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Scientific Visualization

Assignment 5

SS/2021

Due: June 17th, 2021, 9:00 am

We supply you with two basic code templates to use for this assignment but you are free to use your own code. Our supplied code will contain code snippets assisting you in solving the tasks. So be sure to look at the supplied code if you choose to use your own code as a basis for this assignment.

1 Further Custom WebGL2 Shaders

1.1 Writing a per-Pixel Phong Shading (5 pts)

As the per vertex shading yield suboptimal results, per pixel coloring can be used to shade objects with higher detail. Write a vertex shader (`vertShader_sphere_perPixel`) and a fragment shader (`fragShader_sphere_perPixel`) implementing the Phong lighting model to calculate shading on a pixel level and use it to shade the sphere. You can adapt much of the code from the vertex shader of assignment 4 to the fragment shader of this task. Your result should look like in Figure 2.

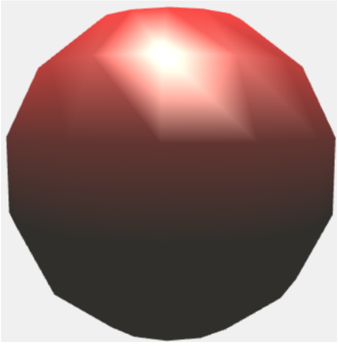


Figure 1: Per-vertex Phong Illumination

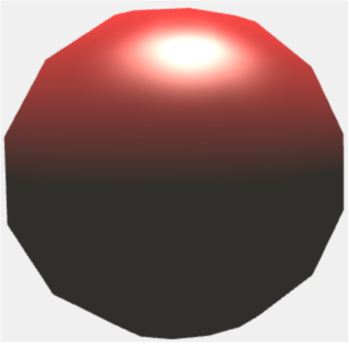


Figure 2: Per-pixel Phong shading

2 Reading files and plotting a 3D scatter plot (9 pts)

In this task you will read in data from a .csv file containing the parameters controlling the appearance of the marks of a 3D scatter plot.

The famous iris dataset (iris.csv) contains four variables describing the dimensions of the petals and sepals of different iris flowers and a fifth value that gives the species of iris. In this exercise, you are tasked to use the first three variables to determine the position in 3D, and the categorical values in column five should be mapped to a color. More specifically, use:

- Column 1 as the x coordinate,
- Column 2 as the y coordinate,
- Column 3 as the z coordinate,
- Column 5 to assign each of the three categories (species) a color.

We already set up a simple csv file reading in the index.html and index.js file that you should use as a basis for the following tasks. Dataset loaction: ./"skeleton"/dist/assets/iris.csv.

2.1 Visualize the Data in a 3D Scatter Plot (7 pts)

Please supply a screenshot with the result of each of the steps below:

- Plot each item (row) in the data set as a point in the scene using the THREE Points class ((x, y, z) coordinates from columns 1–3). The resulting visualization will be off centered, this will be corrected later.
- Color the points according to the category (column 5).
- Draw a wire frame bounding box containing all the points and add an axis indicator displaying the three directions x, y, and z. You should use the appropriate Three.js functionality for this.
- Center the points around the origin of the scene.

2.2 Use Column 4 as color channel (2 pts)

Implement a way to toggle between categorical coloring (column five) and coloring dependent on the fourth variable. The coloring should represent the value range. Choose a linear color scale. You should implement a "live toggle", i.e., add a UI-element and live update of the coloring.

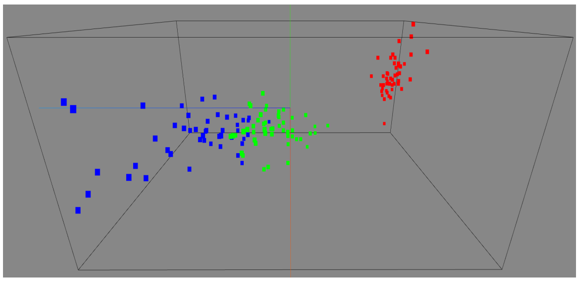


Figure 3: categorical coloring (column five)

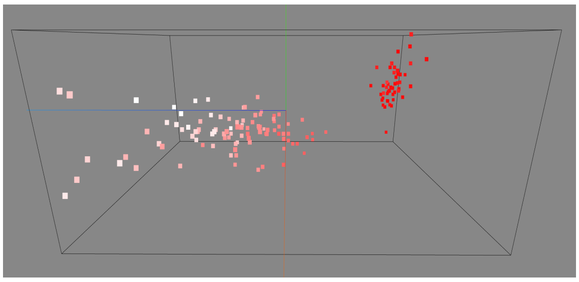
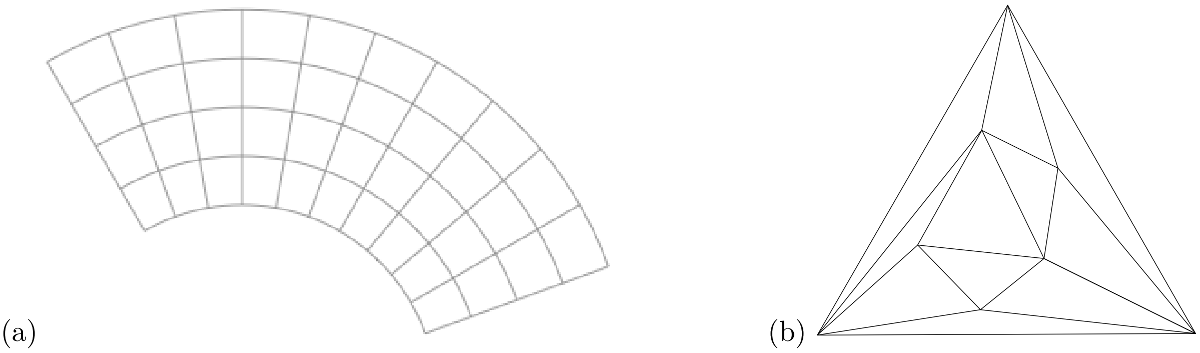


Figure 4: linear coloring (column four)

3 Theory (6 pts)

3.1 Grids (2 pts)

For the below figures: State which two types of grids are depicted below.



3.2 Data Properties (4 pts)

Four data sets (`Data1.csv` to `Data4.csv`) are given in the same folder on Ilias as the assignment (`A5_exercise_3.2_data.zip`). Compute for each data set the following statistical properties and plot the points as well as the derived properties:

1. Mean
2. Variance
3. Correlation
4. The two line coefficients of the trend line (linear regression)

The easiest way to compute and plot the values is Excel, but you can also use Python 3.0+ (with NumPy and Matplotlib) or R. Hand in your Excel files (or your Python/R scripts) and screenshots/images of the plotted results. *You will not get any points if you just copy the absolute values into Excel! You have to use the appropriate function to compute the values.*

Note that Excel might handle decimal numbers in an unexpected way depending on the language. If set to German, Excel usually expects the decimal separator to be a comma (`,`), while in English, it is a point (`.`). The provided files us a decimal point (the easiest way is to replace it with a comma using any plain text editor like Notepad, but you can also use the import function in Excel or change the global settings).

Handing in

For the Hand-in, write the names of both group members at the top of all code files and PDF documents. For the tasks involving transformation matrices, you can hand in a high quality and cropped picture of your calculations. Create a ZIP archive of your project folder and **PLEASE EXCLUDE** the folder **NODE_MODULES** from your archive. Name it with the last and first name of each group member, and the assignment number (e.g., *schaefer_marco___bok_marcel_assignment5.zip*) and upload it to `Hand-In` → `Assignment_5`.