Predicting with regression

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Key ideas

- Fit a simple regression model
- Plug in new covariates and multiply by the coefficients
- Useful when the linear model is (nearly) correct

Pros:

- Easy to implement
- Easy to interpret

Cons:

- Often poor performance in nonlinear settings

Example: Old faithful eruptions

Image Credit/Copyright Wally Pacholka http://www.astropics.com/

Example: Old faithful eruptions

```r
library(caret);data(faithful); set.seed(333)
inTrain <- createDataPartition(y=faithful$waiting,
                               p=0.5, list=FALSE)
trainFaith <- faithful[inTrain,]; testFaith <- faithful[-inTrain,]
head(trainFaith)
```

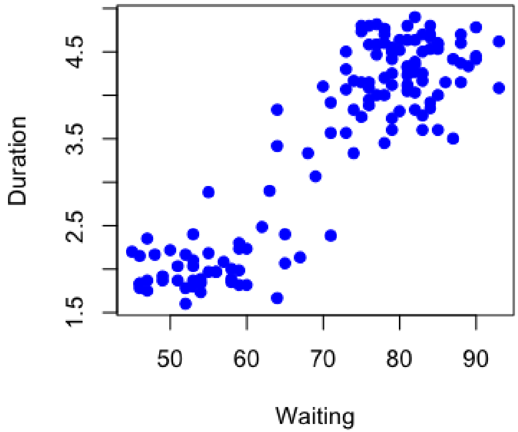
```
   eruptions waiting
6      2.883      55
11     1.833      54
16     2.167      52
19     1.600      52
22     1.750      47
27     1.967      55
```

Only 2 variables:

eruption duration and
waiting time between eruptions

Eruption duration versus waiting time

```
plot(trainFaith$waiting,trainFaith$eruptions,pch=19,col="blue",xlab="Waiting",ylab="Duration")
```



Fit a linear model

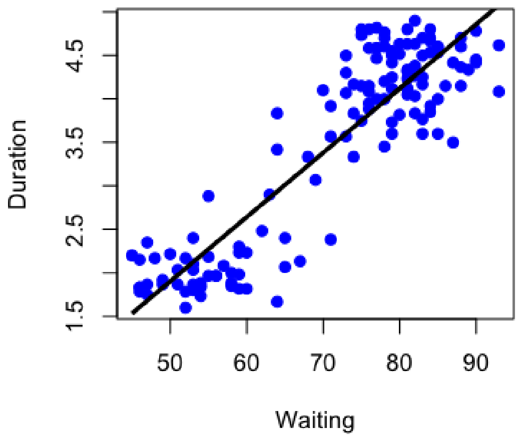
$$ED_i = b_0 + b_1 WT_i + e_i$$

```
lm1 <- lm(eruptions ~ waiting,data=trainFaith)
summary(lm1)
```

```

Call:
lm(formula = eruptions ~ waiting, data = trainFaith)

Residuals:
    Min      1Q  Median      3Q     Max 
-1.2699 -0.3479  0.0398  0.3659  1.0502 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -1.79274    0.22787   -7.87    1e-12 ***     b0
waiting      0.07390    0.00315   23.47   <2e-16 ***     b1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Model fit

```
plot(trainFaith$waiting,trainFaith$eruptions,pch=19,col="blue",xlab="Waiting",ylab="Duration")
lines(trainFaith$waiting,lm1$fitted,lwd=3)
```



Predict a new value

$$\hat{ED} = \hat{b}_0 + \hat{b}_1 WT$$

```
coef(lm1)[1] + coef(lm1)[2]*80
```

```
(Intercept)
      4.119
```

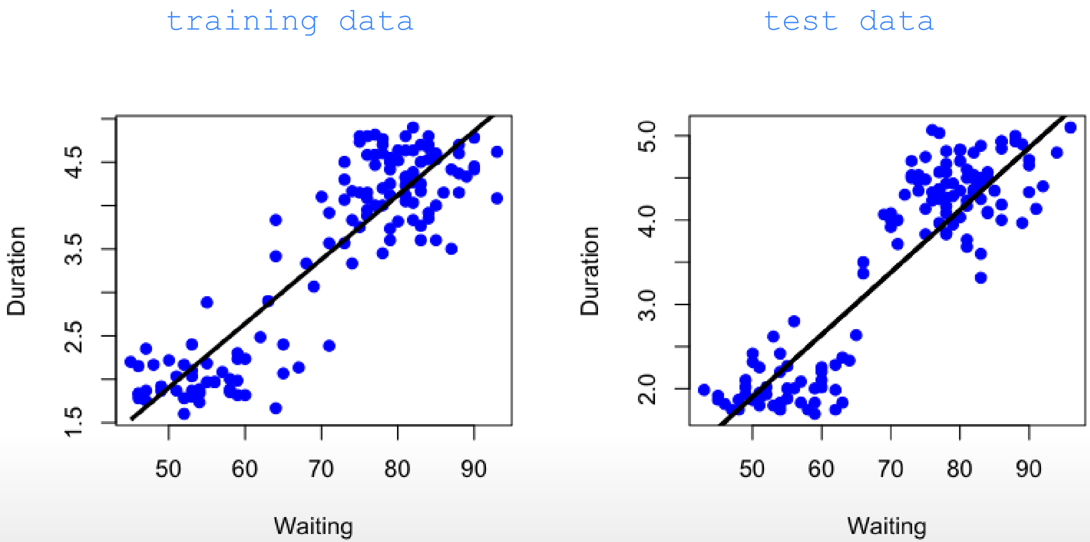
```
newdata <- data.frame(waiting=80)
predict(lm1,newdata)
```

dataframe with just one value (to predict)

```
    1
4.119
```

Plot predictions - training and test

```
par(mfrow=c(1,2))
plot(trainFaith$waiting,trainFaith$eruptions,pch=19,col="blue",xlab="Waiting",ylab="Duration")
lines(trainFaith$waiting,predict(lm1),lwd=3)
plot(testFaith$waiting,testFaith$eruptions,pch=19,col="blue",xlab="Waiting",ylab="Duration")
lines(testFaith$waiting,predict(lm1,newdata=testFaith),lwd=3)
```



Get training set/test set errors

```
# Calculate RMSE on training  root mean square error
sqrt(sum((lm1$fitted-trainFaith$eruptions)^2))
```

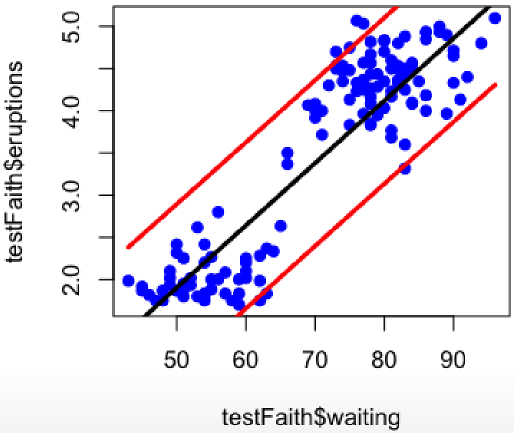
```
[1] 5.752
```

```
# Calculate RMSE on test
sqrt(sum((predict(lm1,newdata=testFaith)-testFaith$eruptions)^2))
```

```
[1] 5.839
```

Prediction intervals

```
pred1 <- predict(lm1,newdata=testFaith,interval="prediction")
ord <- order(testFaith$waiting)
plot(testFaith$waiting,testFaith$eruptions,pch=19,col="blue")
matlines(testFaith$waiting[ord],pred1[ord,],type="l",,col=c(1,2,2),lty = c(1,1,1), lwd=3)
```



Same process with caret

```
modFit <- train(eruptions ~ waiting,data=trainFaith,method="lm")
summary(modFit$finalModel)
```

```

Call:
lm(formula = modFormula, data = data)

Residuals:
    Min      1Q  Median      3Q     Max 
-1.2699 -0.3479  0.0398  0.3659  1.0502 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -1.79274    0.22787   -7.87    1e-12 ***
waiting      0.07390    0.00315   23.47   <2e-16 ***
---
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Residual standard error: 0.495 on 135 degrees of freedom
Multiple R-squared:  0.803, Adjusted R-squared:  0.802 
```

Notes and further reading

- Regression models with multiple covariates can be included
- Often useful in combination with other models
- Elements of statistical learning
- Modern applied statistics with S
- Introduction to statistical learning