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Comparative Analysis Report: Scenarios A and B Across Different Case Studies

1. Introduction

This report presents a comprehensive analysis of five distinct case studies: Static, Sparsely Populated, Slower, Faster, and Densely Populated. Each study compares two scenarios, A and B, across various parameters such as iterations, distances, and crash instances. The objective is to understand the differences in behavior and outcomes between these scenarios under different conditions. The analysis is based on statistical measures and visual representations like histograms and boxplots, derived from the provided datasets.

2. Methodology

The datasets for each case study were loaded and analyzed using Python. Key statistical measures (mean, mode, median, and quartiles) were calculated for iterations, distances, and crashes. Histograms and boxplots were generated to visualize the distributions and compare scenarios A and B.

3. Codes with outputs

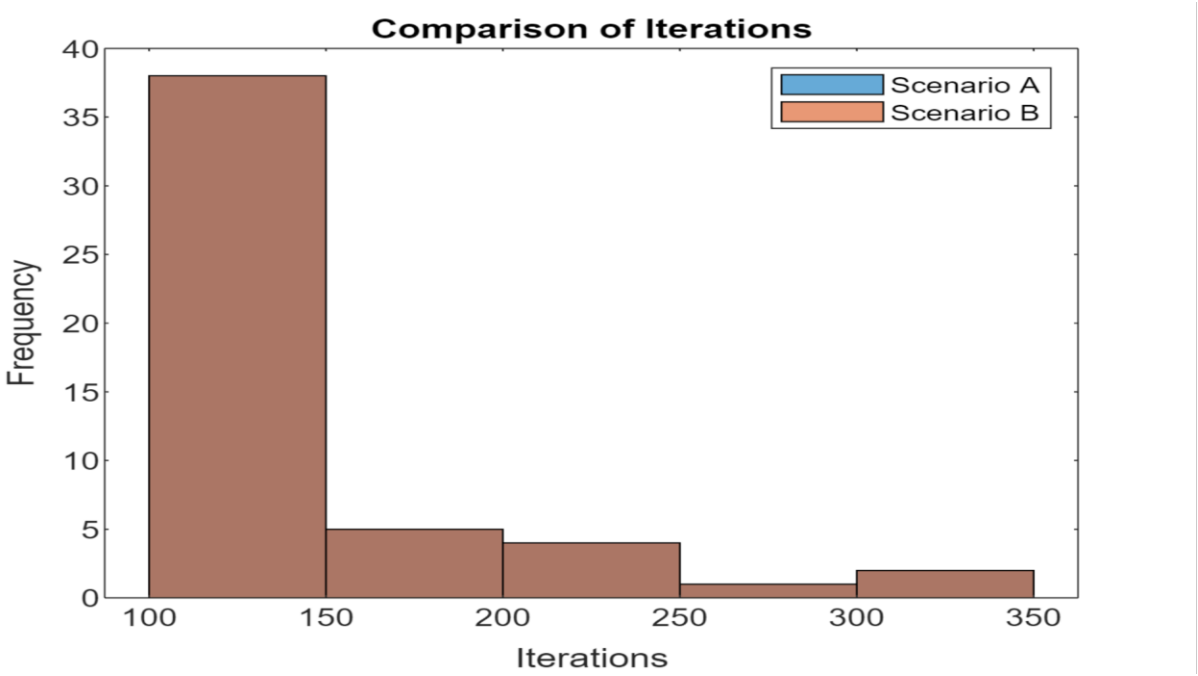
1. Code for Static Case Study.

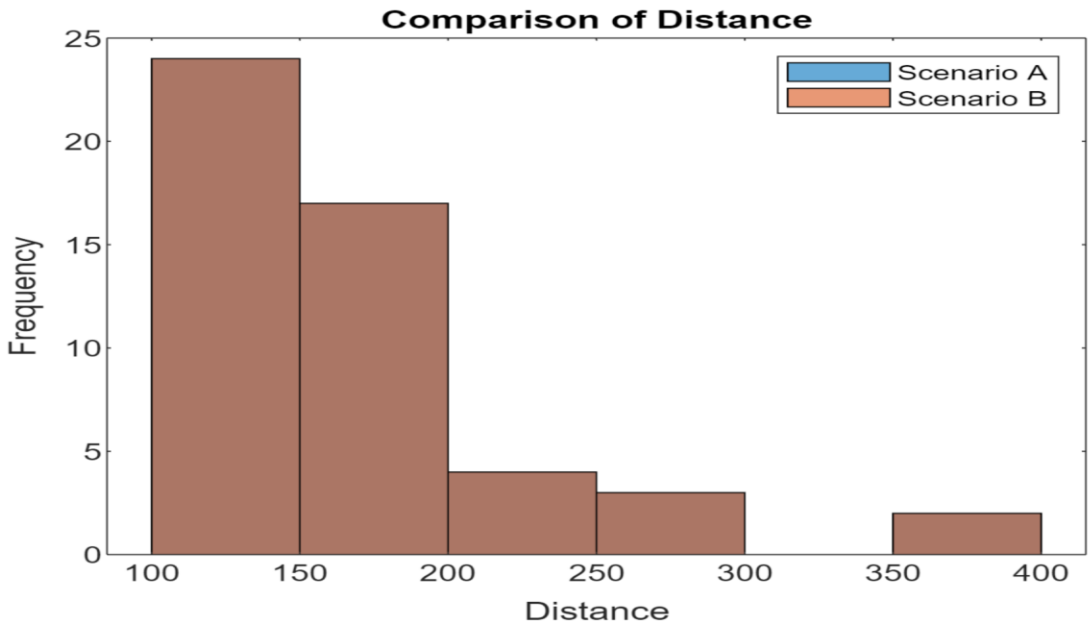
```
file_path = 'static iter50.csv';
data = readtable(file_path);

figure;
histogram(data.A_Iterations);
hold on;
histogram(data.B_Iterations);
title('Comparison of Iterations');
legend('Scenario A', 'Scenario B');
xlabel('Iterations');
ylabel('Frequency');
hold off;


figure;
histogram(data.A_Distance);
hold on;
histogram(data.B_Distance);
title('Comparison of Distance');
legend('Scenario A', 'Scenario B');
```

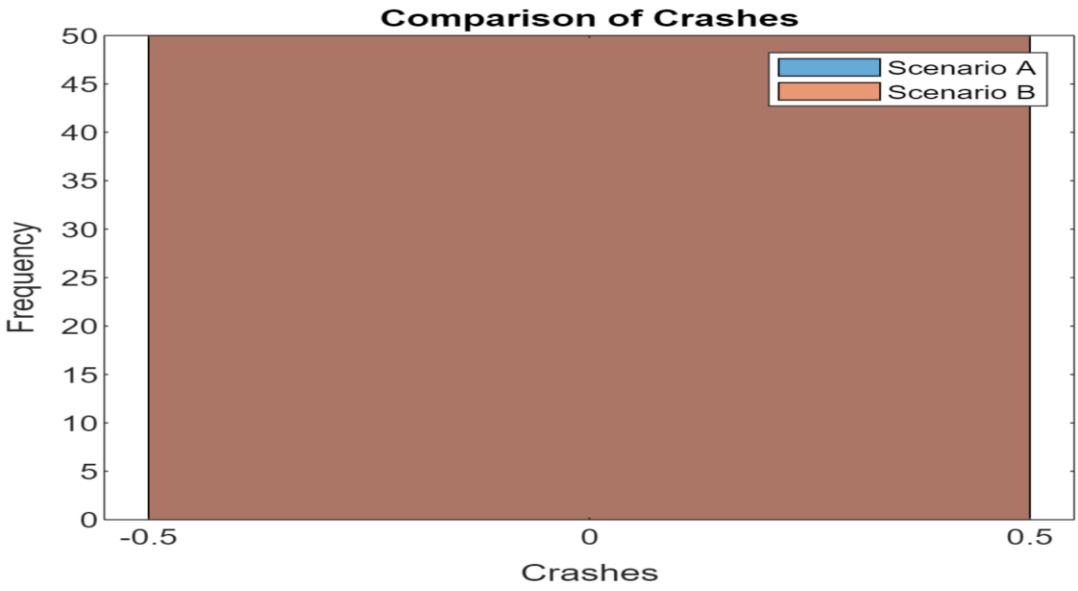
```
xlabel('Distance');
ylabel('Frequency');
hold off;

figure;
histogram(data.A_crashed);
hold on;
histogram(data.B_crashed);
title('Comparison of Crashes');
legend('Scenario A', 'Scenario B');
xlabel('Crashes');
ylabel('Frequency');
hold off;

figure;
boxplot(data.A_Iterations);
title("A Iteration Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Iteration Box Plot");


figure;
boxplot(data.A_Iterations);
title("A Distance Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Distance Box Plot");

mean_data_A = mean(data.A_Distance);
mode_data_A = mode(data.A_Distance);
median_data_A = median(data.A_Distance);
quartiles_A = quantile(data.A_Distance, [0.25, 0.5, 0.75]);

mean_data_B = mean(data.B_Distance);
mode_data_B = mode(data.B_Distance);
median_data_B = median(data.B_Distance);
quartiles_B = quantile(data.B_Distance, [0.25, 0.5, 0.75]);

figure;
bar([mean_data_A, mode_data_A, median_data_A, quartiles_A; mean_data_B, mode_data_B,
median_data_B, quartiles_B]);
xticks(1:2);
xticklabels({'A Distance','B Distance'});
ylabel('Values');
title('Statistics for A_Distance and B_Distance');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");


mean_iterations_A = mean(data.A_Iterations);
mode_iterations_A = mode(data.A_Iterations);
median_iterations_A = median(data.A_Iterations);
quartiles_iterations_A = quantile(data.A_Iterations, [0.25, 0.5, 0.75]);
```

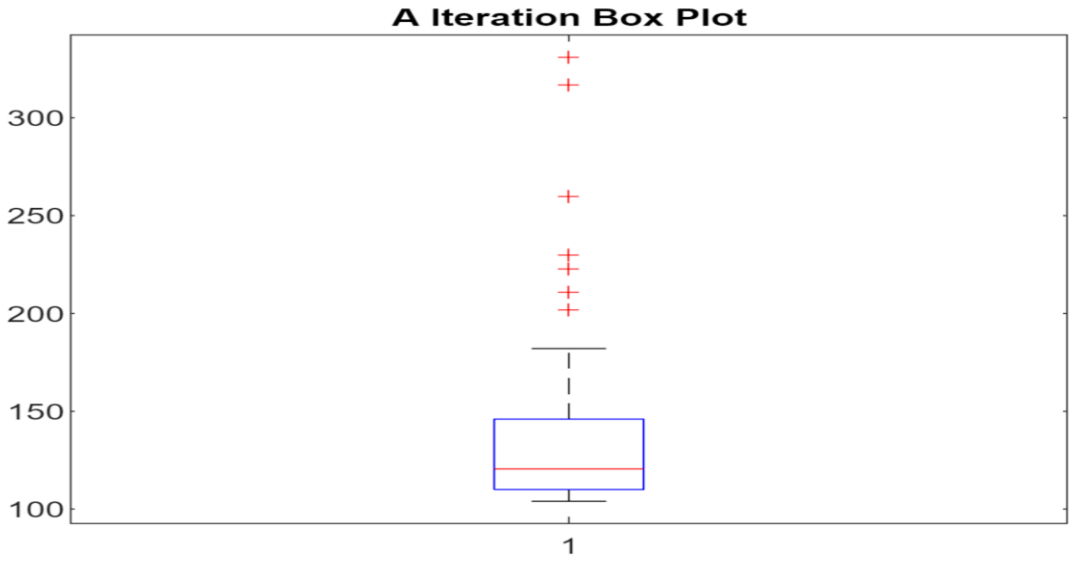
```
mean_iterations_B = mean(data.B_Iterations);
mode_iterations_B = mode(data.B_Iterations);
median_iterations_B = median(data.B_Iterations);
quartiles_iterations_B = quantile(data.B_Iterations, [0.25, 0.5, 0.75]);

figure;
bar([mean_iterations_A, mode_iterations_A,
median_iterations_A,quartiles_iterations_A; mean_iterations_B, mode_iterations_B,
median_iterations_B,quartiles_iterations_B]);
xticks(1:2);
xticklabels({'A Iterations';'B Iteration'});
ylabel('Values');
title('Statistics for A_Iterations and B_Iterations');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");
```

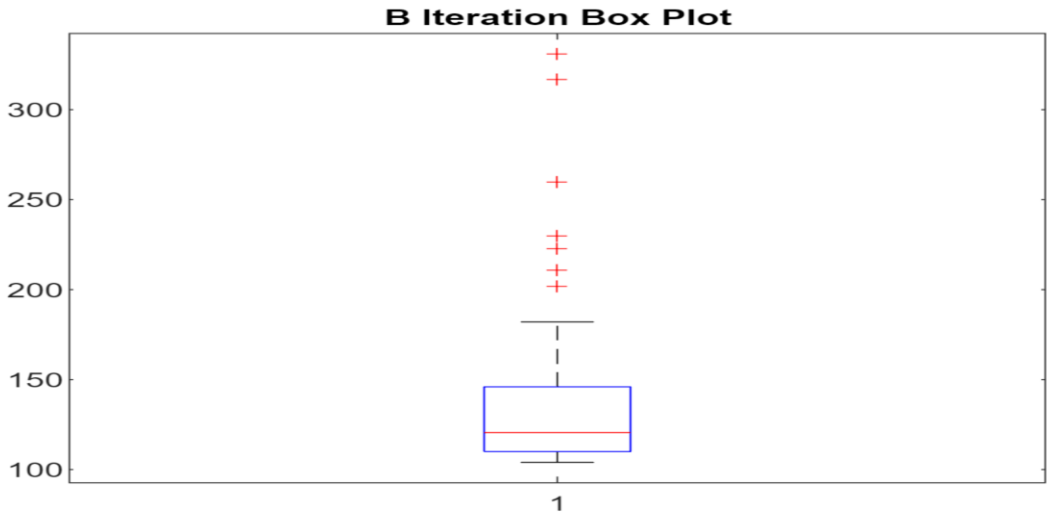
Output



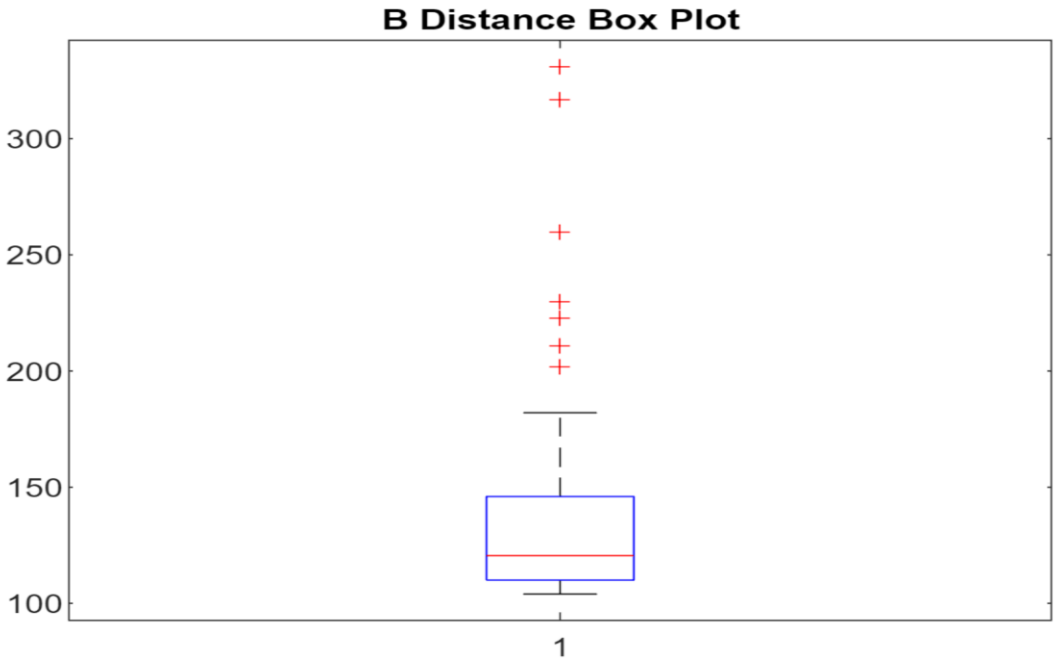

Comparison of Distance
Scenario A
Scenario B
Frequency
Distance
0
5
10
15
20
25
100
150
200
250
300
350
400

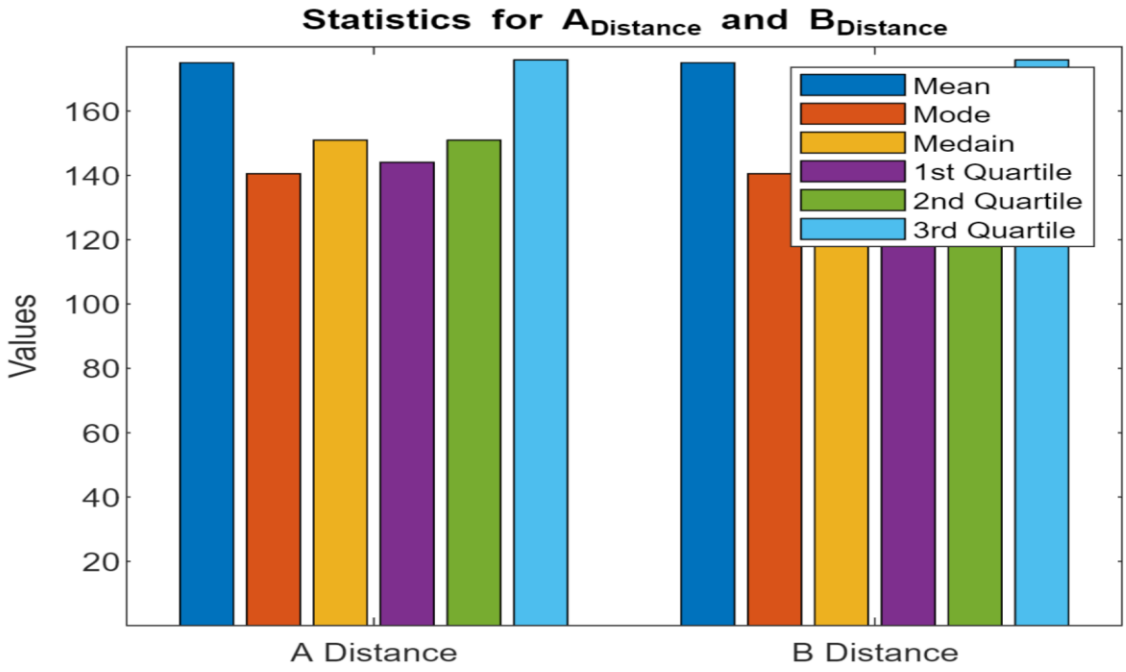

Comparison of Crashes
Scenario A
Scenario B
Frequency
Crashes
0
5
10
15
20
25
30
35
40
45
50
-0.5
0
0.5

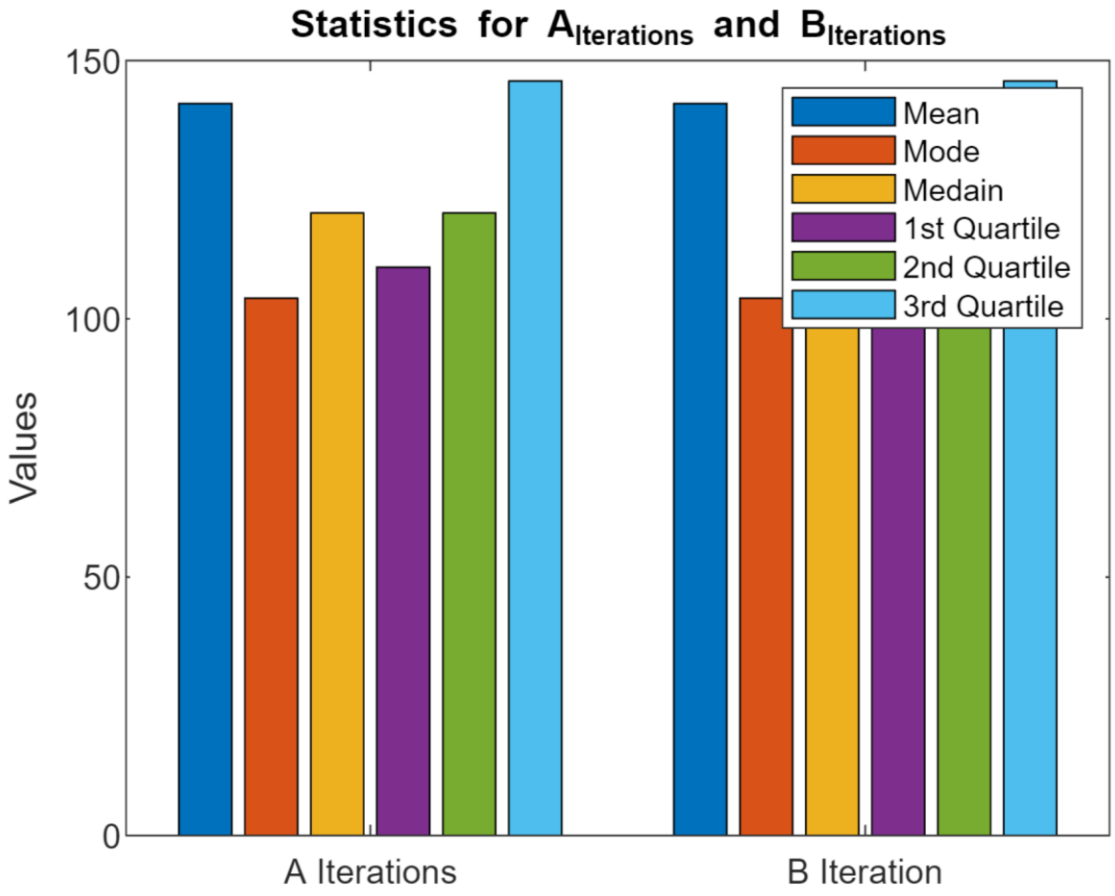

A Iteration Box Plot
300
250
200
150
100
1


B Iteration Box Plot
300
250
200
150
100
1

A Distance Box Plot
300
250
200
150
100
1


B Distance Box Plot
300
250
200
150
100
1


Statistics for A Distance and B Distance
Values
160
140
120
100
80
60
40
20
Mean
Mode
Medain
1st Quartile
2nd Quartile
3rd Quartile
A Distance
B Distance

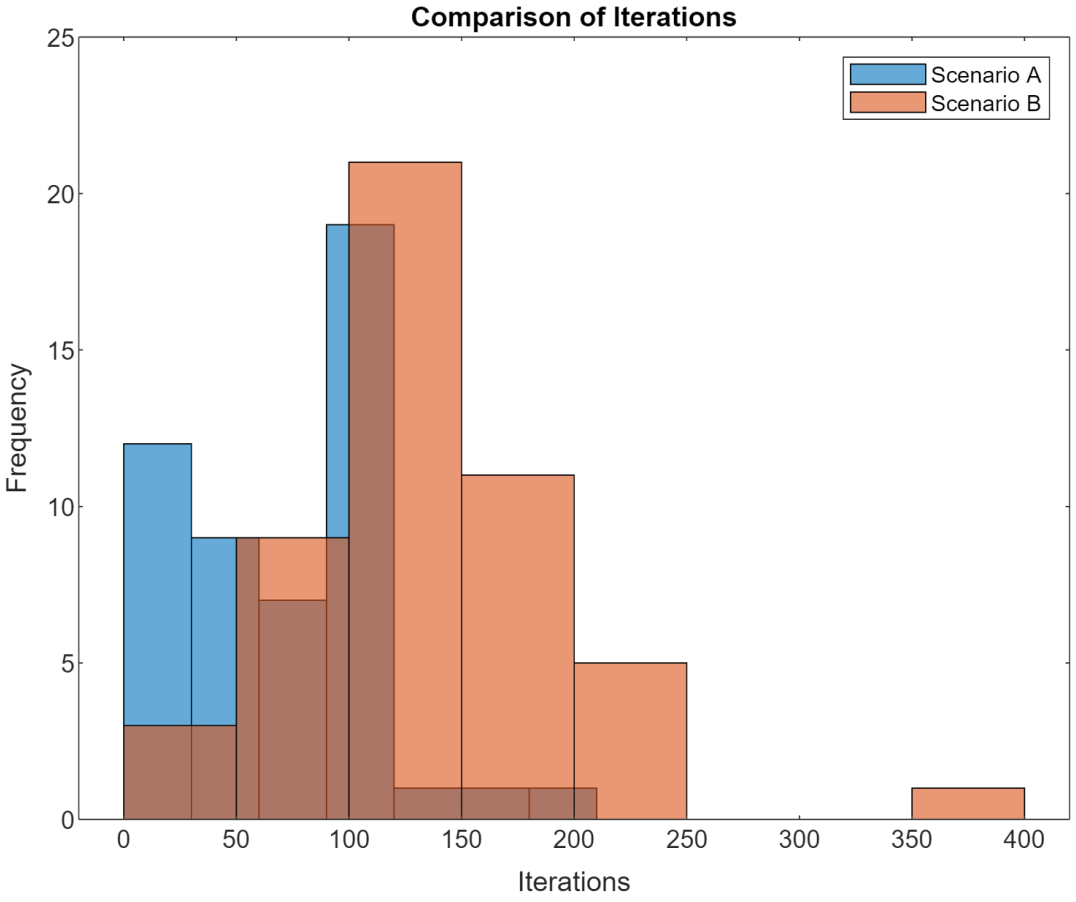

Statistics for A Iterations and B Iterations
Values
150
100
50
0
Mean
Mode
Medain
1st Quartile
2nd Quartile
3rd Quartile
A Iterations
B Iteration

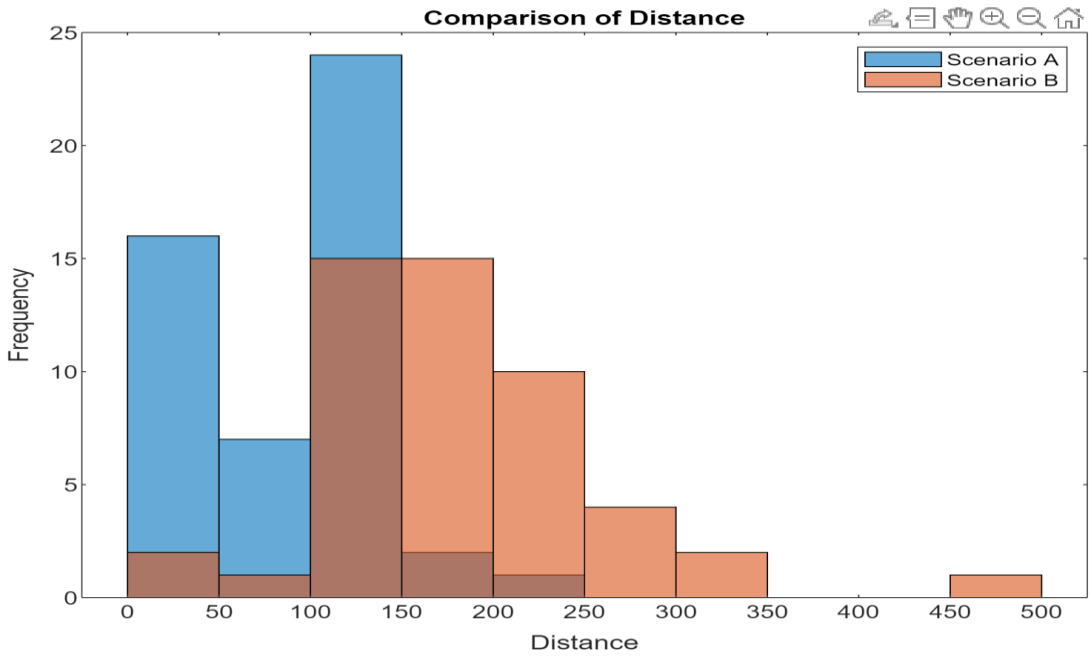
2. Code for Sparsely Populated Case Study

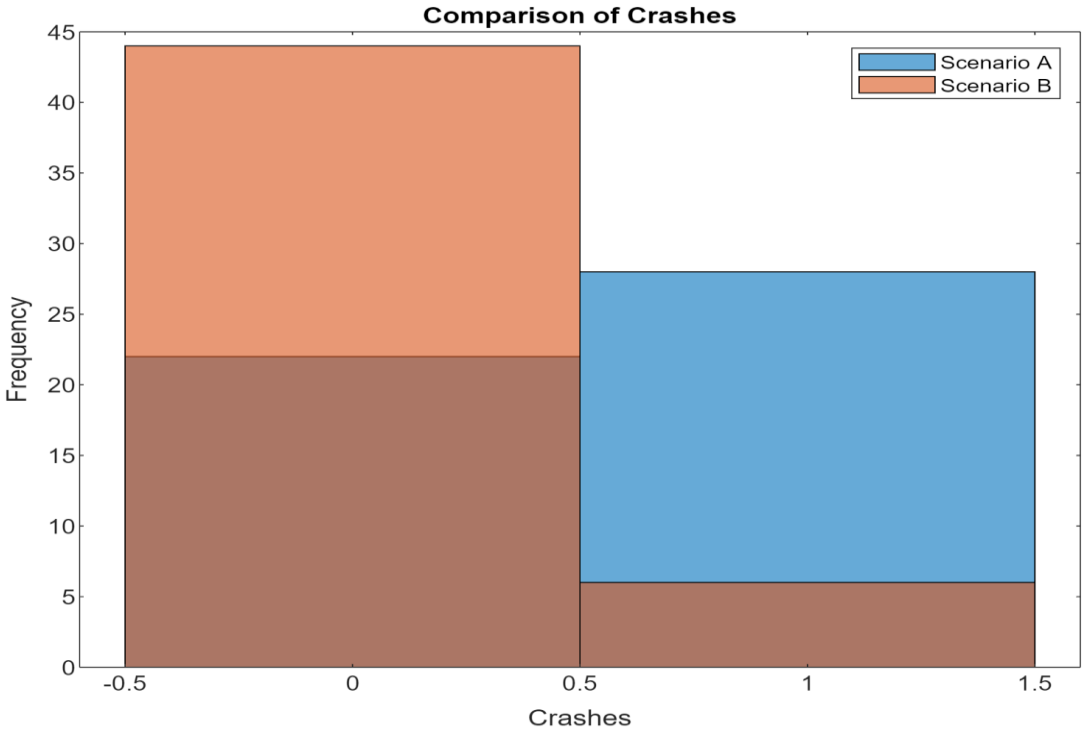
```
file_path = 'sparsely populated iter50.csv';
data = readtable(file_path);

figure;
histogram(data.A_Iterations);
hold on;
histogram(data.B_Iterations);
title('Comparison of Iterations');
legend('Scenario A', 'Scenario B');
xlabel('Iterations');
ylabel('Frequency');
hold off;


figure;
histogram(data.A_Distance);
hold on;
histogram(data.B_Distance);
title('Comparison of Distance');
legend('Scenario A', 'Scenario B');
xlabel('Distance');
ylabel('Frequency');
hold off;

figure;
histogram(data.A_crashed);
hold on;
histogram(data.B_crashed);
title('Comparison of Crashes');
legend('Scenario A', 'Scenario B');
xlabel('Crashes');
ylabel('Frequency');
hold off;

figure;
boxplot(data.A_Iterations);
title("A Iteration Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Iteration Box Plot");


figure;
boxplot(data.A_Iterations);
title("A Distance Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Distance Box Plot");

mean_data_A = mean(data.A_Distance);
mode_data_A = mode(data.A_Distance);
```

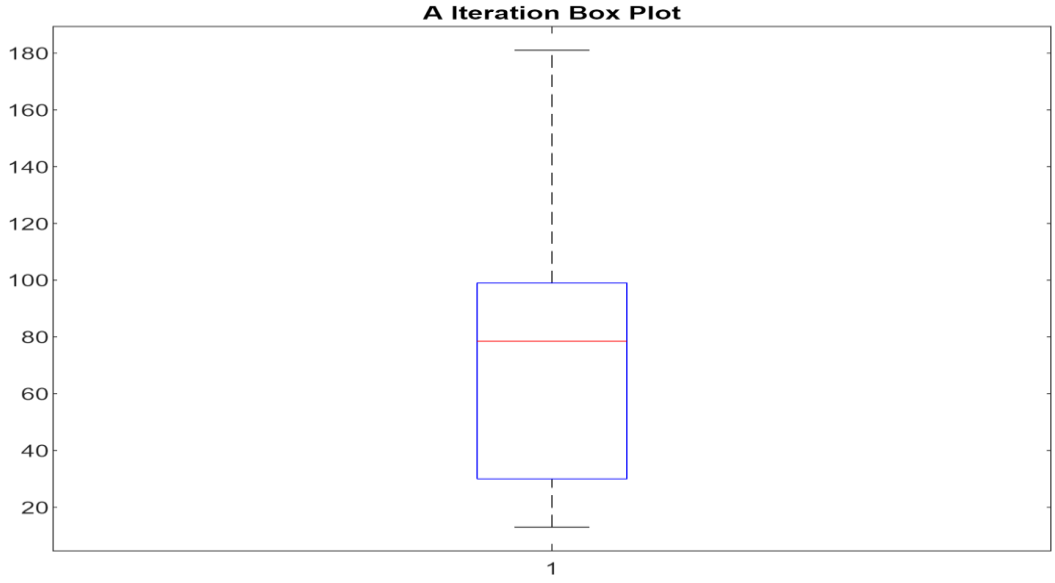
```
median_data_A = median(data.A_Distance);
quartiles_A = quantile(data.A_Distance, [0.25, 0.5, 0.75]);

mean_data_B = mean(data.B_Distance);
mode_data_B = mode(data.B_Distance);
median_data_B = median(data.B_Distance);
quartiles_B = quantile(data.B_Distance, [0.25, 0.5, 0.75]);

figure;
bar([mean_data_A, mode_data_A, median_data_A, quartiles_A; mean_data_B, mode_data_B,
median_data_B, quartiles_B]);
xticks(1:2);
xticklabels({'A Distance','B Distance'});
ylabel('Values');
title('Statistics for A_Distance and B_Distance');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");


mean_iterations_A = mean(data.A_Iterations);
mode_iterations_A = mode(data.A_Iterations);
median_iterations_A = median(data.A_Iterations);
quartiles_iterations_A = quantile(data.A_Iterations, [0.25, 0.5, 0.75]);

mean_iterations_B = mean(data.B_Iterations);
mode_iterations_B = mode(data.B_Iterations);
median_iterations_B = median(data.B_Iterations);
quartiles_iterations_B = quantile(data.B_Iterations, [0.25, 0.5, 0.75]);

figure;
bar([mean_iterations_A, mode_iterations_A,
median_iterations_A,quartiles_iterations_A; mean_iterations_B, mode_iterations_B,
median_iterations_B,quartiles_iterations_B]);
xticks(1:2);
xticklabels({'A Iterations';'B Iteration'});
ylabel('Values');
title('Statistics for A_Iterations and B_Iterations');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");
```

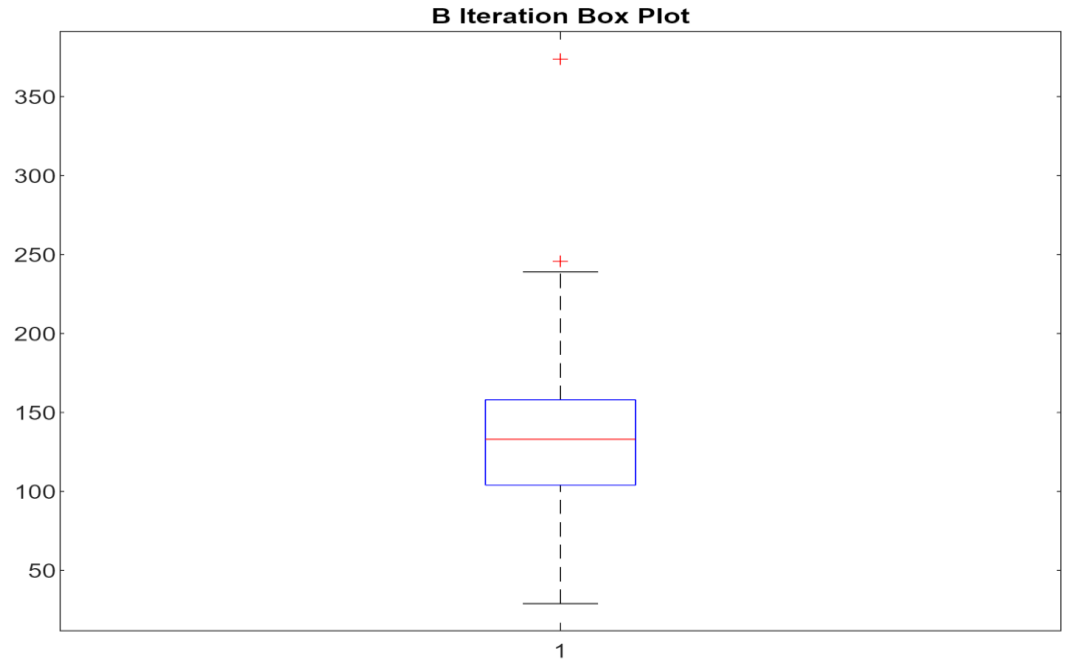
Output

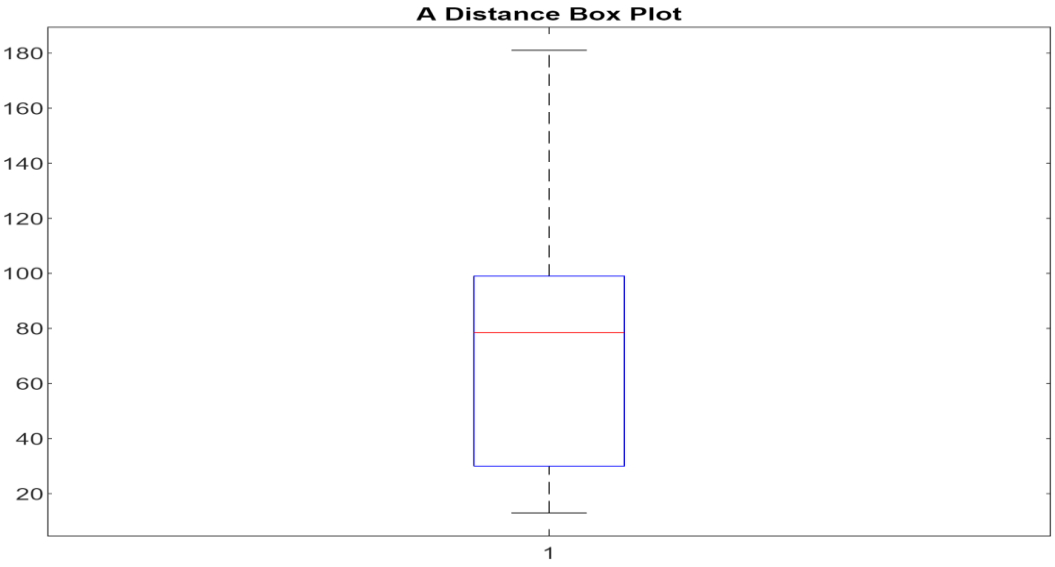

Comparison of Iterations
Scenario A
Scenario B
Frequency
Iterations
0
5
10
15
20
25
0
50
100
150
200
250
300
350
400

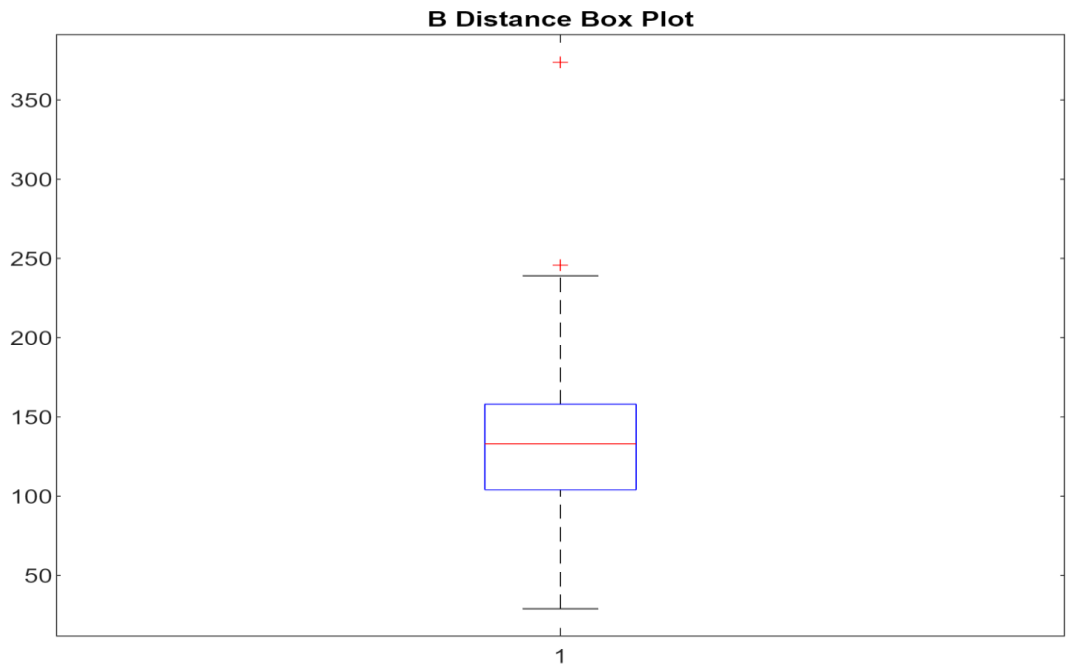

Comparison of Distance
Scenario A
Scenario B
Frequency
Distance
0
5
10
15
20
25
0
50
100
150
200
250
300
350
400
450
500

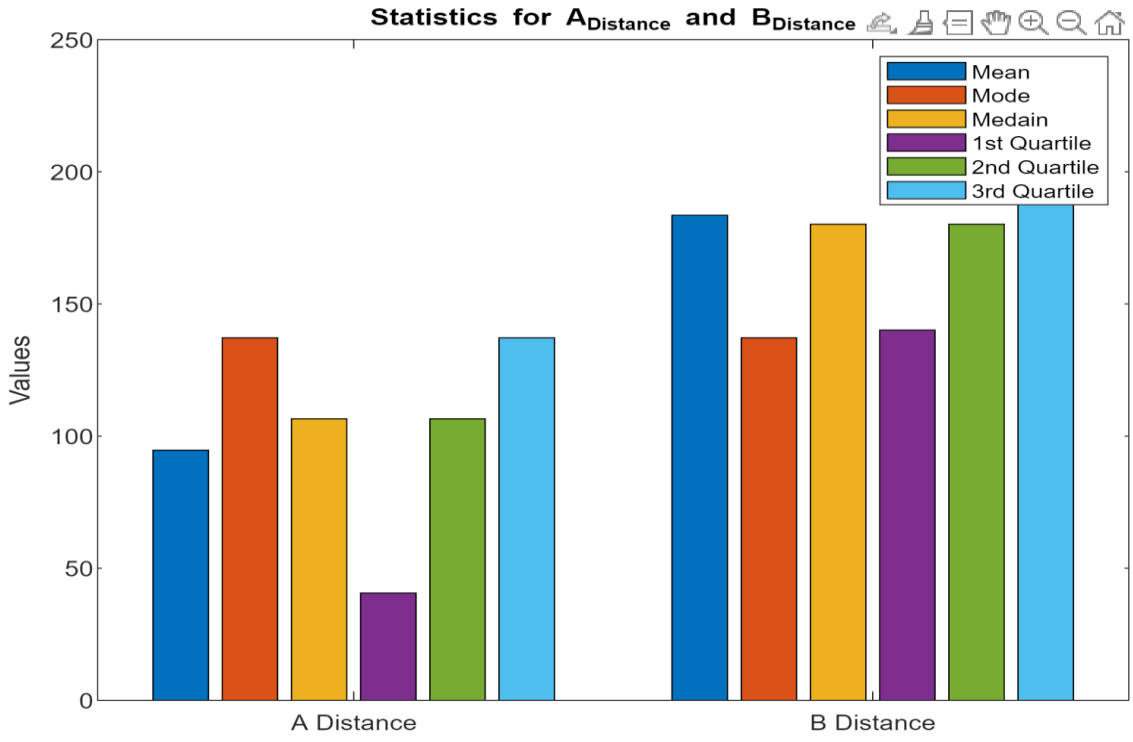

Comparison of Crashes
Scenario A
Scenario B
Frequency
Crashes
45
40
35
30
25
20
15
10
5
0
-0.5
0
0.5
1
1.5

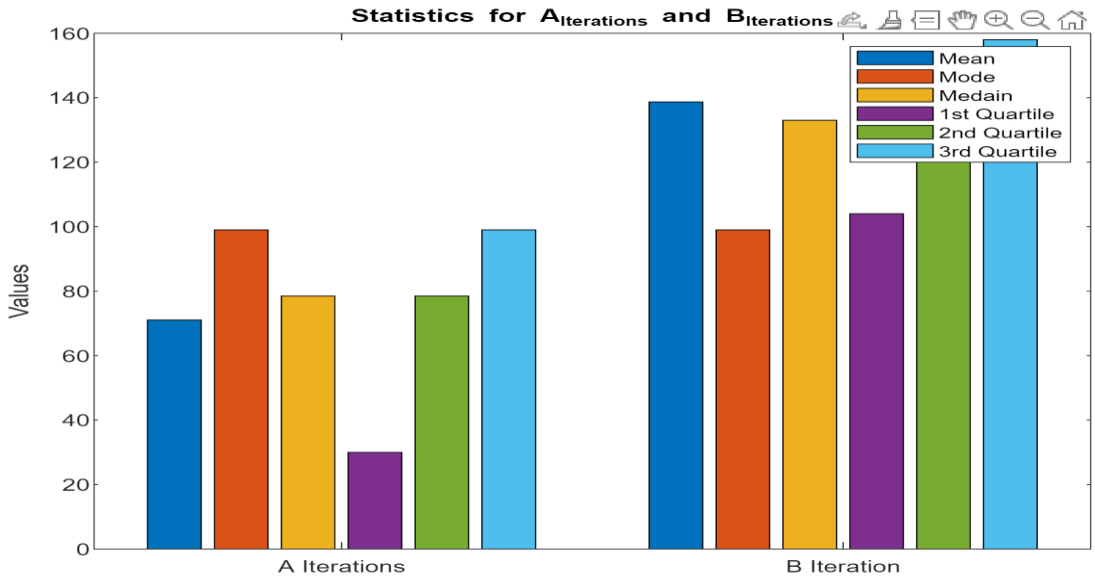

A Iteration Box Plot
180
160
140
120
100
80
60
40
20
1


B Iteration Box Plot
350
300
250
200
150
100
50
1


A Distance Box Plot
180
160
140
120
100
80
60
40
20
1


B Distance Box Plot
350
300
250
200
150
100
50
1


Statistics for A Distance and B Distance
Mean
Mode
Medain
1st Quartile
2nd Quartile
3rd Quartile
Values
250
200
150
100
50
0
A Distance
B Distance



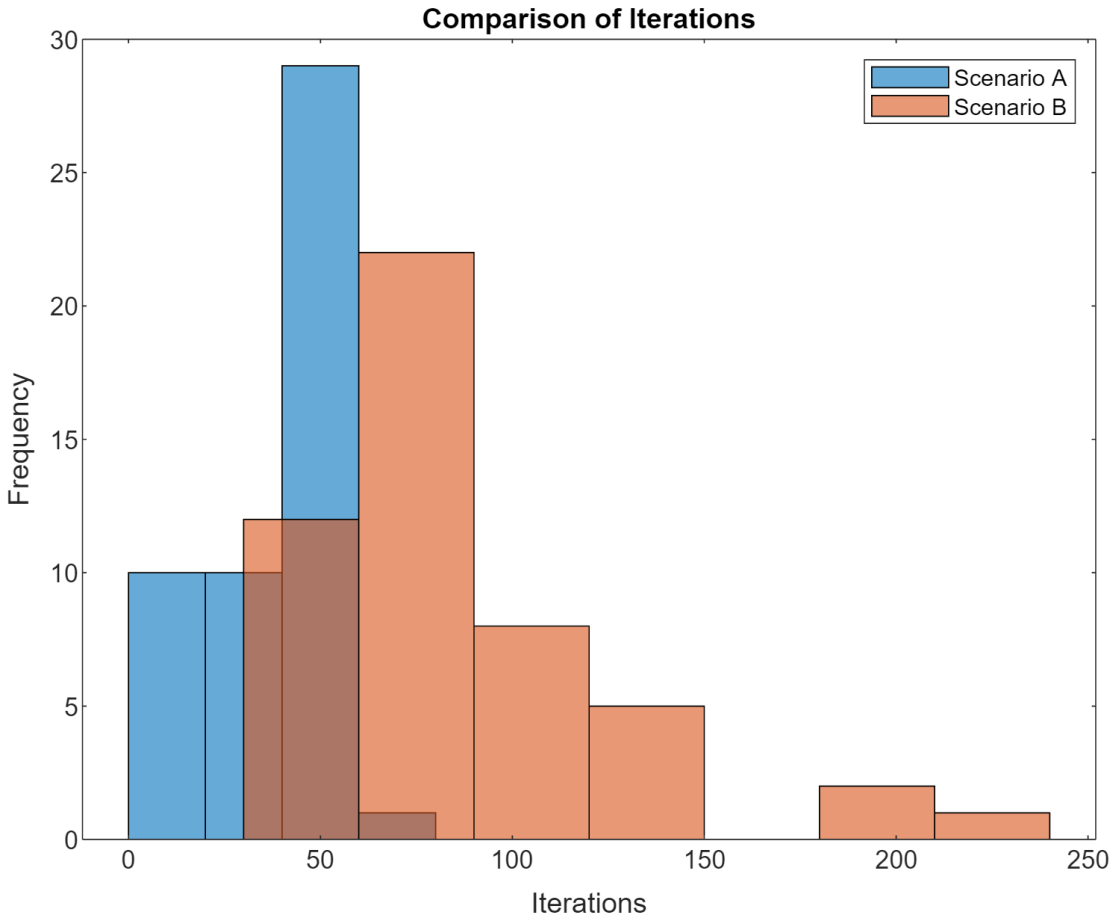
3. Code for Slower Case Study

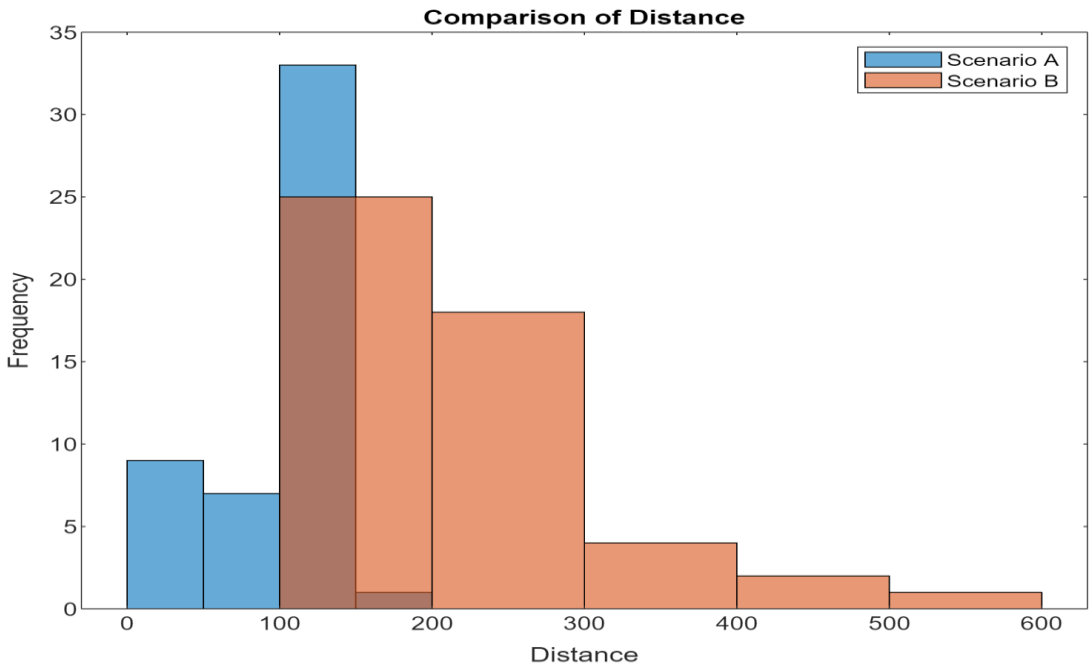
```
file_path = 'slower than MRiter50.csv';
data = readtable(file_path);

figure;
histogram(data.A_Iterations);
hold on;
histogram(data.B_Iterations);
title('Comparison of Iterations');
legend('Scenario A', 'Scenario B');
xlabel('Iterations');
ylabel('Frequency');
hold off;


figure;
histogram(data.A_Distance);
hold on;
histogram(data.B_Distance);
title('Comparison of Distance');
legend('Scenario A', 'Scenario B');
xlabel('Distance');
ylabel('Frequency');
hold off;

figure;
histogram(data.A_crashed);
hold on;
histogram(data.B_crashed);
title('Comparison of Crashes');
legend('Scenario A', 'Scenario B');
xlabel('Crashes');
```

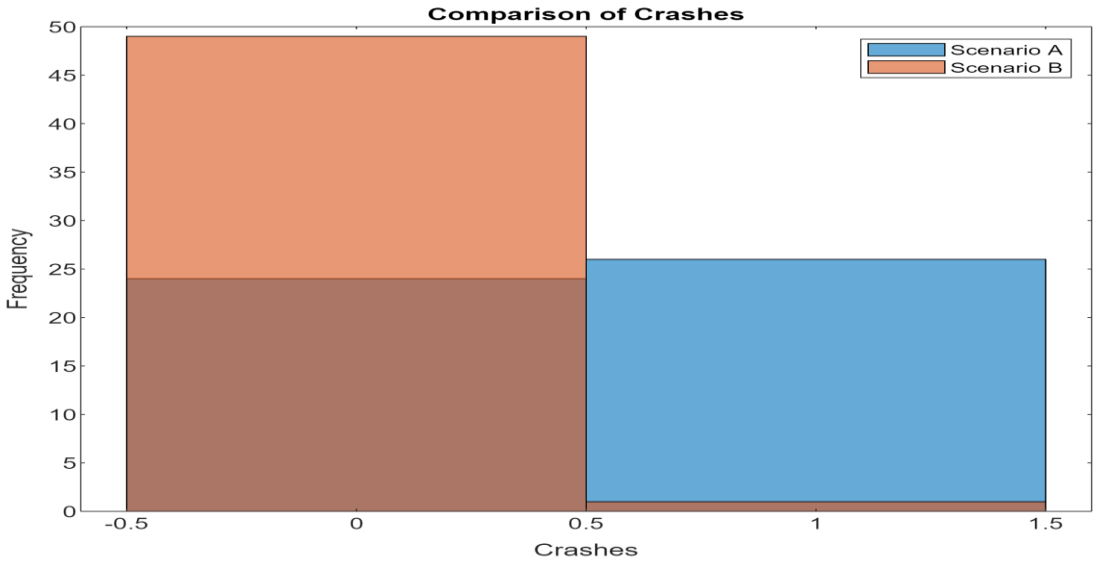
```
ylabel('Frequency');
hold off;

figure;
boxplot(data.A_Iterations);
title("A Iteration Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Iteration Box Plot");


figure;
boxplot(data.A_Iterations);
title("A Distance Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Distance Box Plot");

mean_data_A = mean(data.A_Distance);
mode_data_A = mode(data.A_Distance);
median_data_A = median(data.A_Distance);
quartiles_A = quantile(data.A_Distance, [0.25, 0.5, 0.75]);

mean_data_B = mean(data.B_Distance);
mode_data_B = mode(data.B_Distance);
median_data_B = median(data.B_Distance);
quartiles_B = quantile(data.B_Distance, [0.25, 0.5, 0.75]);

figure;
bar([mean_data_A, mode_data_A, median_data_A, quartiles_A; mean_data_B, mode_data_B,
median_data_B, quartiles_B]);
xticks(1:2);
xticklabels({'A Distance','B Distance'});
ylabel('Values');
title('Statistics for A_Distance and B_Distance');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");


mean_iterations_A = mean(data.A_Iterations);
mode_iterations_A = mode(data.A_Iterations);
median_iterations_A = median(data.A_Iterations);
quartiles_iterations_A = quantile(data.A_Iterations, [0.25, 0.5, 0.75]);

mean_iterations_B = mean(data.B_Iterations);
mode_iterations_B = mode(data.B_Iterations);
median_iterations_B = median(data.B_Iterations);
quartiles_iterations_B = quantile(data.B_Iterations, [0.25, 0.5, 0.75]);

figure;
bar([mean_iterations_A, mode_iterations_A,
median_iterations_A,quartiles_iterations_A; mean_iterations_B, mode_iterations_B,
median_iterations_B,quartiles_iterations_B]);
xticks(1:2);
```

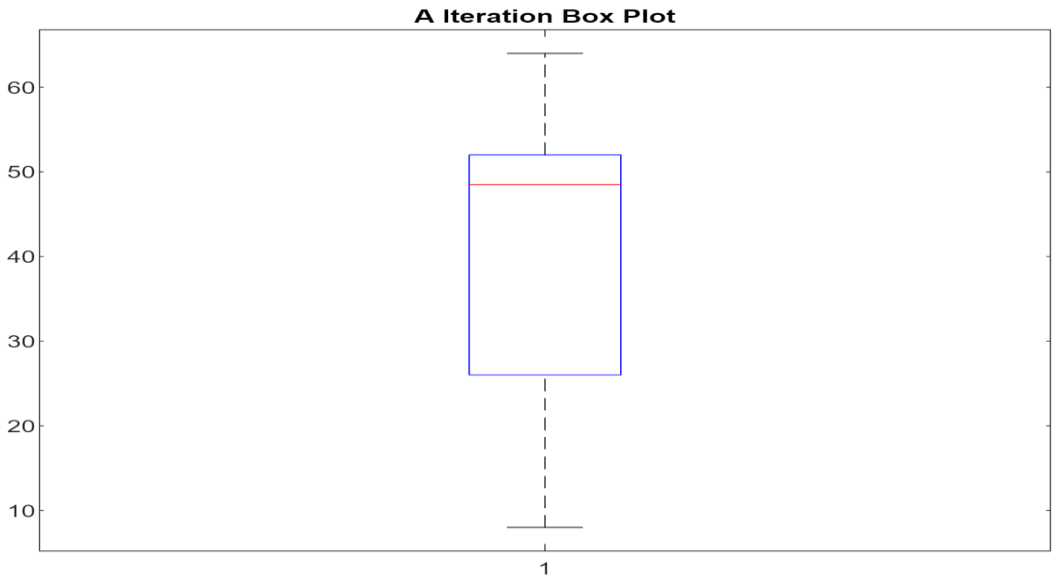
```
xticklabels({'A Iterations';'B Iteration'});
ylabel('Values');
title('Statistics for A_Iterations and B_Iterations');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");
```

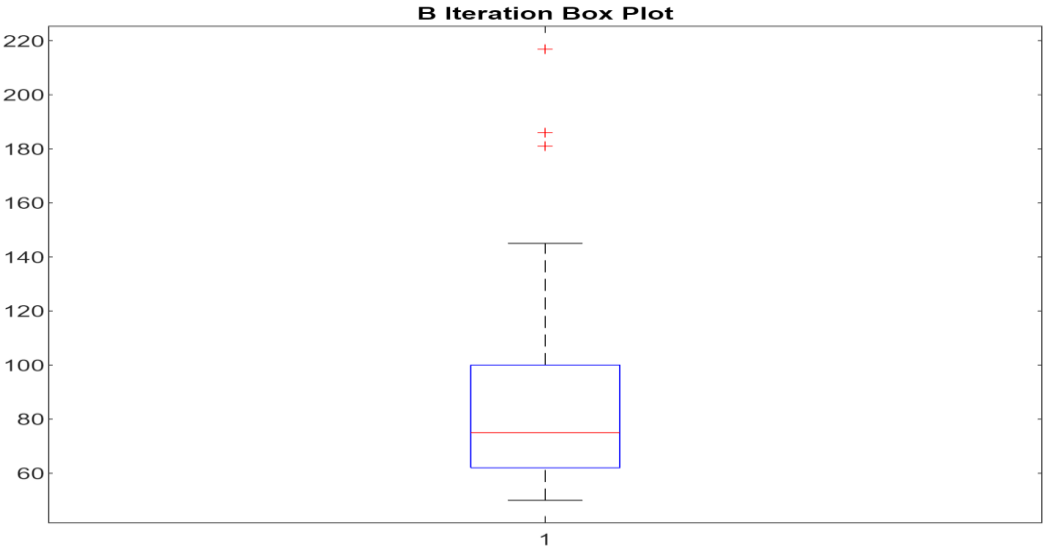
Output

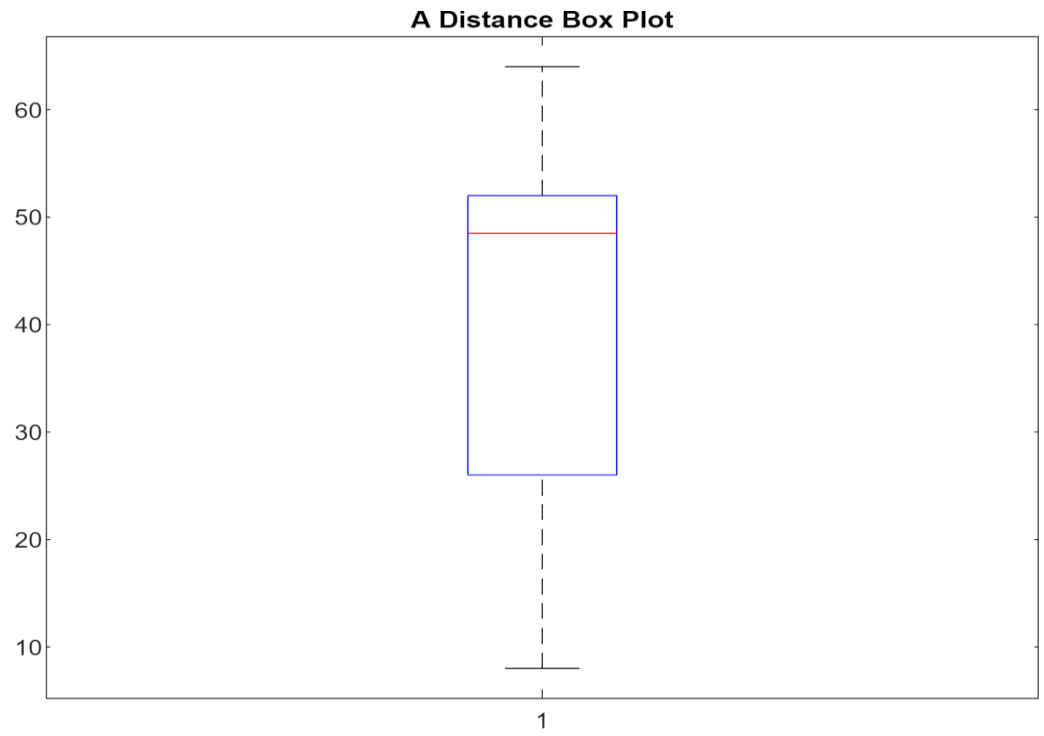


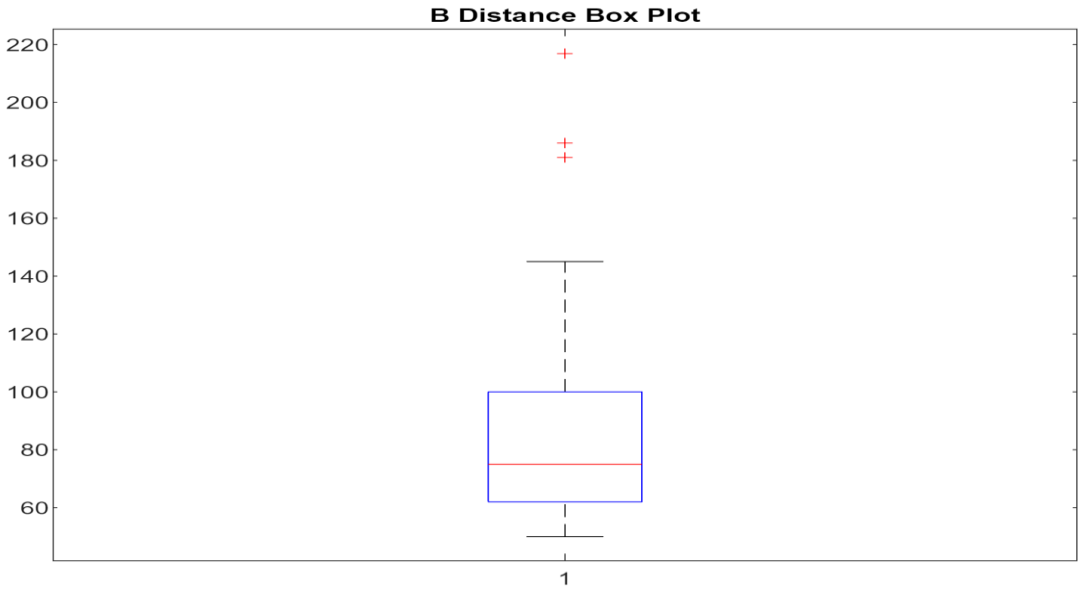

Comparison of Distance
Scenario A
Scenario B
Frequency
Distance
0
5
10
15
20
25
30
35
0
100
200
300
400
500
600

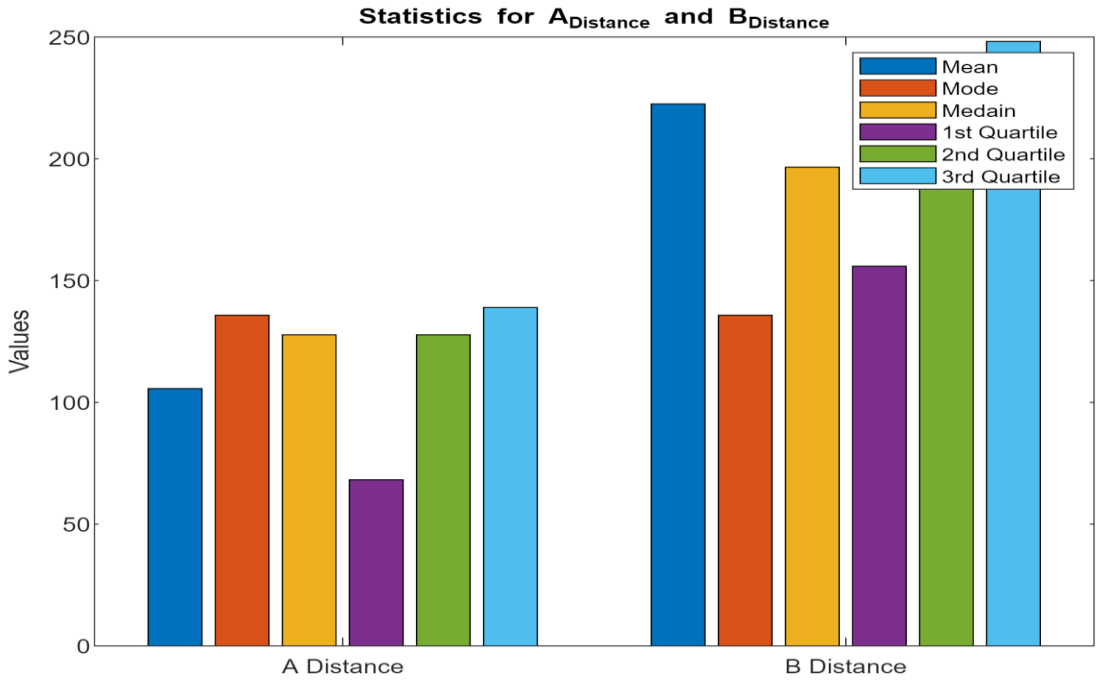

Comparison of Crashes
Scenario A
Scenario B
Frequency
Crashes
0
5
10
15
20
25
30
35
40
45
50
-0.5
0
0.5
1
1.5

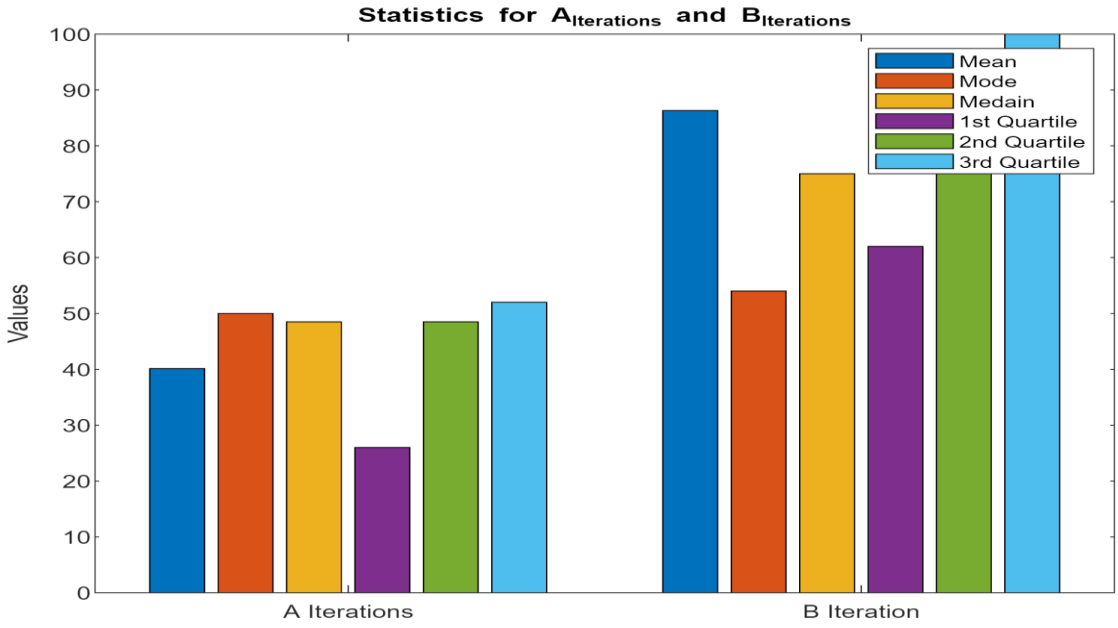

A Iteration Box Plot
60
50
40
30
20
10
1


B Iteration Box Plot
220
200
180
160
140
120
100
80
60
1


A Distance Box Plot
60
50
40
30
20
10
1


B Distance Box Plot
220
200
180
160
140
120
100
80
60
1





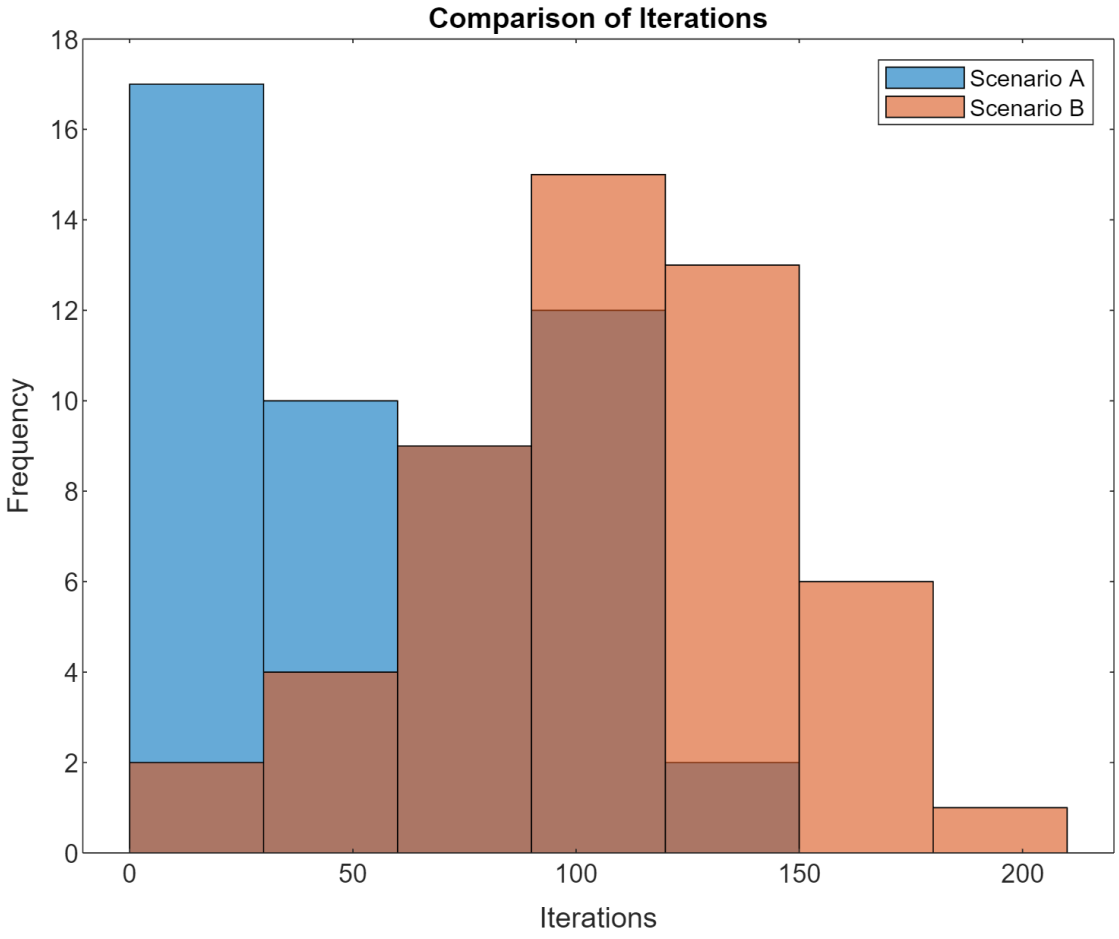
4. Code for Faster Case Study

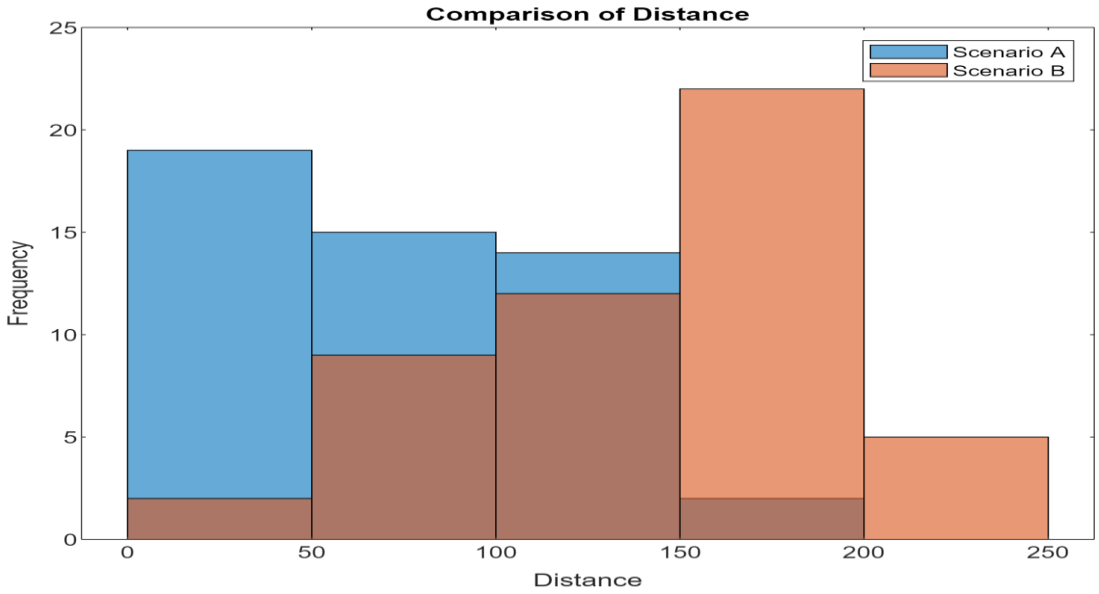
```
file_path = 'faster than MRiter50.csv';
data = readtable(file_path);

figure;
histogram(data.A_Iterations);
hold on;
```

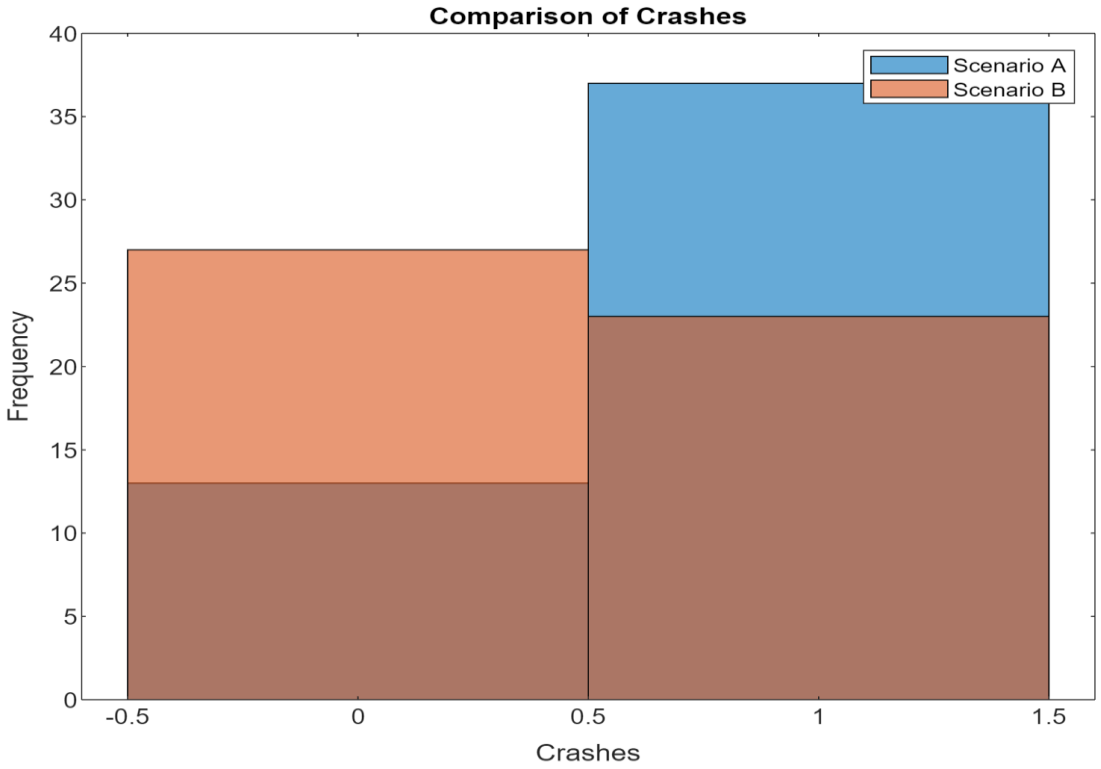
```
histogram(data.B_Iterations);
title('Comparison of Iterations');
legend('Scenario A', 'Scenario B');
xlabel('Iterations');
ylabel('Frequency');
hold off;


figure;
histogram(data.A_Distance);
hold on;
histogram(data.B_Distance);
title('Comparison of Distance');
legend('Scenario A', 'Scenario B');
xlabel('Distance');
ylabel('Frequency');
hold off;

figure;
histogram(data.A_crashed);
hold on;
histogram(data.B_crashed);
title('Comparison of Crashes');
legend('Scenario A', 'Scenario B');
xlabel('Crashes');
ylabel('Frequency');
hold off;

figure;
boxplot(data.A_Iterations);
title("A Iteration Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Iteration Box Plot");


figure;
boxplot(data.A_Iterations);
title("A Distance Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Distance Box Plot");

mean_data_A = mean(data.A_Distance);
mode_data_A = mode(data.A_Distance);
median_data_A = median(data.A_Distance);
quartiles_A = quantile(data.A_Distance, [0.25, 0.5, 0.75]);

mean_data_B = mean(data.B_Distance);
mode_data_B = mode(data.B_Distance);
median_data_B = median(data.B_Distance);
quartiles_B = quantile(data.B_Distance, [0.25, 0.5, 0.75]);
```

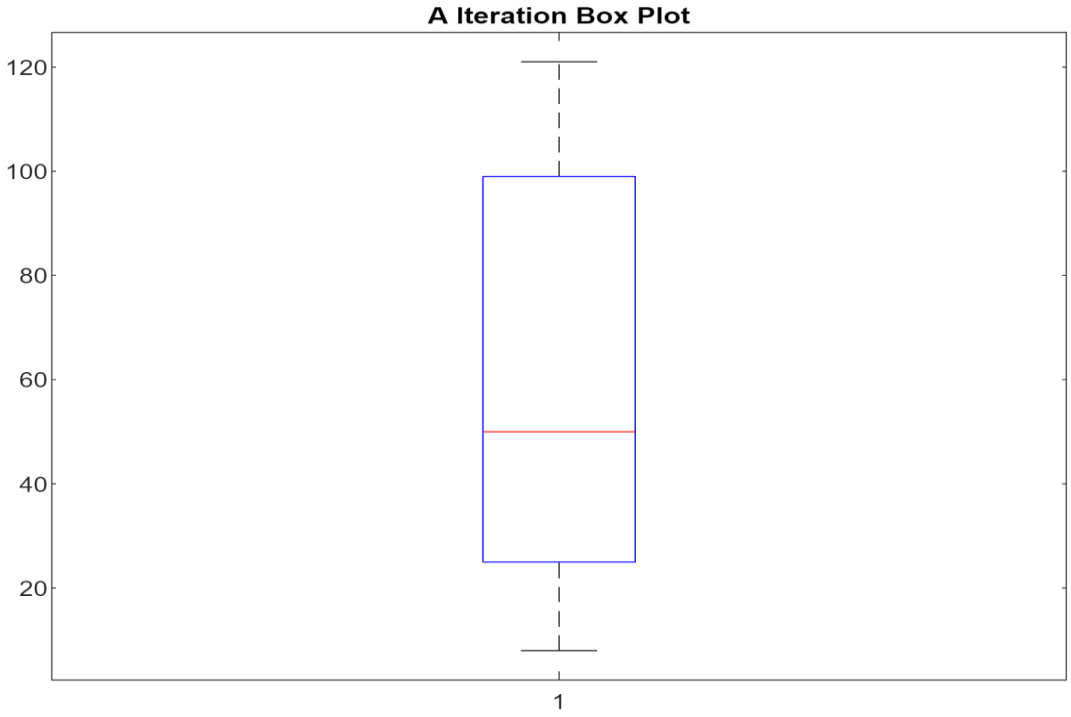
```
figure;
bar([mean_data_A, mode_data_A, median_data_A, quartiles_A; mean_data_B, mode_data_B,
median_data_B, quartiles_B]);
xticks(1:2);
xticklabels({'A Distance','B Distance'});
ylabel('Values');
title('Statistics for A_Distance and B_Distance');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");


mean_iterations_A = mean(data.A_Iterations);
mode_iterations_A = mode(data.A_Iterations);
median_iterations_A = median(data.A_Iterations);
quartiles_iterations_A = quantile(data.A_Iterations, [0.25, 0.5, 0.75]);

mean_iterations_B = mean(data.B_Iterations);
mode_iterations_B = mode(data.B_Iterations);
median_iterations_B = median(data.B_Iterations);
quartiles_iterations_B = quantile(data.B_Iterations, [0.25, 0.5, 0.75]);

figure;
bar([mean_iterations_A, mode_iterations_A,
median_iterations_A,quartiles_iterations_A; mean_iterations_B, mode_iterations_B,
median_iterations_B,quartiles_iterations_B]);
xticks(1:2);
xticklabels({'A Iterations';'B Iteration'});
ylabel('Values');
title('Statistics for A_Iterations and B_Iterations');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");
```

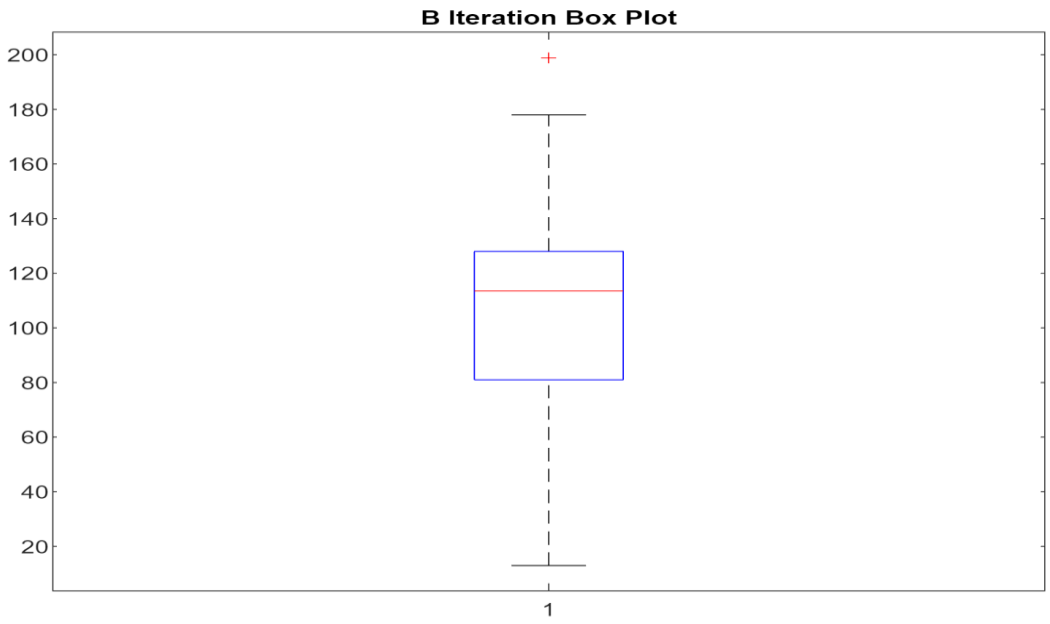
Output

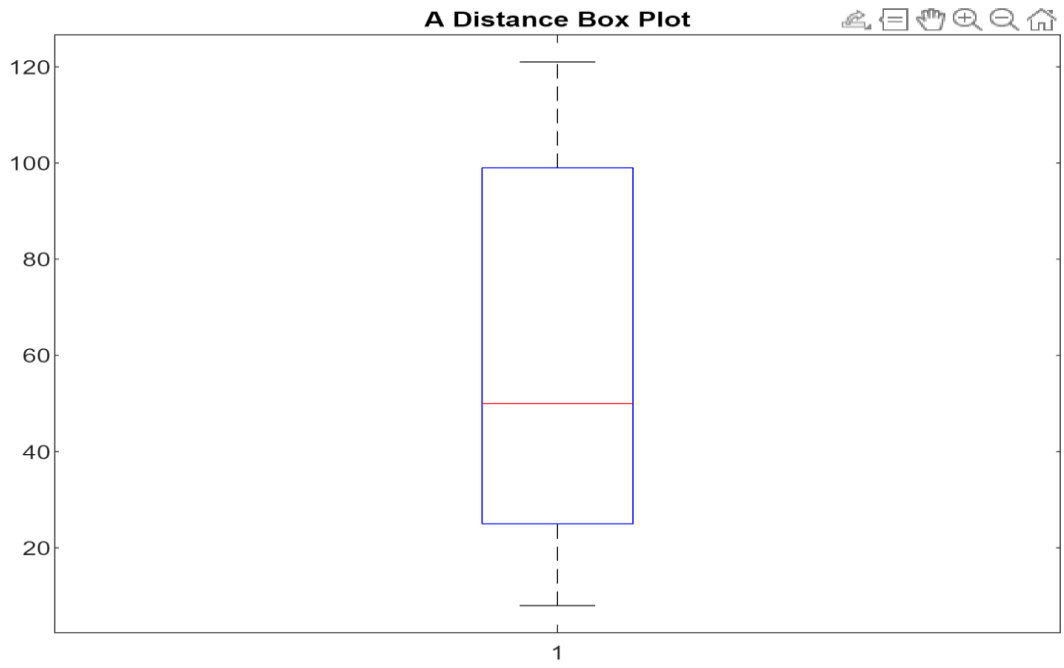

Comparison of Iterations
Scenario A
Scenario B
Frequency
Iterations
0
2
4
6
8
10
12
14
16
18
0
50
100
150
200

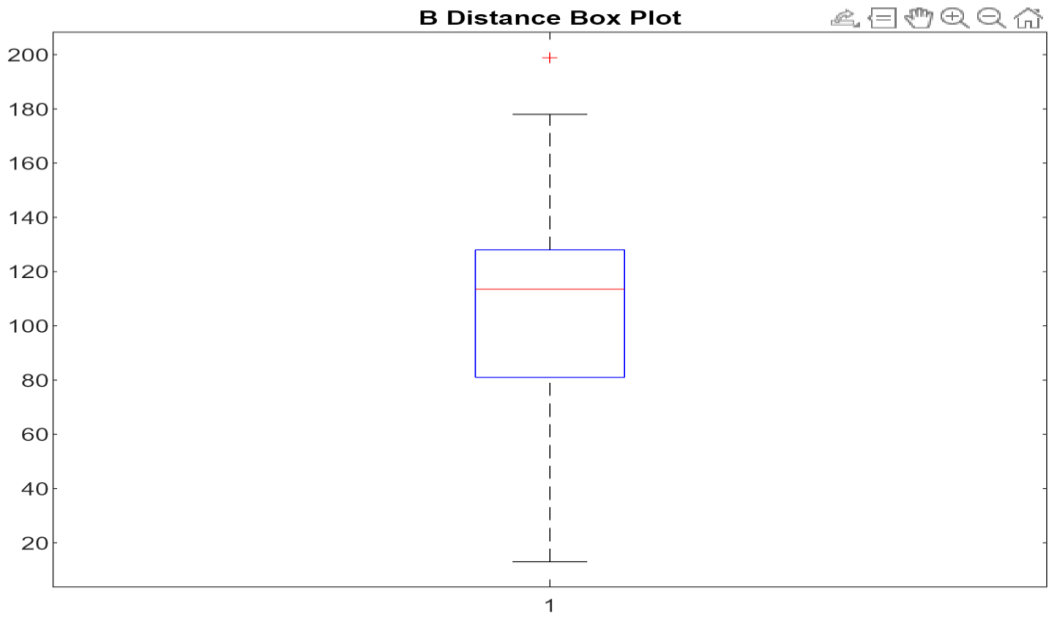

Comparison of Distance
Scenario A
Scenario B
Frequency
Distance
0
5
10
15
20
25
0
50
100
150
200
250

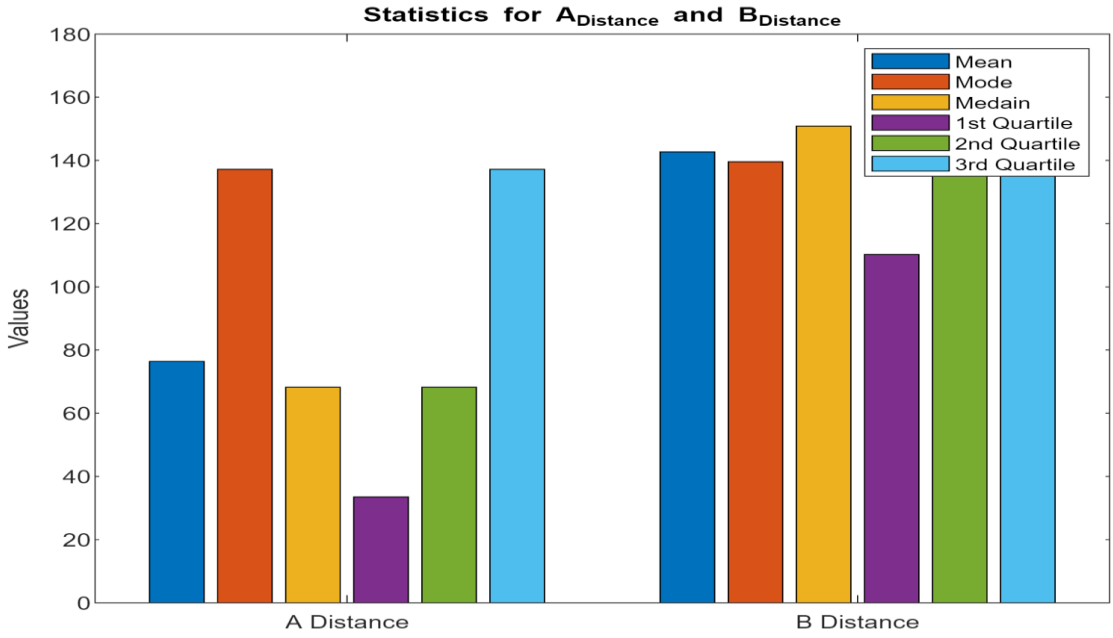

Comparison of Crashes
Scenario A
Scenario B
Frequency
Crashes
0
5
10
15
20
25
30
35
40
-0.5
0
0.5
1
1.5

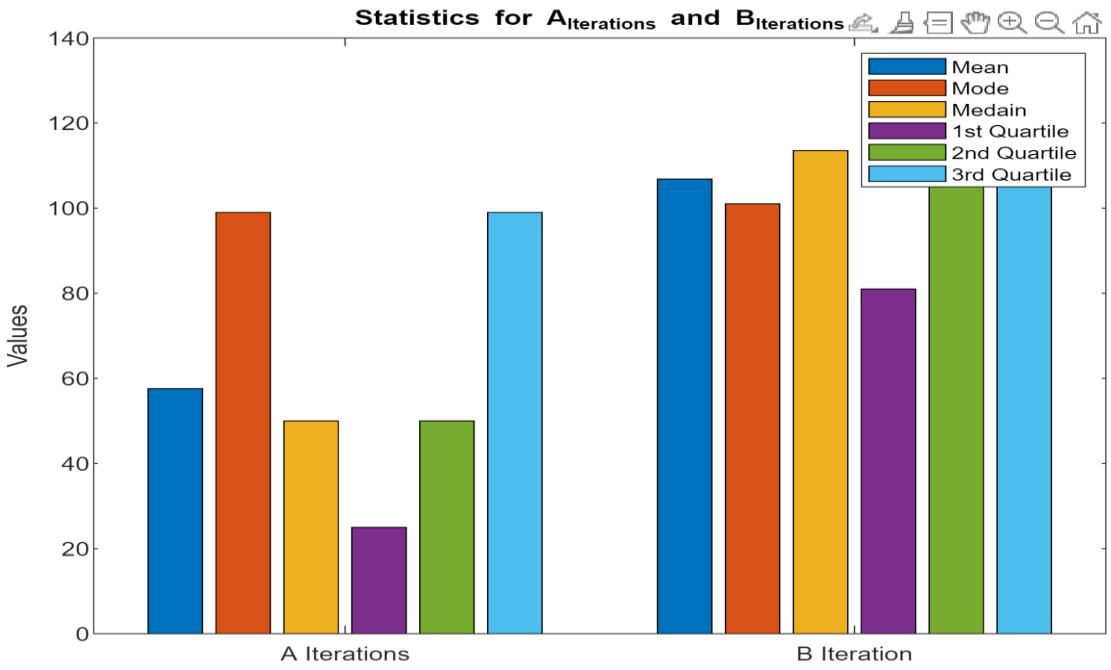

A Iteration Box Plot
20
40
60
80
100
120
1


B Iteration Box Plot
200
180
160
140
120
100
80
60
40
20
1


A Distance Box Plot
120
100
80
60
40
20
1


B Distance Box Plot
200
180
160
140
120
100
80
60
40
20
1


Statistics for A Distance and B Distance
Values
180
160
140
120
100
80
60
40
20
0
Mean
Mode
Medain
1st Quartile
2nd Quartile
3rd Quartile
A Distance
B Distance



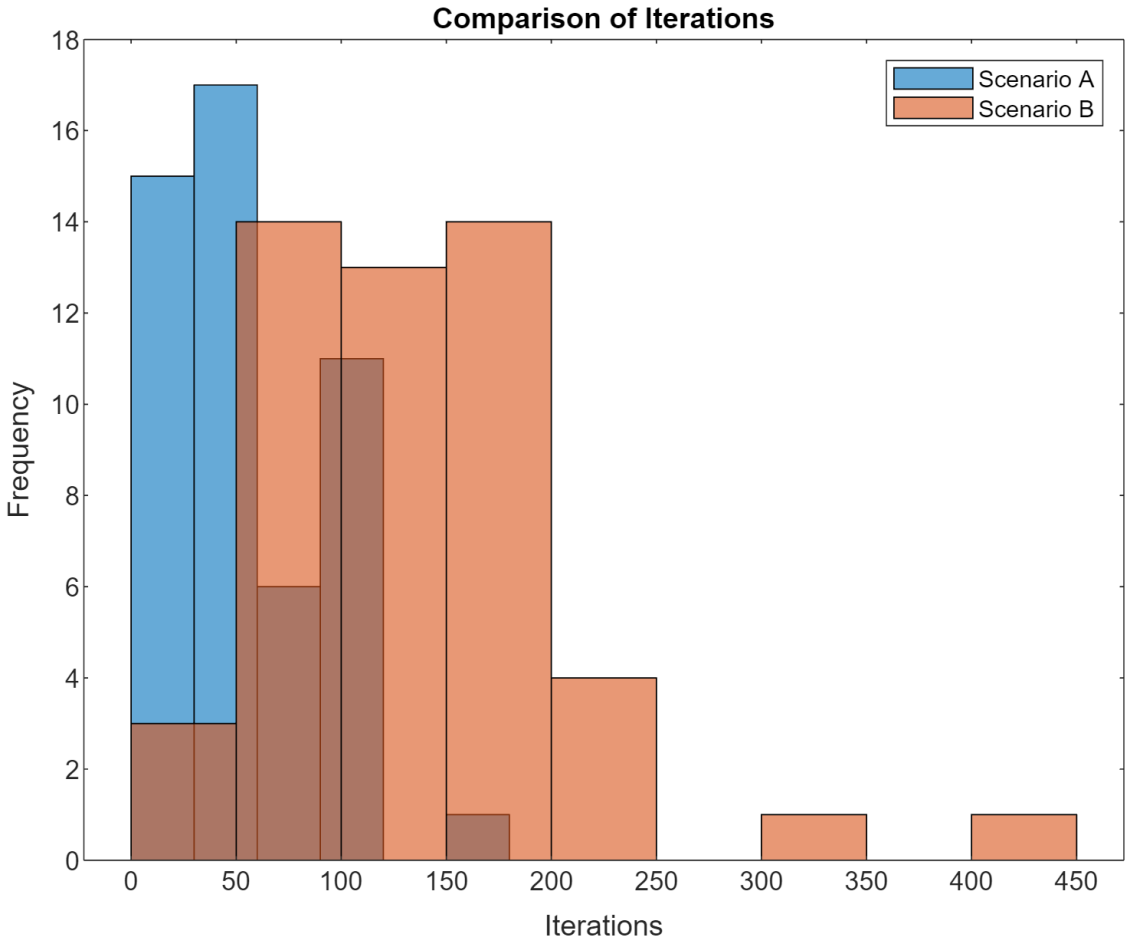
5. Code for Densely Populated Case Study

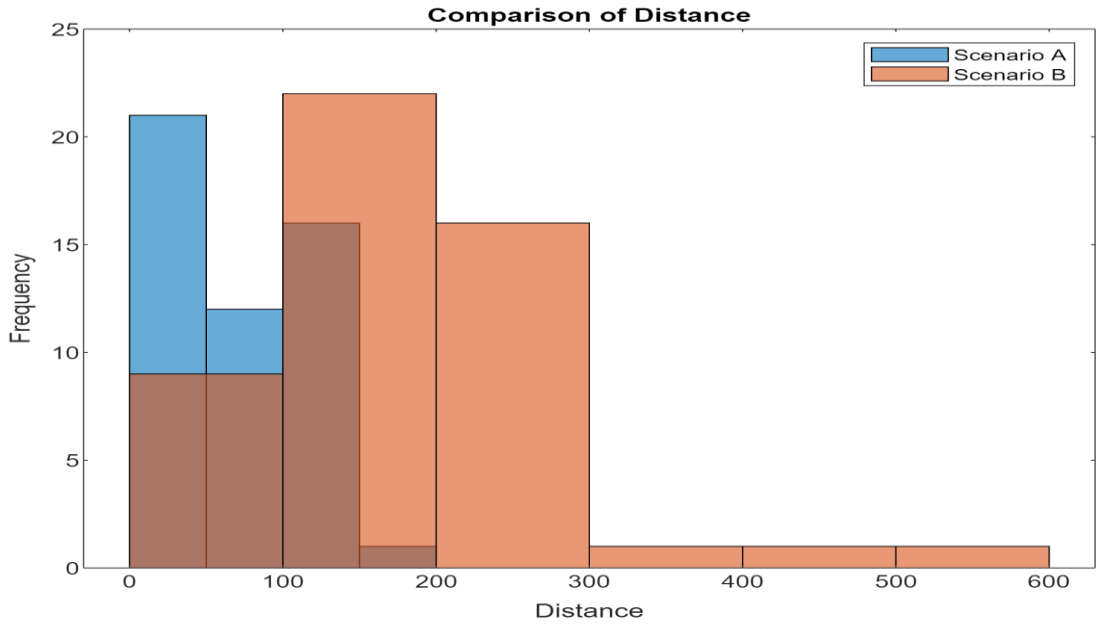
```
file_path = 'Densely populated iter50.csv';
data = readtable(file_path);

figure;
histogram(data.A_Iterations);
hold on;
histogram(data.B_Iterations);
title('Comparison of Iterations');
legend('Scenario A', 'Scenario B');
xlabel('Iterations');
ylabel('Frequency');
hold off;


figure;
histogram(data.A_Distance);
hold on;
histogram(data.B_Distance);
title('Comparison of Distance');
legend('Scenario A', 'Scenario B');
xlabel('Distance');
ylabel('Frequency');
hold off;

figure;
histogram(data.A_crashed);
hold on;
histogram(data.B_crashed);
```

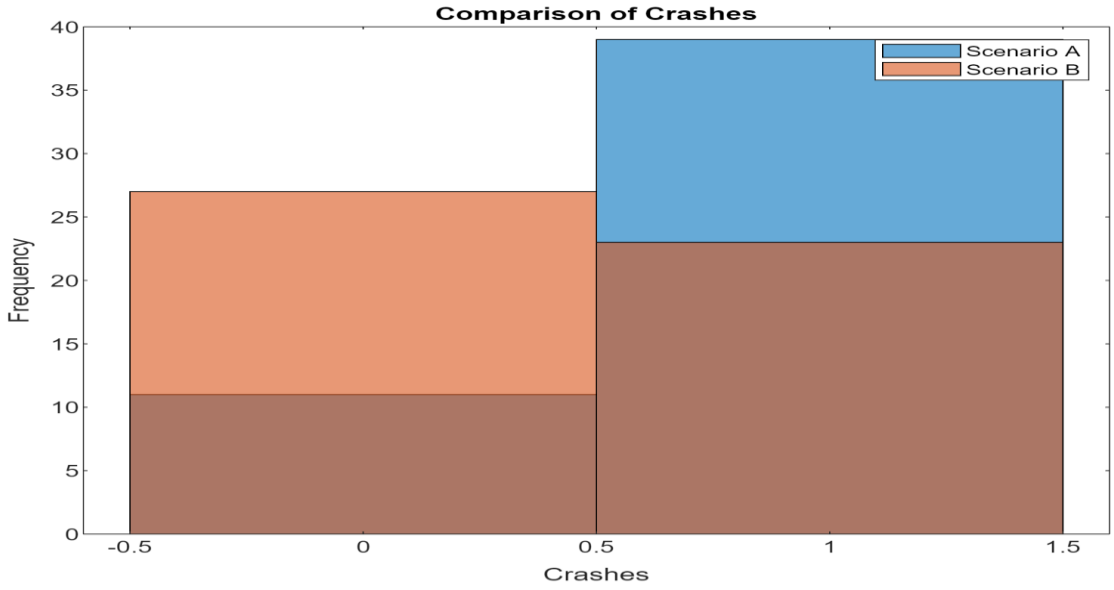
```
title('Comparison of Crashes');
legend('Scenario A', 'Scenario B');
xlabel('Crashes');
ylabel('Frequency');
hold off;

figure;
boxplot(data.A_Iterations);
title("A Iteration Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Iteration Box Plot");


figure;
boxplot(data.A_Iterations);
title("A Distance Box Plot");

figure;
boxplot(data.B_Iterations)
title("B Distance Box Plot");

mean_data_A = mean(data.A_Distance);
mode_data_A = mode(data.A_Distance);
median_data_A = median(data.A_Distance);
quartiles_A = quantile(data.A_Distance, [0.25, 0.5, 0.75]);

mean_data_B = mean(data.B_Distance);
mode_data_B = mode(data.B_Distance);
median_data_B = median(data.B_Distance);
quartiles_B = quantile(data.B_Distance, [0.25, 0.5, 0.75]);

figure;
bar([mean_data_A, mode_data_A, median_data_A, quartiles_A; mean_data_B, mode_data_B,
median_data_B, quartiles_B]);
xticks(1:2);
xticklabels({'A Distance','B Distance'});
ylabel('Values');
title('Statistics for A_Distance and B_Distance');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");


mean_iterations_A = mean(data.A_Iterations);
mode_iterations_A = mode(data.A_Iterations);
median_iterations_A = median(data.A_Iterations);
quartiles_iterations_A = quantile(data.A_Iterations, [0.25, 0.5, 0.75]);

mean_iterations_B = mean(data.B_Iterations);
mode_iterations_B = mode(data.B_Iterations);
median_iterations_B = median(data.B_Iterations);
quartiles_iterations_B = quantile(data.B_Iterations, [0.25, 0.5, 0.75]);

figure;
```

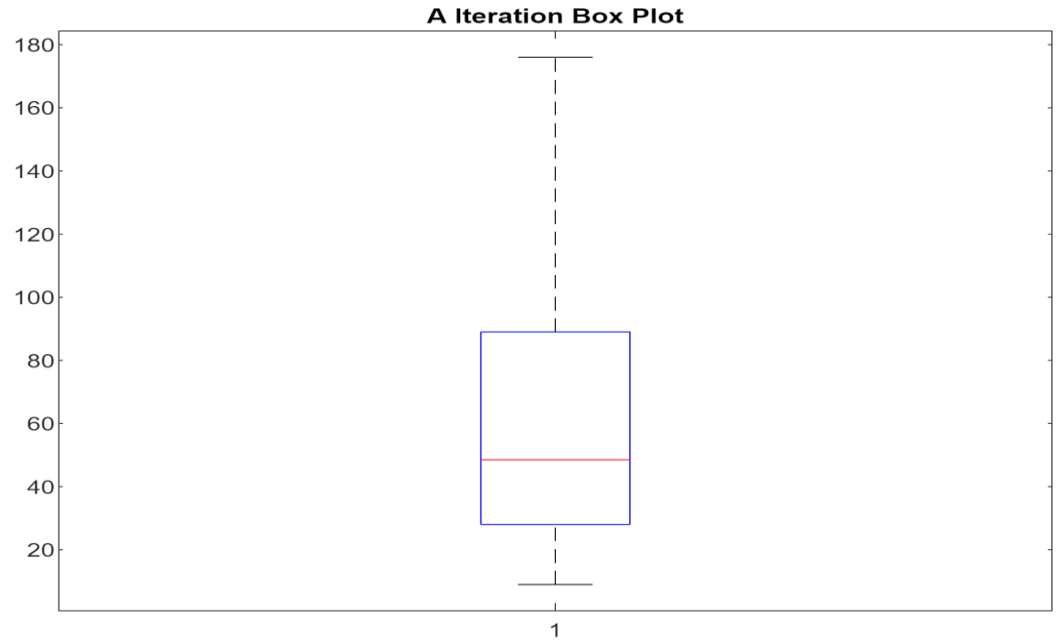
```
bar([mean_iterations_A, mode_iterations_A,
median_iterations_A,quartiles_iterations_A; mean_iterations_B, mode_iterations_B,
median_iterations_B,quartiles_iterations_B]);
xticks(1:2);
xticklabels({'A Iterations';'B Iteration'});
ylabel('Values');
title('Statistics for A_Iterations and B_Iterations');
legend('Mean', 'Mode','Medain',"1st Quartile","2nd Quartile","3rd Quartile");
```

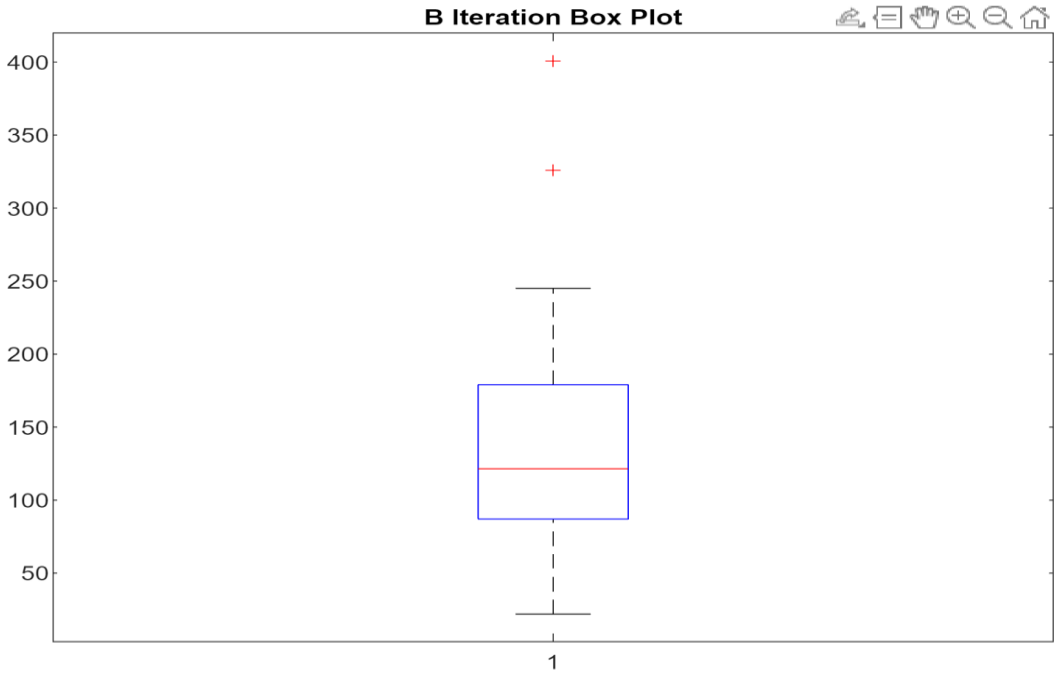
Output

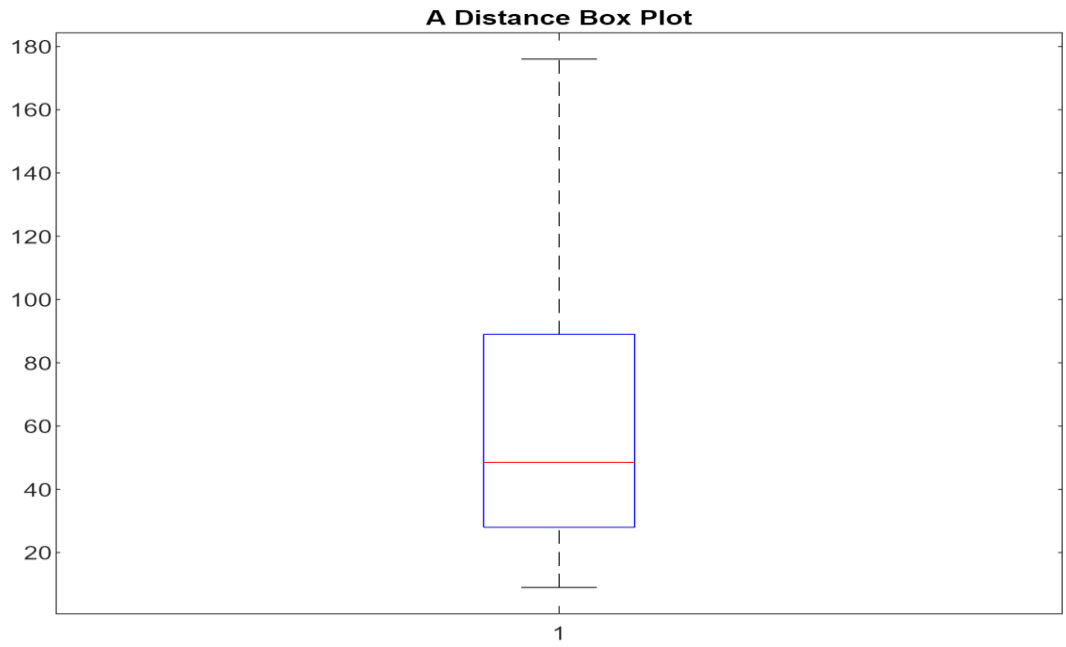


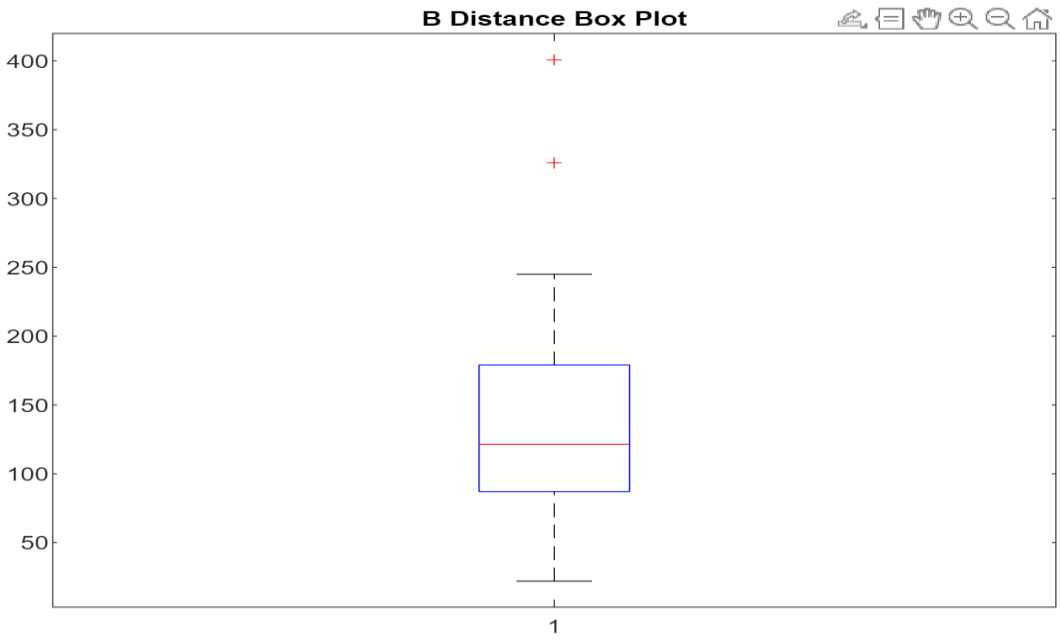

Comparison of Distance
Scenario A
Scenario B
Frequency
Distance
0
5
10
15
20
25
0
100
200
300
400
500
600

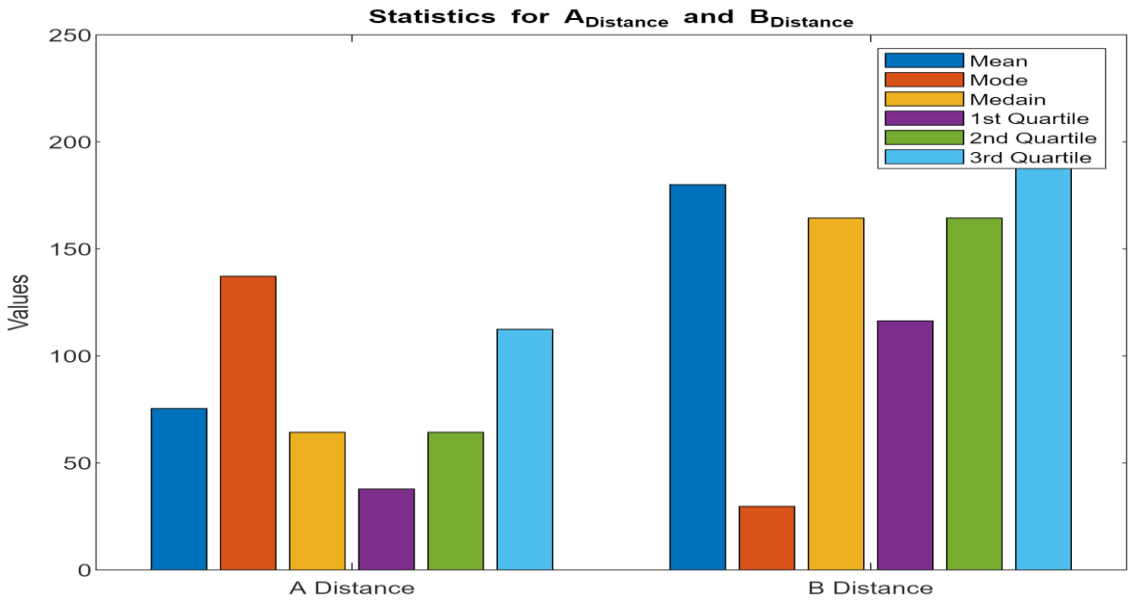

Comparison of Crashes
Scenario A
Scenario B
Frequency
Crashes
0
5
10
15
20
25
30
35
40
-0.5
0
0.5
1
1.5

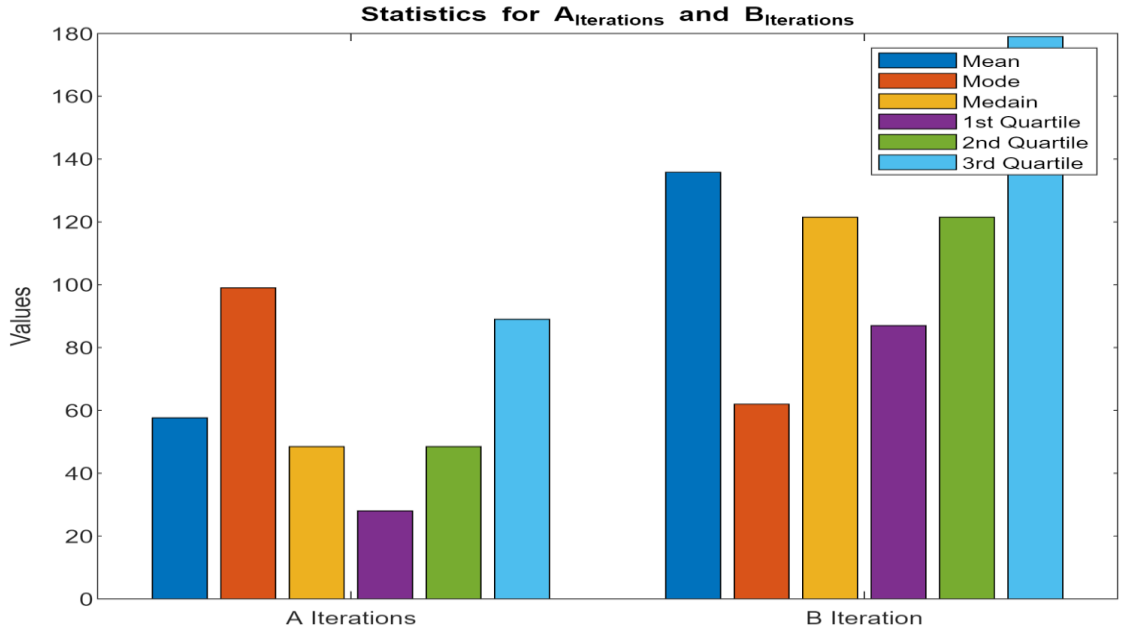

A Iteration Box Plot
180
160
140
120
100
80
60
40
20
1


B Iteration Box Plot
400
350
300
250
200
150
100
50
1


A Distance Box Plot
180
160
140
120
100
80
60
40
20
1


B Distance Box Plot
400
350
300
250
200
150
100
50
1





4. Overview of Datasets

1. Static Case Study

- **Data Attributes:** Includes simulation numbers, iterations, distances, timeouts, crashes, and elapsed times.
- **Initial Observations:** Iterations in the initial simulations range from 108 to 317 for Scenario A, with matching values for Scenario B.

2. Sparsely Populated Case Study

- **Data Attributes:** Similar structure to the static case study, including iterations and distances.
- **Initial Observations:** Iterations for Scenario A vary from 18 to 100, while Scenario B shows a broader range, up to 174.

3. Slower Case Study

- **Data Attributes:** Consistent structure with previous studies.
- **Initial Observations:** Iterations start at 99 for Scenario A and 98 for Scenario B.

4. Faster Case Study

- **Data Attributes:** Includes similar metrics as other studies.
- **Initial Observations:** Iterations for Scenario A begin at 99, slightly lower than Scenario B's start at 101.

5. Densely Populated Case Study

- **Data Attributes:** Contains similar metrics.
- **Initial Observations:** Significant difference in initial iterations; 25 for Scenario A and 245 for Scenario B.

5. Statistical Analysis and Comparative Findings

1. Static Case Study1.

Statistics:

- Scenario A and B both show a Mean Distance of 175.01 units, Mean Iterations of 141.68, Mode Iterations of 104, and Median Iterations of 120.5

Crashes:

- No crashes were observed in either scenario.

Graphs and Interpretation:

- Histograms and boxplots indicate identical distributions for both scenarios, suggesting that under static conditions, both scenarios perform equivalently without any crashes.

2. Sparsely Populated Case Study

Statistics:

- Scenario A: Mean Distance = 94.65 units, Mean Iterations = 71.06, Mode Iterations = 99, Median Iterations = 78.5.

- Scenario B: Mean Distance = 183.56 units, Mean Iterations = 138.7, Mode Iterations = 99, Median Iterations = 133.

Crashes:

- Higher crash rates in Scenario A.

Graphs and Interpretation:

- The histograms show a broader spread for Scenario B in both iterations and distances, indicating more variability and higher values. Scenario A has a higher crash rate, suggesting potential challenges in sparse environments.

3. Slower Case Study

Statistics:

- Scenario A: Mean Distance = 105.62 units, Mean Iterations = 40.14, Mode Iterations = 50, Median Iterations = 48.5.
- Scenario B: Mean Distance = 222.49 units, Mean Iterations = 86.3, Mode Iterations = 54, Median Iterations = 75.

Crashes:

- Scenario A shows more crashes.

Graphs and Interpretation:

- In this study, Scenario B again demonstrates higher mean iterations and distances. The histograms and boxplots exhibit broader distributions for Scenario B, suggesting a more diverse range of responses to slower conditions.

4. Faster Case Study

Statistics:

- Scenario A: Mean Distance = 76.42 units, Mean Iterations = 57.58, Mode=137.179, Median Iterations = 50.
- Scenario B: Mean Distance = 142.70 units, Mean Iterations = 106.84, Mode Iterations = 139.593, Median Iterations = 113.5.

Crashes:

- More crashes in Scenario A.

Graphs and Interpretation:

- Scenario B maintains a lead in both iterations and distances. The visual representations show a clear separation between the two scenarios, with Scenario B achieving higher metrics, indicating better adaptability to faster conditions.

5. Densely Populated Case Study

Statistics:

- Scenario A: Mean Distance = 75.37 units, Mean Iterations = 57.64, Mode Iterations = 99, Media Iterations = 48.5
- Scenario B: Mean Distance = 179.99 units, Mean Iterations = 135.82, Mode Iterations = 62, Media Iterations = 121.5.

Crashes:

- Scenario A faces more crashes.

Graphs and Interpretation:

- The densely populated environment shows the most significant differences, with Scenario B far exceeding Scenario A in performance metrics. The histograms and boxplots reveal that Scenario B manages to navigate the complexity of densely populated settings more effectively.

6. Comparative Analysis

Across all case studies, Scenario B tends to have higher iterations and distances, indicating it might be more challenging or complex. This is consistent in all case studies except the static one, where both scenarios perform identically.

Scenario A generally experiences more crashes in sparsely populated, slower, faster, and densely populated scenarios. In contrast, in the static case study, crashes are non-existent for both scenarios.

The statistical analysis, including histograms and boxplots, reveals notable differences in the performance and outcomes between Scenarios A and B across different environmental conditions. Scenario B consistently shows higher iterations and distances, suggesting different underlying dynamics or more complex requirements compared to Scenario A.