

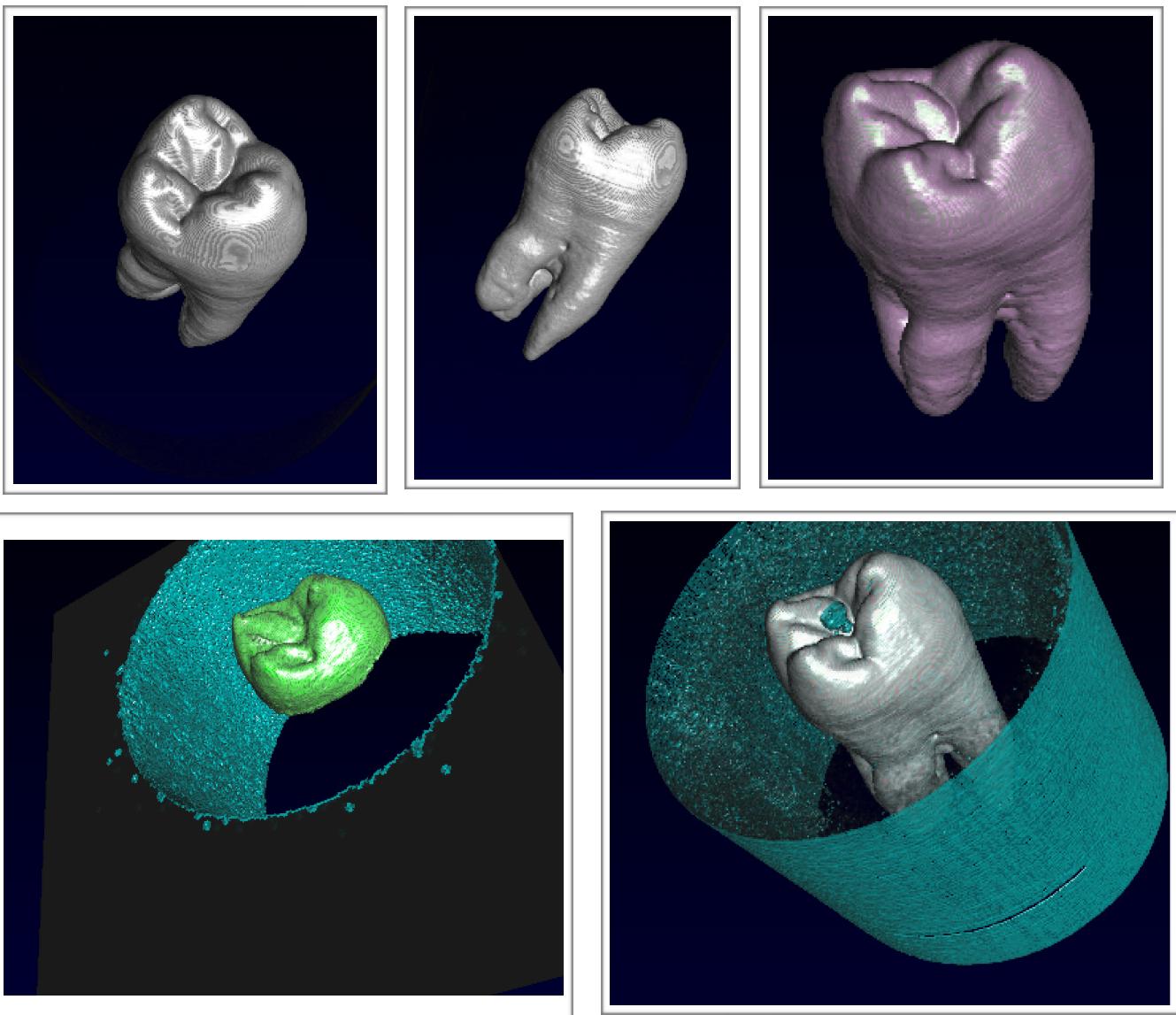
Lab 5 -Transfer Function Design

Requirement no. 1 -

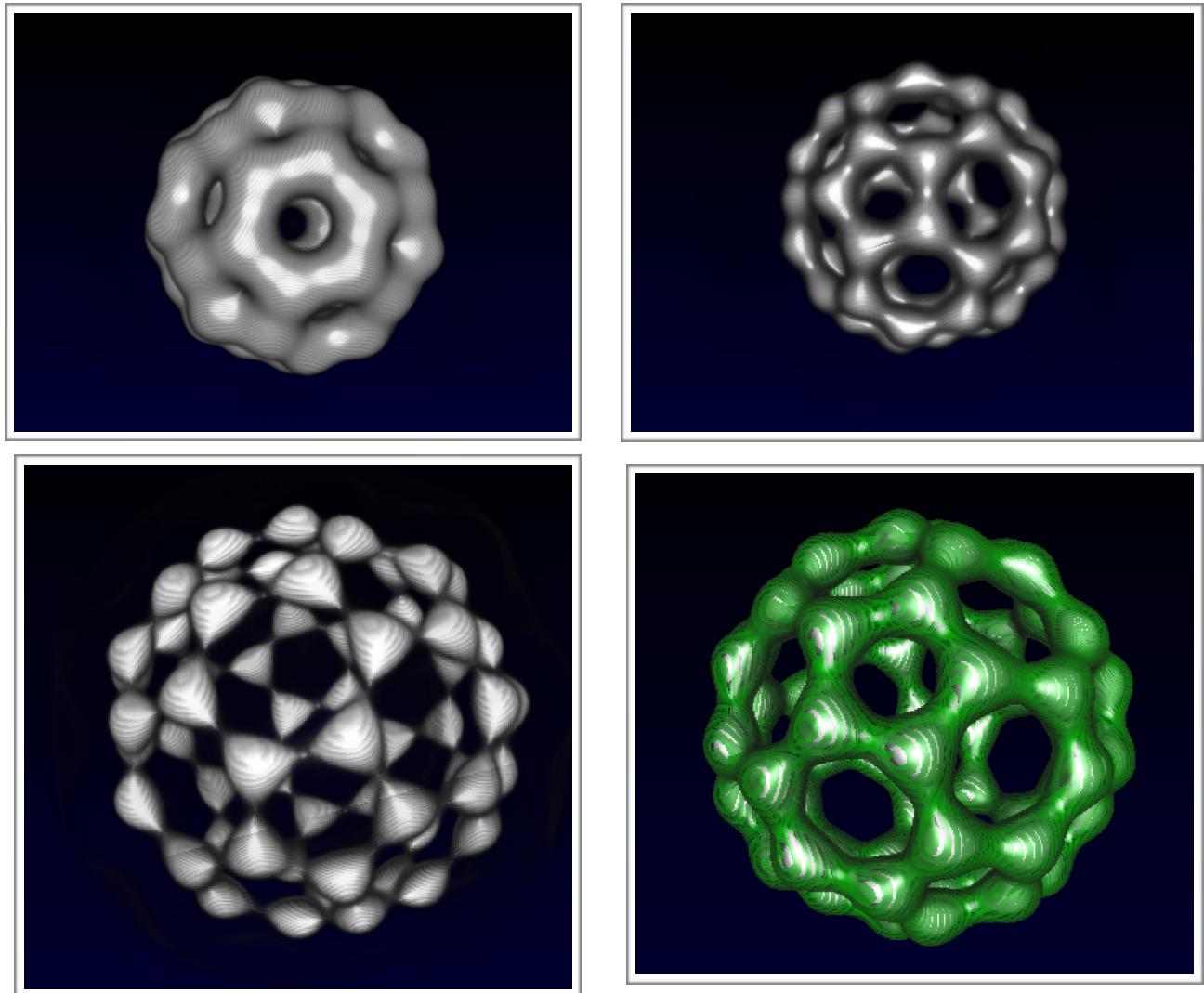
Explore a volume rendering tool: ImageVis3D. Explore the 1D transfer function editor. State the datasets you chose to explore and include several images of different stages of your exploration. What did you like about the transfer function editor? What is difficult about this editor / widget? How would you improve the 1D transfer function editor?

Solution -

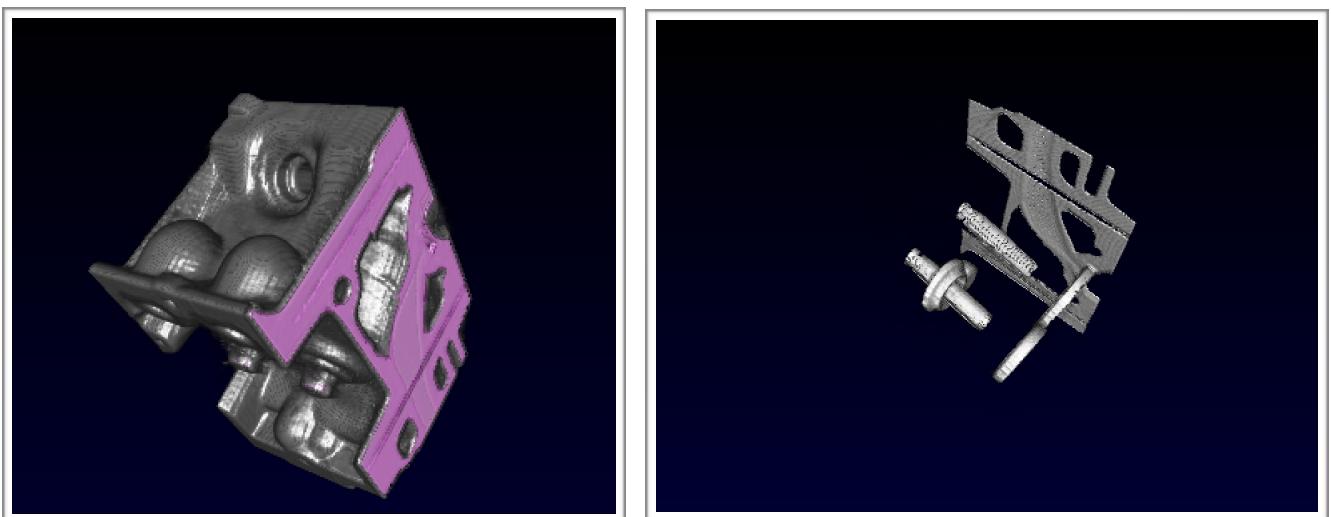
- a) Data set explored - tooth.uvf



b) Data set explored - C60.uvf



b) Data set explored - engine.uvf



What I liked about this transfer function editor?

I liked the freedom to select between the 3 different color channels and the alpha value using the checkbox, meaning deactivating one or more channels to look at other two was a nice feature according to me. The checkered box/bar at the top was not something extremely important or something but it was nice to have a look at the active colors and their blend. Interacting with the alpha channel and highlighting certain parts of the data would kind of be helpful according to me. For example while exploring the data set for tooth I realized that I could look at one part of the tooth and analyze it separately.

What is difficult about this editor or the widget?

In the beginning it was difficult to even figure out what exactly you had to do to make it work but after playing around with it for a while and most importantly (should have done it at the very beginning) reading the manual that came along helped a GREAT deal. I still haven't figured out the usefulness of the histogram which is not really hard to interact with but seems useless to me. Interacting with the lines in the graph was also kind of tricky in the beginning.

How would I improve the 1D transfer function editor?

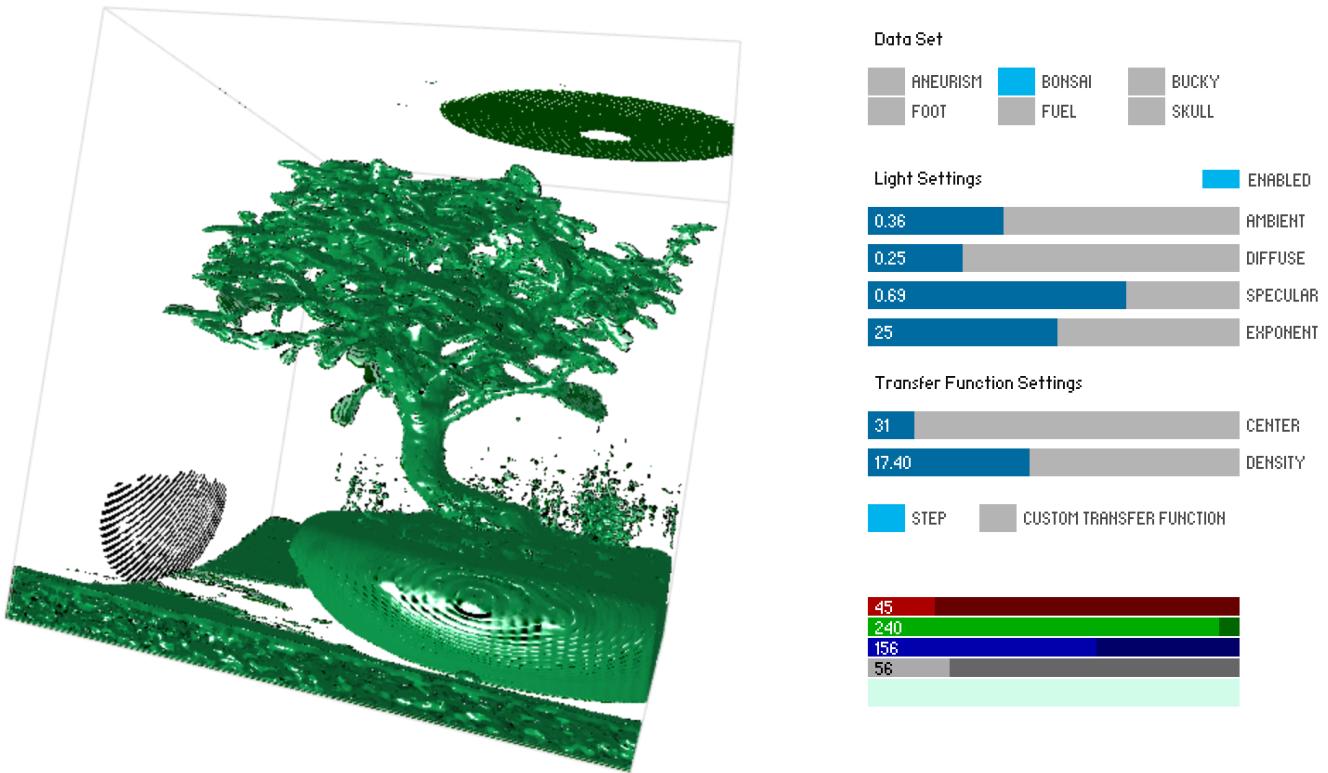
The first thing I would do to improve this editor is to make it more user friendly. There must be a way to interact with the graph because once you perform an action and if you want to go back to the previous stages of your exploration, you cannot. You have to try and remember how your graph looked which is not the best idea. This involved a lot of manual labour of interaction with the graph. I would definitely want to reduce it for the user and make it smoother to work with. I would also remove the histogram if I don't understand its purpose by the end of this assignment. Overall, I like this transfer function editor with the above changes implemented.

Requirement no. 2 -

Test the volume renderer as it is. Choose one of the data sets provided and tweak the step transfer function and lighting settings, in order to produce an effective rendering of your volume. In your report, include a screenshot of both the control panel and the volume and discussion. What were you able to find from your volume data set? What is useful about the step function? What makes this particular function limited?

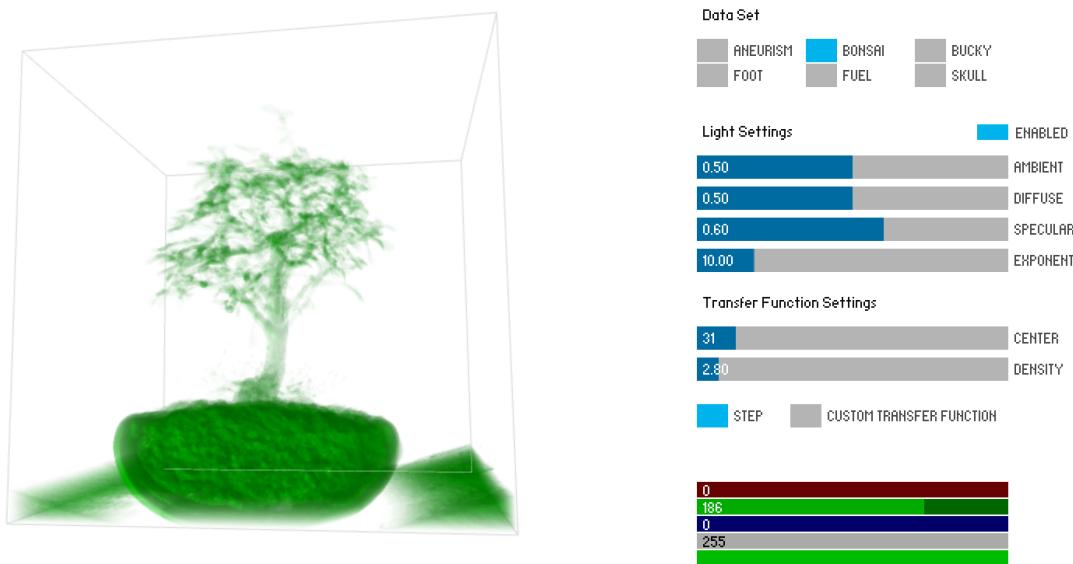
Solution -

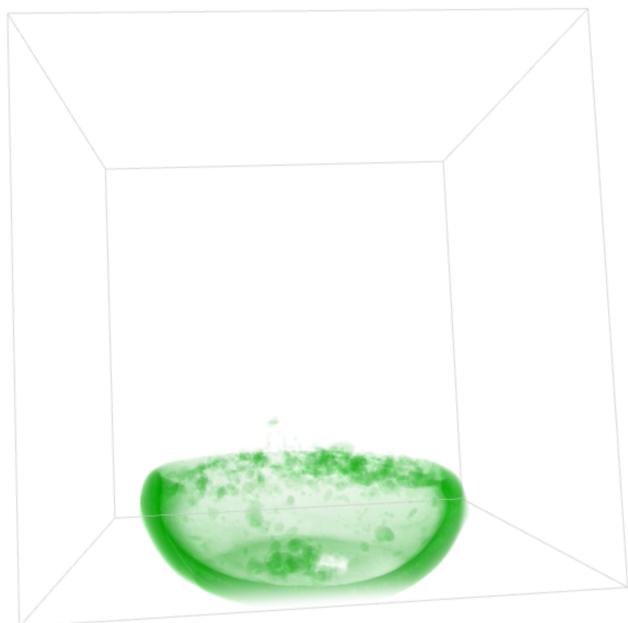
I chose the bonsai data set for exploration. There is nothing much that there is to this volume data set other than the fact that it is a sample of a bonsai tree kept in container. I tried playing around with the light settings which in my opinion did not make much of a difference to this particular data set because I don't think this data set is concerned with the lights etc. But with the center and density I was able to find a finger print kind of a pattern on the surface of the box like structure. I failed to understand if it was a fingerprint or a print of the container that had the bonsai but it appears on the top as well.



What I liked about this function was the center control. It helped looking at different aspects (you could also say layers) of data. It did not really help with this data set but I am sure where something like a blood clot has to be detected it would be really useful. The limitation of this function is that the center function starts from a fixed center and if you want to focus on other aspects of the data and disable some then you won't be able to.

Below are the screenshots from the different stages of the editor exploration. As is evident from the screenshots, I tweaked the density and center to generate the different aspects of the data.





Data Set

	ANEURISM		BONSAI		BUCKY
	FOOT		FUEL		SKULL

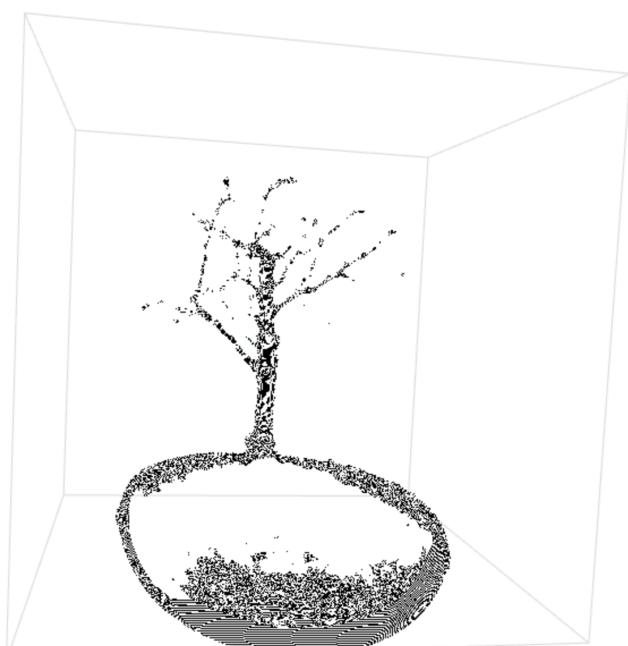
Light Settings

	ENABLED
	AMBIENT
	DIFFUSE
	SPECULAR
	EXPONENT

Transfer Function Settings

	CENTER
	DENSITY

STEP CUSTOM TRANSFER FUNCTION



Data Set

	ANEURISM		BONSAI		BUCKY
	FOOT		FUEL		SKULL

Light Settings

	ENABLED
	AMBIENT
	DIFFUSE
	SPECULAR
	EXPONENT

Transfer Function Settings

	CENTER
	DENSITY

STEP CUSTOM TRANSFER FUNCTION

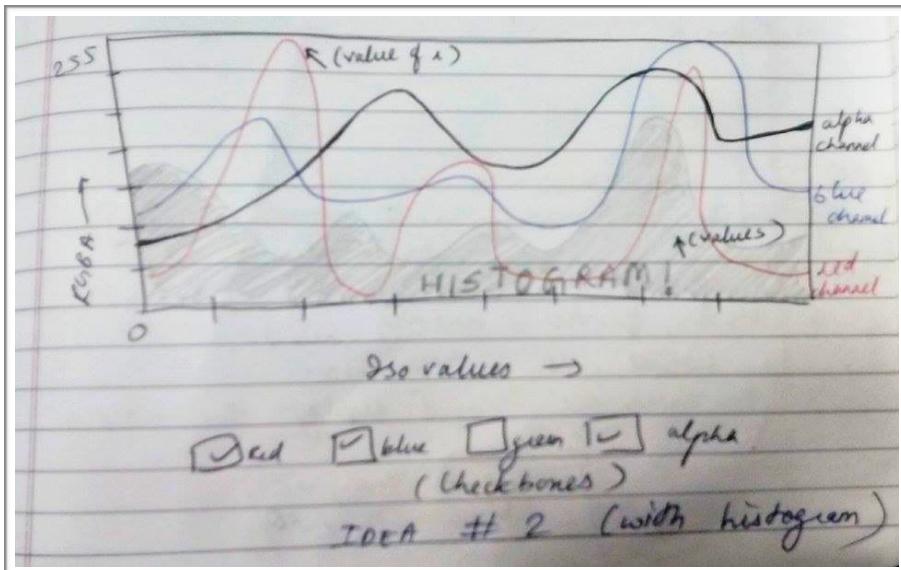
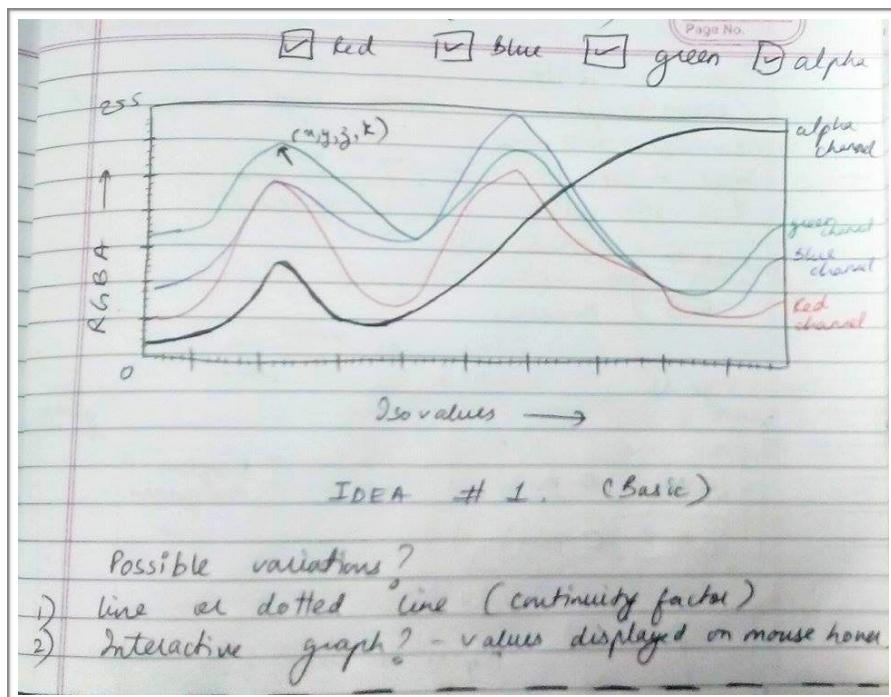


Requirement no. 3 -

Design your own transfer function widget. Think about different ways to represent and encode a 1D transfer function. What controls will the user have access to? What user interactions will exist to make it a useful widget? In your report describe which of your different sketches that you implemented in the code? How does it work? Why did you choose this idea?

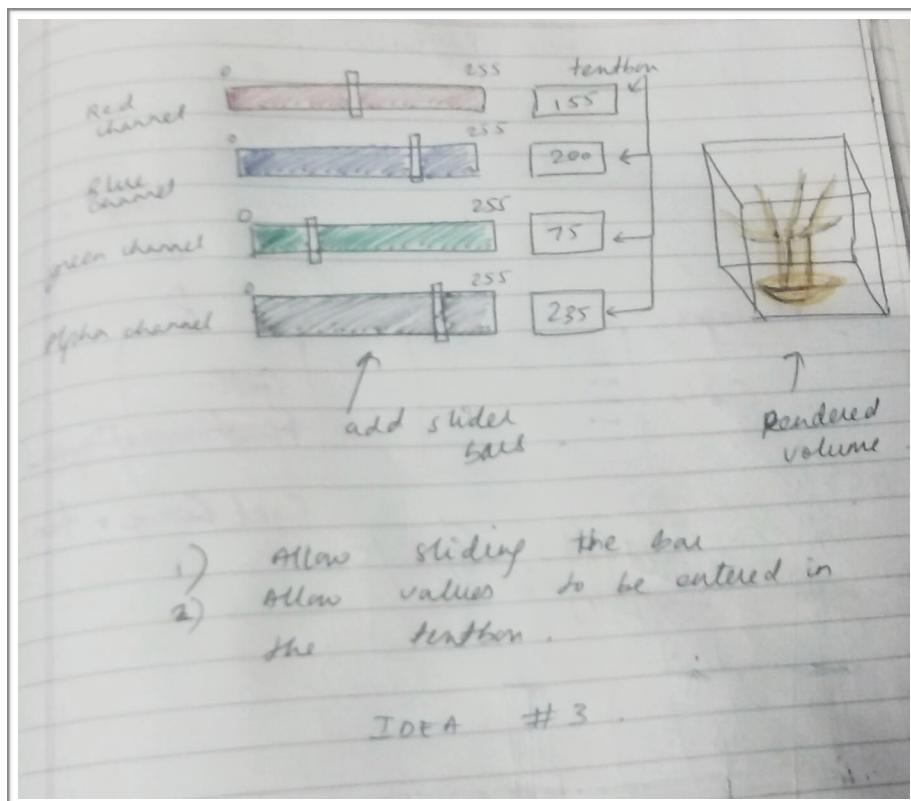
Solution -

I sketched out a couple of ideas before finalizing something. Below are the screenshots of the sketches that I made,



These two ideas are a lot similar to the ImageVis3D because that is how much I liked ImageVis3D. The second one is different from the first one only in a way that the second one has a histogram implemented. I am skeptical about including the histogram because I am not really convinced with it's purpose for a transfer function editor. I mean sure, it shows the value distribution really well. I would still like to keep it optional and hence it is on the second position. About interaction with the RGBA channels the user can use the check boxes to select one or multiple channels. Once he or she has decided what channels to use he or she can drag the mouse over the graph to change the mapping to the volume renderer (quite a lot like what ImageVis3D had). Isovalues are to be mapped on the x-axis and the RGBA values are to be mapped on the Y-axis. Every line representing a particular channel will have it's respective color associated with it so that will work as a legend which I have realized are very important. The lines in the graph could be either continuous or dotted. ImageVis3d implements dotted or connected lines for a reason but I still haven't figured out how and why.

It was difficult coming up with a significantly different third idea because this was so convenient but I thought if I could limit the interaction of the user with the RGBA values then maybe it could help someone who is not really concerned with looking at the graph that takes up so much space on the screen. I sketched out the idea below using sliders and textboxes. The user can select the value by sliding individual channel sliders and the value would automatically appear in the text box or they could simply enter the value in the text box and the slider would react accordingly. Of course every value tweaked will be visible in the rendered data. Below is the screen shot of sketch for this idea,



For the implementation I chose the first design because it is better in my opinion than the second one. The basic function is taken care of nicely. The colors are used appropriately and the controls make it easy to interact. The implementation is the exact replica of the idea that I had thought. I chose to go with lines instead of dotted lines or connected lines because it gave a continuous spread of the data. As was expected this editor comes up on the screen when the user clicks on the custom transfer function checkbox and then he can choose between the various channels through the various checkboxes for the respective channels. Also, the user can click on the graph on the individual lines to tweak the values and the result will be displayed in the rendered screen. I did not implement the mouse over hover value display because I don't have the time and it is not really one of the most important features of the 1d transfer function.

Requirement no. 4 -

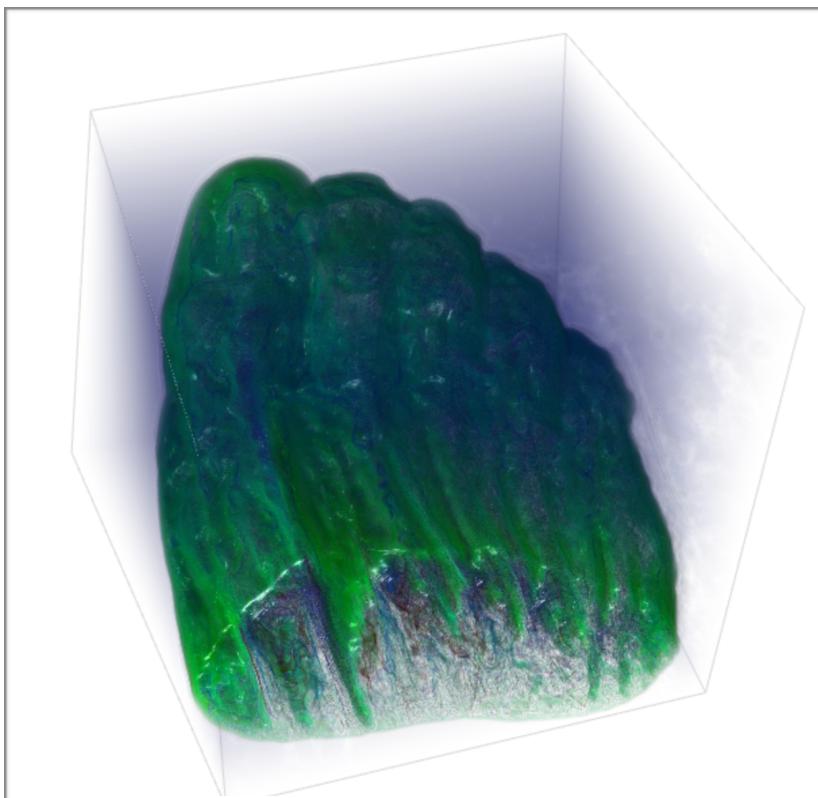
Find good transfer functions using your transfer function editor. Mention something interesting you found in the data sets. What are the strengths and weaknesses of your design? What would you change to make your widget more effective? What are the pros, cons, and challenges for volume rendering as a technique?

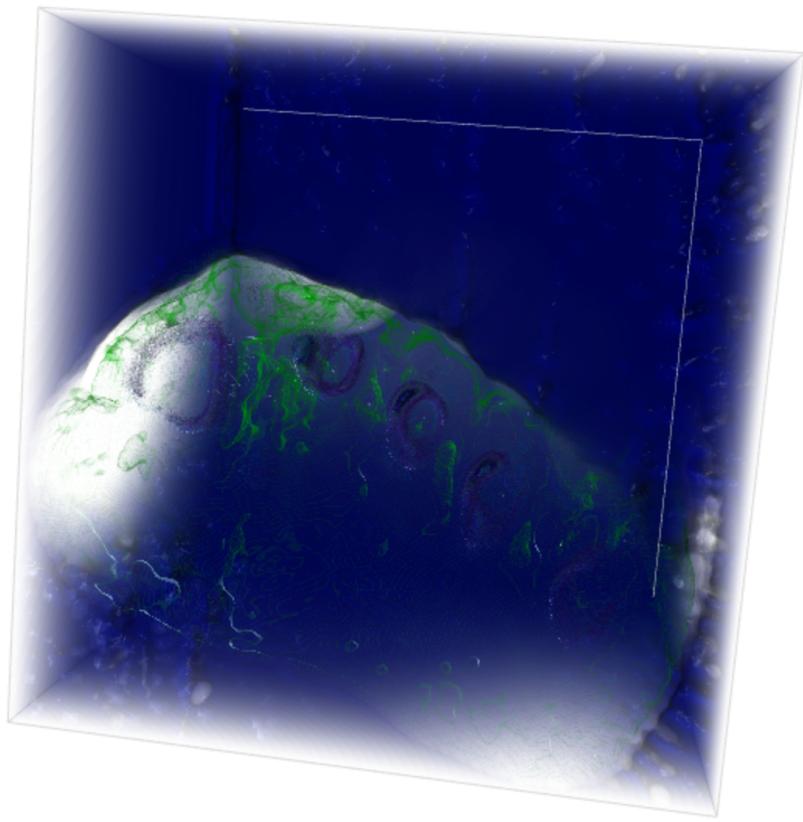
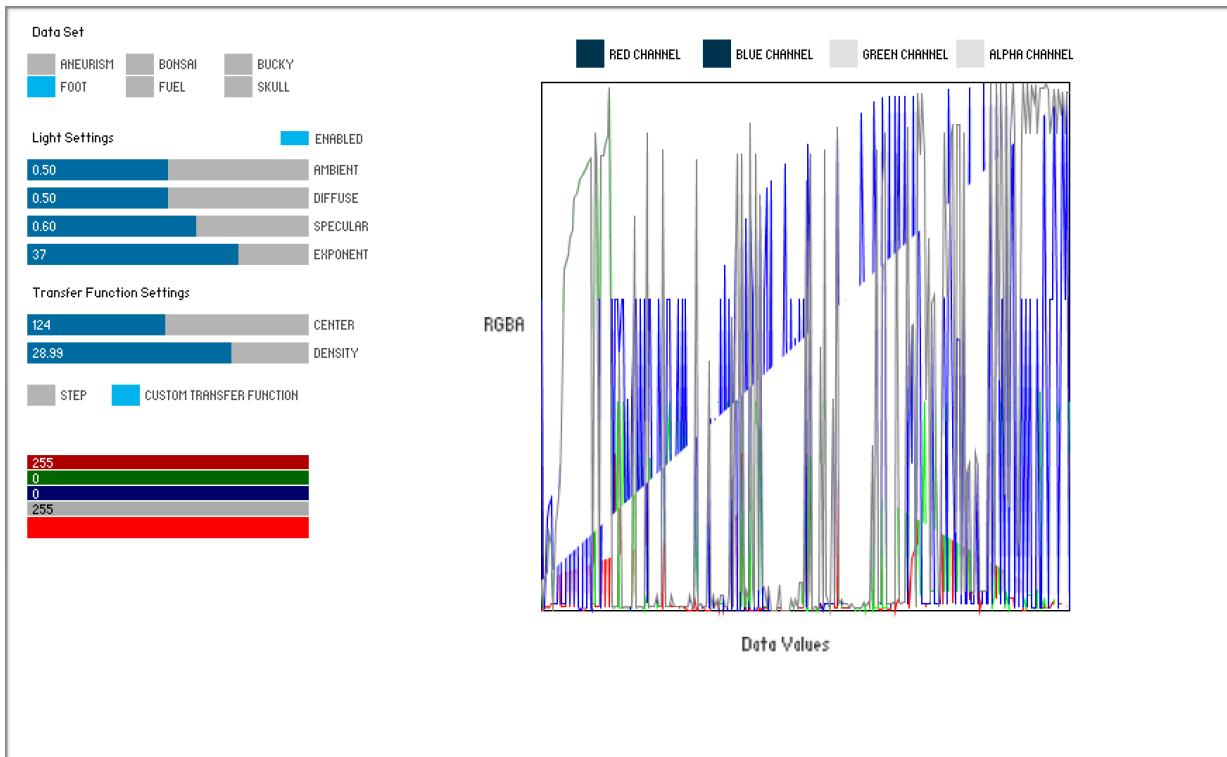
Solution -

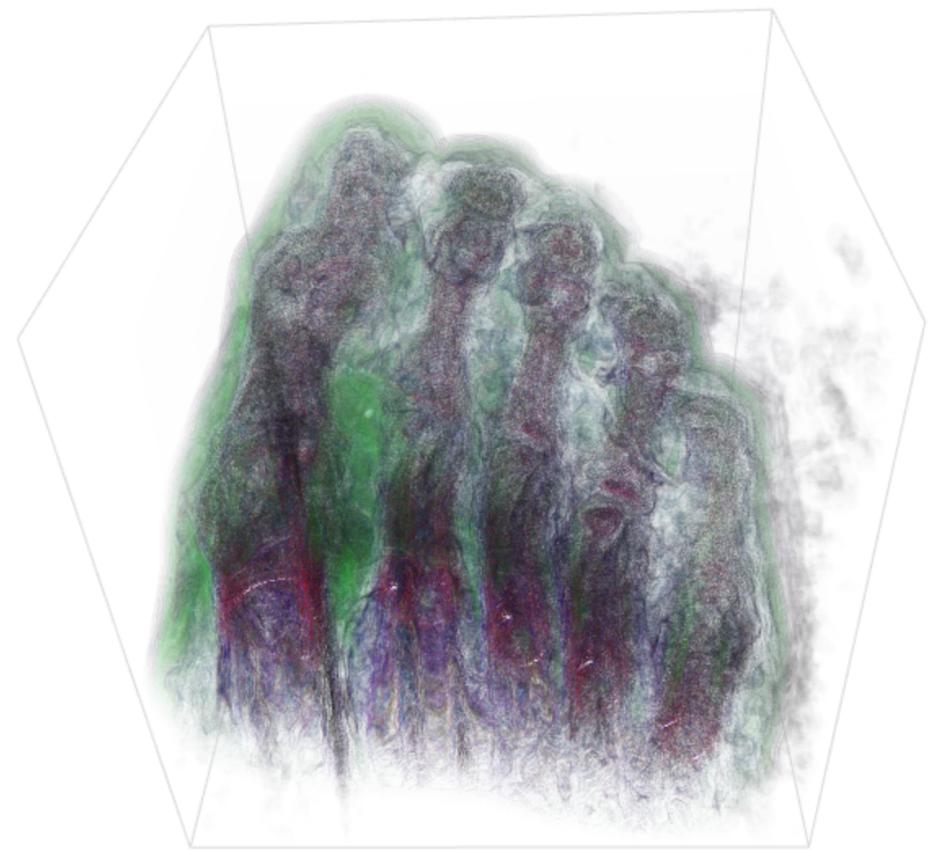
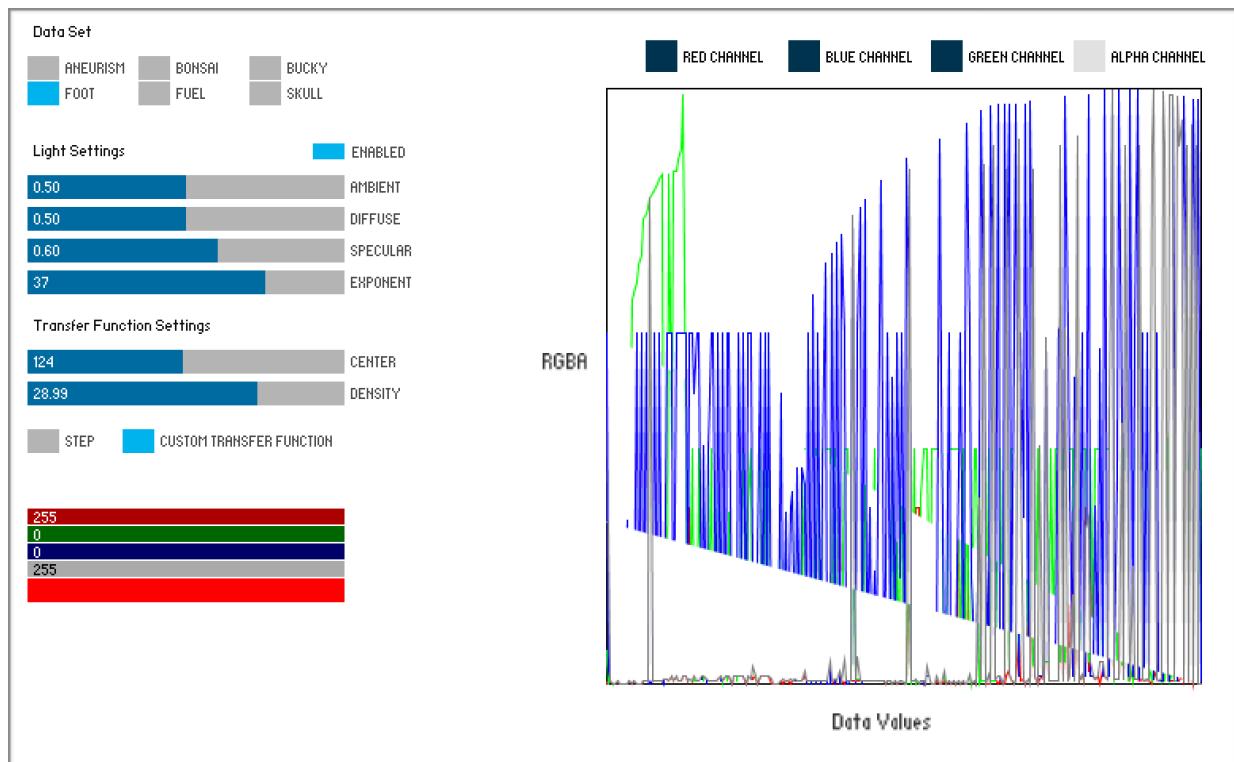
a) Interesting things in the data set -

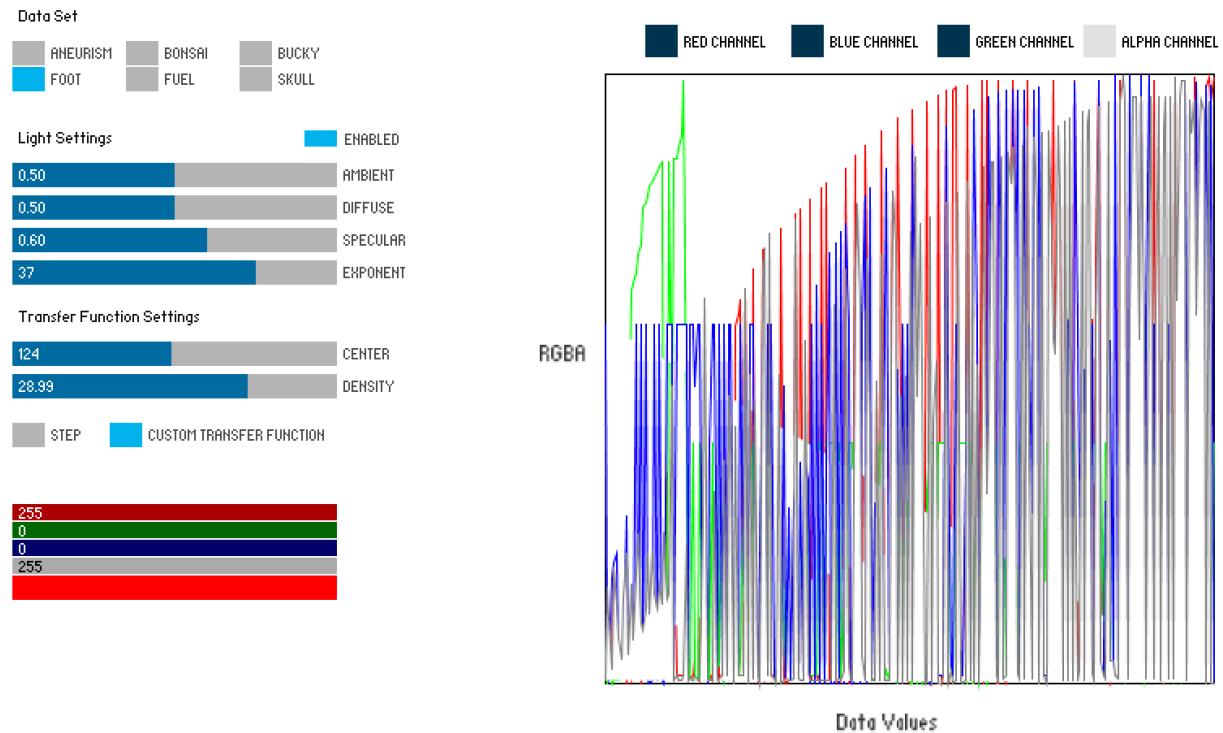
Data set explored - Foot data set

Below are the screenshots of the data exploration I did using my transfer function editor,









What I observed was that just by tweaking the alpha value a little a lot of noise data could be removed. This proves that the data set had a lot of noise data at a particular peak and the transfer function helps you remove it. The second interesting thing I found in the foot data set is the one for the veins. In the second screenshot if you observe then the green lines could represent veins and that information can be used to analyze the data set. One more thing that I found interesting in the third image is the difference in the color for skin and bones. You can distinctly see the skin layer and bone layer separately.

b) Strengths and weaknesses of my design - My transfer function widget does fulfill the basic purpose of a transfer function editor in the simplest way possible and gives user the chance to interact with the various channels and allows interaction with the individual values in the channels but it is not as smooth as ImageVis3d. I would like to allow user to switch between the channels without having to click on the checkboxes. This could be done by double clicking on a particular channel line or something similar. Or some key presses could also work. I would also like to add the checkered box that ImageVis3d had at the top of the graph which displayed the colors that are activated or something like a color bucket could be displayed. I am not sure how helpful will this be for the user but it will definitely enhance the current design. I could also try to separate tabs for the different channels and allow the user to just look at one channel at a time and interact with it. Little things like displaying the value of the data point when the mouse is moved over it could be implemented as well to enhance the usability of my transfer function widget. Scrolling could also be added to the current design and the interaction could be made

smoother. But, if mapping scalar values to RGBA is what the purpose is then the editor does a fine job I feel.

c) Volume rendering as a technique -

It is a very cool technique to extract isosurfaces from the dataset. It feels like a natural way of looking at the data without having to look at the actual object. I am blessed to be looking at a rendered image of a skull instead of looking at an actual skull to detect a broken jaw or something. It is easy to look at different aspects of the data by peeling it layer by layer or value by value. Interactivity becomes quite easy with functions like density, alpha channels, light settings etc. But it looks like it requires a lot of computation because every time I tried to run both imageVis3D and the Volume rendered my almost brand new laptop would start heating up or something. But this definitely can be solved by using better machines etc. The challenges that I faced with volume rendering was mainly trying to look for something significant or interesting. A tree looked like a tree, a skull looked like a skull may be it was these data sets that were mostly “regular” in nature but I am sure volume rendering could turn out to be an awesome technique to look at a crack in the skull, somewhere inside. My favorite part was being able to map between the density of the values to the transparency/ opacity on the screen to reveal different aspects. One thing that bothered me with trying to work with volume rendering and the data sets was noise. There was so much noise in some of the data sets that unless you knew what you were looking at you wouldn’t know if it was something significant and a part of the data set or just plain noise. For example the observation that I made about the fingerprints for the bonsai data could be noise data and it might not be significant at all. Also it takes a lot of time to find a way to interact with the data in the most effective way. For eg. It is not really a cakewalk to find a good transfer function to reveal something extremely important but again this could also be because the data sets that I used for interaction. Overall, volume rendering seems like an important and useful technique.

