System Simulation, Fall 2017

Modeling Challenge Problem #2: Pacific Playland Discrete Event Gate Model

Pacific Playland is a fictional amusement park introduced in Challenge Problem #1. We didn't talk about the park's persistent zombie problem.... we may address that in a later installment of example problems. For now we're going to be concerned with modeling possible congestion at the gates on a busy day.

Pacific Playland is a VERY busy and we park. On an average day, we can assume it gets about 100,000 guests passing through the gates. Note that on an average day, King's Island in Mason OH and Walt Disney world in Orlando Florida get about 20,000 and 50,000 guests respectively. Clearly Pacific Playland has some potentially complicated logistics at the entry point.

Modern amusement parks engineer their entrances to diffuse the load of time consuming activities (buying tickets, extras, customer service) by pushing those activities away from the actual gate. King's Island, for example, sells bar coded tickets on line and sells tickets to on-site guests at kiosks located well away from the gates. This insures that "long" activities are done well away from the gates and by the time someone gets to a gate, entry to the park is a fast (assume three seconds) bar code scan. Pacific Playland also follows this practice. Assume that the model of gate arrival you developed in challenge problem #1 models guests arriving at the gate area with ticket in hand. Your mission is to construct a discrete event gate model to help assess how many card readers / turnstiles you need, on an average day, to ensure that no guest waits for more than five minutes to get into the park once they have ticket in hand are simply waiting to pass through one of (hopefully more than one) turnstiles.

Your simulation MAY assume the following:

A1) Each INDIVIDUAL person, once at the head of the line, takes three seconds to pass through the turnstile

A2) A person who just enters a turnstile line will wait (N+1) * 3 seconds to pass through the turnstile where N is the number of people (including the newly arrived

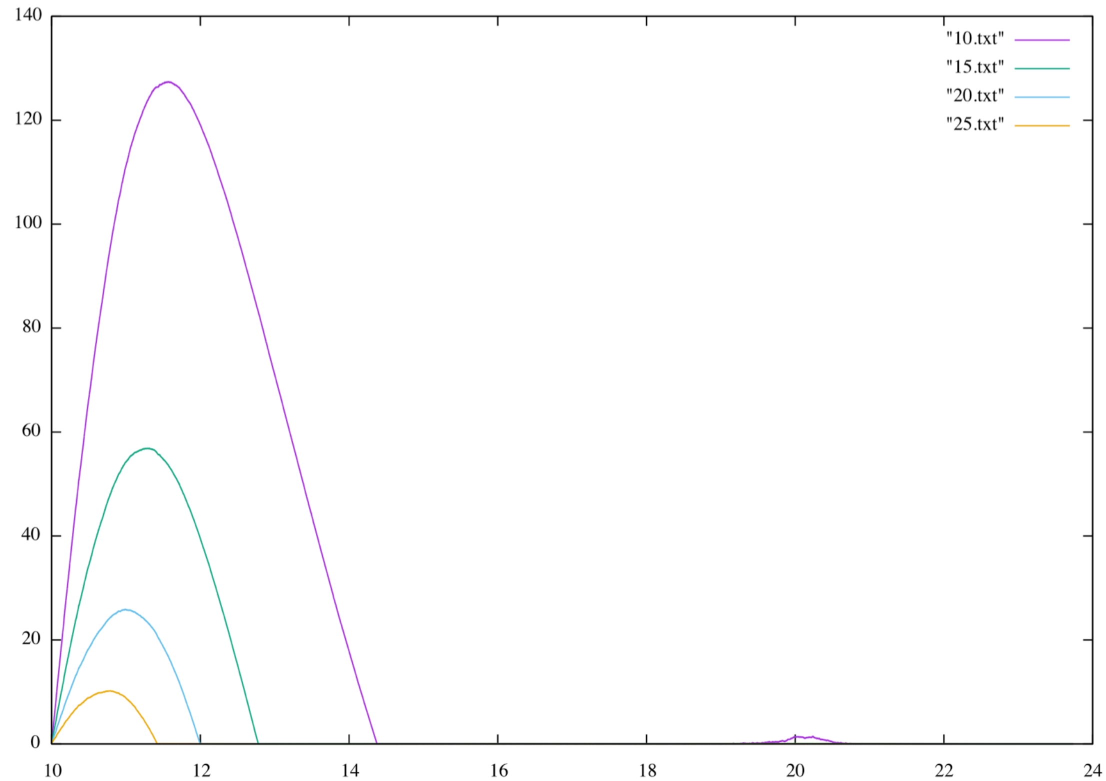

Figure 1: Average Guest Wait Time in Minutes for Various Open Turnstile Counts
Note that jcg's results seem to indicate that the magic number is somewhere greater than 25 open gates. Fewer than that, and the morning rush of guest kills your throughput as your ability to process guests is overtaxed by load. No guest is going to happy waiting for an hour or more just to get into the park.

person) currently waiting in line. This is really just a logical extension of item #1 above

A3) A newly arrived person will always to the currently shortest line. In other words, assume your guests are rational and can see and assess the length of all lines.

Simulation Challenge 2.1 (Entry Level)
Under the assumptions A1, A2, and A3, assess, via the use of a simulation you write, how many turnstiles you need to have open to ensure that no guest ever has to wait more than five minutes at a turnstile. As a hint, figure one shows the average wait time for ALL guests as a function of time of day for the "typical day" modeled in challenge problem #1

Simulation Challenge 2.2 (Medium Level)
Modify assumption A1 so that each person's time to pass the gate once that person has arrived at the turnstile is modeled by an appropriate log-normal distribution. Set the parameters of the log-normal distribution to values that you think make sense and explain how and why you chose those parameters. Run your simulations again to see if the number of turnstiles you need to ensure wait times of less than five minutes is now different. Do not attempt this medium problem until you have solved 2.1

Simulation Challenge 2.3 (Hard Level)
Restore the assumption that every person takes three seconds to get through the turnstile when getting to it. Modify your simulation to support "group arrivals" where groups of multiple people arrive at the same time and all go as a group to the same turnstile. Though each person would enter the line to a turnstile at the same time, they would exit one-by-one at appropriate three second intervals. Develop what you think to be a reasonable model of "random group sizes" and explain how and why you set the parameters of that model like you did. Modify your simulation to use this model to govern people entering turnstile lines. Does this change the number of gates you need to keep open on an average day?

Simulation Challenge 2.4 (Bonus Level)
It costs money to keep gates open. In figure one you can see that afternoon wait times are all VERY short. It's almost as if you need lots of turnstile gates open in the morning for the rush, but perhaps far fewer in the afternoon. Can you use any one of the above three simulations to help determine a "gate open" schedule that, hour by hour, tells how many turnstile gates should be open so that average wait times are kept in the range of one to five minutes all day long? You need not hit the lower bound perfectly, but you should NEVER exceed the upper bound of a five minute wait.