Quiz 4 — Spring 2024

- Due Apr 16 at 3:30pm
- Points 8
- Questions 8
- Available after Apr 9 at 3:30pm
- Time Limit None
- Allowed Attempts Unlimited

Instructions

This quiz covers basic concepts related to cellular automata, queueing models, and the basics of discrete-event simulation. There is no time limit (other than the due date), and you have unlimited attempts.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
KEPT	Attempt 2	4 minutes	8 out of 8
LATEST	Attempt 2	4 minutes	8 out of 8
	Attempt 1	26 minutes	5.5 out of 8

Score for this attempt: 8 out of 8
Submitted Apr 9 at 4:35pm
This attempt took 4 minutes.

Question 1
1 / 1 pts

Recall the renormalization group analysis for the 2-D forest fires model that we built in class. It assumed that fires spread across *Moore neighborhoods*, i.e., considering all 8 nearest neighbors (see [Sa15]). Let p_1 denote the probability that a tree is present at scale 1 (a single cell). We concluded that the probability that a fire would spread in a scale-2 system (2×2) is:

$$p_2 \equiv p_1^2 \left[p_1^2 + 4p_1(1-p_1) + 4(1-p_1)^2\right].$$

Suppose instead that the fire spreads across ***von Neumann neighborhoods***, that is, only via north, south, east, and west neighbors, *excluding* "diagonal" neighbors. Which one of the following expressions best represents the scale-2 system?

- $p_2 \equiv p_1^4 + 4p_1^3(1-p_1) + 4p_1^2(1-p_1)^2$
- $p_2 \equiv p_1^4 + 3p_1^3(1-p_1) + 2p_1^2(1-p_1)^2$

Correct!

- $p_2 \equiv p_1^4 + 4p_1^3(1-p_1) + 2p_1^2(1-p_1)^2$
- $p_2 \equiv (1-p_1)^4 + 4p_1(1-p_1)^3 + 2p_1^2(1-p_1)^2$

Question 2
1 / 1 pts
Consider the elementary cellular automaton for Rule 94. Which one of the following formulas best expresses a mean-field analysis of this rule?
Correct!

- $3p(1-p)^2 + 2p^2(1-p)$
- $3p^2(1-p) + 2p(1-p)^2$
- $3p^3 + 2(1-p)^3$
- $3p^2(1-p)^2$

Question 3
1 / 1 pts

Which of these is the most distinctive characteristic of a discrete event-driven model and simulation, in contrast to, for example, those based on differential equations, cellular automata, or Markov models?

- Being continuous in time
- Having discrete-valued state variables

Correct!

- Encoding state-transitions via logically time-stamped events
- Employing uniform time steps
- Modeling state-transitions as probabilistic events

Question 4

1 / 1 pts

In an event-oriented simulation, which of these is a central action of an event computation (i.e., an event callback)?

- Executing an event-processing loop

Correct!

- Scheduling new events
- Checking whether time-causality is violated
- Maintaining a priority queue

Recall that event computations of a discrete-event simulation do two things, primarily: modify state variables and schedule new events.

Question 5

1 / 1 pts

Recall that in a process-oriented simulation of a queueing model, there is a main “scheduler thread” that manages the processes corresponding to consumer entities of the system. Which of the following is ***NOT*** something that the scheduler thread needs to do?

- Check the future event list for pending events
- Check whether a suspended process is waiting on a predicate
- Call an event handler

Correct!

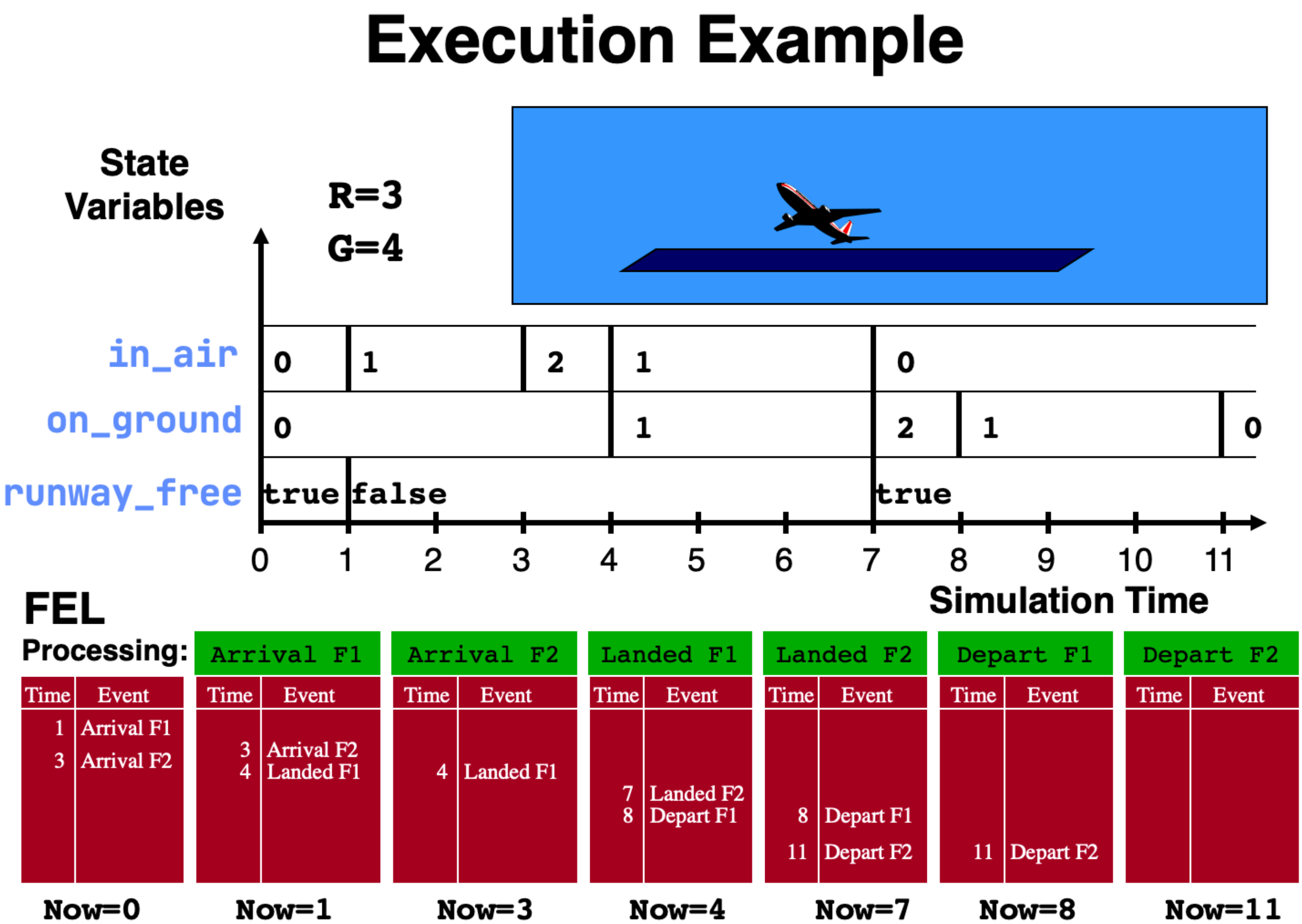
- Call \``waitUntil` $\mathrm{and}$ `advanceTime`\` primitives

The user-supplied process code invokes \``waitUntil` $\mathrm{and}$ `advanceTime`\` to transfer control to the scheduler thread. The scheduler thread takes all other actions among these options.

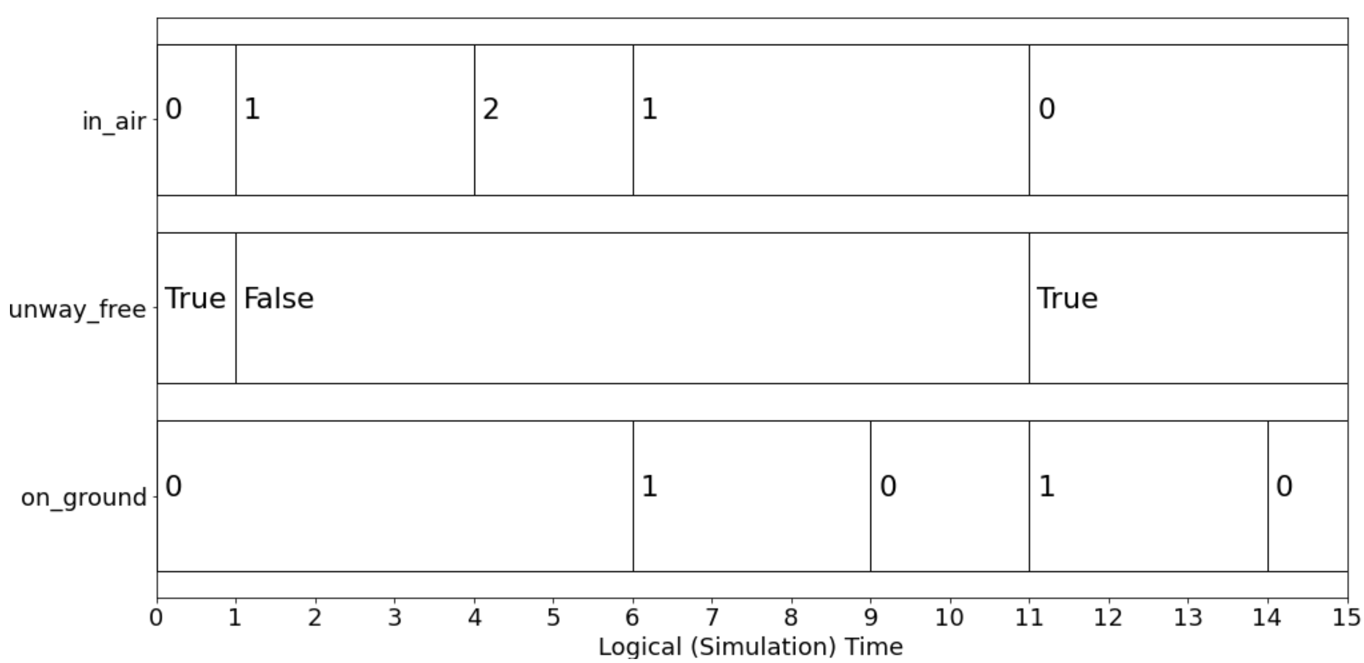
Question 6

1 / 1 pts

Recall the single-runway airport simulator. We showed in class that a sample execution timeline for the case of landing-time \``R=3` $\mathrm{and}\ on - groundtime$ `G=4` $witharrivaleventsatsi\mu lation - \ \times 1\ \mathrm{and}\ 3wo\underline{d}\prod ucethetimel \in eshownbelow(takenomthels). Thel * state - variab \le chan \ge happens$ `on_ground` $chan \ge somthevalue1aircraft \to 0aircraft, whichhappensat \log icalsi\mu lationtime11asshownbelow(c\ \mathrm{or}\ respond \in g \to the$ `Depart F2`\` event):



Someone runs the simulation with two arrival events and shows you the simulated execution timeline:



What simulation parameters did they use? Select the correct answers below.

- R = 5
- G = 3
- First aircraft arrival time = 1
- Second aircraft arrival time = 4

(For the two aircraft arrival times, pick the smaller time value for the first one and the larger time value for the second one.)

Answer 1:

1

2

3

4

Correct!

5

Answer 2:

1

2

Correct!

3

4

5

Answer 3:

Correct!

1

2

3

4

5

Answer 4:

1

2

3

Correct!

4

5

Observe that `in_air` increases twice: once from the value of 0 to 1 at time 1 and again from 1 to 2 at time 4. Therefore, we may conclude the two aircraft arrival times are 1 and 4.

Next, observe that `in_air
$decreases f$ or $the first time om the value of 2 \rightarrow 1 at si\mu lation - time 6. T\widehat{\mu} stc$ or $respond \rightarrow al$ and $\in gcomp \leq tion f$ or $the first aircraf$
R` = 6 - 1 = 5. We can confirm that by observing that the second aircraft, which must have started to land at simulation-time 6 completes its landing at simulation-time 11 (11 - 6 = 5).

The on-ground time must be `G=3`: observe that it decreases twice. The first time, it starts at the value of 1 at simulation-time 6 and decreases to 0 at simulation-time 9, which must correspond to the first aircraft's terminal time. The same 3-unit period occurs between the second change, in the simulation-time interval [11, 14].

Question 7

1 / 1 pts

Suppose you are simulating a polling place (i.e., a place where people go to vote in a political election), and wish to study the potential length of the line of people waiting to vote. You decide to use a queueing model abstraction. Which of the following entities of the real-life system is best represented as a server?

- ( ) A voter - the person who arrives to cast their vote

Correct!

- (selected) A voting machine - the device at which a person casts their vote, one at a time
- The poll worker - this is the person in charge of monitoring the lines to watch for problems
- The exit desk - a voter picks up their "I Voted" sticker and exits the system at this desk

Servers should represent contended resources in the system: these are the places where entities in the system may need to line up (“queue”) to use the resource. In this polling station scenario, the object in this list that is the bottleneck is the voting machine itself. The exit desk may seem like such a resource, too; but since it is where entities exit the system, like departures at the airport, we need not model it explicitly as a resource.

Question 8

1 / 1 pts

True or false? A process-oriented simulation can be built on top of an event-oriented mechanism.

Correct!

- (selected) True
- False

> In an implementation of a process-oriented simulation, a call to \``advanceTime(dt)` $\geq \neq ratesa``re\sum e''eventat$ `now+dt`\`.

Quiz Score: 8 out of 8