$$

$$[2A^T P A x - (A^T P b)^T - b^T P A + 0] + [2Q x - (Q x_0)^T - x_0^T Q + 0] = 0$$

$$2A^T P A x - (P b)^T (A^T)^T - b^T P A + 2Q x - x_0^T Q^T - x_0^T Q = 0$$

$$2A^T P A x - b^T P^T A - b^T P A + 2Q x - x_0^T Q - x_0^T Q = 0$$

$$2A^T P A x - b^T P A - b^T P A + 2Q x - x_0^T Q - x_0^T Q = 0$$

$$2A^T P A x - 2b^T P A + 2Q x - 2x_0^T Q = 0$$

$$2A^T P A x + 2Q x = 2b^T P A + 2x_0^T Q$$

$$A^T P A x + Q x = b^T P A + x_0^T Q$$

$$(A^T P A + Q)^{-1} (A^T P A + Q) x = (A^T P A + Q)^{-1} (b^T P A + x_0^T Q)$$

$$x = (A^T P A + Q)^{-1} (b^T P A + x_0^T Q)$$

$$x = (A^T P A + Q)^{-1} (b^T P^T A + x_0^T Q^T)$$

$$x = (A^T P A + Q)^{-1} [(P b)^T A + (Q x_0)^T]$$

$$x = (A^T P A + Q)^{-1} [(A^T P b)^T + (Q x_0)^T]$$

$$\boxed{x = (A^T P A + Q)^{-1} (A^T P b + Q x_0)^T}$$

### Question 3

### Question 4

### Question 5

### Question 6

O primeiro paper selecionado é de 2002 com 2173 citações. Esse paper foi publicado no JAMA (The Journal of the American Medical Association) que é um jornal da área médica com 48 publicações por ano pela AMA (American Medical Association).

title: Effects of Cognitive Training Interventions With Older Adults - A Randomized Controlled Trial  
year: 2002 cited by: 2173 publication: JAMA reference:

Ball K, Berch DB, Helmers KF, et al. Effects of Cognitive Training Interventions With Older Adults: A Randomized Controlled Trial. JAMA. 2002;288(18):2271–2281. doi:10.1001/jama.288.18.2271

O segundo paper selecionado é de 2009 e conta com 315 citações. Esse paper foi publicado no jornal acadêmico Alzheimer's & Dementia, que conta com publicações mensais da associação sem fins lucrativos Journal of the Alzheimer's Association.

title: Immediate and delayed effects of cognitive interventions in healthy elderly: A review of current literature and future directions year: 2009 cited by: 315 publication: Alzheimer's & Dementia (Volume 5, Issue 1, January 2009, Pages 50-60) reference:

Papp K V, Walsh S J, Snyder P J. Immediate and delayed effects of cognitive interventions in healthy elderly: a review of current literature and future directions. Alzheimer's and Dementia 2009; 5(1): 50-60. [PubMed]