quantile_regression

February 28, 2023

1 Quantile Regression

scikit-learn does not have a quantile regression. mlinsights implements a version of it.

[1]:
```
from jyquickhelper import add_notebook_menu
add_notebook_menu()
```

[1]:
```
<IPython.core.display.HTML object>
```

[2]:
```
%matplotlib inline
```

[3]:
```
import warnings
warnings.simplefilter("ignore")
```

1.1 Simple example

We generate some dummy data.

[4]:
```
import numpy
X = numpy.random.random(1000)
eps1 = (numpy.random.random(900) - 0.5) * 0.1
eps2 = (numpy.random.random(100)) * 10
eps = numpy.hstack([eps1, eps2])
X = X.reshape((1000, 1))
Y = X.ravel() * 3.4 + 5.6 + eps
```

[5]:
```
from sklearn.linear_model import LinearRegression
clr = LinearRegression()
clr.fit(X, Y)
```

[5]:
```
LinearRegression()
```

[6]:
```
from mlinsights.mlmodel import QuantileLinearRegression
clq = QuantileLinearRegression()
clq.fit(X, Y)
```

[6]:
```
QuantileLinearRegression()
```

[7]:
```
from pandas import DataFrame
data= dict(X=X.ravel(), Y=Y, clr=clr.predict(X), clq=clq.predict(X))
df = DataFrame(data)
```

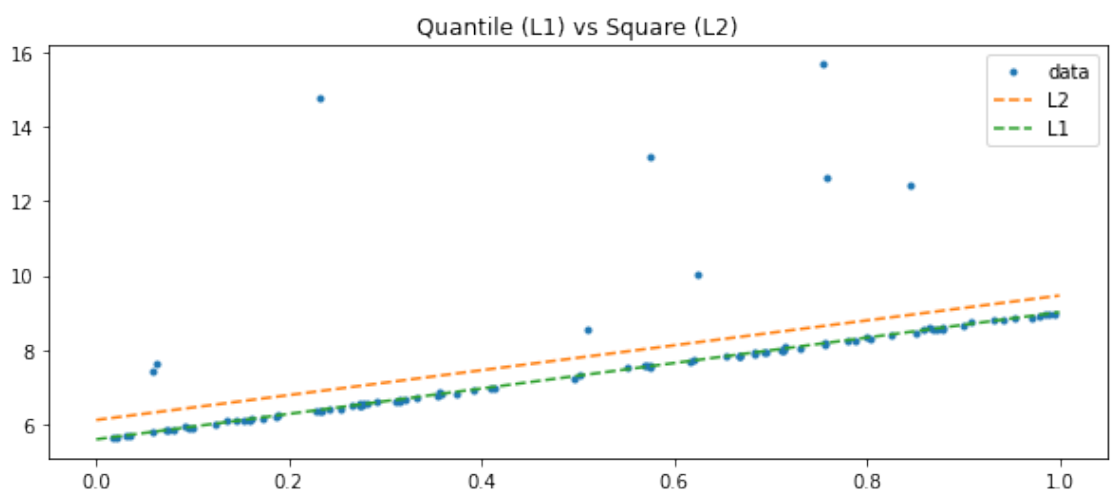
```
df.head()
```

[7]:

	X	Y	clr	clq
0	0.337351	6.768441	7.248171	6.753219
1	0.134276	6.106460	6.570011	6.060008
2	0.441892	7.135170	7.597281	7.110077
3	0.737660	8.110642	8.584988	8.119707
4	0.989550	8.958029	9.426163	8.979550

[8]:

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots(1, 1, figsize=(10, 4))
choice = numpy.random.choice(X.shape[0]-1, size=100)
xx = X.ravel()[choice]
yy = Y[choice]
ax.plot(xx, yy, '.', label="data")
xx = numpy.array([[0], [1]])
y1 = clr.predict(xx)
y2 = clq.predict(xx)
ax.plot(xx, y1, "--", label="L2")
ax.plot(xx, y2, "--", label="L1")
ax.set_title("Quantile (L1) vs Square (L2)");
ax.legend();
```



The L1 is clearly less sensible to extremas. The optimization algorithm is based on Iteratively reweighted least squares. It estimates a linear regression with error L2 then reweights each oberservation with the inverse of the error L1.

[9]:

```
clq = QuantileLinearRegression(verbose=True, max_iter=20)
clq.fit(X, Y)
```

```
[QuantileLinearRegression.fit] iter=1 error=890.6481655281331
[QuantileLinearRegression.fit] iter=2 error=553.443164087279
[QuantileLinearRegression.fit] iter=3 error=518.5974841726787
[QuantileLinearRegression.fit] iter=4 error=517.8860147236843
[QuantileLinearRegression.fit] iter=5 error=517.5129563462485
```

```
[QuantileLinearRegression.fit] iter=6 error=517.2078153294502
[QuantileLinearRegression.fit] iter=7 error=517.0042724262564
[QuantileLinearRegression.fit] iter=8 error=516.8285339347697
[QuantileLinearRegression.fit] iter=9 error=516.6879803415121
[QuantileLinearRegression.fit] iter=10 error=516.5864808002596
[QuantileLinearRegression.fit] iter=11 error=516.5254116312615
[QuantileLinearRegression.fit] iter=12 error=516.4842567183769
[QuantileLinearRegression.fit] iter=13 error=516.4533601589357
[QuantileLinearRegression.fit] iter=14 error=516.4334316544625
[QuantileLinearRegression.fit] iter=15 error=516.4204631587874
[QuantileLinearRegression.fit] iter=16 error=516.4064255197134
[QuantileLinearRegression.fit] iter=17 error=516.3984710347147
[QuantileLinearRegression.fit] iter=18 error=516.391040594802
[QuantileLinearRegression.fit] iter=19 error=516.385223204194
[QuantileLinearRegression.fit] iter=20 error=516.3817712143422
```

[9]:
```
QuantileLinearRegression(max_iter=20, verbose=True)
```

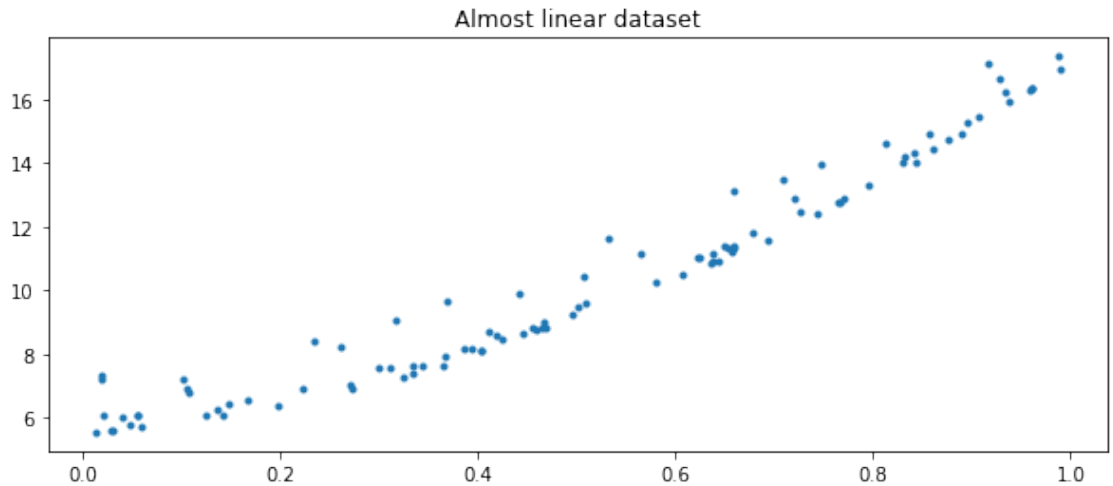
[10]:
```
clq.score(X,Y)
```

[10]:
```
0.5163817712143421
```

1.2 Regression with various quantiles

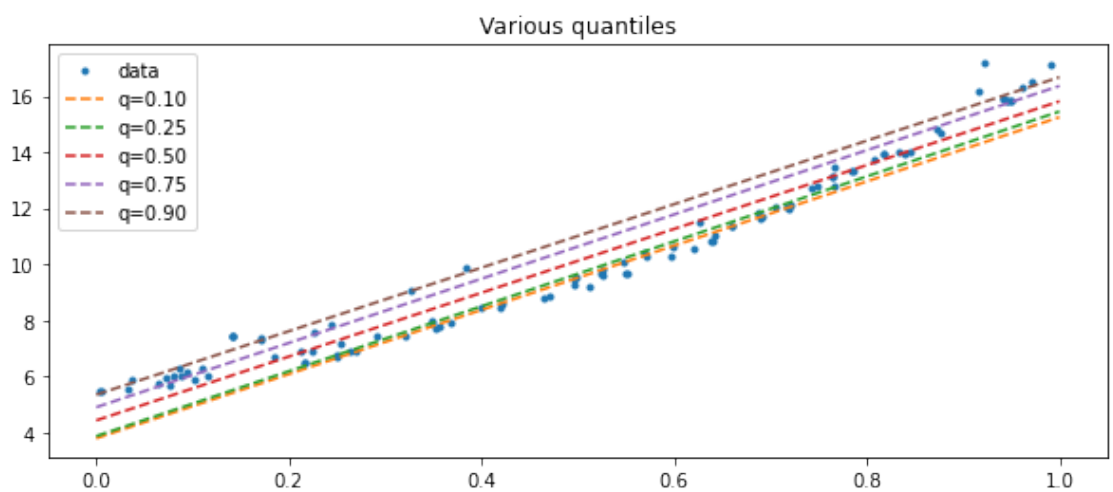
[11]:
```
import numpy
X = numpy.random.random(1200)
eps1 = (numpy.random.random(900) - 0.5) * 0.5
eps2 = (numpy.random.random(300)) * 2
eps = numpy.hstack([eps1, eps2])
X = X.reshape((1200, 1))
Y = X.ravel() * 3.4 + 5.6 + eps + X.ravel() * X.ravel() * 8
```

[12]:
```
fig, ax = plt.subplots(1, 1, figsize=(10, 4))
choice = numpy.random.choice(X.shape[0]-1, size=100)
xx = X.ravel()[choice]
yy = Y[choice]
ax.plot(xx, yy, '.', label="data")
ax.set_title("Almost linear dataset");
```



[13]:
```
clqs = {}
for qu in [0.1, 0.25, 0.5, 0.75, 0.9]:
    clq = QuantileLinearRegression(quantile=qu)
    clq.fit(X, Y)
    clqs['q=%1.2f' % qu] = clq
```

[14]:
```
import matplotlib.pyplot as plt
fig, ax = plt.subplots(1, 1, figsize=(10, 4))
choice = numpy.random.choice(X.shape[0]-1, size=100)
xx = X.ravel()[choice]
yy = Y[choice]
ax.plot(xx, yy, '.', label="data")
xx = numpy.array([[0], [1]])
for qu in sorted(clqs):
    y = clqs[qu].predict(xx)
    ax.plot(xx, y, "--", label=qu)
ax.set_title("Various quantiles");
ax.legend();
```



[15]:

```

```