

Estadística básica con R

Oscar Perpiñán Lamigueiro

<http://oscarperpinan.github.io>

Conjunto de datos: swiss

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

Standardized fertility measure and socio-economic indicators for each of 47 French-speaking provinces of Switzerland at about 1888. 6 variables in percent [0, 100]:

- ▶ **Fertility**: Ig, 'common standardized fertility measure'
- ▶ **Agriculture**: % of males involved in agriculture as occupation
- ▶ **Examination**: % draftees receiving highest mark on army examination
- ▶ **Education**: % education beyond primary school for draftees.
- ▶ **Catholic**: % 'catholic' (as opposed to 'protestant').
- ▶ **Infant.Mortality**: live births who live less than 1 year.

Conjunto de datos: swiss

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
data(swiss)
```

```
summary(swiss)
```

Fertility	Agriculture	Examination	Education
Min. :35.00	Min. : 1.20	Min. : 3.00	Min. : 1.00
1st Qu.:64.70	1st Qu.:35.90	1st Qu.:12.00	1st Qu.: 6.00
Median :70.40	Median :54.10	Median :16.00	Median : 8.00
Mean :70.14	Mean :50.66	Mean :16.49	Mean :10.98
3rd Qu.:78.45	3rd Qu.:67.65	3rd Qu.:22.00	3rd Qu.:12.00
Max. :92.50	Max. :89.70	Max. :37.00	Max. :53.00

Catholic	Infant.Mortality
Min. : 2.150	Min. :10.80
1st Qu.: 5.195	1st Qu.:18.15
Median :15.140	Median :20.00
Mean : 41.144	Mean :19.94
3rd Qu.:93.125	3rd Qu.:21.70
Max. :100.000	Max. :26.60

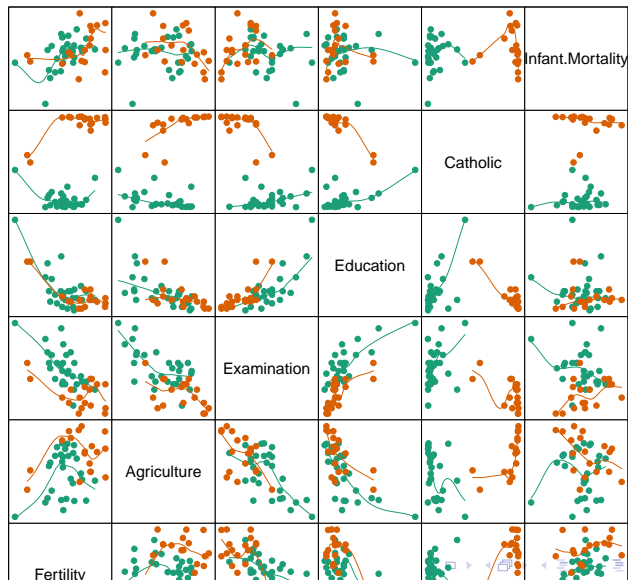
Conjunto de datos

Estadística
Univariante

Regresión lineal

```
library(lattice)
splom(swiss, pscale=0, type=c('p', 'smooth'),
      groups=swiss$Catholic > 50, xlab='')

```



Resumir información

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
summary(swiss)
```

Fertility	Agriculture	Examination	Education
Min. :35.00	Min. : 1.20	Min. : 3.00	Min. : 1.00
1st Qu.:64.70	1st Qu.:35.90	1st Qu.:12.00	1st Qu.: 6.00
Median :70.40	Median :54.10	Median :16.00	Median : 8.00
Mean :70.14	Mean :50.66	Mean :16.49	Mean :10.98
3rd Qu.:78.45	3rd Qu.:67.65	3rd Qu.:22.00	3rd Qu.:12.00
Max. :92.50	Max. :89.70	Max. :37.00	Max. :53.00

Catholic	Infant.Mortality
Min. : 2.150	Min. :10.80
1st Qu.: 5.195	1st Qu.:18.15
Median :15.140	Median :20.00
Mean :41.144	Mean :19.94
3rd Qu.:93.125	3rd Qu.:21.70
Max. :100.000	Max. :26.60

```
mean(swiss$Fertility)
```

```
[1] 70.14255
```

```
colMeans(swiss)
```

Fertility	Agriculture	Examination	Education
70.14255	50.65957	16.48936	10.97872
Catholic	Infant.Mortality		
41.14383	19.94255		

Resumir información

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
sd(swiss$Fertility)
```

```
[1] 12.4917
```

```
sapply(swiss, sd)
```

Fertility	Agriculture	Examination	Education
12.491697	22.711218	7.977883	9.615407
Catholic	Infant.Mortality		
41.704850	2.912697		

Generar datos aleatorios

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
rmnorm(10, mean=1, sd=.4)
```

```
[1] 0.8298012 1.1797862 1.2961353 0.5210375 1.6193431 1.7862777 1.3892613  
[8] 1.1364440 0.7695961 0.5386398
```

```
runif(10, min=-3, max=3)
```

```
[1] 0.2326529 2.1222381 2.5497648 2.3988748 -1.7957398 2.0747642  
[7] -2.9456805 -0.9728395 0.5573549 0.7175066
```

```
rweibull(n=10, shape=3, scale=2)
```

```
[1] 1.0053582 1.8549015 1.4119533 1.5820276 2.0005786 1.6126314 1.9596489  
[8] 2.2541642 1.5065545 0.8168459
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

Generar datos aleatorios

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
x <- seq(1, 100, length=10)
x
```

```
[1] 1 12 23 34 45 56 67 78 89 100
```

```
sample(x)
```

```
[1] 23 34 56 67 78 89 1 100 45 12
```

```
sample(x, 5)
```

```
[1] 34 67 89 23 100
```

```
sample(x, 5, replace=TRUE)
```

```
[1] 56 45 100 78 23
```

Conjunto de datos

Estadística
Univariante

Regresión lineal


```
t.test(swiss$Fertility, mu=70)
```

One Sample t-test

```
data:  swiss$Fertility
t = 0.0782, df = 46, p-value = 0.938
alternative hypothesis: true mean is not equal to 70
95 percent confidence interval:
 66.47485 73.81025
sample estimates:
mean of x
 70.14255
```

```
wilcox.test(swiss$Fertility, mu=70)
```

Wilcoxon signed rank test with continuity correction

```
data:  swiss$Fertility
V = 592.5, p-value = 0.767
alternative hypothesis: true location is not equal to 70
```

Mensajes de aviso perdidos

```
In wilcox.test.default(swiss$Fertility, mu = 70) :
cannot compute exact p-value with ties
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
A <- rnorm(1000)
B <- rnorm(1000)
C <- rnorm(1000, sd=3)
```

```
t.test(A, B)
```

Welch Two Sample t-test

```
data: A and B
t = -1.8693, df = 1997.418, p-value = 0.06173
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.171316781  0.004108949
sample estimates:
 mean of x   mean of y
-0.02630855  0.05729536
```

```
wilcox.test(A, B)
```

Wilcoxon rank sum test with continuity correction

```
data: A and B
W = 479580, p-value = 0.1138
alternative hypothesis: true location shift is not equal to 0
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
t.test(A, C)
```

Welch Two Sample t-test

```
data: A and C
t = 1.3394, df = 1218.573, p-value = 0.1807
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.06274911  0.33276906
sample estimates:
 mean of x mean of y
-0.02630855 -0.16131853
```

```
wilcox.test(A, C)
```

Wilcoxon rank sum test with continuity correction

```
data: A and C
W = 519723, p-value = 0.1267
alternative hypothesis: true location shift is not equal to 0
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
Religion <- ifelse(swiss$Catholic > 50,  
                  'Catholic', 'Protestant')
```

```
t.test(Fertility ~ Religion, data=swiss)
```

Welch Two Sample t-test

```
data: Fertility by Religion  
t = 2.7004, df = 26.742, p-value = 0.01186  
alternative hypothesis: true difference in means is not equal to 0  
95 percent confidence interval:  
 2.455904 18.024939  
sample estimates:  
mean in group Catholic mean in group Protestant  
    76.46111             66.22069
```

```
wilcox.test(Fertility ~ Religion, data=swiss)
```

Wilcoxon rank sum test with continuity correction

```
data: Fertility by Religion  
W = 409.5, p-value = 0.0012  
alternative hypothesis: true location shift is not equal to 0
```

Mensajes de aviso perdidos

```
In wilcox.test.default(x = c(83.1, 92.5, 76.1, 83.8, 92.4, 82.4, :  
cannot compute exact p-value with ties
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

Fertilidad y educación

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
lmFertEdu <- lm(Fertility ~ Education, data = swiss)
summary(lmFertEdu)
```

```
Call:
lm(formula = Fertility ~ Education, data = swiss)

Residuals:
    Min       1Q   Median       3Q      Max
-17.036  -6.711  -1.011   9.526  19.689

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  79.6101     2.1041  37.836 < 2e-16 ***
Education    -0.8624     0.1448  -5.954 3.66e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 9.446 on 45 degrees of freedom
Multiple R-squared:  0.4406, Adjusted R-squared:  0.4282
F-statistic: 35.45 on 1 and 45 DF, p-value: 3.659e-07
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

Fertilidad y educación

`coef(lmFertEdu)`

```
(Intercept)  Education
79.6100585   -0.8623503
```

`residuals(lmFertEdu)`

Courtellary	Delemont	Franches-Mnt	Moutier	Neuveville	Porrentruy
10.9381450	11.2510941	17.2016929	12.2263935	10.2251959	2.5263935
Broye	Glane	Gruyere	Sarine	Veveyse	Aigle
10.2263935	19.6887438	8.8263935	14.5004953	12.6640432	-5.1618550
Aubonne	Avenches	Cossonay	Echallens	Grandson	Lausanne
-6.6736065	-0.3618550	-13.5983071	-9.5853579	-1.0112562	0.2357497
La Vallee	Lavaux	Morges	Moudon	Nyone	Orbe
-8.0630527	-6.7489059	-5.4865556	-12.0230077	-12.6618550	-17.0359568
Oron	Payerne	Paysd'enhaut	Rolle	Vevey	Yverdon
-6.2477082	1.4887438	-5.0230077	-10.4865556	-4.9254030	-7.3112562
Conthey	Entremont	Herens	Martigny	Monthey	St Maurice
-2.3853579	-5.1359568	-0.5853579	-3.9359568	2.3769923	-6.8489059
Sierre	Sion	Boudry	La Chaux-de-Fond	Le Locle	Neuchatel
15.1769923	10.9004953	1.1381450	-4.4242053	4.3004953	12.3851508
Val de Ruz	Val-de-Travers	V. De Geneve	Rive Droite	Rive Gauche	
4.0263935	-5.9736065	1.0945070	-9.9019000	-11.8019000	

`fitted.values(lmFertEdu)`

Courtellary	Delemont	Franches-Mnt	Moutier	Neuveville	Porrentruy
69.26186	71.84891	75.29831	73.57361	66.67480	73.57361
Broye	Glane	Gruyere	Sarine	Veveyse	Aigle
73.57361	72.71126	73.57361	68.39950	74.43596	69.26186
Aubonne	Avenches	Cossonay	Echallens	Grandson	Lausanne
73.57361	69.26186	75.29831	77.88536	72.71126	55.46425
La Vallee	Lavaux	Morges	Moudon	Nyone	Orbe

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

Fertilidad, educación y religión

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
lmFertEduCat <- lm(Fertility ~ Education + Catholic  
,  
                   data = swiss)  
summary(lmFertEduCat)
```

```
Call:  
lm(formula = Fertility ~ Education + Catholic, data = swiss)
```

Residuals:

Min	1Q	Median	3Q	Max
-15.042	-6.578	-1.431	6.122	14.322

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	74.23369	2.35197	31.562	< 2e-16 ***
Education	-0.78833	0.12929	-6.097	2.43e-07 ***
Catholic	0.11092	0.02981	3.721	0.00056 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 8.331 on 44 degrees of freedom
Multiple R-squared: 0.5745, Adjusted R-squared: 0.5552
F-statistic: 29.7 on 2 and 44 DF, p-value: 6.849e-09

Conjunto de datos

Estadística
Univariante

Regresión lineal

Lo mismo con update

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
lmFertEduCat <- update(lmFertEdu, . ~ . + Catholic,  
                        data = swiss)  
summary(lmFertEduCat)
```

```
Call:  
lm(formula = Fertility ~ Education + Catholic, data = swiss)
```

Residuals:

Min	1Q	Median	3Q	Max
-15.042	-6.578	-1.431	6.122	14.322

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	74.23369	2.35197	31.562	< 2e-16 ***
Education	-0.78833	0.12929	-6.097	2.43e-07 ***
Catholic	0.11092	0.02981	3.721	0.00056 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 8.331 on 44 degrees of freedom
Multiple R-squared: 0.5745, Adjusted R-squared: 0.5552
F-statistic: 29.7 on 2 and 44 DF, p-value: 6.849e-09

Conjunto de datos

Estadística
Univariante

Regresión lineal

Fertilidad, educación, religión y agricultura

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
lmFertEduCatAgr <- lm(Fertility ~ Education +  
  Catholic + Agriculture,  
                      data = swiss)  
summary(lmFertEduCatAgr)
```

Call:

```
lm(formula = Fertility ~ Education + Catholic + Agriculture,  
    data = swiss)
```

Residuals:

Min	1Q	Median	3Q	Max
-15.178	-6.548	1.379	5.822	14.840

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	86.22502	4.73472	18.211	< 2e-16 ***
Education	-1.07215	0.15580	-6.881	1.91e-08 ***
Catholic	0.14520	0.03015	4.817	1.84e-05 ***
Agriculture	-0.20304	0.07115	-2.854	0.00662 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.728 on 43 degrees of freedom

Multiple R-squared: 0.6423, Adjusted R-squared: 0.6173

F-statistic: 25.73 on 3 and 43 DF, p-value: 1.089e-09

Lo mismo con update

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
lmFertEduCatAgr <- update(lmFertEduCat, . ~ . +  
  Agriculture,  
                           data = swiss)  
summary(lmFertEduCatAgr)
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
Call:  
lm(formula = Fertility ~ Education + Catholic + Agriculture,  
    data = swiss)
```

Residuals:

Min	1Q	Median	3Q	Max
-15.178	-6.548	1.379	5.822	14.840

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	86.22502	4.73472	18.211	< 2e-16 ***
Education	-1.07215	0.15580	-6.881	1.91e-08 ***
Catholic	0.14520	0.03015	4.817	1.84e-05 ***
Agriculture	-0.20304	0.07115	-2.854	0.00662 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.728 on 43 degrees of freedom
Multiple R-squared: 0.6423, Adjusted R-squared: 0.6173
F-statistic: 25.73 on 3 and 43 DF, p-value: 1.089e-09

Lo mismo con update

```
lmFertEduCatAgr <- update(lmFertEdu, . ~ . +  
  Catholic + Agriculture,  
                           data = swiss)  
summary(lmFertEduCatAgr)
```

```
Call:  
lm(formula = Fertility ~ Education + Catholic + Agriculture,  
    data = swiss)
```

Residuals:

Min	1Q	Median	3Q	Max
-15.178	-6.548	1.379	5.822	14.840

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	86.22502	4.73472	18.211	< 2e-16 ***
Education	-1.07215	0.15580	-6.881	1.91e-08 ***
Catholic	0.14520	0.03015	4.817	1.84e-05 ***
Agriculture	-0.20304	0.07115	-2.854	0.00662 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.728 on 43 degrees of freedom
Multiple R-squared: 0.6423, Adjusted R-squared: 0.6173
F-statistic: 25.73 on 3 and 43 DF, p-value: 1.089e-09

```
anova(lmFertEdu, lmFertEduCat, lmFertEduCatAgr)
```

Analysis of Variance Table

```
Model 1: Fertility ~ Education
Model 2: Fertility ~ Education + Catholic
Model 3: Fertility ~ Education + Catholic + Agriculture
  Res.Df  RSS Df Sum of Sq    F    Pr(>F)
1      45 4015.2
2      44 3054.2  1    961.07 16.093 0.0002365 ***
3      43 2567.9  1    486.28  8.143 0.0066235 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Fertilidad contra todo

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
lmFert <- lm(Fertility ~ ., data=swiss)  
  
summary(lmFert)
```

```
Call:  
lm(formula = Fertility ~ ., data = swiss)  
  
Residuals:  
    Min       1Q   Median       3Q      Max   
-15.2743  -5.2617   0.5032   4.1198  15.3213  
  
Coefficients:  
            Estimate Std. Error t value Pr(>|t|)      
(Intercept)  66.91518   10.70604   6.250 1.91e-07 ***  
Agriculture  -0.17211    0.07030  -2.448 0.01873 *    
Examination  -0.25801    0.25388  -1.016 0.31546        
Education    -0.87094    0.18303  -4.758 2.43e-05 ***  
Catholic      0.10412    0.03526   2.953 0.00519 **     
Infant.Mortality 1.07705    0.38172   2.822 0.00734 **     
---  
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
  
Residual standard error: 7.165 on 41 degrees of freedom  
Multiple R-squared:  0.7067, Adjusted R-squared:  0.671  
F-statistic: 19.76 on 5 and 41 DF,  p-value: 5.594e-10
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

Elegir un modelo

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
anova(lmFert)
```

```
Analysis of Variance Table
```

```
Response: Fertility
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Agriculture	1	894.84	894.84	17.4288	0.0001515	***
Examination	1	2210.38	2210.38	43.0516	6.885e-08	***
Education	1	891.81	891.81	17.3699	0.0001549	***
Catholic	1	667.13	667.13	12.9937	0.0008387	***
Infant.Mortality	1	408.75	408.75	7.9612	0.0073357	**
Residuals	41	2105.04	51.34			

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Elegir un modelo

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
stepFert <- step(lmFert)
```

Start: AIC=190.69

```
Fertility ~ Agriculture + Examination + Education + Catholic +  
          Infant.Mortality
```

	Df	Sum of Sq	RSS	AIC
- Examination	1	53.03	2158.1	189.86
<none>			2105.0	190.69
- Agriculture	1	307.72	2412.8	195.10
- Infant.Mortality	1	408.75	2513.8	197.03
- Catholic	1	447.71	2552.8	197.75
- Education	1	1162.56	3267.6	209.36

Step: AIC=189.86

```
Fertility ~ Agriculture + Education + Catholic + Infant.Mortality
```

	Df	Sum of Sq	RSS	AIC
<none>			2158.1	189.86
- Agriculture	1	264.18	2422.2	193.29
- Infant.Mortality	1	409.81	2567.9	196.03
- Catholic	1	956.57	3114.6	205.10
- Education	1	2249.97	4408.0	221.43

Conjunto de datos

Estadística
Univariante

Regresión lineal

Elegir un modelo

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

```
summary(stepFert)
```

```
Call:
lm(formula = Fertility ~ Agriculture + Education + Catholic +
    Infant.Mortality, data = swiss)

Residuals:
    Min       1Q   Median       3Q      Max
-14.6765  -6.0522   0.7514   3.1664  16.1422

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  62.10131    9.60489   6.466 8.49e-08 ***
Agriculture  -0.15462    0.06819  -2.267  0.02857 *
Education    -0.98026    0.14814  -6.617 5.14e-08 ***
Catholic      0.12467    0.02889   4.315 9.50e-05 ***
Infant.Mortality 1.07844    0.38187   2.824  0.00722 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.168 on 42 degrees of freedom
Multiple R-squared:  0.6993, Adjusted R-squared:  0.6707
F-statistic: 24.42 on 4 and 42 DF,  p-value: 1.717e-10
```

Conjunto de datos

Estadística
Univariante

Regresión lineal

Elegir un modelo

Estadística básica
con R

Oscar Perpiñán
Lamigueiro
[http://
oscarperpinan.
github.io](http://oscarperpinan.github.io)

Conjunto de datos

Estadística
Univariante

Regresión lineal

```
stepFert$anova
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1		NA	NA	41	2105.043	190.6913
2 - Examination	1	53.02656		42	2158.069	189.8606