Review of cgmanalysis Shiny App

Summary

The designer/developer would like to create a visualization tool for visualizing data from continuous glucose monitors (CGMs) that works across CGM models. This will be very useful, as current tools are proprietary and do not work across models. This will build on R code that has already been written to work with the data and produce summary statistics. There will be three main views: aggregate glucose profile (AGP), time in range (TIR), and summary statistics. Each view will have several visualization options that can be selected by the user. The main tasks supported will be lookup (to find extreme patients), browse/identify (AGP, TIR by patient), compare (two patients to each other), summarize (table of summary statistics), derive (summary statistics for user-specified daytime and nighttime ranges).

Project Scope and Prioritization

This is an interesting and ambitious project that will undoubtedly find use by the designer's colleagues at the Barbara Davis Center (BDC) and by the designer him/herself. However, I wonder if it is overly ambitious for a semester project. Given that the designer works at the BDC, it's possible that any work that remains unfinished after this semester could be completed as part of his/her work at the BDC. I have never done a project like this, so I may be worrying about something that I don't need to worry about. I wouldn't suggest that the developer try to dumb it down—I think that all parts of the project as described would be useful and should be included if possible. However, I would encourage the developer to prioritize the different parts of the project and develop them in order. That way, the developer won't end up with everything half done at the end of the semester but may end up with some things completely done and others in progress or not started. It's up to the designer how he or she would like to prioritize things, but I have provided one possible prioritization below at the end of this document.

What's Available and What's Needed

The developer has probably already done this, but if not, he or she should look at what's available in the various visualization tools proprietary to CGM models and brands. While I would be surprised if the developer hasn't done this given that he or she works with the data from those CGMs, it isn't mentioned in the design documents. Determining what's useful and what's not as well as what's implemented well and what's implemented poorly could be very helpful in designing a new tool. Additionally, the developer should ask his or her colleagues at the BDC what they're looking for if he or she hasn't already, although I assume discussions have already taken place given that they are providing the developer with data for the project.

Compare Tasks

I do have one question about the usefulness of the compare task as stated by the developer. Is it really that useful to compare two patients to each other when it comes to TIR or AGP? Wouldn't it be more useful to compare a given patient to the cohort average? That can be done with the AGP visualizations as already conceptualized, as the AGP visualizations described include a cohort average AGP on the same plot as the patient-specific plots. The one change that should be made to facilitate this is the change from standard error band around the cohort average AGP to a 95% prediction band. While a 95% confidence band may seem appropriate, confidence bands and intervals apply to the overall cohort

average, while prediction intervals and bands apply to individual patient values. A user could then easily see if an individual patient's AGP is outside of the range that is consistent with the cohort overall.

A second comparison that might be useful would be to compare a given patient's one-time profile (a single time, not an average) for a given day or other time period deviates from that patient's AGP. The plot could be similar to the AGP plots already proposed, except the average and prediction band sould come from a given patient, meaning the average is the patient's AGP. A patient's profile for a given day could then be compared to that patient's AGP to see if that patient was "off" in some way from his or her "normal." I don't know if the data from the CGMs comes at that level of detail, but if it does, this might be a useful plot and could be constructed using the framework proposed for AGP already.

Layout

I spent two years as an undergraduate research assistant doing website usability research. I'm still no expert, but I do have one suggestion when it comes to the layout of your tool. Website developers run into usability trouble when they put navigation tools in multiple places UNLESS they are redundant. As proposed, the main navigation bar for this tool, which switches among the AGP, TIR, and summary stats views, appears in the top middle of the screen. However, there is a widget called "Views" toward the bottom of the screen that switches among different views within the AGP view, different views within the TIR view, etc. Both are useful and necessary widgets. However, they should be combined or located directly next to each other. Otherwise, it's possible that a user will see the word "Views" in the bottom and be drawn there when trying to switch between AGP, TIR, etc. The research I worked on as an undergraduate showed time and again that, once a person has determined that a given heading (the "Views" heading, in this case) is the right heading, the person will continue to look there for a task associated with that heading despite multiple failures. So, if the view widgets are together, either nested or directly adjacent to one another, the user will be drawn to the right place regardless of which widget he or she needs to use.

Device Accuracy

While inclusion of some sort of accuracy measure for each device would be desirable as stated in the proposal, I'm not sure this could be determined from the data collected. One must distinguish between measurement error and sampling error. Sampling error can be determined from the data collected without knowing the true value or a gold standard. The standard error summarizes the sampling error and is used to build the sampling distribution, calculate confidence intervals, and calculate p-values. This can be done with the CGM data collected. However, as the true value or gold standard is not part of the data being collected, the only way to include measurement error or device accuracy in the tool would be to determine that information elsewhere, either through an experiment or by looking up what the manufacturer reports. This might not be that useful and could easily be omitted from this project.

Suggested Prioritization

1. AGP line plot (basic—no options)
2. TIR stacked bar charts (basic—no options)
3. Summary stats
4. Primary navigation widget (AGP/TIR/Summary stat views)
5. Add options to AGP line plot

       a. Units
       b. Highlighted range
       c. Selectable ID legend
       d. If any of these turn out to be harder than you thought, leave them out for now
6. Add options to TIR stacked bar chart
       a. Day/night/overall
       b. Units
       c. Ranges
7. AGP small multiples
8. TIR multiples
9. AGP radial plot
10. Add options to 7, 8, and 9 as desired