



**DEPARTAMENTO DE ELETRÓNICA, TELECOMUNICAÇÕES  
E INFORMÁTICA**

**MESTRADO INTEGRADO EM ENG. DE COMPUTADORES E TELEMÁTICA**

**ANO 2018/2019**

# **DESEMPENHO E DIMENSIONAMENTO DE REDES**

**ASSIGNMENT GUIDE NO. 1**

**BASIC EXERCISES**

RECALL FROM THEORETICAL CLASSES:

1. Bayes' law: consider a set of mutually exclusive events  $F_1, F_2, \dots, F_n$  such that its union is the set of all possible outcomes of a random experiment. Knowing that event  $E$  has occurred, the probability of event  $F_j$ , with  $j = 1, 2, \dots, n$ , is given by:

$$P(F_j|E) = \frac{P(EF_j)}{P(E)} = \frac{P(E|F_j)P(F_j)}{\sum_{i=1}^n P(E|F_i)P(F_i)}$$

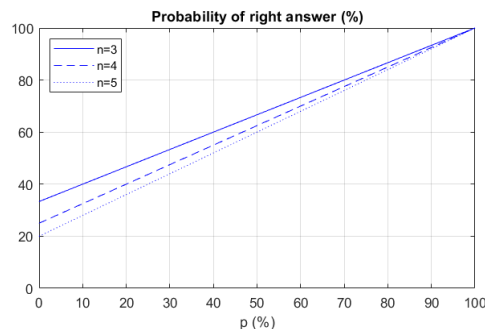
2. The probability function of a binomial random variable with parameters  $n$  and  $p$  is:

$$f(i) = \binom{n}{i} p^i (1-p)^{n-i}, \quad i = 0, 1, \dots, n$$

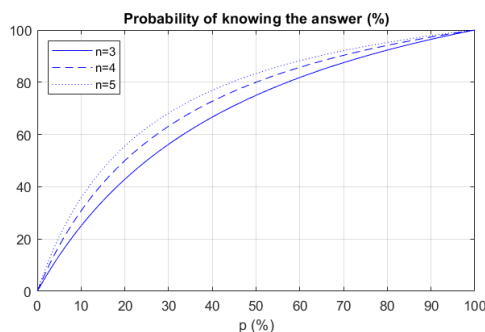
$$\text{where } \binom{n}{i} = \frac{n!}{i!(n-i)!}$$

**1.** On a multiple choice test, each question has  $n$  possible answers and only one is correct. Assume that the student has studied a percentage  $p$  (with  $0\% \leq p \leq 100\%$ ) of the test content. When a question addresses the content the student has studied, he selects the right answer. Otherwise, he selects randomly one of the  $n$  answers.

- 1.a.** When  $p = 60\%$  and  $n = 4$ , determine the probability of the student to select the right answer. Response: 70%
- 1.b.** When  $p = 70\%$  and  $n = 5$ , determine the probability of the student to know the answer when he selects the right answer. Response: 92.1%
- 1.c.** Draw a plot of the probability of the student to select the right answer when  $n = 3, 4, 5$  as a function of the probability  $p$ . Response:



- 1.d.** Draw a plot of the probability of the student to know the answer when he selects the right answer when  $n = 3, 4, 5$  as a function of the probability  $p$ . Response:



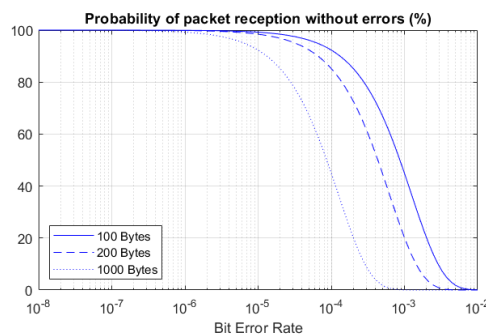
**2.** Consider a wireless link with a bit error rate (ber) of  $p$ . Assume that errors in the different bits of a data packet are statistically independent (i.e., the number of errors of a data packet is a binomial random variable).

**2.a.** Determine the probability of a data packet of 100 Bytes to be received without errors when  $p = 10^{-2}$ . Response: 0.0322%

**2.b.** Determine the probability of a data packet of 1000 Bytes to be received with exactly one error when  $p = 10^{-3}$ . Response: 0.2676%

**2.c.** Determine the probability of a data packet of 200 Bytes to be received with one or more errors when  $p = 10^{-4}$ . Response: 14.7863%

**2.d.** Draw a plot of the probability of a data packet (of 100 Bytes, 200 Bytes or 1000 Bytes) being received without errors as a function of the bit error rate (from  $p = 10^{-8}$  up to  $p = 10^{-2}$ ). Response:



**2.e.** Draw a plot of the probability of a data packet being received without errors (for  $p = 10^{-4}$ ,  $10^{-3}$  and  $10^{-2}$ ) as a function of the packet size (from 64 Bytes up to 1518 Bytes). Response:

