Project Title: Hybrid Federated Multi-Agent Reinforcement Learning with Metaheuristic Optimization for Latency and Energy-Aware Task Offloading in Edge-IoT Environments

---

1. Why This Domain? (Motivation) - The proliferation of IoT devices demands rapid, real-time decision-making capabilities at the network edge. - Traditional cloud systems are inadequate for latency-sensitive and energy-efficient processing. - Edge computing is a necessity for smart cities, autonomous systems, healthcare, and Industry 4.0. - AI-driven decentralized approaches are promising, especially when integrated with optimization techniques.

---

2. Main Problem Statement

> How can we intelligently offload and schedule tasks in edge-IoT environments while minimizing latency and energy consumption, and maximizing throughput and task success—under real-world constraints like device heterogeneity, limited bandwidth, and privacy concerns?

---

3. Importance of This Problem - Edge computing is essential for real-time applications. - Centralized models fail in dynamic, privacy-sensitive, and resource-constrained environments. - There is a lack of integrated solutions optimizing latency, throughput, energy, and task handling simultaneously.

---

4. Objectives - Develop a federated multi-agent reinforcement learning model for decentralized task offloading. - Integrate metaheuristic optimization to improve system-level performance. - Maximize key metrics: latency, throughput, energy efficiency, task success rate, and offloading capability.

---

5. Key Innovations - Hybrid of Federated Learning + Multi-Agent Actor-Critic RL + Metaheuristic Optimization. - Learns task allocation strategies with no centralized data dependency. - Can dynamically adapt to varying edge environments. - Privacy-preserving and scalable approach.

---

6. Related Work (Brief Mention) - Existing models often address either latency or energy—but not both. - Few combine federated learning with RL. - Metaheuristic fine-tuning is often missing in RL models.

---

7. Technologies and Algorithms | Category | Choice | |----------|----------| | Learning | Federated Actor–Critic (e.g., A3C, DDPG) | | Agents | Multi-Agent Cooperative RL | | Optimization | Firefly Algorithm or Rat Swarm Optimizer | | Simulation | iFogSim, EdgeDroid, CloudSim | | Metrics | Latency, Throughput, Energy, Task Success |

---

8. Real-World Applications - Remote Health Monitoring - Smart City Infrastructure - Surveillance using Edge AI - Autonomous Vehicles - Industrial IoT and Automation

---

9. Future Scope - Integration with privacy-preserving techniques like Differential Privacy. - Real-world testing on edge devices (e.g., Raspberry Pi clusters). - Deployment in 5G/6G-enabled smart networks.

---

10. Summary This project proposes a novel hybrid approach that integrates federated multi-agent reinforcement learning with metaheuristic optimization to solve real-world challenges in task offloading and edge resource management. It targets critical performance metrics such as latency, throughput, and energy consumption in privacy-sensitive, resource-constrained IoT environments.

Presentation version (PPT) to follow with slides for each section above.