Final Exam for Computer Graphics Course CS248 at KAUST

Fall 2019

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Student's name:

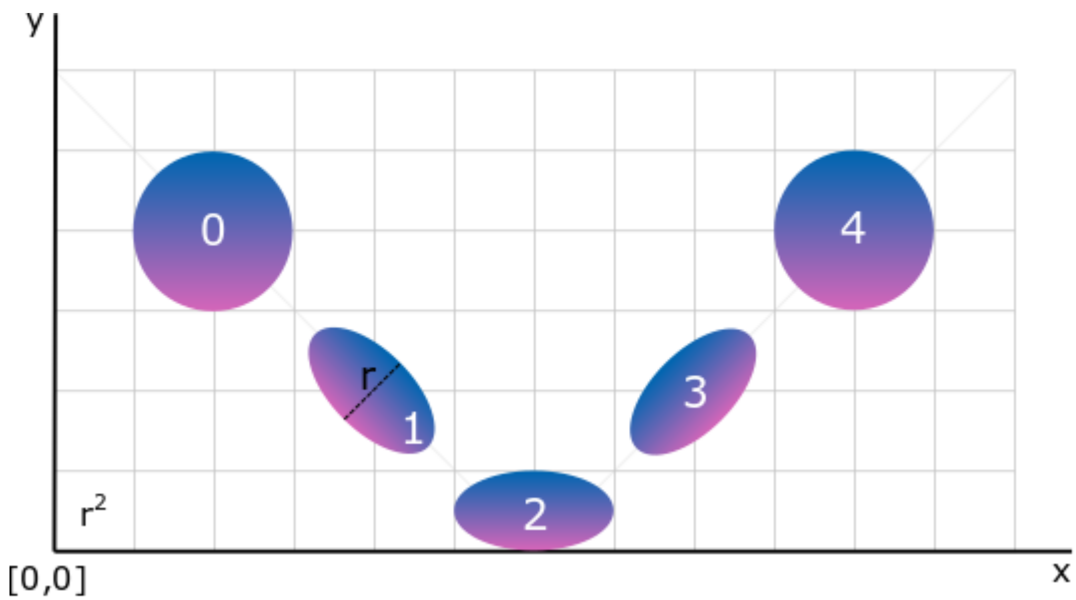
Score (to be filled by the instructor):

[rest of the page can be used for solving problems]

1 Transformations: Consider the following animation of a ball in several different frames of the animation. The original position without any transformations is with ball center at the origin [0,0], with blue on top and purple on the bottom. Its first position in the animation at t=0 is at [2r, 4r], where r is arbitrary positive number. Write the **transformation matrices** for each timestep t=0,1,2,3,4, in order to animate the ball.

Hint 1: For some transformations you first need to bring the object into origin and undo the previously done transformations. You can express this also by previously formulated matrices, their transposes or inverses.

Hint 2: the color gradient indicates the ball orientation. [15 points]



M(0):

M(1):

M(2):

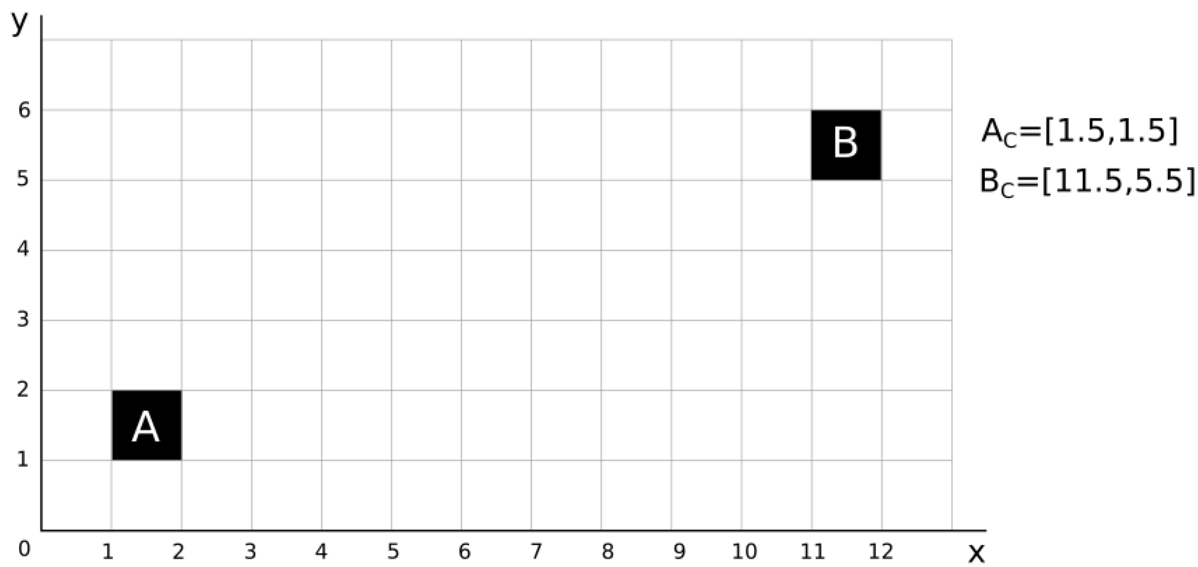
M(3):

M(4):

2 Line Rasterization: Rasterize the line from center point of pixel A (A_c) to center point of pixel B (B_c). Describe the used algorithm and then draw pixels into the xy grid accordingly. Note that for each x value there should be just one drawn pixel.

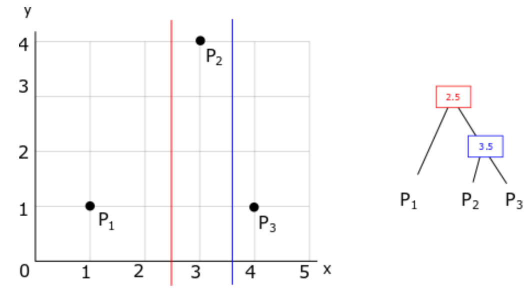
Hint: you can design your own algorithm in case you do not remember the one from the course. It will count as long as it creates a *good-looking* line.

[Description of the algorithm: 7 points; Computation 8 points]



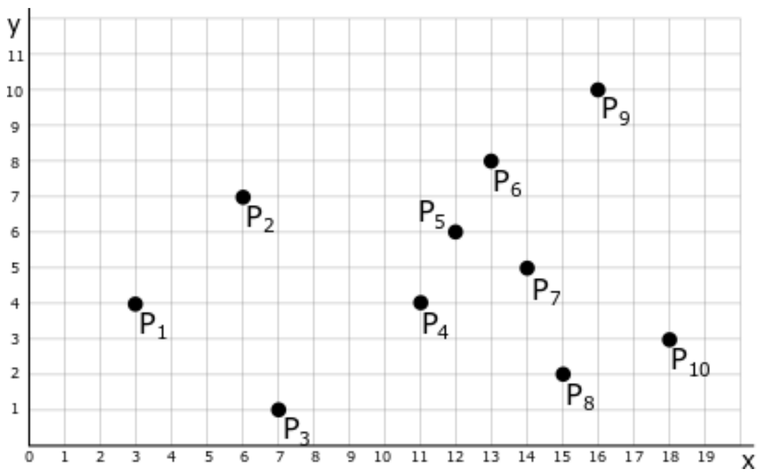
3 Spatial Data Structures.

[Description of the algorithms: 10 points, Drawing of grid and tree 10 points]



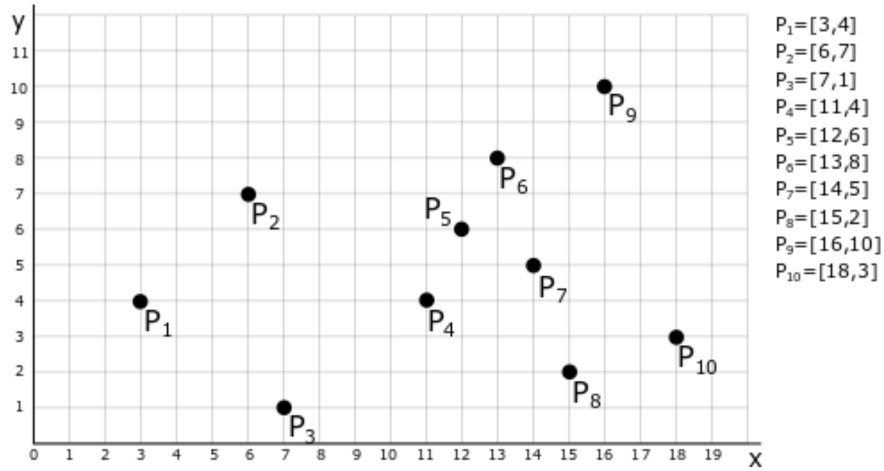
Hint: For simplicity, partitioning should only be done along the x axis as in the example above.

a) Perform a hierarchical **uniform space partitioning** from the given points. Draw the partitioning directly into the x,y grid and draw to the right the corresponding tree structure, where intermediate nodes are labelled according to the analytical equation of the partitioning line (see example above). The leaf nodes are labeled with the names of points.



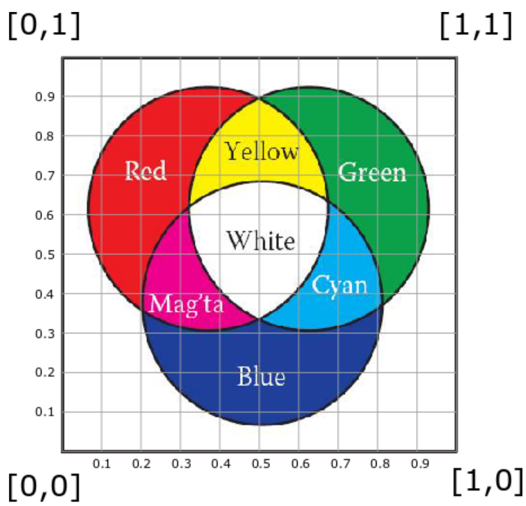
$P_1=[3,4]$
$P_2=[6,7]$
$P_3=[7,1]$
$P_4=[11,4]$
$P_5=[12,6]$
$P_6=[13,8]$
$P_7=[14,5]$
$P_8=[15,2]$
$P_9=[16,10]$
$P_{10}=[18,3]$

b) Perform hierarchical **uniform object partitioning** ($P_1..P_{10}$) from the given points. Follow the same instructions as above



4 Colors:

a) Consider RGB color map as shown in the picture below. What combinations of the basic colors R, G, B are points P_1, P_2, P_3? Then compute the colors of P_1, P_2, P_3.
[Computation 8 points]



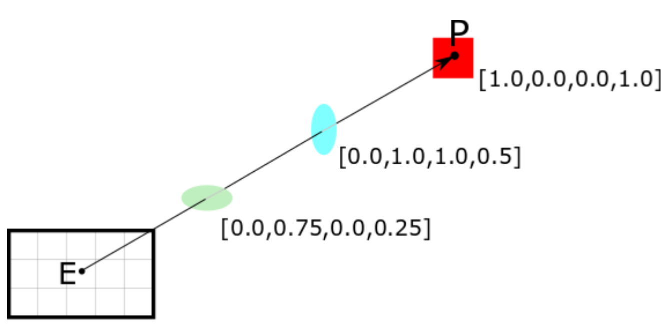
R=[0.75, 0.15, 0.05]

G=[0.15, 0.85, 0.05]

B=[0.35, 0.15, 0.85]

P_1=[0.5, 0.7]
P_2=[0.7, 0.5]
P_3=[0.3, 0.5]

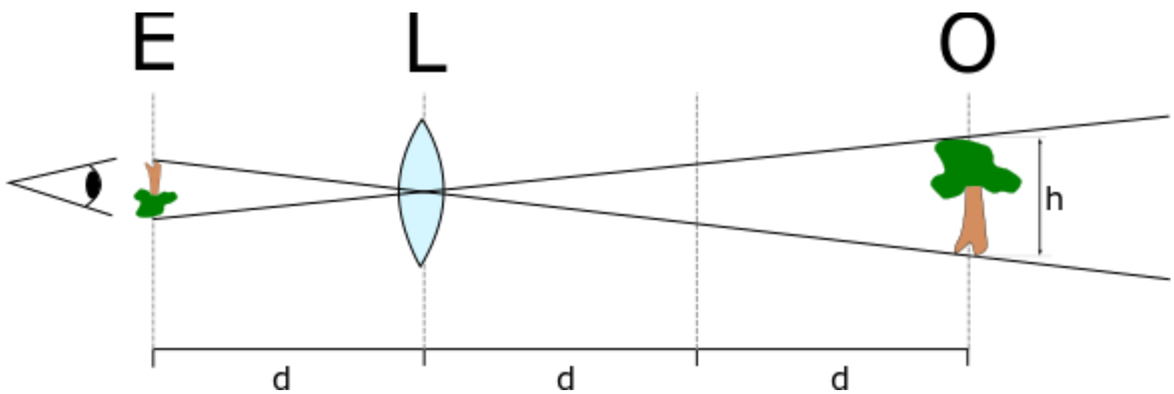
b) You have the color blending function $C = \alpha * C_{fore} + (1 - \alpha) * C_{back}$, where α is the alpha channel of the color, C_{fore} is the foreground color and C_{back} is the background color. Compute the color of E.
Hint: you should compute the color in back-to-front order, from (P) to (E). 1.0 in fourth channel means fully opaque, 0.0 means fully transparent.
[Computation 10 points]



5 Advanced raytracing: Which transformations do you have to apply to the object in E to compensate the lens L transformation in order to see the object O like the image below?

Hint: Just think which transformations make the tree smaller and how much smaller and make it up-side-down in the way it is shown here.

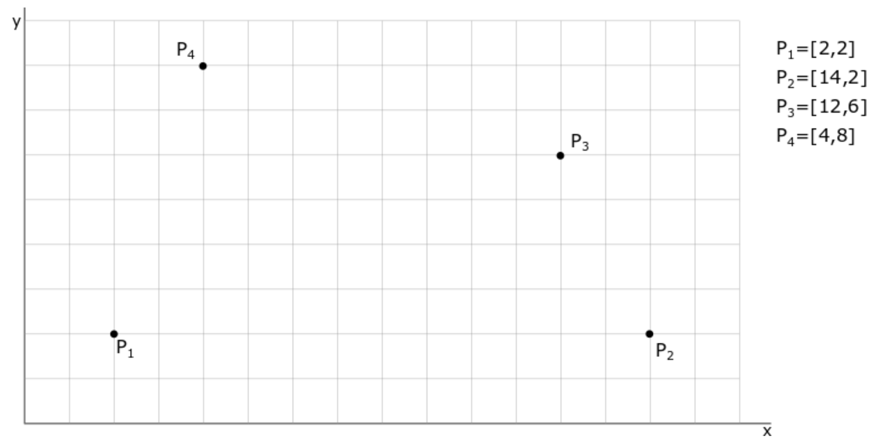
[7 points]



6 Curves:

a) Calculate point on a Bezier curve using De Casteljau algorithm for t=0.6. Sketch and calculate all steps. The curve approximates the polygon P1-P2-P3-P4

[Description of the algorithm: 5 points, Computation 10 points]



b) Calculate y coordinate of points A, B that belong to a Lagrange curve of a given set of points. Then plot the function.

[Computation 8 points, Plot 2 points]