



# Airport Operations Simulation

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## ABSTRACT

This poster, created to fulfill the requirements of CS 225 with an honors distinction, discussed an airport operations simulation designed and programmed by the author to analyze queuing models and provide a tool for determining airport efficiency in response to the manipulation of airport configurations. This research particularly applies to any single airline testing the configuration of an allotted number of gates and gate crews for their departing and arriving flights. By running the simulation a statistically significant number of times, a conclusive estimate for airport efficiency was made for particular user scenarios. These experimental results will be summarized once the experimental data is gathered by utilizing the Airport Operations Simulation. Both the simulation and final report will be completed by the end of the Spring 2022 academic semester and are currently in progress.

## OBJECTIVES

- To simulate daily operations of an airport where the airport configuration can be changed by the user. User inputted variables are:
  - Airport type (Domestic or International).
  - Number of available gates crews.
  - Number of available gates.
  - Estimated traffic contribution of the user's airline to the overall airport traffic.
- To generate the results of the simulation, which can be set to run multiple times. The outputs of the simulation are:
  - Number of aircraft that took off during one scenario.
  - Number of aircraft that landed during one scenario.
  - Number of cancellations during one scenario.
  - Number of delays during one scenario.
  - Number of delays belonging specifically to the airline during one scenario.
  - Number of cancellations belonging specifically to the airline during one scenario.
  - Average time between pushback and takeoff per aircraft, which is split into two numbers. The user views this average for all flights as well as only flights belonging to their airline during one scenario.
  - Average time between landing and gate arrival per aircraft, which is split into two numbers. The user views this average for both all flights as well as only flights belonging to their airline during one scenario.
  - Total time that gates belonging to the airline were empty for.
  - Total time that ground crews were not working for.
  - Weather during the day. This is only outputted if one scenario is run.
  - Final scenario schedule. This is only outputted into an external file if one scenario is run.
  - Statistics tracking for outputs 1 through 10 if multiple scenarios are executed at once.

## PROBLEM DESCRIPTION

International Airport	Domestic Airport
Contains gates with international customs/border control integration.	No border control/customs gates.
Receives both domestic and international flights.	Receives only domestic flights.
Receives a higher frequency of heavy aircraft than domestic airports, affecting flight queue. Aircraft taking off or landing after heavy aircraft must wait longer before taking off or landing (see Takeoff/Landing Constraints section below for specifics).	Lower frequency of heavy aircraft.
International airports have a busier schedule, so their schedules are built differently from domestic airports (see the Daily Schedule section below for specifics).	If a user selects the domestic airport, then the user's airline will automatically be assumed to be domestic only in the scope of the simulation.
	Less busy schedule than an international airport because only domestic flights are serviced.

Weather is the largest cause of air traffic delays and is therefore the primary variable for determining a delay or cancellation for the purpose of this simulation ("FAQ: Weather delay", 2021). The program selects the daily weather based on a pseudo-random model. The program assigns the daily weather based on the below model.

Weather Type	Probability per Day
Good	60%
Medium	30%
Bad	10%

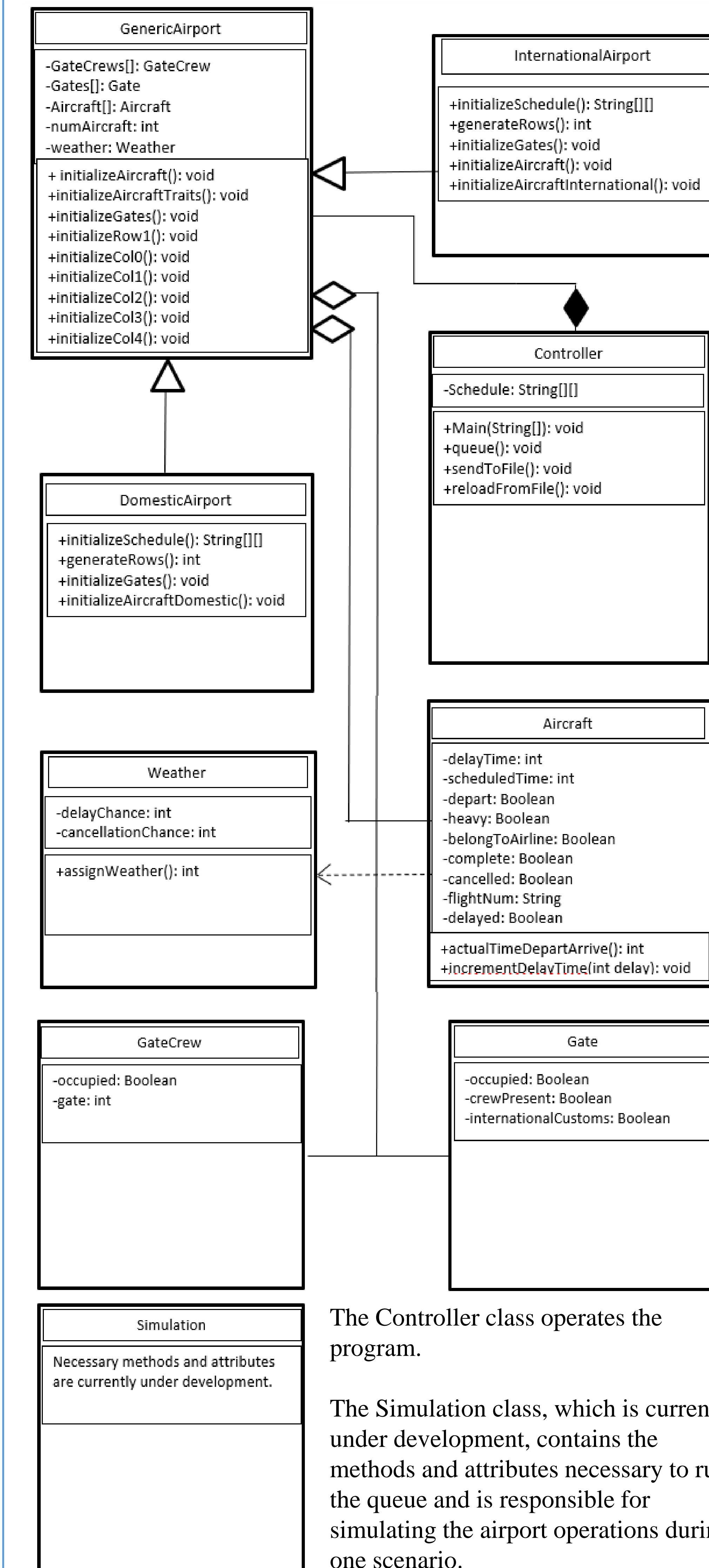
	Chance of Delay	Chance of Cancellation
Weather: Good	10%	1%
Weather: Medium	25%	2%
Weather: Bad	40%	3%

Sample daily schedule format per scenario execution is shown below. The schedule continues until it reaches the end of the day.

Flight Number	Airline	Arrival/Departure	Projected Time	Actual Time
OA001	Other Airline	Departure	00:15	00:15
YA001	Your Airline	Departure	00:45	00:51 (Delay)
OA002	Other Airline	Arrival	00:50	00:54 (Delay)
YA002	Your Airline	Departure	01:25	1:25
YA003	Your Airline	Arrival	03:30	3:30
YA04	Your Airline	Departure	04:30	4:30
OA003	Other Airline	Arrival	04:45	4:45
OA004	Other Airline	Arrival	05:15	05:15
YA005	Your Airline	Departure	05:30	05:30
YA006	Your Airline	Arrival	06:15	CANCELLED
OA005	Other Airline	Arrival	06:30	06:30
OA006	Other Airline	Arrival	06:45	06:45
YA007	Your Airline	Departure	06:48	06:48
OA007	Other Airline	Arrival	07:30	07:30
OA008	Other Airline	Departure	07:45	07:45

## PROBLEM SOLUTION

This tool was programmed using Java and utilizes nine classes. The nine classes are shown below in a Unified Modeling Language (UML) diagram.



The GenericAirport class contains all basic operations for an airport. The child classes InternationalAirport and DomesticAirport specifically cover differences between the two airport types. The GenericAirport class contains arrays of Aircraft, GateCrew, and Gate. The Aircraft class relies on the weather to dictate possible flight delays or cancellations.

The Controller class operates the program.

The Simulation class, which is currently under development, contains the methods and attributes necessary to run the queue and is responsible for simulating the airport operations during one scenario.

## RESULTS

The experimental data from the program is used to show overall trends when inputs are manipulated for both domestic and international airports.

Specifically, graphs will be made that illustrate overall trends in the average time between pushback and takeoff, average time between landing and gate arrival, total time that gates were empty for, and total time that gate crews were not working for when inputs are manipulated. The purpose of these graphs is to portray which configurations may be most desirable for the user to increase airport efficiency.

The gathering of experimental data is currently in progress and will be completed by the end of the Spring 2022 academic semester.

## CONCLUSION

By utilizing the Airport Operations Simulation, a user can determine the efficiency of a desired airport configuration from the perspective of an airline, which may be used to determine resource allocation within real airports. This tool is therefore intended to be primarily used by airlines that wish to test their gate and crew allotments with a known estimated traffic contribution prior to configuring a real airport and hiring crew.

The Airport Operations Simulation was created using nine classes, as shown in the problem solution statement of this poster and was programmed in Java. The program utilizes a GUI to display simulation results and to handle user interaction.

Additionally, future study will be necessary to improve the accuracy of both the simulation and the experimental data.

## ACKNOWLEDGMENTS AND CONTACT

This program was created utilizing Federal Aviation Administration guidelines for airport operations. Please see the printed Works Cited for a full list of references.

The professor advising this project is Dr. Keith Garfield in the EECS College of Engineering Department.

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