tomcarron_exercise9

June 10, 2022

1 Exercise Set 9

Due: **9:30 13 June 2022**

Discussion: **13:00 17 June 2022**

Online submission at via ILIAS in the directory Exercises / Übungen -> Submission of Exercises / Rückgabe des Übungsblätter

Data analysis and code development is typically done in larger collaborations. The most common way to do this is with a cloud service suce as GitHub. `git` is a common method used for version control. You can find a descriptions of the various capabilities for example at Atlassian.

It is recommended that you register on GitHub to get used to it. For the remainder of the course, you may keep your solutions on GitHub and simply send a link to the necessary folder as the ILIAS submission (for example in an ascii file). If you choose to do so, the requirements for a submission remain the same (submit a self-contained pdf) and additional requirements that your repository is called `DataAnalysis` and the exercise solutions are placed in directories `exercise_x/` (so for exercise 9 it would be `exercise_9/`).

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import os
import seaborn as sb
from sklearn import linear_model
from scipy.optimize import curve_fit
from matplotlib import collections as matcoll
import scipy.stats as st
import matplotlib
matplotlib.rcParams['figure.dpi']=300
```

2 1. Regression - Fitting a line [data exercise] [50 Points]

In this problem we will fit a linear function $f(x) = y_0 + \beta_0 x$ to the data from datafile: `line_data.dat`.

a) Perform the linear regression to fit a linear function $f(x) = y_0 + \beta_0 x$ and plot $f(x)$ together with the data points. **25 Points**

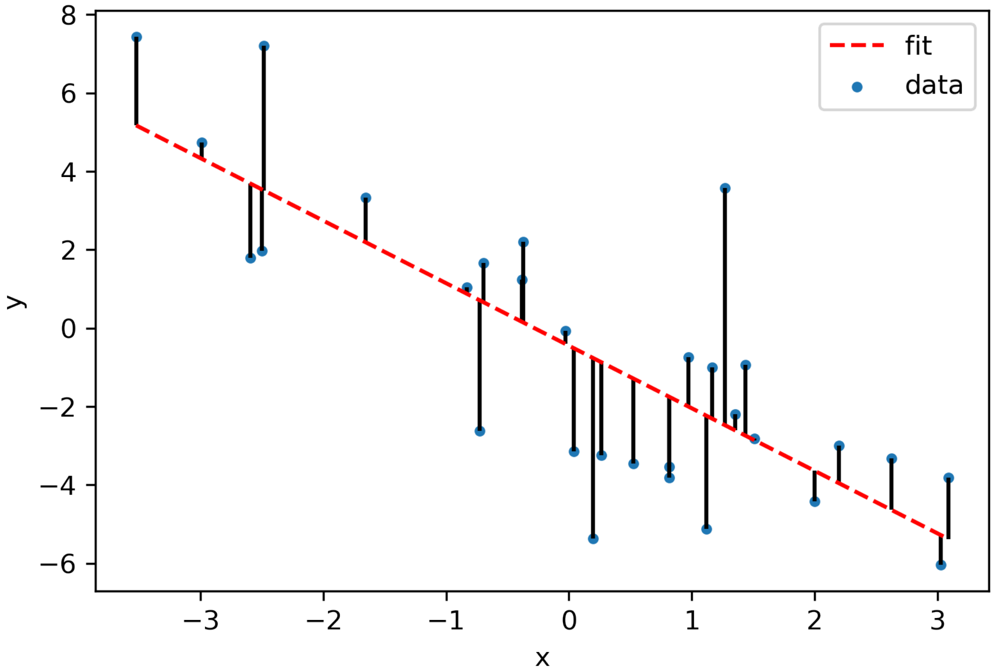
[ ]:

```python
# load the data
df = pd.read_csv("line_data.dat", sep="\s+", names=["x", "y"])
# as arrays
x, y = df["x"].to_numpy(), df["y"].to_numpy()
# Function for fitting
def lin_func(x, y0, beta):
    f = y0 + beta * x
    return f

# linear fit
popt, pcov = curve_fit(lin_func, x, y)
x2 = np.linspace(np.min(x), np.max(x), 1000)
# difference between data and the fit
y_predicted = lin_func(x, popt[0], popt[1])
diff = y - y_predicted

# lines between prediction and data
lines = []
for i in range(len(x)):
    pair = [(x[i], y[i]), (x[i], y_predicted[i])]
    lines.append(pair)

linecoll = matcoll.LineCollection(lines, colors="k")
# plot the data
fig, ax = plt.subplots()
ax.scatter(x, y, label="data", s=9)
# ax.
 ↪scatter(x,lin_func(x,popt[0],popt[1]),s=10,c='green',marker='o',label='predicted')
ax.plot(x2, lin_func(x2, popt[0], popt[1]), ls="--", c="red", label="fit")
ax.add_collection(linecoll)
ax.set_xlabel("x")
ax.set_ylabel("y")
ax.legend()
plt.savefig("plots/linreg.png", dpi=400, bbox_inches="tight")
```

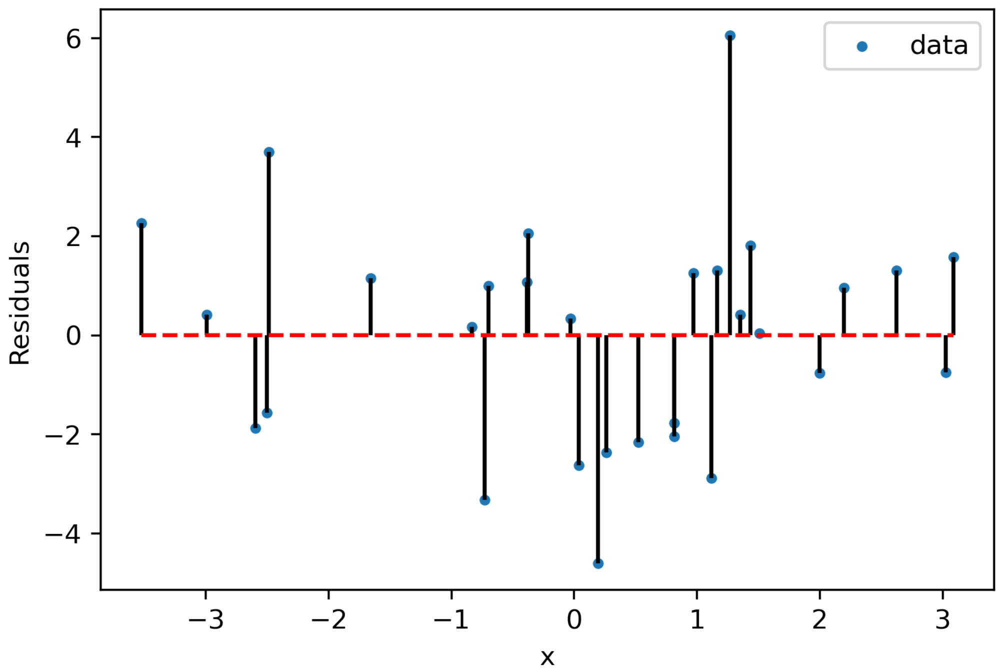


b) Compute the residuals and plot them. What is R^2? **25 Points**

[ ]:
```
# Compute the residuals and plot them
# lines between prediction and data
lines = []
for i in range(len(x)):
    pair = [(x[i], 0), (x[i], y[i] - y_predicted[i])]
    lines.append(pair)

linecoll = matcoll.LineCollection(lines, colors="k")

fig, ax = plt.subplots()
ax.scatter(x, diff, label="data", s=9)
ax.plot(x2, np.zeros_like(x2), "--", c="r")
ax.add_collection(linecoll)
ax.set_ylabel("Residuals")
ax.set_xlabel("x")
ax.legend()
plt.savefig("plots/residuals.png", dpi=400, bbox_inches="tight")
```




```
[ ]: # R^2
     # In the case of only one dependent variable, R^2 is the square of the pearson␣
      ↪corr coeff
     R2 = (st.pearsonr(x, y)[0]) ** 2
     print("R2 = ", R2)
```

```
R2 =  0.6124158502151285
```

3 2. Model fit quality assessment [50 Points]

In this problem you will assess the quality of a fit by inspecting the residuals of the fit. For each of the following plots state whether the residuals indicate a reasonable model fit and briefly explain your conclusion and if applicable how possibly to improve the fit. **50 Points**

4 Plot a)

The residuals indicate a good model fit because the residuals are centred around y=0 and are normally distributed.

5 Plot b)

The residuals of plot b also indicate a good model fit because the residuals are centred around y=0 and are normally distributed.

6 Plot c)

The residuals show a trend with a negative autocrrelation. This suggests the model is not suitable for the data.

7 Plot d)

The resiudals are normally distributed about y=0. The model is a good fit.

8 Plot e)

Trend in the residuals, the model is not suitable for the data. A polynomial model would fit the data better. there is also some negative autocorrelation.