Robotics
exercise 1

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1 Geometry

Read the notes on basic 3D geometry at http://ipvs.informatik.uni-stuttgart.de/mlr/marc/notes/3d-geometry.pdf at least until section 2. We will recap this briefly also in the lecture. Prepare questions for the exercises if you have any.

a) You have a book (coordinate frame B) lying on the table (world frame W). You move the book 1 unit to the right, then rotate it by $45°$ counter-clock-wise. Given a dot p marked on the book at position $p^B = (1, 1)$ in the book coordinate frame, what are the coordinates p^W of that dot with respect to the world frame? Given a point x with coordinates $x^W = (0, 1)$ in world frame, what are its coordinates x^B in the book frame? What is the *coordinate* transformation from world frame to book frame, and from book frame to world frame?

2 Vector derivatives

Let $x \in \mathbb{R}^n,\ y \in \mathbb{R}^d,\ f, g : \mathbb{R}^n \to \mathbb{R}^d,\ A \in \mathbb{R}^{d\times n},\ C \in \mathbb{R}^{d\times d}$.

a) What is $\frac{\partial}{\partial x} x$?

b) What is $\frac{\partial}{\partial x}[x^\top x]$?

c) What is $\frac{\partial}{\partial x}[f(x)^\top f(x)]$?

d) What is $\frac{\partial}{\partial x}[f(x)^\top C g(x)]$?

e) Let B and C be symmetric (and pos.def.). What is the minimum of $(Ax - y)^\top C(Ax - y) + x^\top Bx$?

3 Simulation software

Future exercises will require to code some examples in C/C++. Test if you can compile and run the lib that accompanies this lecture. Report on problems with installation.

On Ubuntu:

- install the packages
  `liblapack-dev freeglut3-dev libqhull-dev libf2c2-dev libann-dev gnuplot doxygen`
- get the code from
  http://ipvs.informatik.uni-stuttgart.de/mlr/marc/source-code/libRoboticsCourse.13.tgz
- ```
  tar xvzf libRoboticsCourse.13.tgz
  cd share/examples/Ors/ors
  make
  ./x.exe
  ```
  ```