Computer Science Tripos Part IA and IB

2019-2020
Exam Question
Cover sheet

Student BGN........2023A........

Paper........1........

Question number........6........

How did you answer this question?

Timed	☐	Open Book	☑
Untimed	☑	Closed Book	☐

Questions

List all the questions you have answered for this paper here. 1,4,6,8,9

Computer Science Tripos Honour Code

1. We take it as a principle that maintaining the integrity and fairness of examinations should be regarded as a collaboration between students and the Department.
2. The students undertake that they will not help others in examinations and will not receive any help from others (students or non-students).
3. Students will actively contribute to ensuring that all students adhere to the code.
4. Students will keep to the conditions of the assessment and will accurately report those conditions when asked.
5. The Department will not make any attempt at remote invigilation of online examinations.

I **undertake to respect the Computer Science Tripos honour code**

Tick the box to confirm ☑

6a) (i) $\frac{\lambda^k e^{-\lambda}}{k!}$

(ii) $\begin{cases} p & \text{if } k = 1 \\ 1-p & \text{if } k = 0 \end{cases}$

(iii) $\binom{n}{k} p^k (1-p)^{n-k}$

b) (i) $X \sim \mathrm{Ber}(\frac{3}{5})$

$\mathrm{E}(X) = \frac{3}{5}$

$\mathrm{Var}(X) = \frac{6}{25}$

(ii) $Y \sim \mathrm{Hyp}(2000, 50, 1200)$

$\mathrm{E}(X) = 30$

$\mathrm{Var}(X) = 12$

(iii) $Z \sim \mathrm{Pois}(3)$

$\mathrm{E}(X) = 3$

$\mathrm{Var}(X) = 3$

c) (i)

$y \setminus x$	-1	0	$+1$	$\mathrm{P}[Y = y]$
-1	0	$1/4$	0	$1/4$
0	$1/4$	0	$1/4$	$1/2$
$+1$	0	$1/4$	0	$1/4$
$\mathrm{P}[X = x]$	$1/4$	$1/2$	$1/4$	1

(ii) $\mathrm{E}[X] = 0, \mathrm{E}[Y] = 0$

(iii) Two discrete random variables S and T are independent if for all values a, b:

$$\mathrm{P}[S = a, T = b] = \mathrm{P}[S = a] \cdot \mathrm{P}[T = b]$$

X and Y are not independent above, since for example
$\mathrm{P}[X = 0, Y = 0] \neq \mathrm{P}[X = 0] \cdot \mathrm{P}[Y = 0]$

(iv) The covariance of two random variables S and T is:

$$\mathrm{Cov}[S, T] = \mathrm{E}[(S - \mathrm{E}[S]) \cdot (T - \mathrm{E}[T])].$$

X and Y above have a covariance of 0, since one of X or Y is always zero, so $(S - 0) \cdot (T - 0)$ will always evaluate to zero.