```
% Exercise 1.

N = 10;

x = randn([1 N]);
y = randn([1 N]);

vector1 = x;
vector2 = y;


x_i = (vector1-mean(vector1))/std(vector1);
y_i = (vector2-mean(vector2))/std(vector2);

r = sum(x_i.*y_i)/N;

disp(sprintf("Calculated correlation coefficient is %.4g",r));
```

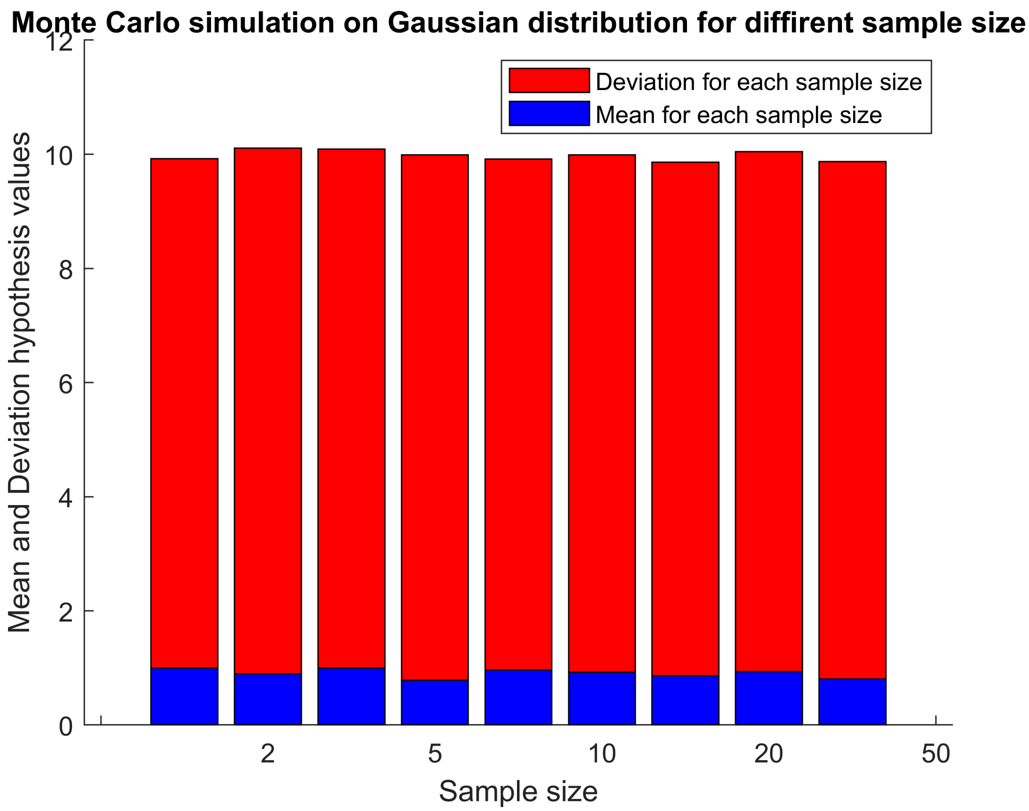
```
Calculated correlation coefficient is 0.01154
```

```
disp(sprintf("Inbounded function correlation coefficient is %.4g",corr(x(:),y(:))));
```

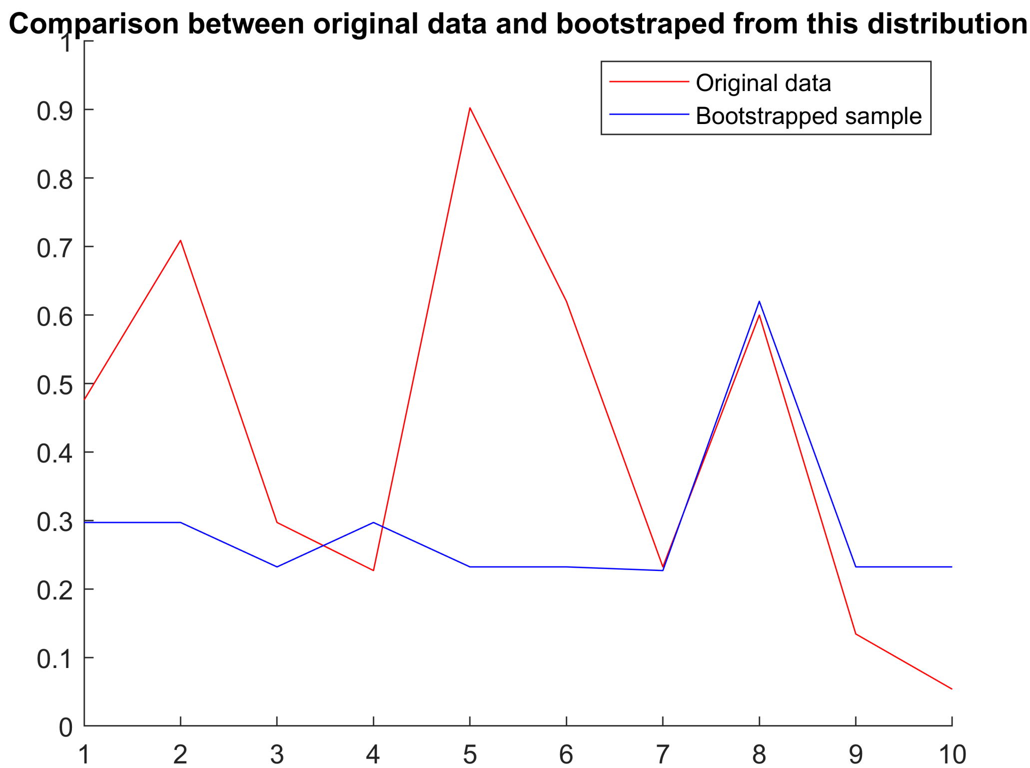
```
Inbounded function correlation coefficient is 0.01282
```

```
% Exercise 2.

sample_sizes = [2 5 10 20 50 100 200 500 10000];
iteration = 100;

results = zeros(9,2);

%results = zeros(size(sample_sizes(:)),iteration)
index = 1;
for r = sample_sizes

    [mean_mean, std_std] = monte_carlo(5,iteration);


    results(index,:) = [mean_mean std_std];
    index = index +1;

end


% visualize the data

names = {'','2', '5' ,'10' ,'20','50' ,'100', '200' ,'500', '10000'};

figure; hold on;
h1 = bar(results(:,1), 'r');
```

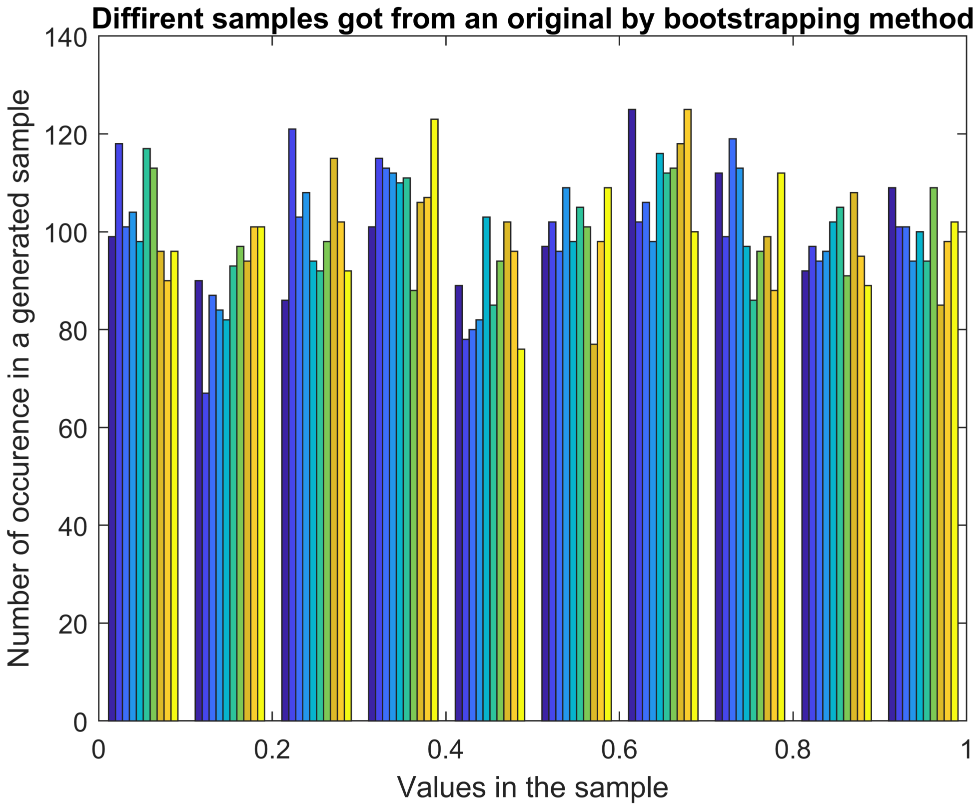
```
h2 = bar(results(:,2), 'b');
legend([h1 h2], 'Deviation for each sample size', 'Mean for each sample size');
title("Monte Carlo simulation on Gaussian distribution for diffirent sample size")
set(gca,'xticklabel',names);
xlabel('Sample size');
ylabel('Mean and Deviation hypothesis values');
```



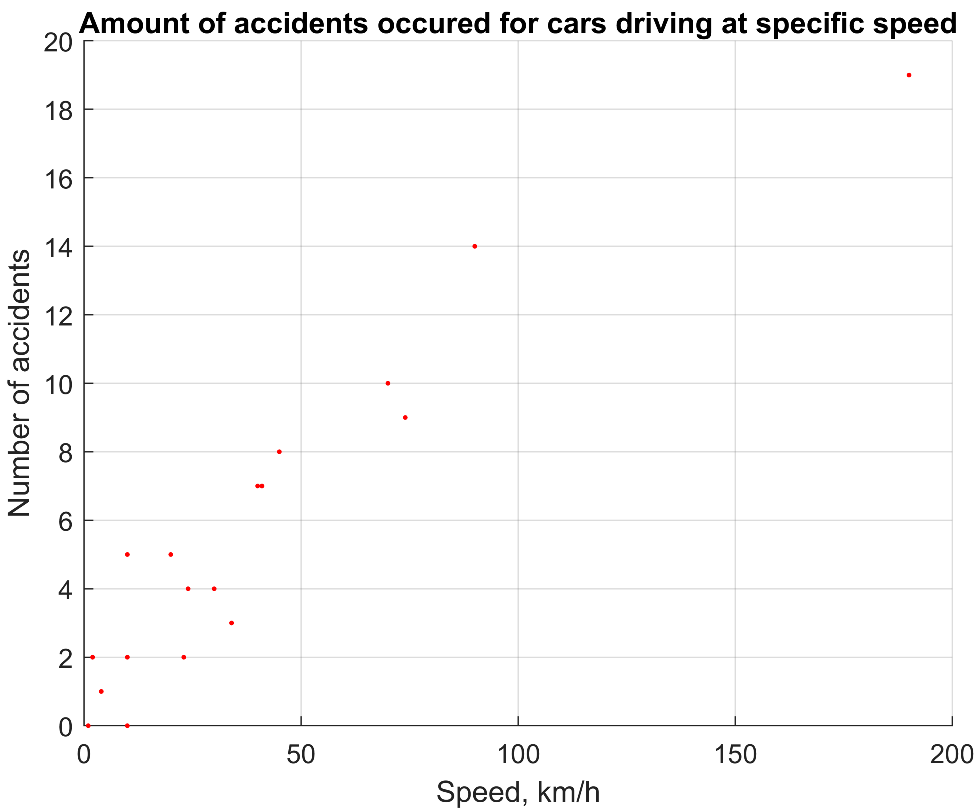

```
% Exercise 3

x = rand(1,10);


bootstrapped = bootstrap(x);

% visualize the original sample and bootstraped

figure; hold on;
h1 = plot(x,'r');
h2 = plot(bootstrapped,'b');
title('Comparison between original data and bootstraped from this distribution')
legend([h1 h2], 'Original data', 'Bootstrapped sample');
```



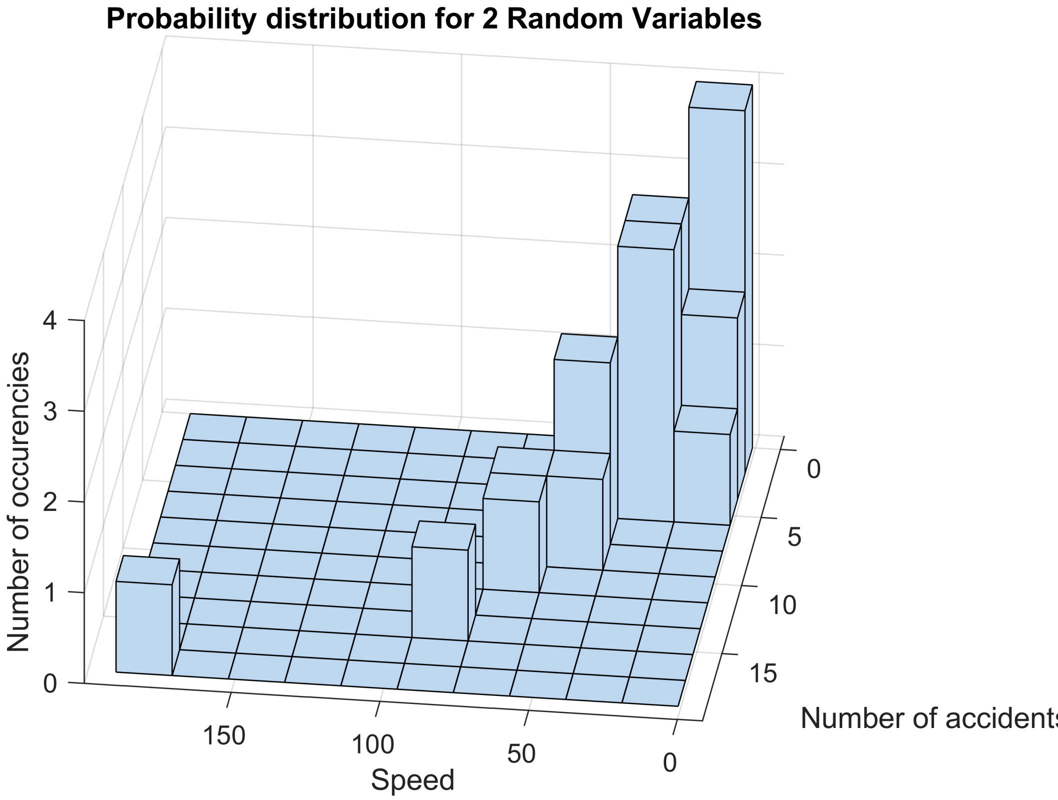

```
% Exercise 4

bootstrapped_array = ex4_return_2d(1000,10);

% Visualize diffirent samples
%
figure;
hist(bootstrapped_array');
title('Diffirent samples got from an original by bootstrapping method');
xlabel('Values in the sample');
ylabel('Number of occurence in a generated sample')
```



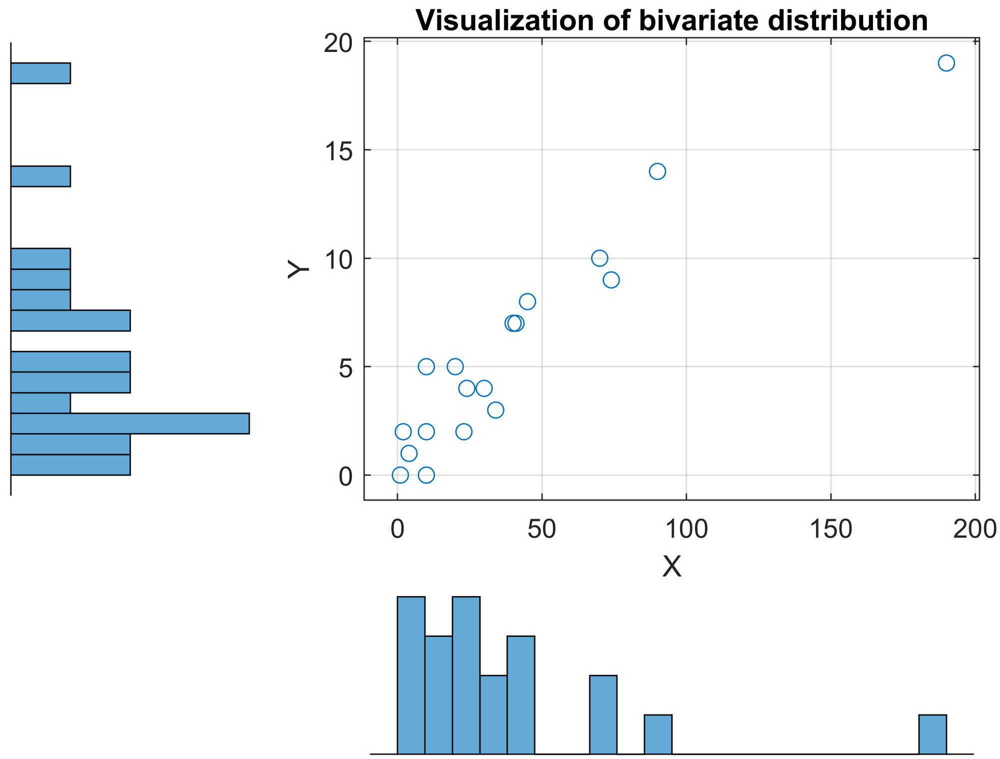

```
% Exercise 5

% X is for the speed of cars
x = [10 20 30 23 10 190 45 34 23 1 10 90 40 70 24 41 4 74 2 4]';

% Y is for the amount of accident for cars at specific speed
y = [ 2 5 4 2 5 19 8 3 2 0 0 14 7 10 4 7 1 9 2 1]';

%Visualize the dependency
figure;
scatter(x,y,'r.');
title('Amount of accidents occured for cars driving at specific speed');
grid;
xlabel('Speed, km/h');
ylabel('Number of accidents');
```




```
% Plot  2D histogram. On x-axis - values from the first distribution. On
% y-axis - values from the second distribution. On z-axis amount of values
% took specific value.
figure;
hist3([x y],[10, 10]);
title("Probability distribution for 2 Random Variables");
xlabel('Speed');
ylabel('Number of accidents');
zlabel('Number of occurencies');
```




```
% Calculate marginal probability for X (stands for speed)

scatterhist(x,y,20);grid;
title('Visualization of bivariate distribution');
xlabel('X')
ylabel('Y')
```




```
% use filter to sort out unnesessary dots for X variable

x_filter_lower = 100;
x_filter_higher = 200;

% Apply a filter on the X
x_i = x( x_filter_lower<x .* (x<=x_filter_higher));

number_of_occurencies = length(x_i);
```

```
number_of_occurencies = 1
```

```

% What we got:
% N(0<x<=50) = 16
% N(50<x<100) = 3
% N(100<x<200) = 1
```

```
% use filter to sort out unnesessary dots for Y variable

y_filter_lower = 15;
y_filter_higher = 20;

% Apply a filter on the Y
```

```
y_i = y( y_filter_lower<y .* (y<=y_filter_higher));

number_of_occurencies = length(y_i);
```

```
number_of_occurencies = 1
```

```
% What we got:
% N(0<y<=5) = 11
% N(5<y<10) = 5
% N(10<y<15) = 1
% N(15<y<20) = 1
```

```
% Finally, we got the matrix with occurancies for X and Y.
% Given that we can calculate the total lenght of samples, we are able to
% calculate the frequency of each random variables separately

N = length(x);


occurencies_x = [16 3 1] ./N
```

```
occurencies_x = 1×3
    0.8000    0.1500    0.0500
```

```
occurencies_y = [11 5 1 1] ./N
```

```
occurencies_y = 1×4
    0.5500    0.2500    0.0500    0.0500
```

```



% This is marginal distribution for P(x) and P(y) respectively
% Obviously, the data can be presented in the following table

% N      x      |P(0<x<=50|y)|P(50<x<100|y)|P(100<x<200|y)  |P(Y)    |
% P(0<y<=5|x) |            |             |                |55%     |
% P(5<y<10|x) |            |             |                |25%     |
% P(10<y<15|x)|            |             |                |5%      |
% P(15<y<20|x)|            |             |                |5%      |
% P(X)        |80%         |15%          |5%              |100%    |
```

```
% Since we expect the variables are independent, then the joint probability
% P(XY) = P(X)*P(Y), where P(X),P(Y) - marginal distribution for X,Y in
% probability space.

joint_probability_matrix = occurencies_x' * occurencies_y
```

```
joint_probability_matrix = 3×4
    0.4400    0.2000    0.0400    0.0400
    0.0825    0.0375    0.0075    0.0075
```

```
    0.0275    0.0125    0.0025    0.0025
```

```
x_names = {'P(0<x<=50|y)'; 'P(50<x<100|y)'; 'P(100<x<200|y)';''};
y_names = {'P(0<y<=5)'; 'P(10<y<15|x)'; 'P(10<y<15|x)';'P(15<y<20|x)'};

s = mesh(joint_probability_matrix);
colormap(jet)
set(gca,'xticklabel',x_names);
set(gca,'yticklabel',y_names);
legend(s,'P(XY)');
title("Joint probability for independent random variables X and Y");
xlabel("P(X|Y)")
ylabel("P(Y|X)")
```