Discrete Mathematics and Probability **Probability Distributions**
Session 2025/26, Semester 1 Week 9 Homework 5

If you need this document in another format please contact course organiser Ian.Stark@ed.ac.uk

This homework runs from Thursday 6 November 2025 until 12 noon on Thursday 13 November 2025. Submission is to Gradescope Homework 5.

You should aim to write out solutions that someone who does not already know the answer could follow and understand.

You will receive marks and feedback on this homework, but this is formative assessment and does not affect your final course grade. You may discuss your work with others and can ask questions about the homework at InfBase, in lectures, to your tutors, and in Piazza: please do.

Question 1

Suppose that a pharmaceutical company has developed a new non-invasive test for a type of cancer. Their studies show that this new test has the following properties.

- If the test is performed on a (random) person who has this type of cancer, then there is an 88% chance that the test result will be positive.
- If, on the other hand, the test is performed on a (random) person who does not have this cancer, then there is a 9% chance that the test result will be positive.

Approximately 1 in 1000 persons in the entire population have this type of cancer.

Suppose that this new test is performed on a (random) person in the population. What is the probability that the person actually has this cancer, given that their test result was positive?

[*3 marks*]

This ends the part of the question to which you have to submit a written answer. The following questions are for you to think through now and then discuss at the tutorial

Considering the probability you have just calculated, suppose you were advising NHS Scotland regarding whether or not to recommend this test for the general population. Would it be worthwhile? What would you say to them?

Suppose also that the test is available at a scale which could cover the whole population of Scotland, but at a cost of £350 for each test. Does this affect your advice?

Suppose further that if this test is positive it requires additional invasive tests to see if the cancer is indeed present; and these follow-up tests are actually quite painful and cause prolonged discomfort for patients, whether or not they actually have the cancer.

What would your recommendation now be to NHS Scotland regarding whether to regularly carry out this test, and why? There is no right answer to this, but it gives you an idea of trade-offs routinely arising in population health care.

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Question 2

A web server runs a job every night to back-up and rebuild all content. While this is running the web sites it serves are temporarily unavailable. The length of time this takes is normally distributed with mean 200 seconds and standard deviation 40 seconds.

Over a year this job runs on 365 nights. Estimate the number of nights when it takes

(a) less than 2 minutes;

(b) longer than 5 minutes;

(c) between 3 and 4 minutes.

Give your answers to the nearest whole number of nights. For each part include your working as well as the final answer. You can use the Standard Normal Distribution table from Appendix A.3 in the course textbook, or other source, to calculate probabilities.

For each part explain your answer and show your working. [*7 marks*]