STAT 802 Applied Multivariate Analysis Nov. 9, 2005

Student Presentations today:

John Bentley	12.3	Hierarchical Cluster Analysis	9-Nov
Mark Wolters	11.8	Classification and Regression Trees	9-Nov

Reminder of guidelines:

The presentations will be limited to 15 minutes!
You may choose any topic from Chapters 8-12. Criteria for guidance:
1. simple enough to be understood by students in a 15 minute presentation
2. complex enough that some students will learn something new
3. illustrated with a real data set (from text CD or elsewhere) or simulated data set
4. should include a graph in the illustration
5. every student needs to choose a different subsection of the book
6. the analysis presented should be original to you

Evaluation: (open to suggestions for modification before November!)
9 marks for clarity, organization, ease of understanding of presentation, and keeping in time limit
7 marks for handout (clarity, brevity, ease of understanding ....)
7 marks for utility of content to students in learning about Multivariate Analysis
7 marks for technical accuracy and proper use of statistical software

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More on Ch 6:

Manova Example with Plastic Film Data p 313

Data set:

> T6.4.df

	extrusion	additive	tear.resist	gloss	opacity
1	0	0	6.5	9.5	4.4
2	0	0	6.2	9.9	6.4
3	0	0	5.8	9.6	3.0
4	0	0	6.5	9.6	4.1
5	0	0	6.5	9.2	0.8
6	0	1	6.9	9.1	5.7
7	0	1	7.2	10.0	2.0
8	0	1	6.9	9.9	3.9
9	0	1	6.1	9.5	1.9
10	0	1	6.3	9.4	5.7
11	1	0	6.7	9.1	2.8

12	1	0	6.6	9.3	4.1
13	1	0	7.2	8.3	3.8
14	1	0	7.1	8.4	1.6
15	1	0	6.8	8.5	3.4
16	1	1	7.1	9.2	8.4
17	1	1	7.0	8.8	5.2
18	1	1	7.2	9.7	6.9
19	1	1	7.5	10.1	2.7
20	1	1	7.6	9.2	1.9

Note: Three Dependent Variables, Two Independent Variables (Factors)

```
> extr.add=interaction(extrusion,additive)
> response=cbind(tear.resist,gloss,opacity)
> manova.output=manova(response~extrusion+additive+extr.add)
> summary(manova.output)
          Df Pillai approx F num Df den Df
extrusion  1 0.6181   7.5543      3     14
additive   1 0.4770   4.2556      3     14
extr.add   1 0.2229   1.3385      3     14
Residuals 16
            Pr(>F)
extrusion 0.003034 **
additive  0.024745 *
extr.add  0.301782
Residuals
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> attributes(manova.output)
$names
 [1] "coefficients"  "residuals"
 [3] "effects"       "rank"
 [5] "fitted.values" "assign"
 [7] "qr"            "df.residual"
 [9] "contrasts"     "xlevels"
[11] "call"          "terms"
[13] "model"
```

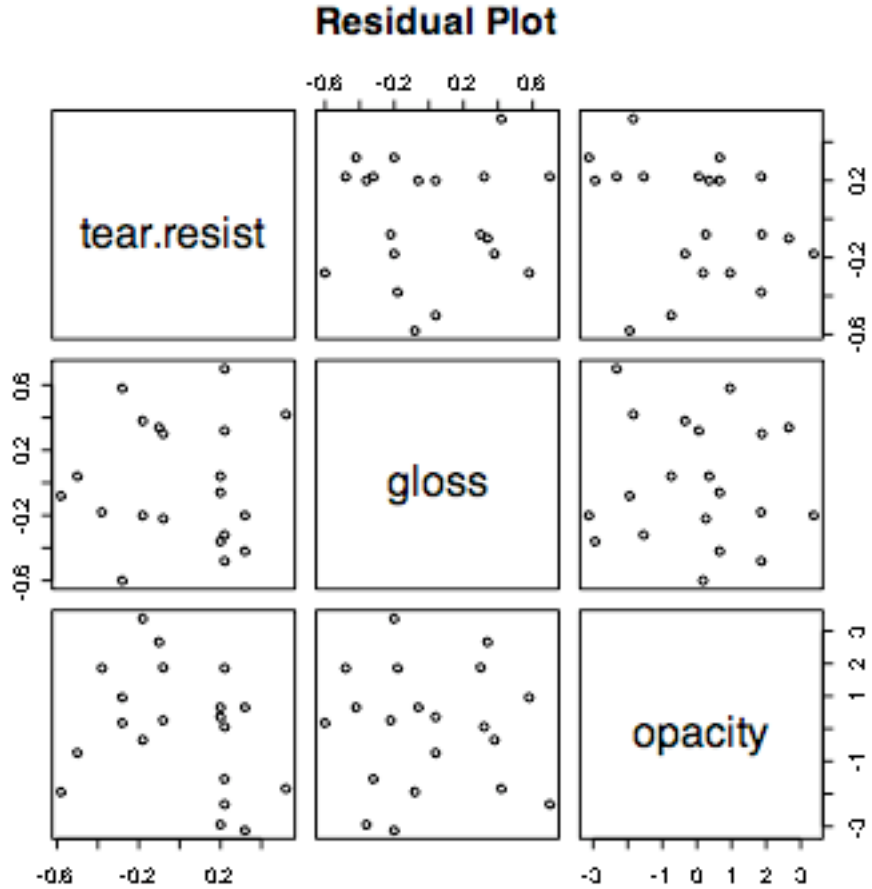
```
manova.output[[1]]
            tear.resist  gloss opacity
(Intercept)       6.785  9.315   3.935
extrusion1        0.300 -0.090   0.590
additive1         0.195  0.175   0.495
extr.add1        -0.010 -0.330  -0.890
extr.add2            NA     NA      NA
extr.add3            NA     NA      NA


> manova.output[[2]] # residuals
   tear.resist gloss opacity
1         0.20 -0.06    0.66
2        -0.10  0.34    2.66
3        -0.50  0.04   -0.74
4         0.20  0.04    0.36
5         0.20 -0.36   -2.94
6         0.22 -0.48    1.86
7         0.52  0.42   -1.84
8         0.22  0.32    0.06
9        -0.58 -0.08   -1.94
10       -0.38 -0.18    1.86
11       -0.18  0.38   -0.34
12       -0.28  0.58    0.96
13        0.32 -0.42    0.66
14        0.22 -0.32   -1.54
15       -0.08 -0.22    0.26
16       -0.18 -0.20    3.38
17       -0.28 -0.60    0.18
18       -0.08  0.30    1.88
19        0.22  0.70   -2.32
20        0.32 -0.20   -3.12
```

```
> manova.output[[3]] #effects
              tear.resist
(Intercept) -30.343442455
extrusion1    1.319280107
additive1     0.872066511
extr.add1    -0.022360680
              0.223606798
              0.130557281
              0.430557281
              0.130557281
             -0.669442719
             -0.469442719
             -0.090557281
             -0.190557281
              0.409442719
              0.309442719
              0.009442719
             -0.403606798
             -0.503606798
             -0.303606798
             -0.003606798
              0.096393202

                  gloss
(Intercept) -41.6579464
extrusion1   -1.1403947
additive1     0.7826238
extr.add1    -0.7379024
             -0.4024922
             -0.5247214
              0.3752786
              0.2752786
             -0.1247214
             -0.2247214
              0.4694427
              0.6694427
             -0.3305573
             -0.2305573
             -0.1305573
                -0.1105573
                -0.5105573
                 0.3894427
                 0.7894427
                -0.1105573

                   opacity
(Intercept) -17.5978550
extrusion1    0.6484597
additive1     2.2137073
extr.add1    -1.9901005
                -3.2870199
                 1.0326548
                -2.6673452
                -0.7673452
                -2.7673452
                 1.0326548
                 0.3531811
                 1.6531811
                 1.3531811
                -0.8468189
                 0.9531811
                 3.5812461
                 0.3812461
                 2.0812461
                -2.1187539
                -2.9187539
```

```
> manova.output[[5]]
#fitted.values
   tear.resist gloss opacity
1         6.30  9.56    3.74
2         6.30  9.56    3.74
3         6.30  9.56    3.74
4         6.30  9.56    3.74
5         6.30  9.56    3.74
6         6.68  9.58    3.84
7         6.68  9.58    3.84
8         6.68  9.58    3.84
9         6.68  9.58    3.84
10        6.68  9.58    3.84
11        6.88  8.72    3.14
12        6.88  8.72    3.14
13        6.88  8.72    3.14
14        6.88  8.72    3.14
15        6.88  8.72    3.14
16        7.28  9.40    5.02
17        7.28  9.40    5.02
18        7.28  9.40    5.02
19        7.28  9.40    5.02
20        7.28  9.40    5.02
```

How to look at residuals?

```
plot(as.data.frame(manova.output[[2]]),main="Residual Plot")
```



What if we look at one response variable at a time?
Asks different questions about effects, because ignores correlation among response variables (and errors).

```
>
lm.output=lm(tear.resist~extrusion+additive+interaction(extrusi
on,additive))
> summary(lm.output)

Call:
lm(formula = tear.resist ~ extrusion + additive +
interaction(extrusion,
    additive))

Residuals:
   Min     1Q Median     3Q
-0.580 -0.205  0.060  0.220
   Max
 0.520

Coefficients: (2 not defined because of singularities)
                                  Estimate
(Intercept)                        6.78500
extrusion1                         0.30000
additive1                          0.19500
interaction(extrusion, additive)1 -0.01000
interaction(extrusion, additive)2       NA
interaction(extrusion, additive)3       NA
                                  Std. Error
(Intercept)                          0.07425
extrusion1                           0.10500
additive1                            0.07425
interaction(extrusion, additive)1    0.14849
interaction(extrusion, additive)2         NA
interaction(extrusion, additive)3         NA
                                  t value
(Intercept)                        91.385
extrusion1                          2.857
additive1                           2.626
interaction(extrusion, additive)1  -0.067
```

```
interaction(extrusion, additive)2      NA
interaction(extrusion, additive)3      NA
                                  Pr(>|t|)
(Intercept)                         <2e-16
extrusion1                          0.0114
additive1                           0.0183
interaction(extrusion, additive)1   0.9471
interaction(extrusion, additive)2       NA
interaction(extrusion, additive)3       NA

(Intercept)                         ***
extrusion1                          *
additive1                           *
interaction(extrusion, additive)1
interaction(extrusion, additive)2
interaction(extrusion, additive)3
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.332 on 16 degrees of freedom
Multiple R-Squared: 0.5864,   Adjusted R-squared: 0.5089
F-statistic: 7.563 on 3 and 16 DF,  p-value: 0.00227



predict(lm.output)
   1    2    3    4    5    6
6.30 6.30 6.30 6.30 6.30 6.68
   7    8    9   10   11   12
6.68 6.68 6.68 6.68 6.88 6.88
  13   14   15   16   17   18
6.88 6.88 6.88 7.28 7.28 7.28
  19   20
7.28 7.28

compare with manova fitted values ....same!

same with residuals
lm.output[[2]]
    1     2     3     4     5
```

```
 0.20 -0.10 -0.50  0.20  0.20
    6     7     8     9    10
 0.22  0.52  0.22 -0.58 -0.38
   11    12    13    14    15
-0.18 -0.28  0.32  0.22 -0.08
   16    17    18    19    20
-0.18 -0.28 -0.08  0.22  0.32
```

So what is new in manova not in lm?

power of tests. Almost like replicated y-values.

Enough of Ch 6!

Next: Ch 7.