

Computer Graphics and Data Visualization

Final Report for 2nd Semester of 2022 to 2023

1. (52 points) Answer the following questions related to computer graphics and data visualization.
 - (a) (7 points) Explain the cause of aliasing in the process of rasterization. Take an example of an anti-aliasing method and explain its main idea and implementation.
 - (b) (10 points) Explain the main idea and working principle of z-buffer, and the role of z-buffer in rasterization, shadow mapping and particle based volume rendering respectively.
 - (c) (12 points) In texture mapping, how to calculate the barycentric coordinates of a triangle from the coordinates of the three vertices of the triangle and the coordinates of a point inside the triangle? In ordinary Kriging interpolation of spatial data, how to calculate the weight value of each known sample point from the covariance? Comparing the barycentric coordinates with the ordinary Kriging interpolation algorithm, can we use Kriging interpolation when calculating the attribute value of a point inside a triangle and use the barycentric coordinates when calculating the interpolation of spatial data? Why?
 - (d) (6 points) How to determine the appropriate mipmap level in mipmapping? When the calculated number of mipmap levels is not an integer, what should be done to prevent color discontinuity in the rendering results?
 - (e) (8 points) Prove that an affine transformation of the Euclidean plane maps parallel lines to parallel lines.
 - (f) (9 points) In the 3D Cartesian coordinate system, the scaling coefficients with respect to the fixed point (x_f, y_f, z_f) in the direction of the x , y and z axes are s_x , s_y and s_z , respectively. Construct the transformation matrix of this scaling transformation.
2. (21 points) In a two-dimensional data set, the values of x and their corresponding values of y are shown in the table below:

x	5	6	4	3
y	16	18	13	12

- (a) (10 points) Visualize the data using a scatter plot. List of code and necessary explanations are required.
 - (b) (2 points) Referring to the results of the scatter plot, explain the possible correlation between x and y .
 - (c) (9 points) Based on the data, calculate the parameters a and b that fit the linear regression model $y = ax + b$.
3. (27 points) Visualize the attached data (**data.csv**) according to the following requirements. List of code and necessary explanations are required.

- (a) (15 points) Calculate the optimal number of clusters by using the elbow method when partitioning the target data using the k-means clustering algorithm.
- (b) (12 points) Partition the target data by using the k-means clustering algorithm and visualize the target data by using parallel coordinates (each cluster is represented by a different color).