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Section 1

MANE 6313

Subsection 1

Week 11, Module C

Student Learning Outcome

- Select an appropriate experimental design with one or more factors,
- Select an appropriate model with one or more factors,
- Evaluate statistical analyses of experimental designs,
- Assess the model adequacy of any experimental design, and
- Interpret model results.

Module Learning Outcome

Appraise minimum aberration designs.

Minimum Aberration Designs

- Concept introduced by Fries and Hunter in 1980
- "The purpose of this paper is to provide a method for selecting a best subset of designs from the set of 2^(k-p) fractional factorial designs of highest resolution"
- Minimum aberration is used as measure for best designs
- Fries and Hunter define a design to be a minimum aberration design if "...the design which minimizes the number of words in the defining relation that are of minimum length."

Fries and Hunter Example

602 ARTHUR FRIES AND WILLIAM G. HUNTER

TABLE 1—*Three choices for a* 2_{IV}^{7-2} *fractional factorial design for seven variables* **1, 2, 3, 4, 5, 6, 7** *in 32 runs. Entries underlined with a tilde (~) are to be regarded as boldfaced characters.*

Design	(a)	(b)	(c)
Generators	6=123,7=234	6=123,7=145	6=1234,7=1235
Defining relation	I=1236=2347=1467	I=1236=1457=234567	I=12346=12357=4567
Strings of aliased two-factor interactions (assuming three-factor and higher-order interactions are negligible)	12+36 13+26 14+67 17+46 24+37 27+34 16+23+47	12+36 13+26 14+57 15+47 16+23 17+45	45+67 46+57 47+56

Figure 1: Minimum Aberration Design Example

FrF2

- FrF2 provides minimum aberration (ma) designs
- FrF2 also considers word length pattern (wlp) and clear 2 factor interactions (2fis)

number of runs

number of factors	8	16	32	64	128	256	512	1024	2048	4096
						only the MA design				
3	full									
4	IV	full								
5	III	V	full							
6	III	IV	VI	full						
7	III	IV	IV	VII	full					
8		IV	IV	V	VIII	full				
9		III	IV	IV	VI	IX	full			
10		III	IV	IV	V	VI	X	full		
11		III	IV	IV	V	VI	VII	XI	full	
12		III	IV	IV	IV	VI	VI	VIII	XII	full
13		III	IV	IV	IV	V	VI	VII	VIII	XIII
14		III	IV	IV	IV	V	VI	VII	VIII	IX
15		III	IV	IV	IV	V	VI	VII	VIII	VIII
16			IV	IV	IV	V	VI	VI	VIII	VIII
17			III	IV	IV	V	VI	VI	VII	VIII
18			III	IV	IV	IV	VI	VI	VII	VIII
19			III	IV	IV	IV	V	VI	VII	VIII
20			III	IV	IV	IV	V	VI	VII	VIII
21			III	IV	IV	IV	V	VI	VII	VIII
22			III	IV	IV	IV	V	VI	VII	VIII
23			III	IV	IV	IV	V	VI	VII	VIII
24			III	IV	IV	IV	IV	VI	VI	VIII

Design Info, part 1

```
66 library(FrF2)
67 design.info(FrF2(nruns=32,nfactors=9))
68 ```

$type
[1] "FrF2"

$nruns
[1] 32

$nfactors
[1] 9

$factor.names
$factor.names$A
[1] -1  1

$factor.names$B
[1] -1  1

$factor.names$C
[1] -1  1

$factor.names$D
[1] -1  1

$factor.names$E
[1] -1  1

$factor.names$F
[1] -1  1

$factor.names$G
[1] -1  1

$factor.names$H
[1] -1  1

$factor.names$J
```

$2^9 = 512$

2^{9-4}

32

$\frac{1}{2} \rightarrow 256$

$\frac{1}{4} \rightarrow 128$

$\frac{1}{8} \rightarrow 64$

$\frac{1}{32} \rightarrow 32$

skips I

Design Info, part 2

```
$catlg.name
[1] "catlg"

$catlg.entry
Design:  9-4.1
   32  runs,  9  factors,
   Resolution  IV
   Generating columns:  7 11 19 29
   WLP (3plus):  0 6 8 0 0 ,  8  clear 2fis
 Factors with all 2fis clear:  J

$aliased
$aliased$legend
[1] "A=A" "B=B" "C=C" "D=D" "E=E" "F=F" "G=G" "H=H" "J=J"

$aliased$main
character(0)

$aliased$fi2
 [1] "AB=CF=DG=EH" "AC=BF"       "AD=BG"       "AE=BH"       "AF=BC"       "AG=BD"       "AH=BE"       "CD=FG"
 [9] "CE=FH"       "CG=DF"       "CH=EF"       "DE=GH"       "DH=EG"

$FrF2.version
[1] "2.2-3"

$replications
[1] 1

$repeat.only
[1] FALSE

$randomize
[1] TRUE

$seed
NULL
```

2^{9-4}

$9-4.1$

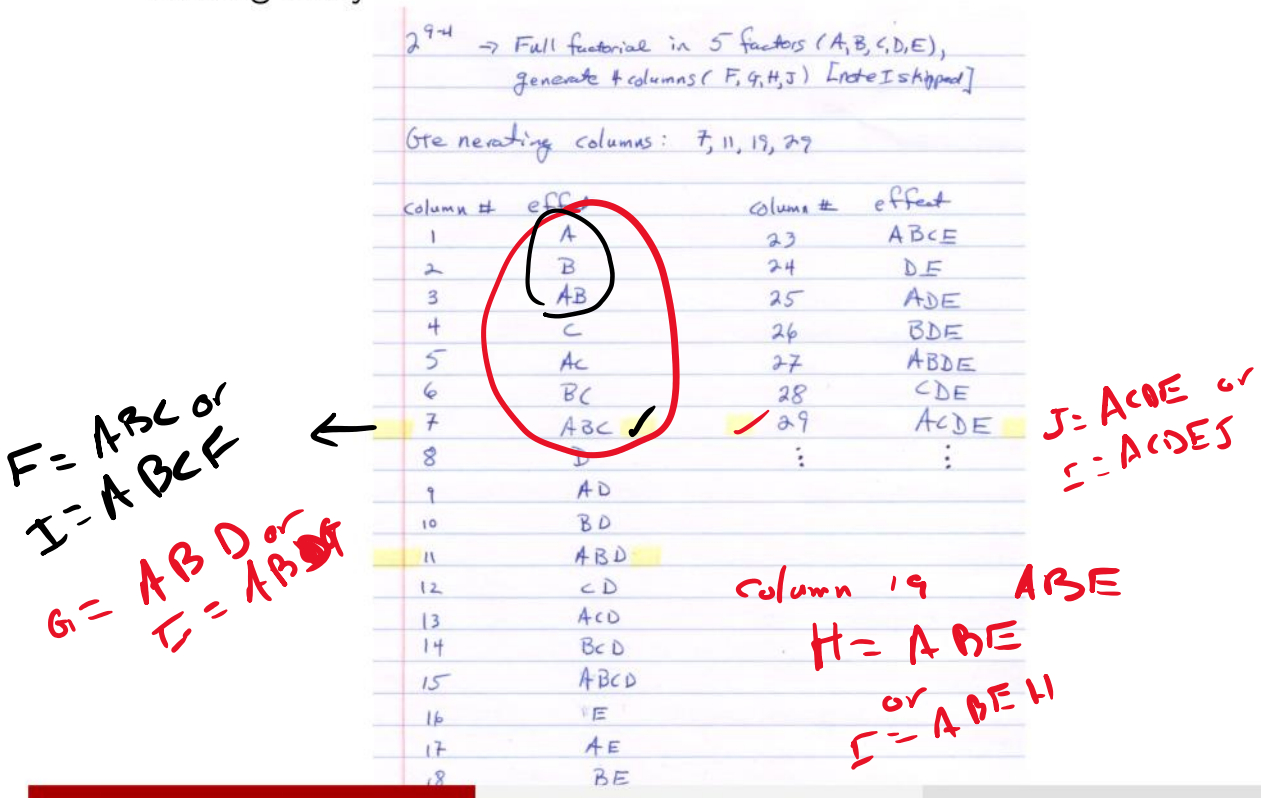
$\binom{9}{2} = 36$ 2-factor interactions

8 clear 2fis

AJ - clear

Generators

- List effects in standard order and match generating columns from catalog entry



Generators

1st Generator (factor F) from column 7
F = ABC → I = ABCF

2nd Generator (factor G) from column 11
G = ABD

3rd Generator (factor H) from column 19
H = ABE

4th Generator (factor J) from column 29
J = ACDE

Generators from FrF2

```r
library(FrF2)
maDesign <- FrF2(design = "9-4.1",randomize=FALSE)
summary(maDesign)
```

R Console | data.frame 2 x 9 | data.frame 32 x 9

```
Call:
FrF2(design = "9-4.1", randomize = FALSE)

Experimental design of type  FrF2
32  runs

Factor settings (scale ends):

Design generating information:
$legend
[1] A=A B=B C=C D=D E=E F=F G=G H=H J=J

$generators
[1] F=ABC  G=ABD  H=ABE  J=ACDE


Alias structure:
$fi2
 [1] AB=CF=DG=EH AC=BF       AD=BG       AE=BH       AF=BC       AG=BD       AH=BE       CD=FG
CE=FH
[10] CG=DF       CH=EF       DE=GH       DH=EG
```