



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/>

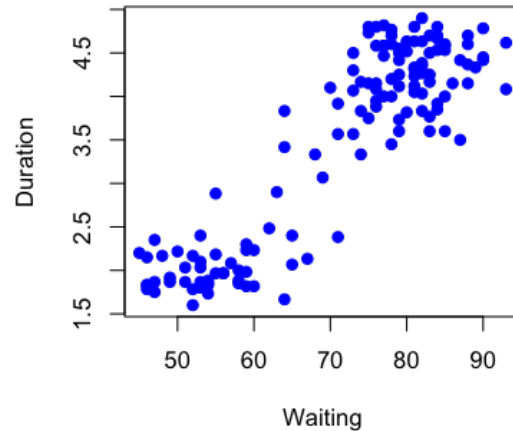
Example: Old faithful eruptions

```
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

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

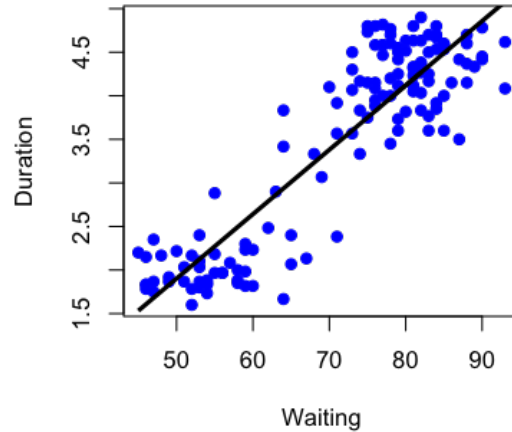
Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-1.79274	0.22787	-7.87	1e-12 ***
waiting	0.07390	0.00315	23.47	<2e-16 ***

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
```

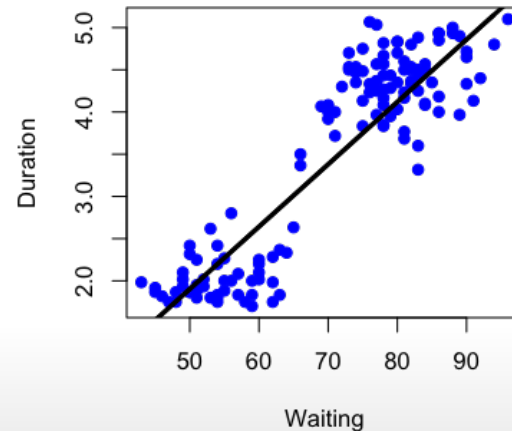
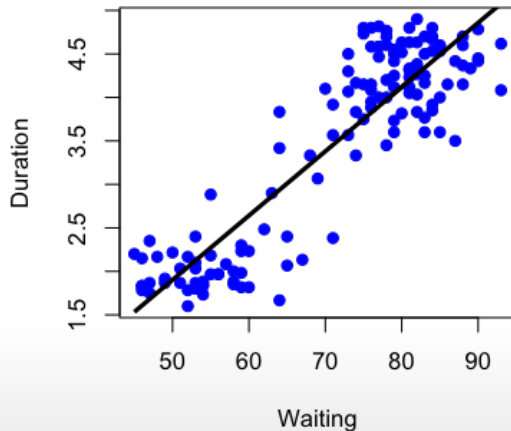
```
(Intercept)  
4.119
```

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

```
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  
sqrt(sum((lm1$fitted-trainFaith$eruptions)^2))
```

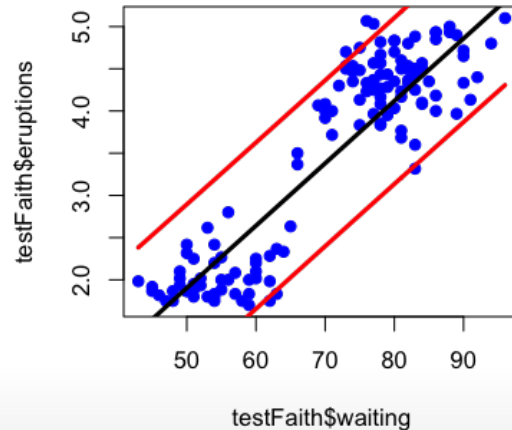
```
[1] 5.752
```

```
# 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)
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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](#)