2015 Summer Entrance Examination

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Creative Informatics

Instructions

1. Do not open this brochure until the signal to begin is given.
2. Write your examinee ID number below on this cover page.
3. Answer three problems out of the four.
4. Three answer sheets are given. Use a separate sheet of paper for each problem. You may write on the back of the sheet.
5. Write down your examinee ID number and the problem number inside the top blanks of each sheet.
6. Do not remove the answer sheets or this brochure from this room.

Examinee ID ______________________________

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Problem 1

Let a stack of n pancakes with different sizes be given. A spatula is a tool to flip over pancakes. If you put the spatula under the k-th pancake from the top, all top to the k-th pancakes are flipped over and placed in the reverse order (Fig.1). Let us rearrange the stack using a spatula so that the smallest pancake appears on the top of the stack, monotonically increasing the size, and the largest at the bottom, which we call "ordered-state". We assume that both sides of each pancake are identical and we know which pancake is the k-th biggest in advance. From now, we use this pancake-number k to identify the pancake. A "stack-state" is denoted by the sequence of pancake-numbers from the top to the bottom. For example, using our notation, state transitions in Fig. 1 are described as in Fig. 2. Answer the following questions.

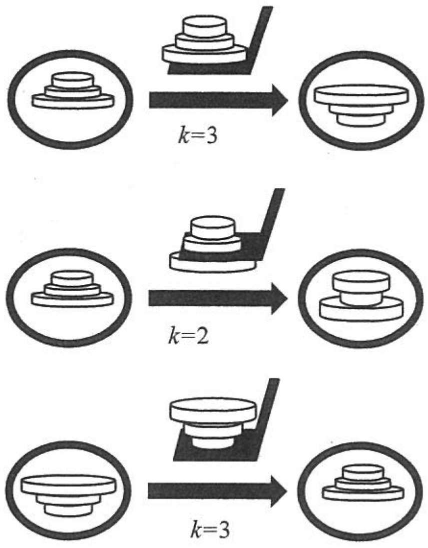

Fig. 1

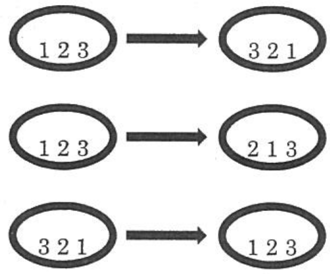

Fig. 2

(1) For n=3, draw a state transition graph, whose vertices are "stack-states" and arcs are transitions by a spatula. Fig. 3 shows one example of the state transition graph for n=2.

(2) For n=3, give an example of "stack-state" which requires the maximum number of flips to reach "ordered-state", and the corresponding number of flips.

Fig. 3

(3) For n=4, give an example of "stack-state" which requires the maximum number of flips to reach "ordered-state", and the corresponding number of flips.

(4) For general n, describe an algorithm for rearrangement to reach "ordered-state" and give its time complexity.

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Problem 2

Consider the system (shown in Fig. 1) that transfers the packets arriving from the three input lines to the output line every discrete time T[sec]. When there is any packet in the buffer, one packet in the buffer is transferred to the output line. Packets from the input lines arrive and are stored in the buffer. The packet arriving probability of three input lines are the same value $\lambda(0 \leqq \lambda \leqq 1)$, all of arriving packets from input lines have the same size, and the maximum number of packets to be able to be stored in the buffer is three. Since the buffer cannot store the larger number of packets than its capacity, the arrived packet(s) that can not be stored in the buffer is(are) discarded. Here, the packet(s) to be discarded is(are) randomly selected regardless of the input line.
Then, answer the following questions.

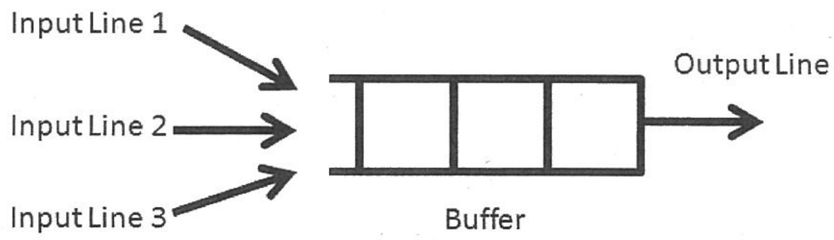

Fig. 1

(1) Show the probability p(s), where the number of arriving packets from three input lines is s in T[sec], and show the expected number of arriving packets.
(2) Show the state transition diagram, related with the number of packets in the buffer.
(3) Describe how to calculate the expected number of packets in the buffer.
(4) Describe how to calculate the probability of packet drop at the buffer.

Consider the modified system: the packets from input line 1 are given the transmission priority to the output line than the packets from other input lines, and no packet arrival from input line 3.

(5) Describe the state transition diagram with the definition of states, in order to calculate the expected number of packets in the buffer and the probability of packet drop at the buffer regarding the packets arriving from input line 2.

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Problem 3

Show a system for measuring a three dimensional position of a point in the three dimensional space and explain the following items on the system. The system can be designed on the basis of either contact or non-contact method. Any operating condition on measuring objects and/or the system can be assumed.

(1) The outline of the measurement principle and the calculation method of the system for detecting the three dimensional position

(2) The main hardware/software components of the system and their configuration of the system

(3) Main requirements for appropriate operation of the system and the reasons of their necessity

(4) Limits of position accuracy and time resolution of the system and the factors in determining them

(5) An application example using the system and outline of its operating principle

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Problem 4

Select <u>four items</u> out of the following eight items concerning information systems, and explain each item in approximately 4～8 lines of text. If necessary, use examples or figures.

(1) Superscalar
(2) Cross site scripting
(3) Support vector machine
(4) Strain gauge
(5) Half adder
(6) Just-in-time compiler
(7) PWM (pulse width modulation) control
(8) Optical flow

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