COMP47460 Tutorial

Regression and Gradient Descent

Q1.

In 1929 Edwin Hubble published a paper which revolutionised astronomy. It is the basis of Hubble's law which was the first observational evidence for the expansion of the universe. Hubble was able to measure the recession velocity (km/sec) (how fast it is moving away from us) and the distance from the earth in megaparsecs of various galaxies (1 megaparsec is about $3x10^{22}$ metres, a long way!)

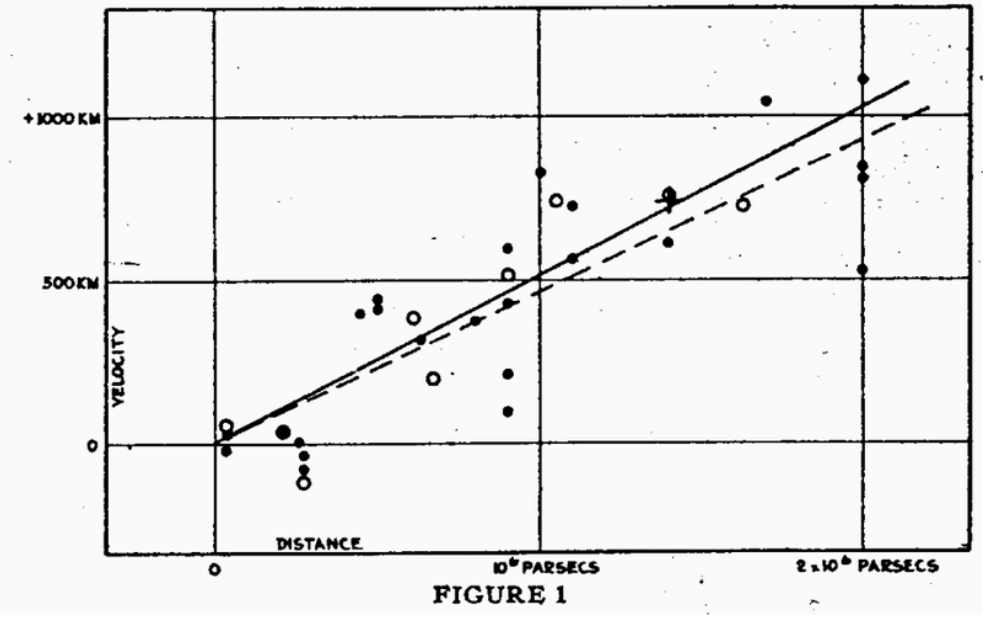


FIGURE 1

a) Just looking at the graph from Hubble's original paper, would you have confidence in his conclusion that there is a linear relationship between the speed of galaxy and its distance from earth?
b) Using OLS find the best fit linear model of the data (β_0, β_1). (do this by hand)
c) Compute the correlation coefficient. (by hand)
d) Using a two-tailed t-test, determine if the relationship between distance and velocity is significant for a p-value of 0.05.
e) The Andromeda Galaxy is the closest spiral galaxy to us at 0.613 megaparsecs. What is it's recession velocity?
f) The slope β_1 is known as the Hubble constant H_0. The latest measurements of the Hubble Space Telescope determine it to be

73.00±1.75 (km/s/megaparsec). How close was Hubble with his original data?

g) Using Weka, run the LinearRegression model and confirm your results.

hubble_constant.csv

```
cov_xy: 189.231820652
sd(x), sd(y): 0.645495752352 371.254666198
<x>, <y>: 0.911375 373.125
beta_1 454.158440923
beta_0 -40.7836490959
corr(x,y) 0.789639487935
r_sq 0.623530520907
```

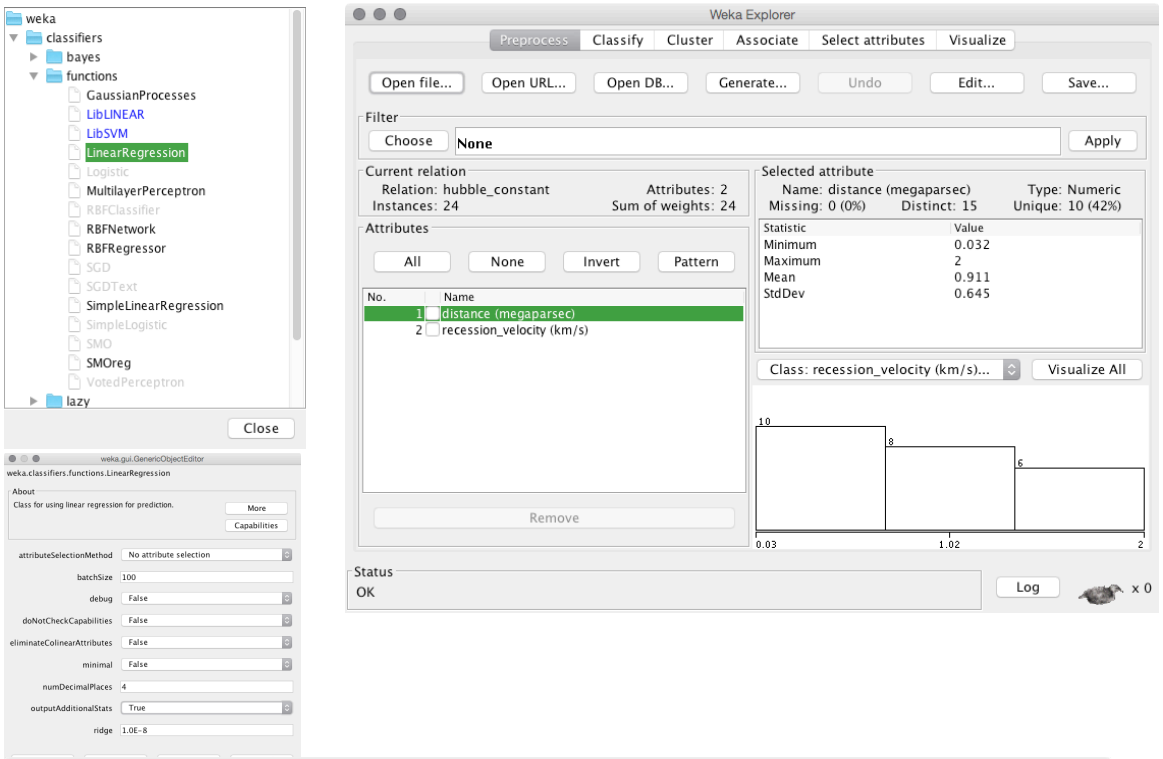
OLS Regression Results

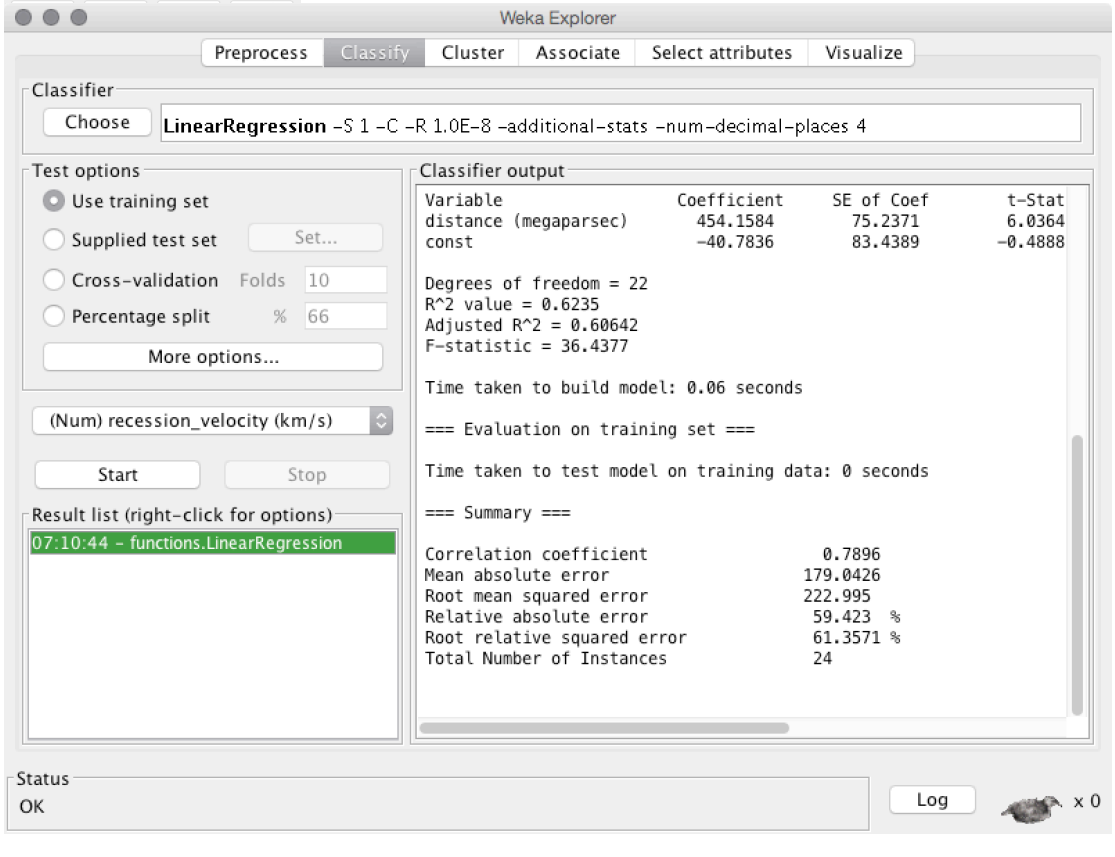
Dep. Variable:	recession_velocity (km/s)	**R-squared:**	0.624
Model:	OLS	**Adj. R-squared:**	0.606
Method:	Least Squares	**F-statistic:**	36.44
Date:	Thu, 02 Nov 2017	**Prob (F-statistic):**	4.48E-06
Time:	07:20:36	**Log-Likelihood:**	-163.83
No. Observations:	24	**AIC:**	331.7
Df Residuals:	22	**BIC:**	334.0
Df Model:	1		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
const	-40.7836	83.439	-0.489	0.630	-213.825	132.258
distance (megaparsec)	454.1584	75.237	6.036	0.000	298.126	610.191

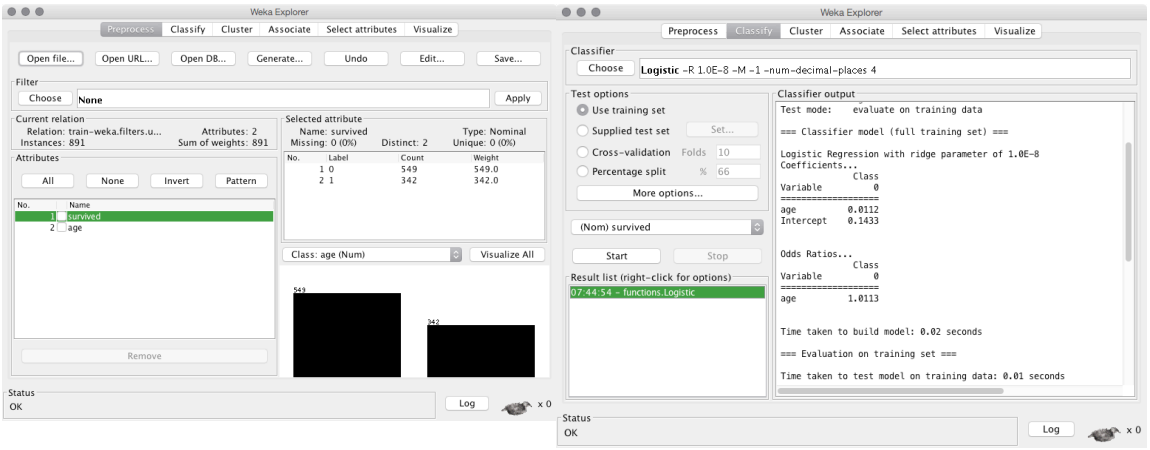
Omnibus:	0.126	**Durbin-Watson:**	2.089
Prob(Omnibus):	0.939	**Jarque-Bera (JB):**	0.293
Skew:	0.138	**Prob(JB):**	0.864
Kurtosis:	2.535	**Cond. No.**	3.22

Linear Regression with Weka:

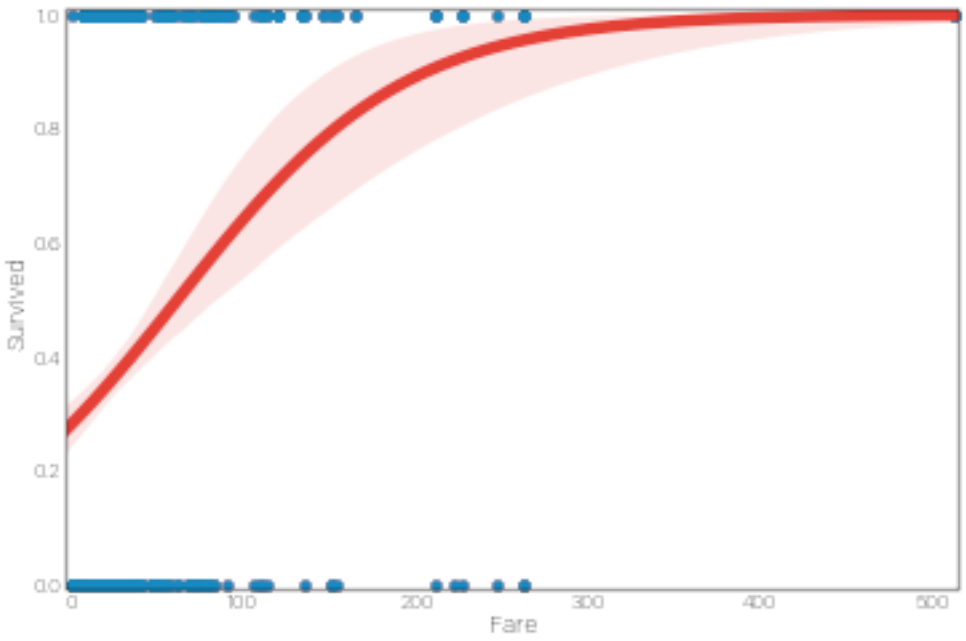


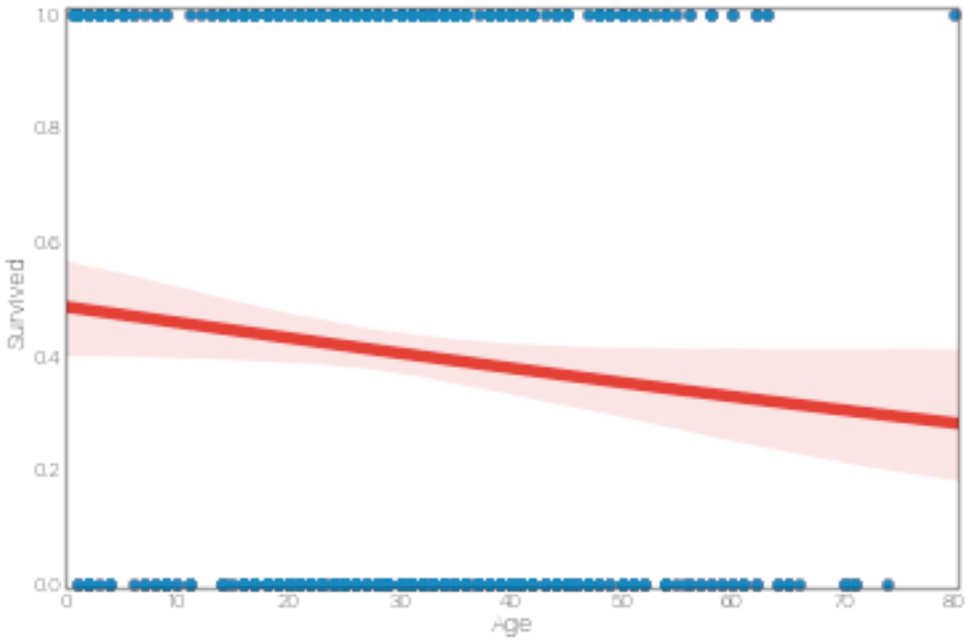


Q2: Titanic:
This is a Weka exercise to build and interpret a logistic regression model:



There doesn't appear to be a strong relationship between survived and age, or fare.





There is not a strong relationship either between Age and Survival.

The odds ratio for *Age* is: 1.0175 which implies a positive relationship between age and survived.

The odds ratio for *Fare:* 0.9839 which implies a negative relationship between Fare and Survived.

Q3.

The OLS model is:
recession_velocity (km/s) = 454.1584 distance (megaparsec) -40.7836

After 100000 iterations with alpha=0.01 the model is:
recession_velocity (km/s) = 456.8329 distance (megaparsec) -34.9857

which is quite far from the OLS model, and doesn't seem to improve much with more iterations.

Setting alpha=1e-4 and epochs=1e6 we find:
recession_velocity (km/s) = 454.178 distance (megaparsec) -40.7225

Could implement a table to show the cost function as we increase the number of iterations.