Nonparametric curves are useful when the type of functional relationship between two variables is not clear (usually not linear). These curves can be the result of a smoothing algorithm or the use of many linear regression functions applied to overlapping intervals on the range of the predictor. To improve the fitting the regression functions may be polynomials and sometimes weightede least squares are also applied to observations with large residual values.
In this example use the `jaws.csv` to fit the following nonparametric curves.

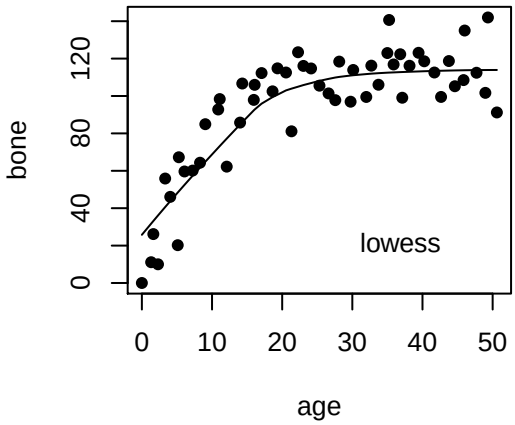
a) Fit a lowess smoothing curve to the data

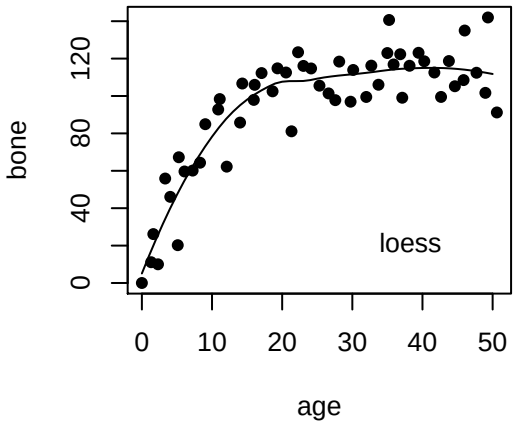
b) Fit a loess regression to the data and plot the smoothing curve

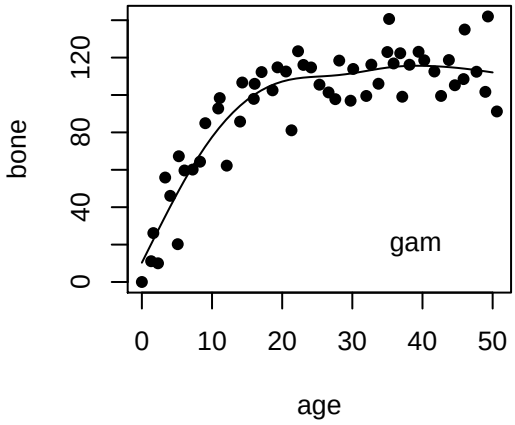
c) Use library `mgcv` to fit a `gam` regression model to the data and plot the smoothing curve

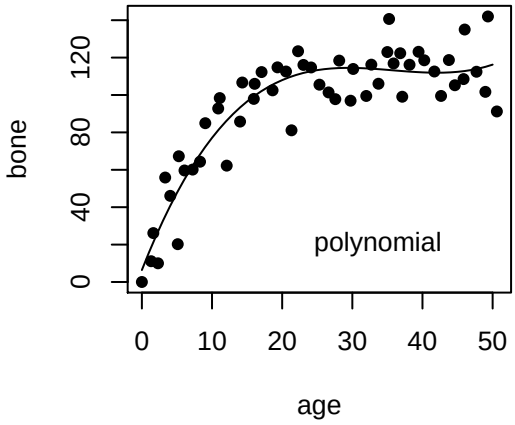
d) Fit a polynomial regression model to the data and plot the smoothing curve

```
d0=read.table("jaws.txt",header=T)
head(d0)
#        age      bone
#1  0.000000   0.00000
#2  5.112000  20.22000
#3  1.320000  11.11130
#4 35.240000 140.65000
#5  1.632931  26.15218
#6  2.297635  10.00100

par(mfrow=c(2,2))
plot(bone~age,d0,pch=16)

# lowess
d1=lowess(age,bone)     # d1, a list of (x,y) of smoothed lowess curve
d1=data.frame(d1)
lines(y~x,d1,col="red")
text(45,20,"lowess",pos=2)

# loess
m2=loess(bone~age)               # m2 is a loess reg model
xv = 0:50
newval = data.frame(age=xv)
yv=predict(m2,newval)

plot(bone~age,d0,pch=16)
text(45,20,"loess",pos=2)
lines(xv,yv,col="red")

# gam James p294
library(mgcv)
m3=gam(bone~s(age))              # m3 is a gam model
yv=predict(m3,newval)

plot(bone~age,d0,pch=16)
text(45,20,"gam",pos=2)
lines(xv,yv,col="red")

# polynomial
m4=lm(bone~age+I(age^2)+I(age^3))
yv=predict(m4,newval)

plot(bone~age,d0,pch=16)
text(45,20,"polynomial",pos=2)
lines(xv,yv,col="red")
```


bone
0
40
80
120
0
10
20
30
40
50
age
lowess


bone
0
40
80
120
0
10
20
30
40
50
age
loess


bone
0
40
80
120
0
10
20
30
40
50
age
gam


bone
0
40
80
120
0
10
20
30
40
50
age
polynomial