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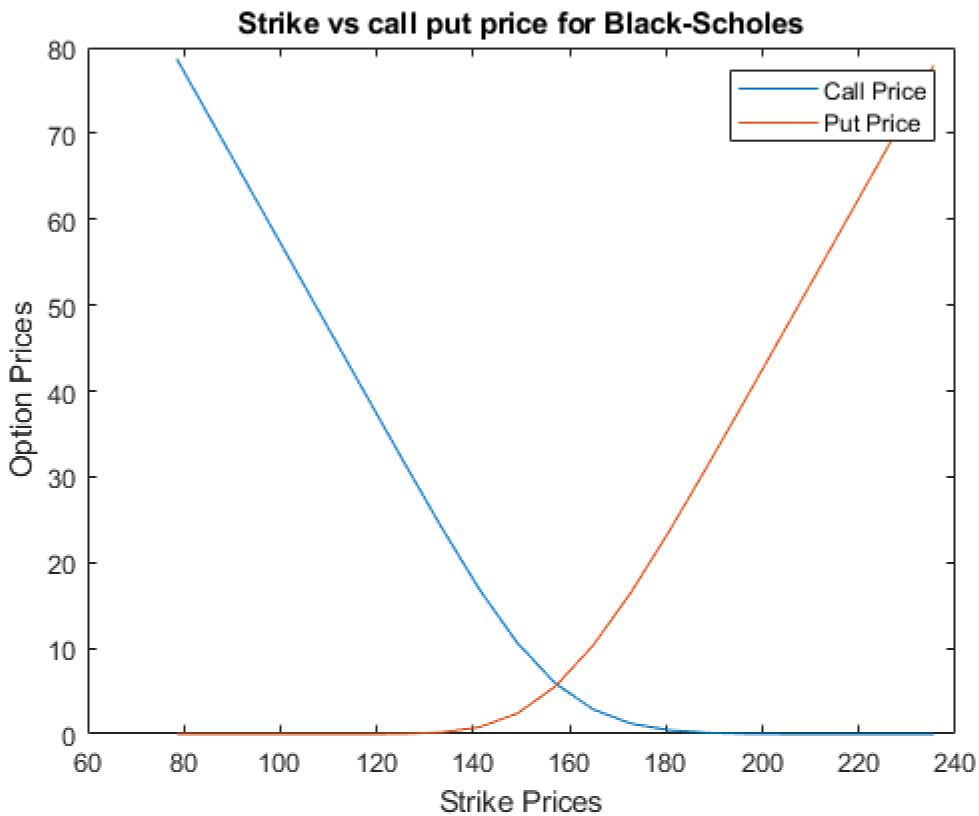
Finding the Call and Put Option Prices by using BS and Binomial Model

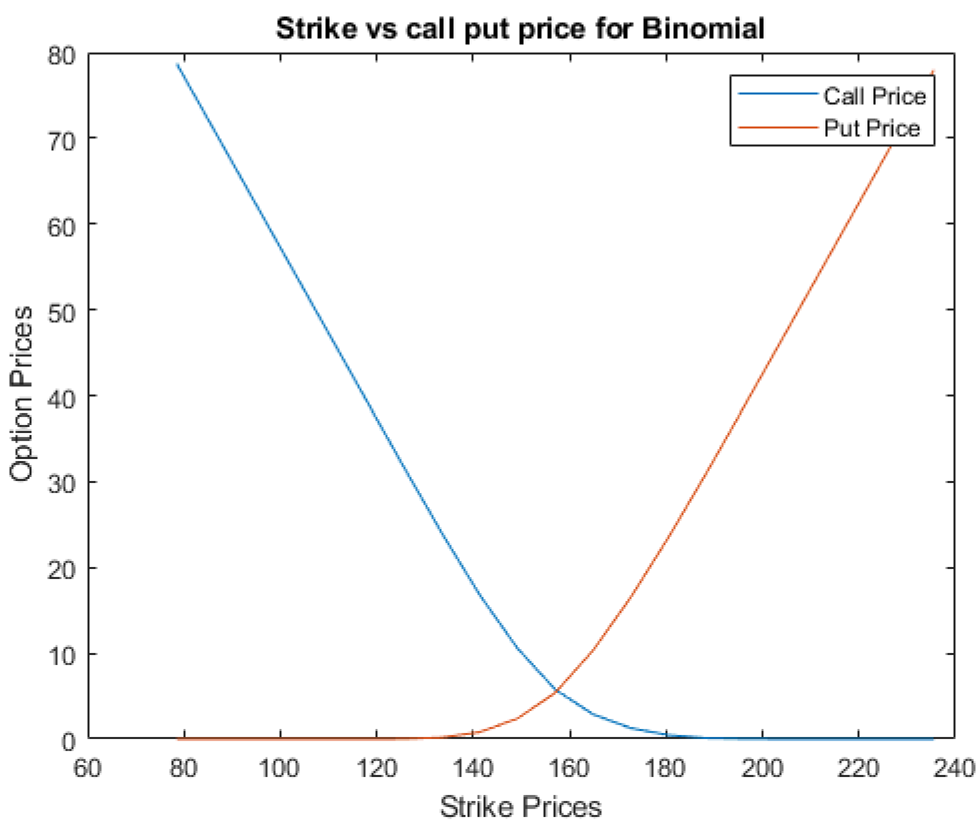
```
% Stock Price= $157.005
% Risk Free Rate = %1.353
% Time to Expiration= 63 Days
% Implied Volatility= 0.22013
% K = Strike Prices (21 different Strike Prices is created to see the
% option prices for out_of_money, in_the_money and at_the_money

% Calculate Call and Put Option Prices by using Black-Scholes formula
[blscallprice,blsputprice,K]=blspricefunction(157.005,...
    0.01353,63/365,0.22013*1);
% Calculate Call and Put Option Prices by using Binomial Tree formula
[bncallprices,bnputprices]=bnpricefunction(157.005,...
    63/365,0.01353,0.22013*1);

% These Steps find how the BLS and Binomial Option Pricing change if
 the
% implied volatility is changed by 1.5 * Sigma and 0.5 * Sigma
[blscallprice_15sigma,blsputprice_15sigma,K]=blspricefunction(157.005,...
    0.01353,63/365,0.22013*1.5);
[bncallprices_15sigma,bnputprices_15sigma]=bnpricefunction(157.005,...
    63/365,0.01353,0.22013*1.5);
[blscallprice_05sigma,blsputprice_05sigma,K]=blspricefunction(157.005,...
    0.01353,63/365,0.22013*0.5);
[bncallprices_05sigma,bnputprices_05sigma]=bnpricefunction(157.005,...
    63/365,0.01353,0.22013*0.5);
```

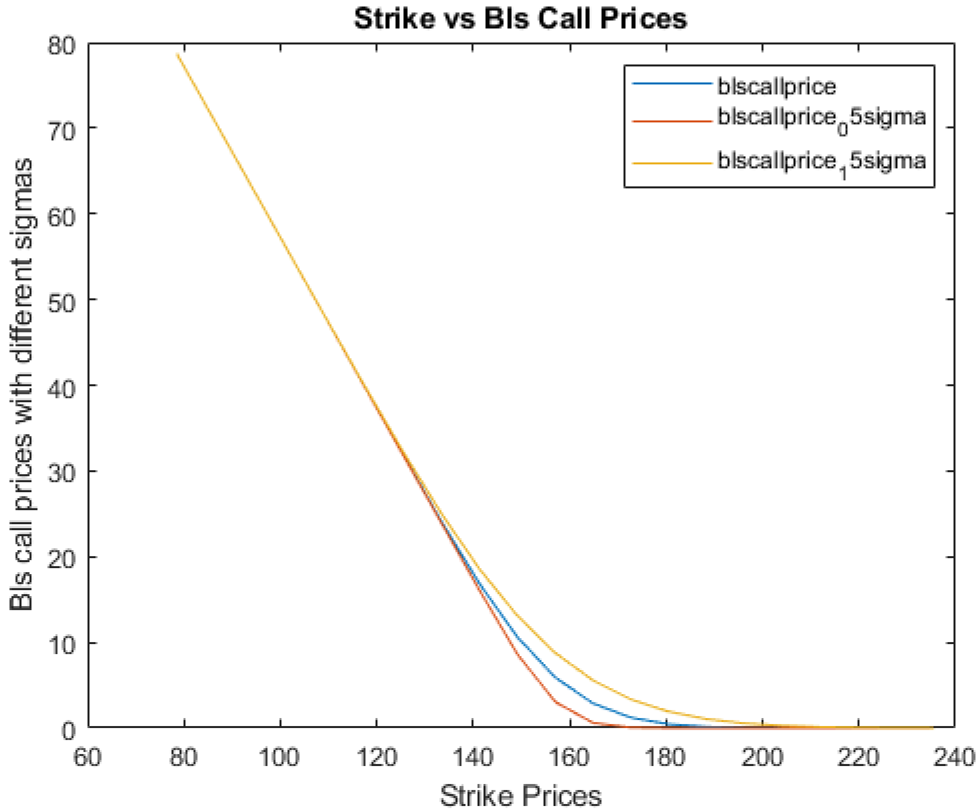
Graph for Black Scholes=> (Strike vs Call-Put_Price)

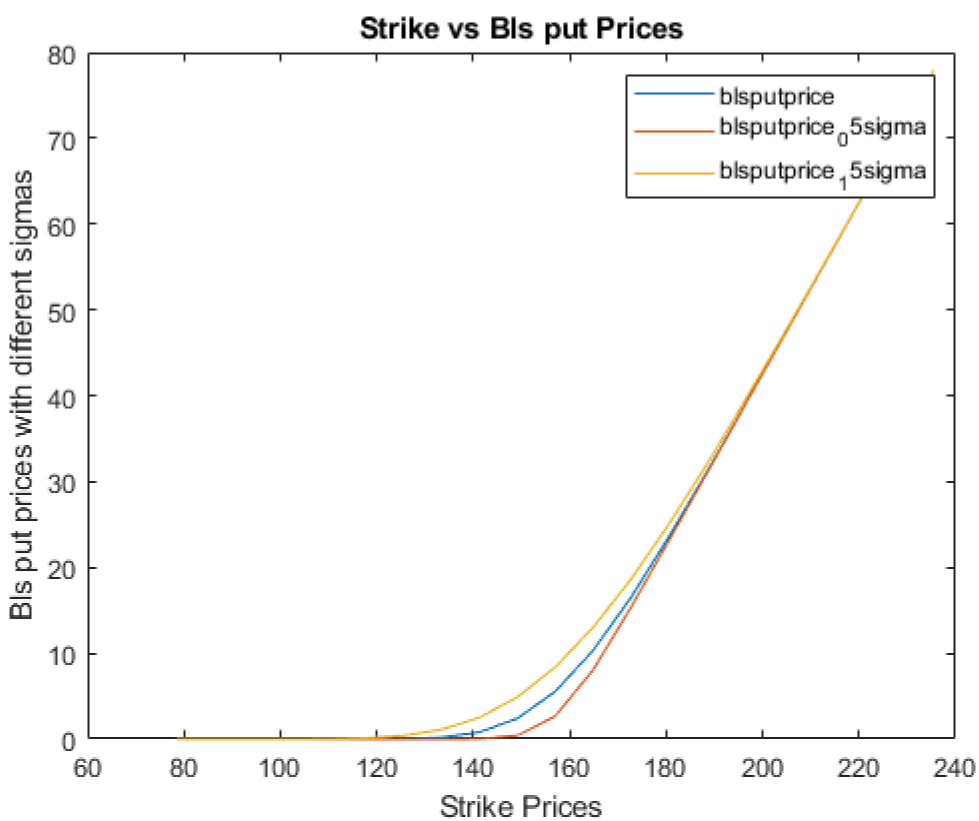
```
figure(1)
plot(K,blscallprice)
hold on
plot(K,blsputprice)
legend('Call Price','Put Price');
xlabel('Strike Prices');
ylabel('Option Prices');
title('Strike vs call put price for Black-Scholes');

% Graph for Black Scholes=> (Strike vs Call-Put_Price)
figure(2)
```

```
plot(K,bncallprices(1,:))
hold on
plot(K,bnputprices(1,:))
legend('Call Price','Put Price');
xlabel('Strike Prices');
ylabel('Option Prices');
title('Strike vs call put price for Binomial');

% Check the Black-Scholes Call Prices in different market volatility
% Also this model illustrates the Call Prices in_the_money
 out_of_money and
% at_themoney
figure(3)
plot(K,blscallprice)
hold on
plot(K,blscallprice_05sigma)
hold on
plot(K,blscallprice_15sigma)
legend('blscallprice','blscallprice_05sigma','blscallprice_15sigma');
xlabel('Strike Prices');
ylabel('Bls call prices with different sigmas');
title('Strike vs Bls Call Prices');

%Check the Black-Scholes Put Prices in different market volatility
%Also this model illustrates the put Prices in_the_money out_of_money
 and
%at_themoney
figure(4)
plot(K,blsputprice)
hold on
plot(K,blsputprice_05sigma)
hold on
plot(K,blsputprice_15sigma)
legend('blsputprice','blsputprice_05sigma','blsputprice_15sigma');
xlabel('Strike Prices');
ylabel('Bls put prices with different sigmas');
title('Strike vs Bls put Prices');

% Result:
% For call and put Option,(out of money)= sigma doesn't effect a big
% change in the price difference.
% (In the money), the sigma effects a big price difference in the
 option
% price
```


Strike vs call put price for Black-Scholes
Call Price
Put Price
Option Prices
Strike Prices
80
70
60
50
40
30
20
10
0
60
80
100
120
140
160
180
200
220
240


Strike vs call put price for Binomial
Call Price
Put Price
Option Prices
Strike Prices
80
70
60
50
40
30
20
10
0
60
80
100
120
140
160
180
200
220
240


Strike vs Bls Call Prices
blscallprice
blscallprice$_0$5sigma
blscallprice$_1$5sigma
Bls call prices with different sigmas
Strike Prices
0
10
20
30
40
50
60
70
80
60
80
100
120
140
160
180
200
220
240


Strike vs Bls put Prices
blsputprice
blsputprice$_0$5sigma
blsputprice$_1$5sigma
Bls put prices with different sigmas
Strike Prices
0
10
20
30
40
50
60
70
80
60
80
100
120
140
160
180
200
220
240

Converge From Binomial Model to Black-Scholes Model

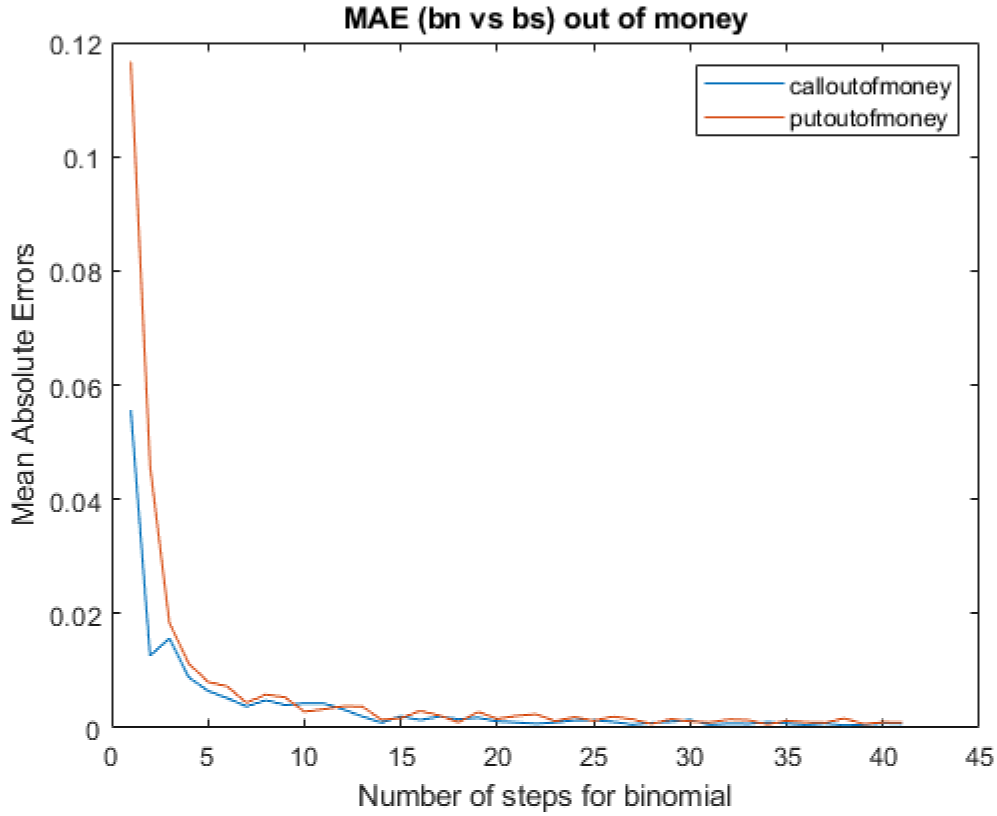
The differences between Black-Scholes prices and Binomial Model prices are calculated to show Binomial Model price converges to Black-Scholes model

```
call_difference= blscallprice-bncallprices;
put_difference=blsputprice-bnputprices;
```

Out of Money

Best step(n) in binomial model to converge Black-Scholes Model. Step 41 represents: The number of steps from 10 up to 2010 with increments of 50. (10:50:2010)

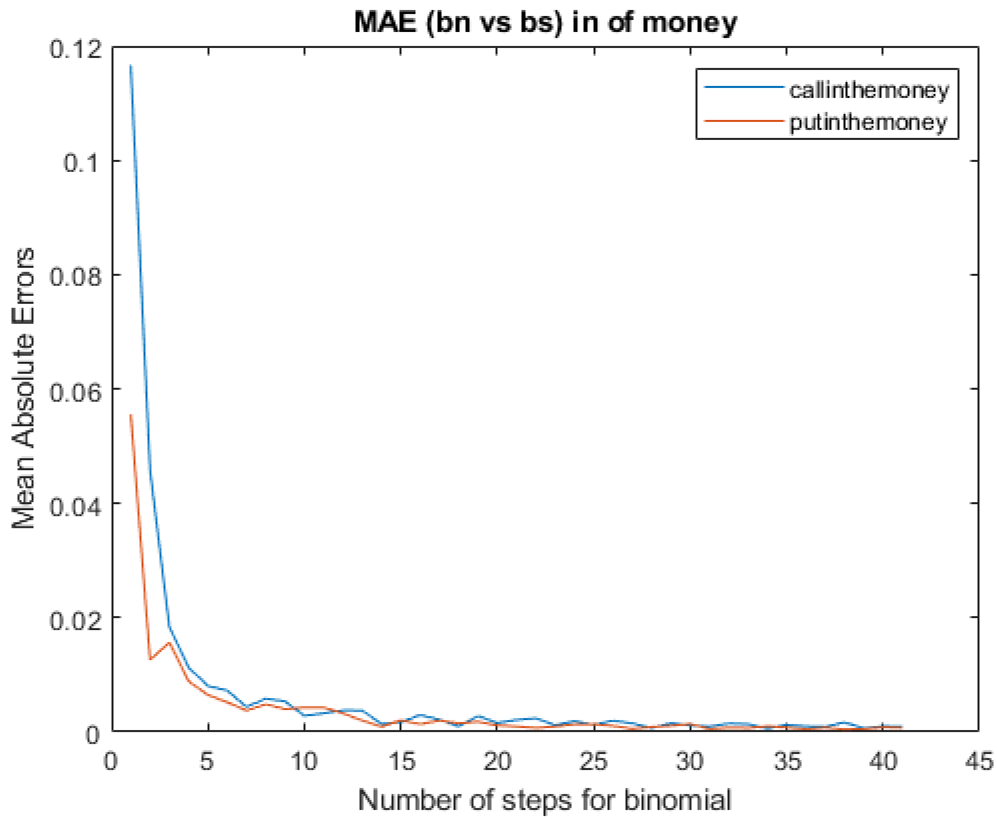
```
% Out the money K= 1:10 for call option
% Out of money K= 12:21 for put option
calloutofmoney(1:41,1)=0;
putoutofmoney(1:41,1)=0;
for j=1:41
    for  i=1:10
    calloutofmoney(j,1)= abs(call_difference(j,i))+...
        calloutofmoney(j,1);
    putoutofmoney(j,1)= abs(put_difference(j,i+11))+...
        putoutofmoney(j,1);
    end
end
% Result for the best number of Binomial Step which is closest to
%Black-scholes for call and put option:
[~,best_step_call_outofmoney]=min(calloutofmoney);
[~,best_step_put_outofmoney]=min(putoutofmoney);

figure(5)
plot(calloutofmoney)
hold on
plot(putoutofmoney)
legend('calloutofmoney','putoutofmoney');
xlabel('Number of steps for binomial');
ylabel('Mean Absolute Errors');
title('MAE (bn vs bs) out of money');
```



In the money

```
% Best step(n) in binomial model to converge Black-Scholes Model.
% Step 41 represents: The number of steps from 10 up to 2010 with
% increments of 50.  (10:50:2010)

% In the money K= 12:21 for call option
% In the money K= 1:10 for put option

callinthemoney(1:41,1)=0;
putinthemoney(1:41,1)=0;

for j=1:41
    for  i=1:10
    callinthemoney(j,1)= abs(call_difference(j,i+11))+...
        callinthemoney(j,1);
    putinthemoney(j,1)= abs(put_difference(j,i))+...
        putinthemoney(j,1);
    end
end
% Result for best number of Binomial Step which is closest to Black-
scholes
% for call and put option:
[~,best_step_call_inthemoney]=min(callinthemoney);
[~,best_step_put_inthemoney]=min(putinthemoney);
```

```
figure(6)
plot(callinthemoney)
hold on
plot(putinthemoney)
legend('callinthemoney','putinthemoney')
xlabel('Number of steps for binomial')
ylabel('Mean Absolute Errors')
title('MAE (bn vs bs) in of money');
```



At The Money

Call Option

```
[~,best_step_call_atthemoney]=min(call_difference(:,11));
% Put
[~,best_step_put_atthemoney]=min(put_difference(:,11));

[best_step_call_atthemoney, best_step_call_inthemoney,...
best_step_call_outofmoney]

[best_step_put_atthemoney, best_step_put_inthemoney,...
best_step_put_outofmoney]
```

```
ans =
```

```
    41    34    38


ans =

    41    38    34
```

Required Functions

1) Black- Scholes Formula

```
function [callprice,putprice,K]=blspricefunction(S0,rate,T,ivol)

%s0 = stock price
%rate= risk free rate
%T= Time to Expiration
%ivol= implied Volatility

for i=1:21
    stprice(i)=0.5+((i-1)*0.05);
    K(i)=S0*stprice(i);
    % K creates 21 different strike pricec which includes
 out_of_money,
    % in_the_money and at_the money to illustrate the different option
    % prices for different strike prices

callprice(1,i)=(S0*normcdf(((log(S0/K(i))+((rate+((ivol^2)/2))*T))/...
    (ivol*sqrt(T)))))-(K(i)*exp(-rate.*T)*normcdf(((log(S0/K(i))...
    +((rate-((ivol^2)/2))*T))/(ivol*sqrt(T)))));

putprice(1,i)=(K(i)*exp(-rate*T)*normcdf(-((log(S0/K(i))+...
    ((rate-((ivol^2)/2))*T))/(ivol*sqrt(T)))))-...
    (S0*normcdf(-((log(S0/K(i))+((rate+((ivol^2)/2))*T))/
(ivol*sqrt(T)))));
end
end


% 2) Binomial Tree Model
function [bncallprices,bnputprices]= bnpricefunction(S0,T,rate,ivol)

%s0 = stock price
%rate= risk free rate
%T= Time to Expiration
%ivol= implied Volatility

 for iteration_strike=1:21
    for binomial_steps =1:41
N=10+((binomial_steps-1)*50);

stprice(iteration_strike)=0.5+((iteration_strike-1)*0.05);
```

```
K(iteration_strike)=S0*stprice(iteration_strike);
dt=T/N;
n=N+1;
u=exp(ivol*sqrt(dt));
d=1/u;
p=(exp(rate*dt)-d)/(u-d);

%The Stock prices for each step
S_price=zeros(n);
S_price(1,1)=S0;
for j=2:n
    S_price(j,j)=S_price(j-1,j-1)*d;
    for i=1:j-1
        S_price(i,j)=S_price(i,j-1)*u;
    end
end
%The option prices for each step
%Call
Option_callprice=zeros(n);
Option_callprice(:,n)=max(S_price(:,n)-K(iteration_strike),0);
for j=n-1:-1:1
    for i=1:j
       Option_callprice(i,j)= exp(-rate*dt)*(p*Option_callprice(i,j
+1)...
           +(1-p)*Option_callprice(i+1,j+1));
    end
end
binomialcallprice=Option_callprice(1,1);
bncallprices(binomial_steps,iteration_strike)=binomialcallprice;

%Put
Option_putprice=zeros(n);
Option_putprice(:,n)=max(K(iteration_strike)-S_price(:,n),0);
for j=n-1:-1:1
    for i=1:j
        Option_putprice(i,j)=exp(-rate*dt)*(p*Option_putprice(i,j
+1)...
            +(1-p)*Option_putprice(i+1,j+1));
    end
end
binomialputprice=Option_putprice(1,1);
bnputprices(binomial_steps,iteration_strike)=binomialputprice;

    end
 end
 end
```

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