Screening Designs

BIOE 498/598 PJ

Spring 2021

Why do we use screening designs?

- Screening designs are used to identify **important factors**.
- A follow-up design estimates effects and interactions for only the important factors.
- The goal of screening is to drop factors so the follow-up is feasible.
- You don't need to screen if
  - You already know every factor is important.
  - A Resolution V design is practical and within budget

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$$\text{important factor} \approx \text{significant main effect}$$

- We don't worry about estimates of TWIs. We're selecting factors, not interactions.

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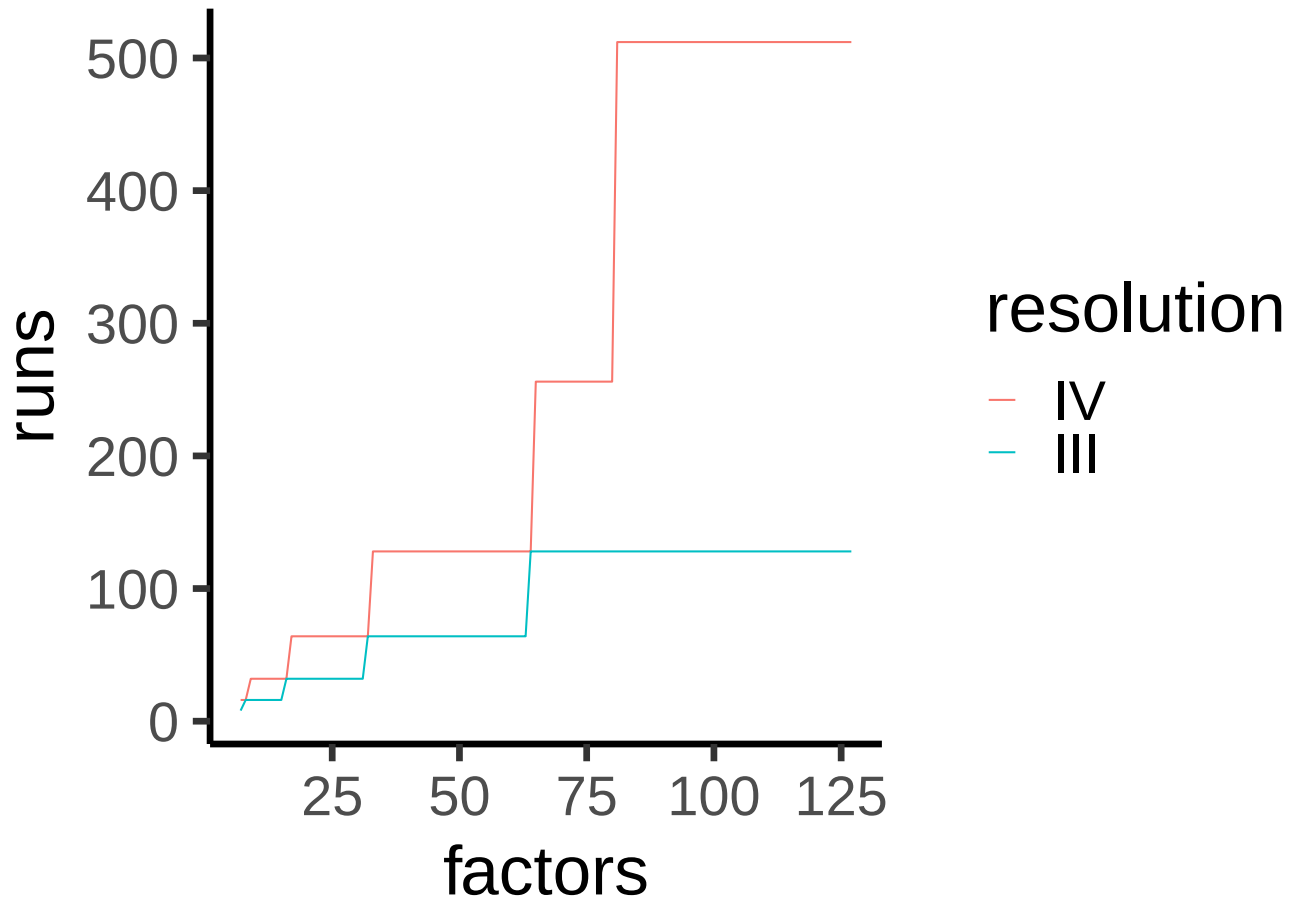
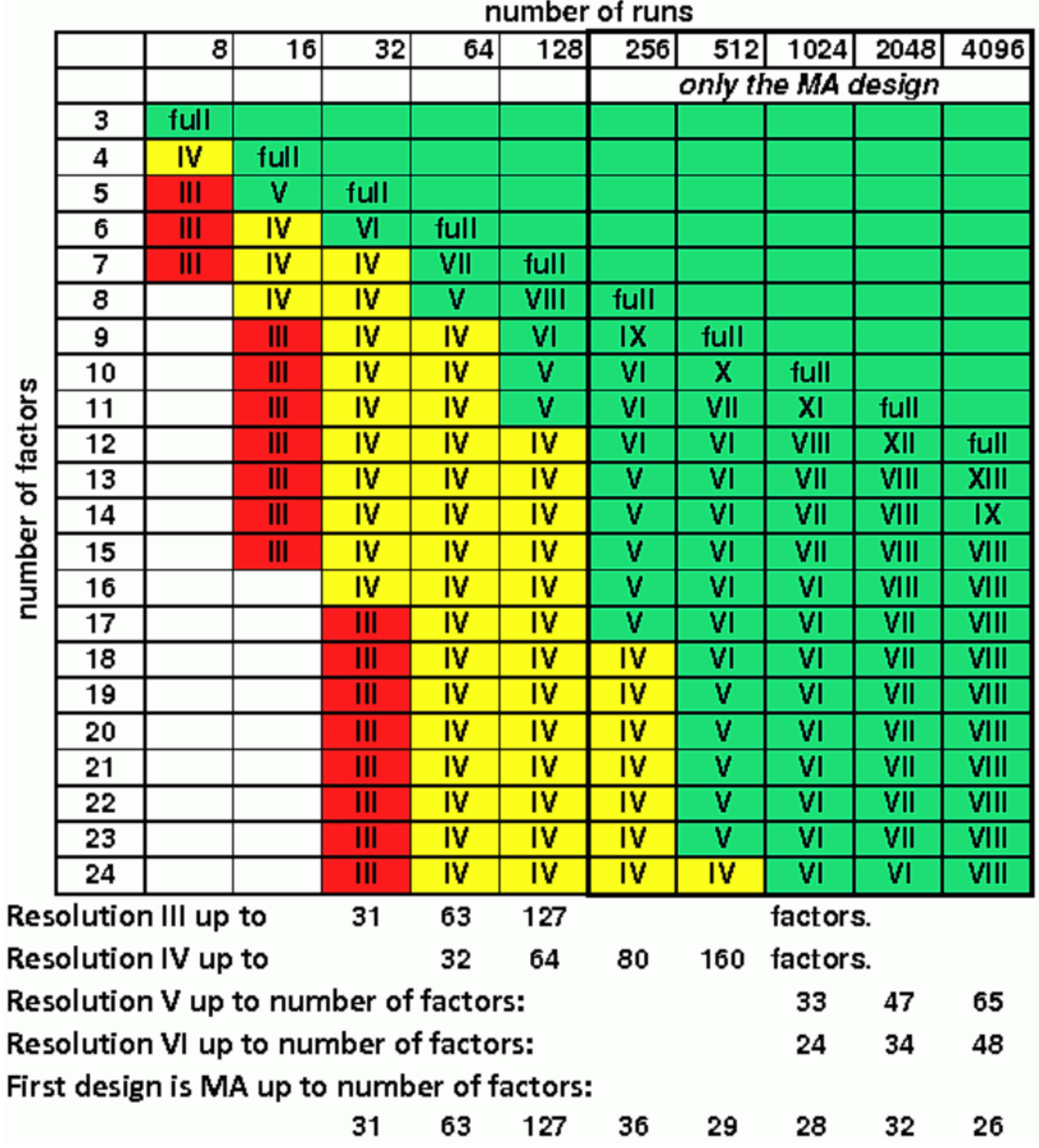
- Definitive Screening Designs
  - Hybrid screening/optimization design. We'll discuss later!

Don't rule out Fractional Factorial Designs.



Workflow for Resolution III screens

1. Run the design
2. Fit the model with main effects. If you have DoF left over, add any TWIs that are **not** confounded with main effects.
3. If the overall model fit is bad, or if you expected certain effects to be significant that were not, consider a second batch of runs with a mirror image design.
4. Drop any factors that are not **important** (practically or statistically).



Gromping, 2014

J. Stat. Software

Workflow for PB designs

1. Run the design.
2. Fit a model with main effects plus an effect for any unused column in the design.
3. Optional: Perform subset regression to identify factors that appear frequently in smaller models with good predictive power.
4. Drop any factors that are not **important** (practically or statistically).
5. If only a small number of factors remain, try refitting the small model.

Creating a PB design (up to 23 factors)

1. Start with the first run from the following table.

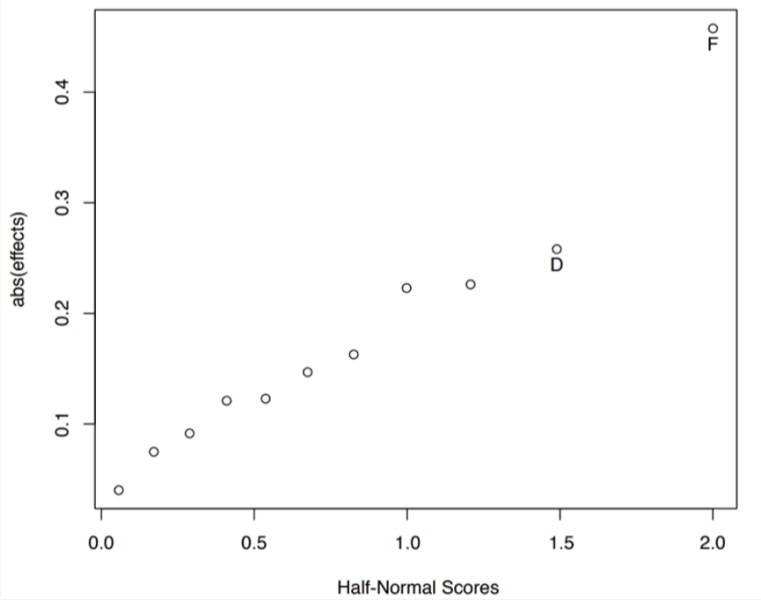
Runs	Factor Levels
12	+ + − + + + − − − + −
20	+ + − − + + + + − + − + − − − − + + −
24	+ + + + + − + − + + − − + + − − + − + − − − −

2. Cycle the factor levels by one to get run #2. Repeat for 11, 19, or 23 runs.
3. Set the final run to all low (−).
4. If the number of factors k is less than the number of runs, select the first k columns.

Example PB design: Cast fatigue

Table 6.11 *Design Matrix and Lifetime Data for Cast Fatigue Experiment*

Run	A	B	C	D	E	F	G	c8	c9	c10	c11	
1	+	−	+	+	+	−	−	−	+	−	+	4.733
2	−	+	+	+	−	−	−	+	−	+	+	4.625
3	+	+	+	−	−	−	+	−	+	+	−	5.899
4	+	+	−	−	−	+	−	+	+	−	+	7.000
5	+	−	−	−	+	−	+	+	−	+	+	5.752
6	−	−	−	+	−	+	+	−	+	+	+	5.682
7	−	−	+	−	+	+	−	+	+	+	−	6.607
8	−	+	−	+	+	−	+	+	+	−	−	5.818
9	+	−	+	+	−	+	+	+	−	−	−	5.917
10	−	+	+	−	+	+	+	−	−	−	+	5.863
11	+	+	−	+	+	+	−	+	−	+	−	6.058
12	−	−	−	−	−	−	−	−	−	−	−	4.809



This design includes 7 factors; however, effects are estimated for all columns. The last 4 “factors” are interactions with complex aliasing.

To replicate or not to replicate?

- Many screening designs are saturated — there are no DoF to estimate confidence intervals for the parameters.
- If you don't replicate the design, you will need to select factors based on the magnitude of the effects alone (half-normal plot).
  - Remember that half-normal plots work better as the number of factors grows.

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  - Remember that half-normal plots work better as the number of factors grows.
- Replicating a Resolution III Design
  - Consider a mirror-image instead. This will give clear main effects.
  - Check if you can afford a Resolution IV instead. This gives clear main effects and a confounding structure.
- Replicating a PB Design
  - Replicating the design will help you estimate the "pure error".
  - You can "move up" to a larger PB design to get extra runs. This won't estimate pure error, but you can add more confounded effects to the model to improve the estimates.

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- Use your experience in science or engineering. How much of your budget did you spend
  - Screening for a hit or working up the mechanism?
  - Building/testing a prototype or refining the second design?

About grading

- Your grade is determined by your process.
- If your methods are justified and implemented correctly, you can earn full credit.
- How your make your final predictions will be graded.
- The result of your final predictions determines a few bonus points and bragging rights.