

Erlangen, 16. January 2017

**Computer Graphics (Exercise Sheet 11)****Submission (Mailbox LS9):** Monday, 23. January 2017, 23:59 pm

**General Information:** The exercise sheets covers old exam assignments. You have to hand in your solution using the LS9 mailbox. Make sure that you **write your names on every sheet** you hand in!

**Assignment 1** [4 Points] (Transformations)

Is there a homogeneous 4x4-matrix for the following 3D-transformations? If so, fill in the corresponding matrix.

a) Translation by 3 in y-direction

☐ no☐ yes: Matrix =  $\begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$ 

b) Conversion from meters to centimeters (scaling by a factor of 100)

☐ no☐ yes: Matrix =  $\begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$ 

c) Rotation around x-axis by 180°

☐ no☐ yes: Matrix =  $\begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$

d) Projection along z-axis to xy-plane

☐ no                      ☐ yes: Matrix =  $\begin{pmatrix} & & \\ & & \\ & & \end{pmatrix}$

e) Projection to unit sphere:  $\begin{pmatrix} x \\ y \\ z \end{pmatrix} \rightarrow \frac{1}{\sqrt{x^2+y^2+z^2}} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$

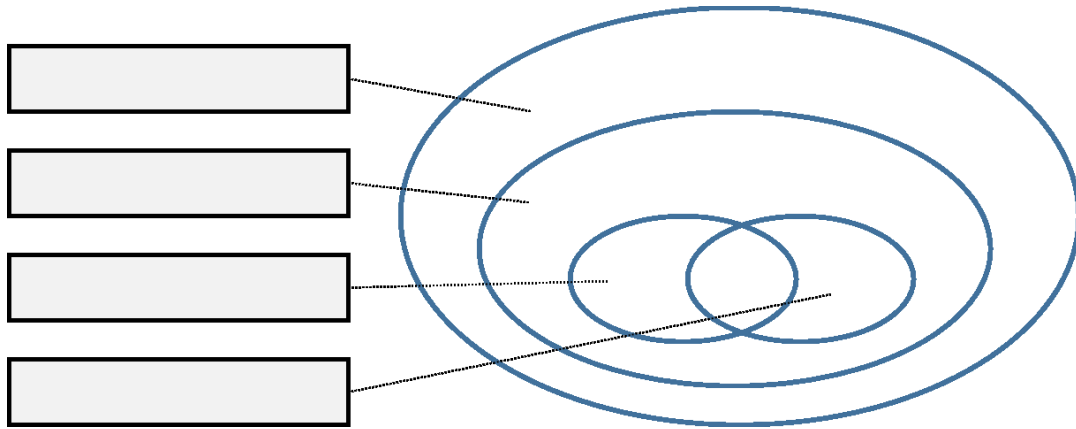
☐ no                      ☐ yes: Matrix =  $\begin{pmatrix} & & \\ & & \\ & & \end{pmatrix}$

f) Please state three different ways to represent rotations in 3D. State for each one, whether it is suited for interpolation or not.

Representation	Suited for interpolation

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g) Label the set diagram with affine, rigid, projective and linear transformations



**Assignment 2** [4 Points] (Rasterization)

In the lecture you heard about the Algorithm of Bresenham

```
int x = x0
int y = y0
int Δx = x1 - x0
int Δy = y1 - y0
int D = Δx - 2Δy , ΔDE = -2Δy , ΔDNE = 2(Δx - Δy)
while (x <= x1)
    ...
```

- a) Use the algorithm to draw a line from (1,2) to (7,4). State the values of x, y, and D at the entrance of the each loop.

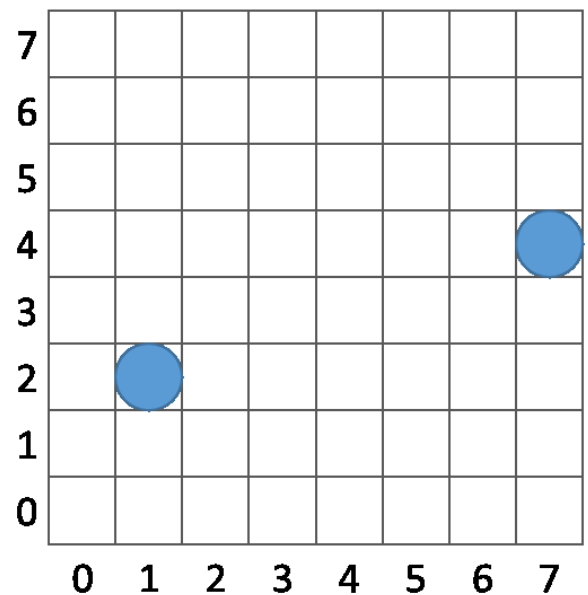
$\Delta x =$

$\Delta y =$

$\Delta DE =$

$\Delta DNE =$

x	y	D
1	2	

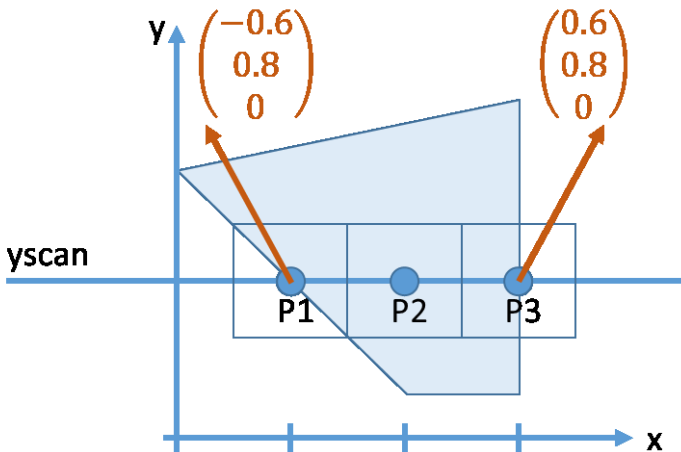


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- b) For which values of  $(x_0, y_0)$  and  $(x_1, y_1)$  does the algorithm deliver a proper result?
- c) How many pixels does the algorithm set for a line of length  $d = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}$  at least and at most?

**Assignment 3** [4 Points] (Shading and Lighting)

a) During scanline-rasterization of a polygon you arrive at the following scan line:



The arrows are the normals at the boundary points P1 and P3.

You are using the Phong-Lighting-Model without ambient component, with a diffuse color of (1,1,0), specular color (1,1,1), and a Phong-exponent of 2. Viewer and light direction are (0,1,0), the incident light intensity is (1,1,1).

Determine the colors of pixels P1 to P3 using Phong-shading. Re-normalize interpolated normals.

position	normal	diffuse	specular
P1	$(-0.6, 0.8, 0)$		
P2			
P3	$(0.6, 0.8, 0)$		

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- b) Describe the three most important terms of the Torrance-Sparrow-Lighting model (with a few words only, e.g. "ratio of texture coordinate and room temperature")

<b>D</b>	
<b>F</b>	
<b>G</b>	