

# Extensiones del modelo lineal: regresión local

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## 1 Algoritmo

- Para  $x_i$ ,  $i = 1, \dots, n$ :
  - Se eligen un total de  $k = s * n$  puntos alrededor de  $x_i$ .
  - Se ajusta un modelo de regresión lineal en  $x_i$  utilizando los  $k$  puntos.
  - Los modelos más utilizados son la recta y el polinomio de segundo orden.
  - El valor predicho en cada punto es  $x_i \Rightarrow \hat{f}(x_i) = X\hat{\beta}$ .
- El parámetro  $s$  controla la suavidad de la curva ( $s \in [0, 1]$ ).
- Se pueden estimar otras funciones polinómicas distintas a la recta.

## 2 Estimacion del modelo

Vamos a utilizar el paquete *loess*. En este paquete: - el parámetro  $s$  se llama *span*. - el grado del polinomio local se indica con *degree*.

```
d = read.csv("datos/Wage.csv")
d = d[d$wage<250,]
d = d[d$wage<250,]
```

```
m1 = loess(wage ~ age, data = d, span = 0.2, degree = 2)
m2 = loess(wage ~ age, data = d, span = 0.5, degree = 2)
summary(m1)
```

```
## Call:
## loess(formula = wage ~ age, data = d, span = 0.2, degree = 2)
##
## Number of Observations: 2921
## Equivalent Number of Parameters: 16.27
## Residual Standard Error: 30.18
## Trace of smoother matrix: 17.99 (exact)
##
## Control settings:
##   span      : 0.2
##   degree    : 2
##   family    : gaussian
```

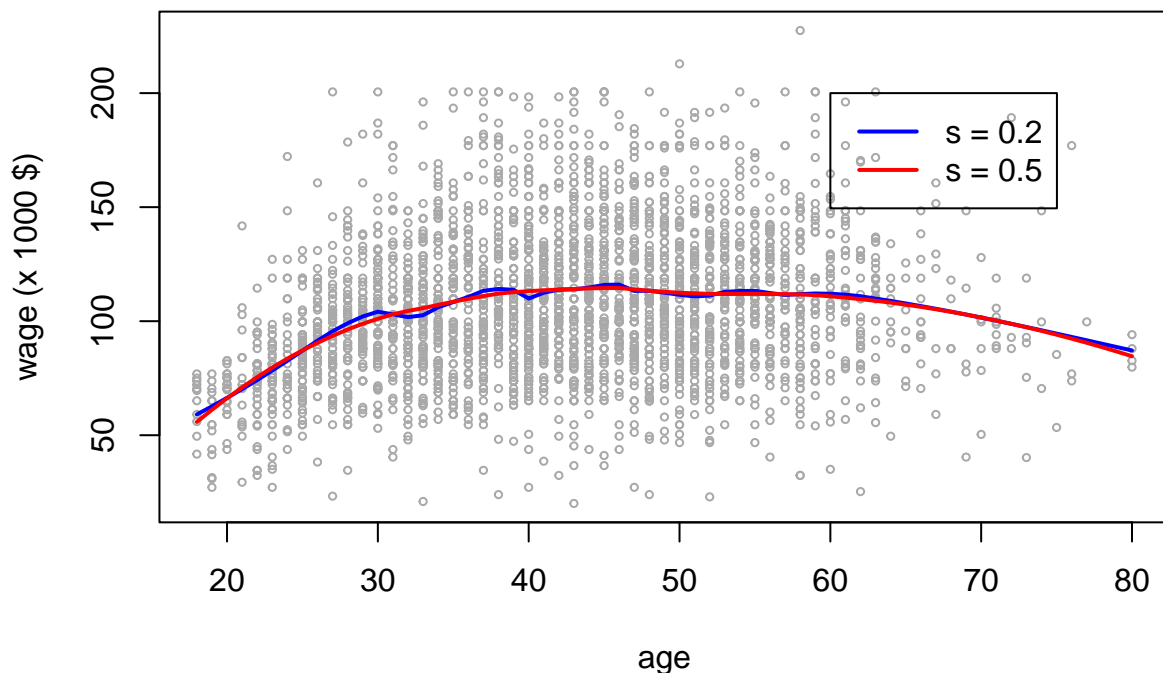
```
## surface : interpolate      cell = 0.2
## normalize: TRUE
## parametric: FALSE
## drop.square: FALSE
```

### 3 Prediccion

#### 3.1 Predicción puntual

```
age_grid = seq(from = min(d$age), to = max(d$age), by = 1)
# con loess hay que utilizar se = T, ya que interval = "" no funciona
yp1 = predict(m1, newdata = data.frame(age = age_grid), se = T)
yp2 = predict(m2, newdata = data.frame(age = age_grid), se = T)

plot(d$age, d$wage, cex = 0.5, col = "darkgrey", ylab = "wage (x 1000 $)", xlab = "age")
#
lines(age_grid, yp1$fit, col = "blue", lwd = 2)
lines(age_grid, yp2$fit, col = "red", lwd = 2)
#
legend(60, 200, legend = c("s = 0.2", "s = 0.5"), col = c("blue", "red"), lty = 1, lwd = 2)
```



#### 3.2 Intervalo de confianza

Recordemos que:

$$\hat{y}_p - t_{\alpha/2} se(\hat{y}_p) \leq E[y_p] \leq \hat{y}_p + t_{\alpha/2} se(\hat{y}_p)$$

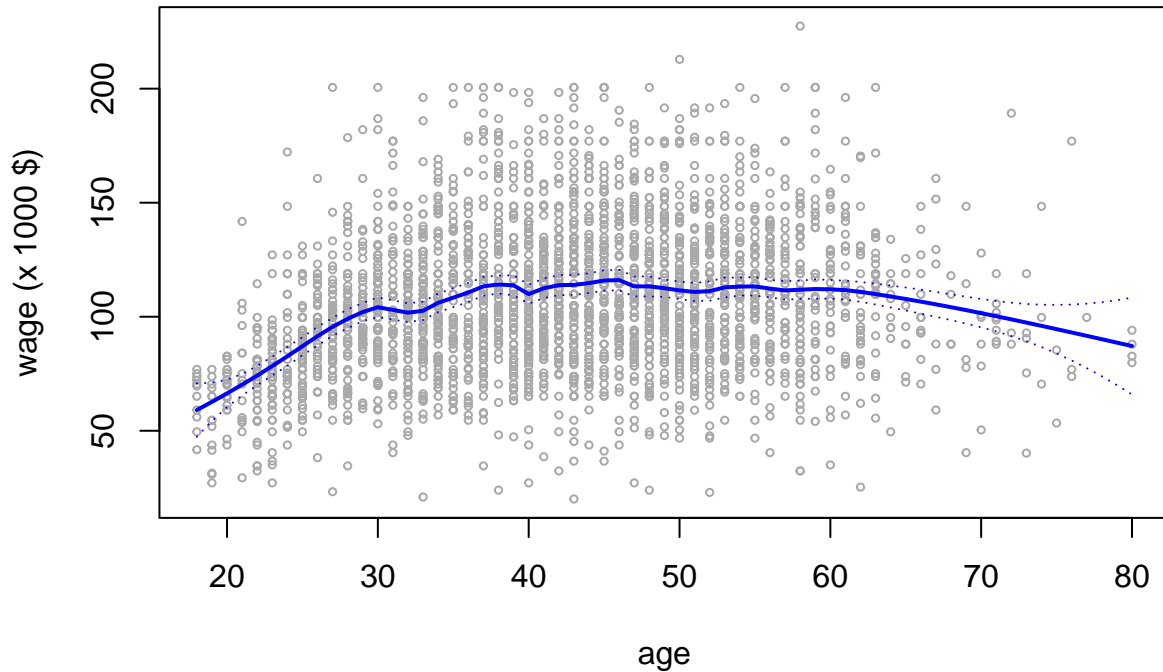
Como la t-student converge a la  $N(0,1)$  cuando  $n$  es grande (para  $n > 30$  la aproximación es aceptable), podemos utilizar:

$$\hat{y}_p - z_{\alpha/2} se(\hat{y}_p) \leq E[y_p] \leq \hat{y}_p + z_{\alpha/2} se(\hat{y}_p)$$

donde  $z_{\alpha/2}$  es el valor de la  $N(0,1)$  que cumple que  $P(z \leq z_{\alpha/2} | z \sim N(0,1)) = 0.1$ . Por tanto:

```
alfa = 0.05
yp11 = yp1$fit + qnorm(alfa/2)*yp1$se.fit # utilizamos la normal en lugar de la t-student
yp12 = yp1$fit + qnorm(1-alfa/2)*yp1$se.fit

plot(d$age,d$wage, cex = 0.5, col = "darkgrey", ylab = "wage (x 1000 $)", xlab = "age")
#
lines(age_grid, yp1$fit, col = "blue", lwd = 2)
lines(age_grid, yp11, col = "blue", lty = 3)
lines(age_grid, yp12, col = "blue", lty = 3)
```



### 3.3 Intervalo de predicción

En regresión lineal se tenía que:

$$\hat{y}_p - t_{\alpha/2} \hat{s}_R \sqrt{1 + v_p} \leq y_p \leq \hat{y}_p + t_{\alpha/2} \hat{s}_R \sqrt{1 + v_p}$$

y además  $se(\hat{y}_p) = \hat{s}_R \sqrt{v_p}$ . Por tanto, el intervalo de predicción se puede calcular usando:

$$\hat{y}_p - t_{\alpha/2} \sqrt{\hat{s}_R^2 + se(\hat{y}_p)^2} \leq y_p \leq \hat{y}_p + t_{\alpha/2} \sqrt{\hat{s}_R^2 + se(\hat{y}_p)^2}$$

```
sR = m1$s
alfa = 0.05
yp13 = yp1$fit + qnorm(alfa/2)*sqrt(sR^2 + yp1$se.fit^2)
yp14 = yp1$fit + qnorm(1-alfa/2)*sqrt(sR^2 + yp1$se.fit^2)

plot(d$age,d$wage, cex = 0.5, col = "darkgrey", ylab = "wage (x 1000 $)", xlab = "age")
#
lines(age_grid, yp1$fit, col = "blue", lwd = 2)
lines(age_grid, yp11, col = "blue", lty = 3)
lines(age_grid, yp12, col = "blue", lty = 3)
```

```
#  
lines(age_grid, yp13, col = "red", lty = 3)  
lines(age_grid, yp14, col = "red", lty = 3)
```

