

**Part I.** (140 points) Do all calculations in SAS. Use a word processor of your choice to write a report. Insert computer text output and graphics to support what you are saying, but you need to write something that looks like an academic paper — not a pile of computer output. Turn in a hard copy of your HW in class (i.e., don't email me your HW). Also:

1. Clearly specify parameters and hypotheses when appropriate.
2. Write a coherent conclusion.

(70<sup>pts</sup>) **1. Kangaroos skull measurements: mandible length**

The data to be analyzed here are selected skull measurements on 299 kangaroos of known sex and species. There are 11 columns of data, corresponding to the following features. Columns, from left to right:

1. sex (1=M, 2=F)
2. species (0=M.\ giganteus, 1=M.f.\ melanops, 2=M.f.\ fuliginosus)
3. post orbit width
4. rostral width
5. supra-occipital - paroccipital depth
6. crest width
7. incisive foramina length
8. mandible length
9. mandible width
10. mandible depth
11. ascending ramus height (cols 3-11 are in mm times 10)

The first 4 observations in the data set are given below. Some of the observations in the data set are missing. These are represented by the SAS default missing value id of a period.

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1 0 249 227 531 153 88 1086 131 179 591
1 0 233 248 632 141 100 1158 148 181 643
1 0 244 240 575 144 107 1131 116 169 610
1 0 224 242 568 116 79 1090 132 189 594
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I am interested whether there is any effect of sex or species on the mandible length.

- (a) (10 pts) Provide side-by-side boxplots of the data, comparing the mandible lengths across the 6 combinations of sex and species. Comment on the distributional shapes and compare the typical mandible lengths across groups.
- (b) (10 pts) Produce an interaction plot (i.e., profile plot of cell means) for these data. Discuss what you see in the plot.
- (c) (10 pts) Provide an ANOVA table for this two-factor setting.
- (d) (10 pts) Test for the presence of interaction between sex and species. Also test for the presence of main effects, effects due to the sex and species.
- (e) (10 pts) Summarize differences, if any, in sexes and species using relevant multiple comparisons. Give clear interpretations of any significant effects.
- (f) (10 pts) Do the assumptions for a standard two-factor analysis appear reasonable? If not, suggest and carry out an alternative analysis.
- (g) (10 pts) Summarize your findings on the effect of sex and species on the mandible lengths.

(70<sup>pts</sup>) **2. Kangaroos skull measurements: crest width**

Repeat the analysis, using the crest width.

- (a) (10 pts) Provide side-by-side boxplots of the data, comparing the crest widths across the 6 combinations of sex and species. Comment on the distributional shapes and compare the typical crest widths across groups.
- (b) (10 pts) Produce an interaction plot (i.e., profile plot of cell means) for these data. Discuss what you see in the plot.
- (c) (10 pts) Provide an ANOVA table for this two-factor setting.

70 pts

70 pts

100 pts

- (d) (10 pts) Test for the presence of interaction between sex and species. Also test for the presence of main effects, effects due to the sex and species.
- (e) (10 pts) Summarize differences, if any, in sexes and species using relevant multiple comparisons. Give clear interpretations of any significant effects.
- (f) (10 pts) Do the assumptions for a standard two-factor analysis appear reasonable? If not, suggest and carry out an alternative analysis.
- (g) (10 pts) Summarize your findings on the effect of sex and species on the crest widths.