Computational Physics

Final Exam (two problems)

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Problem I : COMPS-21 virus (70 points)

Question : Please analyze the following artificial data obtained from the number of daily infected people for a new disease called “COMPS-21” for 25 days.

Assume the data are purely counting and we consider only the statistical uncertainties. In other words, we assume, these patients are emerging uniformly and randomly from the country’s entire population.

1) Draw a plot for the data points (N infected versus Nth day) with error bars on the number of the infected.

2) Perform a fitting with (a) a constant function model and (b) a linear function model separately. (b) could be a quadratic function model instead or your own model choice is okay.

3) Please overlay the model best fit lines with the data points.

4) For each model, please specify parameter values with errors, chi-square values, and p-values.

5) Please validate those models using the goodness-of-fitting method.

6) Please interpret the results.

Nth day	N infected
0	575
1	626
2	575
3	566
4	532
5	574
6	579
7	577
8	633
9	524
10	553
11	561
12	588
13	535
14	491

Nth day	N infected
15	538
16	495
17	537
18	528
19	533
20	543
21	505
22	508
23	494
24	480

Note that this is a take-home exam.
No discussion is allowed with anyone.

Problem II (30 points)

Question : Please quantify how much those two high schools are different to each other in terms of their exam performances.

(1) Provide means and sigmas of two distributions.

(2) Quantify the difference between two distributions

(3) Provide codes and plots if necessary.

Note that the upper row of each table is scores and the lower row is the number of students who got the particular score. For example, at the “A” table, 4 students received 15 points (see blue boxed area below).

Hint : Use Gaussian Fit to estimate the means and sigmas. (See next page for example). You do not have to consider uncertainties in this case.

“A” high school scores for an exam (100 students)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	10	13	11	17	14	15	5	2	2	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

“B” high school scores for the same exam (100 students)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	2	2	9	8	12	14	11	17	6	6	2	4	2	1	1	0	0	0	0	0	0

Hint for the problem II
(Example Gaussian Fit)

```
import numpy as np
from scipy.optimize import curve_fit

## Gaussian Fit Example ##
def gaus(x, *p):
    A, mu, sigma = p
    return A*np.exp(-(x-mu)**2/(2.*sigma**2))

scores = np.array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10])
nums   = np.array([ 8,  7, 20, 30, 44, 33, 30, 31, 10,  1])

start = (10,5,1) # starting position
popt,pcov = curve_fit(gaus,scores,nums,p0 = start,absolute_sigma=True)

print(popt)
```