KTH Stockholm
EECS :: CST
Introduction to Visualization and Computer Graphics, Spring 2018, DH2320/DD2258
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Homework assignment No. 01

Due January 26, 2018

Task 1.1: Vector Calculus — 3+2+2 P

(a) Compute the Euclidean norm of the following vectors and normalize them:

$$\begin{pmatrix}1\\4\\3\end{pmatrix}, \begin{pmatrix}0\\0\\12\end{pmatrix}, \begin{pmatrix}-2\\0\\1\end{pmatrix}.$$

(b) Compute the following dot products:

$$\begin{pmatrix}1\\4\\7\end{pmatrix}^T \begin{pmatrix}-2\\0\\3\end{pmatrix}, \qquad \begin{pmatrix}4\\0\\-5\end{pmatrix}^T \begin{pmatrix}0\\4\\0\end{pmatrix}.$$

(c) Compute the following cross products:

$$\begin{pmatrix}5\\3\\0\end{pmatrix} \times \begin{pmatrix}-2\\4\\0\end{pmatrix}, \qquad \begin{pmatrix}1\\0\\0\end{pmatrix} \times \begin{pmatrix}0\\1\\1\end{pmatrix}.$$

Task 1.2: Cross Product — 4 P

Show that the vector $\mathbf{c} = \mathbf{a} \times \mathbf{b}$ is orthogonal to both $\mathbf{a}$ and $\mathbf{b}$!

Task 1.3: Transformations — 3+3+3+3 P

(a) Determine the 2D transformation matrix describing a reflection at the axis $y = -x + 3$.

(b) Given are the three points

$$\mathbf{x}_1 = \begin{pmatrix}0\\1\end{pmatrix}, \mathbf{x}_2 = \begin{pmatrix}1\\0\end{pmatrix}, \mathbf{x}_3 = \begin{pmatrix}1\\2\end{pmatrix}$$

as well as their images after transformation

$$\mathbf{x}_1' = \begin{pmatrix}-1\\5\end{pmatrix}, \mathbf{x}_2' = \begin{pmatrix}-1\\1\end{pmatrix}, \mathbf{x}_3' = \begin{pmatrix}1\\5\end{pmatrix}.$$

Determine the transformation matrix $\mathbf{T}$ in homogenous coordinates such that $\mathbf{x}_i' = \mathbf{T}\mathbf{x}_i$ for $i = 1, 2, 3$!

(c) Determine the transformation matrix $\mathbf{T}$ in homogenous coordinates for the following transformation:

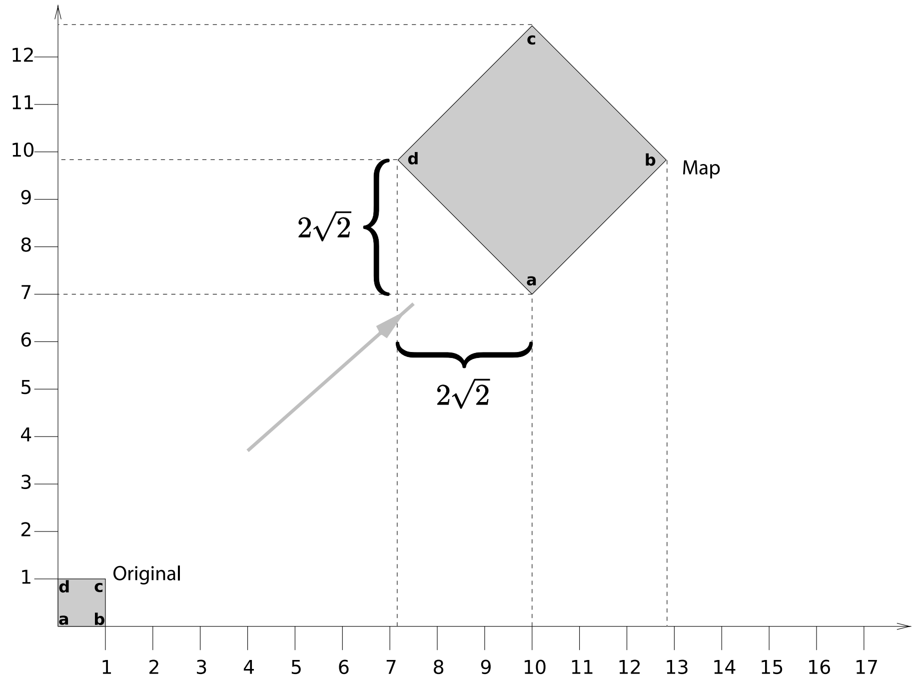
$$\begin{pmatrix}x\\y\end{pmatrix} \longmapsto \begin{pmatrix}\cos^2\alpha\, x - \sin^2\alpha\, y + \frac{\pi}{2}\\ \tan^2\alpha\, y + \cos^2\alpha\, x - \pi\end{pmatrix}.$$

(d) Determine the transformation matrix $\mathbf{T}$ in homogenous coordinates for the following transformation:

$$\begin{pmatrix}x\\y\end{pmatrix} \longmapsto \begin{pmatrix}\pi\\ \frac{3y}{x+\pi} + 2\end{pmatrix}.$$

Task 1.4: Rectangle — 5 P

Given are an original rectangle (left) and its map after transformation (right). The mapped rectangle has been obtained using an unknown transformation.



Determine the transformation matrix $\mathbf{T}$ in homogenous coordinates for this 2D transformation. You can write it as a product of several matrices.

Task 1.5: My first visualization **2+3 P**

88 students filled out the self-introduction form. An anonymized version of the data has been created by replacing all names with the Top100 baby names of 2016 and removing other identifying information. The data can be downloaded from Canvas as well.

It is now your turn to visualize this data. A visualization is always connected to a data analysis task: what do I want to know from the data?

Hence, define a data analysis task first, and then try to answer it by visualizing the data. You may choose any tool for this.

(a) Define a data analysis task for the self-introduction data! Describe the task in 1 sentence!

(b) Address the data analysis task by visualizing the data using a tool of your choice. Print the result(s) and attach them to your hand-in paper.

Remarks: We explicitly refrain from guiding you for your first visualization. We did not teach any visualization method yet, nor how to deal with the data in the first place. This is by design. We count on your creativity! Surprise us!

Obviously, we will grade this task very generously.

Task 1.6: Rotations *(Extra Task)* **5 EP**

Show that 2D rotations are additive, i.e., that two subsequent 2D rotations can be expressed as one as follows:

$$\mathbf{R}(\theta_1)\,\mathbf{R}(\theta_2) = \mathbf{R}(\theta_1 + \theta_2).$$