LISTIC

Internship Position 2024-25 – Université Savoie Mont Blanc

Classification and Comparison of Multimodal 3D Images Using GNN and/or VGAE Architectures: Application to Early Detection of Alzheimer's Disease

Laboratory : LISTIC Laboratoire d'Informatique, Systèmes, Traitement de l'Information et de la Connaissance

Level: Master / last year - Engineering school **Start/End Date:** February–July 2025 **Location :** Le Bourget du Lac, France

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1. Subject Description

We offer a Master's internship in Graph Machine Learning for applications in multimodal imaging (medical or environmental). The intern will contribute to the state of the art on Graph Neural Network (GNN and/or VGAE) architectures applied to graphs derived from segmentations of multimodal images (e.g., 3D MRI, PET, and T1 brain scans). The internship will not involve image segmentation, which is already handled by the 3DBrainMiner platform. This platform enables the straightforward generation of multi-attributed graphs corresponding to 3D MRI images.

The focus will be on developing Graph Neural Network models in Python using popular deep learning libraries such as PyTorch Geometric. Beyond achieving high classification performance, the work will aim to develop GNN models capable of explaining decisions by producing informative latent spaces or identifying nodes, subgraphs (geographical/anatomical regions), or dimensions (embeddings) that characterize classification decisions (explainability).

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2. Missions

- **State-of-the-art Study**: Investigate graph representations for multimodal 3D images and GNN/VGAE models suitable for processing such data.
- **Graph Construction**: Select graph construction methods using pre-implemented image segmentation techniques on T1 and PET brain MRI scans. This includes defining parameters for effectively integrating multimodal information into the graphs (e.g., segmentation modes, node and edge creation methods, attributes of graph nodes/edges).
- **Model Implementation**: Develop GNN and/or VGAE models with associated explainability procedures. Apply these to graphs representing human brains, ranging from healthy to various pathological states. This includes identifying biomarkers associated with the studied task.
- **Evaluation**: Evaluate models on a dataset of 3D brain MRI scans, focusing on the early detection of Alzheimer's disease.
- **Performance Comparison**: Compare proposed models with other methods to assess their relevance for this context. Evaluate their performance in detecting patterns or anomalies associated with Alzheimer's disease progression.

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3. References

- Kipf, T.N., & Welling, M. (2016). *Variational Graph Auto-Encoders*. Link
- Pan, S., Hu, R., Long, G., Jiang, J., Yao, L., & Zhang, C. (2018). *Adversarially Regularized Graph Autoencoder for Graph Embedding*. Link
- Parisot, S., Ktena, S.I., Ferrante, E., Lee, M., & Rueckert, D. (2018). *Disease Prediction using Graph Convolutional Networks: Application to Autism Spectrum Disorder and Alzheimer's Disease*. Link
- Kazi, A., Mikolajczyk, T., Eickhoff, C., Staring, M., & Initiative, A.D.N. (2021). *InceptionGCN: Receptive Field Aware Graph Convolutional Network for Disease Prediction*. Link
- Zhang, L., Zhao, Y., Che, T., Li, S., & Wang, X. (2023). *Graph neural networks for image-guided disease diagnosis: A review*. Wiley Online Library

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4. Required Skills

- Master's or Engineering student in Computer Science, Machine Learning, or Data Science.
- Knowledge of Machine Learning (especially variational autoencoders, GNNs, VGAEs).
- Proficiency in Python and associated libraries (PyTorch, TensorFlow, scikit-learn).
- Analytical mindset and teamwork skills.

Compensation: According to current French legislation.

Supervisors/Contacts

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- Please send your CV and cover letter.