library(splines)

library(rstan)

library(loo)

data("Boston", package = "MASS")

Y=Boston$medv

X=Boston$lstat

p=ggplot(Boston,aes(X, Y) ) + geom\_point() + stat\_smooth()

p+ labs(x = "Lower Status", y = "House Value",title="Figure 12.1")

num\_knots = 10

knots = unname(quantile(X,probs=seq(from=0, to=1, length.out = num\_knots)))

B <- t(bs(X, knots=knots, degree=3, intercept = TRUE))

D=list(num\_data=506,Y=Y,X=X, num\_basis=nrow(B),B=B)

model = "

data {

int num\_data;

int num\_basis;

vector[num\_data] Y;

vector[num\_data] X;

matrix[num\_basis, num\_data] B;

}

parameters {

row\_vector[num\_basis] b\_raw;

real a0;

real<lower=0> sigma;

real<lower=0> tau;

}

transformed parameters {

row\_vector[num\_basis] b;

vector[num\_data] Y\_hat;

b[1] = b\_raw[1];

for (i in 2:num\_basis)

b[i] = b[i-1] + b\_raw[i]\*tau;

Y\_hat = a0\*to\_vector(X) + to\_vector(b\*B);

}

model {

b\_raw ~ normal(0, 5);

tau ~ cauchy(0, 5);

sigma ~ cauchy(0, 5);

Y ~ normal(Y\_hat, sigma);

}

generated quantities { vector[num\_data] log\_lik;

for (i in 1:num\_data) {log\_lik[i]=normal\_lpdf(Y[i]|Y\_hat[i],sigma);}}

"

fit = stan(model\_code=model, data= D, iter=2000, chains=2, seed="1234")

S=summary(fit, pars = c("Y\_hat"), probs = c(0.025,0.975))$summary

loo(as.matrix(fit,pars="log\_lik"))

F=as.vector(S[,1])

plot(X,F,xlab="Lower Status",ylab="Median House Value", main="Figure 12.2, Smooth for K=10 Knots")