EE230 HW2 MATLAB Question

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Step b)

p = 0.35

```
% Determine parameters of Binomial PMF
p = 0.35 ; n = 10 ; k = 0:10 ;
% Use pdf() function in Matlab to get PMF values of Binomial PMF at required % points
pXk = pdf('bino' ,k ,n, p) ;
% Compute Expected Value
ExpVal = sum( k .* pXk ) ;
% Compute Variance
Var = sum( (k-ExpVal) .^2 .* pXk ) ;
% Plot PDF and label axes
figure , bar(k,pXk); grid ; xlabel('k'); ylabel('p_X(k)')
% Put a title on plot
title (sprintf( 'PMF of Binomial r.v. with n=%d , p=%2.2f , E[X]=%3.2f , var(X)=%3.2f ' ,n , p
```


PMF of Binomial r.v. with n=10 , p=0.35 , E[X]=3.50 , var(X)=2.27
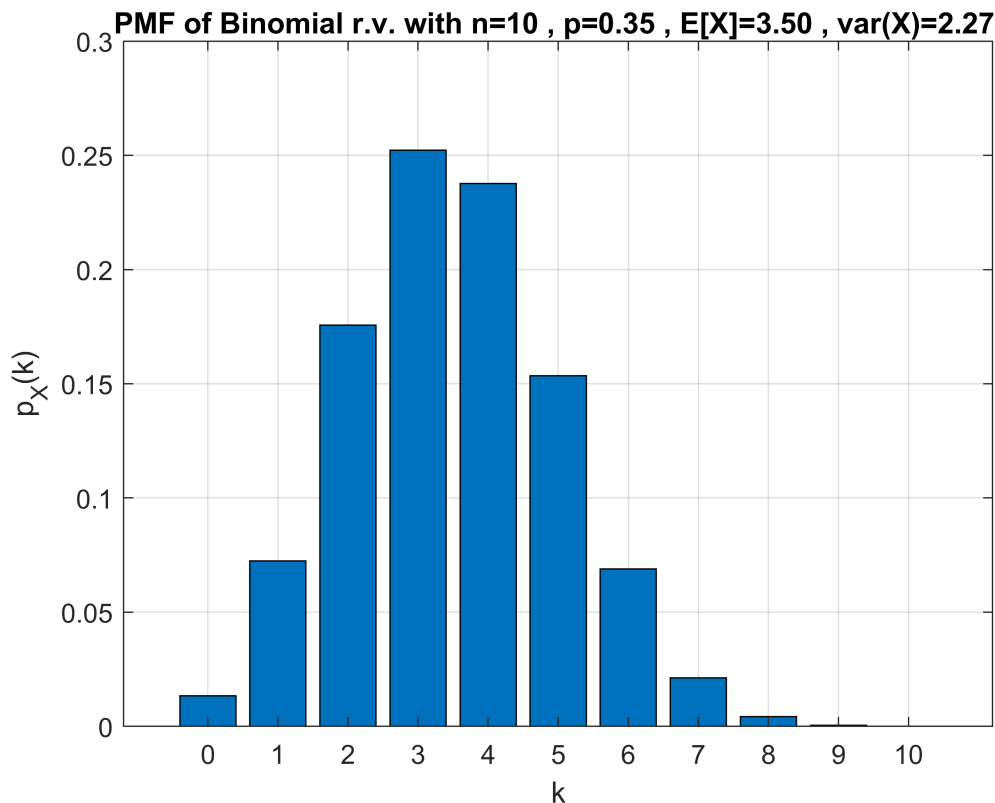
p = 0.2

```
% Determine parameters of Binomial PMF
p = 0.2 ; n = 10 ; k = 0:10 ;
```

```
% Use pdf() function in Matlab to get PMF values of Binomial PMF at required % points
pXk = pdf('bino' ,k ,n, p) ;
% Compute Expected Value
ExpVal = sum( k .* pXk ) ;
% Compute Variance
Var = sum( (k-ExpVal) .^2 .* pXk ) ;
% Plot PDF and label axes
figure , bar(k,pXk); grid ; xlabel('k'); ylabel('p_X(k)')
% Put a title on plot
title (sprintf( 'PMF of Binomial r.v. with n=%d , p=%2.2f , E[X]=%3.2f , var(X)=%3.2f ' ,n , p
```

PMF of Binomial r.v. with n=10 , p=0.20 , E[X]=2.00 , var(X)=1.60
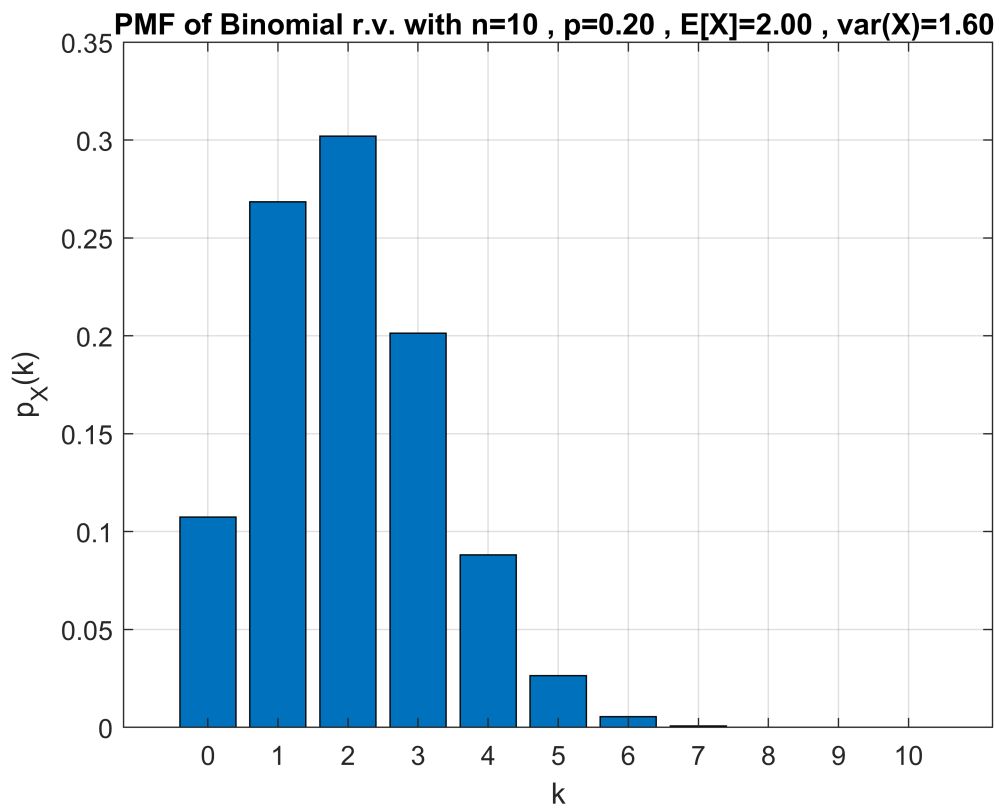

Step c)

```
% Determine parameters of Discrete Uniform PMF
k = 2:6;
% Use pdf() function in Matlab to get PMF values of Binomial PMF at required % points
pXk = pdf('Discrete Uniform', k-1, k(end)-1) ;
% Compute Expected Value
ExpVal = sum( k .* pXk ) ;
% Compute Variance
Var = sum( (k-ExpVal) .^2 .* pXk ) ;
% Plot PDF and label axes
figure , bar(k,pXk); grid ; xlabel('k'); ylabel('p_X(k)')
% Put a title on plot
title (sprintf( 'PMF of Discrete Uniform r.v. with p=%2.2f , E[X]=%3.2f , var(X)=%3.2f ' , p ,
```
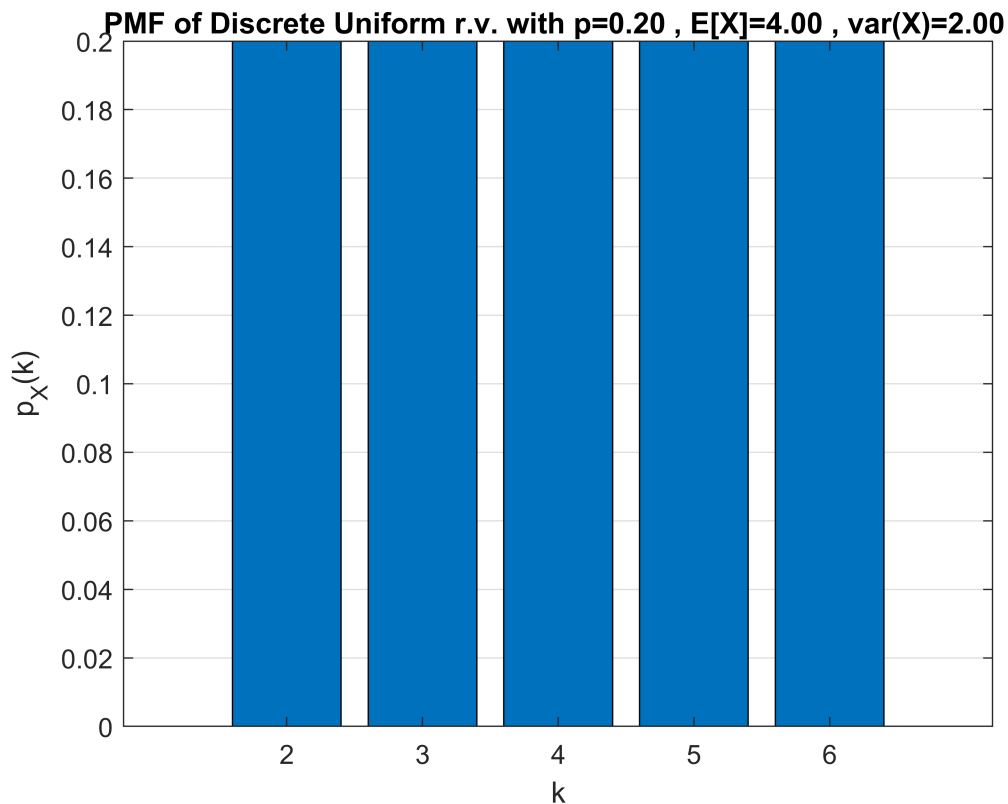
PMF of Discrete Uniform r.v. with p=0.20 , E[X]=4.00 , var(X)=2.00

Step d)

```matlab
function ber_rv = get_bernoulli_rv(p)
    if ~((0<=p)&&(p<=1))
        ME = MException('myComponent:inputError', ...
            'Variable p=%.2f is not between 0 and 1.',p);
        throw(ME)
    end
    if rand<=p
      ber_rv=1;
    else
      ber_rv=0;
    end
end
```

Step e)

```matlab
% No need for k parameter
function binom_rv = get_binomial_rv(p, n)
    if ~(0<=n)
        ME = MException('myComponent:inputError', ...
            'Variable n=%d is not equal of bigger than 0.',n);
        throw(ME)
    end
    binom_rv=0;
    if n~=0
        for step = 1:n
            binom_rv = binom_rv + get_bernoulli_rv(p);
        end
    end
```

```
            end
        end
```

Step f)

```matlab
        function plot_bernoulli_histogram(p, numberoftimes)
            samples = zeros(1,numberoftimes);
            for step = 1:numberoftimes
                samples(step) = get_bernoulli_rv(p);
            end
            C = categorical(samples,0:1);
            figure;
            histogram(C,'Normalization','probability')
            xlabel('Values')
            ylabel('Normalized number of outcomes')
            title(sprintf('Histogram of Bernoulli r.v. with total %d outcomes', numberoftimes))
        end

        function plot_binomial_histogram(p, n, numberoftimes)
            samples = zeros(1,numberoftimes);
            for step = 1:numberoftimes
                samples(step) = get_binomial_rv(p, n);
            end
            C = categorical(samples,0:n);
            figure;
            histogram(C,'Normalization','probability')
            xlabel('Values')
            ylabel('Normalized number of outcomes')
            title(sprintf('Histogram of Binomial r.v. with total %d outcomes', numberoftimes))
        end
```
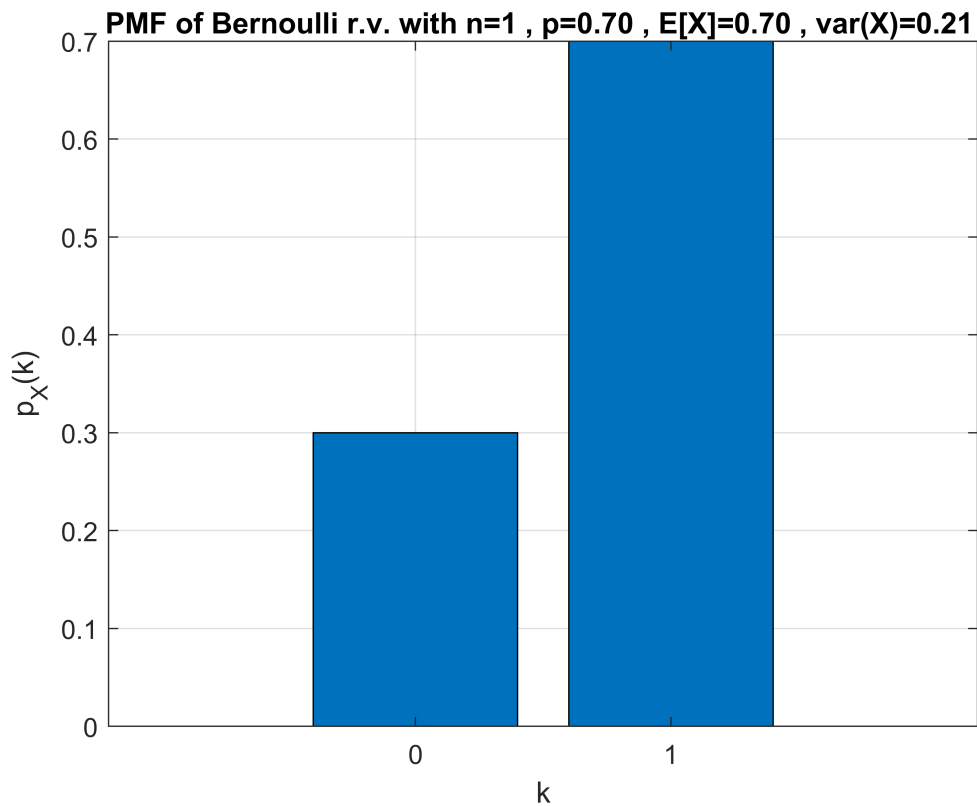
Step f-i)

```matlab
p = 0.7;
numberoftimes = [10 100 1000];
for times = numberoftimes
    plot_bernoulli_histogram(p, times)
end
```

Histogram of Bernoulli r.v. with total 10 outcomes

Histogram of Bernoulli r.v. with total 100 outcomes

Histogram of Bernoulli r.v. with total 1000 outcomes
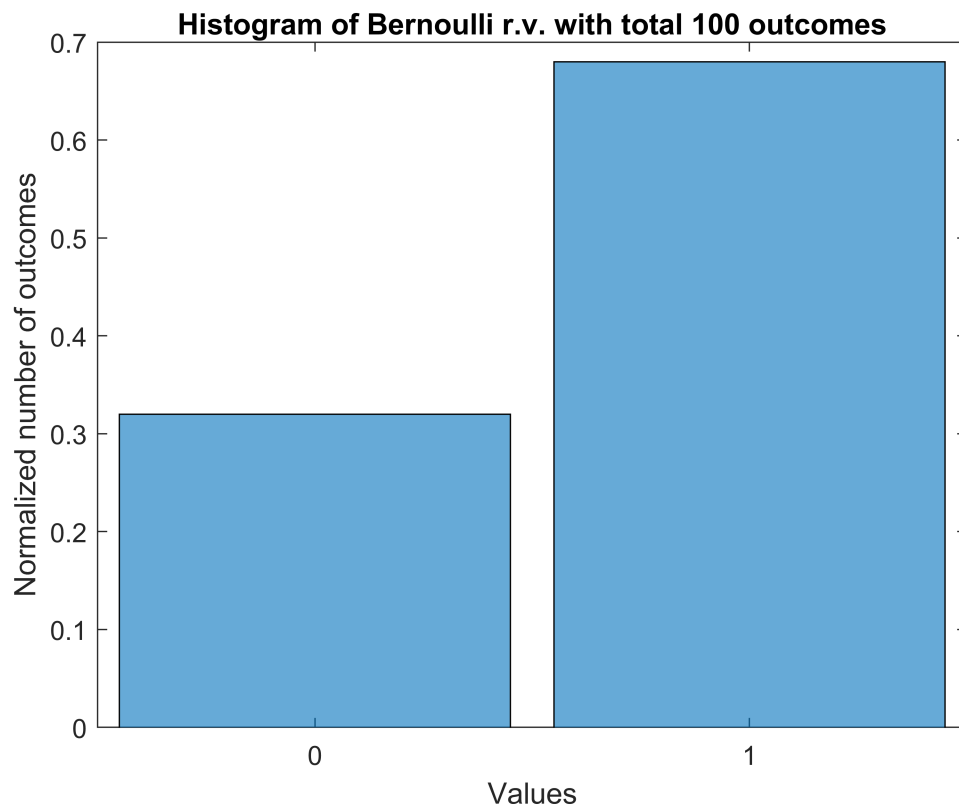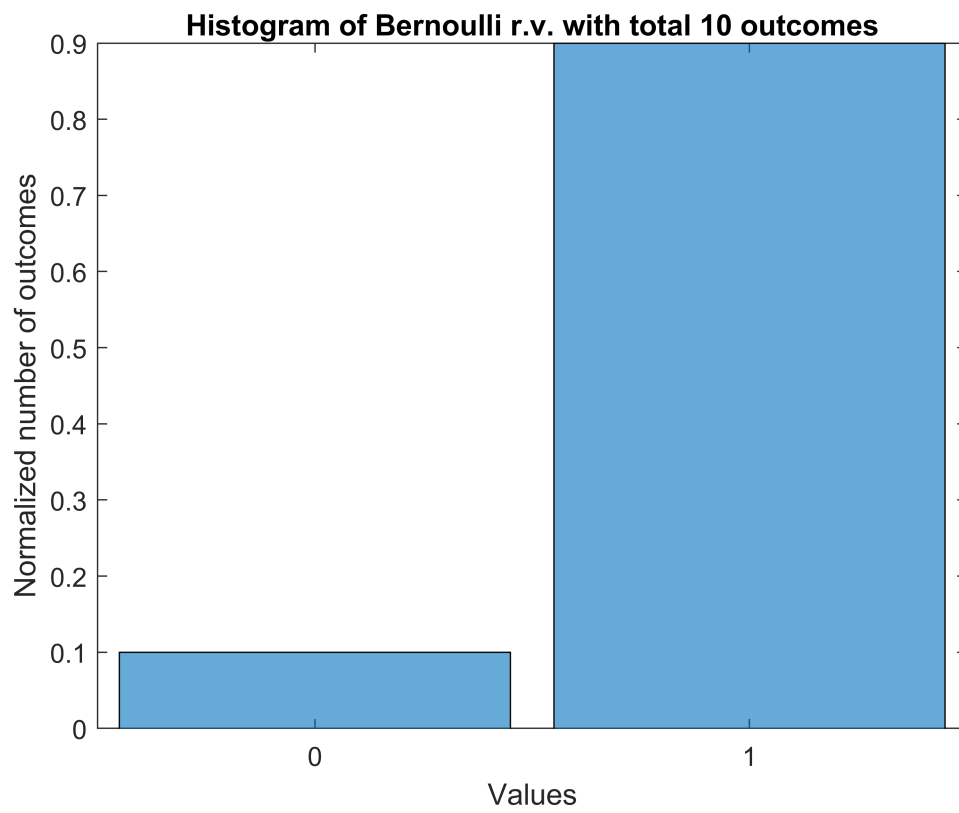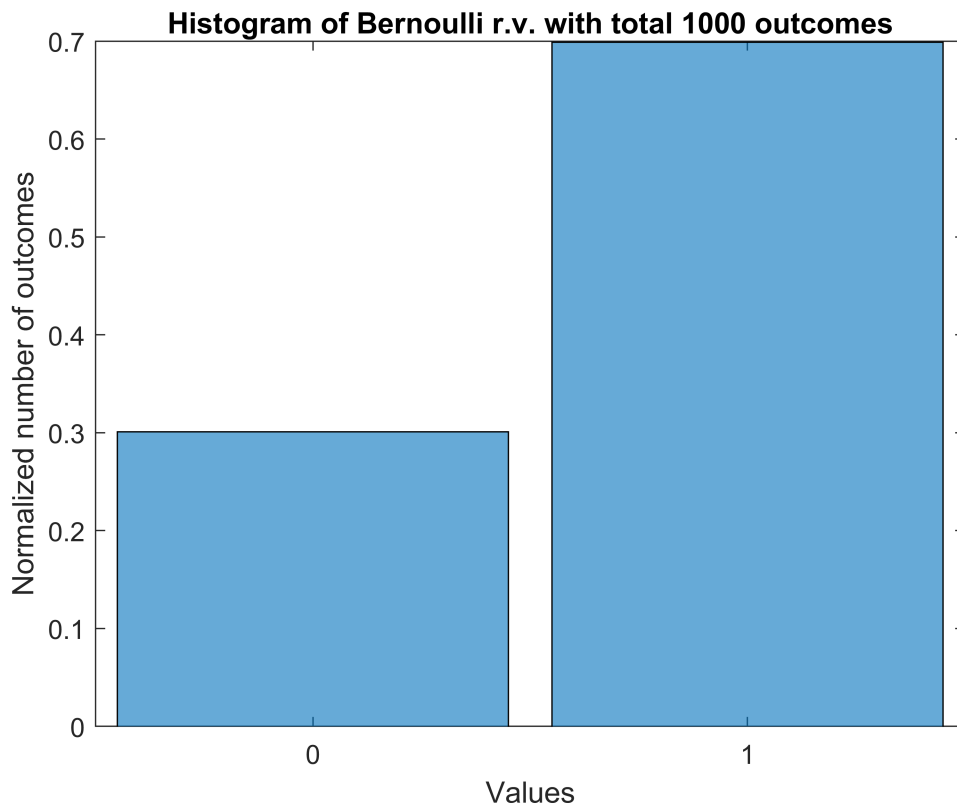
Bernoulli PMF with pdf() function

```matlab
% Determine parameters of Bernoulli PMF
p = 0.7 ; n = 1 ; k = 0:1;
% Use pdf() function in Matlab to get PMF values of Bernoulli PMF at required % points
pXk = pdf('bino', k, n, p) ;
% Compute Expected Value
ExpVal = sum( k .* pXk ) ;
% Compute Variance
Var = sum( (k-ExpVal) .^2 .* pXk ) ;
% Plot PDF and label axes
figure , bar(k,pXk); grid ; xlabel('k'); ylabel('p_X(k)')
% Put a title on plot
title (sprintf( 'PMF of Bernoulli r.v. with n=%d , p=%2.2f , E[X]=%3.2f , var(X)=%3.2f ' ,n , p
```
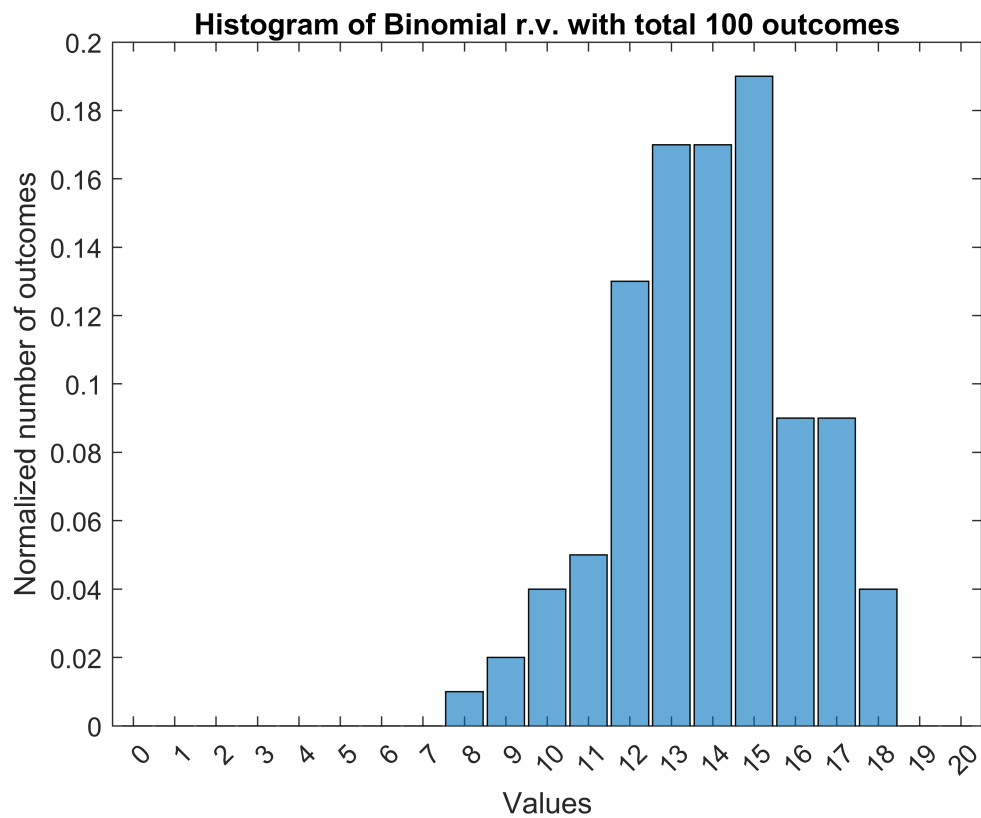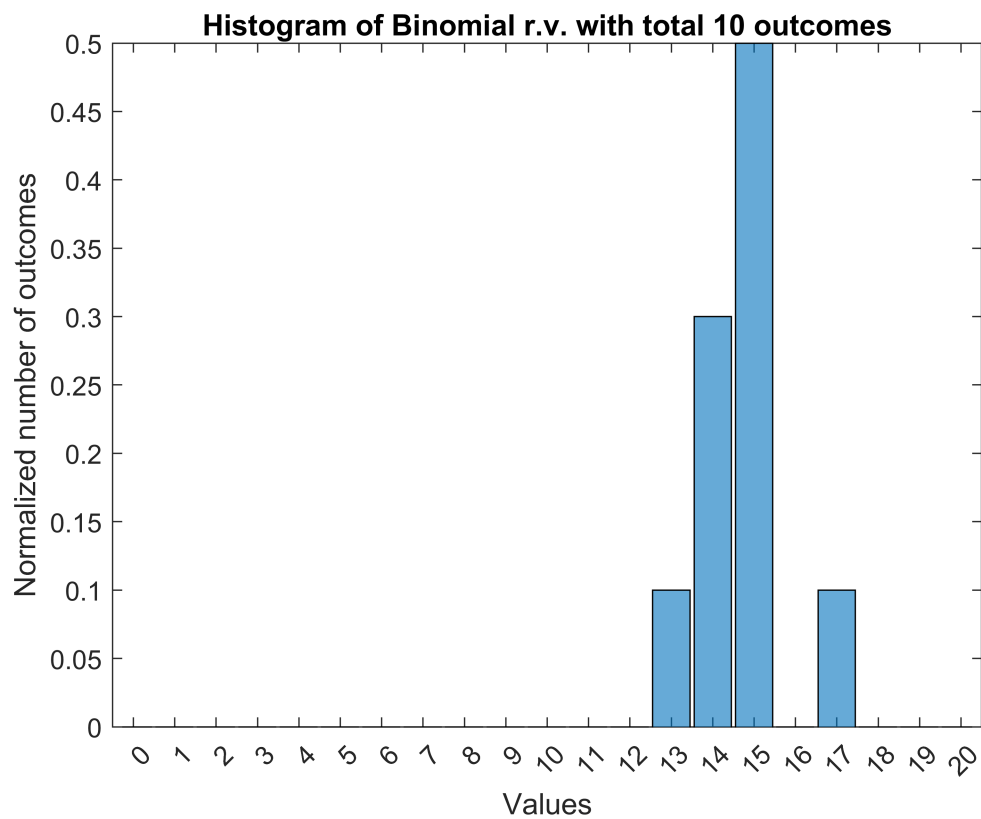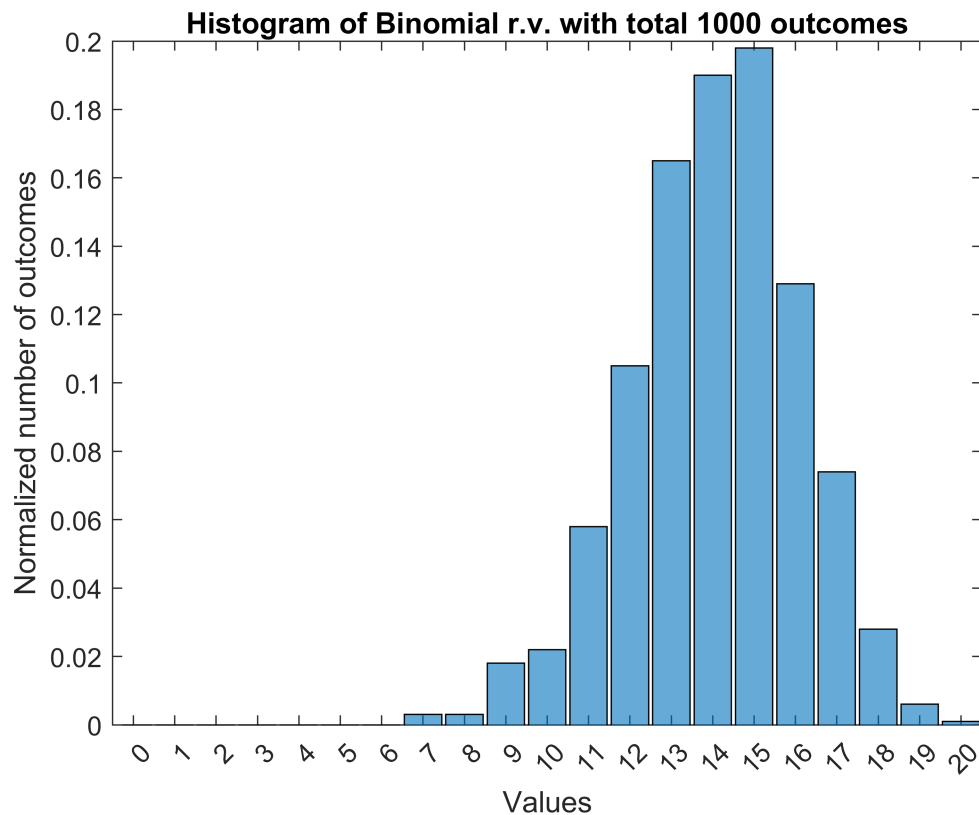
PMF of Bernoulli r.v. with n=1 , p=0.70 , E[X]=0.70 , var(X)=0.21

Comment:

If we look at the histograms drawn by the plot_bernoulli_histogram(), as the number of total outcomes (numberoftimes) increases, the normalized numbers of outcomes approach (converge) to 0.3 and 0.7 gradually. Therefore, we can state that the histogram with the max total outcome is much more similar to the plot of Bernoulli PMF.

Step f-ii)

```
p = 0.7; n = 20;
numberoftimes = [10 100 1000];
for times = numberoftimes
    plot_binomial_histogram(p, n, times)
end
```

Histogram of Binomial r.v. with total 10 outcomes

Histogram of Binomial r.v. with total 100 outcomes

Histogram of Binomial r.v. with total 1000 outcomes

Binomial PMF with pdf() function

```
% Determine parameters of Binomial PMF
p = 0.7 ; n = 20 ; k = 0:n ;
% Use pdf() function in Matlab to get PMF values of Binomial PMF at required % points
pXk = pdf('bino', k, n, p) ;
% Compute Expected Value
ExpVal = sum( k .* pXk ) ;
% Compute Variance
Var = sum( (k-ExpVal) .^2 .* pXk ) ;
% Plot PDF and label axes
figure , bar(k,pXk); grid ; xlabel('k'); ylabel('p_X(k)')
% Put a title on plot
title (sprintf( 'PMF of Binomial r.v. with n=%d , p=%2.2f , E[X]=%3.2f , var(X)=%3.2f ' ,n , p
```

PMF of Binomial r.v. with n=20 , p=0.70 , E[X]=14.00 , var(X)=4.20
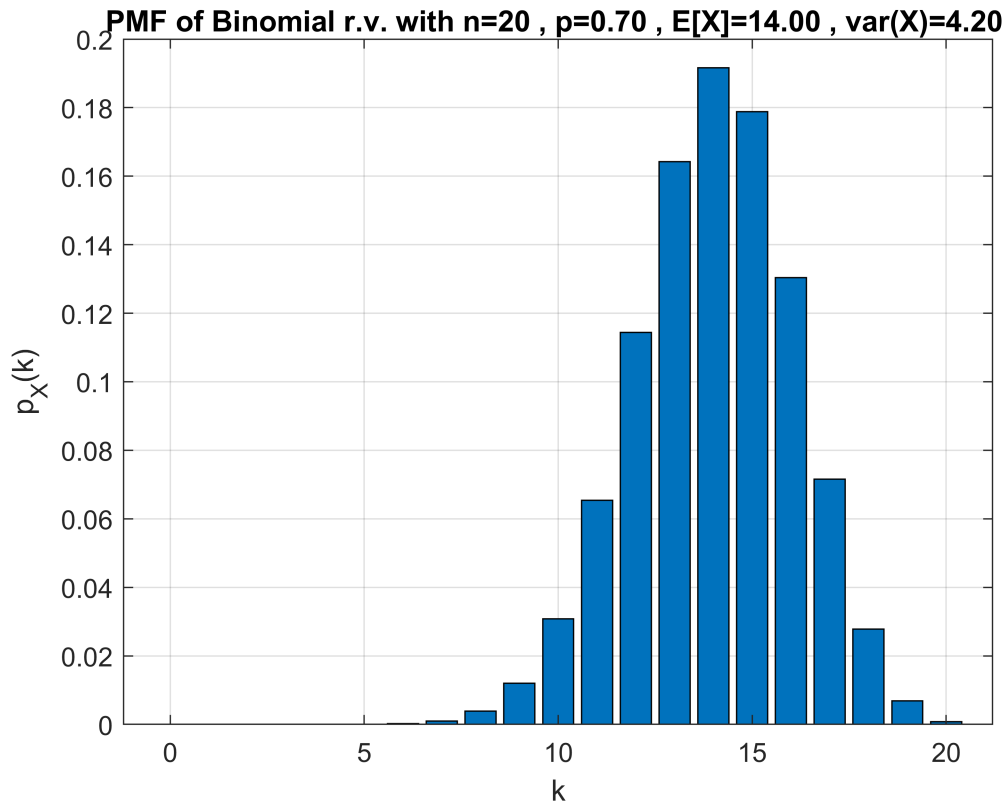
Comment:

Similarly, if we look at the histograms sketched by the plot_binomial_histogram(), as the number of total outcomes (numberoftimes) increases, the plot itself becomes much more identical to the plot of Binomial PMF. Hence, it can be understood that the histogram with the max total outcome is the most similar to the plot of Binomial PMF among the other histograms.

Functions

```
function ber_rv = get_bernoulli_rv(p)
    if ~((0<=p)&&(p<=1))
        ME = MException('myComponent:inputError', ...
            'Variable p=%.2f is not between 0 and 1.',p);
        throw(ME)
    end
    if rand<=p
      ber_rv=1;
    else
      ber_rv=0;
    end
end

% No need for k parameter
function binom_rv = get_binomial_rv(p, n)
    if ~(0<=n)
        ME = MException('myComponent:inputError', ...
```

```matlab
                'Variable n=%d is not equal of bigger than 0.',n);
            throw(ME)
        end
        binom_rv=0;
        if n~=0
            for step = 1:n
                binom_rv = binom_rv + get_bernoulli_rv(p);
            end
        end
end

function plot_bernoulli_histogram(p, numberoftimes)
    samples = zeros(1,numberoftimes);
    for step = 1:numberoftimes
        samples(step) = get_bernoulli_rv(p);
    end
    C = categorical(samples,0:1);
    figure;
    histogram(C,'Normalization','probability')
    xlabel('Values')
    ylabel('Normalized number of outcomes')
    title(sprintf('Histogram of Bernoulli r.v. with total %d outcomes', numberoftimes))
end

function plot_binomial_histogram(p, n, numberoftimes)
    samples = zeros(1,numberoftimes);
    for step = 1:numberoftimes
        samples(step) = get_binomial_rv(p, n);
    end
    C = categorical(samples,0:n);
    figure;
    histogram(C,'Normalization','probability')
    xlabel('Values')
    ylabel('Normalized number of outcomes')
    title(sprintf('Histogram of Binomial r.v. with total %d outcomes', numberoftimes))
end
```