

## ECS526 Engineering Statistics

### **Final Project: ARENA Simulation (Romeu/Fall 2018)**

Assume you are an Airport Security Operation manager. You want to find how your operation will be affected with changes in Passenger Input Flow and Security Screening Probability.

Simulate, using the attached ARENA program, these two situations.

1. The original Operation, with Initial Arrival & Processing Rate, and Security Screening Probability.
2. A Proposed Operation (two runs) with Group Dependent values of the above parameters.

Run the Simulation, collect and analyze the data and determine the impact of changes in the Operation.

Simulation Parameters:

1. The arrival time distribution is Group Dependent with mean time in minutes.
2. The processing time distribution is Group Dependent (Triangular Distribution).
3. The Security Processing distribution is also Group Dependent.

**Collect data from your ARENA simulation FOR 10 + Grp. No BATCHES, for variables:**

**Avg. passenger (1) time in the system, (2) waiting time in Q, (3) Number waiting in Q, and for (4) resource UTILIZATION. Each Group Member will work on one variable.**

Implement Minitab Normality GOF tests for all variable & assess results.

Implement one-way ANOVAs between the Original, and the two Proposed configurations, using your group parameters, and assuming Normality. Perform all ANOVA model verifications: assess all assumptions via residual analysis.

Select the statistically significant variables, rerun the model with them, and obtain estimations.

Implement Tukey's Multiple Comparison test for means between all analyzed configurations, using the Minitab procedure. Interpret & Conclude.

Implement the Kruskal-Wallis test (Non-Parametric equivalent to ANOVA). Compare results.

Regress variables (1) waiting time in Q, and (2) Number waiting in Q, on: Mean Arrival Time, Mode of the Triangular process time distribution, and resource UTILIZATION. Perform all Regression model verifications: assess all assumptions via residual analysis (**See Note<sup>1</sup>**).

Select statistically significant variables and rerun the model with them. Compare results.

**Conclude, regarding this problem, as the Operations Manager would, with obtained results.**

### Group Distribution Parameters:

The Exponential Distribution is given with its Mean Time (in minutes).

Security Parameter (e.g.  $p=0.97$ ) goes inside the ARENA Pass Security Module. It means that:

If  $p < 0.97$  then passenger is CLEARED; otherwise, it is DENIED right to board.

<u>Group No.</u>	<u>Arrival Dist Par</u>	<u>Chk Dist Par</u>	<u>Security Param</u>
One	Expon(2)	Trian(.75,1.5,3)	P = 0.97
Two	Expon(3)	Trian(.75,1.8,3.5)	P = 0.94
Three	Expon(4)	Trian(.75,2,3.8)	P = 0.95
Four	Expon(3)	Trian(.75,2.5,4)	P = 0.96
Five	Expon(3)	Trian(.75,1.8,3.5)	P = 0.97
Six	Expon(4)	Trian(.75,2,3.8)	P = 0.95
Seven	Expon(2)	Trian(.75,2.5,4)	P = 0.94
Eight	Expon(4)	Trian(.75,2.2,3.8)	P = 0.96
Original	Expon(3)	Trian(.75,2,4)	P = 0.95

**FOR THE SECOND RUN EACH GROUP SHOULD SUBTRACT HALF UNIT TO ARRIVAL Exp Mean [E.G. FOR GRP ONE WOULD BE Exp(1.5)]. For Triangular Distribution, select another one of the given; FOR SECURITY PARAMETER ADD TWO UNITS (E.G. GRP 1:  $P= 0.93 + 0.02 = 0.95$ ).**

**FOR THE THIRD RUN, USE THE PARAMETERS FOR THE FOLLOWING GROUP (I.E.GROUP ONE WOULD USE PARAMETERS IN THE LINE CORRESPONDING TO GROUP TWO. LAST GROUP USE THE PARAMETERS CORRESPONDING TO GROUP ONE.**

The simulation goal is to analyze variations (1) when arrival rates change, (2) when searches become more in-depth, and (3) when security parameter (e.g. passenger behavior) varies.

Our ECS526 TA will show you how to change ARENA simulation parameters, run it, and identify in the corresponding output the results of interest.

**1: COMBINE YOUR RESULTS WITH THE ONES SIMULATED IN TEST #2, FOR THE REGRESSION.**