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PhD Funding Proposal (+ Master Internship)
“Geometrically Explainable Networks for the Generation of Photo-Realistic Images”

Proposition de financement de thèse (+ stage Master)
“Des réseaux géométriquement explicables pour la génération d’images photoréalistes”

Supervisors:

- Frédéric Jurie (Professeur des Universités).
- David Tschumperlé (Chargé de Recherche CNRS - Head of the IMAGE team/GREYC lab),
- Julien Rabin (Maître de Conférences UNICAEN),

Date / Duration: 3 years (+ opt. 6 months for the Master internship).

Remuneration: Env. 1758 € bruts / mois (Env. 650 € / mois pour le stage Master).

Subject Description:

If impressive results, which would have seemed incredible only a few years ago, have been obtained thanks to deep learning, neural networks have the disadvantage of being very complex big black boxes whose functioning is difficult to explain, and for which control by humans remains out of reach. We can, for example, take the case of GANs for which it is difficult to know if the images created are really new, for which it is difficult to understand how they work and what are the role of the massive number of parameters, and for which it is difficult to adjust "by hand" the parameters of the generation process.

In this context, this thesis topic aims at imagining, characterizing and using new operators (or "modules") of data projections, geometrically and photometrically explainable for the generation of photo-realistic images, with applications to computational photography and artistic imagery: automatic colorization of images, super-resolution, generation of realistic faces, etc.

The projection operators that we imagine to implement in this thesis are inspired by the work on non-local "patch-based" methods, and on dictionary learning methods, which remain relatively efficient with respect to the very small number of parameters they need. These methods also offer a finer user control over the generation of the images obtained than GAN methods, which are more like "black boxes", difficult to control and interpret. As such, our approach falls within the recent field of explainable AI, a concept that is fundamental to current societal issues.

With this thesis topic, we wish to explore the algorithmic combination of "deep neural networks" approaches and approaches based on "image data projection" (in the space of patches or prelearned dictionaries) in order to benefit from the best of both worlds: on the one hand, photo-realistic image generation capabilities, and on the other hand, lighter models in number of parameters.

Context and Location:

The thesis will take place in IMAGE Team of the GREYC Laboratory, in Caen / France. The funding of this thesis is guaranteed, financed by an AI Chair. The candidate will be able to do a Master internship (6 months) before starting the thesis.

Candidate Profile:

The candidate must have a Master M2 level with knowledge in Machine Learning and Image Processing. He can send his application to the supervisors, by e-mail, at the following addresses:

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Bibliographical References on Related Topics:

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- Brendel, W., Bethge, M., 2019. *Approximating CNNs with Bag-of-local-Features models works surprisingly well on ImageNet*, in: *ICLR*.
- Dong et al., 16] Dong, Loy, He, Tang, *Image Super-Resolution Using Deep Convolutional Networks*, *IEEE TPAMI*, vol. 38, 2016.
- Goodfellow, Pouget-Abadie, Mirza, Xu, Warde-Farley, Ozair, Courville, Bengio, *Generative adversarial nets*, *NIPS*, vol. 27, pp. 2672–2680, 2014.
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