Demonstrating BinomialTree and Option Classes

In this notebook, I will demonstrate the functionality of the `BinomialTree` and `Option` classes defined in `methods.binomialtree` and `methods.option` respectively. I will do this by working through exercises proposed in:

Hull, J. C. (2003). *Options, Futures, and Other Derivatives* (2nd ed.). Prentice-Hall. Chapter 14: Numerical Methods.

In [1]:

```python
from methods.binomialtree import BinomialTree
from methods.option import Option, Put, Call
from methods.node import Node
```

Ex 14.1 American Put on no-dividend asset

In [2]:

```python
# Time to maturity
T = 0.4167
# Number of timesteps
steps = 5
# Current asset price
S = 50
# Option to price
X = 50
option = Put(X, american=True)
# Risk free interest rate and asset volatility (we assume these are constant up
# to maturity). BinomialTree class can be extended so that these can be a
# function of time.
r = 0.10
sigma = 0.4
```

In [3]:

```python
# Initialize and fit BinomialTree model
american_put_tree = BinomialTree(T, steps)
american_put_tree.fit(r=r, sigma=sigma, S=S, option=option)
```

In [4]:

```python
american_put_tree
```

Out[4]:

```
BinomialTree
(time 0.4167 in 5 steps)
(r = 0.1, q = 0, sigma = 0.4)
(S = 50, f = 4.4886)
```

In [5]:

```python
print(f'The computed option price for the given american put is {american_put_tree.f:.5f} dollars.')
```

```
The computed option price for the given american put is 4.48860 dollars.
```

In [6]:

```python
# Binomial tree representation
print(american_put_tree)
```

```
                                        (50.00, 4.49)_00
                                            /       \
                              (44.55, 6.96)_10 (56.12, 2.16)_11
                                  /       \       /       \
                    (39.69, 10.36)_20 (50.00, 3.77)_21 (62.99, 0.64)_22
                        /       \       /       \       /       \
          (35.36, 14.64)_30 (44.55, 6.38)_31 (56.12, 1.30)_32 (70.70, 0.00)_33
              /       \       /       \       /       \       /       \
(31.50, 18.50)_40 (39.69, 10.31)_41 (50.00, 2.66)_42 (62.99, 0.00)_43 (79.35, 0.00)_44
    /       \       /       \       /       \       /       \       /       \
(28.07, 21.93)_50 (35.36, 14.64)_51 (44.55, 5.45)_52 (56.12, 0.00)_53 (70.70, 0.00)_54 (89.07, 0.00)_55
```

Ex 14.3 American Call on a Futures Contract

In [7]:

```python
# Time to maturity
T = 0.3333
# Number of timesteps
steps = 4
# Current asset price
S = 300
# Option to price
X = 300
option = Call(X, american=True)
# Risk free interest rate and asset yield (set to r for Futures Contract)
# and volatility
r = 0.08
q = r
sigma = 0.4
```

In [8]:

```python
# Initialize and fit BinomialTree model
american_call_forward_tree = BinomialTree(T, steps)
american_call_forward_tree.fit(r=r, q=q, sigma=sigma, S=S, option=option)
```

In [9]:

```python
american_call_forward_tree
```

Out[9]:

```
BinomialTree
(time 0.3333 in 4 steps)
(r = 0.08, q = 0.08, sigma = 0.4)
(S = 300, f = 25.5221)
```

In [10]:

```python
print(f'The computed option price for the given american put is {american_call_forward_tree.f:.5f} dollars.')
```

```
The computed option price for the given american put is 25.52205 dollars.
```

In [11]:

```python
# Binomial tree representation
print(american_call_forward_tree)
```

```
                                    (300.00, 25.52)_00
                                        /       \
                          (267.29, 8.04)_10 (336.72, 45.50)_11
                              /       \       /       \
               (238.14, 0.00)_20 (300.00, 17.19)_21 (377.93, 77.93)_22
                   /       \       /       \       /       \
    (212.17, 0.00)_30 (267.29, 0.00)_31 (336.72, 36.72)_32 (424.19, 124.19)_33
        /       \       /       \       /       \       /       \
(189.03, 0.00)_40 (238.14, 0.00)_41 (300.00, 0.00)_42 (377.93, 77.93)_43 (476.11, 176.11)_44
```

In [ ]:

```python

```