# Machine Learning
# exercise 1

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## 1 Hastie, Tibshirani & Friedman

Read chapter 1 of Hastie et al.'s "Elements of Statistical Learning" (http://www-stat.stanford.edu/~tibs/ElemStatLearn/). Consider the DNA microarray data of Figure 1.3. Let's assume that samples 1-32 are taken from cancer cells whereas samples 33-64 from non-cancer cells. How could one analyze which genes are "involved with cancer"? No formal answers needed, but ceative ideas.

## 2 Matrix equations

a) Let $X, A$ be arbitrary matrices, $A$ invertible. Solve for $X$:

$$XA + A^\top = \mathbf{I}$$

b) Let $X, A, B$ be arbitrary matrices, $(C - 2A^\top)$ invertible. Solve for $X$:

$$X^\top C = [2A(X + B)]^\top$$

c) Let $x \in \mathbb{R}^n, y \in \mathbb{R}^d, A \in \mathbb{R}^{d\times n}$. $A$ obviously *not* invertible, but let $A^\top A$ be invertible. Solve for $x$:

$$(Ax - y)^\top A = \mathbf{0}_n^\top$$

d) As above, additionally $B \in \mathbb{R}^{n\times n}$, $B$ positive-definite. Solve for $x$:

$$(Ax - y)^\top A + x^\top B = \mathbf{0}_n^\top$$

## 3 Vector derivatives

Let $x \in \mathbb{R}^n, y \in \mathbb{R}^d, A \in \mathbb{R}^{d\times n}$.
a) What is $\frac{\partial}{\partial x} x$ ? (Of what type/dimension is this thing?)
b) What is $\frac{\partial}{\partial x} [x^\top x]$ ?
c) Let $B$ be symmetric (and pos.def.). What is the minimum of $(Ax - y)^\top (Ax - y) + x^\top Bx$ w.r.t. $x$?

## 4 Code

Future exercises will need you to code some Machine Learning methods. I'll support C++, but you are free to choose your programming language, which needs to support linear algebra and matrix manipulations.

For those using C++, download and test http://ipvs.informatik.uni-stuttgart.de/mlr/marc/source-code/libMLcourse.13.tgz (see README). In particular, have a look at test/array/main.cpp with many examples on how to use the array class. Report on problems with installation.