IMPLY

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IMPLY produces deduced intervals (DIs) on any number of secondary contrasts from a set of confidence intervals (CIs) on (J – 1) primary contrasts on J means. IMPLY also provides the coefficient vectors used to express the secondary contrasts as linear combinations of the primary contrasts.

Before running IMPLY, you will need to have obtained the two CI limits for each primary contrast from a statistical package or a program such as PSY (which can be downloaded from http://www.psy.unsw.edu.au/research/resources/psyprogram.html). Imply is written in R, which can be downloaded from http://www.r-project.org/

To run IMPLY:

1. Open R
2. Copy the code (from the file *Imply_code.txt*) into R
3. Type imply() into R and press Enter

You will be asked *How many means?* (Answer and press Enter) and *How many Primary Contrasts?* (Answer and press Enter). For each primary contrast, you will be asked for a label/name, a set of J contrast coefficients (separated by commas), a *Scaling Option* (see below), and the confidence interval lower and upper limits (separated by a comma). Once you have provided this information for all primary contrasts, you will be asked *How many Secondary Contrasts?* For each secondary contrast, you will be asked for a label/name, a set of J contrast coefficients (separated by commas), and a Scaling Option.

The *Scaling Options* allow you rescale the contrast coefficients if you have entered the coefficients as integers (for convenience) when the CI limits assume either mean difference scaling or interaction scaling. Press 0 if no rescaling is required, 1 if the confidence interval

refers to the mean difference version of the contrast, 2 if the CI refers to a two-factor interaction contrast expressed as a difference-in-a-difference, and so on. For more on this, see Bird, 2002, pp. 211-212, or Masson & Loftus, 2003, pp. 210-211. Note that the scaling options do **not** change CI limits. The program assumes that if coefficients of *primary* contrasts are to be rescaled, the CI limits provided by you refer to the rescaled version of those contrasts (as is the case if the CIs were constructed by PSY). If the coefficients of *secondary* contrasts are to be rescaled, the DI limits provided by the program refer to the rescaled versions of those contrasts.

Output includes midpoints, limits and widths of all CIs and DIs. In addition, the output shows the coefficients used to express the DIs as linear combinations of the CIs provided.

Example: Find the DIs on *A* and *B* simple effect contrasts implied by CIs on *A* and *B* main effect contrasts and the *AB* interaction contrast from a 2 × 2 design, where the CIs are:

$$A = \mu_{1.} - \mu_{2.} = 0.5(\mu_{11} + \mu_{12}) - 0.5(\mu_{21} + \mu_{22}) \in [5.6, 10.4],$$

$$B = \mu_{.1} - \mu_{.2} = 0.5(\mu_{11} + \mu_{21}) - 0.5(\mu_{12} + \mu_{22}) \in [-0.4, 4.4]$$

and $$AB = (\mu_{11} - \mu_{12}) - (\mu_{21} - \mu_{22}) = (\mu_{11} - \mu_{21}) - (\mu_{12} - \mu_{22}) \in [15.2, 24.8].$$

In the following, the order of cell means is μ_{11}, μ_{12}, μ_{21}, μ_{22}. Text entered by the user is shown in bold.

```
How many means? 4
How many Primary Contrasts? 3

For each Primary Contrast:
1.  Enter a label/name for the contrast and then press enter
2.  Enter the contrast coefficients, separated by commas, and then press
enter
3.  Enter the scaling option and then press enter
        0  -  No rescaling
        1  -  Mean difference scaling
        2  -  Two-factor interaction
        3  -  Three-factor interaction
          ...
        n  -  n-factor interaction
4.  Enter the lower and upper limits of its CI, separated by a comma, and
then press enter
```

```
PRIMARY CONTRAST  1
Label: A
Coefficients: 1,1,-1,-1
Scaling Option: 1
CI: 5.6,10.4

PRIMARY CONTRAST  2
Label: B
Coefficients: 1,-1,1,-1
Scaling Option: 1
CI: -0.4,4.4

PRIMARY CONTRAST  3
Label: AB
Coefficients: 1,-1,-1,1
Scaling Option: 2
CI: 15.2,24.8

How many Secondary Contrasts? 4

For each Secondary Contrast
1.  Enter a label/name for the contrast and then press enter
2.  Enter the contrast coefficients, separated by commas, and then press
enter
3.  Enter the scaling option and then press enter
        0  -  No rescaling
        1  -  Mean difference scaling
        2  -  Two-factor interaction
        3  -  Three-factor interaction
          ...
        n  -  n-factor interaction

SECONDARY CONTRAST  1
Label: A(b1)
Coefficients: 1,0,-1,0
Scaling Option: 1

SECONDARY CONTRAST  2
Label: A(b2)
Coefficients: 0,1,0,-1
Scaling Option: 1

SECONDARY CONTRAST  3
Label: B(a1)
Coefficients: 1,-1,0,0
Scaling Option: 1

SECONDARY CONTRAST  4
Label: B(a2)
Coefficients: 0,0,1,-1
Scaling Option: 1
```

Output:

```
Rescaled Primary Contrasts:
   [,1] [,2] [,3] [,4]
A   0.5  0.5 -0.5 -0.5
B   0.5 -0.5  0.5 -0.5
AB  1.0 -1.0 -1.0  1.0

Confidence Intervals:
   Lower Upper
A    5.6  10.4
B   -0.4   4.4
AB  15.2  24.8

Mid-points of CIs:
   [,1]
A     8
B     2
AB   20

Widths of CIs:
   [,1]
A   4.8
B   4.8
AB  9.6

Rescaled Secondary Contrasts:
      [,1] [,2] [,3] [,4]
A(b1)    1    0   -1    0
A(b2)    0    1    0   -1
B(a1)    1   -1    0    0
B(a2)    0    0    1   -1

SCs as linear combinations of PCs:
      A B   AB
A(b1) 1 0  0.5
A(b2) 1 0 -0.5
B(a1) 0 1  0.5
B(a2) 0 1 -0.5

Deduced Intervals:
      Lower Upper
A(b1)  13.2  22.8
A(b2)  -6.8   2.8
B(a1)   7.2  16.8
B(a2) -12.8  -3.2

Mid-points of DIs:
      [,1]
A(b1)   18
A(b2)   -2
B(a1)   12
B(a2)   -8
```

```
Widths of DIs:
      [,1]
A(b1)  9.6
A(b2)  9.6
B(a1)  9.6
B(a2)  9.6
```

Given the CIs on the three primary (main and interaction effect) contrasts, the DIs on secondary (simple effect) contrasts are

$$A(b_1) = A + 0.5AB \in [13.2, 22.8],$$

$$A(b_2) = A - 0.5AB \in [-6.8, 2.8],$$

$$B(a_1) = B + 0.5AB \in [7.2, 16.8],$$

$$B(a_2) = B - 0.5AB \in [-12.8, -3.2].$$

Implied directional inferences are

$\mu_{11} > \mu_{21}$ (from $A(b_1) > 0$)

$\mu_{11} > \mu_{12}$ (from $B(a_1) > 0$)

and $\mu_{21} < \mu_{22}$ (from $B(a_2) < 0$).

Note that in this example the scaling option of 1 (mean difference scaling) was specified for all contrasts except for the primary contrast AB (an interaction contrast). The scaling option 0 (no rescaling) could have been used for the four secondary contrasts, with the same results. If the coefficients for the primary contrasts A and B had been entered in the form shown under the heading Rescaled Primary Contrasts, then the scaling option 0 could have been chosen for all primary and secondary contrasts, with the same results.

References

Bird, K.D. (2002). Confidence intervals for effect sizes in analysis of variance. *Educational and Psychological Measurement*, *62*, 197-226.

Masson, M., and Loftus, G.R. (2003). Using confidence intervals for graphically based data interpretation. *Canadian Journal of Experimental Psychology*, *57*, 203-220.