Lab 01

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Binomial Asset Pricing Model

To ensure no arbitrage, the following condition has to be satisfied:

$$0 < d < e^r < u$$

Where, r is the risk-free interest rate during the duration of the time step and u and d is up-factor and the down-factor respectively.

Q-1:

M	Call	Put
1	43.690448	25.464531
5	41.354882	23.128964
10	41.590750	23.364832
20	41.463404	23.237486
50	41.227779	23.001861
100	41.191562	22.965644
200	41.252254	23.026336
400	41.231376	23.005458

Observation: With increase in sub-intervals, the initial option prices for both put and call converge to around 41.23 and 23.005 respectively.

How large can M be: Larger the value of M, more accurate the result would be. So, in theory M can be set to infinity to mimic a continuous model. In practice, M can be set according to the acceptable tolerance of the error in derivative prices. This can save computation time and resources.

Q-2:

Running computations with M ranging from 1 to 250 with step size 1.
No-arbitrage condition satisfied for all configurations.

Call_option price: 41.23629993289957
Put option price: 23.010382155397004

Running computations with M ranging from 1 to 250 with step size 5.
No-arbitrage condition satisfied for all configurations.

Call_option price: 41.23629993289957
Put option price: 23.010382155397004
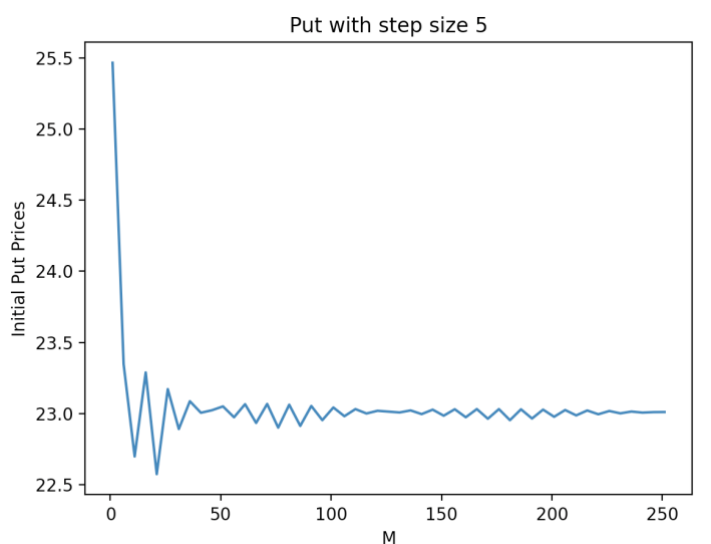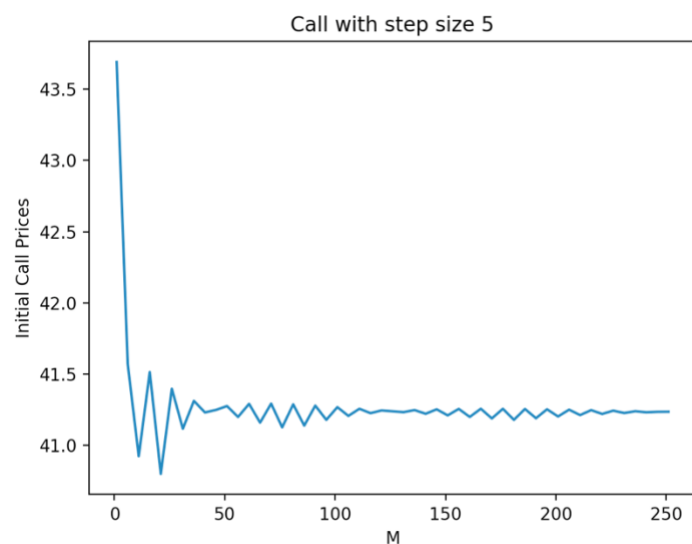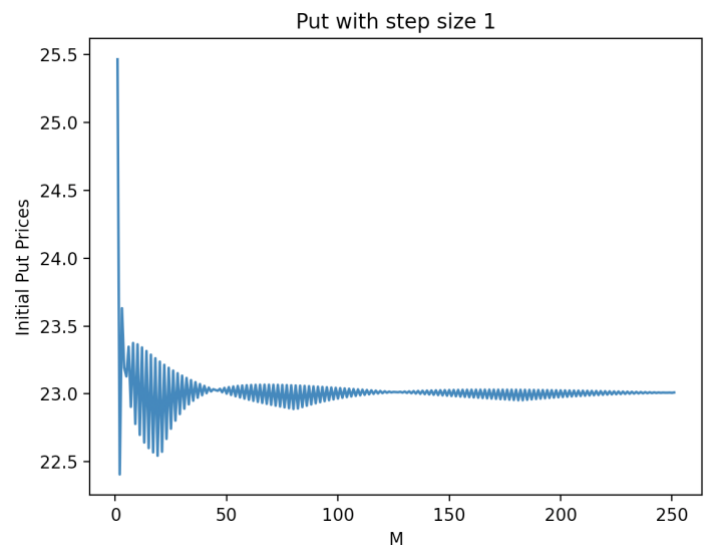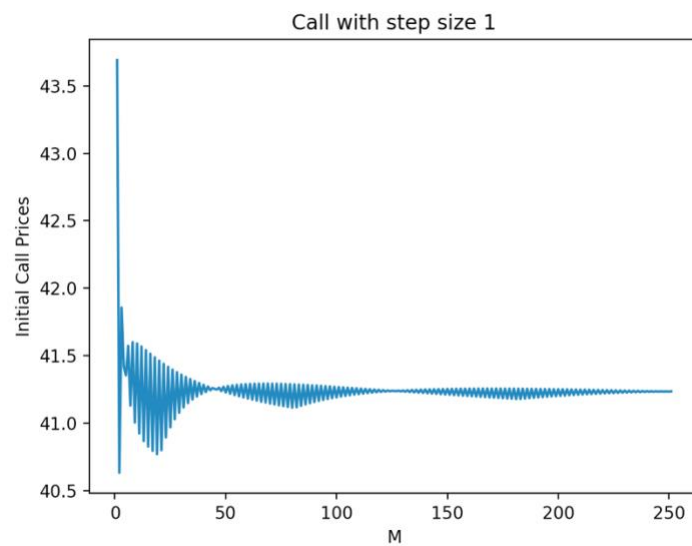
Observation: Final convergence values are same irrespective of the step size. But the convergence speed with step increments of 5 is greater than step increments of 1. As a result, oscillations about the limit are decreased.

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Q-3:

```
T = 4.5
            Call           Put
0      3095.238437      0.000000
1      2041.038658      0.000000
2      1334.387414      0.000000
3       860.704919      0.000000
4       543.186048      0.000000
5       330.346783      0.000000
6       187.676358      0.000000
7        92.041511      0.000000
8        32.544848      4.609291
9         5.713814     20.749764
10        0.000000     43.840612
11        0.000000     63.148954
12        0.000000     76.091723
13        0.000000     84.767521
14        0.000000     90.583082
15        0.000000     94.481369
16        0.000000     97.094469
17        0.000000     98.846082
18        0.000000    100.020224
```

```
T = 3.0
            Call           Put
0       912.434537      0.000000
1       580.300951      0.000000
2       357.731699      0.066549
3       209.127321      0.699410
4       111.824978      3.433781
5        51.891331     10.556749
6        19.500857     23.115667
7         5.421859     39.167148
8         0.971959     54.914313
9         0.083160     67.564011
10        0.000000     76.555976
11        0.000000     82.639215
12        0.000000     86.716932
```

```
T = 1.5
            Call           Put
0       231.471732      2.212378
1       130.634789      6.016624
2        67.555182     13.080104
3        31.010664     23.553903
4        12.189009     36.249569
5         3.936235     49.123486
6         0.992388     60.341285
```

```
T = 1.0
            Call           Put
0       136.669118      6.659221
1        72.389701     13.582968
2        34.584379     23.506555
3        14.473872     35.389691
4         5.137162     47.498962
```

```
T = 0.5
            Call           Put
0        77.090785     13.973555
1        38.063851     23.396860
2        16.753059     34.563234
```

```
T = 0.0
            Call           Put
0        41.463404     23.237486
```

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