HW #3

- Due date: Tues, June 30 by 11:59pm EST. If you need extra time, just let me know.
- Download the two data folders, eyetracking and tom_localizer to your homework directory.
- This HW assignment might be on the longer side. If you're short on time, read over both problems and choose the one that looks more interesting to you.
- **REMEMBER GOOD CODING PRACTICES. WRITE DOCUMENTATION FOR ALL YOUR SCRIPTS AND/OR FUNCTIONS.**
- Turn in the assignment by email at mlnguyen@princeton.edu
- Data in this assignment are shared with permission from the authors as noted below.

Problem 1

In this problem, you will visualize sample data from an eye-tracking experiment conducted by Aaron Kurosu (GS) and Yoko Urano (UG) in the Todorov Lab at Princeton. During the experiment, subjects freely viewed real-life posters while their eyes were tracked and then judged each poster for attractiveness. Here, you will visualize data from 3 subjects in a single trial. The data consists of the x- and y-coordinates for each subject's fixation points while viewing img01.png.

a. Open the CSV file in Excel and familiarize yourself with it. CSV is a file type where values are separated by commas (ie. Comma Separated Values). Next, load the data into MATLAB using the readcsv() function:

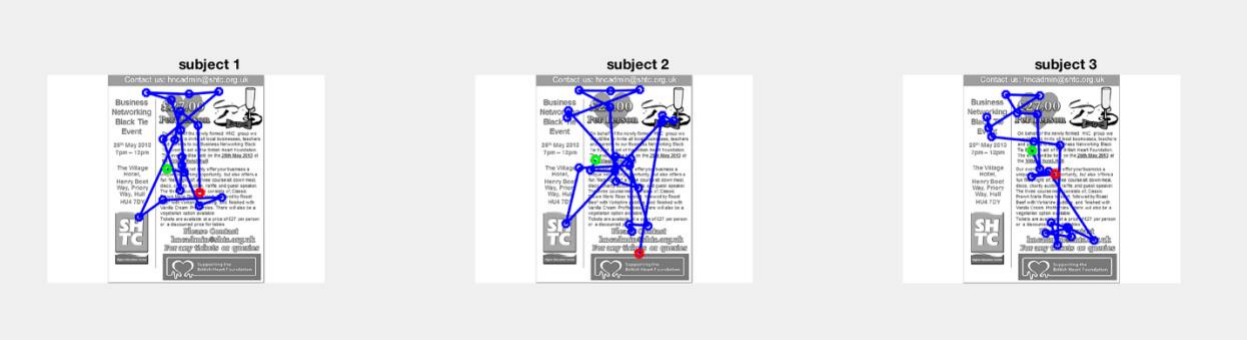
```
eye_data = csvread('eyetracking/vis_hierarchy_eyetracking.csv',1);
stim_image = 'eyetracking/img1.jpg';
```

b. Examine the data in MATLAB and familiarize yourself with it. Which column is the subject number? Which column is the x-coordinate? Which column is the y-coordinate? Make a note for yourself.

c. Open a new figure. Using a for loop, plot each subject's fixation pattern overlaid on img01.jpg side-by-side on a single figure window (see example below). Indicate fixation points with a marker, and include solid lines to indicate the trajectory between fixation points. Indicate the subject's first fixation point with a green marker and the last fixation point with a red marker. The (x,y)-coordinates in the csv file are already aligned to the image. You can display img01.jpg using imshow():

```
imshow(stim_image); hold on;
```

Add an appropriate title for each subplot. Your final figure should look something like this:



d. Take a look at your figures. What features of the poster do subjects look at most frequently? Where do subjects look first? What patterns do you see (informally)?

Problem #2

In this problem, you will example fMRI data from 15 subjects who participated in an experiment on how context changes interpretation of a narrative in the brain. The data was collected by Yaara Yeshurun, a former postdoc in the Hasson Lab at Princeton, and published here. As part of the experiment, subjects were scanned in a "theory of mind localizer," a type of task that is used to localize (=identify) regions of the brain that are involved in theory of mind, or making inferences about other people's mind state. During the scan, subjects read short stories and answer True/False questions about either people and their beliefs ("belief" condition, requiring theory of mind) or about photographs and their contents ("photo" condition, not requiring theory of mind). Using this data, I've defined three regions of interest (ROIs) where neural activity is greater during the belief condition than during the photo condition, suggesting that these regions are involved in theory of mind. These regions include left temporal parietal junction, right temporal parietal junction, and precuneous (see slide 28 in the lecture notes from 6/26 for references). In this problem, you will load and plot fMRI timeseries data from these 3 ROIs during the theory of mind localizer.

a. Copy data from the GitHub directory to a directory named "tom_localizer." Each .mat file contains a subject's average timeseries data for the ROIs in a matrix with dimensions nROIs x nTimePoints. Row 1 contains data for right TPJ, row 2 for left TPJ, and row 3 for precuneous.

b. Using a for loop, load the subject data in a 3D matrix with dimensions nSubs x nROIs x nTimePoints. You can specify each subject's data file by concatenating strings like this:

```
subdata_file = ['tom_localizer/s' num2str(subjNum) '_roidata.mat'])
```

c. Next, visualize the experimental design. The goal is to make the figure on slide 27 of the lecture notes. The ToM localizer has 5 trials each of the Belief condition and the Photo condition. Each condition is 14 seconds. The onsets of the Belief trials at 12, 90, 142,

194, and 220 seconds, while the onsets of the Photo trials are 38, 64, 116, 168, and 246 seconds. To visualize the experimental design, we first need to convert the trial onset and length from seconds to units of TR (=repetition time), which is the frequency at which the fMRI scan takes a brain image. The TR for this experiment was 1.5 seconds. To convert experimental timing to TRs, run:

```
belief = [12 90 142 194 220] / 1.5;
photo = [38 64 116 168 246] / 1.5;
trialLength = 14/1.5;
```

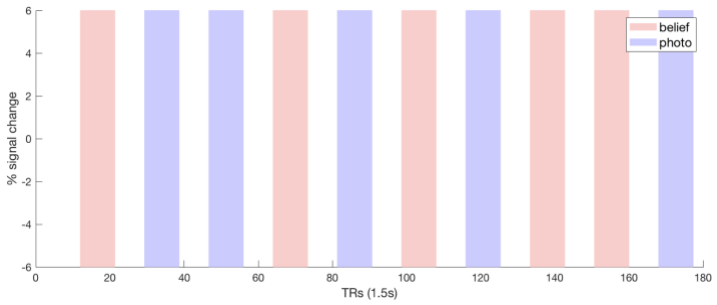
Next, we will visualize the trial periods using a plotting function, rectangle(), that allows us to plot (you guessed it) rectangles on a figure. Look up the rectangle() documentation to see how it works. Here is some code for plotting the belief trials as rectangles:

```
figure('name', 'exp_design', 'color', 'w'); hold on;
for j = 1:length(belief)
      rectangle('position', [belief(j), - 6, trialLength, 12], ...
         'edgecolor', [1 .8 .8], 'facecolor', [1 .8 .8]);
end
```

Write a second for loop for plotting the Photo trials on the same figure. Set the color of the Photo trials to [.8 .8 1]. At the end of your code to plot the experimental design, add these two lines, which will be useful for making your legend later.

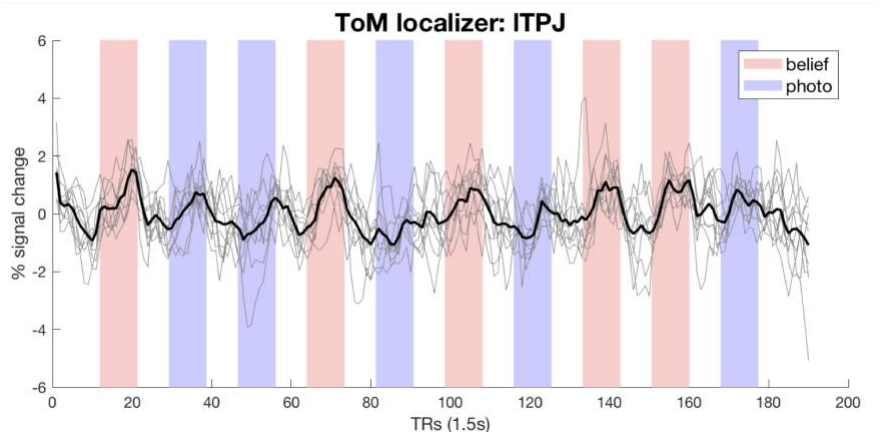
```
plot(belief_lag(j), -6, '-', 'color', [1 .8 .8], 'linewidth', 8);
plot(photo_lag(j), -6, '-', 'color', [.8 .8 1], 'linewidth', 8);
legend({'belief', 'photo');
```

The experimental design figure should look something like this:



d. At this point, you should have a figure with a bunch of colored stripes for the two conditions. Now, we need to modify the onset of the trials to take into account the hemodynamic response function (HRF) lag. The fMRI signal is dependent on changes in blood oxygenation levels in the brain. The change in the fMRI signal is slow: if a trial starts at TR = 1, the fMRI signal doesn't reach its peak until TR = 5, or about 6 seconds later. Because we're interested in visualizing how each trial affects the fMRI signal, we need to shift the onset of each trial by the HRF lag. Modify your code from 2c to shift the onset of each belief and photo trial by 4 TRs. The trial length doesn't change. Update your visualization.

e. Now we will plot each subject's fMRI response on top of the experimental design on the same figure (see example below). For each ROI, plot the experimental design from part 2d. Next, plot each subject's timeseries of response as a thin gray solid line. Next, plot the average response timeseries (averaged across all subjects) as a thicker, black solid line. Add a legend, axis labels, and a title.



f. Take a look at your 3 final figures. How does the fMRI signal change over time? Does the signal increase more in certain conditions or others? Does the pattern of response look different in the 3 ROIs?