Math Tools for Neuroscience
Handout 1: Linear Algebra

April 1, 2015

1 Overview

These exercises are designed to give you some familiarity with matrix multiplication.

2 Dot products

Prompt. *Complete the following matrix multiplications.*

$$x^T y = \begin{pmatrix} 1 & -1 \end{pmatrix} \cdot \begin{pmatrix} y_1 \\ y_2 \end{pmatrix} \qquad Wx = \begin{pmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} \qquad XX^T = \begin{pmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & a_{22} & x_{23} \end{pmatrix} \cdot \begin{pmatrix} x_{11} & x_{21} \\ x_{12} & x_{22} \\ x_{13} & x_{23} \end{pmatrix}$$

3 Outer products

Prompt. *The first matrix multiplication we learned was the element-wise multiplication, where as an example we scaled each variable by its standard deviation,*

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} ./ \begin{pmatrix} \sigma_1 & \sigma_1 \\ \sigma_2 & \sigma_2 \end{pmatrix} = \begin{pmatrix} a_{11}/\sigma_1 & a_{12}/\sigma_1 \\ a_{21}/\sigma_2 & a_{22}/\sigma_2 \end{pmatrix}.$$

But how would we construct $\Sigma = \begin{pmatrix} \sigma_1 & \sigma_1 \\ \sigma_2 & \sigma_2 \end{pmatrix}$ in MATLAB? Given a 2 dimensional row vector of standard deviations (`std(A')` in MATLAB), construct Σ using an outer product instead of a `for` loop.