Lab_3_data_fitting PDF

November 1, 2023

[ ]:
```
# Initialize Otter
import otter
grader = otter.Notebook("Lab_3_data_fitting.ipynb")
```

1 Lab week 3: Data fitting to see if we can detect a pick success y/n

Can you use the finger 1 stop time and max value to tell the difference between a successful and a failed pick? Lab slides: https://docs.google.com/presentation/d/1NtoXYbl2nq1dkIU0KQE8ogjSCfb22wgLigY3JJpHHGI/edit?usp=shari

[ ]:
```
# Doing the imports for you
import numpy as np
import json as json
from scipy.stats import linregress
import matplotlib.pyplot as plt
import csv
from numpy.polynomial import polynomial
import math
```

1.1 Read the data in

[ ]:
```
# Read the same data in as for pre_lecture_3.py data in and put it in the data_␣
 ↪variables

# Read in week3_Motor position f1_success and failed
data_success_from_csv = np.loadtxt("Data/Week3_Motor position f1_successful.
 ↪csv", delimiter=',')
pick_data_success = data_success_from_csv

data_fail_from_csv = np.loadtxt("Data/Week3_Motor position f1_failed.csv",␣
 ↪delimiter=',')
pick_data_fail = data_fail_from_csv

data_successful = pick_data_success
data_failed = pick_data_fail
# END PROMPT"""
```

[ ]:
```
grader.check("Read data")
```

[ ]:
```
Read data results: All test cases passed!
```

1.2 Box plot of fitted lines for all data

In the pre-lecture you fit a line to just one row (each) of the successful versus failed picks. In this lab you'll fit the line to ALL of the picks. For each pick, save the end point (time at the y_max value and the y_max value). You'll be making a box plot of this data to see if it looks different for successful versus failed picks.

Why a box plot? Box plots are better for visually showing multiple distributions in the same plot, where they can be compared side-by-side

See lab slides for what this should look like when you're done.

[ ]:
```
time_step = 1/30
def fit_line_to_middle_bit(ts, ys, eps=1e-2):
# TODO: get the fit_line_to_middle_bit function, either by copying it over␣
 ↪here, or importing it from a .py file
#. Optional (import):
# from pre_lecture_3_fitting import fit_line_to_middle_bit
# Otherwise, copy function here
    y_min = np.min(ys)
    y_max= np.max(ys)

    start = np.where( ys > y_min + eps * (y_max - y_min))[0][0]
    end = np.where( ys < y_max - eps * (y_max - y_min))[0][-1]

    select_ts = ts[ start: end +1]
    select_ys = ys[ start: end +1]

    slope, intercept , r_value, p_value, std_err = linregress( select_ts,␣
 ↪select_ys )

    x_min = (y_min - intercept) / slope
    x_max = (y_max - intercept) / slope

    return (x_min, y_min), (x_max, y_max)

# TODO: Check that it works
#. - Create t values
#  - Call fit_line_to_middle_bit with the first row of the successful data and␣
 ↪see if your answers
#. match the answers from pre-lecture
# END PROMPT"""
```

[ ]:
```
# TODO:
#  Create a function that loops over all of the rows of the data and␣
 ↪accumulates the start and end times
#. in an nx2 array of t (first row) and y (second row)
# I'd recommend a function that takes both the t values and the data, so you␣
 ↪don't have to keep recomputing
#.  the t values
#. def fit_middle_all(ts, data)
def fit_middle_all(ts, data ):
    array = np.zeros([data.shape[0], 2 ])
    for i in range (data.shape[0]):
        start_pt, end_pt = fit_line_to_middle_bit(ts, data[i,:])
        array[i,:] = end_pt
    return array
#.    make numpy array to put data in (nx2)
#.    for each row in data
#.       start_pt, end_pt = fit_line_to_middle_bit(ts, current row)
#        copy end_pt information into appropriate row in nx2 output
#. return nx2 numpy array
# END PROMPT"""
```

[ ]:
```
# TODO:
#  Create a function that computes the
# nx2 arrays of t, y values of end point of fitted line

# END PROMPT"""

# Should print Mean successful [3.98791579e-01 4.07402569e+02] and failed [  0.
 ↪40810473 392.76044707]
```

[ ]:
```
# Check that it works properly

# TODO:
#  Create the t values
ts = np.arange(start = 0, stop = data_successful.shape[1] * time_step, step =␣
 ↪time_step)
#. Call your function twice, once with the successful data, once with the failed
end_times_successful = fit_middle_all( ts, data_successful)
end_times_failed = fit_middle_all( ts, data_failed)
print(f"Mean successful {np.mean(end_times_successful, 0)} and failed {np.
 ↪mean(end_times_failed, 0)}")
# END PROMPT"""
```

```
Mean successful [3.98791579e-01 4.07402569e+02] and failed [  0.40810473
392.76044707]
```

[ ]:
```
grader.check("Fitted line code")
```

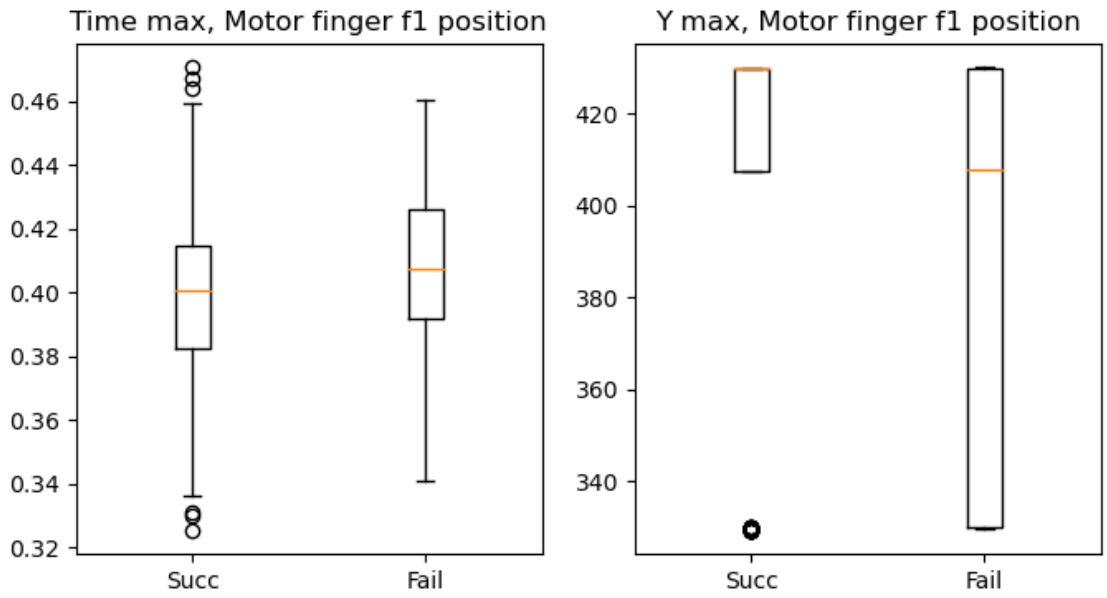
[ ]: Fitted line code results: All test cases passed!

[ ]:
```
# Two plots
n_rows = 1
n_cols = 2
fig, axs = plt.subplots(n_rows, n_cols, figsize=(8, 4))


axs[0].boxplot(end_times_successful[:,0], positions = [0], labels = ['Succ'])
axs[0].boxplot(end_times_failed[:,0], positions = [1], labels = ['Fail'])
axs[0].set_title(f"Time max, Motor finger f1 position")

axs[1].boxplot(end_times_successful[:,1], positions = [0], labels = ['Succ'])
axs[1].boxplot(end_times_failed[:,1], positions = [1], labels = ['Fail'])
axs[1].set_title(f"Y max, Motor finger f1 position")
plt.show()

# Do the box plots...
# END PROMPT"""
```



2 Part 2: Fitting a curve to the wrist force data

2.1 First step: Getting the data

The wrist force data has three channels (x,y,z). For this assignment, we want to get out the total summed force at the wrist, rather than each channel individually:

Equation: **sqrt (sum x,y,z (wrist force data)^2)**

Just like the last problem, the data has already been extracted from the proxy_pick_data.csv file and output for you (week3_Wrist force_summed_*.csv).

Optional: Do this extraction yourself. Read in wrist force data, sum it, and write it out to two csv files (one for successful, one for failed). Feel free to swipe code from Lecture_3_data_analysis.ipynb to do this.

[ ]:
```
# TODO: Read in the data from Data/week3_Wrist_force summed*.csv (successful␣
 ↪and failed)
# TODO: Optional: Read in the pick data and its description file, extract out␣
 ↪the rows and columns you
#. care about, and write that data out (should be same as the .csv files)
data_from_Wrist_force_success_csv = np.loadtxt("Data/week3_Wrist␣
 ↪force_summed_successful.csv", dtype="float", delimiter=",")
pick_data_Wrist_force_success = data_from_Wrist_force_success_csv

data_from_Wrist_force_fail_csv = np.loadtxt("Data/week3_Wrist␣
 ↪force_summed_failed.csv", dtype="float", delimiter=",")
pick_data_Wrist_force_fail = data_from_Wrist_force_fail_csv

data_wrist_force_successful = pick_data_Wrist_force_success
data_wrist_force_failed = pick_data_Wrist_force_fail
# END PROMPT"""
```

[ ]:
```
grader.check("Fit curve")
```

[ ]:
```
Fit curve results: All test cases passed!
```

2.2 Second step: Fit a cubic to the wrist force data (18 rows each successful/failed)

Split by successful and failed.

TODO: See slides for what the final plots should look like. I've handled the for loop and the plot indexing for you.

At this point, you should have the data in the form ts, ys for both the successful and the failed data.

Where you're headed (pseudo code)

for 18 rows of data

```
Fit a cubic polynomial to the data

Plot the original data plus the fitted polynomial

   First three rows: successful, last three rows: failed
```

Implementation steps: You could write a function for doing the polynomial fit, but since there already is one (polynomial.polyval) you probably don't need one.

Steps - Fit polynomial for one row of data - Plot it and make sure it looks correct - Copy that code into the for loop, adjusting for which row (p) and which subplot (axs[r, c]) - Repeat for the failed data

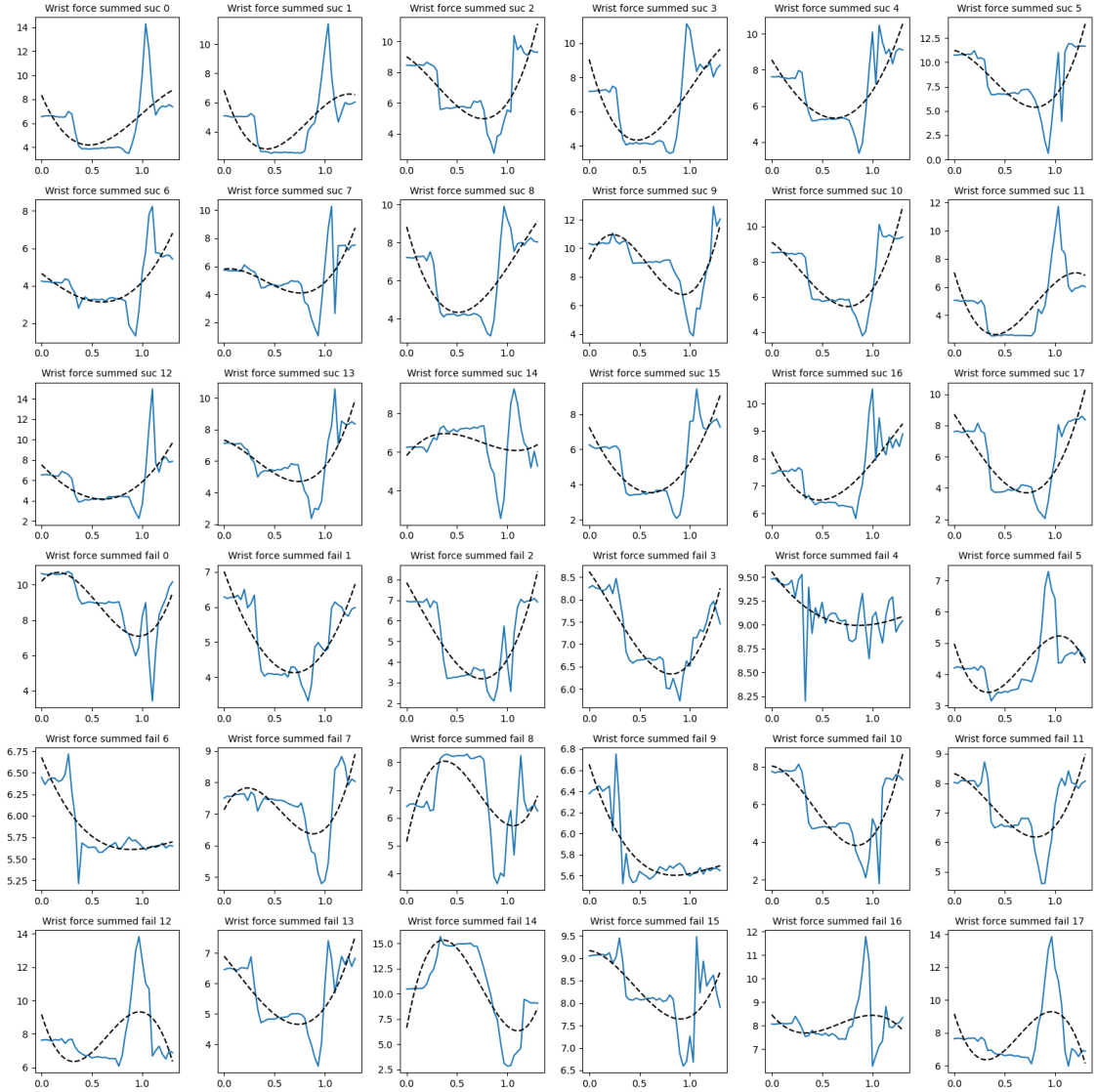
Note: It can take a few seconds to plot.

[ ]:
```
n_rows = 6
n_cols = 6
fig, axs = plt.subplots(n_rows, n_rows, figsize=(16, 16))
ch_name = "Wrist force"

for p in range(0, (n_rows // 2) * n_cols):
    r, c = p // n_cols, p % n_cols
    ys = data_wrist_force_successful[p]
    coefficients = np.polyfit(ts, data_wrist_force_successful[p] , 3)
    fitted_curve = np.polyval(coefficients , ts)
    axs[r, c].plot(ts, data_wrist_force_successful[p])
    axs[r, c].plot(ts, fitted_curve, color = "black",linestyle ='--')
    axs[r, c].set_title(f"{ch_name} summed" + f" suc {p}", fontsize=10)

for p in range(0, (n_rows // 2) * n_cols):
    r, c = 3 + p // n_cols, p % n_cols
    ys = data_wrist_force_failed[p]
    coefficients = np.polyfit(ts, data_wrist_force_failed[p] , 3)
    fitted_curve = np.polyval(coefficients , ts)
    axs[r, c].plot(ts, data_wrist_force_failed[p])
    axs[r, c].plot(ts, fitted_curve, color = "black",linestyle ='--')
    axs[r, c].set_title(f"{ch_name} summed" + f" fail {p}", fontsize=10)

plt.tight_layout()
```



2.3 Hours and collaborators

Required for every assignment - fill out before you hand-in.

Listing names and websites helps you to document who you worked with and what internet help you received in the case of any plagiarism issues. You should list names of anyone (in class or not) who has substantially helped you with an assignment - or anyone you have *helped*. You do not need to list TAs.

Listing hours helps us track if the assignments are too long.

[ ]:
```
# List of names (creates a set)
worked_with_names = {}
# List of URLS (creates a set)
```

```
websites = {}
# Approximate number of hours, including lab/in-class time
hours = 10
# for all row, column in all_indices_from_where
#.   if this is the column for wrist torque
#.      print(f"Row: {r}, Time step: {c // n_time_steps} Successful y/n:␣
 ↪{pick_data[r, -1] == 1}, value: {pick_data[r, c]}")
for r in range(len(worked_with_names)):
    for c in range(len(websites)):
         wrist_torque_column = 2
         if c == wrist_torque_column:
            print(f"Row: {r}, Time step: {c // n_time_steps}, Successful y/n:␣
 ↪{pick_data[r][-1] == 1}, value: {pick_data[r][c]}")
            # Assuming 'your_column_for_wrist_torque' is the column index you␣
 ↪are interested in
```

[ ]:
```
grader.check("hours_collaborators")
```

[ ]:
```
hours_collaborators results: All test cases passed!
```

2.4 Submission

Make sure you have run all cells in your notebook in order before running the cell below, so that all images/graphs appear in the output. The cell below will generate a zip file for you to submit. **Please save before exporting!**

Submit through gradescope, lab 3 data analysis. Turn in just the .ipynb file - we will supply the data files.

[ ]:
```
# Save your notebook first, then run this cell to export your submission.
grader.export(run_tests=True)
```

```
c:\Users\user10\anaconda3\Lib\site-packages\nbconvert\utils\pandoc.py:51:
RuntimeWarning: You are using an unsupported version of pandoc (3.1.8).
Your version must be at least (1.12.1) but less than (3.0.0).
Refer to https://pandoc.org/installing.html.
Continuing with doubts…
  check_pandoc_version()

Running your submission against local test cases…
```

```
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
```

```
c:\Users\user10\Desktop\ME␣
 ↪203\IntroPythonProgramming\IntroPythonProgramming\Week_3_fitting\Lab_3_data_f.tting.
 ↪ipynb Cell 23 line 2
      <a href='vscode-notebook-cell:/c%3A/Users/user10/Desktop/ME%20203/
 ↪IntroPythonProgramming/IntroPythonProgramming/Week_3_fitting/
 ↪Lab_3_data_fitting.ipynb#X31sZmlsZQ%3D%3D?line=0'>1</a> # Save your notebook␣
 ↪first, then run this cell to export your submission.
----> <a href='vscode-notebook-cell:/c%3A/Users/user10/Desktop/ME%20203/
 ↪IntroPythonProgramming/IntroPythonProgramming/Week_3_fitting/
 ↪Lab_3_data_fitting.ipynb#X31sZmlsZQ%3D%3D?line=1'>2</a> grader.
 ↪export(run_tests=True)

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\utils.py:184, in␣
 ↪grading_mode_disabled(wrapped, self, args, kwargs)
    182 if type(self)._grading_mode:
    183     return
--> 184 return wrapped(*args, **kwargs)

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\utils.py:166, in␣
 ↪incompatible_with.<locals>.incompatible(wrapped, self, args, kwargs)
    164     else:
    165         return
--> 166 return wrapped(*args, **kwargs)

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\utils.py:217, in␣
 ↪logs_event.<locals>.event_logger(wrapped, self, args, kwargs)
    215 except Exception as e:
    216     self._log_event(event_type, success=False, error=e)
--> 217     raise e
    219 if ret is None:
    220     ret = LoggedEventReturnValue(None)

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\utils.py:213, in␣
 ↪logs_event.<locals>.event_logger(wrapped, self, args, kwargs)
    208 """
    209 Runs a method, catching any errors and logging the call. Returns the␣
 ↪unwrapped return value
    210 of the wrapped function.
    211 """
    212 try:
--> 213     ret: Optional[LoggedEventReturnValue[T]] = wrapped(*args, **kwargs)
    215 except Exception as e:
    216     self._log_event(event_type, success=False, error=e)

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\notebook.py:523, i␣
 ↪Notebook.export(self, nb_path, export_path, pdf, filtering, pagebreaks, files␣
 ↪display_link, force_save, run_tests)
    520         display(HTML(out_html))
    522 if pdf_created or not self._nbmeta_config.require_no_pdf_confirmation:
```

```
--> 523     continue_export()
    524 else:
    525     display_pdf_confirmation_widget(
    526         self._nbmeta_config.export_pdf_failure_message, continue_export

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\notebook.py:505, i
 ↪Notebook.export.<locals>.continue_export()
    503 if run_tests:
    504     print("Running your submission against local test cases…\n")
--> 505     results = grade_zip_file(zip_path, nb_path, self._tests_dir)
    506     print(
    507         "Your submission received the following results when run agains
 ↪" + \
    508         "available test cases:\n\n" + indent(results.summary(), "    ")
    510 if display_link:
    511     # create and display output HTML

File c:\Users\user10\anaconda3\Lib\site-packages\otter\check\utils.py:103, in
 ↪grade_zip_file(zip_path, nb_arcname, tests_dir)
    100 print(results.stdout.decode("utf-8"))
    102 if results.stderr:
--> 103     raise RuntimeError(results.stderr.decode("utf-8"))
    105 with open(results_path, "rb") as f:
    106     results = dill.load(f)

RuntimeError: C:
 ↪\Users\user10\AppData\Roaming\Python\Python311\site-packages\zmq\_future.py:
 ↪693: RuntimeWarning: Proactor event loop does not implement add_reader family
 ↪of methods required for zmq. Registering an additional selector thread for
 ↪add_reader support via tornado. Use `asyncio.
 ↪set_event_loop_policy(WindowsSelectorEventLoopPolicy())` to avoid this warnin
 ↪.

  self._get_loop()
```