Correcting Misconceptions about Optimal Design

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Misconception #1

Optimal designs are not orthogonal

What is true

All the standard orthogonal textbook designs are D-optimal for an appropriate model.

The default settings in the Custom Designer aim to produce orthogonal designs.

Custom Design Examples

1. Full Factorial Design
2. Resolution III Fractional Factorial Design
3. Resolution V Fractional Factorial Design
4. Plackett-Burman Design
5. Latin Square Design

Also true

Orthogonal designs are not always good.

Example:

Orthogonal Latin Hypercube that is not space-filling.

So what if a design is not orthogonal?

Box-Behnken designs have correlated quadratic effects but they are very popular and for good reason.

No standard mixture design is orthogonal.

So – a design can be non-orthogonal and still be good.

One Final Truth

Optimal designs are certainly not always orthogonal

When?

1. The number of runs is not a “magic number”.
2. The model does not allow it.
3. The allowable factor combinations are restricted.

Misconception #2

Optimal designs depend on a pre-specified model.

Desired Inference?

1. An optimal design is not good unless the model fit is the pre-specified model.
2. Orthogonal designs do not depend on a model.

What is true

Yes, to create an optimal design you must specify a model*, but

No, the optimal design will generally be efficient for many models, and

No, orthogonal designs very much depend on the form of the “true” model.

* or group of models – see model robust design literature

Example – 6 Factors 24 Runs

Compare two orthogonal designs and the D-optimal design for the two-factor interactions model.

Misconception #3

Optimal designs are plagued by complex aliasing.

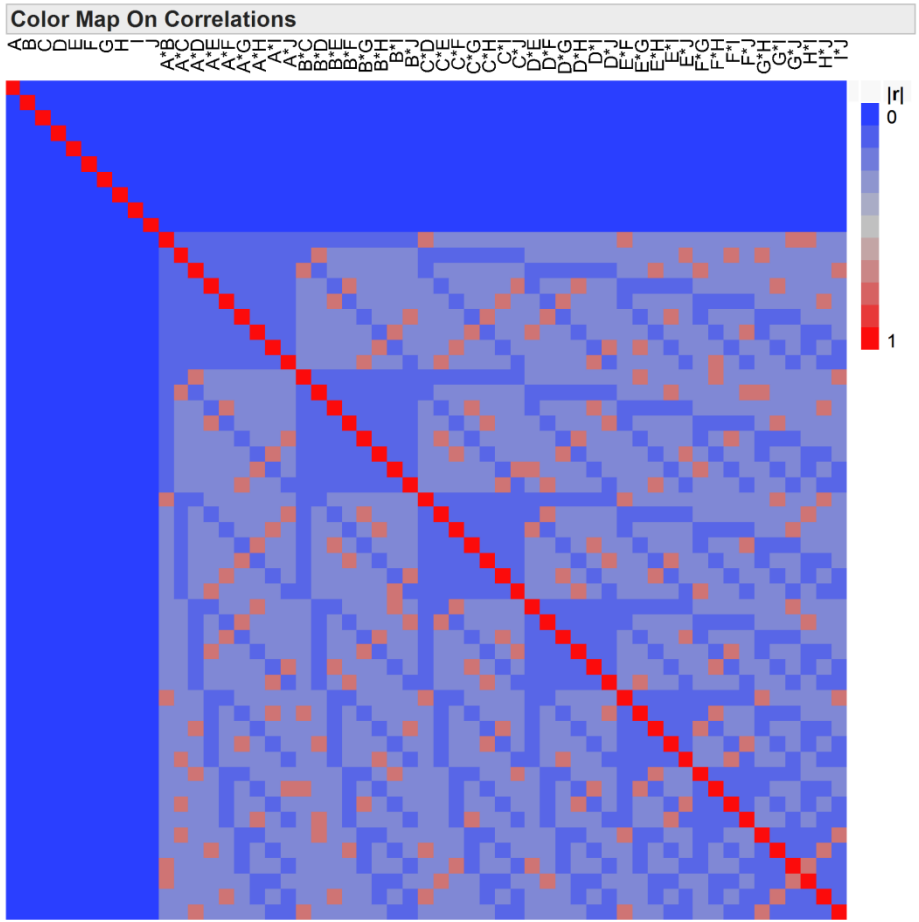
What is true

Yes, in some cases D-optimal designs have complex aliasing, but

There is a new optimality criterion!

Introducing Alias Optimal designs.

Back to Custom Design in JMP



Summary

Optimal designs are orthogonal for textbook cases.

Optimal designs perform competitively with orthogonal designs for a family of models.

Alias optimal designs can drastically reduce or eliminate aliasing of a specified model due to higher order terms.

References

Jones, B. and Nachtsheim, C. J. (2011) "Efficient Designs with Minimal Aliasing" *Technometrics*, **53**. 62-71.

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