Communications and Transport Systems
Department of Science and Technology
Linköping University

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Dr. Christiane Schmidt

TNK051: Planning of Air Traffic

Homework Set 3, 2021

Solutions are due October 11, 2021, 23:59. **Please put your name on all pages!**

Question 1 (Longest Path in a DAG):
Use the algorithm from the lecture to compute the longest path in the DAG from Figure 1.

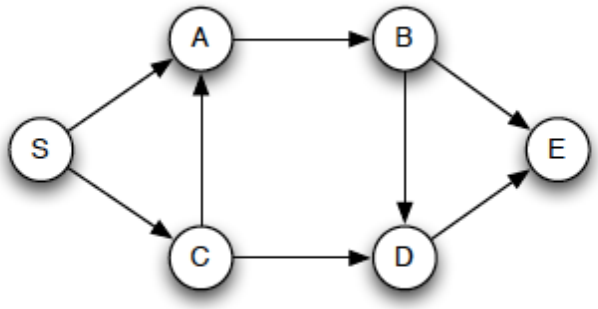

Figure 1: DAG

Question 2 (Maximize Yield): You get hired by a new airline, AirSweden, to make sure that they operate with a profit. The owner of AirSweden, Mrs. A, has heard representatives of other airlines talking about yield, and now suggests to maximize the yield. Explain to Mrs. A what yield is, and detail why it is not a good idea to solely aim for maximizing the yield.

Question 3 (Separation): Background. To avoid accidents, air traffic controllers (ATCOs) have to ensure safe separation of all aircraft at all times. This is often measured in distance. For arrival flight, the distance depends on the category of the leading and the trailing aircraft: super, heavy, medium, or light. Any two aircraft landing on the same runway must keep a distance of 3NM under approach. However, different aircraft have differnt landing

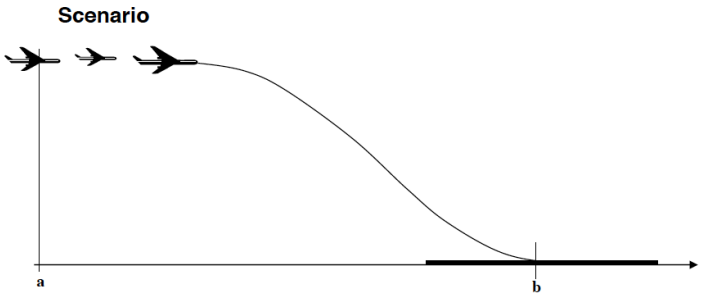

Figure 2: Scenario for Landing.

speed, thus, aircraft of different categories cannot stick to a distance of 3NM for the full approach, hence, their initial distance must be larger.
Assume that we consider a single runway with the sequence of aircraft that need to land. In Figure 2, all aircraft must have reached their landing speed at point b (the runway), this depends on the aircraft type. At point a (still at flight level) ATCOs usually aim for a separation of 5 ± 1NM, and we assume for simplicity that all aircraft have a speed of 240 knots (NM/h). ATCOs place aircraft in a sequence, a "queue" at point a. When landing at b all aircraft should be separated mutually by 3 NM (in reality this separation distance also depends on the category of the leading and trailing aircraft, see, e.g., `https://www.skybrary.aero/bookshelf/books/1166.pdf`).
If the trailing aircraft has a lower landing speed than the leading aircraft the gap at b will most likely be larger than 3NM. This is not efficient, but it does not impede safety.
If the trailing aircraft has higher landing speed than the leading aircraft the gap might reduce. However, if it goes below 2.5 NM this is considered as impacting safety and the trailing aircraft must make a go-around and reenter the queue at a as the last aircraft.
Landing speed and deceleration for all aircraft types are given in Table 1.

Table 1: Landing speed and deceleration

A/c category	example	landing speed	decelaration
Heavy	B747	160 knots	1.0 ± 0.2 knots/second
Medium 2	B737-800	140 knots	1.1 ± 0.3 knots/second
Medium 1	B737-600	120 knots	1.2 ± 0.4 knots/second
Light	Turboprop	100 knots	2.0 ± 0.5 knots/second

Task. Air Traffic Control wants to know how the separation between aircraft at point a should be chosen such that the throughput is as high as possible,

which also includes that go-arounds can be avoided. It is your task to create an application that, given a sequence of aircraft, computes the throughput of the runway (in movements/hour). The application should also output how many go-arounds were necessary.
It must be possible to give the aircraft sequence and the initial pairwise aircraft distance as input. Preferably, you draw the decelaration randomly from the given interval (using a uniform distribution). Because this integrates stochastics into your app, it should be possible to run the application for a certain number of times to compute an average throughput.
The application can be made, e.g., as a java program, with matlab or excel. You can choose the tool.
Write a simple report. If possible email me an executable copy of the application. If that is not possible we book an online meeting where you can demonstrate your application. The report should enable the reader to understand how your application works, that is, either the code must be well written and documented, or you should describe the algorithm in pseudocode. Moreover, you should include assumptions, delimitations and experimental results.

Question 1 and 2 should be submitted individually, question 3 should be handled in groups and a short report should be submitted for both.
The report can sent by email to christiane.schmidt@liu.se or uploaded to lisam no later than the due date.