Notes on post-hoc Bonferroni-testing with repeated measures in R

The phoc() function gives the same results as a worked example using SPSS from this website (note you must run library(ez) for phoc() to work)

http://www.microbiologybytes.com/maths/spss4.html

subsection Two-Way Repeated Measures ANOVA light blue table, Treatment, Weedkiller, Flamethrower

Treatment:	Weedkiller					Flamethrower				
Severity:	1	2	3	4	5	1	2	3	4	5
Field1	10	15	18	22	37	9	13	13	18	22
Field2	10	18	10	42	60	7	14	20	21	32
Field3	7	11	28	31	56	9	13	24	30	35
Field4	9	19	36	45	60	7	14	9	20	25
Field5	15	14	29	33	37	14	13	20	22	29
Field6	14	13	26	26	49	5	12	17	16	33
Field7	9	12	19	37	48	5	15	12	17	24
Field8	9	18	22	31	39	13	13	14	17	17
Field9	12	14	24	28	53	12	13	21	19	22
Field10	7	11	21	23	45	12	14	20	21	29

This table is in an R-readable form in the same website from which you have downloaded the `phoc()` function as `weed.txt`. The SPSS example carries out a post-hoc test on the within-subjects factor Severity and reports the following results of a Bonferroni t-tests:

Pairwise Comparisons

(I) severity	(J) severity	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
1	2	-4.200(*)	.895	.011	-7.502	-.898
	3	-10.400(*)	1.190	.000	-14.790	-6.010
	4	-16.200(*)	1.764	.000	-22.709	-9.691
	5	-27.850(*)	2.398	.000	-36.698	-19.002
2	1	4.200(*)	.895	.011	.898	7.502
	3	-6.200(*)	1.521	.028	-11.810	-.590
	4	-12.000(*)	1.280	.000	-16.723	-7.277
	5	-23.650(*)	2.045	.000	-31.197	-16.103
3	1	10.400(*)	1.190	.000	6.010	14.790
	2	6.200(*)	1.521	.028	.590	11.810
	4	-5.800	1.690	.075	-12.036	.436
	5	-17.450(*)	2.006	.000	-24.852	-10.048
4	1	16.200(*)	1.764	.000	9.691	22.709
	2	12.000(*)	1.280	.000	7.277	16.723
	3	5.800	1.690	.075	-.436	12.036
	5	-11.650(*)	1.551	.000	-17.373	-5.927
5	1	27.850(*)	2.398	.000	19.002	36.698
	2	23.650(*)	2.045	.000	16.103	31.197
	3	17.450(*)	2.006	.000	10.048	24.852
	4	11.650(*)	1.551	.000	5.927	17.373

*** The mean difference is significant at the .05 level.**

a Adjustment for multiple comparisons: Bonferroni.

We get exactly the same results with phoc() as follows:

# read in the data
weed = read.table(file.path(pfad, "weed.txt"))

We now try and do a post-hoc test on the factor Sev. This will (correctly) fail because there are repeated measures (two measures per Sev per subject)

```
phoc(weed, .(field), .(Subj), .(Sev))
Error in phoc(weed, .(field), .(Subj), .(Sev)) :
  Unique values per subject-factor combination required;
aggregate over factors and try again
```

So we must aggregate first over Sev:

```
weedm = with(weed, aggregate(field, list(Subj, Sev), mean))
# give names to the columns
names(weedm) = c("Subj", "Sev", "field")
# redo
ph = phoc(weedm, .(field), .(Subj), .(Sev))
round(ph$res, 3)
           t df prob-adj
1-2   -4.692  9    0.011
1-3   -8.741  9    0.000
1-4   -9.183  9    0.000
1-5  -11.614  9    0.000
2-3   -4.077  9    0.028
2-4   -9.374  9    0.000
2-5  -11.563  9    0.000
3-4   -3.432  9    0.075
3-5   -8.698  9    0.000
4-5   -7.511  9    0.000
```

These are the same probabilities as those highlighted in yellow in the SPSS calculation. Therefore, there is strong evidence (!) that this phoc() function does exactly what SPSS does in applying a post-hoc Bonferroni test to repeated measures.

See the above lecture Die Varianzanalyse mit Messwiederholungen for further details.

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