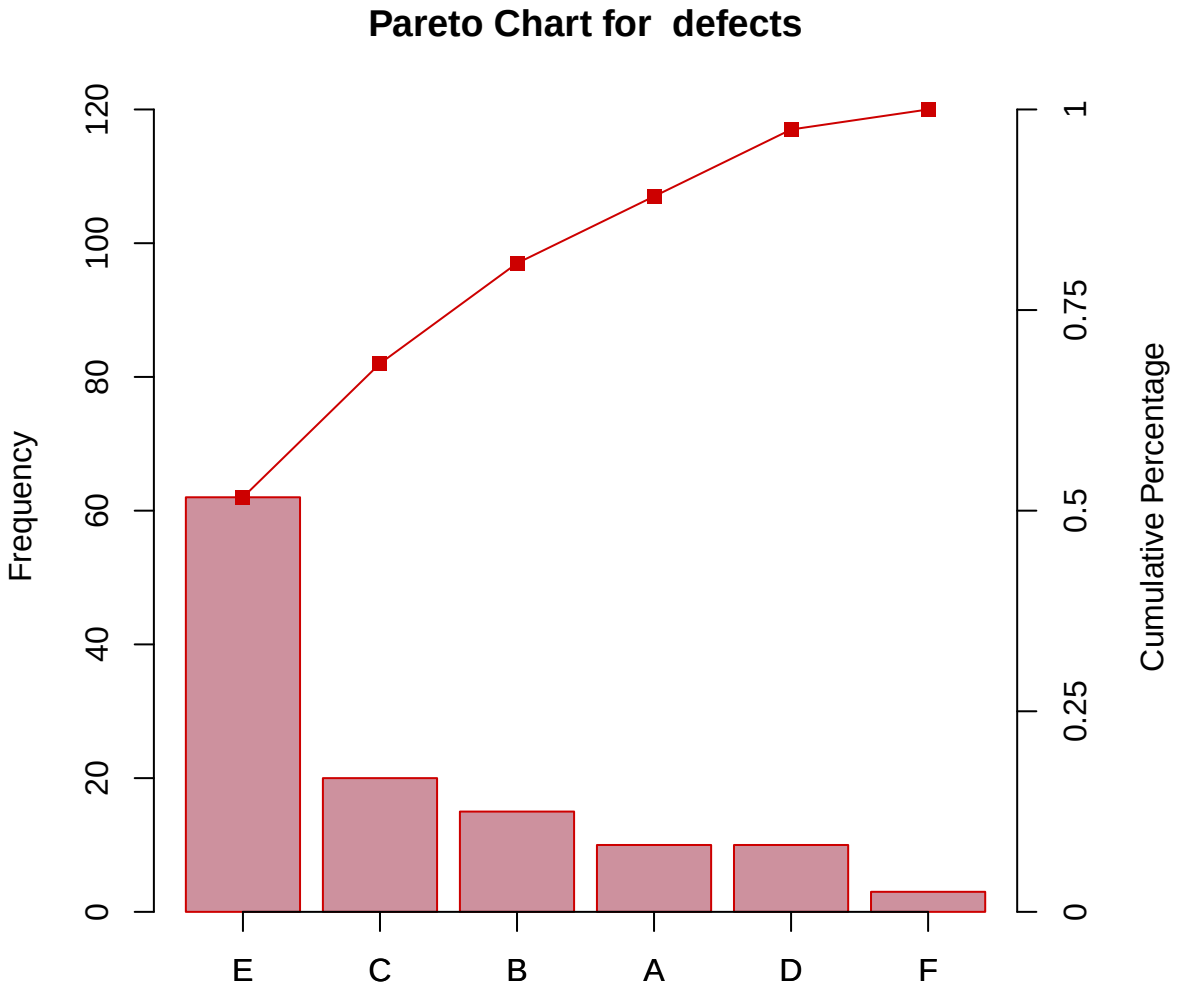
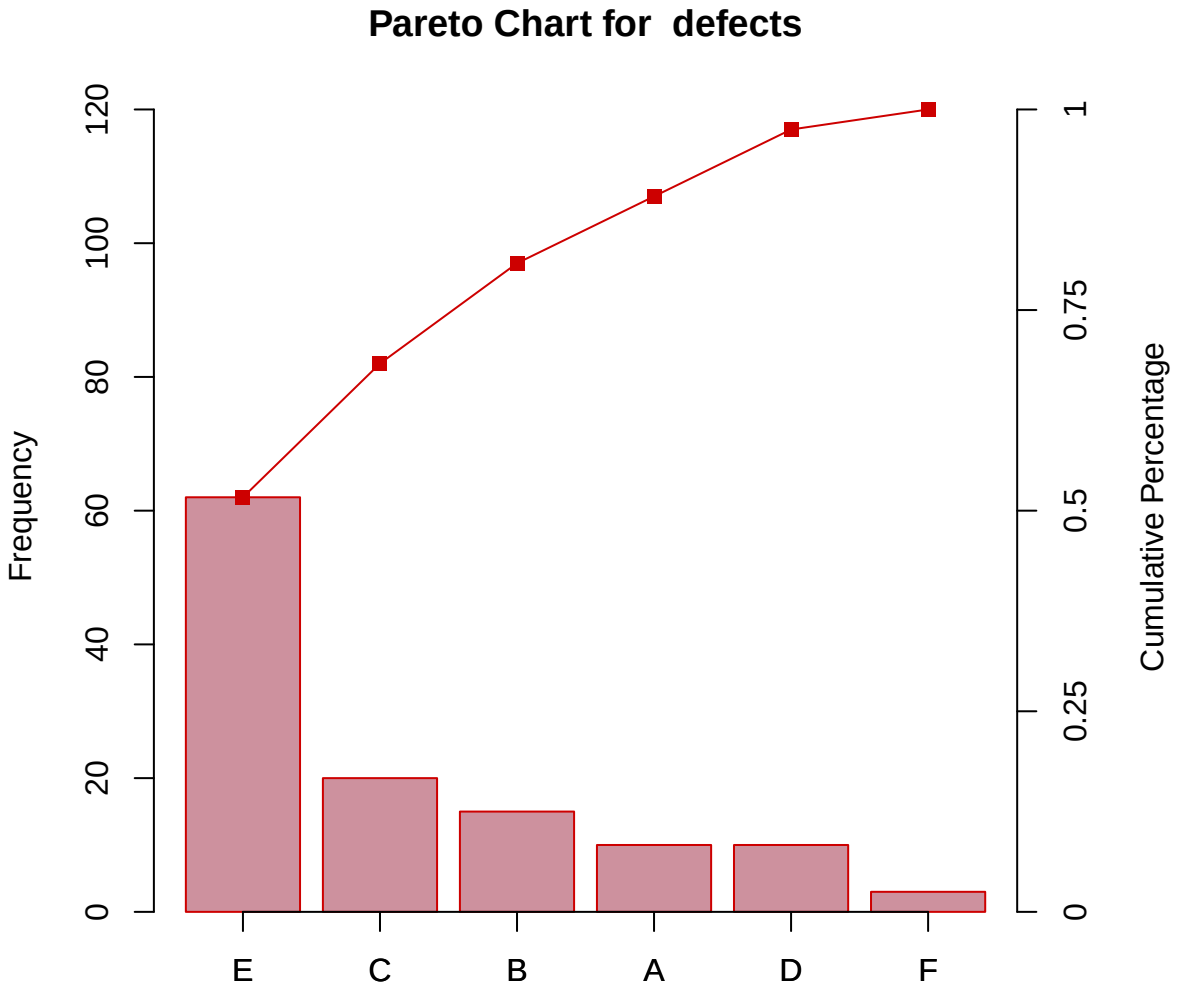


Frequency	62	20	15	10	10	3
Cum. Frequency	62	82	97	107	117	120
Percentage	52	17	12	8	8	2
Cum. Percentage	52	68	81	89	98	100



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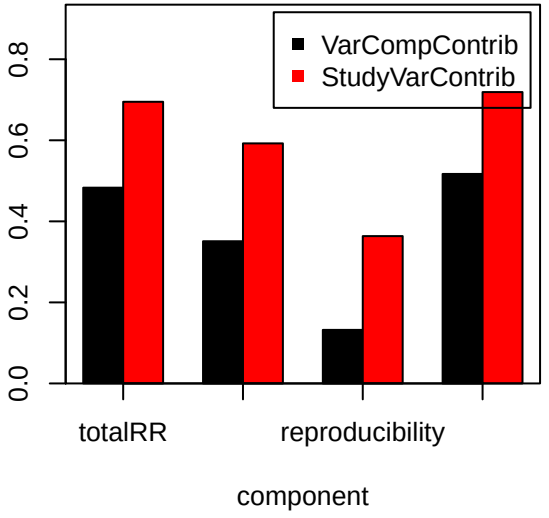
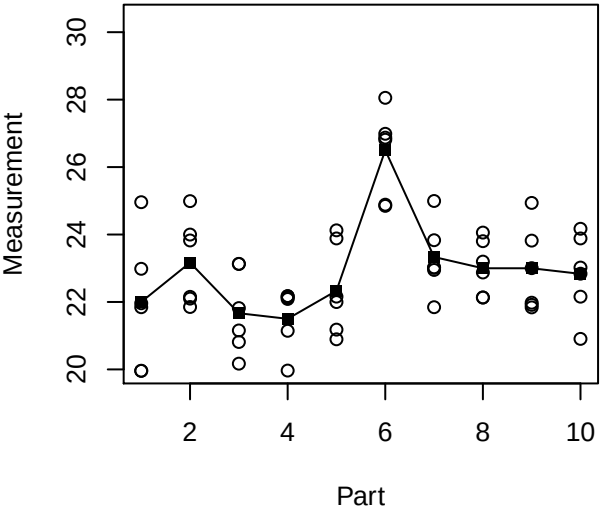
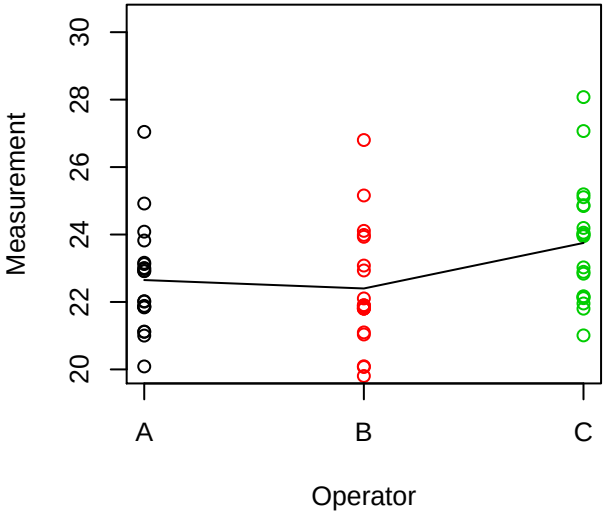
Components of Variation



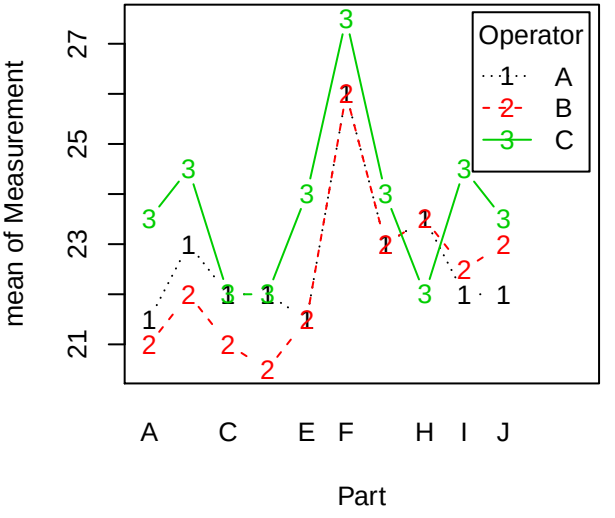
Measurement by Part



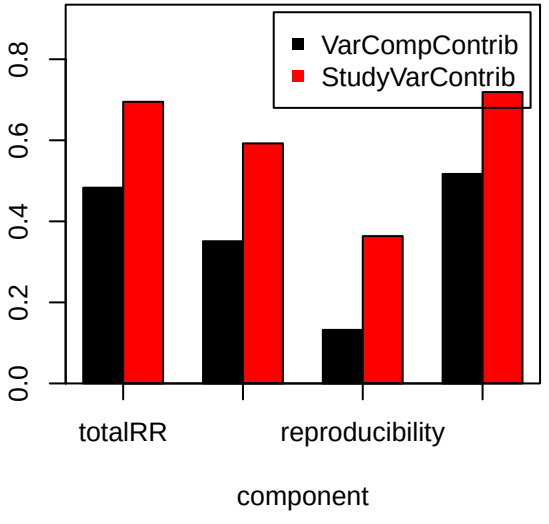
Measurement by Operator



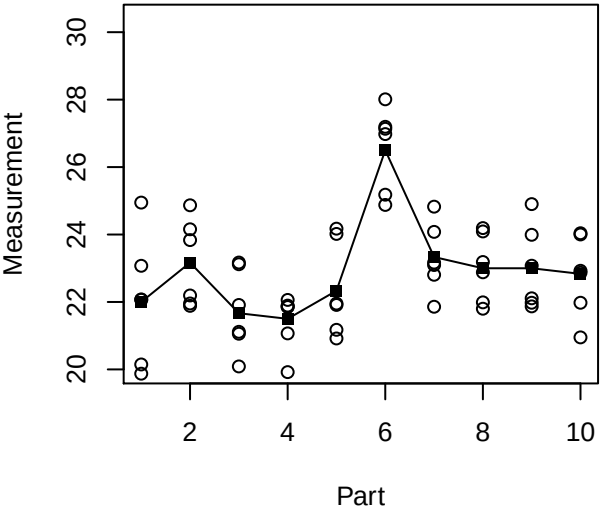
Interaction Operator:Part



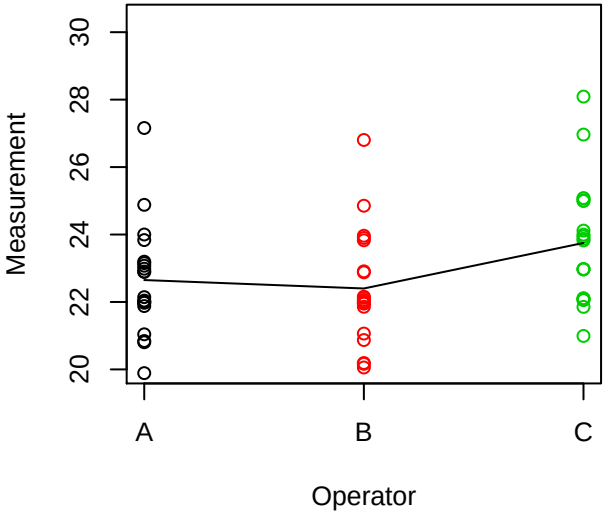
Components of Variation



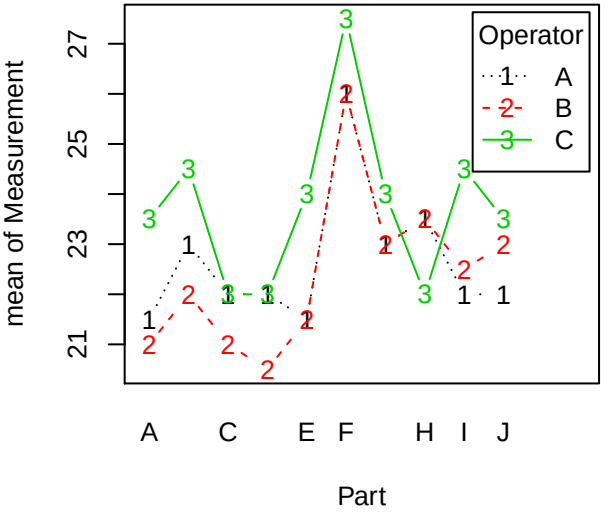
Measurement by Part

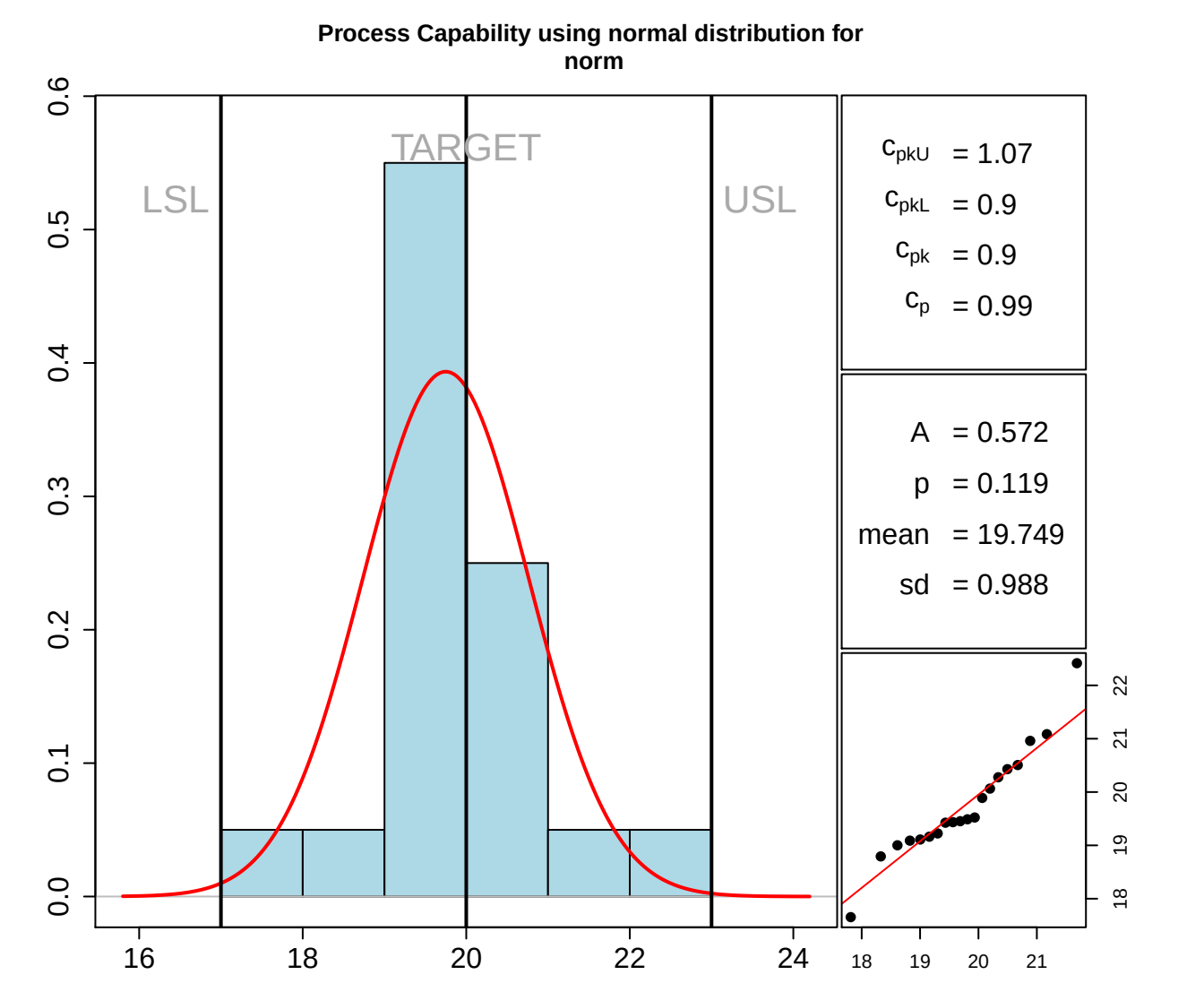


Measurement by Operator



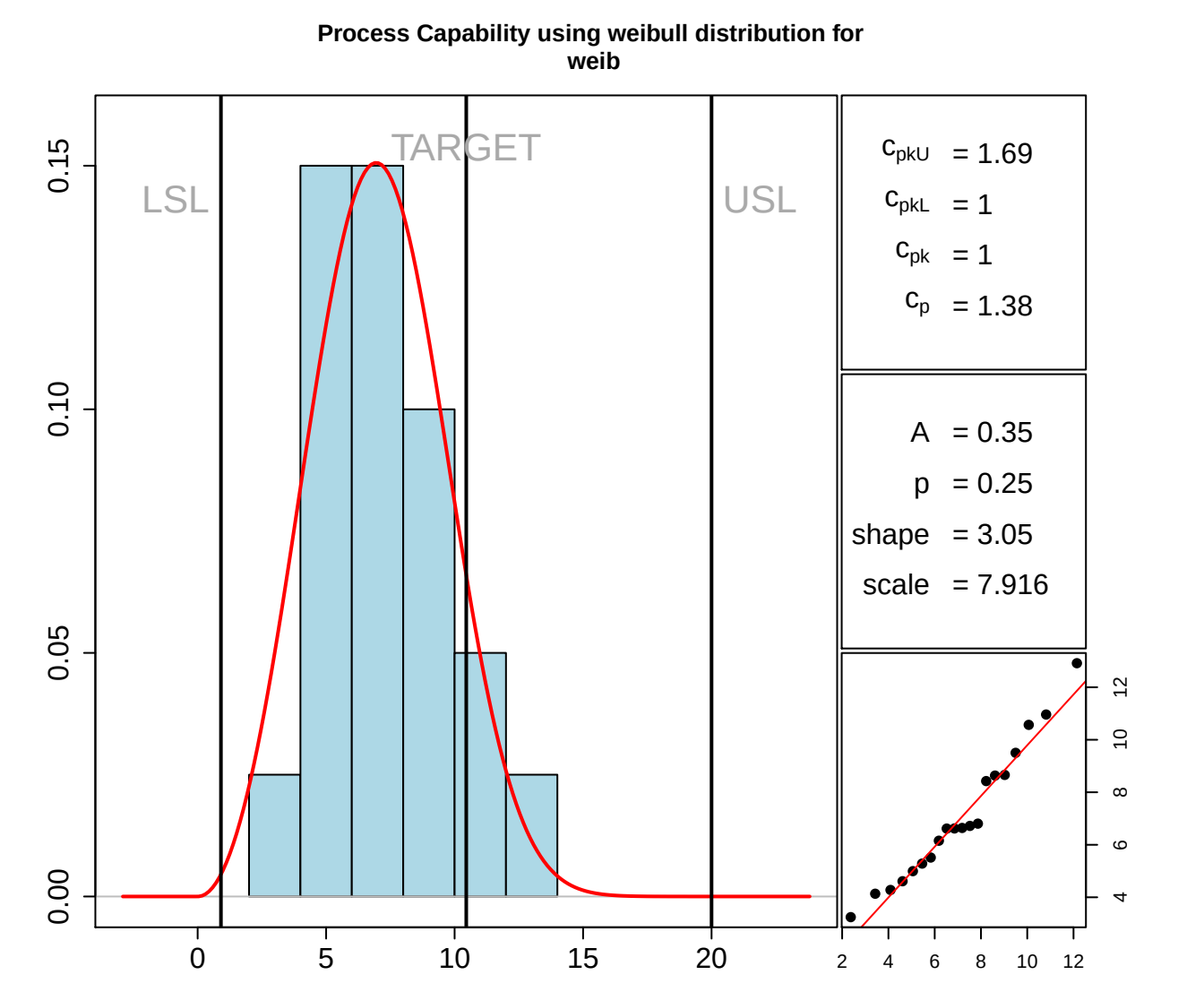
Interaction Operator:Part





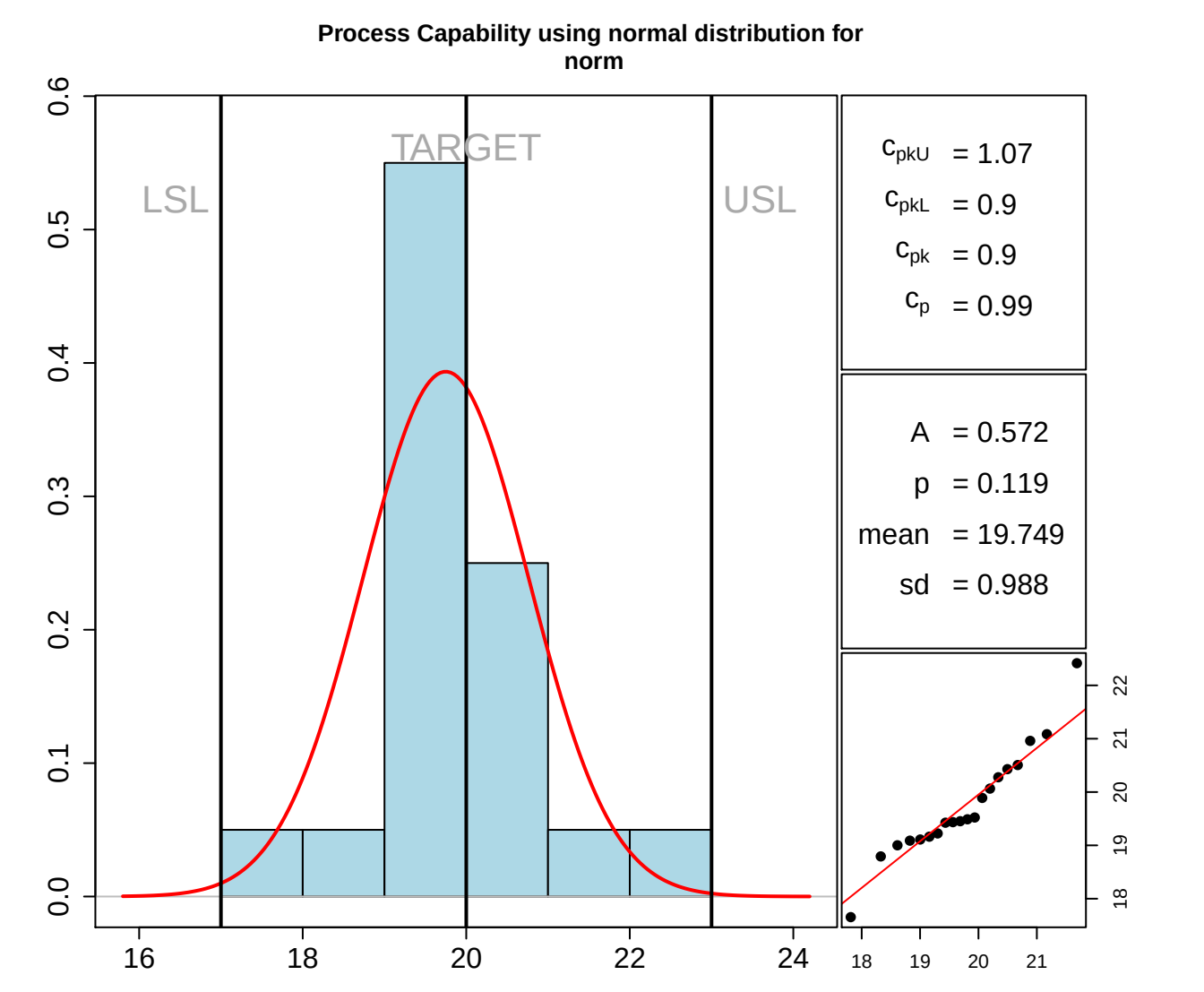
$\bar{x}$ = 19.749
s = 1.014
n = 20

Nominal Value = 20
USL = 23
LSL = 17



$\bar{x}$ = 7.065
s = 2.543
n = 20

Nominal Value = 10.454
USL = 20
LSL = 0.907



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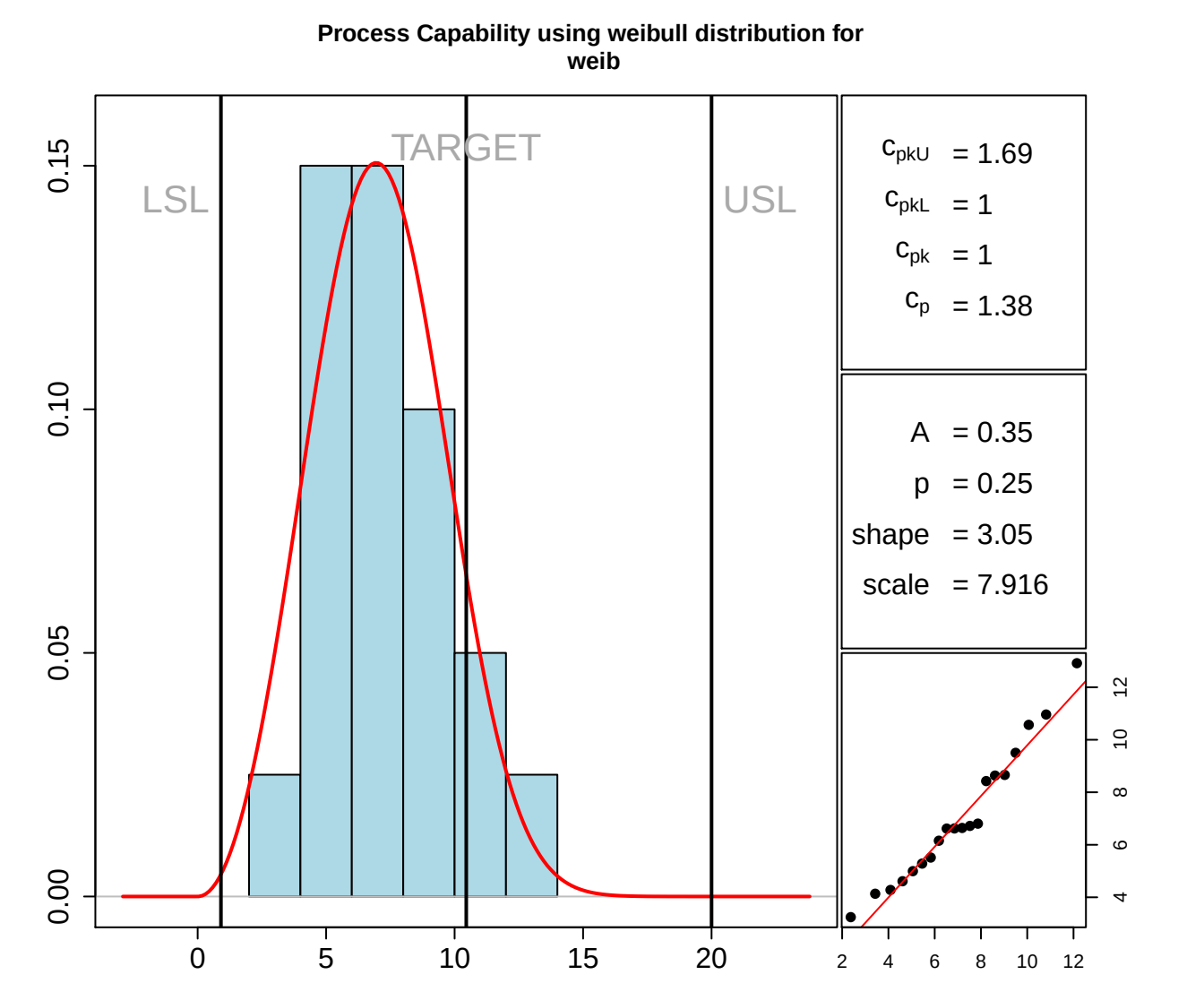

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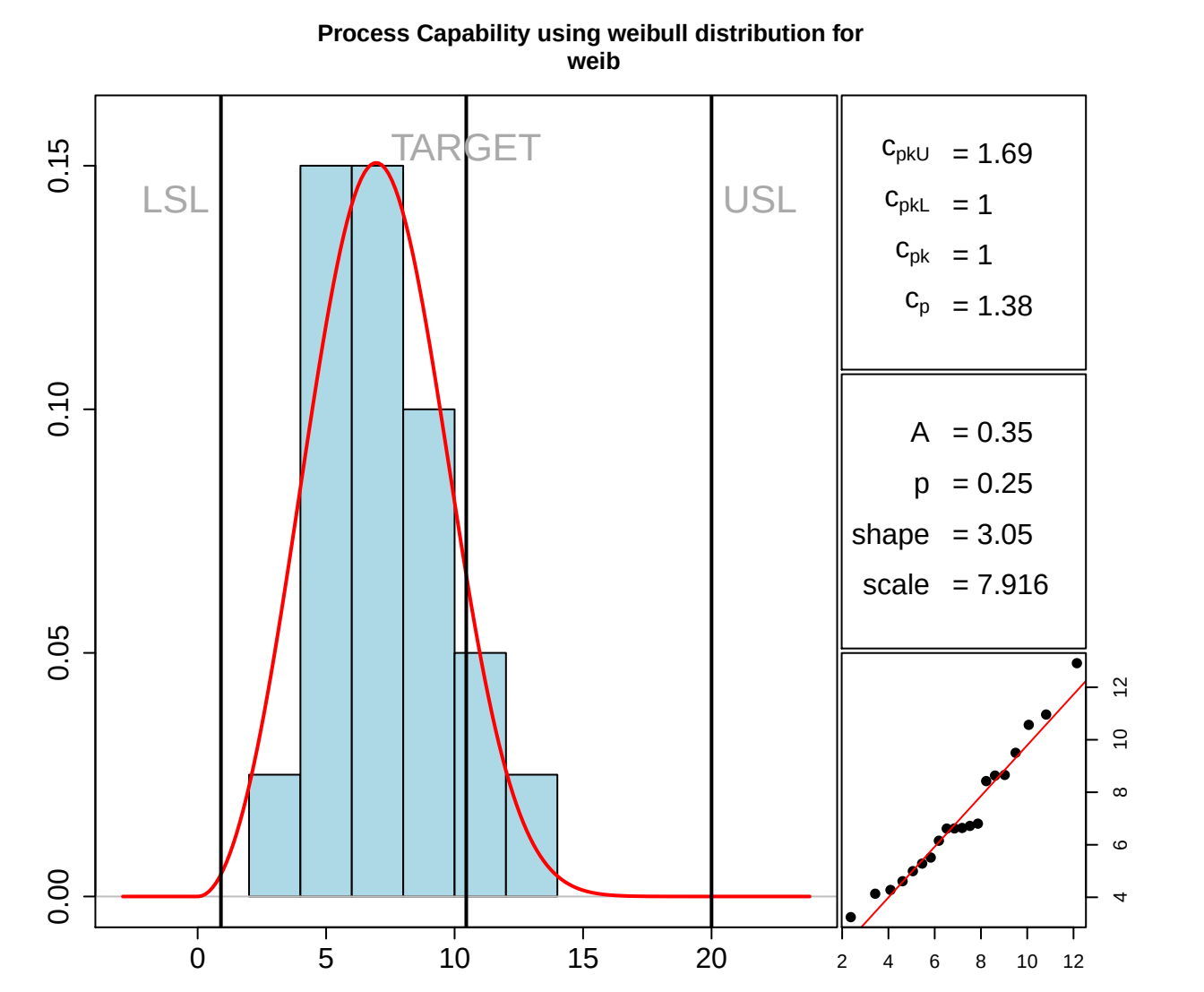

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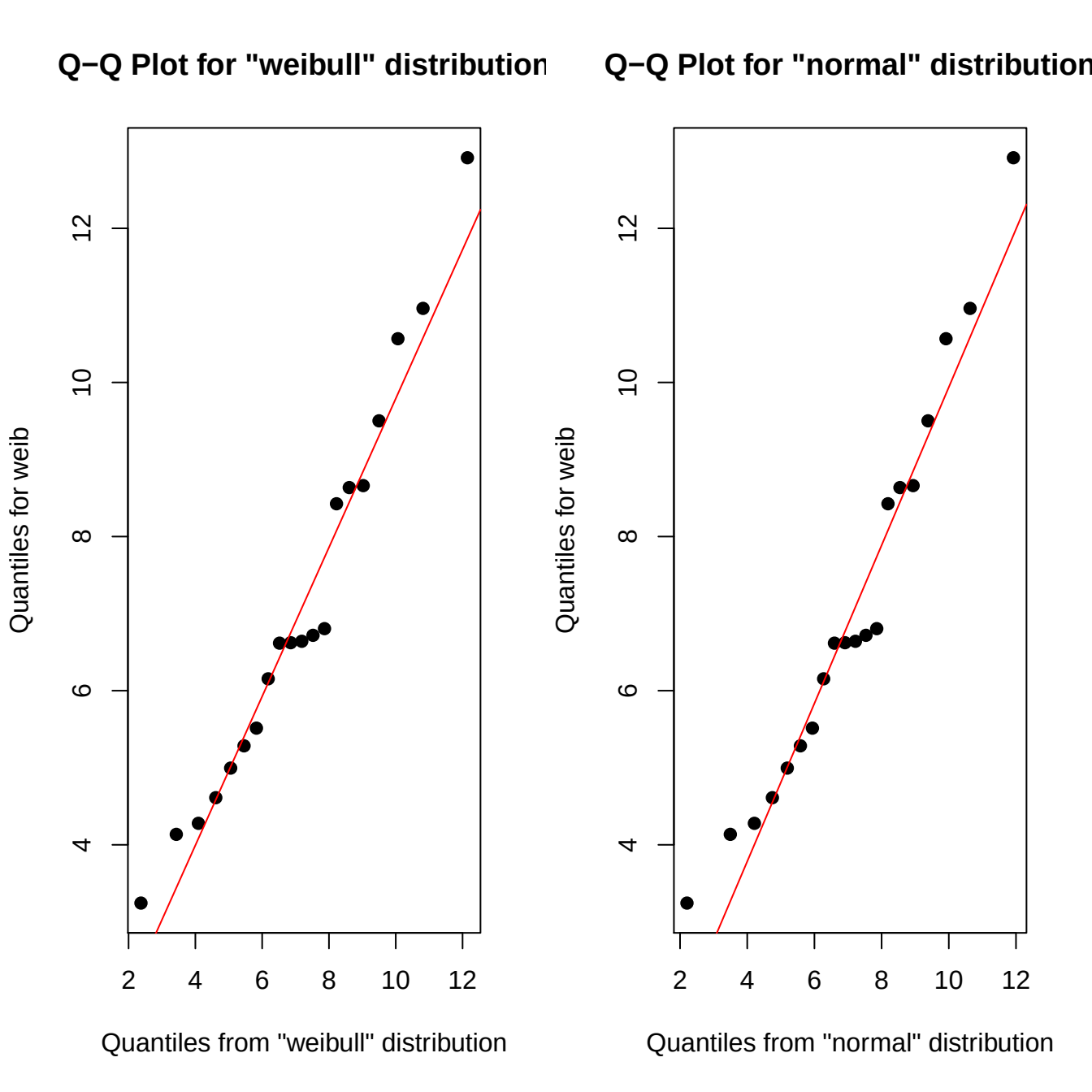
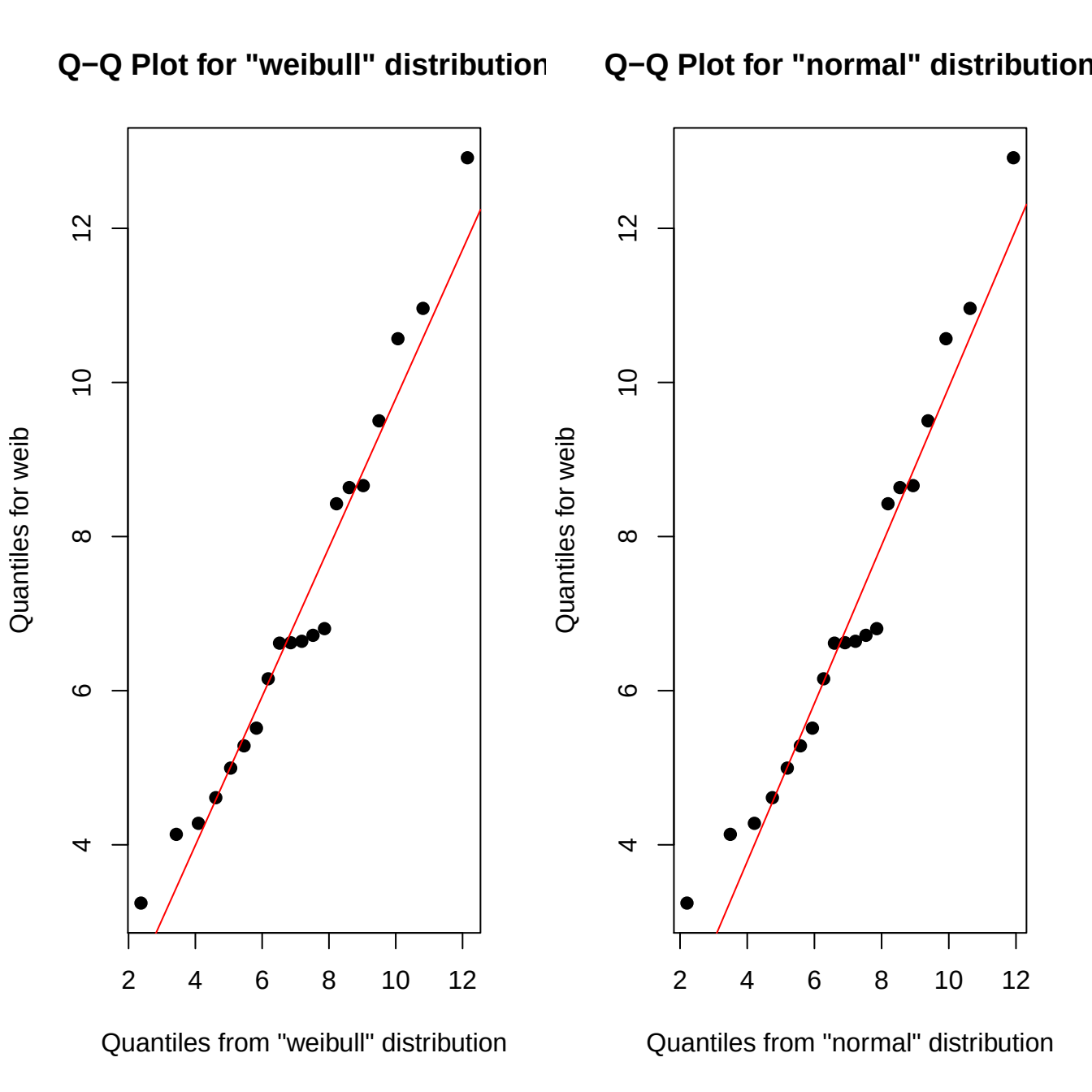

Q−Q Plot for "weibull" distribution
Quantiles for weib
Quantiles from "weibull" distribution
Q−Q Plot for "normal" distribution
Quantiles for weib
Quantiles from "normal" distribution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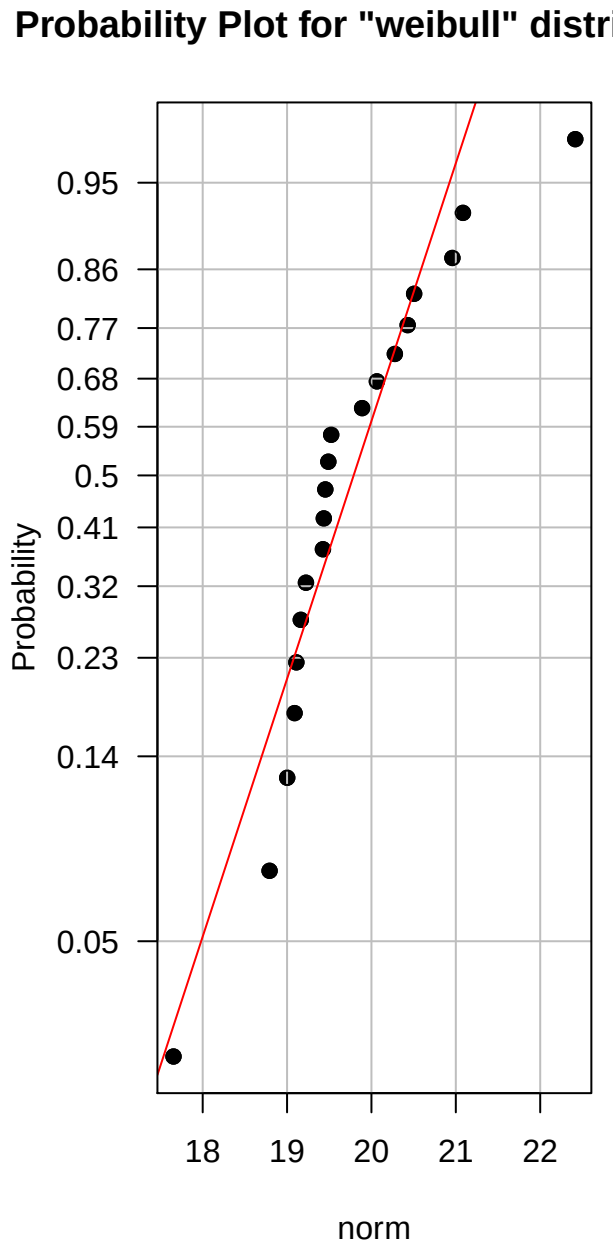
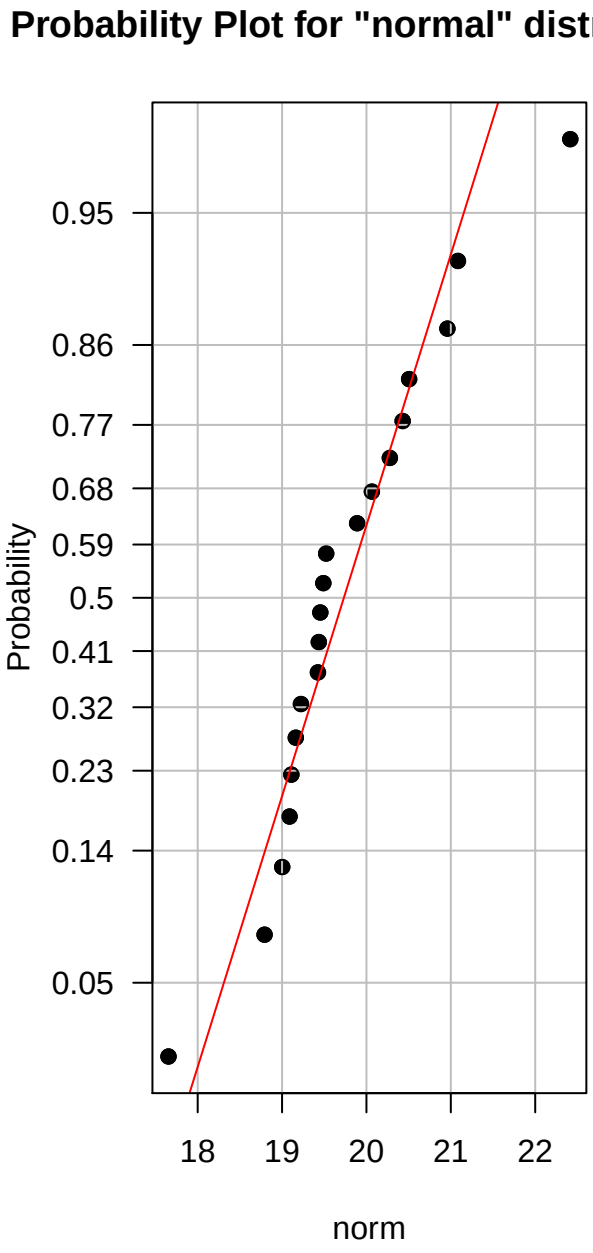

Probability Plot for "weibull" distribut
0.95
0.86
0.77
0.68
0.59
0.5
0.41
0.32
0.23
0.14
0.05
Probability
18
19
20
21
22
norm


Probability Plot for "normal" distribut
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0.86
0.77
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0.59
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0.23
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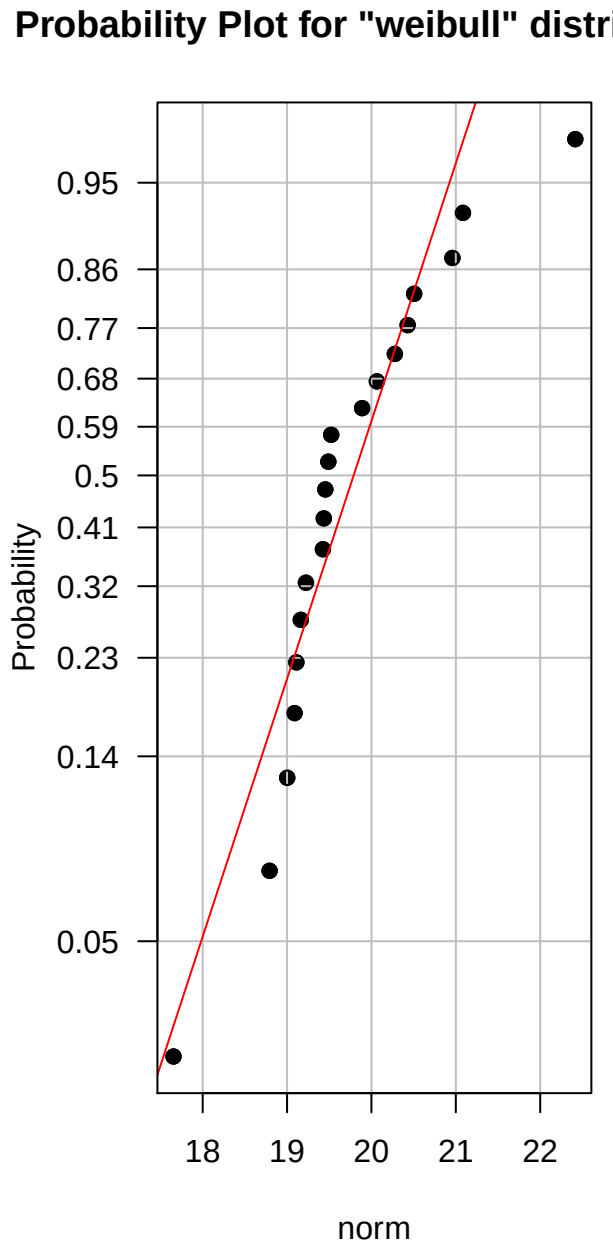
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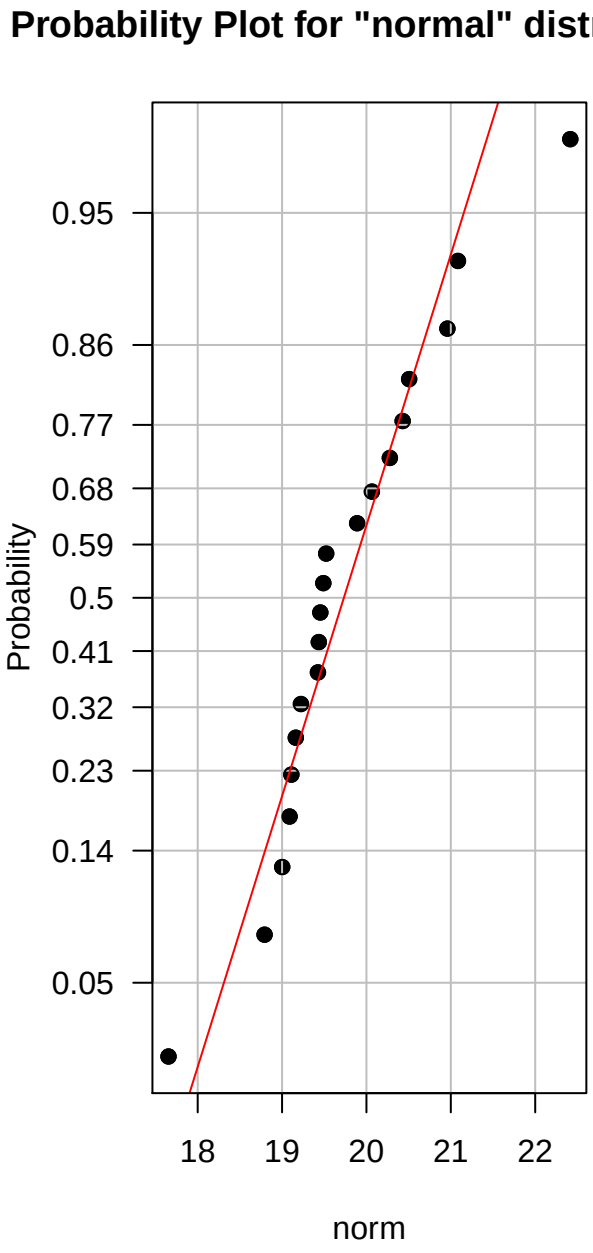
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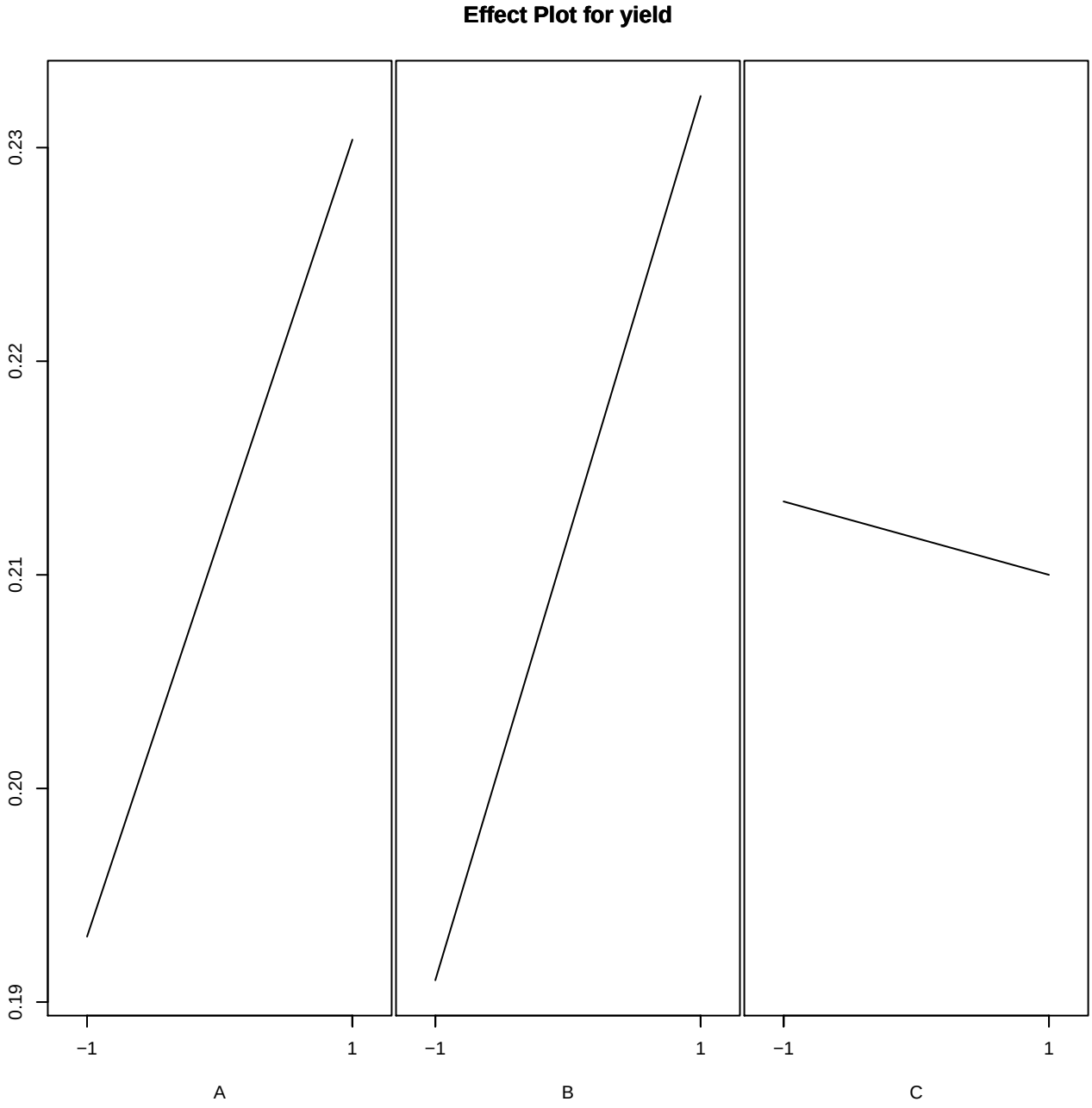
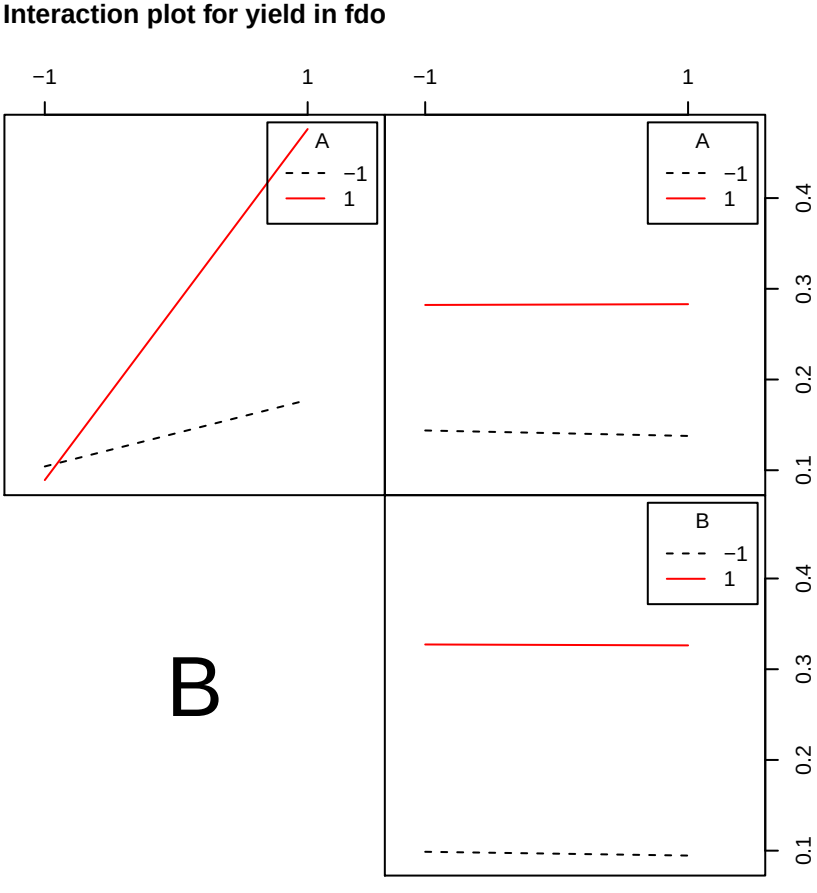
21
22
norm

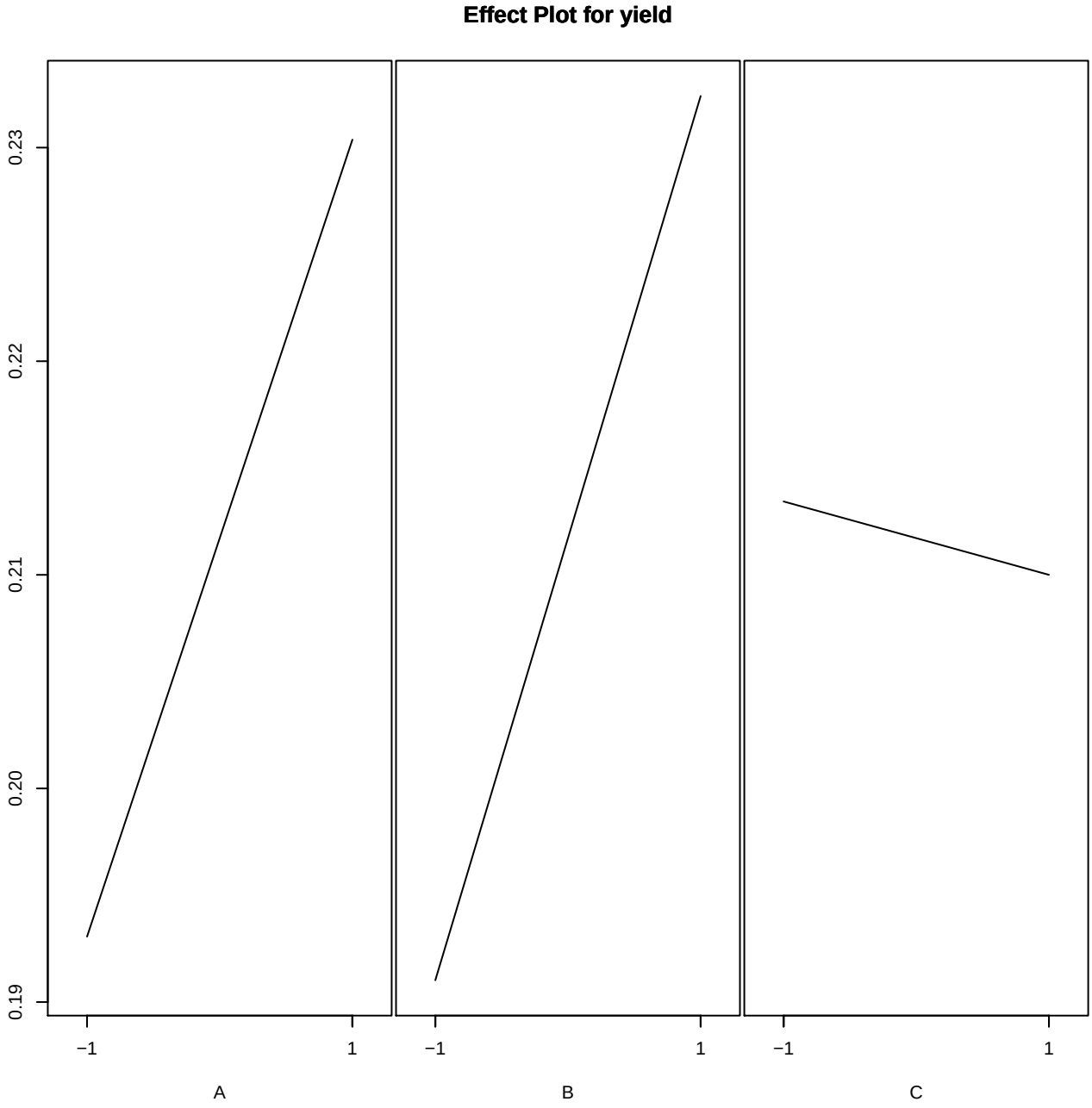

Effect Plot for yield
0.23
0.22
0.21
0.20
0.19
−1
1
A
B
C

A

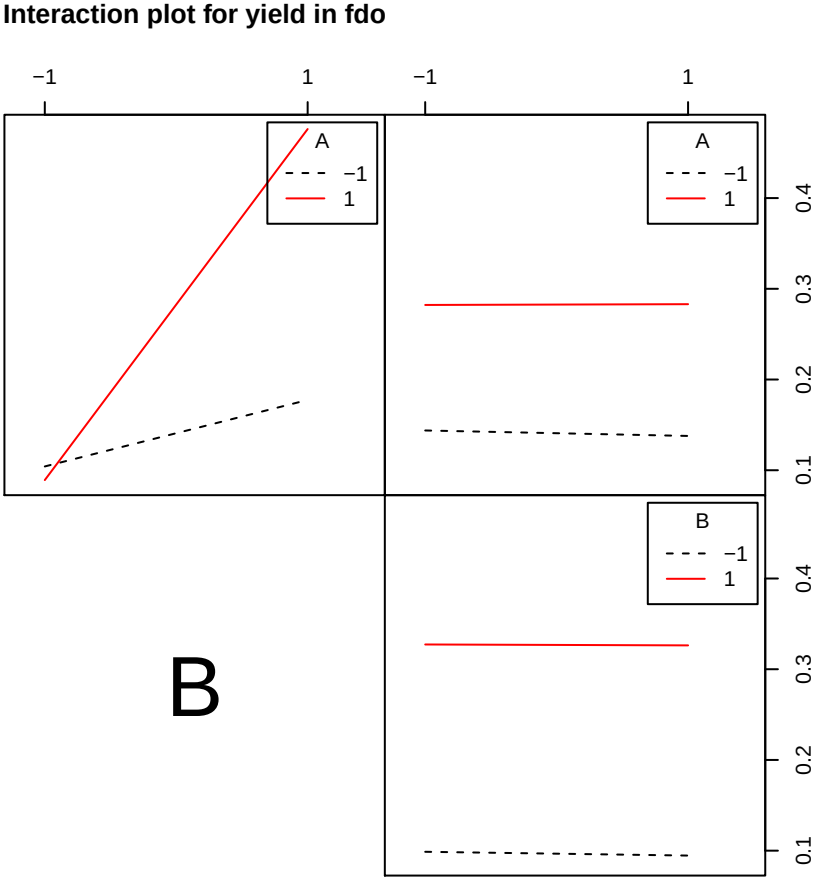

Interaction plot for yield in fdo
−1
1
−1
1
A
−1
1
A
−1
1
B
−1
1
0.1
0.2
0.3
0.4
0.1
0.2
0.3
0.4

B

C

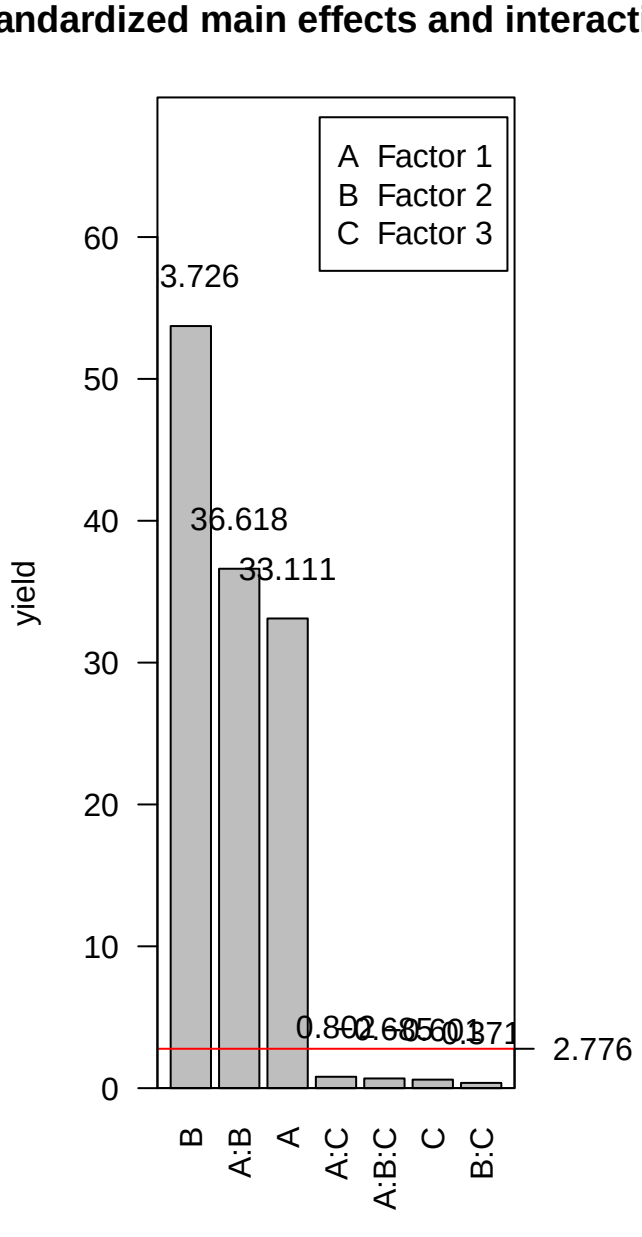

Effect Plot for yield
0.23
0.22
0.21
0.20
0.19
−1
1
A
B
C

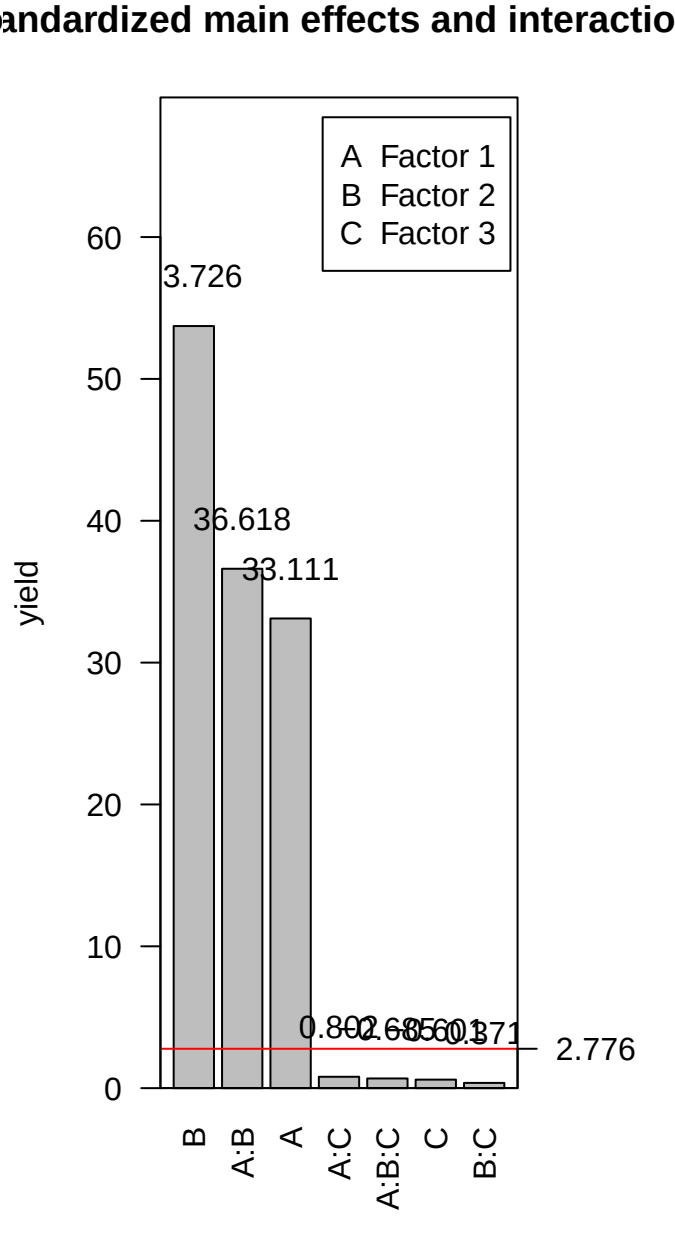
A


Interaction plot for yield in fdo
−1
1
−1
1
A
−1
1
A
−1
1
B
−1
1
0.1
0.2
0.3
0.4
0.1
0.2
0.3
0.4

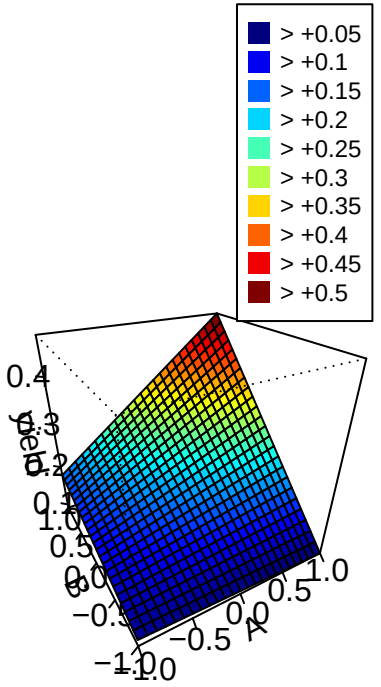
B

C

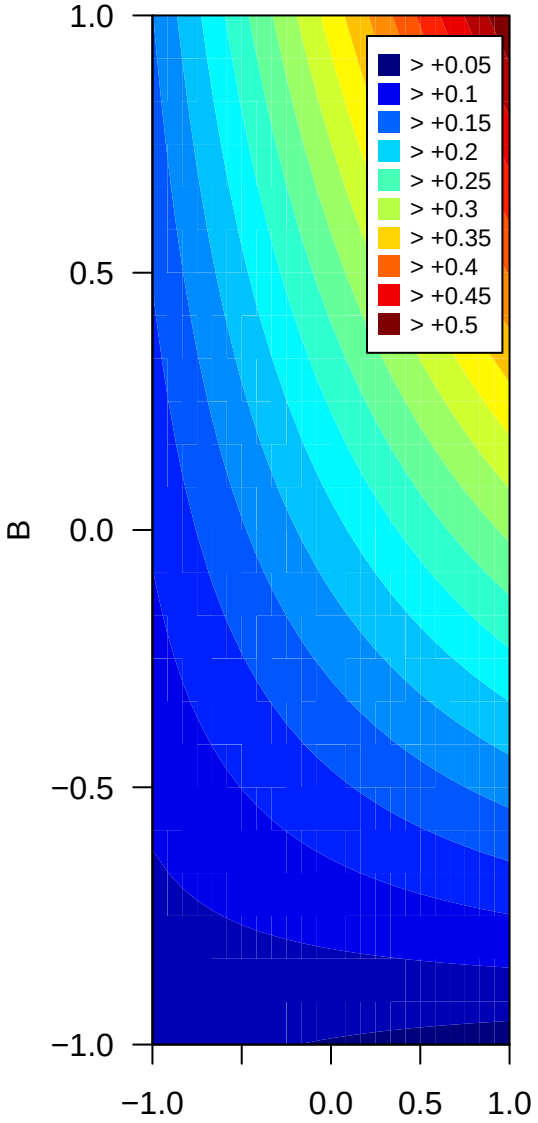

andardized main effects and interactio
A Factor 1
B Factor 2
C Factor 3
yield
60
50
40
30
20
10
0
3.726
36.618
33.111
2.776
B
A:B
A
A:C
A:B:C
C
B:C


andardized main effects and interactio
A Factor 1
B Factor 2
C Factor 3
yield
60
50
40
30
20
10
0
3.726
36.618
33.111
2.776
B
A:B
A
A:C
A:B:C
C
B:C

Response Surface for yield

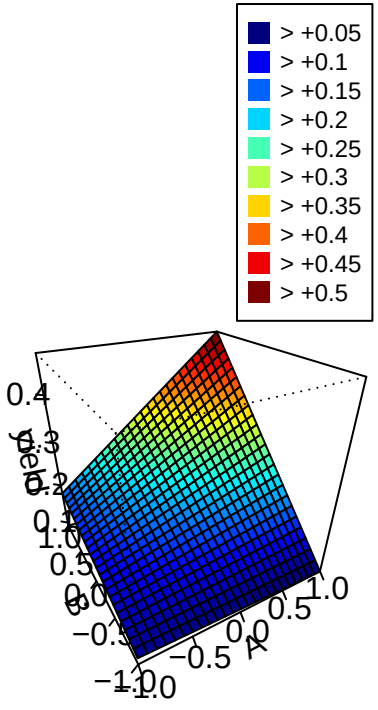


Filled Contour for yield

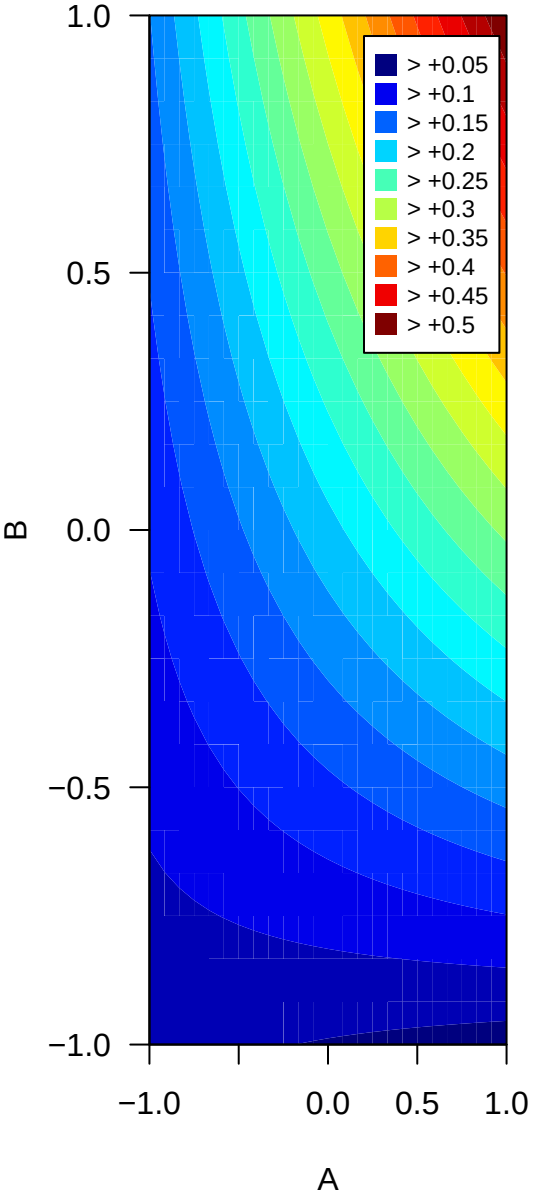


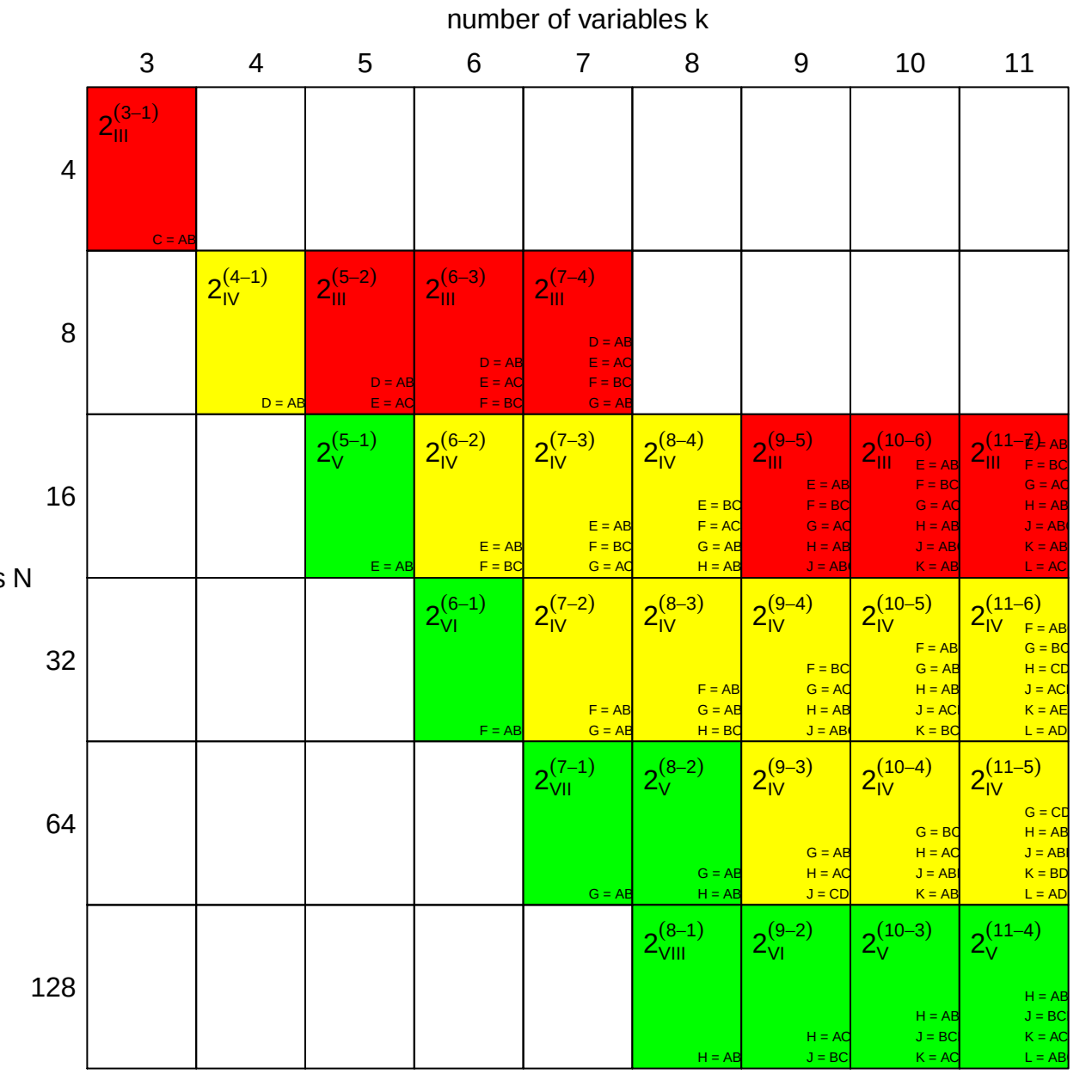
yield ~ A + B + A:B

Response Surface for yield



Filled Contour for yield




number of variables k
3
4
5
6
7
8
9
10
11
s N
4
8
16
32
64
128
$2_{III}^{(3-1)}$ C = AB
$2_{IV}^{(4-1)}$ D = AB
$2_{III}^{(5-2)}$ D = AB E = AC
$2_{III}^{(6-3)}$ D = AB E = AC F = BC
$2_{III}^{(7-4)}$ D = AB E = AC F = BC G = AB
$2_{V}^{(5-1)}$ E = AB
$2_{IV}^{(6-2)}$ E = AB F = BC
$2_{IV}^{(7-3)}$ E = AB F = BC G = AC
$2_{IV}^{(8-4)}$ E = BC F = AC G = AB H = AB
$2_{III}^{(9-5)}$ E = AB F = BC G = AC H = AB J = AB
$2_{III}^{(10-6)}$ E = AB F = BC G = AC H = AB J = AB K = AB
$2_{III}^{(11-7)}$ E = AB F = BC G = AC H = AB J = AB K = AB L = AC
$2_{VI}^{(6-1)}$ F = AB
$2_{IV}^{(7-2)}$ F = AB G = AB
$2_{IV}^{(8-3)}$ F = AB G = AB H = BC
$2_{IV}^{(9-4)}$ F = BC G = AC H = AB J = AB
$2_{IV}^{(10-5)}$ F = AB G = AB H = AB J = AC K = BC
$2_{IV}^{(11-6)}$ F = AB G = BC H = CD J = AC K = AE L = AD
$2_{VII}^{(7-1)}$ G = AB
$2_{V}^{(8-2)}$ G = AB H = AB
$2_{IV}^{(9-3)}$ G = AB H = AC J = CD
$2_{IV}^{(10-4)}$ G = BC H = AC J = AB K = AB
$2_{IV}^{(11-5)}$ G = CD H = AB J = AB K = BD L = AD
$2_{VIII}^{(8-1)}$ H = AB
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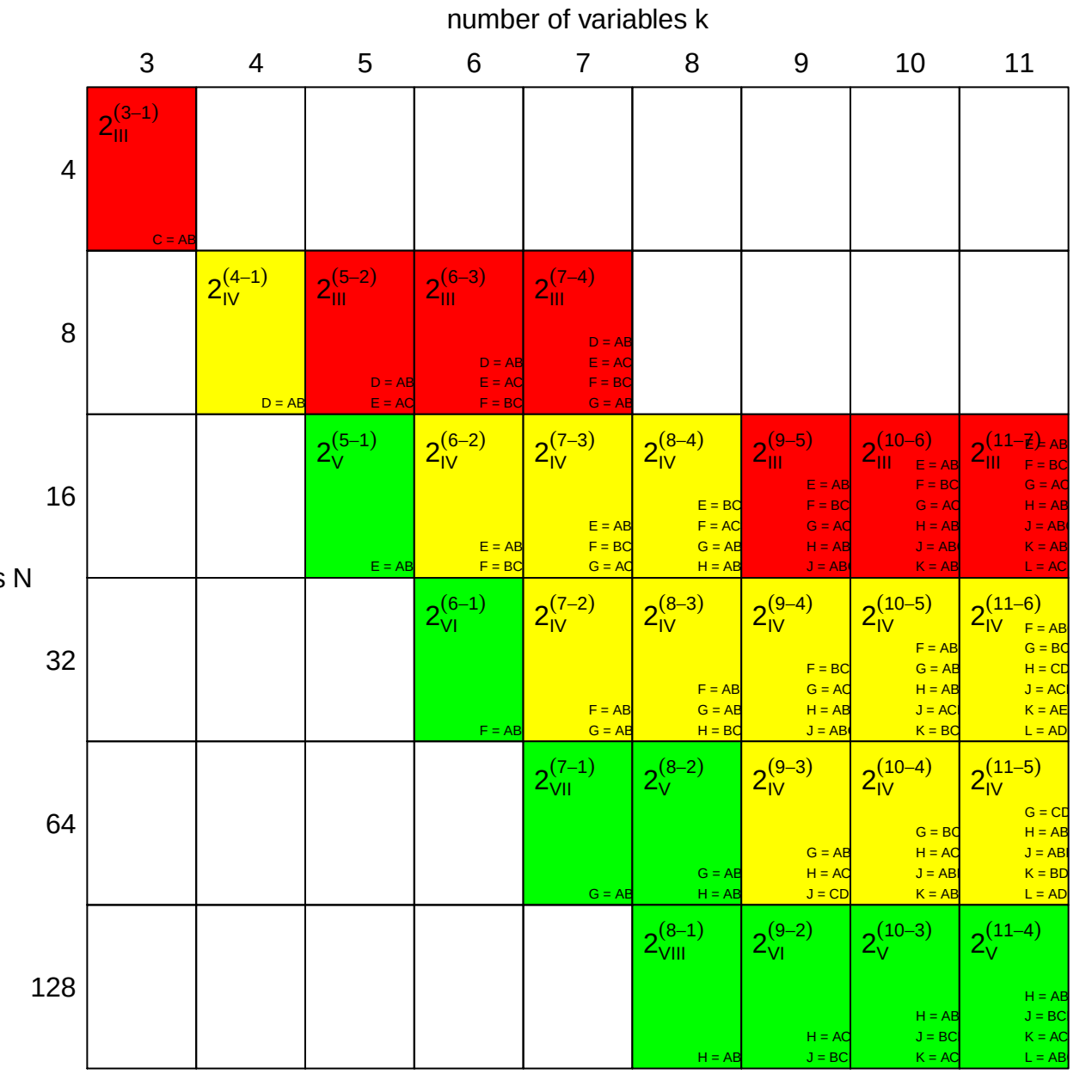
$2_{V}^{(10-3)}$ H = AB J = BC K = AC
$2_{V}^{(11-4)}$ H = AB J = BC K = AC L = AB


number of variables k
3
4
5
6
7
8
9
10
11
s N
4
8
16
32
64
128
$2_{III}^{(3-1)}$ C = AB
$2_{IV}^{(4-1)}$ D = AB
$2_{III}^{(5-2)}$ D = AB E = AC
$2_{III}^{(6-3)}$ D = AB E = AC F = BC
$2_{III}^{(7-4)}$ D = AB E = AC F = BC G = AB
$2_{V}^{(5-1)}$ E = AB
$2_{IV}^{(6-2)}$ E = AB F = BC
$2_{IV}^{(7-3)}$ E = AB F = BC G = AC
$2_{IV}^{(8-4)}$ E = BC F = AC G = AB H = AB
$2_{III}^{(9-5)}$ E = AB F = BC G = AC H = AB J = AB
$2_{III}^{(10-6)}$ E = AB F = BC G = AC H = AB J = AB K = AB
$2_{III}^{(11-7)}$ E = AB F = BC G = AC H = AB J = AB K = AB L = AC
$2_{VI}^{(6-1)}$ F = AB
$2_{IV}^{(7-2)}$ F = AB G = AB
$2_{IV}^{(8-3)}$ F = AB G = AB H = BC
$2_{IV}^{(9-4)}$ F = BC G = AC H = AB J = AB
$2_{IV}^{(10-5)}$ F = AB G = AB H = AB J = AC K = BC
$2_{IV}^{(11-6)}$ F = AB G = BC H = CD J = AC K = AE L = AD
$2_{VII}^{(7-1)}$ G = AB
$2_{V}^{(8-2)}$ G = AB H = AB
$2_{IV}^{(9-3)}$ G = AB H = AC J = CD
$2_{IV}^{(10-4)}$ G = BC H = AC J = AB K = AB
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$2_{VIII}^{(8-1)}$ H = AB
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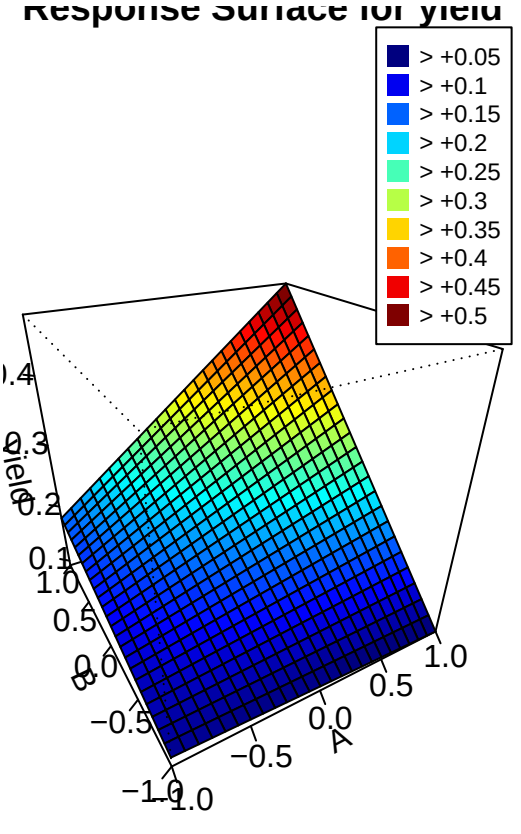
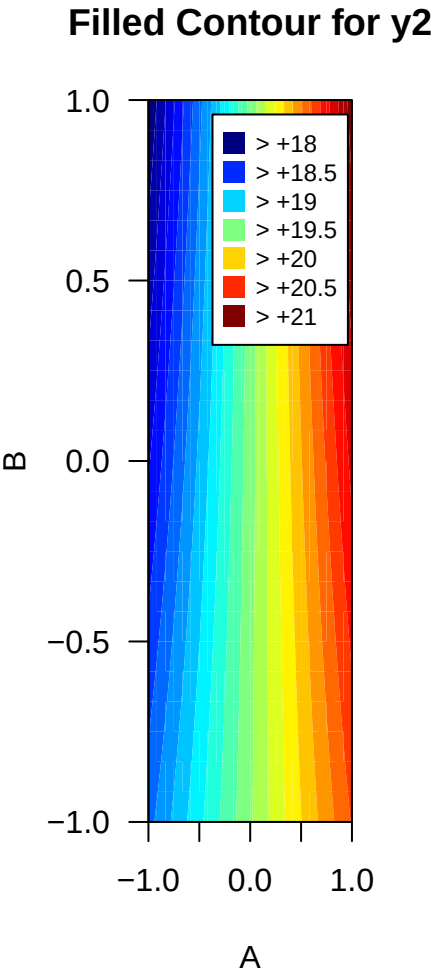
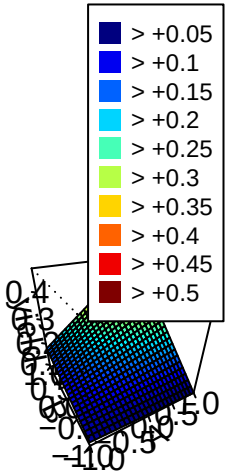
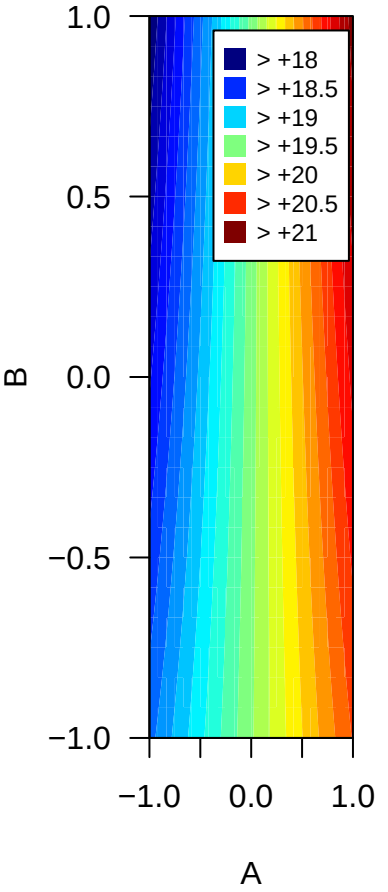

Response Surface for yield
> +0.05
> +0.1
> +0.15
> +0.2
> +0.25
> +0.3
> +0.35
> +0.4
> +0.45
> +0.5
yield
1.4
0.3
0.2
0.1
B
1.0
0.5
0.0
−0.5
−1.0
A
−1.0
−0.5
0.0
0.5
1.0


Filled Contour for y2
> +18
> +18.5
> +19
> +19.5
> +20
> +20.5
> +21
B
1.0
0.5
0.0
−0.5
−1.0
−1.0
0.0
1.0
A

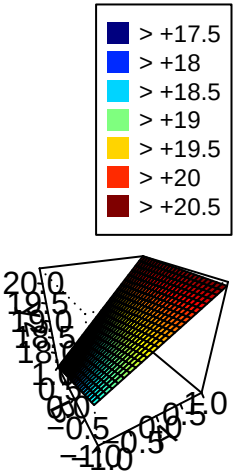
Response Surface for yield



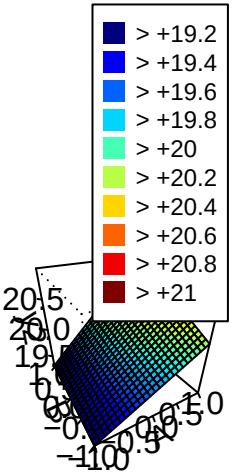
Filled Contour for y2



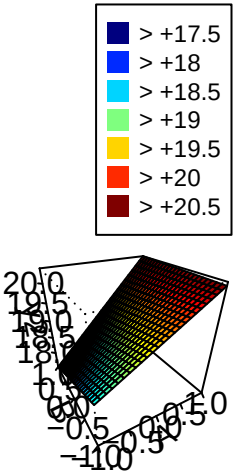
Response Surface for y2



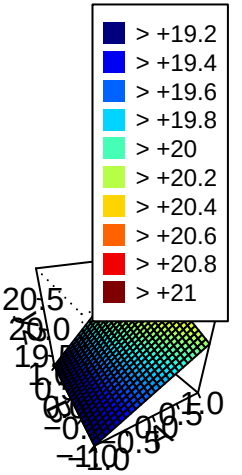
Response Surface for y2

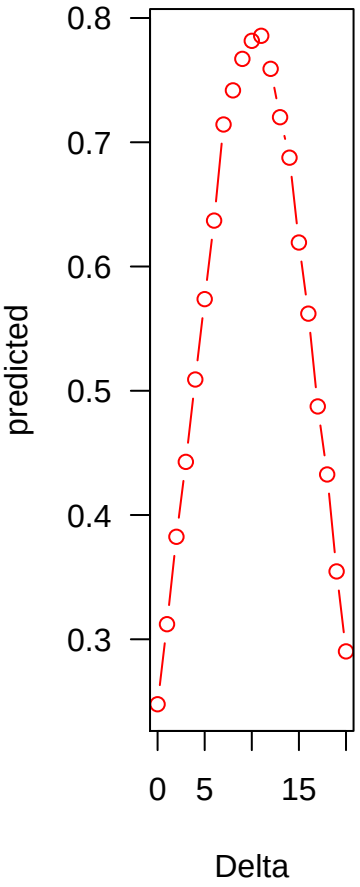


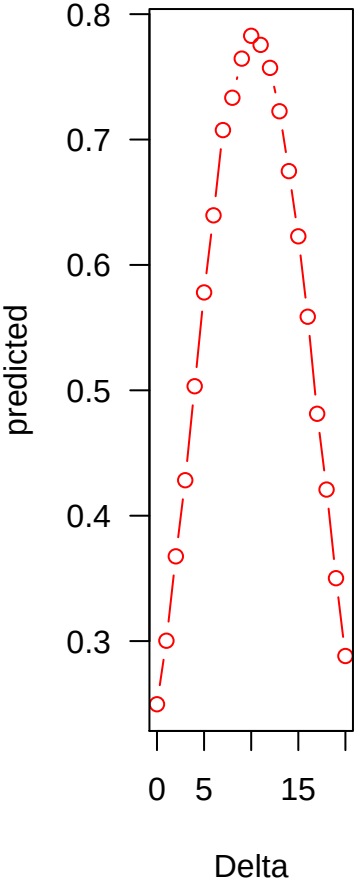
Response Surface for y2



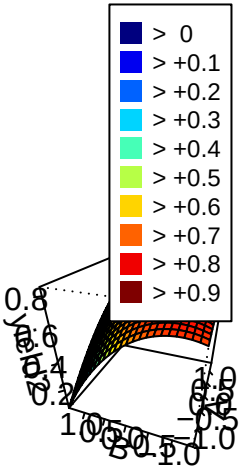
Response Surface for y2



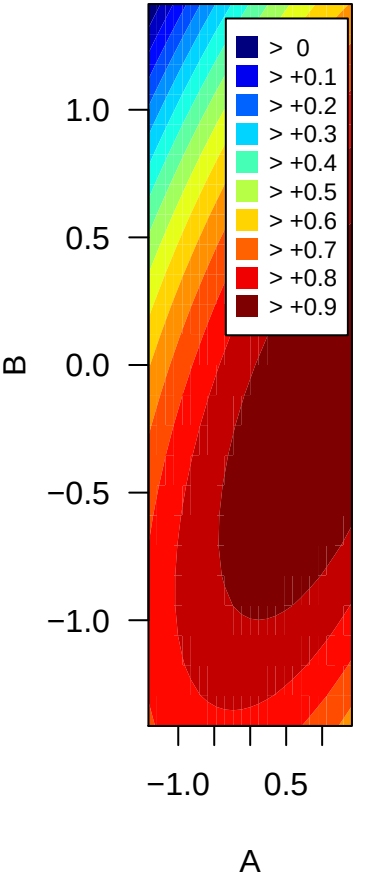

predicted
0.8
0.7
0.6
0.5
0.4
0.3
0
5
15
Delta


predicted
0.8
0.7
0.6
0.5
0.4
0.3
0
5
15
Delta

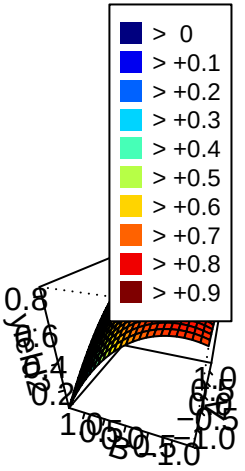
Response Surface for yield2



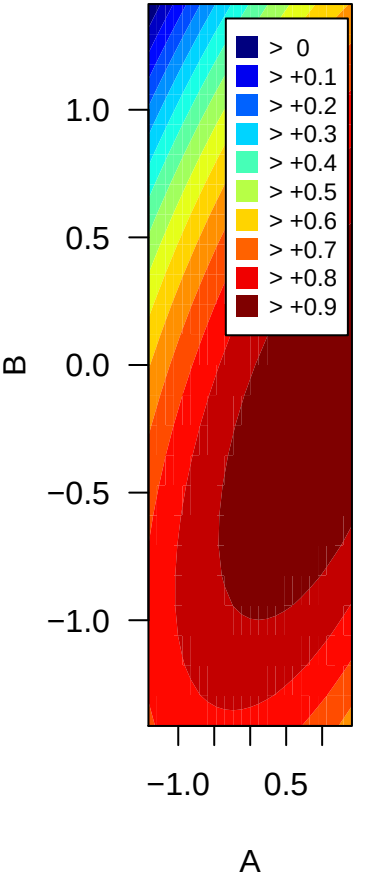
Filled Contour for yield2

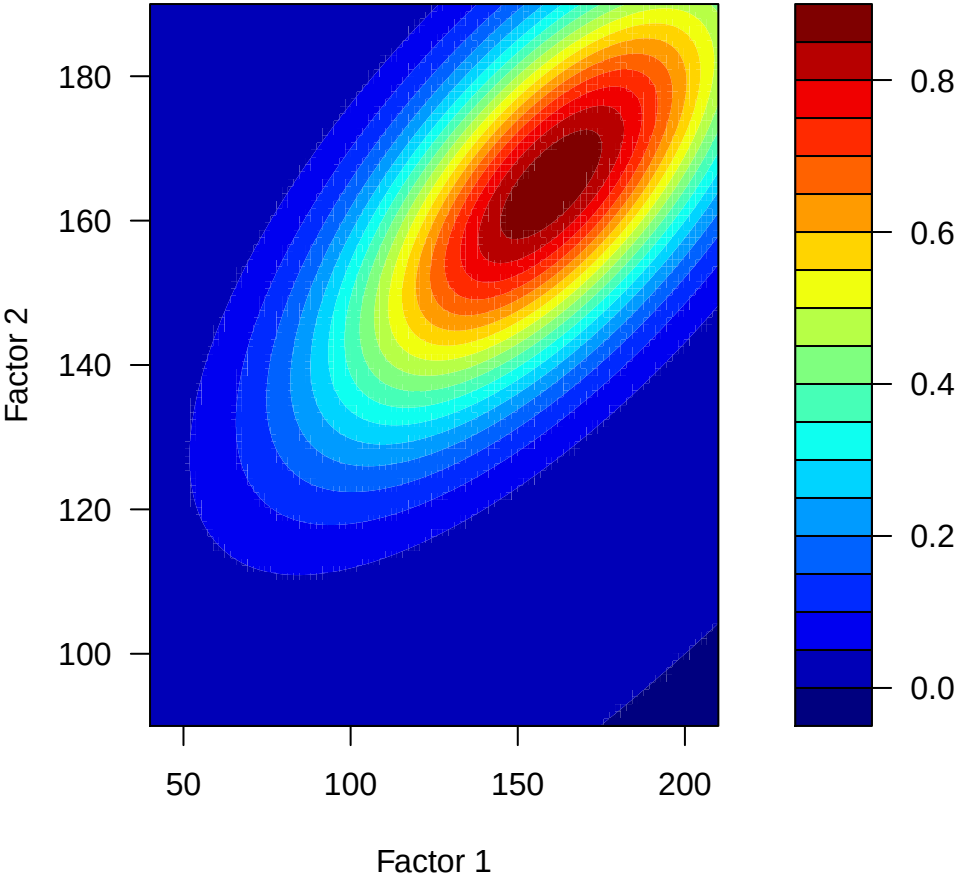


Response Surface for yield2



Filled Contour for yield2




Factor 2
180
160
140
120
100
50
100
150
200
Factor 1
0.8
0.6
0.4
0.2
0.0

number of factors k

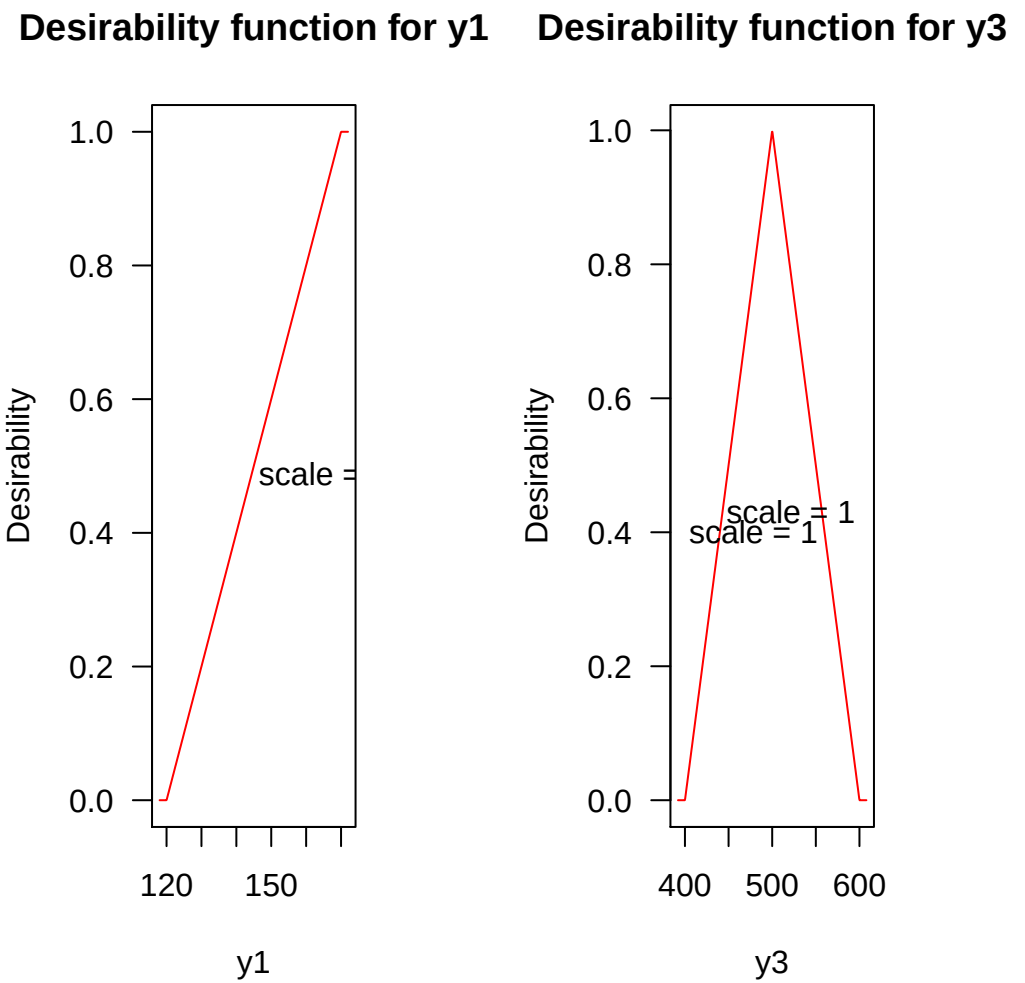
	2	3	4	5	5	6	6	7	7
1	N = 8 k = 2 p = 0 .centerPo Cube: 0 Axial: 0	N = 14 k = 3 p = 0 .centerPo Cube: 0 Axial: 0	N = 24 k = 4 p = 0 .centerPo Cube: 0 Axial: 0	N = 42 k = 5 p = 0 .centerPo Cube: 0 Axial: 0	N = 28 k = 5 p = 1 .centerPo Cube: 0 Axial: 0	N = 76 k = 6 p = 0 .centerPo Cube: 0 Axial: 0	N = 46 k = 6 p = 1 .centerPo Cube: 0 Axial: 0	N = 142 k = 7 p = 0 .centerPo Cube: 0 Axial: 0	
2	N = 14 k = 2 p = 0 .centerPo Cube: 3 Axial: 3	N = 18 k = 3 p = 0 .centerPo Cube: 2 Axial: 2	N = 28 k = 4 p = 0 .centerPo Cube: 2 Axial: 2	N = 48 k = 5 p = 0 .centerPo Cube: 2 Axial: 4	N = 35 k = 5 p = 1 .centerPo Cube: 6 Axial: 1	N = 83 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 52 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 154 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	
3		N = 20 k = 3 p = 0 .centerPo Cube: 2 Axial: 2	N = 30 k = 4 p = 0 .centerPo Cube: 2 Axial: 2	N = 50 k = 5 p = 0 .centerPo Cube: 2 Axial: 4	N = 41 k = 5 p = 1 .centerPo Cube: 6 Axial: 1	N = 84 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 56 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 155 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	
5			N = 34 k = 4 p = 0 .centerPo Cube: 2 Axial: 2	N = 54 k = 5 p = 0 .centerPo Cube: 2 Axial: 4	N = 53 k = 5 p = 1 .centerPo Cube: 6 Axial: 1	N = 86 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 64 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 157 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	
9				N = 62 k = 5 p = 0 .centerPo Cube: 2 Axial: 4		N = 90 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 80 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 161 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	N = 92 k = 7 p = 1 .centerPo Cube: 1 Axial: 4
17						N = 98 k = 6 p = 0 .centerPo Cube: 1 Axial: 6		N = 169 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	

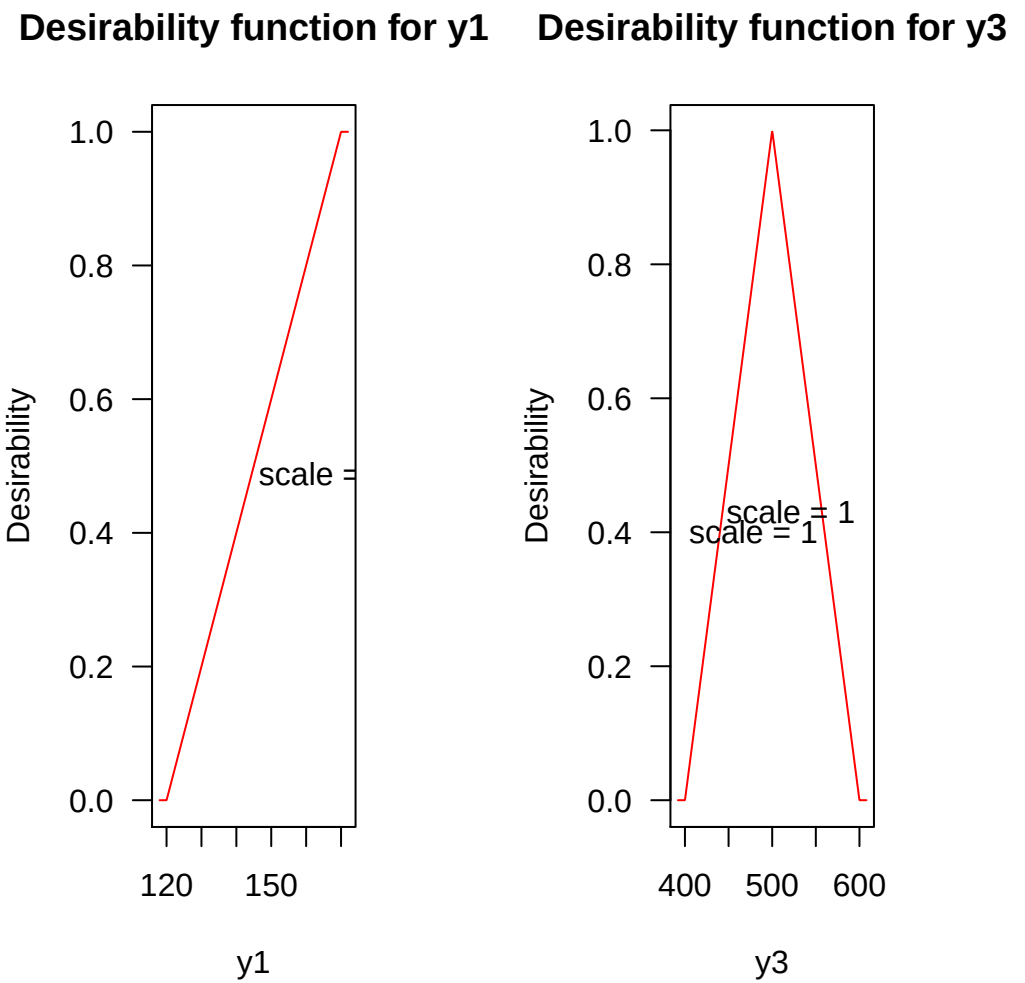
cks

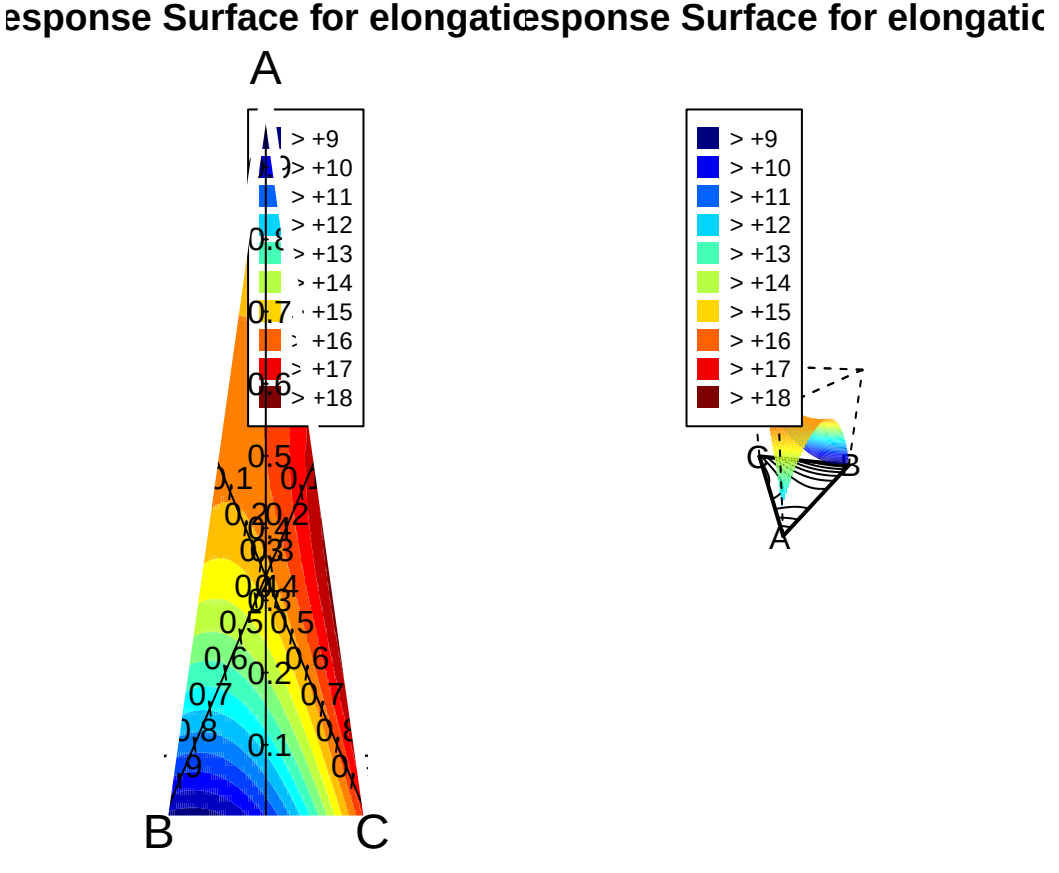
number of factors k

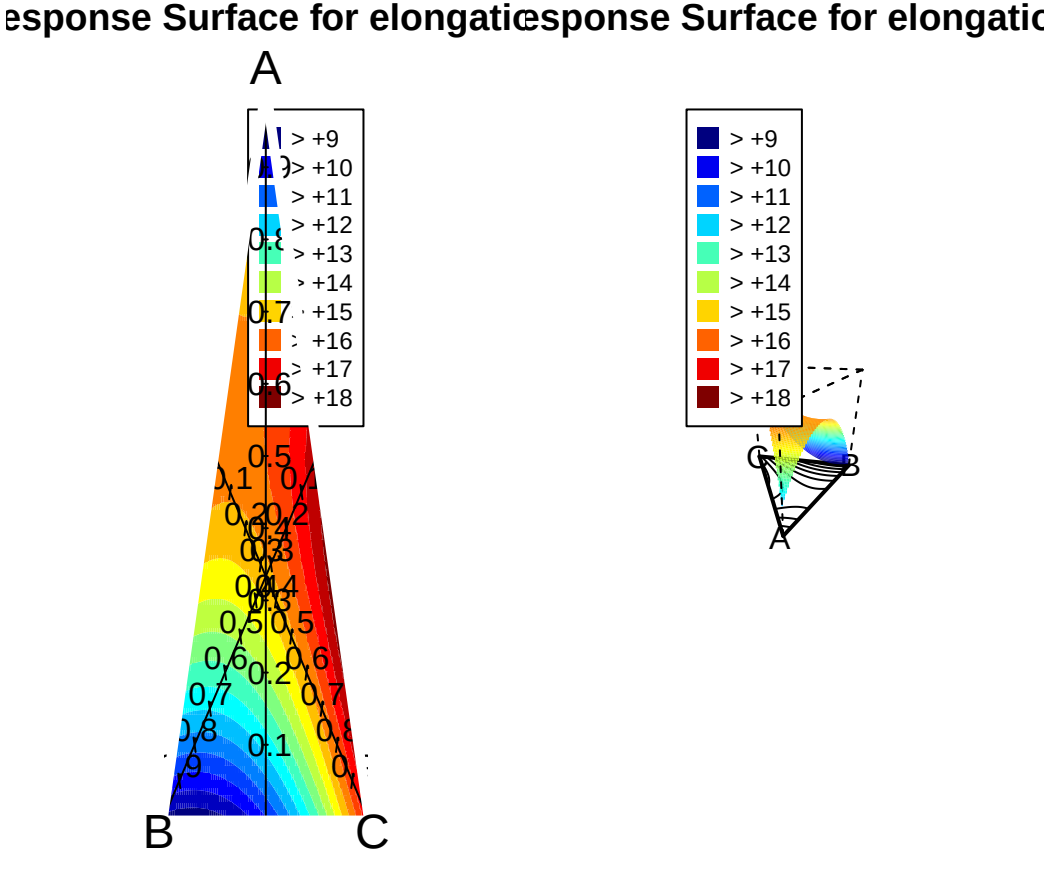
	2	3	4	5	5	6	6	7	7
1	N = 8 k = 2 p = 0 .centerPo Cube: 0 Axial: 0	N = 14 k = 3 p = 0 .centerPo Cube: 0 Axial: 0	N = 24 k = 4 p = 0 .centerPo Cube: 0 Axial: 0	N = 42 k = 5 p = 0 .centerPo Cube: 0 Axial: 0	N = 28 k = 5 p = 1 .centerPo Cube: 0 Axial: 0	N = 76 k = 6 p = 0 .centerPo Cube: 0 Axial: 0	N = 46 k = 6 p = 1 .centerPo Cube: 0 Axial: 0	N = 142 k = 7 p = 0 .centerPo Cube: 0 Axial: 0	
2	N = 14 k = 2 p = 0 .centerPo Cube: 3 Axial: 3	N = 18 k = 3 p = 0 .centerPo Cube: 2 Axial: 2	N = 28 k = 4 p = 0 .centerPo Cube: 2 Axial: 2	N = 48 k = 5 p = 0 .centerPo Cube: 2 Axial: 4	N = 35 k = 5 p = 1 .centerPo Cube: 6 Axial: 1	N = 83 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 52 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 154 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	
3		N = 20 k = 3 p = 0 .centerPo Cube: 2 Axial: 2	N = 30 k = 4 p = 0 .centerPo Cube: 2 Axial: 2	N = 50 k = 5 p = 0 .centerPo Cube: 2 Axial: 4	N = 41 k = 5 p = 1 .centerPo Cube: 6 Axial: 1	N = 84 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 56 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 155 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	
5			N = 34 k = 4 p = 0 .centerPo Cube: 2 Axial: 2	N = 54 k = 5 p = 0 .centerPo Cube: 2 Axial: 4	N = 53 k = 5 p = 1 .centerPo Cube: 6 Axial: 1	N = 86 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 64 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 157 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	
9				N = 62 k = 5 p = 0 .centerPo Cube: 2 Axial: 4		N = 90 k = 6 p = 0 .centerPo Cube: 1 Axial: 6	N = 80 k = 6 p = 1 .centerPo Cube: 4 Axial: 2	N = 161 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	N = 92 k = 7 p = 1 .centerPo Cube: 1 Axial: 4
17						N = 98 k = 6 p = 0 .centerPo Cube: 1 Axial: 6		N = 169 k = 7 p = 0 .centerPo Cube: 1 Axial: 11	

cks


Desirability function for y1
Desirability
1.0
0.8
0.6
0.4
0.2
0.0
scale =
120
150
y1
Desirability function for y3
Desirability
1.0
0.8
0.6
0.4
0.2
0.0
scale = 1
scale = 1
400
500
600
y3


Desirability function for y1
Desirability
1.0
0.8
0.6
0.4
0.2
0.0
scale =
120
150
y1
Desirability function for y3
Desirability
1.0
0.8
0.6
0.4
0.2
0.0
scale = 1
scale = 1
400
500
600
y3


esponse Surface for elongatic
esponse Surface for elongatic
A
B
C
> +9
> +10
> +11
> +12
> +13
> +14
> +15
> +16
> +17
> +18


esponse Surface for elongatic
esponse Surface for elongatic
A
B
C
> +9
> +10
> +11
> +12
> +13
> +14
> +15
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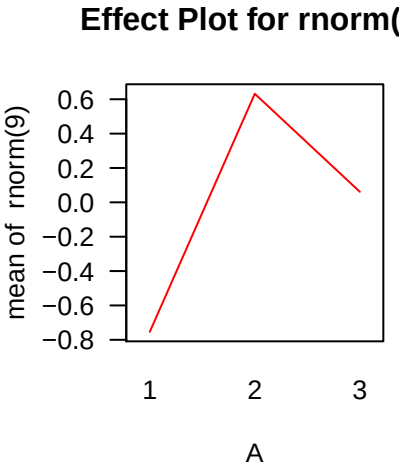
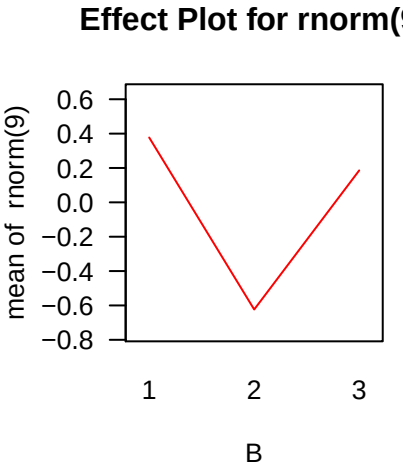
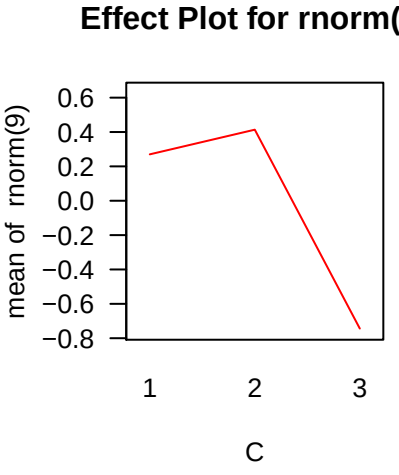
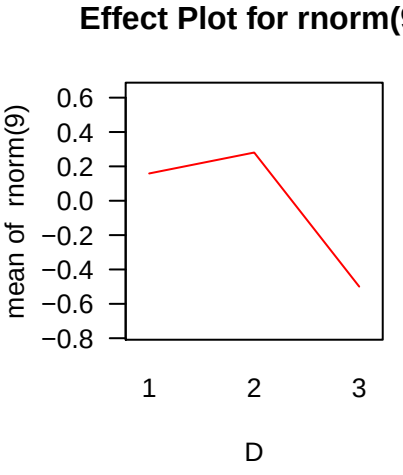
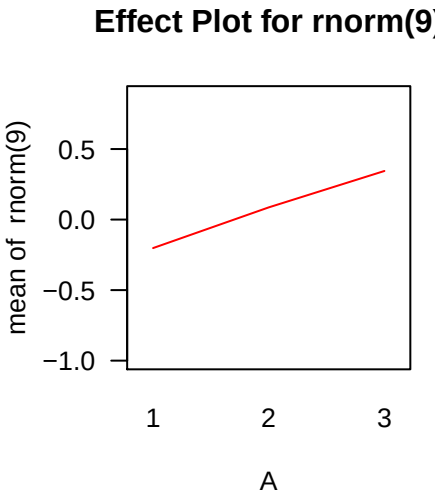
> +17
> +18

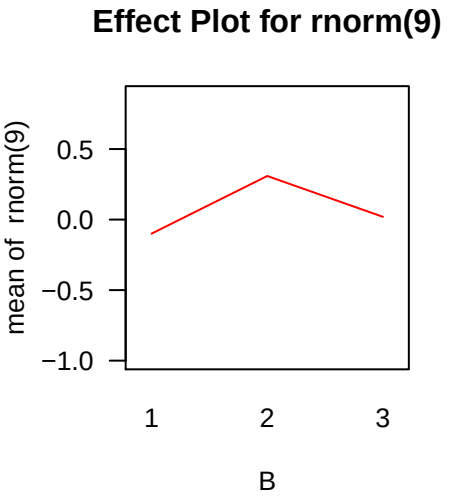

Effect Plot for rnorm(9)
mean of rnorm(9)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
1
2
3
A

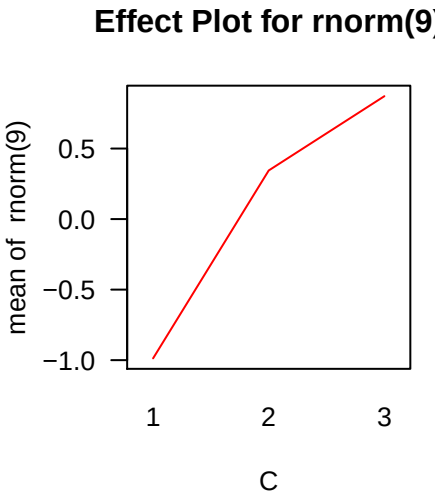

Effect Plot for rnorm(9)
mean of rnorm(9)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
1
2
3
B

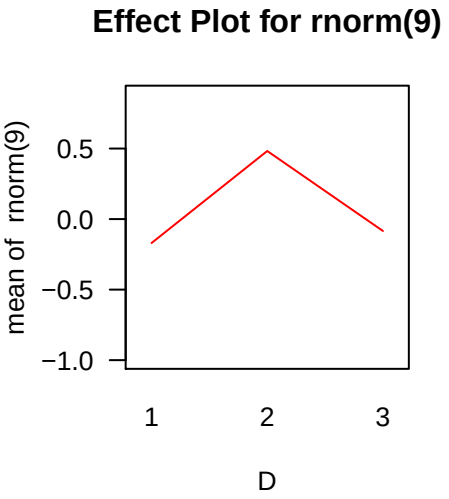

Effect Plot for rnorm(9)
mean of rnorm(9)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
1
2
3
C


Effect Plot for rnorm(9)
mean of rnorm(9)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
1
2
3
D


Effect Plot for rnorm(9)
mean of rnorm(9)
0.5
0.0
−0.5
−1.0
1
2
3
A


Effect Plot for rnorm(9)
mean of rnorm(9)
0.5
0.0
−0.5
−1.0
1
2
3
B


Effect Plot for rnorm(9)
mean of rnorm(9)
0.5
0.0
−0.5
−1.0
1
2
3
C


Effect Plot for rnorm(9)
mean of rnorm(9)
0.5
0.0
−0.5
−1.0
1
2
3
D