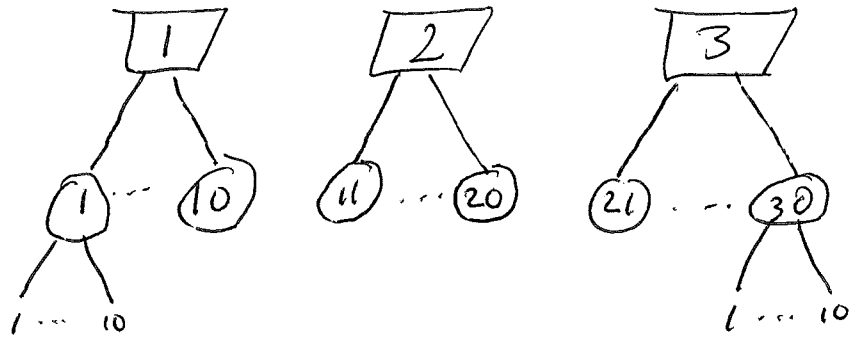


QE1.

A Traffic Signal Settings

B(A) Intersection



ANOVA

Source	df	Factor type	F	"Error" df
Settings(A)	3-1=2	Fixed	MSA/MSB(A)	27
Intersection(A)	30-3=27	Random		
Time Points(Error)	30(10-1)=270	Random		

$30(10) - 1 = 299$

QE.2.

Source	df	SS	MS	F	$F_{.05, 2, 12}$
(Fixed) Area	3-1=2	4000	2000	2000/200 = 10	3.885
(Random) River w/in Area	3(5-1)=12	2400	200	200/50 = 4	≈ 1.977
Error	15(4-1)=45	2250	50		
Total	15(4)-1=59	8650			

b. $t(.025/3, 12) = 2.779$ $\sqrt{\frac{2MSB(A)}{bn}} = \sqrt{\frac{2(200)}{5(4)}} = \sqrt{20} = 4.472$

$B_{ij} = 2.779(4.472) = 12.428$

Q.E.3.

Source	df	F	F(.05)
Types	$3-1=2$	$MS_{TYPE}/MS_{INT(TYPE)}$	5.143
Intersect (Types)	$3(3-1)=6$	$MS_{INT/TYPE}/MS_E$	≈ 2.229
Error	$9(8-1)=72$		
TOTAL	$9(8)-1=79$		

Q.E.4. $\bar{y}_{1..} = \frac{93}{4(4)} = 5.8125$ $\bar{y}_{2..} = \frac{81}{16} = 5.0625$ $\bar{y}_{3..} = 5.1250$

$\bar{y}_{4..} = \frac{88}{16} = 5.50$ $\bar{y}_{5..} = \frac{58}{16} = 3.625$ $\bar{y}_{...} = \frac{93+81+82+88+58}{16(5)} = 5.025$

i	$(\bar{y}_{i..} - \bar{y}_{...})^2$
1	0.6202
2	0.0614
3	0.0100
4	0.2256
5	1.9600
	<u>2.8172</u>

$$SS_{MACHINE} = 16(2.8172) = 45.0752$$

$$df_{MACHINE} = 5-1=4$$

$$MS_{MACHINE} = 11.2688$$

	Source	df	SS	MS	F	F(.05)
$H_0: \alpha_i = 0$	MACHINE	4	45.08	11.27	$11.27/18.86 = 0.60$	$F_{.05, 4, 15} = 3.056$
$H_0: \sigma_b^2 = 0$	Head (M)	15	282.88	18.86	$18.86/10.70 = 1.76$	$F_{.05, 15, 60} = 1.836$
	Error	60	642	10.70		$P > .05$
	TOTAL	79	969.96			

Q.E. 4. Continued p. 4. c.

MSAB = 18.86 bn = 4(4) = 16 q(.05, 5, 15) = 4.37 C = $\frac{5(5-1)}{2} = 10$

$W = 4.37 \sqrt{\frac{18.86}{16}} = 4.74$

t(.025/10, 15) = 3.29 B = $3.29 \sqrt{\frac{2(18.86)}{16}} = 5.05$

3.625 5.0625 5.1250 5.50 5.8125

None are significant
different

Q.E. 5

$\bar{y} = \frac{4.000 + 2.017 - 4.567 - 1.117 + 4.050 - 1.100}{6} = 0.547$

Batch	$(y_i - \bar{y})^2$
1	11.923
2	2.16
3	26.153
4	2.769
5	2.713
6	57.99

Source	df	SS	MS	F	F(.05)
Batch	5	347.94	69.59	6.73	4.39
Grp(B)	6	62.05	10.34		
Error	24	438.57	18.27		
Total	35	774.93			

$SS_{BATCH} = 2(3)(45.714) = 294.284$ ~~294.284~~ 347.94

$H_0: \sigma_b^2 = 0$ $H_A: \sigma_b^2 > 0$ T.S. $F_{obs} = \frac{10.34}{18.27} = 0.57$

RR: $F_{obs} \geq F_{.05, 6, 24} = 2.51$

P > .05

$H_0: \sigma_a^2 = 0$ $H_A: \sigma_a^2 > 0$ T.S. $F_{obs} = \frac{69.59}{10.34} = 6.73$

RR: $F_{obs} \geq F_{.05, 5, 6} = 4.39$ P < .05

$\hat{\sigma}_a^2 = \frac{MS_{Batches} - MS_{Grp(B)}}{3(2)} = \frac{69.59 - 10.34}{6} = 9.88$ $\hat{\sigma}_b^2 = \frac{10.34 - 18.27}{3} < 0$

$\hat{\sigma}^2 = 18.27$

QE. 6.

 $a = 3$ habitats $b = 3$ patches per habitat $n = 5$ reps per patch

<u>ANOVA</u>				
Source	df	SS	MS	F
Habitat	$3-1=2$	403.3	201.7	$201.7/50.8 = 3.97$
Patch (Habitat)	$3(3-1)=6$	304.7	50.8	4.75
Error	$3(3)(5-1)=36$	386.6	10.7	—
TOTAL	$3(3)(5)-1=44$	1094.6	—	—

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = 0 \quad TS: F_A = 3.97 \quad RR: F_A \geq F_{.05, 2, 6} = 5.14$$

$$H_0: \sigma_{ab}^2 = 0 \quad TS: F_{AB} = 4.75 \quad RR: F_{AB} \geq F_{.05, 6, 36} \approx 2.38$$

$$MSP(H) = 50.8 \quad bn = 3(5) = 15 \quad \cancel{9(5-1)=4.37}$$

$$t(.025/3, 6) = 3.29 \quad B = 3.29 \sqrt{\frac{2(50.8)}{15}} = 8.56$$

$$\hat{\sigma}_{ab}^2 = \frac{50.8 - 10.7}{5} = 8.02 \quad \hat{\sigma}^2 = 10.7$$

Q.F.1.

Typical Block

	Temp1	Temp2	Temp3	Temp4
Form1				
2				
3				
4				
5				

Whole plot Factor: Temperature, Block: Day Subplot: Formulations

a = 4

b = 7

c = 5

Source	df	F	df ₁	df ₂
Temperature (A)	4-1=3	MSTemp/MSE1	3	18
Block (B)	7-1=6			
Temp*Block (Error 1)	3(6)=18			
Form (C)	5-1=4	MSForm/MSE2	4	96
Temp*Form (AC)	3(4)=12	MST*F/MSE2	12	96
Error 2	4(7-1)(5-1)=96			
Total	4(7)(5)-1=139			

Q.F.2. P.2.a.

B4	D2	D1	D3	C1	C2	C3	A2	A3	A1	B3	B1	B2
B2	B3	B1	B2	A3	A2	A1	C1	C2	C3	D2	D1	D3
B3	D1	D3	D2	A3	A2	A1	B2	B3	B1	C1	C2	C3
B4	C3	C1	C2	D1	D2	D3	A1	A2	A3	B2	B1	B3
B5	C2	C1	C3	B2	B1	B3	A2	A1	A3	D3	D1	D2

Q.F. 2. p. 2. b. $\overset{\text{Grass}}{a=4}, \overset{\text{Block}}{b=5}, \overset{\text{Fert}}{c=3}$

Source	df	MS	F	F(.05)
Grass	$4-1=3$	$SSG/3$	MSG/MSG_B	$F(.05, 3, 12) = 3.49$
Block	$5-1=4$	$SSB/4$	MSB/MSG_B	—
GxB (E1)	$3(4)=12$	$SSG_B/12$	—	—
Fert	$3-1=2$	$SSF/2$	MSF/MSE_2	$F(.05, 2, 32) \approx 3.30$
GxF	$3(2)=6$	$SSGF/6$	$MSGF/MSE_2$	$F(.05, 6, 32) \approx 2.40$
Error 2	$4(5-1)(3-1)=32$	$SSE_2/32$	—	—
Total	$4(5)(3)-1=59$	—	—	—

Q.F. 3. WP = Nitrogen ($a=4$) Block = Green ($b=2$) SP = ^{Time} Length ($c=3$)

	1	2	3	4	5	6	7	8	9	10	11	12
Block 1	A1	A2	A3	C2	C3	C1	D3	D1	D2	B1	B3	B2
Block 2	C3	C2	C1	A1	A2	A3	B2	B3	B1	D2	D1	D3

Source	df	SS	MS	F	F.05	P
NIT	$4-1=3$	37.32	9.11	$9.11/0.42 = 21.69$	$F(.05, 3, 3) = 9.12$	$<.05$
ALK	$2-1=1$	0.51	0.51	—	—	—
NxB	$3(1)=3$	1.26	0.42	—	—	—
Thatch	$3-1=2$	3.82	1.91	8.88	$F(.05, 2, 8) = 4.46$	$<.05$
NxT	$3(2)=6$	4.15	0.69	3.21	$F(.05, 6, 8) = 3.58$	$\geq .05$
Error 2	$4(2-1)(3-1)=8$	1.72	0.215	—	—	—
Total	$4(2)(3)-1=23$	48.78	—	—	—	—

Q.F. 3. d.

Nitrogen: $MS_{N \times B} = 0.42$ $bc = 6$ $q(.05, 4, 3) = 6.83$

$$W^{Nit} = 6.83 \sqrt{\frac{0.42}{6}} = 1.81$$

Thatch: $MSE_2 = 0.215$ $ab = 8$ $q(.05, 3, 8) = 4.04$

$$W^{Thatch} = 4.04 \sqrt{\frac{0.215}{8}} = 0.66$$

Q.F. 4.

$a=4$ $b=5$ $c=3$
 WP: Cooking Condition Block: Day SP: Recipes

Source	Label	df	Error df	F(.05)
WP	Cook Cond	$4-1=3$	12	$F(.05, 3, 12) = 3.49$
Block	Day	$5-1=4$	—	
Error 1	CC × Day	$3(4) = 12$	—	
SP	Recipe	$3-1=2$	32	$F(.05, 2, 32) \approx 3.30$
WP × SP	CC × REC	$3(2) = 6$	32	$F(.05, 6, 32) = 2.40$
Error 2	REC × DAY + CC × DAY	$4(5-1)(3-1) = 32$	—	
Total	—————	$4(5)(3) - 1 = 59$	—	

Q6.1. $a = 4$ Diet Plans 160 subjects $\begin{cases} n_1 = 40 \\ n_2 = 40 \\ n_3 = 40 \\ n_4 = 40 \end{cases}$

$t = 3$ time points

Source	df
Diets	$4 - 1 = 3$
Subjects (Diets)	$160 - 4 = 156$
Time Points	$3 - 1 = 2$
Diets \times Time	$3(2) = 6$
Time \times subjects (Diet)	$2(156) = 312$
TOTAL	$160(3) - 1 = 479$

Q6.2 $a = 2$ Trts 34 cats $\begin{cases} 17 \text{ 271 keene} \\ 17 \text{ Placebo} \end{cases}$ $t = 5$ time points

Source	df	SS	MS	F	$F_{.05}$
Trts	$2 - 1 = 1$	383	383	$383/66.63 = 5.75$	~ 4.154
Cats (Trts)	$34 - 2 = 32$	2132	66.63	—	—
Time	$5 - 1 = 4$	324	81	$81/3.03 = 26.73$	~ 2.942
Trts \times Time	$1(4) = 4$	51	12.75 12.75	$12.7/3.03 = 4.21$	~ 2.442
Error 2	$4(32) = 128$	388	3.03	—	—
TOTAL	$34(5) - 1 = 169$	3278	—	—	—

All p-values $< .05$

P.2.b. $\bar{y}_1 - \bar{y}_2 \pm t_{.025, 32} \sqrt{\frac{2 \text{MSC}(T)}{nt}} = 3.00 \pm 2.038 \sqrt{\frac{2(66.63)}{17(5)}}$
 $= 3.00 \pm 2.083(1.25) = 3.00 \pm 2.61 = (0.39, 5.61)$

Q6.3. $Q = 3$ recycling programs $N = 21 \begin{matrix} \leftarrow 7 \\ \rightarrow 7 \\ \rightarrow 7 \end{matrix}$ $t = 8$

$$SSA = 7(8) \left[(-7.4 - 5.5)^2 + (35.8 - 5.5)^2 + (-11.9 - 5.5)^2 \right]$$

$$= 56 [166.41 + 918.09 + 302.76] = 56(1387.26) = 77686.56$$

Source	df	SS	MS	F	F(.05)
Strategy	3-1=2	77686.56	38843.28	69.92	3.555
Store(Strategy)	21-3=18	10060	555.56	—	—
Time	8-1=7	10780	1540	0.77	~2.084 1.775
Time x Strategy	2(7)=14	42000	3000	1.50	~1.562
Error 2	7(18)=126	252000	2000	—	—
Total	21(8)-1=167	392466.56	—	—	—

P-values: Time x Strategy > .05 Time > .05 Strategy < .05

$$B = t(.05/2(3), 18) \sqrt{\frac{2MS_{Store(Strategy)}}{Nt}}$$

$$= 2.639 \sqrt{\frac{2(555.56)}{7(8)}} = 2.639(4.454) = 11.76$$

S3	S1	S2
-11.9	-7.4	35.8

Strategy 2 significantly better than others
S1, S3 NSD

Q.G.4.

$a=4$ Doses

$n_1=21$

$n_2=25$

$n_3=24$

$n_4=21$

$t=4$

$N=91$ rats

EDP. 28.

Source	df	SS	MS	F	$F_{.05}$	Signif
Dose	$4-1=3$	16890	5630	2.77	~ 2.710	Y
Rat(Dose)	$91-4=87$	176677	2030.8	—	—	
Time	$4-1=3$	176765	58921.7	165.65	~ 2.639	Y
Dose*Time	$3(3)=9$	2161	240.1	0.68	~ 1.987	N
Error 2	$3(87)=261$	92826	355.7	—		
Total	$91(4)-1=363$	465319	—			

$t(.05/2(4), 87) = 2.700$



$MSR(D) = 2030.8$

	$\frac{D}{B}$	$2.700 \sqrt{2030.8(.0219)} = 18.0$
1 v 2	18.2	
1 v 3	18.2	
1 v 4	18.8	
2 v 3	17.4	
2 v 4	18.0	
3 v 4	18.2	

$D_i - D_j$	$D_i - D_j$
$131.8 - 139.6 = -7.8$	
$131.8 - 133.9 = -2.1$	
$131.8 - 149.9 = -18.1$	
$139.6 - 133.9 = 5.7$	
$139.6 - 149.9 = -10.3$	
$133.9 - 149.9 = -16.0$	

None meet significance (method is conservative, and original p-value $\approx .05$).

QH 1.

P. 1. a. Factors: Seat Design (Fixed) Subjects (Random)

Source	df	F	F-critical
Seat	$6-1=5$	MS_{seat}/MSE	$F(.05, 5, 55)$
Subject	$12-1=11$	MS_{subj}/MSE	$F(.05, 11, 55)$
Error	$5(11)=55$		
Total	$6(12)-1=71$		

P. 1. b. Factors: Color (F), Balance (F)

Source	df	F	F-critical
Color	1	MSC/MSE	$F(.05, 1, 64)$
Balance	1	MSB/MSE	"
CxB	1	$MSCB/MSE$	"
Error	$2(2)(17-1)=64$		
Total	$2(2)(17)-1=67$		

P. 1. c. Factors: Machine (F), Variety (F/R), CHEF (F/R)
Same analysis (Latin Square)

Source	df	F	F-crit
Machine	$6-1=5$	MSM/MSE	$F(.05, 5, 20)$
Variety	$6-1=5$	MSV/MSE	"
Chef	$6-1=5$	MSC/MSE	"
Error	$(6-1)(6-2)=20$		
Total	$6^2-1=35$		

Q.H.1. P.1.d.

Factors: Judge (R), Gymnaest (R)

n = 3 reps/trt

Source	df	F	F-crit
Judge	8-1=7	MSJ/MSJG	F(.05, 7, 21)
Gymnaest	4-1=3	MSG/MSJG	F(.05, 3, 21)
JxG	7(3)=21	MSJG/MSE	F(.05, 21, 64)
Error	8(4)(3-1)=64		
TOTAL	8(4)(3)-1=95		

Q.H.2.

P.2.9. Factors: Lab (F), Batch (R), sub-batch (R) - Error

~~Source df~~

~~Lab 6-1=5~~

~~Batch 5-1=4~~

~~Error 5(4)(4-1)=90~~

~~TOTAL 6(5)(4)-1=119~~

Source	df	F	F-crit
Lab	6-1=5	MSL/MSLB	F(.05, 5, 20)
Batch	5-1=4	MSB/MSLB	F(.05, 4, 20)
L x B	5(4)=20	MSLB/MSE	F(.05, 20, 90)
Error	6(5)(4-1)=90		
TOTAL	6(5)(4)-1=119		

P.2.b. Factors: Oil (F), Meat (F)

Source	df	F	F-crit
Oil	$7-1=6$	MSO/MSE	$F(.05, 6, 21)$
Meat	$3-1=2$	MSM/MSE	$F(.05, 2, 21)$
$O \times M$	$6(2)=12$	$MSOM/MSE$	$F(.05, 12, 21)$
Error	$7(3)(2-1)=21$		
Total	$7(3)(2)-1=41$		

P.2.c. Factors: Seed Rate (F), Row (R), Col (R)

Source	df	F	F-crit
Seed Rate	$5-1=4$	$MSSR/MSE$	$F(.05, 4, 12)$
Row	$5-1=4$	MSR/MSE	"
Col	$5-1=4$	MSC/MSE	"
Error	$(5-1)(5-2)=12$		
Total	$5^2-1=24$		

P.2.c. Factor Diet (F)

Source	df	F	F-crit
Diet	$4-1=3$	MSD/MSE	$F(.05, 3, 156)$
Error	$160-4=156$		
Total	$160-1=159$		