Deep diffusion models for anomaly detection

Stage de master II - 2023

CREATIS

Keywords Deep Learning, Weakly supervised segmentation, Diffusion models

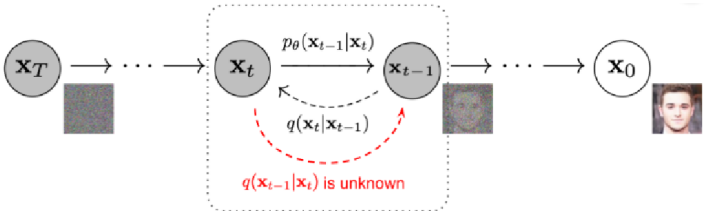

Figure 1: Diffusion Model [Song et al]

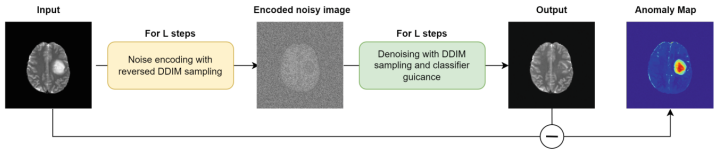

Figure 2: Anomaly detection with a diffusion model [Wolleb et al]

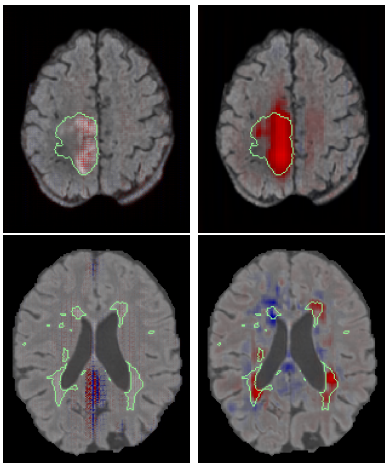

Figure 3: Our method: anomaly detection with attribution constrained learning [Wargnier-Dauchelle et al]. Top: tumor, bottom: multiple sclerosis. Left: standard learning, right: our constrained learning.

Scientific context Deep learning is now an established approach for medical image processing, providing state of the art results for image segmentation. However, best results are obtained with supervised learning, requiring a large annotated dataset. Especially for medical image segmentation, annotation is a tedious and time consuming task, requiring experienced clinician as annotator. In a previous work, we propose to use constrained learning with attribution maps to segment tumor or multiple sclerosis (MS) lesions in a weakly supervised way. Deep unsupervised learning is often based on generative models such as generative adversarial network (GAN) or variational autoencoder (VAE) but these models has strong limitations: GAN are notoriously difficult to train and VAE produces blurry images. Recently, diffusion model [Song et al] have shown there ability to generate images that can be highly resolved and trained in a stable manner. Some authors already proposed to use them for anomaly detection on medical images [Wolleb et al].

Objective The objective of the internship would be to propose a new weakly supervised anomaly detection method based on diffusion models. A work program could be: 1/ deeply understand the mechanism of diffusion models, 2/ reproduce the results of [Wolleb et al] and apply them to different data and different pathology (MS), 3/ combine the methods of [Wargnier et al] and [Wolleb et al] and evaluate the performance of the combined method. This work program can evolve based on the results obtained during the internship and new ideas of the intern.

Data Several datasets are already available for use in the lab.

Application The successful candidate is expected to be autonomous, to show strong motivation and interest in multidisciplinary research (image processing and machine learning for medical applications), to be highly proficient in python (pytorch is a plus) and to have a background in either

- Image analysis
- deep learning
- or applied mathematics

Interested applicants are required to send a cover letter, resume and any other relevant documents (reference letter, recent transcripts of marks,...) to: `michael.sdika[at]creatis.insa-lyon.fr`, `valentine.wargnier[at]creatis.insa-lyon.fr` and `thomas.grenier[at]creatis.insa-lyon.fr`.

Bibliography

1. J. Song et al, Denoising Diffusion Implicit Models, ICLR 2021
2. J. Wolleb et al, Diffusion Models for Medical Anomaly Detection, MICCAI 2022,
3. V. Wargnier Dauchelle, A Weakly-Supervised Gradient Attribution Constraint for Interpretable Classification and Anomaly Detection, et al, IEEE TMI (submitted)