DSAI510_Assignment_04

October 26, 2024

0.1 Assignment 4 - Deadline: Oct 28, 2024, Mon 11pm

DSAI 510 Fall 2024 Complete the assignment below and upload both the .ipynb file and its pdf to https://moodle.boun.edu.tr by the deadline given above. The submission page on Moodle will close automatically after this date and time.

To make a pdf, this may work: Hit CMD+P or CTRL+P, and save it as PDF. You may also use other options from the File menu.

```python
[1]: # Run this cell first

import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import LabelEncoder


# Set the display option to show all rows scrolling with a slider
pd.set_option('display.max_rows', None)
# To disable this, run the line below:
# pd.reset_option('display.max_rows')
```

0.2 Note:

In the problems below, if it asks, "show the number of records that are nonzero", the answer is a number; so you don't need to show the records themselves. But if it asks, "show the records with NaN", it wants you to print those records (rows) containing NAN and other entries, not asking how many such records there are. So be careful about what you're asked.

0.3 Total: 60 pts

0.4 Problem 1 (10 pts)

(a) Load the Ames house dataset from the file **train.csv**.

(b) By using one-hot encoding, create bins for the SalePrice variable wrt the intervals `bins_SalePrice = [0, 250000, 500000, 1000000]`. The result should look like this:

(c) Use simple multiplication between the bin columns and SalePrice to generate this table:

(d) Remove the SalePrice column, melt the final dataframe and by using `sns.boxplot()` create the boxplot below. Make sure you're getting exactly the same plot as below with the same axes names and title.

```
[2]: # a

df = pd.read_csv("house-prices/train.csv")
```

```
[3]: # Break your computations into multiple cells

# b
bins_SalePrice = [0, 250000, 500000, 1000000]


def fit_transform_2(num:int, ranges=[0, 250000, 500000, 1000000]):
    try:
        for i in range(len(ranges)):
            if num <= ranges[i]:
                return i
    except:
        print("There is a problem with encoding")


df["bin"] = df["SalePrice"].apply(fit_transform_2)
encoded_df = pd.get_dummies(data=df[["bin", "SalePrice"]], columns=["bin"],
 ↪prefix_sep="") * 1
columns = ["bin1", "bin2", "bin3", "SalePrice"]
encoded_df[columns]
```

```
[3]:      bin1  bin2  bin3  SalePrice
0          1     0     0     208500
1          1     0     0     181500
2          1     0     0     223500
3          1     0     0     140000
4          1     0     0     250000
5          1     0     0     143000
6          0     1     0     307000
7          1     0     0     200000
8          1     0     0     129900
9          1     0     0     118000
10         1     0     0     129500
11         0     1     0     345000
12         1     0     0     144000
13         0     1     0     279500
14         1     0     0     157000
15         1     0     0     132000
16         1     0     0     149000
```

17	1	0	0	90000
18	1	0	0	159000
19	1	0	0	139000
20	0	1	0	325300
21	1	0	0	139400
22	1	0	0	230000
23	1	0	0	129900
24	1	0	0	154000
25	0	1	0	256300
26	1	0	0	134800
27	0	1	0	306000
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30	1	0	0	40000
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38	1	0	0	109000
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1245	1	0	0	178000
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1247	1	0	0	169900
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1251	1	0	0	171750
1252	1	0	0	130000
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1254	1	0	0	165400
1255	1	0	0	127500
1256	0	1	0	301500
1257	1	0	0	99900
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1260	1	0	0	181000
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1262	1	0	0	161500
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1265	1	0	0	183900
1266	1	0	0	122000
1267	0	1	0	378500
1268	0	1	0	381000
1269	1	0	0	144000
1270	0	1	0	260000
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1272	1	0	0	137000
1273	1	0	0	177000
1274	1	0	0	139000
1275	1	0	0	137000
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1278	1	0	0	237000
1279	1	0	0	68400
1280	1	0	0	227000
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1283	1	0	0	139000
1284	1	0	0	169000
1285	1	0	0	132500

1286	1	0	0	143000
1287	1	0	0	190000
1288	0	1	0	278000
1289	0	1	0	281000
1290	1	0	0	180500
1291	1	0	0	119500
1292	1	0	0	107500
1293	1	0	0	162900
1294	1	0	0	115000
1295	1	0	0	138500
1296	1	0	0	155000
1297	1	0	0	140000
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1299	1	0	0	154000
1300	1	0	0	225000
1301	1	0	0	177500
1302	0	1	0	290000
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1304	1	0	0	130000
1305	0	1	0	325000
1306	1	0	0	202500
1307	1	0	0	138000
1308	1	0	0	147000
1309	1	0	0	179200
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1311	1	0	0	203000
1312	0	1	0	302000
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1314	1	0	0	119000
1315	1	0	0	206900
1316	0	1	0	295493
1317	1	0	0	208900
1318	0	1	0	275000
1319	1	0	0	111000
1320	1	0	0	156500
1321	1	0	0	72500
1322	1	0	0	190000
1323	1	0	0	82500
1324	1	0	0	147000
1325	1	0	0	55000
1326	1	0	0	79000
1327	1	0	0	130500
1328	0	1	0	256000
1329	1	0	0	176500
1330	1	0	0	227000
1331	1	0	0	132500
1332	1	0	0	100000

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1334	1	0	0	125000
1335	1	0	0	167900
1336	1	0	0	135000
1337	1	0	0	52500
1338	1	0	0	200000
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1343	1	0	0	177000
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1345	1	0	0	108500
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1349	1	0	0	122000
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1358	1	0	0	177500
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1360	1	0	0	189000
1361	0	1	0	260000
1362	1	0	0	104900
1363	1	0	0	156932
1364	1	0	0	144152
1365	1	0	0	216000
1366	1	0	0	193000
1367	1	0	0	127000
1368	1	0	0	144000
1369	1	0	0	232000
1370	1	0	0	105000
1371	1	0	0	165500
1372	0	1	0	274300
1373	0	1	0	466500
1374	1	0	0	250000
1375	1	0	0	239000
1376	1	0	0	91000
1377	1	0	0	117000
1378	1	0	0	83000
1379	1	0	0	167500

1380	1	0	0	58500
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1388	0	1	0	377500
1389	1	0	0	131000
1390	1	0	0	235000
1391	1	0	0	124000
1392	1	0	0	123000
1393	1	0	0	163000
1394	1	0	0	246578
1395	0	1	0	281213
1396	1	0	0	160000
1397	1	0	0	137500
1398	1	0	0	138000
1399	1	0	0	137450
1400	1	0	0	120000
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1402	1	0	0	193879
1403	0	1	0	282922
1404	1	0	0	105000
1405	0	1	0	275000
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1407	1	0	0	112000
1408	1	0	0	125500
1409	1	0	0	215000
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1411	1	0	0	140000
1412	1	0	0	90000
1413	0	1	0	257000
1414	1	0	0	207000
1415	1	0	0	175900
1416	1	0	0	122500
1417	0	1	0	340000
1418	1	0	0	124000
1419	1	0	0	223000
1420	1	0	0	179900
1421	1	0	0	127500
1422	1	0	0	136500
1423	0	1	0	274970
1424	1	0	0	144000
1425	1	0	0	142000
1426	0	1	0	271000

```
1427    1    0    0    140000
1428    1    0    0    119000
1429    1    0    0    182900
1430    1    0    0    192140
1431    1    0    0    143750
1432    1    0    0     64500
1433    1    0    0    186500
1434    1    0    0    160000
1435    1    0    0    174000
1436    1    0    0    120500
1437    0    1    0    394617
1438    1    0    0    149700
1439    1    0    0    197000
1440    1    0    0    191000
1441    1    0    0    149300
1442    0    1    0    310000
1443    1    0    0    121000
1444    1    0    0    179600
1445    1    0    0    129000
1446    1    0    0    157900
1447    1    0    0    240000
1448    1    0    0    112000
1449    1    0    0     92000
1450    1    0    0    136000
1451    0    1    0    287090
1452    1    0    0    145000
1453    1    0    0     84500
1454    1    0    0    185000
1455    1    0    0    175000
1456    1    0    0    210000
1457    0    1    0    266500
1458    1    0    0    142125
1459    1    0    0    147500
```

[4]:
```python
# c

encoded_df[columns[:-1]] = encoded_df[columns[:-1]].
 ↪multiply(encoded_df[columns[-1]], axis=0)

encoded_df[columns]
```

[4]:
```
        bin1    bin2    bin3   SalePrice
0     208500       0       0      208500
1     181500       0       0      181500
2     223500       0       0      223500
3     140000       0       0      140000
4     250000       0       0      250000
```

5	143000	0	0	143000
6	0	307000	0	307000
7	200000	0	0	200000
8	129900	0	0	129900
9	118000	0	0	118000
10	129500	0	0	129500
11	0	345000	0	345000
12	144000	0	0	144000
13	0	279500	0	279500
14	157000	0	0	157000
15	132000	0	0	132000
16	149000	0	0	149000
17	90000	0	0	90000
18	159000	0	0	159000
19	139000	0	0	139000
20	0	325300	0	325300
21	139400	0	0	139400
22	230000	0	0	230000
23	129900	0	0	129900
24	154000	0	0	154000
25	0	256300	0	256300
26	134800	0	0	134800
27	0	306000	0	306000
28	207500	0	0	207500
29	68500	0	0	68500
30	40000	0	0	40000
31	149350	0	0	149350
32	179900	0	0	179900
33	165500	0	0	165500
34	0	277500	0	277500
35	0	309000	0	309000
36	145000	0	0	145000
37	153000	0	0	153000
38	109000	0	0	109000
39	82000	0	0	82000
40	160000	0	0	160000
41	170000	0	0	170000
42	144000	0	0	144000
43	130250	0	0	130250
44	141000	0	0	141000
45	0	319900	0	319900
46	239686	0	0	239686
47	249700	0	0	249700
48	113000	0	0	113000
49	127000	0	0	127000
50	177000	0	0	177000
51	114500	0	0	114500

52	110000	0	0	110000
53	0	385000	0	385000
54	130000	0	0	130000
55	180500	0	0	180500
56	172500	0	0	172500
57	196500	0	0	196500
58	0	438780	0	438780
59	124900	0	0	124900
60	158000	0	0	158000
61	101000	0	0	101000
62	202500	0	0	202500
63	140000	0	0	140000
64	219500	0	0	219500
65	0	317000	0	317000
66	180000	0	0	180000
67	226000	0	0	226000
68	80000	0	0	80000
69	225000	0	0	225000
70	244000	0	0	244000
71	129500	0	0	129500
72	185000	0	0	185000
73	144900	0	0	144900
74	107400	0	0	107400
75	91000	0	0	91000
76	135750	0	0	135750
77	127000	0	0	127000
78	136500	0	0	136500
79	110000	0	0	110000
80	193500	0	0	193500
81	153500	0	0	153500
82	245000	0	0	245000
83	126500	0	0	126500
84	168500	0	0	168500
85	0	260000	0	260000
86	174000	0	0	174000
87	164500	0	0	164500
88	85000	0	0	85000
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91	98600	0	0	98600
92	163500	0	0	163500
93	133900	0	0	133900
94	204750	0	0	204750
95	185000	0	0	185000
96	214000	0	0	214000
97	94750	0	0	94750
98	83000	0	0	83000

99	128950	0	0	128950
100	205000	0	0	205000
101	178000	0	0	178000
102	118964	0	0	118964
103	198900	0	0	198900
104	169500	0	0	169500
105	250000	0	0	250000
106	100000	0	0	100000
107	115000	0	0	115000
108	115000	0	0	115000
109	190000	0	0	190000
110	136900	0	0	136900
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113	217000	0	0	217000
114	0	259500	0	259500
115	176000	0	0	176000
116	139000	0	0	139000
117	155000	0	0	155000
118	0	320000	0	320000
119	163990	0	0	163990
120	180000	0	0	180000
121	100000	0	0	100000
122	136000	0	0	136000
123	153900	0	0	153900
124	181000	0	0	181000
125	84500	0	0	84500
126	128000	0	0	128000
127	87000	0	0	87000
128	155000	0	0	155000
129	150000	0	0	150000
130	226000	0	0	226000
131	244000	0	0	244000
132	150750	0	0	150750
133	220000	0	0	220000
134	180000	0	0	180000
135	174000	0	0	174000
136	143000	0	0	143000
137	171000	0	0	171000
138	230000	0	0	230000
139	231500	0	0	231500
140	115000	0	0	115000
141	0	260000	0	260000
142	166000	0	0	166000
143	204000	0	0	204000
144	125000	0	0	125000
145	130000	0	0	130000

146	105000	0	0	105000
147	222500	0	0	222500
148	141000	0	0	141000
149	115000	0	0	115000
150	122000	0	0	122000
151	0	372402	0	372402
152	190000	0	0	190000
153	235000	0	0	235000
154	125000	0	0	125000
155	79000	0	0	79000
156	109500	0	0	109500
157	0	269500	0	269500
158	0	254900	0	254900
159	0	320000	0	320000
160	162500	0	0	162500
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163	103200	0	0	103200
164	152000	0	0	152000
165	127500	0	0	127500
166	190000	0	0	190000
167	0	325624	0	325624
168	183500	0	0	183500
169	228000	0	0	228000
170	128500	0	0	128500
171	215000	0	0	215000
172	239000	0	0	239000
173	163000	0	0	163000
174	184000	0	0	184000
175	243000	0	0	243000
176	211000	0	0	211000
177	172500	0	0	172500
178	0	0	501837	501837
179	100000	0	0	100000
180	177000	0	0	177000
181	200100	0	0	200100
182	120000	0	0	120000
183	200000	0	0	200000
184	127000	0	0	127000
185	0	475000	0	475000
186	173000	0	0	173000
187	135000	0	0	135000
188	153337	0	0	153337
189	0	286000	0	286000
190	0	315000	0	315000
191	184000	0	0	184000
192	192000	0	0	192000

193	130000	0	0	130000
194	127000	0	0	127000
195	148500	0	0	148500
196	0	311872	0	311872
197	235000	0	0	235000
198	104000	0	0	104000
199	0	274900	0	274900
200	140000	0	0	140000
201	171500	0	0	171500
202	112000	0	0	112000
203	149000	0	0	149000
204	110000	0	0	110000
205	180500	0	0	180500
206	143900	0	0	143900
207	141000	0	0	141000
208	0	277000	0	277000
209	145000	0	0	145000
210	98000	0	0	98000
211	186000	0	0	186000
212	0	252678	0	252678
213	156000	0	0	156000
214	161750	0	0	161750
215	134450	0	0	134450
216	210000	0	0	210000
217	107000	0	0	107000
218	0	311500	0	311500
219	167240	0	0	167240
220	204900	0	0	204900
221	200000	0	0	200000
222	179900	0	0	179900
223	97000	0	0	97000
224	0	386250	0	386250
225	112000	0	0	112000
226	0	290000	0	290000
227	106000	0	0	106000
228	125000	0	0	125000
229	192500	0	0	192500
230	148000	0	0	148000
231	0	403000	0	403000
232	94500	0	0	94500
233	128200	0	0	128200
234	216500	0	0	216500
235	89500	0	0	89500
236	185500	0	0	185500
237	194500	0	0	194500
238	0	318000	0	318000
239	113000	0	0	113000

240	0	262500	0	262500
241	110500	0	0	110500
242	79000	0	0	79000
243	120000	0	0	120000
244	205000	0	0	205000
245	241500	0	0	241500
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252	173000	0	0	173000
253	158000	0	0	158000
254	145000	0	0	145000
255	230000	0	0	230000
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257	220000	0	0	220000
258	231500	0	0	231500
259	97000	0	0	97000
260	176000	0	0	176000
261	0	276000	0	276000
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263	130000	0	0	130000
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266	185000	0	0	185000
267	179500	0	0	179500
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269	148000	0	0	148000
270	0	266000	0	266000
271	241500	0	0	241500
272	0	290000	0	290000
273	139000	0	0	139000
274	124500	0	0	124500
275	205000	0	0	205000
276	201000	0	0	201000
277	141000	0	0	141000
278	0	415298	0	415298
279	192000	0	0	192000
280	228500	0	0	228500
281	185000	0	0	185000
282	207500	0	0	207500
283	244600	0	0	244600
284	179200	0	0	179200
285	164700	0	0	164700
286	159000	0	0	159000

287	88000	0	0	88000
288	122000	0	0	122000
289	153575	0	0	153575
290	233230	0	0	233230
291	135900	0	0	135900
292	131000	0	0	131000
293	235000	0	0	235000
294	167000	0	0	167000
295	142500	0	0	142500
296	152000	0	0	152000
297	239000	0	0	239000
298	175000	0	0	175000
299	158500	0	0	158500
300	157000	0	0	157000
301	0	267000	0	267000
302	205000	0	0	205000
303	149900	0	0	149900
304	0	295000	0	295000
305	0	305900	0	305900
306	225000	0	0	225000
307	89500	0	0	89500
308	82500	0	0	82500
309	0	360000	0	360000
310	165600	0	0	165600
311	132000	0	0	132000
312	119900	0	0	119900
313	0	375000	0	375000
314	178000	0	0	178000
315	188500	0	0	188500
316	0	260000	0	260000
317	0	270000	0	270000
318	0	260000	0	260000
319	187500	0	0	187500
320	0	342643	0	342643
321	0	354000	0	354000
322	0	301000	0	301000
323	126175	0	0	126175
324	242000	0	0	242000
325	87000	0	0	87000
326	0	324000	0	324000
327	145250	0	0	145250
328	214500	0	0	214500
329	78000	0	0	78000
330	119000	0	0	119000
331	139000	0	0	139000
332	0	284000	0	284000
333	207000	0	0	207000

334	192000	0	0	192000
335	228950	0	0	228950
336	0	377426	0	377426
337	214000	0	0	214000
338	202500	0	0	202500
339	155000	0	0	155000
340	202900	0	0	202900
341	82000	0	0	82000
342	87500	0	0	87500
343	0	266000	0	266000
344	85000	0	0	85000
345	140200	0	0	140200
346	151500	0	0	151500
347	157500	0	0	157500
348	154000	0	0	154000
349	0	437154	0	437154
350	0	318061	0	318061
351	190000	0	0	190000
352	95000	0	0	95000
353	105900	0	0	105900
354	140000	0	0	140000
355	177500	0	0	177500
356	173000	0	0	173000
357	134000	0	0	134000
358	130000	0	0	130000
359	0	280000	0	280000
360	156000	0	0	156000
361	145000	0	0	145000
362	198500	0	0	198500
363	118000	0	0	118000
364	190000	0	0	190000
365	147000	0	0	147000
366	159000	0	0	159000
367	165000	0	0	165000
368	132000	0	0	132000
369	162000	0	0	162000
370	172400	0	0	172400
371	134432	0	0	134432
372	125000	0	0	125000
373	123000	0	0	123000
374	219500	0	0	219500
375	61000	0	0	61000
376	148000	0	0	148000
377	0	340000	0	340000
378	0	394432	0	394432
379	179000	0	0	179000
380	127000	0	0	127000

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975	165000	0	0	165000
976	85500	0	0	85500
977	199900	0	0	199900
978	110000	0	0	110000
979	139000	0	0	139000
980	178400	0	0	178400
981	0	336000	0	336000
982	159895	0	0	159895
983	0	255900	0	255900
984	126000	0	0	126000
985	125000	0	0	125000
986	117000	0	0	117000
987	0	395192	0	395192
988	195000	0	0	195000
989	197000	0	0	197000
990	0	348000	0	348000
991	168000	0	0	168000

992	187000	0	0	187000
993	173900	0	0	173900
994	0	337500	0	337500
995	121600	0	0	121600
996	136500	0	0	136500
997	185000	0	0	185000
998	91000	0	0	91000
999	206000	0	0	206000
1000	82000	0	0	82000
1001	86000	0	0	86000
1002	232000	0	0	232000
1003	136905	0	0	136905
1004	181000	0	0	181000
1005	149900	0	0	149900
1006	163500	0	0	163500
1007	88000	0	0	88000
1008	240000	0	0	240000
1009	102000	0	0	102000
1010	135000	0	0	135000
1011	100000	0	0	100000
1012	165000	0	0	165000
1013	85000	0	0	85000
1014	119200	0	0	119200
1015	227000	0	0	227000
1016	203000	0	0	203000
1017	187500	0	0	187500
1018	160000	0	0	160000
1019	213490	0	0	213490
1020	176000	0	0	176000
1021	194000	0	0	194000
1022	87000	0	0	87000
1023	191000	0	0	191000
1024	0	287000	0	287000
1025	112500	0	0	112500
1026	167500	0	0	167500
1027	0	293077	0	293077
1028	105000	0	0	105000
1029	118000	0	0	118000
1030	160000	0	0	160000
1031	197000	0	0	197000
1032	0	310000	0	310000
1033	230000	0	0	230000
1034	119750	0	0	119750
1035	84000	0	0	84000
1036	0	315500	0	315500
1037	0	287000	0	287000
1038	97000	0	0	97000

1039	80000	0	0	80000
1040	155000	0	0	155000
1041	173000	0	0	173000
1042	196000	0	0	196000
1043	0	262280	0	262280
1044	0	278000	0	278000
1045	139600	0	0	139600
1046	0	0	556581	556581
1047	145000	0	0	145000
1048	115000	0	0	115000
1049	84900	0	0	84900
1050	176485	0	0	176485
1051	200141	0	0	200141
1052	165000	0	0	165000
1053	144500	0	0	144500
1054	0	255000	0	255000
1055	180000	0	0	180000
1056	185850	0	0	185850
1057	248000	0	0	248000
1058	0	335000	0	335000
1059	220000	0	0	220000
1060	213500	0	0	213500
1061	81000	0	0	81000
1062	90000	0	0	90000
1063	110500	0	0	110500
1064	154000	0	0	154000
1065	0	328000	0	328000
1066	178000	0	0	178000
1067	167900	0	0	167900
1068	151400	0	0	151400
1069	135000	0	0	135000
1070	135000	0	0	135000
1071	154000	0	0	154000
1072	91500	0	0	91500
1073	159500	0	0	159500
1074	194000	0	0	194000
1075	219500	0	0	219500
1076	170000	0	0	170000
1077	138800	0	0	138800
1078	155900	0	0	155900
1079	126000	0	0	126000
1080	145000	0	0	145000
1081	133000	0	0	133000
1082	192000	0	0	192000
1083	160000	0	0	160000
1084	187500	0	0	187500
1085	147000	0	0	147000

1086	83500	0	0	83500
1087	0	252000	0	252000
1088	137500	0	0	137500
1089	197000	0	0	197000
1090	92900	0	0	92900
1091	160000	0	0	160000
1092	136500	0	0	136500
1093	146000	0	0	146000
1094	129000	0	0	129000
1095	176432	0	0	176432
1096	127000	0	0	127000
1097	170000	0	0	170000
1098	128000	0	0	128000
1099	157000	0	0	157000
1100	60000	0	0	60000
1101	119500	0	0	119500
1102	135000	0	0	135000
1103	159500	0	0	159500
1104	106000	0	0	106000
1105	0	325000	0	325000
1106	179900	0	0	179900
1107	0	274725	0	274725
1108	181000	0	0	181000
1109	0	280000	0	280000
1110	188000	0	0	188000
1111	205000	0	0	205000
1112	129900	0	0	129900
1113	134500	0	0	134500
1114	117000	0	0	117000
1115	0	318000	0	318000
1116	184100	0	0	184100
1117	130000	0	0	130000
1118	140000	0	0	140000
1119	133700	0	0	133700
1120	118400	0	0	118400
1121	212900	0	0	212900
1122	112000	0	0	112000
1123	118000	0	0	118000
1124	163900	0	0	163900
1125	115000	0	0	115000
1126	174000	0	0	174000
1127	0	259000	0	259000
1128	215000	0	0	215000
1129	140000	0	0	140000
1130	135000	0	0	135000
1131	93500	0	0	93500
1132	117500	0	0	117500

1133	239500	0	0	239500
1134	169000	0	0	169000
1135	102000	0	0	102000
1136	119000	0	0	119000
1137	94000	0	0	94000
1138	196000	0	0	196000
1139	144000	0	0	144000
1140	139000	0	0	139000
1141	197500	0	0	197500
1142	0	424870	0	424870
1143	80000	0	0	80000
1144	80000	0	0	80000
1145	149000	0	0	149000
1146	180000	0	0	180000
1147	174500	0	0	174500
1148	116900	0	0	116900
1149	143000	0	0	143000
1150	124000	0	0	124000
1151	149900	0	0	149900
1152	230000	0	0	230000
1153	120500	0	0	120500
1154	201800	0	0	201800
1155	218000	0	0	218000
1156	179900	0	0	179900
1157	230000	0	0	230000
1158	235128	0	0	235128
1159	185000	0	0	185000
1160	146000	0	0	146000
1161	224000	0	0	224000
1162	129000	0	0	129000
1163	108959	0	0	108959
1164	194000	0	0	194000
1165	233170	0	0	233170
1166	245350	0	0	245350
1167	173000	0	0	173000
1168	235000	0	0	235000
1169	0	0	625000	625000
1170	171000	0	0	171000
1171	163000	0	0	163000
1172	171900	0	0	171900
1173	200500	0	0	200500
1174	239000	0	0	239000
1175	0	285000	0	285000
1176	119500	0	0	119500
1177	115000	0	0	115000
1178	154900	0	0	154900
1179	93000	0	0	93000

1180	250000	0	0	250000
1181	0	392500	0	392500
1182	0	0	745000	745000
1183	120000	0	0	120000
1184	186700	0	0	186700
1185	104900	0	0	104900
1186	95000	0	0	95000
1187	0	262000	0	262000
1188	195000	0	0	195000
1189	189000	0	0	189000
1190	168000	0	0	168000
1191	174000	0	0	174000
1192	125000	0	0	125000
1193	165000	0	0	165000
1194	158000	0	0	158000
1195	176000	0	0	176000
1196	219210	0	0	219210
1197	144000	0	0	144000
1198	178000	0	0	178000
1199	148000	0	0	148000
1200	116050	0	0	116050
1201	197900	0	0	197900
1202	117000	0	0	117000
1203	213000	0	0	213000
1204	153500	0	0	153500
1205	0	271900	0	271900
1206	107000	0	0	107000
1207	200000	0	0	200000
1208	140000	0	0	140000
1209	0	290000	0	290000
1210	189000	0	0	189000
1211	164000	0	0	164000
1212	113000	0	0	113000
1213	145000	0	0	145000
1214	134500	0	0	134500
1215	125000	0	0	125000
1216	112000	0	0	112000
1217	229456	0	0	229456
1218	80500	0	0	80500
1219	91500	0	0	91500
1220	115000	0	0	115000
1221	134000	0	0	134000
1222	143000	0	0	143000
1223	137900	0	0	137900
1224	184000	0	0	184000
1225	145000	0	0	145000
1226	214000	0	0	214000

1227	147000	0	0	147000
1228	0	367294	0	367294
1229	127000	0	0	127000
1230	190000	0	0	190000
1231	132500	0	0	132500
1232	101800	0	0	101800
1233	142000	0	0	142000
1234	130000	0	0	130000
1235	138887	0	0	138887
1236	175500	0	0	175500
1237	195000	0	0	195000
1238	142500	0	0	142500
1239	0	265900	0	265900
1240	224900	0	0	224900
1241	248328	0	0	248328
1242	170000	0	0	170000
1243	0	465000	0	465000
1244	230000	0	0	230000
1245	178000	0	0	178000
1246	186500	0	0	186500
1247	169900	0	0	169900
1248	129500	0	0	129500
1249	119000	0	0	119000
1250	244000	0	0	244000
1251	171750	0	0	171750
1252	130000	0	0	130000
1253	0	294000	0	294000
1254	165400	0	0	165400
1255	127500	0	0	127500
1256	0	301500	0	301500
1257	99900	0	0	99900
1258	190000	0	0	190000
1259	151000	0	0	151000
1260	181000	0	0	181000
1261	128900	0	0	128900
1262	161500	0	0	161500
1263	180500	0	0	180500
1264	181000	0	0	181000
1265	183900	0	0	183900
1266	122000	0	0	122000
1267	0	378500	0	378500
1268	0	381000	0	381000
1269	144000	0	0	144000
1270	0	260000	0	260000
1271	185750	0	0	185750
1272	137000	0	0	137000
1273	177000	0	0	177000

1274	139000	0	0	139000
1275	137000	0	0	137000
1276	162000	0	0	162000
1277	197900	0	0	197900
1278	237000	0	0	237000
1279	68400	0	0	68400
1280	227000	0	0	227000
1281	180000	0	0	180000
1282	150500	0	0	150500
1283	139000	0	0	139000
1284	169000	0	0	169000
1285	132500	0	0	132500
1286	143000	0	0	143000
1287	190000	0	0	190000
1288	0	278000	0	278000
1289	0	281000	0	281000
1290	180500	0	0	180500
1291	119500	0	0	119500
1292	107500	0	0	107500
1293	162900	0	0	162900
1294	115000	0	0	115000
1295	138500	0	0	138500
1296	155000	0	0	155000
1297	140000	0	0	140000
1298	160000	0	0	160000
1299	154000	0	0	154000
1300	225000	0	0	225000
1301	177500	0	0	177500
1302	0	290000	0	290000
1303	232000	0	0	232000
1304	130000	0	0	130000
1305	0	325000	0	325000
1306	202500	0	0	202500
1307	138000	0	0	138000
1308	147000	0	0	147000
1309	179200	0	0	179200
1310	0	335000	0	335000
1311	203000	0	0	203000
1312	0	302000	0	302000
1313	0	333168	0	333168
1314	119000	0	0	119000
1315	206900	0	0	206900
1316	0	295493	0	295493
1317	208900	0	0	208900
1318	0	275000	0	275000
1319	111000	0	0	111000
1320	156500	0	0	156500

1321	72500	0	0	72500
1322	190000	0	0	190000
1323	82500	0	0	82500
1324	147000	0	0	147000
1325	55000	0	0	55000
1326	79000	0	0	79000
1327	130500	0	0	130500
1328	0	256000	0	256000
1329	176500	0	0	176500
1330	227000	0	0	227000
1331	132500	0	0	132500
1332	100000	0	0	100000
1333	125500	0	0	125500
1334	125000	0	0	125000
1335	167900	0	0	167900
1336	135000	0	0	135000
1337	52500	0	0	52500
1338	200000	0	0	200000
1339	128500	0	0	128500
1340	123000	0	0	123000
1341	155000	0	0	155000
1342	228500	0	0	228500
1343	177000	0	0	177000
1344	155835	0	0	155835
1345	108500	0	0	108500
1346	0	262500	0	262500
1347	0	283463	0	283463
1348	215000	0	0	215000
1349	122000	0	0	122000
1350	200000	0	0	200000
1351	171000	0	0	171000
1352	134900	0	0	134900
1353	0	410000	0	410000
1354	235000	0	0	235000
1355	170000	0	0	170000
1356	110000	0	0	110000
1357	149900	0	0	149900
1358	177500	0	0	177500
1359	0	315000	0	315000
1360	189000	0	0	189000
1361	0	260000	0	260000
1362	104900	0	0	104900
1363	156932	0	0	156932
1364	144152	0	0	144152
1365	216000	0	0	216000
1366	193000	0	0	193000
1367	127000	0	0	127000

1368	144000	0	0	144000
1369	232000	0	0	232000
1370	105000	0	0	105000
1371	165500	0	0	165500
1372	0	274300	0	274300
1373	0	466500	0	466500
1374	250000	0	0	250000
1375	239000	0	0	239000
1376	91000	0	0	91000
1377	117000	0	0	117000
1378	83000	0	0	83000
1379	167500	0	0	167500
1380	58500	0	0	58500
1381	237500	0	0	237500
1382	157000	0	0	157000
1383	112000	0	0	112000
1384	105000	0	0	105000
1385	125500	0	0	125500
1386	250000	0	0	250000
1387	136000	0	0	136000
1388	0	377500	0	377500
1389	131000	0	0	131000
1390	235000	0	0	235000
1391	124000	0	0	124000
1392	123000	0	0	123000
1393	163000	0	0	163000
1394	246578	0	0	246578
1395	0	281213	0	281213
1396	160000	0	0	160000
1397	137500	0	0	137500
1398	138000	0	0	138000
1399	137450	0	0	137450
1400	120000	0	0	120000
1401	193000	0	0	193000
1402	193879	0	0	193879
1403	0	282922	0	282922
1404	105000	0	0	105000
1405	0	275000	0	275000
1406	133000	0	0	133000
1407	112000	0	0	112000
1408	125500	0	0	125500
1409	215000	0	0	215000
1410	230000	0	0	230000
1411	140000	0	0	140000
1412	90000	0	0	90000
1413	0	257000	0	257000
1414	207000	0	0	207000

1415	175900	0	0	175900
1416	122500	0	0	122500
1417	0	340000	0	340000
1418	124000	0	0	124000
1419	223000	0	0	223000
1420	179900	0	0	179900
1421	127500	0	0	127500
1422	136500	0	0	136500
1423	0	274970	0	274970
1424	144000	0	0	144000
1425	142000	0	0	142000
1426	0	271000	0	271000
1427	140000	0	0	140000
1428	119000	0	0	119000
1429	182900	0	0	182900
1430	192140	0	0	192140
1431	143750	0	0	143750
1432	64500	0	0	64500
1433	186500	0	0	186500
1434	160000	0	0	160000
1435	174000	0	0	174000
1436	120500	0	0	120500
1437	0	394617	0	394617
1438	149700	0	0	149700
1439	197000	0	0	197000
1440	191000	0	0	191000
1441	149300	0	0	149300
1442	0	310000	0	310000
1443	121000	0	0	121000
1444	179600	0	0	179600
1445	129000	0	0	129000
1446	157900	0	0	157900
1447	240000	0	0	240000
1448	112000	0	0	112000
1449	92000	0	0	92000
1450	136000	0	0	136000
1451	0	287090	0	287090
1452	145000	0	0	145000
1453	84500	0	0	84500
1454	185000	0	0	185000
1455	175000	0	0	175000
1456	210000	0	0	210000
1457	0	266500	0	266500
1458	142125	0	0	142125
1459	147500	0	0	147500

```
[5]: df_melted = pd.melt(encoded_df[columns[:-1]],var_name="Sale Price Bins",␣
     ↪value_name="SalePrice")

     plt.figure(figsize=(10,6))
     sns.boxplot(x="Sale Price Bins", y="SalePrice", data=df_melted)
     plt.title("Boxplot of Bins")
     plt.show()
```
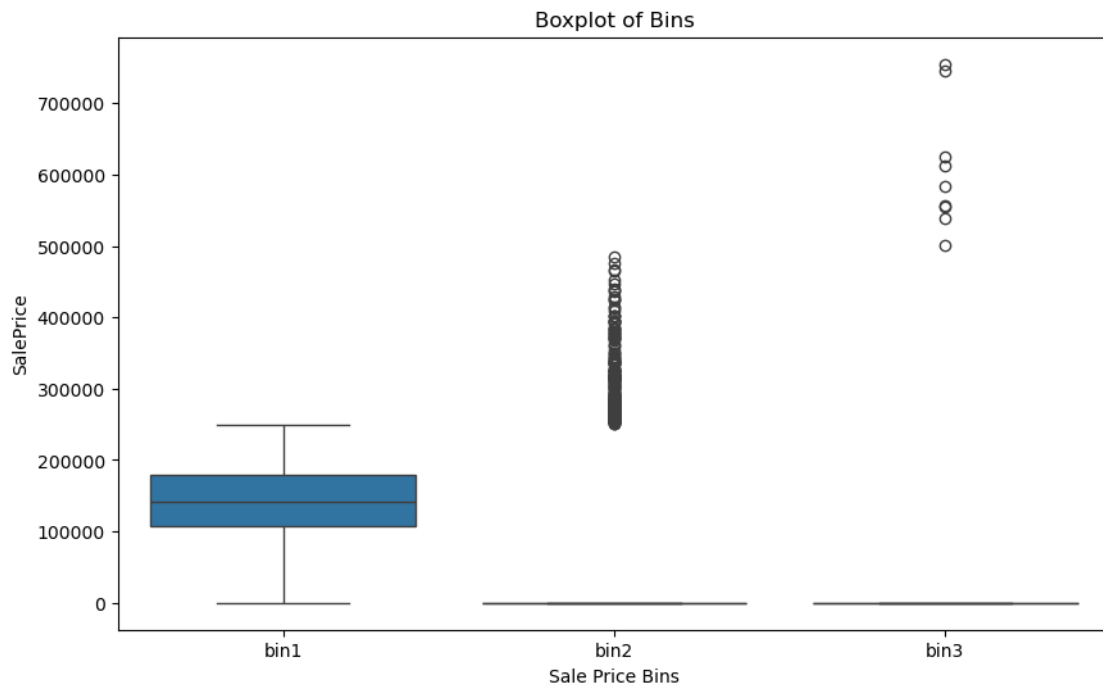

0.5 Problem 2 (5 pts)

Produce the plot of the sliced section of the correlation matrix as shown below.

Hint: Just use the `correlation_matrix` we generated in the class and single out the relevant variables with `.loc()` method and then use `sns.heatmap()`to create the plot shown below.

[ ]:

0.6 Problem 3 (5 pts)

(a) Load the `Breast_Cancer_Wisconsin.csv` into a dataframe and then **normalize** the numerical columns to the interval $[0,1]$. Check with `.describe()` and write a sentence or two to explain what exactly in the outcome of `.describe()` tells you the **normalization** you did was successful.

(b) This time, **standardize** the numerical columns. Check with `.describe()` and write a sentence or two to explain what exactly in the outcome of `.describe()` tells you the **standard-**

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ization you did was successful.

```
[6]: df_cancer = pd.read_csv("Breast_Cancer_Wisconsin.csv")
     df_cancer.drop("Unnamed: 32", axis=1, inplace=True)

     df_cancer.describe()
```

[6]:

	id	radius_mean	texture_mean	perimeter_mean	area_mean
count	5.690000e+02	569.000000	569.000000	569.000000	569.000000
mean	3.037183e+07	14.127292	19.289649	91.969033	654.889104
std	1.250206e+08	3.524049	4.301036	24.298981	351.914129
min	8.670000e+03	6.981000	9.710000	43.790000	143.500000
25%	8.692180e+05	11.700000	16.170000	75.170000	420.300000
50%	9.060240e+05	13.370000	18.840000	86.240000	551.100000
75%	8.813129e+06	15.780000	21.800000	104.100000	782.700000
max	9.113205e+08	28.110000	39.280000	188.500000	2501.000000

	smoothness_mean	compactness_mean	concavity_mean	concave points_mean
count	569.000000	569.000000	569.000000	569.000000
mean	0.096360	0.104341	0.088799	0.048919
std	0.014064	0.052813	0.079720	0.038803
min	0.052630	0.019380	0.000000	0.000000
25%	0.086370	0.064920	0.029560	0.020310
50%	0.095870	0.092630	0.061540	0.033500
75%	0.105300	0.130400	0.130700	0.074000
max	0.163400	0.345400	0.426800	0.201200

	symmetry_mean	...	radius_worst	texture_worst	perimeter_worst
count	569.000000	...	569.000000	569.000000	569.000000
mean	0.181162	...	16.269190	25.677223	107.261213
std	0.027414	...	4.833242	6.146258	33.602542
min	0.106000	...	7.930000	12.020000	50.410000
25%	0.161900	...	13.010000	21.080000	84.110000
50%	0.179200	...	14.970000	25.410000	97.660000
75%	0.195700	...	18.790000	29.720000	125.400000
max	0.304000	...	36.040000	49.540000	251.200000

	area_worst	smoothness_worst	compactness_worst	concavity_worst
count	569.000000	569.000000	569.000000	569.000000
mean	880.583128	0.132369	0.254265	0.272188
std	569.356993	0.022832	0.157336	0.208624
min	185.200000	0.071170	0.027290	0.000000
25%	515.300000	0.116600	0.147200	0.114500
50%	686.500000	0.131300	0.211900	0.226700
75%	1084.000000	0.146000	0.339100	0.382900
max	4254.000000	0.222600	1.058000	1.252000

```
      concave points_worst  symmetry_worst  fractal_dimension_worst
count             569.000000      569.000000               569.000000
mean                0.114606        0.290076                 0.083946
std                 0.065732        0.061867                 0.018061
min                 0.000000        0.156500                 0.055040
25%                 0.064930        0.250400                 0.071460
50%                 0.099930        0.282200                 0.080040
75%                 0.161400        0.317900                 0.092080
max                 0.291000        0.663800                 0.207500

[8 rows x 31 columns]
```

```python
# Get the columns with quantitative and qualitative data with list comprehension
quantitative = [f for f in df_cancer.columns if df_cancer.dtypes[f] != 'object']
qualitative  = [f for f in df_cancer.columns if df_cancer.dtypes[f] == 'object']

df_normalized = (df_cancer[quantitative] - df_cancer[quantitative].min()) /␣
 ↪(df_cancer[quantitative].max() - df_cancer[quantitative].min())

# The data is scaled to range [0,1]. Min = 0 && max = 1
df_normalized.describe()
```

```
[7]:                id  radius_mean  texture_mean  perimeter_mean    area_mean  \
count  569.000000   569.000000    569.000000      569.000000   569.000000
mean     0.033318     0.338222      0.323965        0.332935     0.216920
std      0.137187     0.166787      0.145453        0.167915     0.149274
min      0.000000     0.000000      0.000000        0.000000     0.000000
25%      0.000944     0.223342      0.218465        0.216847     0.117413
50%      0.000985     0.302381      0.308759        0.293345     0.172895
75%      0.009661     0.416442      0.408860        0.416765     0.271135
max      1.000000     1.000000      1.000000        1.000000     1.000000

       smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
count       569.000000        569.000000      569.000000           569.000000
mean          0.394785          0.260601        0.208058             0.243137
std           0.126967          0.161992        0.186785             0.192857
min           0.000000          0.000000        0.000000             0.000000
25%           0.304595          0.139685        0.069260             0.100944
50%           0.390358          0.224679        0.144189             0.166501
75%           0.475490          0.340531        0.306232             0.367793
max           1.000000          1.000000        1.000000             1.000000

       symmetry_mean  …  radius_worst  texture_worst  perimeter_worst  \
count     569.000000  …    569.000000     569.000000       569.000000
mean        0.379605  …      0.296663       0.363998         0.283138
std         0.138456  …      0.171940       0.163813         0.167352
min         0.000000  …      0.000000       0.000000         0.000000
```

```
25%        0.282323  …    0.180719    0.241471    0.167837
50%        0.369697  …    0.250445    0.356876    0.235320
75%        0.453030  …    0.386339    0.471748    0.373475
max        1.000000  …    1.000000    1.000000    1.000000


        area_worst  smoothness_worst  compactness_worst  concavity_worst  \
count  569.000000        569.000000         569.000000       569.000000
mean     0.170906          0.404138           0.220212         0.217403
std      0.139932          0.150779           0.152649         0.166633
min      0.000000          0.000000           0.000000         0.000000
25%      0.081130          0.300007           0.116337         0.091454
50%      0.123206          0.397081           0.179110         0.181070
75%      0.220901          0.494156           0.302520         0.305831
max      1.000000          1.000000           1.000000         1.000000


        concave points_worst  symmetry_worst  fractal_dimension_worst
count            569.000000      569.000000               569.000000
mean               0.393836        0.263307                 0.189596
std                0.225884        0.121954                 0.118466
min                0.000000        0.000000                 0.000000
25%                0.223127        0.185098                 0.107700
50%                0.343402        0.247782                 0.163977
75%                0.554639        0.318155                 0.242949
max                1.000000        1.000000                 1.000000

[8 rows x 31 columns]
```

```python
[8]:  df_standardize = (df_normalized – df_normalized.mean()) / df_normalized.std()

      # This data centered around the mean with a standart deviation 1.
      df_standardize.describe()
```

```
[8]:                  id    radius_mean   texture_mean   perimeter_mean      area_mean  \
count   5.690000e+02   5.690000e+02   5.690000e+02     5.690000e+02   5.690000e+02
mean    6.243785e-17   6.868164e-17  -2.278982e-16     2.122887e-16  -8.116921e-17
std     1.000000e+00   1.000000e+00   1.000000e+00     1.000000e+00   1.000000e+00
min    -2.428653e-01  -2.027864e+00  -2.227289e+00    -1.982759e+00  -1.453164e+00
25%    -2.359820e-01  -6.887793e-01  -7.253249e-01    -6.913472e-01  -6.666089e-01
50%    -2.356876e-01  -2.148925e-01  -1.045442e-01    -2.357726e-01  -2.949274e-01
75%    -1.724412e-01   4.689800e-01   5.836621e-01     4.992377e-01   3.631877e-01
max     7.046429e+00   3.967796e+00   4.647799e+00     3.972634e+00   5.245913e+00


        smoothness_mean   compactness_mean   concavity_mean   concave points_mean  \
count      5.690000e+02       5.690000e+02     5.690000e+02          5.690000e+02
mean       2.247763e-16      -1.123881e-16    -1.248757e-17          3.746271e-17
std        1.000000e+00       1.000000e+00     1.000000e+00          1.000000e+00
min       -3.109349e+00      -1.608721e+00    -1.113893e+00         -1.260710e+00
```

```
25%        -7.103378e-01      -7.464292e-01   -7.430941e-01        -7.372951e-01
50%        -3.486040e-02      -2.217454e-01   -3.419391e-01        -3.973715e-01
75%         6.356397e-01       4.934227e-01    5.255994e-01         6.463664e-01
max         4.766717e+00       4.564409e+00    4.239858e+00         3.924477e+00


          symmetry_mean    …   radius_worst   texture_worst   perimeter_worst  \
count       5.690000e+02    …   5.690000e+02    5.690000e+02       5.690000e+02
mean       -8.741299e-17    …   1.998011e-16   -2.497514e-17       2.497514e-17
std         1.000000e+00    …   1.000000e+00    1.000000e+00       1.000000e+00
min        -2.741705e+00    …  -1.725382e+00   -2.222039e+00      -1.691872e+00
25%        -7.026215e-01    …  -6.743279e-01   -7.479711e-01      -6.889721e-01
50%        -7.156354e-02    …  -2.688030e-01   -4.347738e-02      -2.857288e-01
75%         5.303125e-01    …   5.215568e-01    6.577623e-01       5.398040e-01
max         4.480808e+00    …   4.090590e+00    3.882489e+00       4.283568e+00


            area_worst   smoothness_worst   compactness_worst   concavity_worst  \
count     5.690000e+02       5.690000e+02        5.690000e+02      5.690000e+02
mean     -4.995028e-17      -2.497514e-16        1.498508e-16      9.990056e-17
std       1.000000e+00       1.000000e+00        1.000000e+00      1.000000e+00
min      -1.221348e+00      -2.680337e+00       -1.442609e+00     -1.304683e+00
25%      -6.415713e-01      -6.906227e-01       -6.804845e-01     -7.558491e-01
50%      -3.408813e-01      -4.680159e-02       -2.692639e-01     -2.180402e-01
75%       3.572747e-01       5.970195e-01        5.391944e-01      5.306742e-01
max       5.924959e+00       3.951897e+00        5.108382e+00      4.696536e+00


          concave points_worst   symmetry_worst   fractal_dimension_worst
count             5.690000e+02     5.690000e+02              5.690000e+02
mean             -1.123881e-16     3.746271e-17              1.373633e-16
std               1.000000e+00     1.000000e+00              1.000000e+00
min              -1.743529e+00    -2.159060e+00             -1.600431e+00
25%              -7.557349e-01    -6.412994e-01             -6.913035e-01
50%              -2.232725e-01    -1.272975e-01             -2.162538e-01
75%               7.118836e-01     4.497425e-01              4.503661e-01
max               2.683516e+00     6.040726e+00              6.840837e+00

[8 rows x 31 columns]
```

0.7   Problem 4 - Bayes' Theorem (10 pts)

Let's assume the probability of being infected by covid is 0.1. If you're infected, PCR tests show you're covid positive with 80% accuracy. If you're not infected, PCR tests show you're covid positive with probability 1/90 (false positive). If you test covid positive in a PCR test, what is the probability that you're really infected with covid?

Hint 1: You can use c+ and c- for covid infection, and pcr+ and pcr- for test results, like P(c+)=0.1. Hint 2: The answer is 0.89. Show in the cell below your algebraic steps involved in your solution. You don't need to write a Python code.

0.7.1 Answer

Given

- Let A (A' is complement) be the event that being infected by Covid and B be the event that test is positive.
- $P(A) = 0.1$
- $P(B|A) = 0.8$

- $P(B|\ A') = \frac{1}{90}$

Asked

- $P(A|B) = ?$

Solution   Bayes' Theorem States:

$$P(A|\ B) = \frac{P(B|\ A).P(A)}{P(B)}$$

In our case using the **Law of Total Probabilities**

$$P(B) = P(B|A).P(A) + P(B|A').P(A') = 0.8.0.1 + (\frac{1}{90}.0.9) = 0.09$$

Substituting second equation to the first one,

$$P(A|\ B) = \frac{P(B|\ A).P(A)}{P(B)} = \frac{0.8.0.1}{0.09} = 0.89$$

0.8 Problem 5 (5 pts)

Calculate the mean of the random variable K which assumes the values k=1, 2, 3 and 4 by using the pmf given below.

(You don't need to write a Python code; please show the algebraic steps involved in your solution.)

Answer   By definiton: $\mu = \sum_i x_i.pmf_i$

So,

$\mu = \sum((1 * 0.2) + (2 * 0.1) + (3 * 0.6) + (4 * 0.1) + (5 * 0)) = 2.6$

0.9 Problem 6 (10 pts)

A joint pmf is provided on the table, where X and Y are not independent.

(a) You randomly select values for X and Y. What is the probability that X=2 and Y=3?

(b) Your friend randomly select values for X and Y, and tells you that X turned out to be 3, but he does not reveal what Y came out to be. What's the probability that Y=2 given that you know that X=3.

(c) What is the probability that Y=3 regardless of the value of X?

(You don't need to write a Python code; please show the algebraic steps involved in your solution and explain your solution in words if necessary.)

(a)

$$P(X = 2 \ \cap Y = 3) = \frac{3}{50}$$

(b) p := jpmf

$$P(Y = 2|X = 3) = p_{X,Y}(y = 3|x = 3) = \frac{p_{X,Y}(y = 3|x = 3)}{p_{X,Y}(x = 3)} = \frac{\frac{29}{200}}{\frac{3}{8}} = \frac{29}{75}$$

(c)

$$P(Y = 3) = \frac{27}{200} + \frac{13}{100} + \frac{9}{100} = \frac{71}{200}$$

0.10 Problem 7 (5 pts)

We observe that ice-cream sales and sunburns on people's back co-occur. Are the statements below True or False?

   (a) "These two phenomena are correlated" True/False?
   (b) "There's a direct causal relationship between these two phenomena" True/False?

```
[9]: # Your answer (type True or False)
     # (a) True
     # (b) False
```

0.11 Problem 8 (10 pts)

A particle in a box can be somewhere between x=0 and x=1 m. The pdf about where it can be found is given by

$$f(x) = ax(1 - x)$$

   (a) What should be the value of a so that the pdf is normalized? (Hint 1: The area under the pdf should be equal to 1.)

   (b) What's the probability that this particle can be found in the region 0 x 0.1?

Hint 2: For the second question, you'll take the integral. You can use https://www.wolframalpha.com for that or get help from fellow students. In any case, explain how you did it, or if you used wolframalpha, attach a screenshot by using a Markdown cell. The answer for part (b) is 0.028; but show your work on how you reached the answer.

Answer a We have antiderivative of f as below,

$$a \int_0^1 (x - x^2)dx = a.(\frac{x^2}{2} - \frac{x^3}{3}) + C$$

Since f is continuous in the given interval by the **Fundamental Theorem of Calculus**,

$$\int_b^a f(x)dx = F(b) - F(a)$$

Then

$$a.(\frac{1^2}{2} - \frac{1^3}{3}) + C] - 0 = a.\frac{1}{6}$$

Then a should be 6 for the area to be equal to 1. Further computational calcualtions are shown below.

```
[10]: def int_f(x):
          return (x**2)/2 - (x**3)/3


      def plot(x_coords, y_coords):
          # Plot the scattered plots
          plt.scatter(x_coords, y_coords, color='blue', marker='.')  # 'o' denotes␣
          ↪circle markers
          plt.title('Scatter Plot of Points')
          plt.xlabel('X-axis')
          plt.ylabel('Y-axis')
          plt.grid(True)
          plt.show()
```

```
[11]: sensitivity = 0.01

      # Create incremental ranges and corresponding probability values as tuple
      points = [(i,int_f(i)) for i in np.arange(0, 1, sensitivity)]

      # Divide x and y points into two lists
      x_coords, y_coords = zip(*points)

      # Clearly the integral converges. What we want is this ares under the function␣
      ↪is to be converged to 1.
      plot(x_coords, y_coords)
```

Scatter Plot of Points
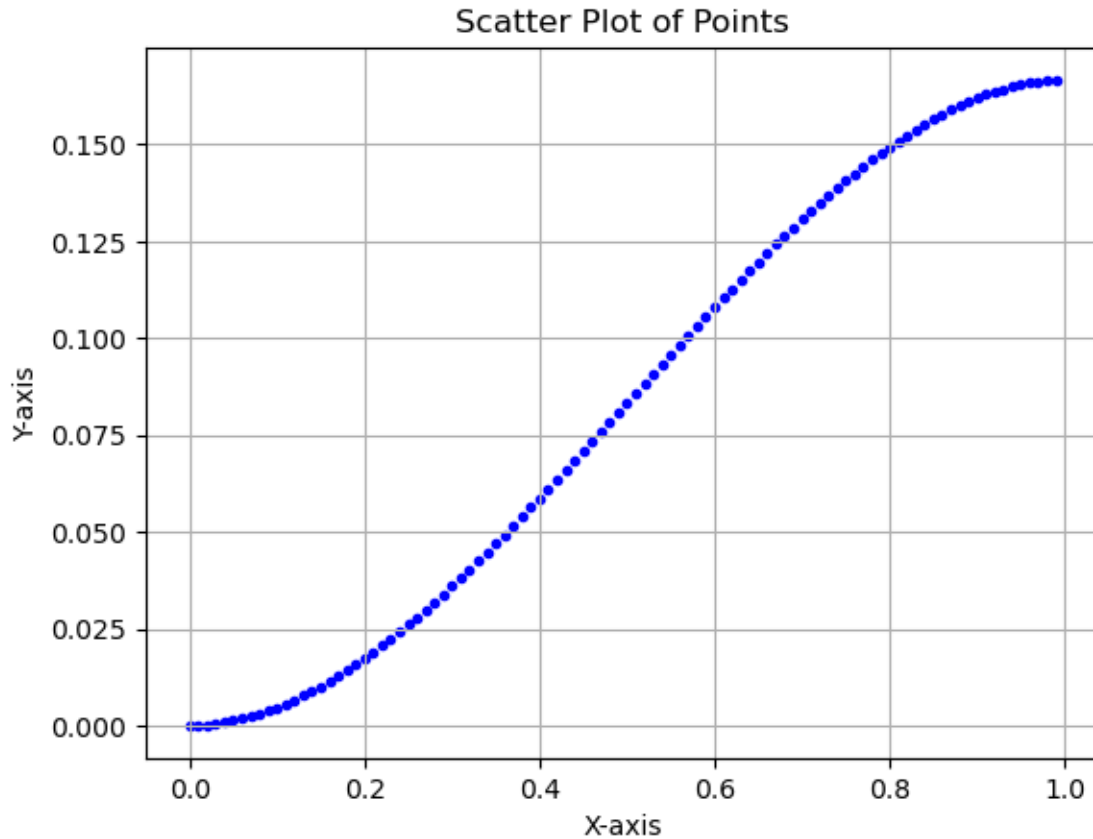
[12]: `# a should converges to 6 as sensitivity increases or dx(increment) decreases`

`print( 1 / (y_coords[-1] - y_coords[0]))`

6.001788532982831

Answer b   The probability for the particule to be between $0 \leq x \leq 0.1$ is the area under the curve between the given range. By Fundamental Theorem of Calculus, again the following calculations follows:

[13]:
```
sensitivity = 0.01
points = [(i, int_f(i)) for i in np.arange(0, 1, sensitivity)]
x_coords, y_coords = zip(*points)
plot(x_coords, y_coords)
```

Scatter Plot of Points
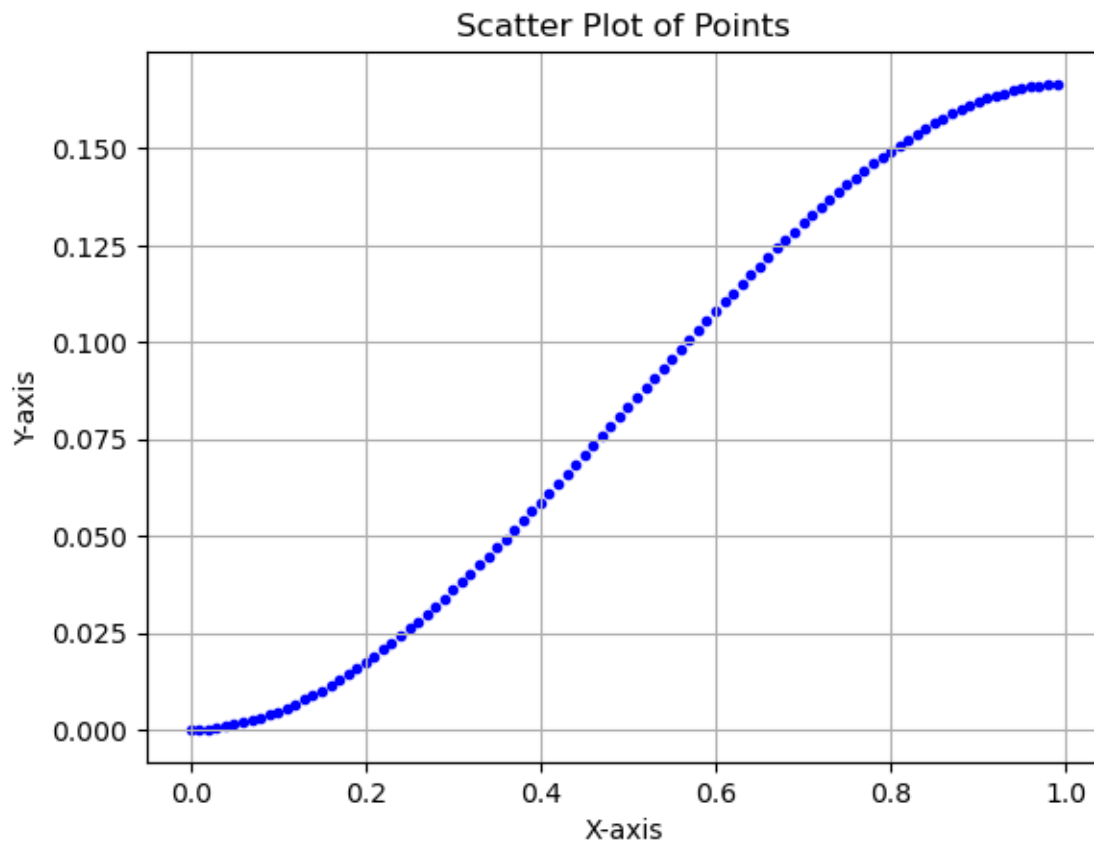
```
[14]: print(6 * (int_f(0.1) - int_f(0))) # with sensitivity = 0.01
```

0.028000000000000008