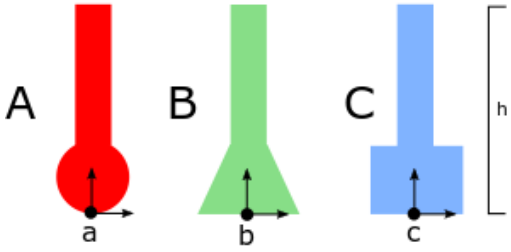
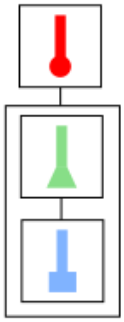
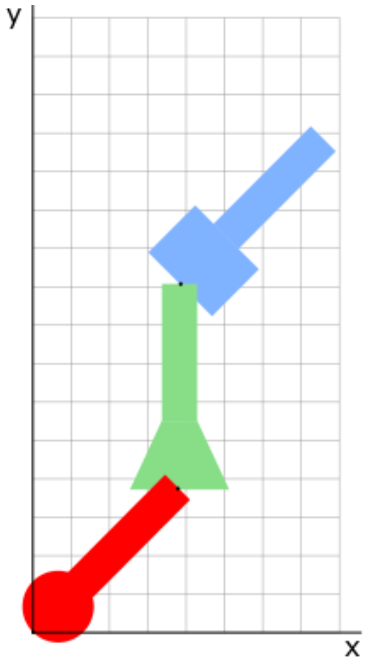
1 Scenegraph - Hierarchical transformations: You are given 3 objects (A, B, C), scene graph and the scheme of the target configuration. What transformations do you have to apply to every of these objects to get the final configuration? Write the transformation matrices. Assume, that all the objects are initially placed to [0,0] by their respective points a,b,c.

[description of the algorithm 3 points, formulating matrices 7 points]

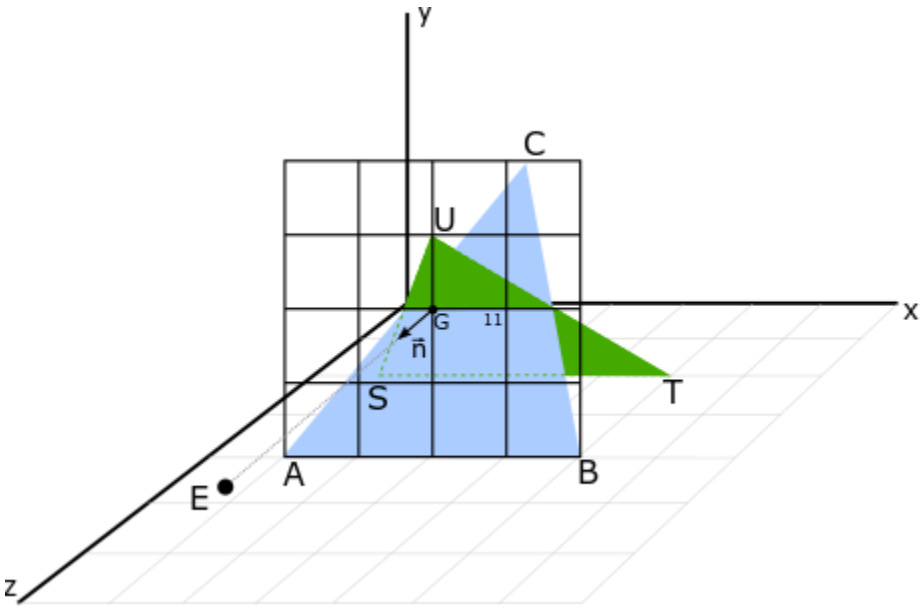






2 Z-Buffer: You are given two triangles ABC and STU and the rasterized viewing plane in the following configuration. Describe the Z-buffer algorithm. Then compute intersection points of the ray from E with triangles ABC and STU leading through the center of the grid cell 11.

[description of the algorithm 8 points, calculation 12 points]



A=[1,0,4]
B=[5,0,4]
C=[3,3,2]

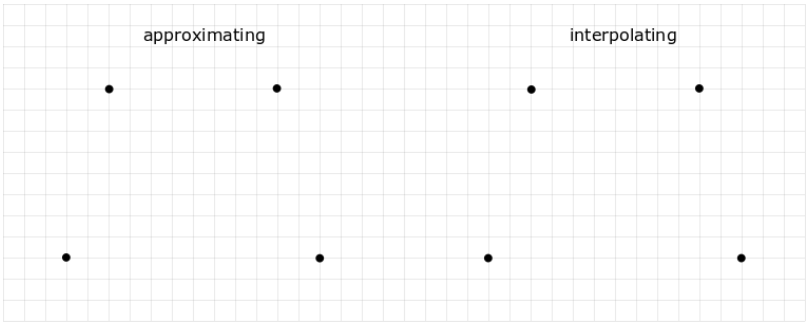
S=[1,0,2]
T=[5,0,2]
U=[3,3,4]

E=[3,2,7]

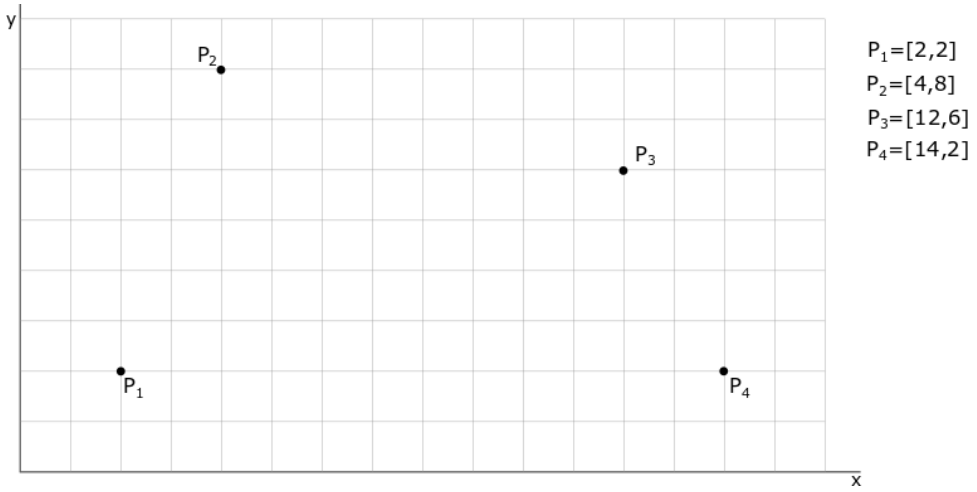
G=[3,2,4]
$\vec{n}$=(0,0,1)

3 Curves:

a) What is a difference between approximating and interpolating curve? Sketch an approximative and interpolative curve using the points below
[3 points]

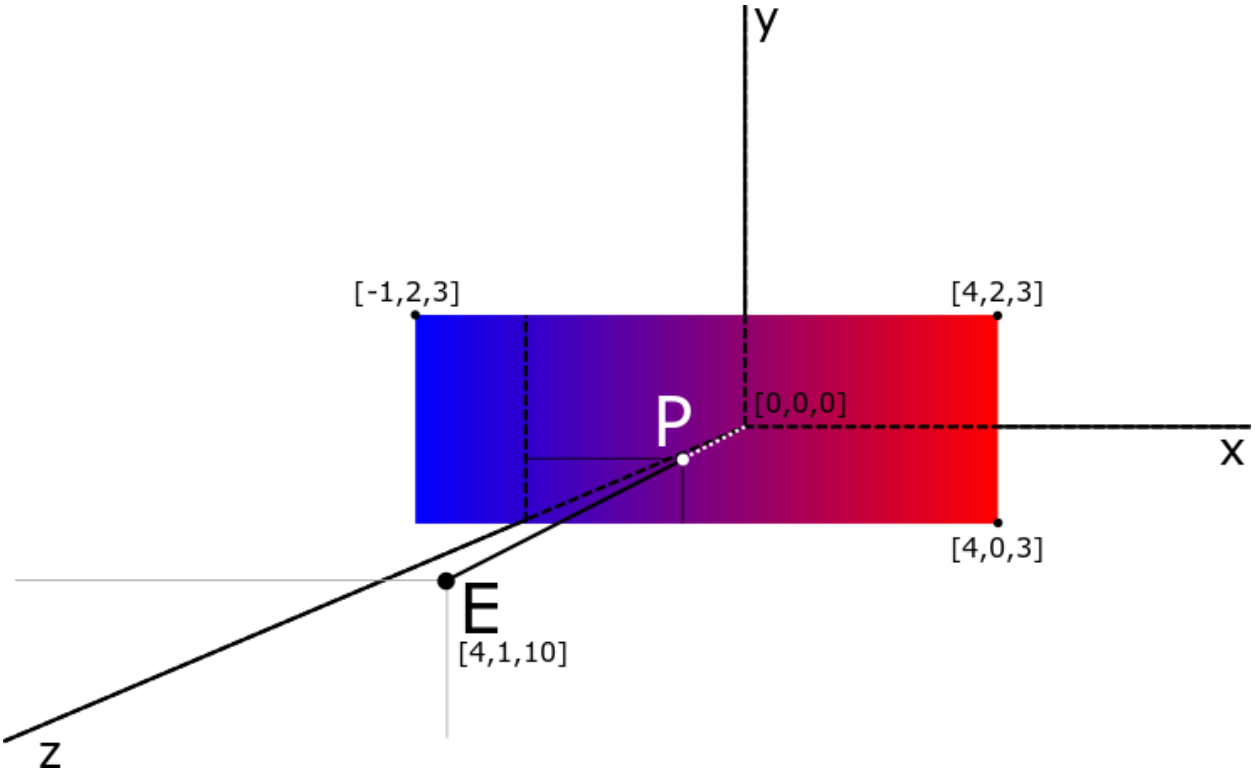


b) Calculate point on a Bezier curve using De Casteljau algorithm for t=0.6. Sketch and calculate all steps.
[description of the algorithm 7 points, computation 10 points]



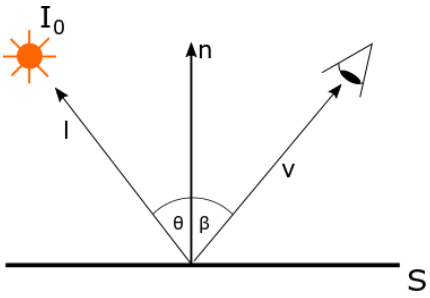
4 Interpolation: You have the following scene. The quad is textured with a one-dimensional gradient. Point P lies on the quad and on the ray E-to-origin. The gradient goes from Blue (0,0,1) to Red (1,0,0). Compute the resulting color at the point P.

[description of the algorithm 6 points, computation 9 points]

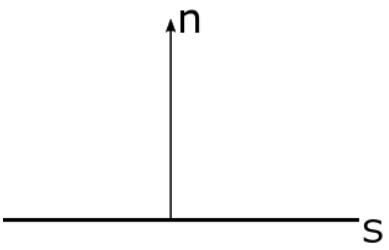


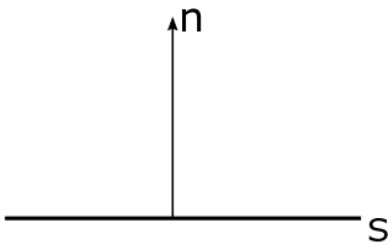
5 Illumination: Let θ=45°. How will be the result different in both models if the viewer changes his/her position to angles β=30° and β=60°? Material of S is defined through ka,kd,ks,e and incoming light is I_0. Describe the principle of Lambertian and Phong shading and write down illumination equations and express angle relationships generally and numerically for each of the four cases (Lambertian 30, Lambertian 60, Phong 30, Phong 60).

[Lambertian model 5 points, Phong model 10 points, illustration 50%, equation 50%]

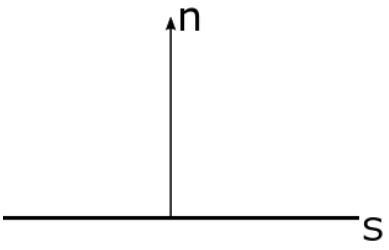


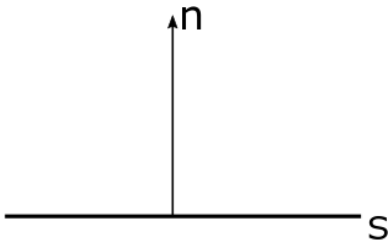
Lambertian model





Phong model





6 Implicit modeling: You are given points P_1=1 and P_2=3. Define a one-dimensional potential function f(x) that will be sum of two Gaussian kernels (e^{-x^2}) placed in P_1 and P_2. Compute f(x) at [0, 1, 1.5, 2, 2.5, 3, 4]. Sketch the profile of f(x).

[Definition function 5 points, computation 10 points, plot 5 points]