

Information Theory and Applications

Matlab Homeworks

Part I: Information Theory

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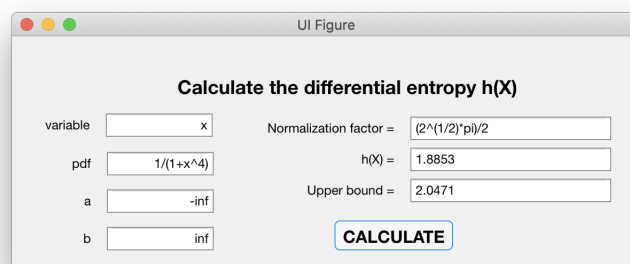
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- The following exercises shall be implemented by using Matlab, its toolboxes, and (if required) C language extensions interfaced by MEX. Source codes of everything must be delivered along with an explanatory report.
 - These homeworks are individual and any kind of cooperation is strictly forbidden.
 - The Matlab programs cannot be copied from the Internet, they must be original work.
 - The evaluation takes into account the following characteristics:
 - correspondence to the description
 - correctness (the program must run and give the expected results, otherwise the grade is 0)
 - clarity, compactness, and readability of the source codes
 - organization of the program
 - accuracy of the results
 - completeness of the implementation
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1. Implement a GUI accepting as inputs:

- a variable name;
- an unnormalized pdf, function of the previous variable name;
- the parameters a, b specifying the variable range (a, b) outside of which the pdf is identically equal to 0 (any of a, b may be $\pm\infty$).

The output shall report

- the normalization factor of the pdf (i.e., the integral of the unnormalized pdf from a to b);
- the differential entropy corresponding to the normalized pdf;
- the Gaussian upper bound.
- The GUI implements all necessary sanity checks on the input data.



2. Implement a GUI interface with the following characteristics:

- Consider three independent random variables X, Y, Z .
- The GUI accepts three ranges in Matlab notation, one for each random variable (*e.g.*, `1:10` or `[1:5,8:10]` etc.)
- The GUI accepts the three unnormalized probability distribution and checks for the consistency of the input data after the normalization.
- The GUI accepts a function $f(X, Y, Z)$ in symbolic form.
- The GUI calculates and reports the entropies of the random variables and of the specified function $f(X, Y, Z)$.
- The GUI checks all the possible inequalities relevant to the calculated entropies and reports the results.
- The GUI implements all necessary sanity checks on the input data.

3. Implement a GUI interface with the following characteristics:

- It accepts a character range such as `abcdef` as an input alphabet.
- It accepts a probability distribution for the input alphabet above, possibly unnormalized and, in that case, it normalizes it.
- It accepts an arbitrary input string such as `abba`.
- It outputs the corresponding binary string obtained by applying an arithmetic code to the input string, as specified in https://en.wikipedia.org/wiki/Arithmetic_coding or other resources.
- The GUI implements all necessary sanity checks on the input data.

