Dan Morris
2/2/00

CS194 :

Independent Study in Scientific Visualization Techniques for Applications in Neuroimaging

**Very broad objective (why I'm doing this independent study) :**

My previous research experience has been computational, but has been oriented entirely toward solving biological problems. The goal of this independent study is to begin "porting" my background in biology to a set of problems with general relevance in computer science, and to hopefully make a unique contribution to the graphics group that will draw on my experience in neuroscience and biology.

**Slightly less broad objective (things I'd like to learn about/do this semester) :**

- Become familiar with basic approaches to medical image manipulation and storage
- Explore the state of the art in *interactive* medical image visualization
- Learn a bit about the mathematics required for tensor calculation and analysis
- ***Write code***

**Prerequisites (relevant skills I am bringing *into* the semester that I hope to _use_) :**

- A strong general background in neuroscience, including previous coursework in cellular neurobiology and genetics, functional connectivity in the CNS, neuroanatomy, and computational neuroscience
- A reasonably strong familiarity with relevant imaging modalities, including a previous term paper on diffusion-weighted MRI for neuroimaging (what are the odds of that?)
- Knowledge of several programming languages, including Java and C++, and several relevant packages such as GL and AWT

**Initial thoughts :**

I have already spoken with Song Zhang; it seems that he is working on a project that will incorporate many of the "prerequisites" in which I'm interested. As I understand it, his goals are to obtain structural information from dtMRI data and display both structural and diffusion information in a useful, non-cluttered, generally distinguishable manner.

I am personally less interested in extracting more raw information from diffusion-weighted images by manipulating the tensors than I am in creating software for useful data presentation. In particular, I am interested in exploring interactive techniques for visualizing diffusion tensors, which is a subset of the more general case : interactive techniques for visualizing multi-valued data. By "interactive", I mean at least time-varying, but probably also requiring user input to control the display. Could tensor streamline density be controlled in a way that effectively allows a user to remain oriented on a T1- or T2-weighted background, while obtaining a nearly complete picture of the tensor field?

This problem, I think, is a sufficient starting point. I intend to use it as that, and I will bend my objectives as interesting work becomes available…

**Rough schedule :**

| Week | Topic | Things to do |
|------|-------|--------------|
| 1,2 | Background | Read some of the literature on dtMRI, on multi-valued-data visualization, on tensor analysis |
| 3,4 | Playing with software | Become familiarized with some of the software and libraries used to store, access, and manipulate the image sets available. Look through and start working with Song's code (or someone else's code if another project seems more appropriate). |
| 5 | Specification | Identify a particular piece of software to which I will be able to contribute, and specify what I intend to complete before the end of the semester, hopefully to the level of individual classes. |
| 6-12 | Programming | Write a lot of code that hopefully implements a particular visualization algorithm in an interactive form that is especially useful in image exploration (perhaps something that is useful for clinical evaluation). |
| 13-14 | Presentation | Comment, document, finish… put my work in a state that will render it useful to whoever follows, or to myself at my next destination (wherever that may be). Prepare a "manual" that summarizes my semester, much like this "syllabus" does. |