

Python 3.12.4 | packaged by Anaconda, Inc. | (main, Jun 18 2024, 15:03:56) [MSC v.1929 64 bit (AMD64)]

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IPython 8.25.0 -- An enhanced Interactive Python.

Populating the interactive namespace from numpy and matplotlib

In [1]: runcell(0, 'E:/git/machine-learning-option-pricing/train_main.py')

Tue Oct 1 19:56:24 2024

loading data...

100% | 550/550 files | 2.06files/s | Elapsed: 04:27 | Remaining: 00:00 | Prices:
25092525

duplicates dropped: 0

preparing data...

	spot_price	strike_price	w	heston_price	30D	60D	\
0	1416.59	1274.0	put	50.467710	10.5383	11.5175	
1	1416.59	1274.0	put	55.996144	10.5383	11.5175	
2	1416.59	1274.0	put	61.602990	10.5383	11.5175	
3	1416.59	1274.0	put	67.262141	10.5383	11.5175	
4	1416.59	1274.0	put	72.952283	10.5383	11.5175	

...
25092520	1362.14	1497.0	put	1000.496544	21.2572	21.5039
25092521	1362.14	1497.0	put	1003.074440	21.2572	21.5039
25092522	1362.14	1497.0	put	1005.636292	21.2572	21.5039
25092523	1362.14	1497.0	put	1008.182192	21.2572	21.5039
25092524	1362.14	1497.0	put	1010.712234	21.2572	21.5039

	3M	6M	12M	18M	24M	moneyness \
0	12.2136	13.3022	13.9976	14.3090	14.5891	-0.100657
1	12.2136	13.3022	13.9976	14.3090	14.5891	-0.100657
2	12.2136	13.3022	13.9976	14.3090	14.5891	-0.100657
3	12.2136	13.3022	13.9976	14.3090	14.5891	-0.100657
4	12.2136	13.3022	13.9976	14.3090	14.5891	-0.100657

...
25092520	21.7415	22.4016	22.5289	22.6166	22.6696	0.099006
25092521	21.7415	22.4016	22.5289	22.6166	22.6696	0.099006
25092522	21.7415	22.4016	22.5289	22.6166	22.6696	0.099006
25092523	21.7415	22.4016	22.5289	22.6166	22.6696	0.099006
25092524	21.7415	22.4016	22.5289	22.6166	22.6696	0.099006

	risk_free_rate	dividend_rate	kappa	theta	rho	eta \
0	0.04	1.8125	0.233438	0.082956	-1.0	0.098497
1	0.04	1.8125	0.233438	0.082956	-1.0	0.098497
2	0.04	1.8125	0.233438	0.082956	-1.0	0.098497
3	0.04	1.8125	0.233438	0.082956	-1.0	0.098497
4	0.04	1.8125	0.233438	0.082956	-1.0	0.098497

...
25092520	0.04	2.1471	2.625854	0.055611	-1.0	0.191762

25092521	0.04	2.1471	2.625854	0.055611	-1.0	0.191762
25092522	0.04	2.1471	2.625854	0.055611	-1.0	0.191762
25092523	0.04	2.1471	2.625854	0.055611	-1.0	0.191762
25092524	0.04	2.1471	2.625854	0.055611	-1.0	0.191762

	v0	days_to_maturity	expiration_date	calculation_date	\
0	0.010662	30	2007-02-02	2007-01-03	
1	0.010662	31	2007-02-03	2007-01-03	
2	0.010662	32	2007-02-04	2007-01-03	
3	0.010662	33	2007-02-05	2007-01-03	
4	0.010662	34	2007-02-06	2007-01-03	
...	
25092520	0.043887	182	2008-12-08	2008-06-09	
25092521	0.043887	183	2008-12-09	2008-06-09	
25092522	0.043887	184	2008-12-10	2008-06-09	
25092523	0.043887	185	2008-12-11	2008-06-09	
25092524	0.043887	186	2008-12-12	2008-06-09	

	moneyiness_tag	observed_price
0	otm	50.467710
1	otm	55.996144
2	otm	61.602990
3	otm	67.262141
4	otm	72.952283
...
25092520	itm	1000.814167
25092521	itm	1003.246268
25092522	itm	1005.636292

25092523	itm	1008.223856
25092524	itm	1010.890940

[16359714 rows x 24 columns]

	spot_price	strike_price	heston_price	30D	60D	\
count	1.635971e+07	1.635971e+07	1.635971e+07	1.635971e+07	1.635971e+07	
mean	1.446322e+03	1.445306e+03	5.909304e+02	1.740956e+01	1.789071e+01	
min	1.274240e+03	1.146000e+03	4.726311e+01	8.636700e+00	9.495000e+00	
25%	1.398050e+03	1.368000e+03	4.281200e+02	1.240810e+01	1.291570e+01	
50%	1.449930e+03	1.443000e+03	6.100989e+02	1.709790e+01	1.840720e+01	
75%	1.503360e+03	1.523000e+03	7.576045e+02	2.201880e+01	2.235960e+01	
max	1.565180e+03	1.720000e+03	1.061961e+03	2.995070e+01	2.829370e+01	
std	6.591097e+01	1.064472e+02	2.112008e+02	5.347308e+00	5.028113e+00	

	3M	6M	12M	18M	24M	\
count	1.635971e+07	1.635971e+07	1.635971e+07	1.635971e+07	1.635971e+07	
mean	1.812346e+01	1.837540e+01	1.856880e+01	1.874065e+01	1.929819e+01	
min	1.014580e+01	1.168230e+01	1.272360e+01	1.319620e+01	1.352750e+01	
25%	1.324410e+01	1.371090e+01	1.412510e+01	1.449040e+01	1.473800e+01	
50%	1.883760e+01	1.928180e+01	1.954480e+01	1.970890e+01	2.067210e+01	
75%	2.242450e+01	2.231210e+01	2.214810e+01	2.215590e+01	2.277320e+01	
max	2.760590e+01	2.687800e+01	2.587950e+01	2.534040e+01	2.563270e+01	
std	4.807522e+00	4.331106e+00	3.953922e+00	3.781332e+00	3.867254e+00	

	moneyness	risk_free_rate	dividend_rate	kappa	\
count	1.635971e+07	1.635971e+07	1.635971e+07	1.635971e+07	
mean	-7.039879e-04	4.000000e-02	1.952650e+00	2.049842e+00	

min	-1.007480e-01	4.000000e-02	1.779800e+00	3.970018e-02
25%	-5.072076e-02	4.000000e-02	1.851700e+00	1.004526e+00
50%	-7.059778e-04	4.000000e-02	1.911800e+00	1.679351e+00
75%	4.929428e-02	4.000000e-02	2.065400e+00	2.278343e+00
max	9.935351e-02	4.000000e-02	2.308100e+00	1.232603e+01
std	5.773390e-02	7.907564e-14	1.321761e-01	1.815439e+00

	theta	rho	eta	v0 \
count	1.635971e+07	1.635971e+07	1.635971e+07	1.635971e+07
mean	4.535315e-02	-9.452017e-01	1.895748e-01	3.391006e-02
min	1.992058e-02	-1.000000e+00	8.817807e-02	5.244166e-03
25%	3.107256e-02	-1.000000e+00	1.237251e-01	1.499869e-02
50%	4.690581e-02	-9.999999e-01	1.675529e-01	2.975613e-02
75%	5.647989e-02	-9.999997e-01	1.988970e-01	4.931998e-02
max	4.050494e-01	-2.766103e-01	1.457690e+00	1.350097e-01
std	2.399709e-02	1.462547e-01	1.359214e-01	2.146813e-02

	days_to_maturity	expiration_date \
count	1.635971e+07	16359714
mean	1.080000e+02	2008-01-03 14:53:13.504922880
min	3.000000e+01	2007-02-02 00:00:00
25%	6.900000e+01	2007-08-29 00:00:00
50%	1.080000e+02	2008-01-01 00:00:00
75%	1.470000e+02	2008-05-10 00:00:00
max	1.860000e+02	2008-12-12 00:00:00
std	4.532108e+01	NaN

calculation_date observed_price

count		16359714	1.635971e+07
mean	2007-09-17 14:53:13.504923392		5.909902e+02
min	2007-01-03 00:00:00		4.726311e+01
25%	2007-05-14 00:00:00		4.281810e+02
50%	2007-09-17 00:00:00		6.101599e+02
75%	2008-01-23 00:00:00		7.576634e+02
max	2008-06-09 00:00:00		1.061961e+03
std		NaN	2.112008e+02

spot(s):

```
[1274.24 1276.84 1288.77 1293.41 1298.46 1304.46 1308.8 1311.13 1314.81
 1315.19 1320.45 1322.21 1325.42 1325.9 1326.38 1326.79 1328.62 1329.65
 1329.75 1330.53 1330.91 1331.14 1331.49 1333.24 1333.44 1333.8 1334.79
 1336.97 1337.24 1338.73 1339.01 1340.92 1342.48 1348.8 1348.82 1348.83
 1349.69 1349.91 1351.52 1352.69 1353.69 1353.73 1354.63 1354.95 1360.03
 1360.47 1360.48 1362.14 1363.84 1365.56 1365.65 1366.54 1367.41 1367.69
 1369.22 1369.79 1370.68 1371.44 1372.41 1372.91 1374.2 1376.17 1376.18
 1376.5 1377.07 1377.59 1377.99 1379.83 1380.11 1380.72 1380.79 1381.38
 1385.23 1385.42 1385.74 1386.77 1386.98 1387.16 1388.04 1388.3 1388.63
 1390.08 1390.45 1390.84 1391.01 1391.18 1391.82 1392.05 1392.46 1394.07
 1395. 1395.15 1396.31 1397.45 1398. 1398.05 1399.4 1399.96 1401.2
 1401.5 1401.77 1402.74 1403.05 1403.12 1403.51 1403.52 1406.48 1406.58
 1406.64 1406.77 1407.53 1408.06 1409.11 1409.14 1409.82 1410.74 1411.59
 1412.12 1412.71 1413.18 1413.53 1413.8 1414.71 1416.12 1416.34 1416.4
 1416.59 1416.97 1418.28 1418.38 1419.95 1420.46 1420.83 1422.42 1422.43
 1423.07 1423.24 1423.8 1424.27 1424.44 1425.15 1426.09 1426.43 1426.6
 1428.02 1428.35 1428.7 1428.81 1430.36 1430.59 1430.69 1431.78 1433.18]
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1433.19 1433.55 1433.65 1434.56 1434.69 1436.11 1437.38 1437.45 1438.07
1438.45 1438.91 1438.99 1439.15 1439.53 1439.88 1439.97 1443.66 1444.24
1444.47 1445.28 1445.5 1445.71 1446.04 1446.9 1447.03 1447.04 1447.54
1447.77 1447.89 1448.38 1448.46 1449.6 1449.93 1451.21 1451.23 1451.6
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1460.37 1462.63 1462.85 1463.59 1463.78 1466.35 1466.84 1467.25 1467.54
1467.95 1468.23 1469.04 1469.89 1470.07 1470.62 1471.33 1471.43 1471.49
1471.93 1471.99 1472.32 1472.58 1472.83 1473.51 1474.26 1475.44 1476.23
1476.68 1476.91 1477.65 1477.88 1478.45 1479.09 1480.49 1480.57 1481.12
1481.25 1482.47 1483.7 1484.16 1484.4 1484.51 1484.68 1484.86 1486.09
1486.9 1488.85 1489.28 1489.55 1491.66 1492.47 1493.24 1494.22 1494.32
1495.27 1496. 1496.9 1497.37 1497.42 1497.46 1500.66 1501.4 1502.13
1502.3 1502.37 1503.06 1503.36 1504.31 1505.36 1505.49 1506. 1506.03
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1515.9 1516.16 1516.28 1517.65 1517.78 1517.93 1518.08 1518.59 1518.8
1519.26 1519.38 1519.66 1520.45 1521.61 1522.16 1522.51 1522.95 1523.96
1524.76 1524.84 1525.35 1525.39 1525.5 1526.61 1528.78 1529.95 1530.14
1530.37 1530.69 1531.05 1531.08 1531.44 1531.83 1532.93 1533.31 1534.08
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1544.83 1546.47 1546.48 1547.66 1548.82 1549.07 1549.66 1549.68 1552.26
1552.65 1552.8 1554.55 1557.09 1561.58 1562.09 1565.18]

strikes:

[1146. 1147. 1148. 1149. 1150. 1151. 1152. 1153. 1154. 1155. 1156. 1157.
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maturities:

[30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101
102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119
120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137
138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155
156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173
174 175 176 177 178 179 180 181 182 183 184 185 186]

types:
['put']

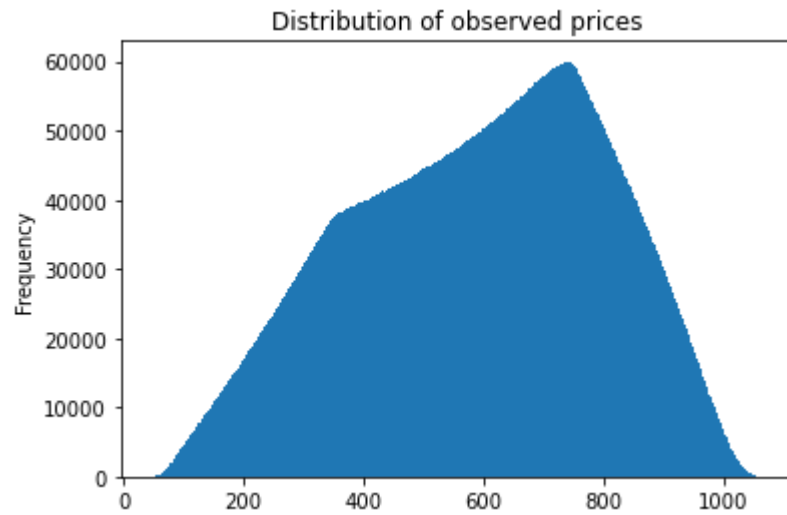
['otm' 'itm' 'atm']

moneyness:
[-0.10074799 -0.10070293 -0.10070209 ... 0.09931666 0.0993387
0.09935351]

number of calls, puts:
0,16359714

initial count:
25092525

total prices:
16359714



test size: 1.0%
random state: None
maximum iterations: 1000

target:
observed_price

features:
['spot_price', 'strike_price', 'days_to_maturity', 'dividend_rate', 'w']

feature transformer(s):
('StandardScaler', StandardScaler(), ['spot_price', 'strike_price', 'days_to_maturity', 'dividend_rate'])

('OrdinalEncoder', OrdinalEncoder(), ['w'])

target transformer(s):
StandardScaler()

train data count:
16195495

Deep Neural Network
hidden layers sizes: (10, 10, 10)
learning rate: adaptive
activation: relu
solver: sgd
alpha: 0.0001

training...

results:

test data count: 163591

mean 0.0031068509

std 0.0034863656

min 0.0000000106

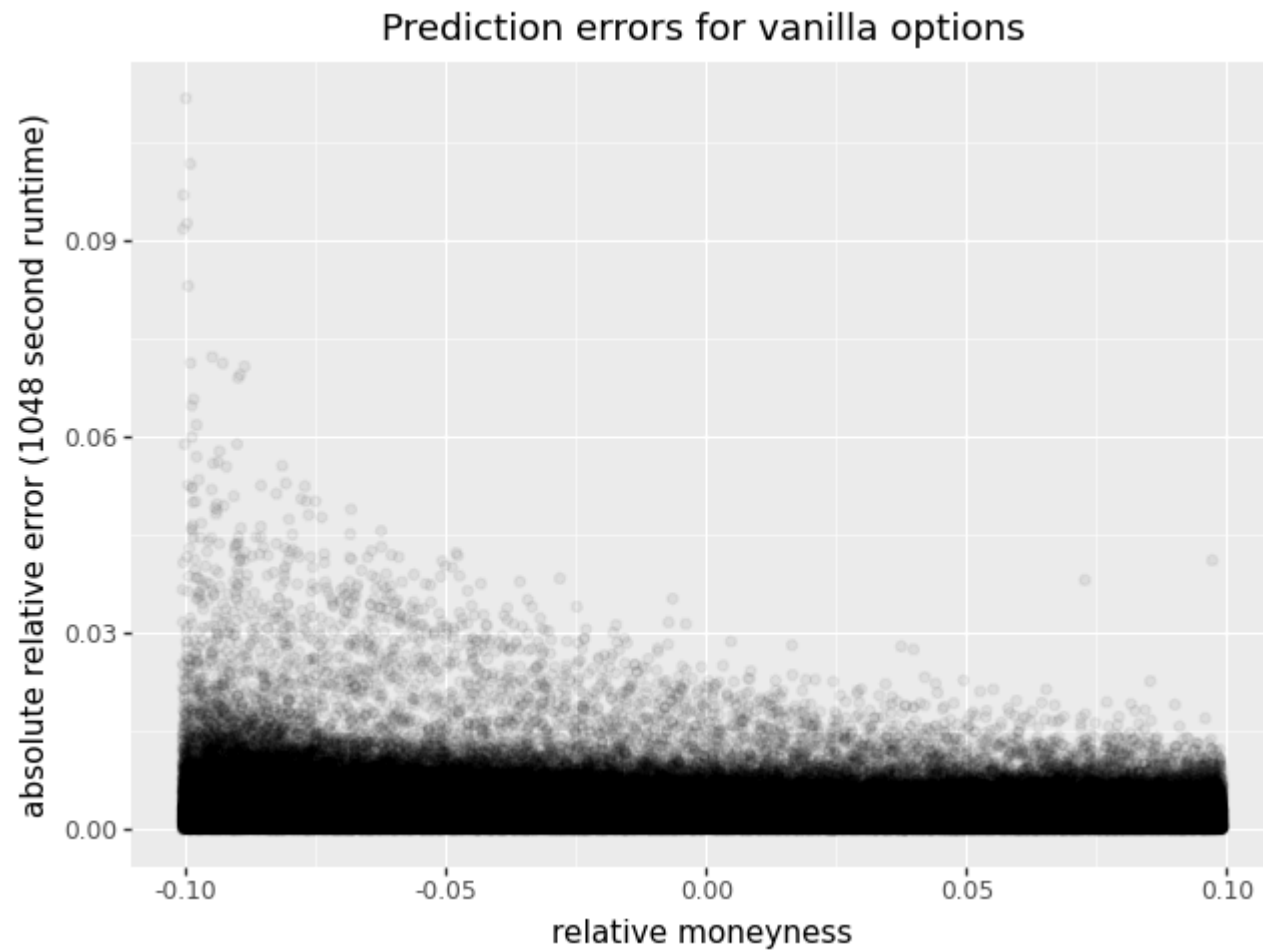
25% 0.0010824822

50% 0.0022784854

75% 0.0039459635

max 0.1116680858

Name: abs_relative_error, dtype: float64



runtime: 1386 seconds

<Figure size 432x288 with 0 Axes>

```
In [2]: runcell(0, 'E:/git/machine-learning-option-pricing/trained_model_testing.py')
```

Tue Oct 1 20:19:31 2024