

# Assignment 2 — Volume visualization

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**Number of credits:** 20% of the module

**Recommended hours:** 20–25 hours

**Submission deadline:** 31 March, 2020 11:00am

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## 1 Motivation

You are given a selection of three volume data sets. Two of the three are unknown and mysterious. Your job is to explore, hypothesize, and discover what phenomena the data sets depict through the use of volume rendering. Rather than producing a volume renderer from scratch, you are to use an existing volume renderer such as:

- The Visualization Toolkit (<http://www.vtk.org/>)
- Voreen (<https://www.uni-muenster.de/Voreen/>)
- ParaView (<http://www.paraview.org>)
- Inviwo (<http://www.inviwo.org/>)

to help you with your exploration. Voreen is installed on the lab machines. *You are not restricted to the above software. You may use any volume rendering software but you need to clear it with me first.*

## 2 Tasks

The tools above are advanced, state-of-the-art volume rendering tools freely available for educational and research purposes. They are open source volume rendering libraries which enable interactive visualization of volumetric data sets with high flexibility. They are implemented as a multi-platform (Windows and Linux) C++ libraries using OpenGL and GLSL for GPU-based rendering, licensed under the terms of the GNU General Public License. In order to accomplish this task, you are to explore the software's features (look for “Features”)

with a special focus on their various volume rendering techniques and transfer functions.

The aim of this assignment is to learn to use state-of-the-art volume visualization tools. Select a tool and, for each dataset, indentify the characteristics of the data and ultimately unravel what they are or what you think they are.

- Can you use volume rendering to gain an overview of the data?
- Can you discover any patterns or trends in the data?
- Does the data have any features, at a large scale or a small scale?
- What do you think the data sets are?
- What phenomena do the data sets try to capture?
- Can you support your answers with visualizations that provide evidence?

You do not necessarily need to answer these questions directly. My hope is that in the proces of doing the assignment you will discover some of the answers to these questions. You will do this for 3 different tasks listed below.

## 2.1 Task 1: Getting started

Start off with rendering a known data set. We recommend you render a known data set supplied by one of the renderers from the list first. For example with Voreen, there is a standard Walnut data set. It can be downloaded from: <http://www.voreen.org/108-Data-Sets.html>. Any sample data set provided by a rendering package may be used to get started.

## 2.2 Task 2: Mystery Data Sets

There are 2 mystery data sets listed with the assignment. Your job is to use one of the volume visualization software packages to produce 2 visualizations for each of the 2 datasets (so 4 total).

Currently, there are two phenomena to discover, one is called data1 and the other data2. They are not exciting names but part of your task is to discover what these 2 objects are! These are both volume datasets that have appeared in the scientific visualization literature many times already.

## 2.3 Task 3: The Visible Human Project

For the third part, include two different volume visualizations and a description of each from the Visible Human Project: [https://www.nlm.nih.gov/research/visible/visible\\_human.html](https://www.nlm.nih.gov/research/visible/visible_human.html). Instructions on how to download the data for the Visible Human is available on their website. You can make two different visualizations of the same dataset or use two different datasets. Experiment!

# 3 Guidance

## 3.1 Data Format Conversion

Since the field of data visualization has not yet evolved to the point of using universal data format standards, the format of the data you have been given

will have to be converted to a format that your chosen program(s) can read. The input data format for each tool is described on each tool's respective web pages.

### 3.2 Help and Hints

- Each tool's web sites have lots of helpful documentation on how to use them.
- YouTube features helpful introductory videos on how to use the ParaView, Voreen, and other volume rendering software.
- You can post any number of questions on VisGuides.org or the tool authors for help if you run into problems.
- The teaching assistant can also help you. But don't wait until the day before the deadline.

## 4 Submission

Your task is to produce 7 different visualizations that convey some meaningful and hopefully interesting insight about four data sets and support your hypothesis as to what they may be. The four data sets are 1) one of the sample data sets provided by the software you choose, 2) data1, 3) data2, and 4) the Visible Human.

### 4.1 Description Template

For each of your 7 visualizations, use the following template.

**Image:** The visualization itself as an image

**Tool:** The name of the tool used to generate the image

**Visual Mappings:** Each of the visual mappings, e.g., color is mapped to ..., opacity is mapped to ..., this is where you describe your transfer function

**Data conversion:** If you performed any data conversion/editing, then describe it here

**Unique Observation:** Things we can learn from the visualization, e.g., from this visualization we can see this pattern...

### 4.2 Submission

The report must be in a single pdf file! No other format is acceptable. You are required to submit a report which contains:

1. Describe, briefly how you converted each data set such that it can be rendered by the volume visualization software of your choice. If the data has been modified in order to create your images, please describe the changes that were made. Please also indicate the number of hours spent on this part of the assignment for help us to calibrate the difficulty levels in future assignments.
2. **Show 7 different images** 2 different images for data1, data2, and the Visible Human. Only 1 sample image for the given data set accompanying your chosen software. For each data set, each of which is accompanied by

a template description like in the example provided. Provide a template description for each of your images. For each data set, your volume visualization types are distinct, e.g., an isosurface and a direct volume rendering using MIP. In other words, two different isosurfaces visualizations are two instances of one type of visualization. You may submit additional visualizations, e.g., other volume visualization techniques are slicing or the various transfer functions covered in lecture.

3. **Demo video via Screen Capture** Use screen capturing software to demonstrate the interaction of your application. Show what your visualizations look like when you rotate them and modify parameters such as the cutting plane position, the iso-value, or the transfer function(s). The file(s) is named after the tool and feature(s) being demonstrated e.g., laramie16vtkSlicingAndIsosurface.mpg. The movie files are saved in MPEG or MP4 format. You may only submit one movie file that captures all the visualizations is ideal. Blackboard cannot store very large files. Therefore, you are encouraged to upload any video demo files to YouTube or Vimeo. They do not have to be public. YouTube has a “Unlisted” option for videos making them only accessible to those with a direct link.

Submit both files: report in pdf + demo video(s) to Blackboard as a .zip file or as a .tar.gz file. Note that these are the only two platform independent file formats.