ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
AGRICULTURAL UNIVERSITY OF ATHENS

Ορθογώνια πολυώνυμα
Ανάλυση τάσης

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2018

> Plant_Density # Παράδειγμα R.Kuehl

	density	yield
1	10	12.2
2	10	11.4
3	10	12.4
4	20	16.0
5	20	15.5
6	20	16.5
7	30	18.6
8	30	20.2
9	30	18.2
10	40	17.6
11	40	19.3
12	40	17.1
13	50	18.0
14	50	16.4
15	50	16.6

Πειραματικοί Σχεδιασμοί

```
> density=factor(density)
> fit=aov(yield~density)
> anova(fit)

Analysis of Variance Table

Response: yield
            Df  Sum Sq Mean Sq F value    Pr(>F)
density      4 87.600  21.900  29.278 1.69e-05 ***
Residuals   10  7.480   0.748
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Πειραματικοί Σχεδιασμοί

```
> contrasts(density) = contr.poly(5)
> contrasts(density)
```

	.L	.Q	.C	^4
10	-0.6324555	0.5345225	-3.162278e-01	0.1195229
20	-0.3162278	-0.2672612	6.324555e-01	-0.4780914
30	0.0000000	-0.5345225	-4.095972e-16	0.7171372
40	0.3162278	-0.2672612	-6.324555e-01	-0.4780914
50	0.6324555	0.5345225	3.162278e-01	0.1195229

Πειραματικοί Σχεδιασμοί

```
> fit2=aov(yield~density)
> summary.lm(fit2)

Call:
aov(formula = yield ~ density)

Residuals:
   Min     1Q Median     3Q    Max
 -0.90  -0.55  -0.40   0.45   1.30

Coefficients:
             Estimate   Std. Error  t value   Pr(>|t|)
(Intercept)  16.4000     0.2233     73.441   5.35e-15 ***
density.L     3.7947     0.4993      7.600   1.84e-05 ***
density.Q    -3.7417     0.4993     -7.493   2.08e-05 ***
density.C     0.3162     0.4993      0.633    0.541
density^4     0.8367     0.4993      1.676    0.125
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.8649 on 10 degrees of freedom
Multiple R-squared:  0.9213,       Adjusted R-squared:  0.8899
F-statistic: 29.28 on 4 and 10 DF,  p-value: 1.69e-05
```

Πειραματικοί Σχεδιασμοί

```
> summary(fit2, split = list(density= list("Linear" = 1, "Quadratic" = 2,"Cubic" = 3, "Quartic" = 4)))

                     Df  Sum Sq Mean Sq F value     Pr(>F)
density               4  87.60   21.90  29.278 1.69e-05 ***
  density: Linear     1  43.20   43.20  57.754 1.84e-05 ***
  density: Quadratic  1  42.00   42.00  56.150 2.08e-05 ***
  density: Cubic      1   0.30    0.30   0.401      0.541
  density: Quartic    1   2.10    2.10   2.807      0.125
Residuals            10   7.48    0.75
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Πειραματικοί Σχεδιασμοί

```
> contrasts(density)=cbind( c(-2,-1,0,1,2), c(2,-1,-2,-1,2), c(-1,2,0,-2,1), c(1,-4,6,-4,1) )
> contrasts(density)
```

	[,1]	[,2]	[,3]	[,4]
10	-2	2	-1	1
20	-1	-1	2	-4
30	0	-2	0	6
40	1	-1	-2	-4
50	2	2	1	1

Πειραματικοί Σχεδιασμοί

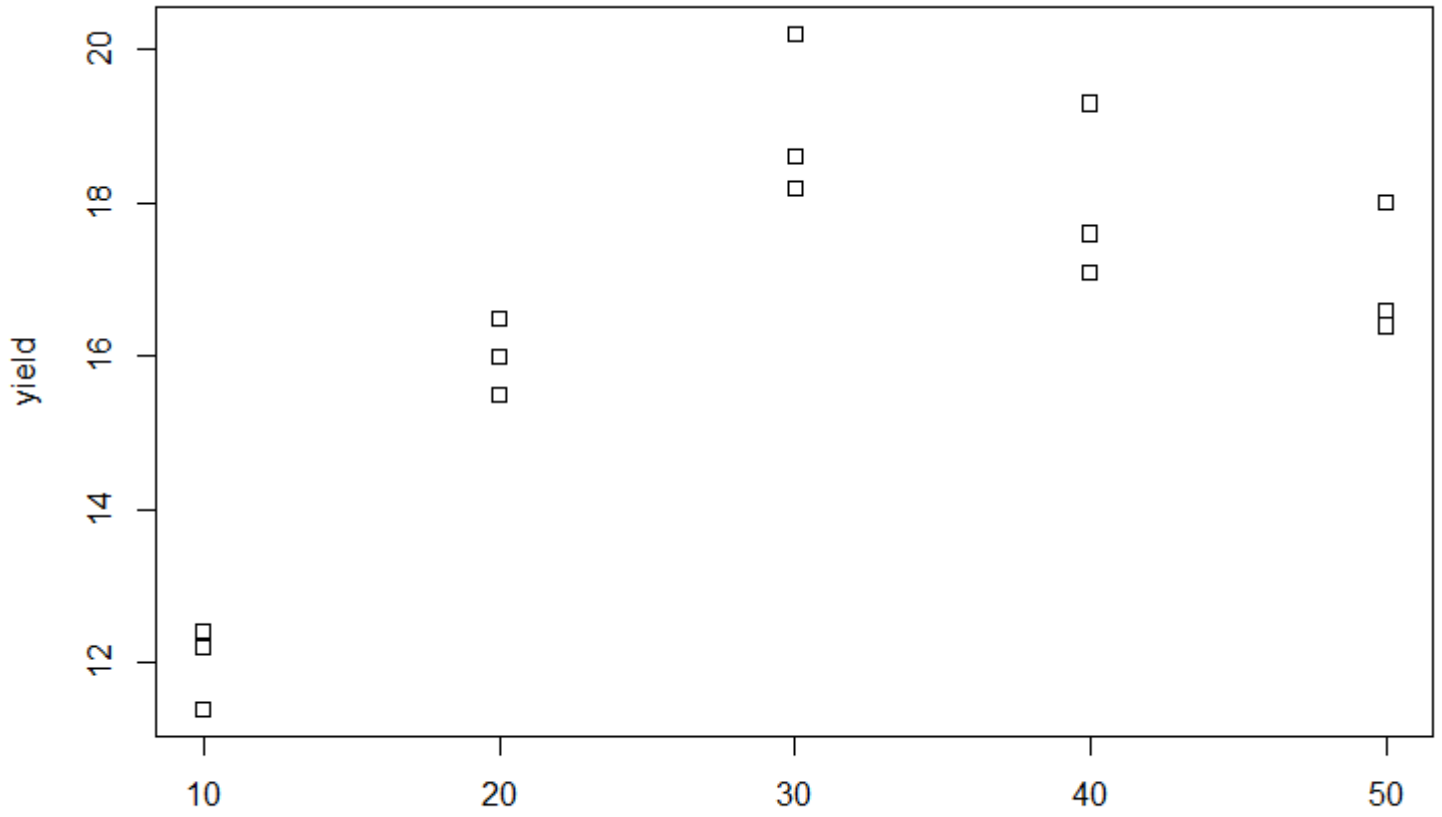
```
> fit3=aov(yield~density)
> summary(fit3, split = list(density= list("Linear" = 1, "Quadratic" = 2,"Cubic" = 3, "Quartic" = 4)))
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
density	4	87.60	21.90	29.278	1.69e-05 ***
density: Linear	1	43.20	43.20	57.754	1.84e-05 ***
density: Quadratic	1	42.00	42.00	56.150	2.08e-05 ***
density: Cubic	1	0.30	0.30	0.401	0.541
density: Quartic	1	2.10	2.10	2.807	0.125
Residuals	10	7.48	0.75		

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

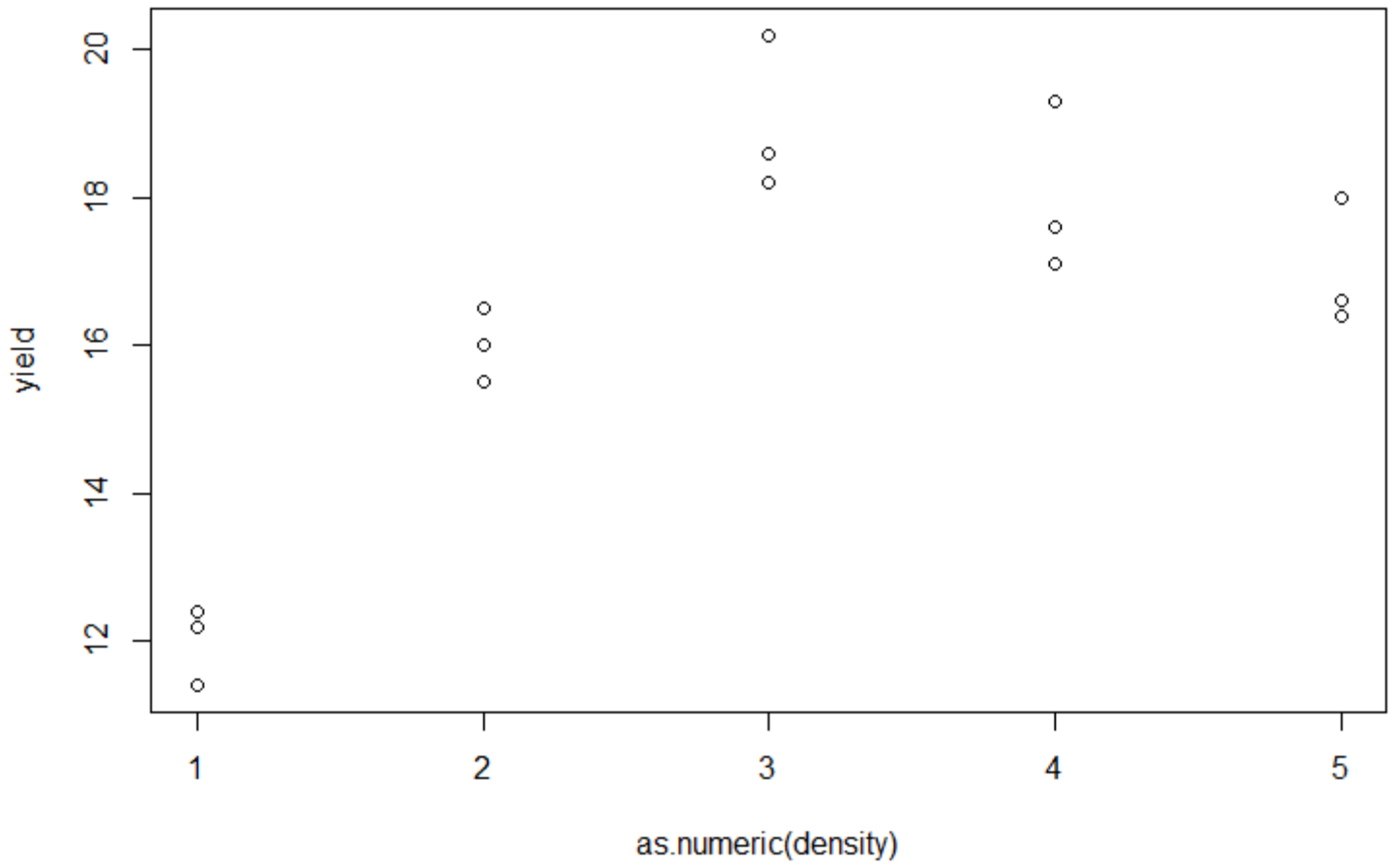
Πειραματικοί Σχεδιασμοί

> stripchart(yield~density, vertical=TRUE)



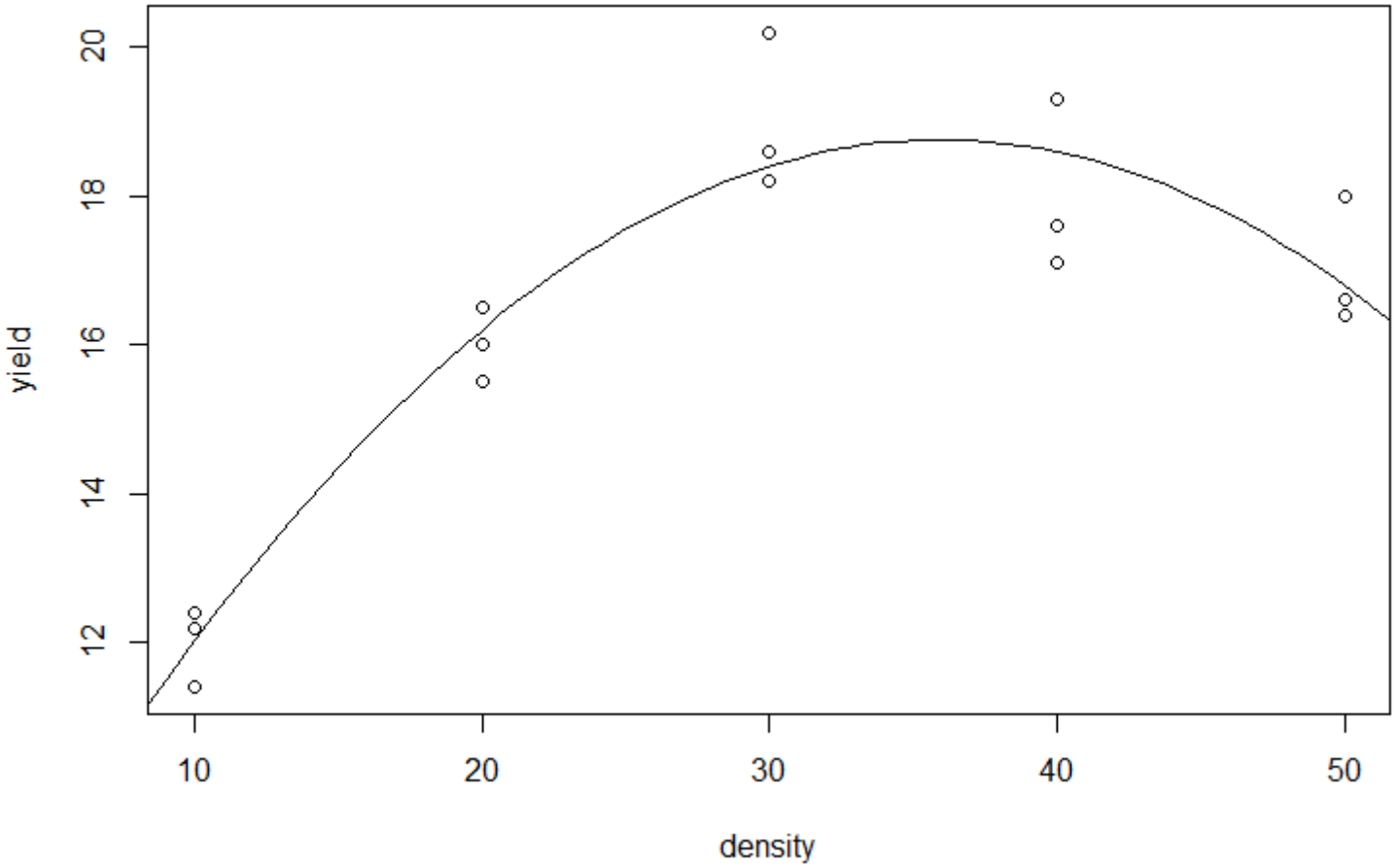
Πειραματικοί Σχεδιασμοί

```
> density=as.numeric(density)
> plot(density,yield)
```



Πειραματικοί Σχεδιασμοί

```
> fit4=lm(yield~density + I(density^2))
> densitynew=seq(0, 60, length=100)
> lines(densitynew, predict(fit4, data.frame(density=densitynew)))
```



Πειραματικοί Σχεδιασμοί

```
> fit5=lm(yield~density + I(density^2) + I(density^3) + I(density^4))
> anova(fit5)

Analysis of Variance Table

Response: yield
             Df  Sum Sq Mean Sq F value    Pr(>F)
density       1  43.20  43.200 57.7540 1.841e-05 ***
I(density^2)  1  42.00  42.000 56.1497 2.079e-05 ***
I(density^3)  1   0.30   0.300  0.4011    0.5407
I(density^4)  1   2.10   2.100  2.8075    0.1248
Residuals    10   7.48   0.748
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Πειραματικοί Σχεδιασμοί

> factorial_2X3_crd

	A	B	R	Y
1	1	1	1	12
2	1	1	2	10
3	1	1	3	8
4	1	1	4	8
5	1	2	1	12
6	1	2	2	16
7	1	2	3	17
8	1	2	4	19
9	1	3	1	13
10	1	3	2	16
11	1	3	3	15
…				
16	2	1	4	4
17	2	2	1	9
18	2	2	2	8
19	2	2	3	8
20	2	2	4	9
21	2	3	1	15
22	2	3	2	16
23	2	3	3	16
24	2	3	4	13

Πειραματικοί Σχεδιασμοί

```
> A=factor(A)
> B=factor(B)
> contrasts(A) = contr.poly(2)
> contrasts(A)
           .L
1  -0.7071068
2   0.7071068

> contrasts(B) = contr.poly(3)
> contrasts(B)
              .L          .Q
1  -7.071068e-01   0.4082483
2  -7.850462e-17  -0.8164966
3   7.071068e-01   0.4082483
> contrasts(B) = cbind(c(-1,0,1), c(1,-2,1))
> contrasts(B)

  [,1] [,2]
1   -1    1
2    0   -2
3    1    1
```

Πειραματικοί Σχεδιασμοί

```
> summary(fit, split=list(A=list("Linear"=1),B=list("Linear" = 1, "Quadratic" = 2)))
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	88.17	88.17	23.687	0.000124 ***
A: Linear	1	88.17	88.17	23.687	0.000124 ***
B	2	228.00	114.00	30.627	1.61e-06 ***
B: Linear	1	225.00	225.00	60.448	3.67e-07 ***
B: Quadratic	1	3.00	3.00	0.806	0.381166
A:B	2	49.33	24.67	6.627	0.006972 **
A:B: Linear.Linear	1	9.00	9.00	2.418	0.137361
A:B: Linear.Quadratic	1	40.33	40.33	10.836	0.004054 **
Residuals	18	67.00	3.72		

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Πειραματικοί Σχεδιασμοί

Επεμβάσεις	Response	1	2	3	4	5	6	7	8	9	Σc^2
2	Linear	-1	1								2
3	Linear	-1	0	1							2
	Quadratic	1	-2	1							6
4	Linear	-3	-1	1	3						20
	Quadratic	1	-1	-1	1						4
	Cubic	-1	3	-3	1						20
5	Linear	-2	-1	0	1	2					10
	Quadratic	2	-1	-2	-1	2					14
	Cubic	-1	2	0	-2	1					10
	Quartic	1	-4	6	-4	1					70
6	Linear	-5	-3	-1	1	3	5				70
	Quadratic	5	-1	-4	-4	-1	5				84
	Cubic	-5	7	4	-4	-7	5				180
	Quartic	1	-3	2	2	-3	1				28
	Quintic	-1	5	-10	10	-5	1				252
7	Linear	-3	-2	-1	0	1	2	3			28
	Quadratic	5	0	-3	-4	-3	0	5			84
	Cubic	-1	1	1	0	-1	-1	1			6
	Quartic	3	-7	1	6	1	-7	3			154
	Quintic	-1	4	-5	0	5	-4	1			84
	Sextic	1	-6	15	-20	15	-6	1			924
8	Linear	-7	-5	-3	-1	1	3	5	7		168
	Quadratic	7	1	-3	-5	-5	-3	1	7		168
	Cubic	-7	5	7	3	-3	-7	-5	7		264
	Quartic	7	-13	-3	9	9	-3	-13	7		616
	Quintic	-7	23	-17	-15	15	17	-23	7		2184
	Sextic	1	-5	9	-5	-5	9	-5	1		264
	Septic	-1	7	-21	35	-35	21	-7	1		2343
9	Linear	-4	-3	-2	-1	0	1	2	3	4	60
	Quadratic	28	7	-8	-17	-20	-17	-8	7	28	2772
	Cubic	-14	7	13	9	0	-9	-13	-7	14	990
	Quartic	14	-21	-11	9	18	9	-11	-21	14	2002
	Quintic	-4	11	-4	-9	0	9	4	-11	4	468
	Sextic	4	-17	22	1	-20	1	22	-17	4	1980
	Septic	-1	6	-14	14	0	-14	14	-6	1	858
	Octic	1	-8	28	-56	70	-56	28	-8	1	12870