Independent Study in Scientific Visualization

*High-level Objective:*
Although I am a Computer Science major, I also have a very strong interest in the biological sciences. Up until now, these interests have remained largely independent of each other. In doing this independent study, I hope to combine these interests while gaining experience in research in Computer Science.

*Objectives:*
- Gain an understanding about how research in Computer Science works
- Gain research experience
- Have the opportunity to combine my interests in Computer Science and Biology
- Facilitate research in a scientific discipline through the use of Computer Science
- Work on an algorithmic problem
- Hopefully make a positive impact on Biology research or Computer Science research (or, ideally, both areas)
- Possibly write a paper

*Prerequisites:*
- Software engineering and programming experience
- Solid biology background (for example, a background in Neuroscience)
- Solid mathematics background (statistical analysis)

*Discussion:*
I hope to work with people doing research in some area of the biological sciences and develop a tool that will help them gain new insight in their area of research. Research areas that caught my eye in particular are the research in MS and HIV-related Neuropathology. I hope that this tool will provide new statistical information and that, in developing this tool, I will have the opportunity to attack some current algorithmic problems in Computer Science.

*Project Details: (based on our January 4th meeting)*
Some of the specifications for the project are listed below:
- Allow the user to load DTI data and visualize the resulting streamtubes
- Allow the user to edit the streamtubes for a given set of DTI data (for example, the user should be able to color the tubes, and delete tubes)
- Allow the user to save/load the edits
- Allow the user to select a set of streamtubes as a region of interest. The user will be able to perform various computations on the resulting volume:
  - Calculate the volume
  - Calculate FA, $<D>$
  - Calculate and graph the FA along the region of interest as a function of ROI length. With this kind of data from multiple “normal” subjects, an average graph can be computed and used to normalize the data (divide
each point on the graph by the corresponding point on the average graph).
An FA graph computed from the DTI data of a subject with a disorder can
be normalized with the average as well in order to see where FA differs
from a healthy subject.

- Allow the user to select a smaller portion (for example, a smaller subset of image
slices) of the ROI and perform above computations on the smaller volume.

Schedule:

<table>
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<tr>
<th>Semester</th>
<th>Week</th>
<th>Topic</th>
<th>Description</th>
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| Winter Break   |          | Background                | Background reading: MRI/DTI, papers from the Viz website  
                |          |                           | 1/4 meeting to discuss what to implement  
                |          |                           | Read documentation on SG and play around with it |
| Spring 2005    | Weeks 1, 2| Phase I                   | Design/Programming:  
                |          |                           | Allow user to load DTI-data and visualize as streamtubes  
                |          |                           | Allow user to edit (color, delete) streamtubes  
                |          |                           | Allow user to save/load edits |
|                | Week 3   | Testing, Modification     | Let the doctors test this out for feedback  
                |          | and Debugging             | Fix things that break and modify functionality based on feedback  
                |          |                           | Plan a paper |
|                | Weeks 4, 5| Phase II                  | Design/Programming:  
                |          |                           | Allow user to select multiple streamtubes to define an ROI  
                |          |                           | Create a volume encompassing the ROI  
                |          |                           | Allow user to break up ROI into smaller chunks  
                |          |                           | Compute FA, <D>, volume of ROI |
|                | Week 6   | More testing and writing  | Ask the doctors to play around with what I've got  
                |          |                           | Gather feedback and modify functionality where necessary  
                |          |                           | Keep going on the paper |
|                | Weeks 7, 8| Phase III                 | Design/Programming:  
                |          |                           | Compute/graph FA, <D> as a function of ROI length |
|                | Week 9   | More testing and writing  | Gather feedback again and debug/modify |
|                | Weeks 10, 11| Testing and writing      | Hopefully by this time we can use what I've implemented to make some  
                |          |                           | interesting and meaningful analyses in each of the doctors' research  
                |          |                           | areas.  
                |          |                           | Write, write, write |
|                | Week 12  | Wrap up                   | Finish up my paper(s) and present what I've done |