PhD Candidate M/F (36 months)

Toward Sustainable AI: Frugal Generative GNNs for Graph Synthesis

(*Reference INSFT055*)

Thesis Supervisors

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INRIA: **Marc Lelarge**, researcher

Environnement

This CIFRE PhD thesis will be jointly supervised by INRIA and MERCE: academically within the Argo team at INRIA Paris; industrially within the DIS/SAS team at Mitsubishi Electric R&D Centre Europe (MERCE) in Rennes. The project is aligned with MERCE's strategy for deploying AI in constrained (edge/embedded) environments with a focus on computational frugality.

General context

A member of the MITSUBISHI ELECTRIC group—Japan's leader in the production and sale of electrical and electronic equipment—the MERCE center in Rennes conducts R&D activities in control, artificial intelligence, and information systems.
This PhD opening is within the SAS team (Synergistic Autonomous Systems), dedicated to the study, design, and modeling of complex autonomous systems, with applications particularly in robotics (control and perception), industrial automation, and the transversal aspects of telecommunications.
The Argo team at INRIA Paris develops optimized artificial intelligence solutions for data networks. Its research aims to create faster algorithms, more efficient AI architectures, and secure, energy-efficient collaborative learning methods.

Thesis topic

The goal is to design, analyze, and evaluate frugal graph-generation architectures and pipelines, reconciling structural fidelity with efficiency (time/memory/energy), in order to make graph synthesis feasible on edge and embedded devices.

Targeted use cases include:

- Real-time semantic perception and representation (scene-graph micro-edits through a "propose–verify" loop constrained by ontology and validated by sensors).
- Communication topologies for robotic swarms (synthesis/editing under connectivity, bandwidth, and robustness constraints).
- Sim-to-Real transfer through scene generation and morphological co-design (graph grammars for "body-brain" systems).

Detailed objectives

Detailed objectives may include:

- **Frugal generative architectures**

Transitioning from heavy sequential processes (autoregressive) to parallel/latent/hierarchical methods (non-autoregressive, one-shot) that reduce time and memory complexity while preserving validity (e.g., connectivity, degree distributions).

- **Temporal and topological dynamics**

Modeling the evolution of graphs (multi-agent, robotics) for predictive control and adaptation.

- **Constraint-aware learning**

Integrating physical/functional constraints directly into the generation process (networks, kinematics, bandwidth) to avoid costly post-processing.

- **Transfer and validation**

Validation on benchmarks and software platforms targeting Edge/Embedded systems (semantic 3D scenes, swarms), and documentation of compression techniques (quantization, structured sparsity, untrained sparse subnetworks).

- **Publications**

Targeting top-tier conferences and journals: NeurIPS, ICLR, ICRA, JMLR, IEEE TNNLS.

Required Skills & Profile:

- Master's degree (or equivalent) in AI, robotics, systems control, computer science, or a related field.
- Ability and motivation to combine theoretical analysis with practical validation.
- Strong foundation in machine learning (ideally GNNs/generative models) and/or control/robotics.
- Proficiency in Python and AI libraries (e.g., PyTorch); good software engineering practices (Git, CI).
- Analytical mindset, autonomy, initiative.
- English required.

Duration: 36-month contract

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