Initialize R by entering the following commands at the prompt:

```r
options(contrasts=c("contr.sum","contr.poly"),digits=4 ) # set definition of contrasts
source(file=url("http://psycserv.mcmaster.ca/bennett/psy710/problems/ps5/p5init.R") ) # load data
```

1. An experiment was conducted to measure the effect of practice on visual contrast sensitivity. Detection threshold was measured on four consecutive days for eight subjects. The dependent variable was contrast sensitivity, which was defined as the reciprocal of the minimum amount of contrast needed to detect the pattern; higher sensitivity corresponds to better performance. The data are stored in the data frame `dat1`. Each row contains the data from one subject; the four columns contain contrast sensitivity measured on four days.

   (a) Evaluate the effect of day with a univariate ANOVA. Use the Huynh-Feldt correction for all tests that make the sphericity assumption.

   (b) The command `contr.poly` can be used to calculate the contrast weights to evaluate the linear and quadratic trends of contrast sensitivity across four evenly-spaced days:

   ```r
   contr.poly(n=4)
   ## .L .Q .C
   ## [1,] -0.6708 0.5 -0.2236
   ## [2,] -0.2236 -0.5 0.6708
   ## [3,] 0.2236 -0.5 -0.6708
   ## [4,] 0.6708 0.5 0.2236
   ``

   The linear weights are in column 1 and the quadratic weights are in column 2. Use those weights to evaluate the linear and quadratic trends of contrast sensitivity across days.

2. An experiment was conducted to assess the effects of factors A and B on performance. The experiment used a 2 x 2 factorial within-subjects design: the two levels of factor A were crossed with the two levels of factor B, and each subject was tested in all four conditions in a random order. The data are stored in the data frame `dat2`. Evaluate the effects of A and B with a univariate ANOVA. If the A × B interaction is significant, then evaluate the simple main effect of B at each level of A.

3. An experiment measured memory for lists of words in young, middle-aged, and senior adults. The experiment used three sets of words (w1, w2, and w3) that varied in terms of complexity, and two study-test intervals (short and long). The three word sets and two study-test intervals were combined in a 3 (word) x 2 (delay) x 3 (group) split-plot design. The dependent variable was the score on a memory test; higher numbers indicate better performance. The data are stored in the data frame `dat3`.

   (a) Conduct a split-plot ANOVA to evaluate the effects of word list, study-test interval, and age group (and all interactions) on memory. Where appropriate, adjust p-values with the Huynh-Feldt correction.

   (b) The experimenter believes that the effect of test-study interval differs for low complexity (w1) and high complexity (w3) words, and that this difference may vary across age groups. Evaluate these hypotheses conducting a single ANOVA on a set of contrast scores.

4. An experiment was conducted to measure the effects of average luminance (low vs. high) and stimulus duration (100, 200, and 300 msec) on sensitivity for visual patterns in younger and older subjects. The two levels of luminance and three stimulus durations were combined factorially, and each subject was tested in all six conditions. The data are stored in the data frame `dat4`. 
(a) The experimenter is interested in determining if there is a significant linear trend of sensitivity across stimulus duration, and if the trend varies as a function of luminance and/or age group. Evaluate these hypotheses by conducting a single, split-plot ANOVA. (N.B. The weights for a linear trend across 3 equally-spaced levels are c(-1, 0, 1)).

(b) What is the sphericity assumption? Would the sphericity assumption have any impact on your interpretation of the results of the previous analysis? Explain