

# Machine Learning - Homework 1

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You may want to use calculators to help you with the homework. For example, a powerful on-line math tool which you may use it for Linear Algebra, Plotting, Calculus, Statistics, etc. <https://www.wolframalpha.com/>

Please send your answers to your personal Slack Channel before **June 9**.

## 1 Probability

A class of students are tested for cannabis drug use. The imperfect test gives positive results (indicating drug use) for 90% of all drug-users but also (and incorrectly) for 2% of those who do not use drug. Suppose that we know 5% of all students in the city use drug. If a student of the class is tested positive, what is the probability that he/she uses drug?

## 2 Linear Algebra

We have a vector

$$\mathbf{x} = \begin{pmatrix} 2 \\ 5 \\ 3 \end{pmatrix}$$

and a matrix

$$A = \begin{pmatrix} 1 & 3 & 5 \\ 2 & -1 & 0 \\ 4 & 7 & 9 \end{pmatrix}$$

What is  $\mathbf{x}^T A \mathbf{x}$ ?

## 3 Calculus

Please have a quick look and learn from a very intuitive and friendly tutorial for Calculus:

<https://www.youtube.com/watch?v=WUvTyaaNkzM>

<https://www.youtube.com/watch?v=9vKqVkmQHKk>.

And answer: If  $f(x) = |x^3|$ , where  $|\cdot|$  means taking the absolute value, then what is  $f'(x)$ ?

## 4 Advanced Calculus

*Optional. You may do this part if you know undergraduate-level math.*

Define a vector  $\boldsymbol{x} \in \mathbb{R}^n$  and a matrix  $A \in \mathbb{R}^{n \times n}$ . We have a multi-variate function

$$f(\boldsymbol{x}) = \boldsymbol{x}^T A \boldsymbol{x}$$

What is its gradient  $\nabla f$ ?