Quality evaluation of spike-based image compression using convolutional neural networks

We are seeking a highly motivated candidate who is interested in a *multidisciplinary project* that combines *neuroscience*, *signal processing* and *machine learning*. The goal of the proposed, 9-weeks long internship is to (i) compress natural images using spike-based compression and (ii) use these images to evaluate the compression rate where the ability of a pre-trained neural network to correctly classify the compressed image is lost. The candidate will have the unique opportunity to lay solid foundations for applied neuroscience in data science.

Motivation: Neurons are able to communicate each other by propagating the important and informative stimulus using *electrical impulses* which are also known as *action potentials* or *spikes*. A sequence of action potentials generated by a neuron is called *spike train*. Based on the Leaky Integrate-and-Fire (LIF) model it is possible to tune the sensitivity of neurons and as a consequence the amount of information which is transmitted by a spike train[1]. The LIF model was recently adopted by a novel architecture, the *spike-based compression*[2,3], that transforms a still-image into a dense code of spikes approximating the neuronal spike generation mechanism. This code might be used to reconstruct the original image with some distortion. By tuning the LIF parameters it is possible to reduce the number of bits (bitrate) required to store the input image. However, it is desired to find the best rate-distortion trade-off that satisfies the human visual perception. The human visual perception will be evaluated using Convolutional Neural Networks (CNNs). Assuming that a CNN has been trained to classify a given image dataset, we are interested in studying how the rate-distortion trade-off influences the accuracy of such a pre-trained neural network.

Host Institution: The MediaCoding group belongs to SIS Team of the I3S lab, which is the largest information and communication science laboratory in French Riviera. MediaCoding is a group of experts working on image and video coding as well as geometric processing and compression of static surface meshes and animations. MediaCoding researchers are also interested in the analysis of the information contained by the neural code in the visual system, with bio-inspired applications in image and video compression. More recently, they lead activities on the storage of digital images onto synthetic DNA. Four permanent researchers, one associate member, seven PhD students and one engineer are currently working in MediaCoding group.

Preferred Qualifications: Bachelor Degree in Computer Science or Electrical Engineering or Mathematics. Programming Skills in Python and/or MATLAB.

For any further inquiry please contact Dr. Marc Antonini at am@i3s.unice.fr.

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[1] W. Gerstner and W. Kistler, "Spiking neuron models: Single Neurons Populations Plasticity," Cambridge University Press, 2002.

[2] E. Doutsi, M. Antonini, P. Tsakalides, "An end-to-end spike-based image compression architecture," *Asilomar Conference*, 2020.

[3] E. Doutsi, L. Fillatre and M. Antonini, "Efficiency of the bio-inspired Leaky Integrate-and-Fire neuron for signal coding," 2019 27th European Signal Processing Conference (EUSIPCO), A Coruna, Spain, 2019, pp. 1-5