Name _____

Psychology 5068
Hierarchical Linear Models
Homework 11
Due April 23, 2018

In class we examined the following model:

Level 1

$$\eta_{ij} = \beta_{0j} + \beta_{1j} age\_GMC_{ij} + \beta_{2j} sex_{ij}$$

Level 2

$$\beta_{0j} = \gamma_{00} + \gamma_{01} crowded\_GMC_j + \gamma_{02} economic_j + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11} crowded\_GMC_j + \gamma_{12} economic_j + u_{1j}$$
$$\beta_{2j} = \gamma_{20} + \gamma_{21} crowded\_GMC_j + \gamma_{22} economic_j$$

For this assignment you will extend these analyses to test nonlinearity and interactions. The data for this assignment are contained in the file, Safety_Binary.csv.

If you have problems getting some of the models to converge, you can try alternative optimizers and increase the number of iterations that are used before the algorithm gives up. The easiest way to do this is to create several alternative control lists and then substitute them into the model statement as needed:

```
cl1 <- glmerControl(optimizer = "bobyqa", optCtrl=list(maxfun=10000))
cl2 <- glmerControl(optimizer = "Nelder_Mead" optCtrl=list(maxfun=10000))
cl3 <- glmerControl(optimizer="optimx",optCtrl=list(method="nlminb",maxiter=10000))
```

You will need the *optimx* package for the last one.

Switch to a different optimizer like this:

```
Safety_Fit_1 <- glmer(unsafe ~ 1 + Z_Age + Z_Age_SQ + sex +
                (1 + Z_Age + Z_Age_SQ + sex|street), data=Safety_Data, binomial("logit"),
                control=cl1)
```

1. In the data file, two of the variables are named *age* and *crowded*. Standardize them and name them *Z_Age* and *Z_Crowded*. Create a new variable that is the square of *Z_Age*; name it *Z_Age_SQ*.

2. Test a Level 1 model that contains *Z_Age, Z_Age_SQ*, and *sex*. Level 2 should be unconditional (no predictors) with all residual variances estimated.
   (a) Is there a nonlinear relationship between age and feeling unsafe?
   (b) Is sex still a significant predictor?

(c) Can this model be simplified by eliminating any Level 2 variances? Test the following simplifications (the intercept is retained in all random effects specifications):
   i. Eliminate *Z_Age_SQ* from the random effects.
   ii. Eliminate *Z_Age* and *Z_Age_SQ* from the random effects.
   iii. Eliminate *sex* from the random effects.
   iv. Eliminate sex and *Z_Age_SQ* from the random effects.
   v. Eliminate *sex*, *Z_Age*, and *Z_Age_SQ* from the random effects.

   Compared to the original model, identify what you consider to be the simplest model using the likelihood ratio test as well as AIC.

3. Carry out a similar series of analyses, but substitute the *sex:Z_age* interaction for the nonlinear age effect.
   (a) Is there an interaction between age and sex?
   (b) What is the simplest Level 2 variance model that can be used? Test the following simplifications (the intercept is retained in all random effects specifications):
      i. Eliminate sex:*Z_Age* from the random effects.
      ii. Eliminate *Z_Age* and sex:*Z_Age* from the random effects.
      iii. Eliminate *sex* and sex:*Z_Age* from the random effects.
      iv. Eliminate sex, Z_Age, and sex:*Z_Age* from the random effects.

      Compared to the original model, identify what you consider to be the simplest model using the likelihood ratio test as well as AIC.

4. Now add *Z_Crowded* to the simplest model from Question 3 and include all two-way interactions and the three-way interaction.
   (a) What is the highest order effect that is significant?
   (b) Plot the highest order significant effect with probability of feeling unsafe as the outcome.
   (c) Provide an interpretation for the plotted effect.