Centre for AI-Fundamentals
RAEng Google DeepMind Summer Internship Programme 2025

Project proposal

Project Title	Robust Reinforcement Learning for Quadruped Robot Locomotion in Dynamic Environments
Lead supervisor	Amr Mousa
Project Description	This project focuses on improving quadruped robot locomotion in dynamic environments by integrating self-supervised representation learning into Reinforcement Learning (RL). The key goal is to develop policies that improve feature extraction and representation learning to enhance policy robustness, generalization, and adaptability across various environmental conditions. **Key Objectives:** • Develop locomotion strategy that generalize across different conditions such as terrain variations and disturbances. • Evaluate the impact of self-supervised learning techniques on policy robustness, stability and adaptability. Using an established RL pipeline, the intern will experiment with different representation learning approaches and test their effectiveness in both simulated environments (IsaacSim) and real-world hardware platform such as Unitree-Go2. **Internship Plan** 1. **Literature Review & System Familiarization (Weeks 1–2)** – Explore RL fundamentals, self-supervised learning techniques, and representation learning for locomotion while running baseline RL policies in IsaacSim. 2. **Algorithm Selection & Theoretical Integration (Week 3)** – Choose a representation learning technique based on research insights and design an integration plan for the RL pipeline. 3. **Implementation & Testing (Weeks 4–5)** – Implement the method, conduct experiments and compare performance against baselines under varying conditions.

4. **Optimization & Evaluation (Weeks 6–7)** – Fine-tune hyperparameters, address failure cases, validate generalization across different conditions, and document findings in a final report and presentation.

Expected Outcomes & Skills Development

By the end of the internship, the intern will have developed expertise in:

1. Fundamental and applied knowledge in Representation Learning and Reinforcement Learning
2. Robotics simulation and real-world experimentation for autonomous systems
3. ML software engineering, including model debugging, AI experimentation, and performance optimization
4. Advanced research methodologies and scientific communication, including data interpretation and effective presentation of findings

Through this project, the intern will contribute to advancing quadruped robot locomotion, helping to develop policies that can operate reliably in real-world, unpredictable conditions. The methodologies explored in this research will also have broader applications in reinforcement learning for other dynamic and uncertain environments.

Internship Role & Requirements

As an intern, you will:

- Implement and experiment with a self-supervised learning techniques, such as SimCLR, BYOL, and InfoNCE.
- Train and test locomotion policies in both simulated environments and real-world hardware platforms.
- Analyse results and contribute to research publications.

Requirements:

- Basic knowledge of reinforcement learning (understanding of policy-based methods such as PPO is a plus).
- Familiarity with machine learning and deep learning (experience with PyTorch is beneficial).
- Programming experience in Python, including working with numerical libraries such as NumPy.

	• Some exposure to simulation environments (e.g., NVIDIA IsaacSim, PyBullet, or Mujoco is helpful but not required). • Problem-solving mindset and willingness to learn new AI and robotics concepts.