Adaptive and Array Signal Processing/Processamento de Sinais Adaptativo

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Tutorial Questions/Lista de Exercícios - 1

1. Prove or disprove each of the following statements:

a) The product of two upper triangular matrices is upper triangular.

b) The product of two Toeplitz matrices is Toeplitz.

c) The product of two centrosymmetric matrices is centrosymmetric.

2. Consider the set of inconsistent linear equations $Ax=b$given by

$$\left[\begin{matrix}1&0\\0&1\\1&1\end{matrix}\right]\left[\begin{matrix}x\_{1}\\x\_{2}\end{matrix}\right]=\left[\begin{matrix}1\\1\\0\end{matrix}\right]$$

a) Find the least squares solution to these equations.

b) Find the projection matrix $P\_{A}$.

c) Find the best approximation $\hat{b}=P\_{A}b$to$b$.

d) Consider the matrix $ P\_{A}^{⊥}=I- P\_{A}$ , find the vector $b^{⊥}= P\_{A}^{⊥}b$andshow that it is orthogonal to $\hat{b}$. What does the matrix $ P\_{A}^{⊥}$ represent**?**

3. Consider the following 3x3 symmetric matrix

$$A=\left[\begin{matrix}1&-1&0\\-1&2&-1\\0&-1&1\end{matrix}\right]$$

a) Find the eigenvalues and eigenvectors of $A$.

b) Find the determinant of $A$.

c) Compute the spectral decomposition of $A$.

d) What are the eigenvalues of $A+I$ and how are the eigenvectors related to those of $A$?