



**DEPARTAMENTO DE ELETRÓNICA, TELECOMUNICAÇÕES
E INFORMÁTICA**

MESTRADO EM ENGENHARIA DE COMPUTADORES E TELEMÁTICA

ANO 2025/2026

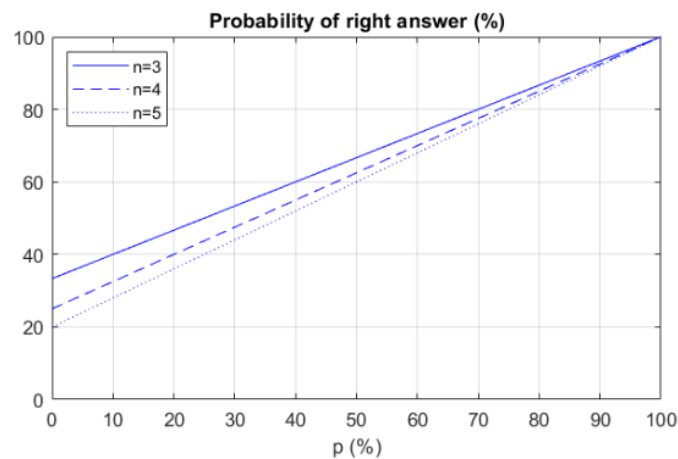
MODELAÇÃO E DESEMPENHO DE REDES E SERVIÇOS

PRACTICAL GUIDE

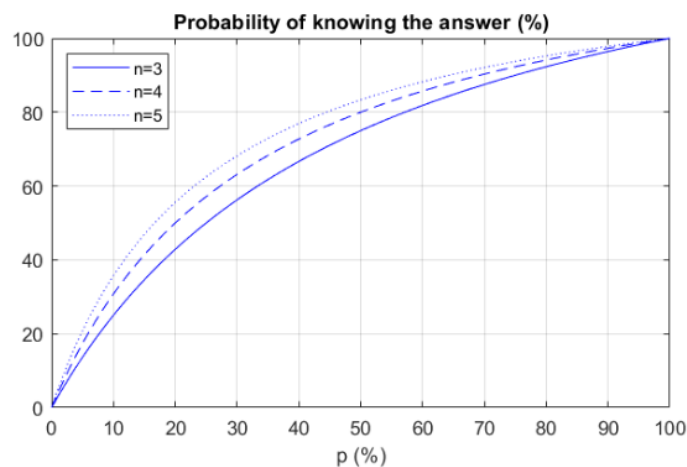
Task 1

Consider a multiple-choice test such that each question has n multiple 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 that the student has studied, he selects the right answer with 100% of probability. Otherwise, the student always selects randomly one of the n answers with a uniform distribution.

- 1.a. When $p = 60\%$ and $n = 4$, determine the probability of the student to select the right answer. Answer: 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. Answer: 92.1%
- 1.c. Draw a plot (with the same look as the plot below) with the probability of the student to select the right answer as a function of the probability p (consider the number of multiple answers $n = 3, 4$ and 5). What do you conclude from these results? Answer:



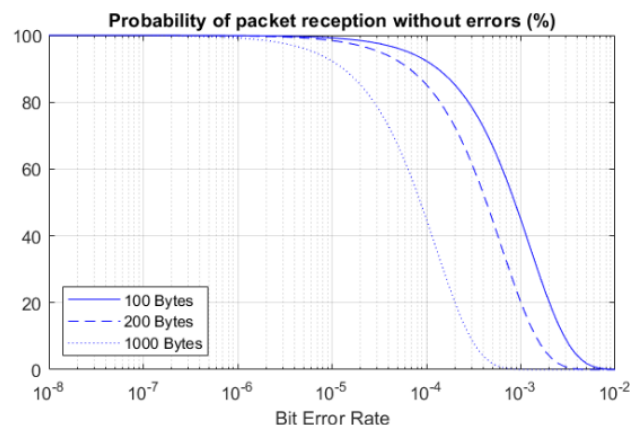
- 1.d. Draw a plot (with the same look as the plot below) with the probability of the student to know the answer when he selects the right answer as a function of the probability p (consider $n = 3, 4$ and 5). What do you conclude from these results? Answer:



Task 2

Consider a wireless link between multiple stations for data communications with a bit error rate (*ber*) of p . Assume that transmission errors in the different bits of a data frame 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 frame of 100 Bytes to be received without errors when $p = 10^{-2}$. Answer: 0.0322%
- 2.b. Determine the probability of a data frame of 1000 Bytes to be received with exactly one error when $p = 10^{-3}$. Answer: 0.2676%
- 2.c. Determine the probability of a data frame of 200 Bytes to be received with one or more errors when $p = 10^{-4}$. Answer: 14.7863%
- 2.d. Draw a plot using a logarithmic scale for the X-axis (use the MATLAB function `semilogx`) with the same look as the plot below with the probability of a data frame (of size 100 Bytes, 200 Bytes or 1000 Bytes) being received without errors as a function of the *ber* (from $p = 10^{-8}$ up to $p = 10^{-2}$). What do you conclude from these results? Answer:



- 2.e. Draw a plot using a logarithmic scale for the Y-axis (use the MATLAB function `semilogy`) with the same look as the plot below with the probability of a data frame being received without errors (for $p = 10^{-4}$, 10^{-3} and 10^{-2}) as a function of the packet size (all integer values from 64 Bytes up to 1518 Bytes). What do you conclude from these results? Answer:

