Overview

Career Aspirations and Research Vision

As an assistant professor in Mathematics at UAB, I aim to bridge statistical theory with AI through the innovative *Representative Learning* (RL) framework. Developed in response to Federated Learning's (FL) inefficiencies—namely communication overhead, data heterogeneity, and security concerns—RL, as conceptualized in one of my previous papers, employs data abstractions or 'representatives.' These encapsulate essential data traits from local nodes, enabling efficient central analysis while minimizing data movement and enhancing privacy.

RL offers a paradigm shift in distributed AI systems, significantly improving scalability and adaptability by reducing communication overhead through compact representatives and adeptly handling heterogeneous data. This adaptability is crucial for ensuring privacy, efficiency, and flexibility in distributed environments, setting RL apart from traditional FL approaches.

My career vision is to refine RL's principles and advocate for its integration into AI and statistics, establishing a new generation of AI systems that are secure, scalable, and grounded in statistical rigor. This effort aligns with my goal to advance AI technology responsibly, enhancing societal benefits.

Educational Philosophy and Objectives

My long-term educational goal is to reshape AI and statistics teaching, bridging theory with practical application. This CAREER proposal's educational objective focuses on creating a dynamic, research-informed curriculum with the latest advancements in AI and statistics to prepare students for tomorrow's technological challenges. Initiatives include integrating my three PhD students and one co-mentored PhD student in Computer Science into hands-on distributed machine learning research, expanding mentorship in REU programs, and updating course content with the latest research, fostering a generation of technically adept and ethically aware AI and statistics professionals capable of leading in a rapidly evolving technological landscape.

Intellectual Merit

My research integrates RL with deep learning, creating scalable, robust frameworks optimized for distributed environments. RL stands out by adeptly handling heterogeneous data and diverse tasks, prioritizing privacy, efficiency, and explainability. Such capabilities make AI systems more understandable and trustworthy, essential for sensitive areas. To actualize this vision, the project sets forth the following primary objectives:

1. **Foundational Expansion of RL:** Adapting RL to accommodate both smooth and non-smooth loss functions, broadening its applicability and robustness.
2. **RL in Decentralized Systems:** Extending RL to decentralized environments to ensure secure and flexible data processing.
3. **Deep Learning Architecture:** The ultimate goal, developing adaptive deep learning frameworks based on RL, leveraging tasks 1 and 2 to achieve scalability and robustness in distributed AI.

Achieving these objectives promises to revolutionize AI systems' scalability and reliability, making them more adaptable, secure, and interpretable across diverse and distributed digital ecosystems.

Broader Impacts

This project amplifies societal benefits through partnerships with local high schools for summer research experiences and by developing both Python and R open-source software, enhancing access to cutting-edge AI tools and fostering inclusivity in STEM. The application of RL in Personalized Medicine and collaborative efforts showcases real-world impacts, advancing public health and promoting scientific collaboration. These initiatives collectively cultivate a diverse, skilled STEM workforce, demonstrating the project's dedication to societal progress.