ST512 - Osborne
Block design activity

1. Refer to “golfballs.sas”, which contains a dataset with distances travelled by golf balls on greens grown with different varieties of grass. Four blocks are formed as sets of plots with similar slopes. The 5 varieties are randomized to the 5 slopes within each block.

(a) Obtain a scatterplot for the data, with variety as the horizontal axis and lines connecting the blocks:

```sas
symbol1 i=join; symbol2 i=join;
symbol3 i=join; symbol4 i=join;
proc gplot;
    plot y*variety=block;
run;
```

Consider an additive model. Note that the order of the blocks is preserved within each variety, so that the profiles across varieties don’t cross.

(b) Specify a model for this randomized block design

(c) Fit the model using proc glm:

```sas
proc glm;
    class block variety;
    model y=block variety;
run;
```

(d) Note the $F$ ratio and $p$-value for the treatment effect. $F = 8.31, p = 0.0019$.

(e) Note that much of the variability in distances is due to blocks. Glancing at the table on p. 714, there is a big ‘row’ effect. This is a good thing. Slopes evidently differ BETWEEN blocks, but are hopefully similar WITHIN blocks.

(f) Report the variety means and their standard errors:

```sas
lsmeans variety/stderr;
```

Note the SE of a variety mean is 0.058 on 12 df.

(g) Report the mean differences among varieties and their standard errors and confidence intervals adjusted for multiplicity using Tukey.

```sas
estimate "v2-v1" variety -1 1 0 0 0;
lsmeans variety/pdiff cl adj=tukey;
```

(The SE from the estimate statement (0.082) is common to all pairwise differences.)

(h) Fit a model with a random block effect (next topic in lecture):

```sas
proc mixed method=type3;
    class block variety;
    model y=variety/ddfm=satterth;
    random block;
    lsmeans variety/pdiff adjust=tukey;
run;
```

Note that everything is the same except

i. We get an estimated variance component for random blocks

ii. The standard errors for a sample variety mean (0.1422) are bigger and require a Satterthwaite approx for $df$, which is less ($df = 3.98$).