Erlangen, 29. January 2019

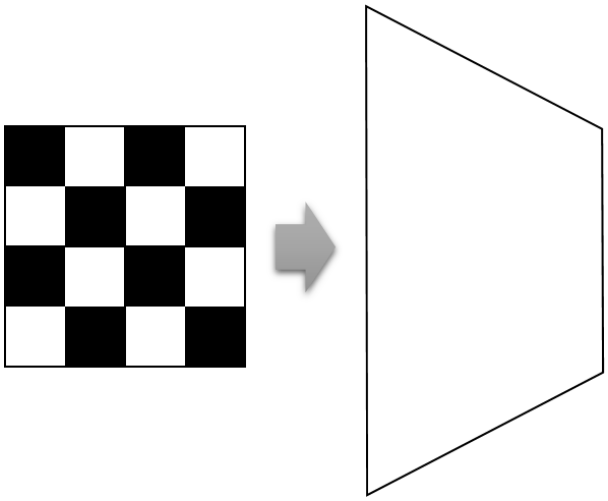
Computer Graphics (Exercise Sheet 13 [Bonus])

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 [1 Point] (Textures)

a) Map the checker board texture to the neighboring perspective square using correct perspective projection.



b) Why is the above mapping not affine?

c) State (shortly!) the three dimensions, in which tri-linear MIP-mapping happens.

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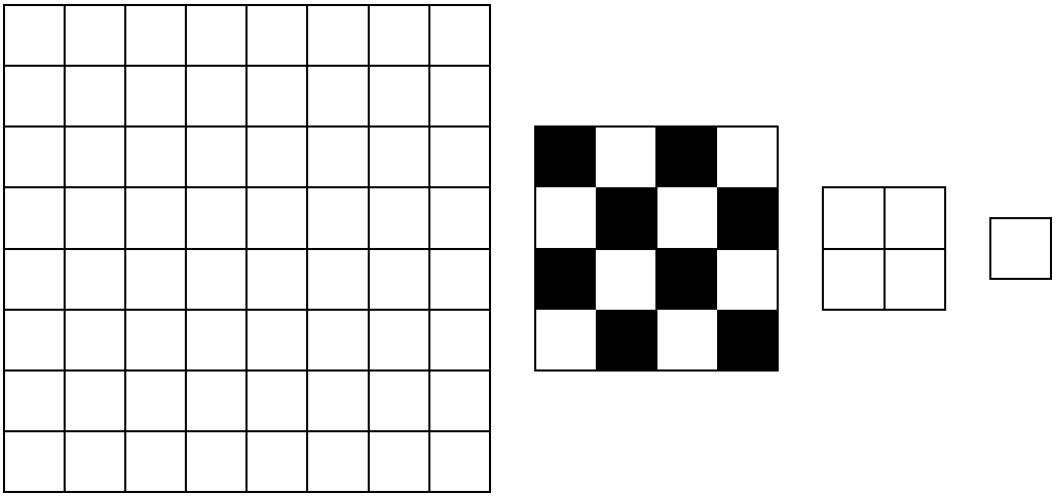
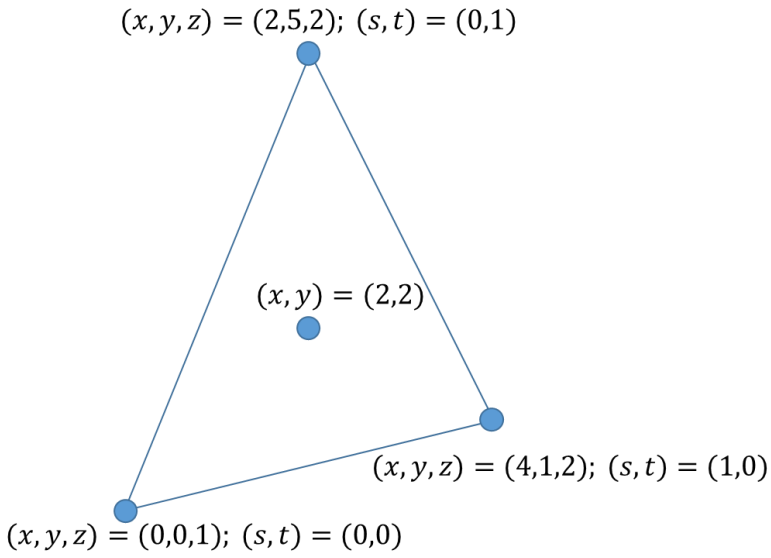
d) The 4x4-texture from sub-assignment a) is part of a MIP-map-pyramid. Fill in the missing levels of the pyramid. For MIP-map filtering you can assume a simple box filter.



e) Given is the triangle on the right with 2D-vertices (0,0), (2,5), and (4,1). With the vertices, also their z-coordinate as well as texture coordinates (s,t) are provided. Compute a perspective-corrected interpolation of the texture coordinates at position (2,2) (2D-barycenter of the triangle).



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Assignment 2 [1 Point] (Ray Casting)

a) Intersect the sphere with center $(1,2,6)$ and radius 5 with the ray $(4,6,0) + t(0,0,1)$. How many intersection points are there? State the intersection point(s).

b) Intersect the same sphere as in a) with the ray $(1,6,0) + t(0,0,1)$. How many intersection points are there? State the intersection point(s).

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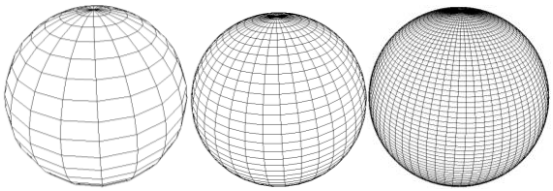
c) Explain (ideally with a formula) how you can generally find the intersection of a ray $e + td$ with a triangle with vertices A,B,C. It is sufficient to provide a system of equations!

d) Given is a sphere, subdivided into n quadrilaterals and to be rendered into an image full frame. State the time complexity (in O-notation) of ray-casting, depending on the number p of pixels and the number n of quadrilaterals.



n=400 n=1.600 n = 6.400

O( )

How does time complexity change if you directly intersect the rays with the sphere (as in sub-assignment a) instead of the quadrilaterals?

O( )

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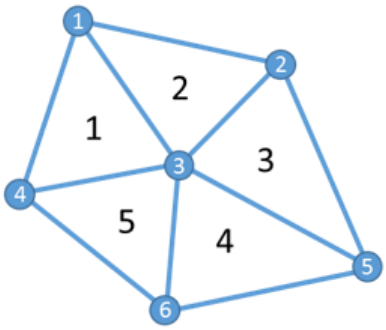
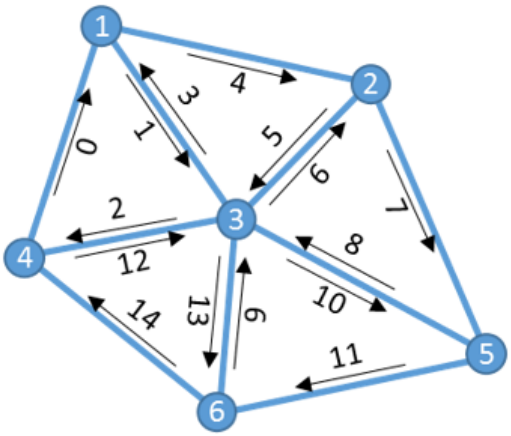
Assignment 3 [1 Point] (Indexed Face Set & Directed Edge)

a) Given the mesh on the right, fill in the face list for an indexed face set. Please take care that the faces have counter-clockwise orientation. Order the triangles by the given numbers.



1,4,3,

b) Fill in the table for the edge list of a directed-edge data structure. Please use the given half edge numbering.



half edge	start vertex	pair
0	4	-1
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

c) How many indices are stored per triangle using an indexed face set and a directed-edge data structure?

Indexed Face Set: | Directed Edge:

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Assignment 4 [1 Point] (Color)

Convert the given RGB color values to CMYK and HSV. Take care that for CMYK the K value is as large as possible. In HSV it is possible that some values are not uniquely defined, in this case you can choose an arbitrary value.

Hint: in HSV, the angles for red, green, and blue are 0°, 120°, and 240°

Color	RGB	CMYK	HSV
Black	(0,0,0)		
White	(1,1,1)		
Red	(1,0,0)		
Pink	(1,0.5,0.5)		
Yellow	(1,1,0)		
Grey	(0.5,0.5,0.5)		

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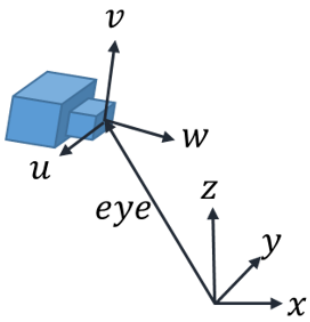
Assignment 5 [1 Point] (Viewing & Perspective)

a) Specify the camera coordinate system for a camera at position (3,4,5) looking at a point (3,4,9) with up-vector (0,1,0) (don't care about right- or left-handed coordinate systems):



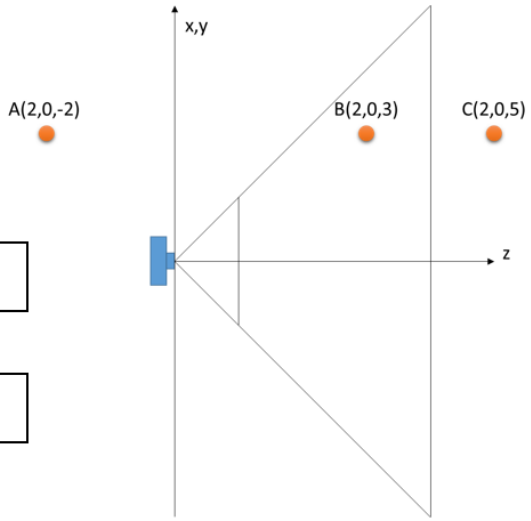
eye = ( )

u = ( )

v = ( )

w = ( )

For normalization (perspective projection) we want to use a viewing frustum as shown on the right with $x_{min} = y_{min} = -1$, $x_{max} = y_{max} = 1$, $near = 1$, $far = 4$.



b) What is the field of view and the aspect ratio of this perspective?

field of view = [ ]

aspect ratio = [ ]

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c) Fill in the last line of the corresponding matrix:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -5/3 & -8/3 \\ \square & \square & \square & \square \end{pmatrix}$$

Hint: the last row only contains the values 0 and -1

d) Sketch the position of points A,B,C from the previous figure after the perspective mapping (and after dehomogenization). Also sketch the image of the line segments AB and BC. Mark the part of the image of AB that is to be kept by clipping.