Erlangen, 29. January 2019

Computer Graphics (Exercise Sheet 13 [Bonus])

Submission (Mailbox LS9): Friday, 8. February 2019, 11:59 am

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 [2 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 = $\begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$

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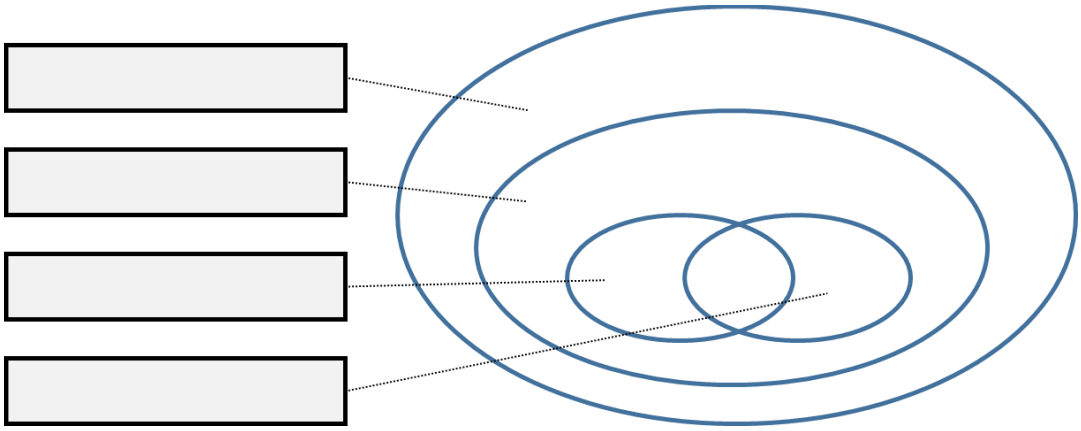
g) Label the set diagram with affine, rigid, projective and linear transformations



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Assignment 2 [1.5 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.

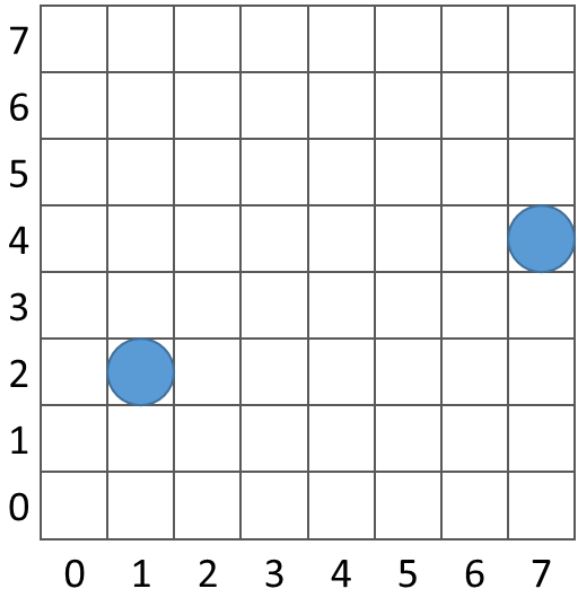
Δx =

Δy =

ΔDE =

ΔDNE =

x	y	D
1	2	



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b) For which values of (x0,y0) and (x1,y1) does the algorithm deliver a proper result?

c) How many pixels does the algorithm set for a line of length $d = \sqrt{(x1 - x0)^2 + (y1 - y0)^2}$ at least and at most?

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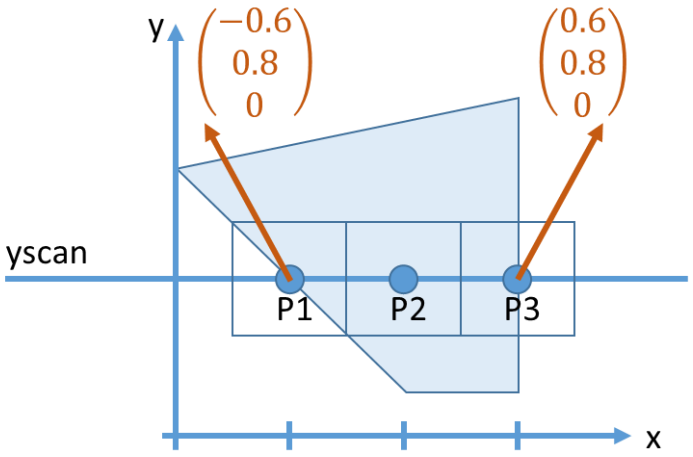
Assignment 3 [1.5 Points] (Shading and Lighting)

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”)

D	
F	
G	