Assignment 1

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1a

The straddle price is 18.4891

```
clear
clc
global S0 r sigma T K
S0=100;   %Initial stock price
K=90; %Strike price
r=0.02; %risk-free rate
h=0.25; %length of the period in years
T=4; %# of periods
u=exp((r*h)+0.2*sqrt(h));   %up move
d=exp((r*h)-0.2*sqrt(h)); %down move

% Straddle is long call and long put on the same strike.
% The sum of the two values should lead to value of straddle

[~,optionprice1,hedgeportfoliostock1,hedgeportfolioriskfree1]=...
    EuropeanPricing(S0,@CallPayoff,r,h,u,d,T,0,[]);
[~,optionprice2,hedgeportfoliostock2,hedgeportfolioriskfree2]=...
    EuropeanPricing(S0,@PutPayoff,r,h,u,d,T,0,[]);

straddlePrice = optionprice1{T+1,1} + optionprice2{T+1,1};

straddlePrice
```

1b

The straddle price is 17.7555

```
S0=100;
K=90;
T = 40;
r=0.02;
h = 0.025;
u=exp((r*h)+0.2*sqrt(h));
d=exp((r*h)-0.2*sqrt(h));

[~,optionprice1,hedgeportfoliostock1,hedgeportfolioriskfree1]=...
    EuropeanPricing(S0,@CallPayoff,r,h,u,d,T,0,[]);
[stockprice2,optionprice2,hedgeportfoliostock2,hedgeportfolioriskfree2]=...
    EuropeanPricing(S0,@PutPayoff,r,h,u,d,T,0,[]);
```

```
straddlePrice = optionprice1{T+1,1} + optionprice2{T+1,1}
```

1c

The binary call option price is 63.6274

```
%Binary Payoff - If above K, option returns is K. If less than K, option
%returns 0s
S0=100;   %Initial stock price
K=90; %Strike price
r=0.02; %risk-free rate
h=0.25; %length of the period in years
T=4; %# of periods
u=exp((r*h)+0.2*sqrt(h));   %up move
d=exp((r*h)-0.2*sqrt(h)); %down move

[stockprice1,optionprice1,hedgeportfoliostock1,hedgeportfolioriskfree1]=...
    EuropeanPricing(S0,@BinaryPayoff,r,h,u,d,T,0,[]);

binaryCallPrice = optionprice1{T+1,1}
```

2a

American Option

Price of American Call Option is 0.5286

Price of American Call Option is 0.4653

```
K=10;
r = 0.01;
h = 1/365;
S0 = 10;
T=250;
u=exp((r*h)+0.15*sqrt(h));
d=exp((r*h)-0.15*sqrt(h));

[~,callPrices,hedgeportfoliostock,hedgeportfolioriskfree,exerciseDate]=...
    AmericanPricing(S0,@CallPayoff,r,h,u,d,T,0,[]);
callPrices{T+1,1}

[~,putPrices,hedgeportfoliostock1,hedgeportfolioriskfree1,exerciseDate1]=...
    AmericanPricing(S0,@PutPayoff,r,h,u,d,T,0,[]);
putPrices{T+1,1}
```

3a

Discrete Dividends Option

American Put option with dividend is worth 1.456

American Call option with dividend is worth 0.3399

```
S0=10;   %Initial stock price
K=10; %Strike price
r=0.02; %risk-free rate
h=1/365; %length of the period in years
T=200; %# of periods
u=exp(0.2*sqrt(h));   %up move
d=exp(-0.2*sqrt(h)); %down move
delta = 0.05;
DivDate = [50,100,150];

[stockprice,putPrice,hedgeportfoliostock,hedgeportfoliorisk free,exerciseDate]=...
    DiscreteDividendsPricing(S0,@PutPayoff,'American',r,h,u,d,DivDate,delta,T);
putPrice{T+1,1}
[stockprice1,callPrice,hedgeportfoliostock1,hedgeportfoliorisk free1,exerciseDate1]=...
    DiscreteDividendsPricing(S0,@CallPayoff,'American',r,h,u,d,DivDate,delta,T);
callPrice{T+1,1}
```

3b

The American straddle price with dividend is 1.642. It is less than the sum of call and put american option with dividend. This is because the when looked at it seperately, we can excercise the put and call at seperate dates to maximize the returns, which is not possible in a straddle, as we exercise both components at the same time

```
S0=10;   %Initial stock price
K=10; %Strike price
r=0.02; %risk-free rate
h=1/365; %length of the period in years
T=200; %# of periods
u=exp(0.2*sqrt(h));   %up move
d=exp(-0.2*sqrt(h)); %down move
delta = 0.05;
DivDate = [50,100,150];
```

```
[stockprice1,straddlePrice,hedgeportfoliostock,hedgeportfolioriskfree,exerciseDate]=...
    DiscreteDividendsPricing(S0,@StraddlePayoff,'American',r,h,u,d,DivDate,delta,T);
straddlePrice{T+1,1}
```

4

Asian Options

The Monte Carlo price for Asian option is 3.2299

The Confidence interval at 95% confidence is (3.1749,3.2849)

```
S0=200;   %Initial stock price
K=220; %Strike price
r=0.02; %risk-free rate
sigma = 0.2; %standard deviation
h=1/365; %length of the period in years
T=1; %# of periods
NoOfPaths = 100000;

randn('seed',0);
pathPayoffs = zeros(NoOfPaths,1);

for path = 1:NoOfPaths
    stockPrices = GenerateStockPath(S0,r,T,h,sigma);
    pathPayoffs(path) = max(mean(stockPrices)-K,0);
end
montecarloprice = mean(pathPayoffs) * exp(-r * T)

sd = std(pathPayoffs * exp(-r * T))/sqrt(length(pathPayoffs));
CIInterval = [montecarloprice - (1.96*sd),montecarloprice + (1.96*sd)]
```

5a

American Option LMC

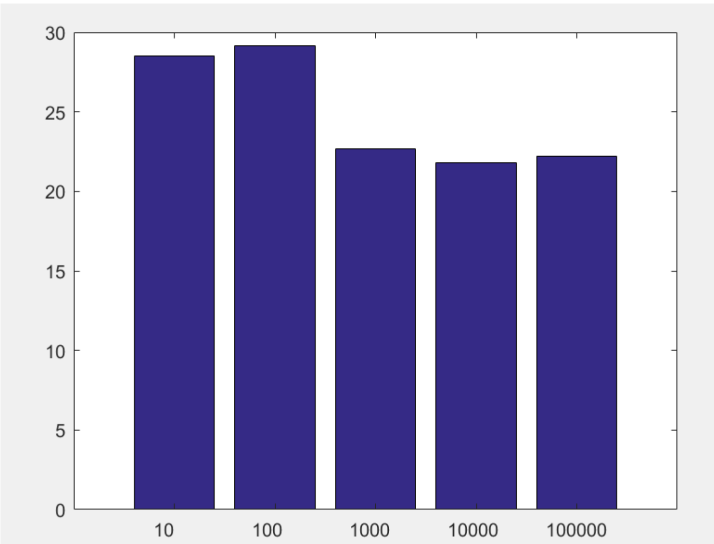
Price from the Least squares calculation for American Option with N=250 and No Of Paths=100,000 is 22.2625

```
S0=200;   %Initial stock price
K=220; %Strike price
r=0.1; %risk-free rate
```

```
sigma = 0.3; %standard deviation
N=250; %length of the period in years
T=1; %# of periods
NoOfPaths = 100000;

randn('seed',0);
price = LSLeastSquares(N,NoOfPaths)
```

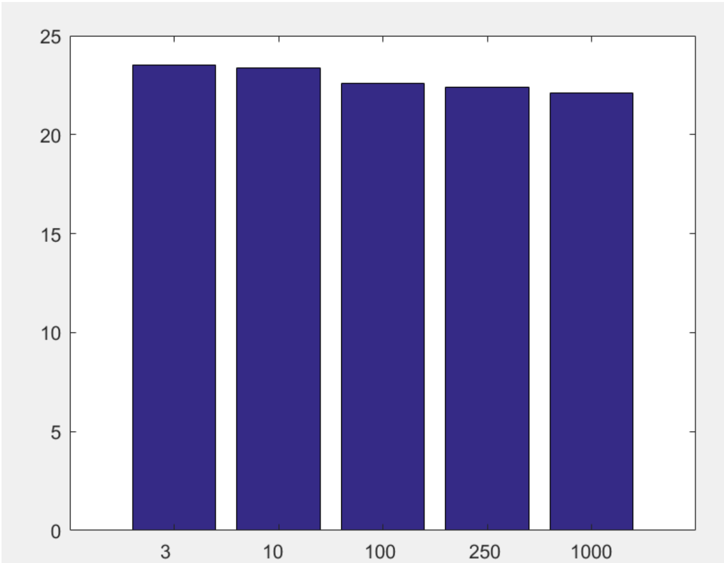
5b




```
S0=200;   %Initial stock price
K=220; %Strike price
r=0.1; %risk-free rate
sigma = 0.3; %standard deviation
N=250; %length of the period in years
T=1; %# of periods

NoOfPaths = [10 100 1000 10000 100000];
priceResult = zeros(5,2);
priceResult(:,1) = NoOfPaths;
for pathCount = 1:length(priceResult)
    priceResult(pathCount,2) = LSLeastSquares(N,priceResult(pathCount,1));
end
bar(priceResult(:,2))
set(gca,'xticklabel',NoOfPaths)
```

5c




```
S0=200;   %Initial stock price
K=220; %Strike price
r=0.1; %risk-free rate
sigma = 0.3; %standard deviation
NoOfPaths=100000; %length of the period in years
T=1; %# of periods

N = [3 10 100 250 1000];
priceResult = zeros(5,2);
priceResult(:,1) = N;
for pathCount = 1:length(priceResult)
    priceResult(pathCount,2) = LSLeastSquares(priceResult(pathCount,1),NoOfPaths);
end
bar(priceResult(:,2))
set(gca,'xticklabel',N)
```