

# Maximum Entropy and Bayesian inference: Where do we stand and where do we go?

Ali Mohammad-Djafari

Laboratoire des signaux et systèmes(L2S),  
UMR 8506 du CNRS-Supélec-Univ. Paris-sud,  
Plateau de Moulon, 91192 Gif-sur-Yvette, France

In this tutorial talk, I will first review the main notions of Uncertainty, Random variable, Probability distribution, Information and Entropy. Then, we will consider the following main questions in any inference method:

- 1) Assigning a (prior) probability law to a quantity to represent our knowledge about it,
- 2) Updating the probability laws when there is new piece of information, and
- 3) Extracting quantitative estimates from a (posterior) probability law

For the first, I will mainly present the Maximum Entropy Principle (MEP).

For the second, we have two tools:

- 1) Maximising the relative entropy or equivalently minimizing the Kullback-Leibler discrepancy measure, and
- 2) The Bayes rule.

We will precise the appropriate situations to use them as well as their possible links.

For the third problem, we will see that, even if it can be handled through the decision theory, the choice of an utility function may depend on the two previous tools used to arrive at that posterior probability.

Finally, these points will be more illustrated through examples of inference methods for some inverse problems such as image restoration or blind sources separation.

**Key Words:** Uncertainty, Probability distribution, Information and Entropy, Maximum Entropy Principle, Bayesian inference, Decision theory