IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING

HIGH IMPACT PRACTICES (HIPS)

CORNERSTONE PROJECTS: Automated Knowledge Discovery

INFORMATION PACKET

2025 - 2026

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INSTITUTE OF AERONAUTICAL ENGINEERING
25 YEARS 2000 2025

I appreciate your interest in the Cornerstone Project (CoP), Department of Information Technology at the Institute of Aeronautical Engineering!

A **cornerstone project (CoP)** is typically introduced during the early or middle stages of an academic program at the Institute of Aeronautical Engineering. It focuses on helping students build foundational skills and understand how to apply basic concepts to real-world scenarios. These projects are usually smaller in scope, moderately complex, and designed to strengthen practical understanding of core subjects.

These projects encourage students to connect theoretical learning to data-centric applications, such as developing the data learning model, performing simple data analysis, or creating prototype engineering solutions. Emphasis is placed on learning by doing, helping students build confidence in applying methods like data preprocessing, statistical analysis, basic modeling, and reporting results. By working on these projects, students begin to understand how engineering and data science principles apply in real-world scenarios. Ultimately, cornerstone projects act as the foundation of experiential learning at IARE, transitioning students from passive learners to active problem-solvers, equipped with both technical skills and professional behaviors necessary for the challenges of advanced engineering education.

Cornerstone Project (CoP) teams are:

- Collaborative Project – This is an excellent opportunity for students who are committed to working towards social developments and emerging needs.
- Project Activity – The project coordinator listed current working areas for offering cornerstone projects with a team size of at least two students. The coordinator allotted mentors based on the work area and facilitated exclusive project laboratories for selected cornerstone project (CoP)students. This cornerstone project (CoP)bridges the gap between academic learning and real-world social applications. It helps enhance the professional development
- Short-term - Each undergraduate student may participate in a project for an assigned period.

The primary goal of cornerstone projects is to provide a level of moderate complexity, expertise, and diversity of thought in social data-centric areas that will allow them to gain hands-on experience with the cornerstone projects.

- Simulate real-world project work environments - Familiarize students with the structure, expectations, and deliverables typical of data-driven and software development projects.
- Encourage interdisciplinary thinking - Promote the application of data mining methods to diverse domains such as healthcare, finance, education, environment, and smart cities.
- Promote ethical and responsible data use - Instil awareness of data ethics, privacy, security, and responsible AI practices during project planning and execution.
- Support data-driven decision making - Enable students to create data solutions that drive actionable insights, support evidence-based decisions, and add value to stakeholders.
- Foster hands-on project experience - Engage students in comprehensive, real-world data science project work that integrates the full data lifecycle from collection to insight generation and emerging technologies like AutoML, NLP, and LLMs.
- Build strong project portfolios - To enable students to create social and industry-ready project portfolios that demonstrate technical depth, innovation, and impact on careers.
- Bridge academic learning and practical application - Apply theoretical knowledge to practical challenges involving data analysis, machine learning, and visualization using real datasets.

Cornerstone Projects (CoPs) focuses on the challenges presented by the Sustainable Development Goals (SDGs)

Sustainability Development Goals (SDGs) for the Dept. of IT, IARE	
SDG 3	Ensure healthy lives and promote well-being for all at all ages
SDG 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG 10	Reduce inequality within and among countries
SDG 12	Ensure sustainable consumption and production patterns
SDG 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Themes of Cornerstone Projects (CoPs) for the Information Technology:

The following project domains are recommended for cornerstone projects (CoPs), and the students should frame the problem statements from any one of the following themes:

1. Student Performance Prediction System **(SDG #4, SDG #8, SDG #9, SDG #10)**
2. Federated Graph Neural Networks for Privacy-Preserving Community Detection in Social Networks **(SDG #4, SDG #9, SDG #10, SDG #10)**
3. Scalable Data Mining for Big Data Analytics in Cloud Ecosystems **(SDG #9, SDG #12)**
4. Privacy-preserving and Explainable Medical AI Systems using GAN/Diffusion-based Counterfactuals for Disease Classification, Diagnostic Insight Generation, and Data De-identification **(SDG #3, SDG #9, SDG #10, SDG #16)**
5. Crime Pattern Analysis and Prediction. **(SDG #1, SDG #11, SDG #16)**
6. Multi-Modal Deep Reinforcement Learning for Real-Time Decision-Making in Autonomous Healthcare Robots **(SDG #3, SDG #4, SDG #9, SDG #10)**
7. Privacy-Preserving Data Mining for Ethical AI System **(SDG #9, SDG #10, SDG #12, SDG #16)**
8. AI-Powered IoT System for Predictive Crop Health Monitoring and Automated Sustainable Farming **(SDG #9, SDG #10, SDG #12, SDG #16)**
9. Smart Healthcare: Disease Prediction System **(SDG #3, SDG #9, SDG #10)**
10. Self-Supervised Deep Learning for Anomaly Detection in Medical Imaging with Limited Labeled Data **(SDG #3, SDG #9, SDG #10)**
11. Temporal and Sequential Pattern Mining for Smart Systems **(SDG #9, SDG #11, SDG #12, SDG #13)**
12. IoT-Driven Leaf Disease Detection and Precision Pesticide Management using Machine Learning **(SDG #2, SDG #9, SDG #12)**

In order to participate in cornerstone projects, you must formally apply and be accepted by the project coordinator. To proceed, please mail to the project coordinator, Mr. N Rajasekhar (rajasekharnennuri@iare.ac.in), Head of Information Technology. This will bring up all available open positions tagged as cornerstone projects.

Please note that participation by the cornerstone project (CoP)team requires registration for the accompanying project work from any of the specified domains. More information will be provided to all selected cornerstone project (CoP)applicants who have been offered a position.

If you have any questions about a particular team, please contact the faculty mentor.
We encourage you to contemplate this fascinating new opportunity. We look forward to receiving your application submission!

Student Performance Prediction System

Dr.Basetty Mallikarjuna, Professor, Department of IT-Faculty Member

GOALS

The Student Performance Prediction System combines data mining and machine learning to enable proactive, data-informed academic management. The system can enhance educational outcomes, personalize learning, and reduce dropout rates when designed and implemented with care for privacy, scalability, and accuracy.

The Student Performance Prediction System, a cornerstone project in Data Mining and Machine Learning, covering Goals, Methods and Technologies, Design, and Technical Issues.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for Data mining and Machine Learning.

- Programming Language: Python / R
- ML Libraries: scikit-learn, pandas, numpy, seaborn, XGBoost
- Data Storage: CSV/Excel, MySQL, SQLite, or cloud databases (Firebase, MongoDB)
- Visualization: Matplotlib, Seaborn, Plotly, Power BI / Tableau (optional)
- Web Interface: Flask / Django / Streamlit (for deployment)

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest of Data Mining and Machine Learning.

- Data Quality & Missing Values: Incomplete records may skew results → Use imputation or discard incomplete rows
- Imbalanced Datasets: Few failing students vs. many passing → Use SMOTE, class weights
- Overfitting : Complex models may memorize → Use cross-validation, regularization
- Privacy and Ethics : Sensitive student data → Anonymize records, comply with data protection laws
- Feature Selection: Irrelevant features reduce accuracy → Use correlation analysis or PCA
- Model Interpretability: Black-box models hard to explain → Use decision trees or SHAP for interpretability
- Deployment Issues: Model hosting and API integration → Use Flask/Streamlit and lightweight APIs

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Relevant Fields and Skills Development Through Project Execution

- Predictive analytics, supervised learning, image classification
- Performance and Latency– Ensuring high performance for global users.
- Cloud & Edge Computing – Scalable deployment of models and services
- Geospatial Analytics – Spatial analysis using satellite and GIS data
- Software Development – Full-stack implementation of intelligent applications
- Sustainable Computing – Technology for environment-friendly, efficient agriculture

MENTOR CONTACT INFORMATION

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Federated Graph Neural Networks for Privacy-Preserving Community Detection in Social Networks

Dr. A Karthik, Assistant Professor, Department of Information Technology– Faculty Mentor

GOALS

To design a novel framework that integrates Federated Learning (FL) with Graph Neural Networks (GNNs) to enable privacy-preserving community detection in social networks. This framework aims to ensure that user data remains decentralized across client devices while collaboratively training a powerful graph-based model. A key objective is to protect the privacy of individual users by incorporating secure aggregation and differential privacy techniques, thereby preventing the exposure of sensitive graph structure and node attributes during the training process.

Another major goal is to accurately identify communities across distributed graph data, even when the social graph is fragmented across multiple clients. The proposed model must demonstrate high clustering performance and predictive accuracy, while minimizing degradation due to privacy constraints. Additionally, the research seeks to evaluate the effectiveness of the proposed FedGNN framework on real-world benchmark datasets such as Cora and Pubmed, measuring accuracy, normalized mutual information (NMI), privacy loss (ε), and communication overhead.

Furthermore, the study aims to reduce the computational and communication burden commonly associated with federated models, making the approach suitable for deployment on resource-constrained edge devices. Finally, the proposed framework is designed to be extensible and generalizable, allowing it to be applied beyond social networks to other domains such as fraud detection, personalized recommendations, and biomedical network analysis.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP)leverages advanced decentralized learning techniques and graph-based neural architectures to ensure privacy-preserving analytics on social network data.

- **Federated Learning Frameworks** – FL enables collaborative model training without sharing raw data, using frameworks like TensorFlow Federated, PySyft, and Flower for secure aggregation and model orchestration.
- **Graph Neural Networks (GNNs)** – Models such as GCN, GraphSAGE, and GAT are used to extract topological and feature-based information from local social graphs for accurate community detection.
- **Secure Aggregation Protocols –** Homomorphic encryption and cryptographic methods are employed to ensure that local model updates remain private during federated averaging.
- **Differential Privacy (DP)** – Controlled noise is added to gradients or weights using ε-DP to ensure that individual user contributions cannot be inferred.
- **Community Detection Algorithms** – Clustering techniques like k-means, modularity-based methods, and label propagation are applied to the GNN embeddings to detect communities.
- **Edge Computing Infrastructure** – Decentralized devices such as mobile phones or IoT-enabled systems participate in training, reducing server dependency and enhancing scalability.
- **Graph Data Libraries** – Tools like PyTorch Geometric, DGL (Deep Graph Library), and NetworkX are used for building and simulating the graph learning pipeline.
- **Benchmark Datasets** – Social network datasets such as Cora, Citeseer, and Pubmed are used to evaluate model accuracy, privacy, and scalability under federated settings.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team addresses several key design and technical challenges that arise in deploying privacy-preserving, graph-based machine learning systems for social networks using decentralized data. The following issues are central to the study:

- Ensuring privacy-preserving training without compromising model accuracy through differential privacy and secure aggregation.
- Accessing and simulating decentralized social graph data that is non-IID, sparse, and locally fragmented across devices.
- Designing scalable federated GNN architectures that can handle dynamic client participation and graph topology changes.
- Addressing communication overhead and latency issues inherent in federated learning systems, especially in edge computing environments.
- Mitigating adversarial threats such as poisoning and inference attacks on model updates in a federated setup.
- Generalizing community detection models across heterogeneous social networks with diverse graph structures and user behaviors.
- Creating interpretable and explainable graph models to ensure transparency in social behavior analysis.
- Defining robust evaluation metrics for privacy, community structure quality (e.g., modularity, NMI), and communication efficiency.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest:

- Privacy-Preserving Machine Learning – Developing models that ensure user data privacy through differential privacy, encryption, and federated learning.
- Graph-Based Social Network Analysis – Using GNNs for analyzing interactions, detecting communities, and understanding social dynamics.
- Edge AI & Federated Systems – Training intelligent models on distributed devices without requiring data centralization.
- Data Security & Ethics – Promoting fairness, accountability, and transparent decision-making in social data applications.
- Human-Centered AI – Building interpretable and inclusive systems that empower users and respect autonomy.
- Digital Inclusion – Extending intelligent services to underserved or privacy-sensitive communities through mobile and cloud deployment.
- Scalable AI Infrastructure – Leveraging cloud-edge hybrid environments to support federated training and deployment across networks.
- Computational Social Science – Enabling quantitative and structural analysis of social behavior at scale using AI.

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Scalable Data Mining for Big Data Analytics in Cloud Ecosystems

Ms. C S L Vijaya Durga, Assistant Professor, Information Technology – Faculty Mentor

GOALS

This research area focuses on mining valuable patterns, trends, and insights from extremely large and diverse datasets stored in distributed and cloud environments. With the explosion of data from IoT devices, social media, and enterprise applications, there is a pressing need for data mining algorithms that are scalable, fault-tolerant, and parallelizable. The objective is to enable organizations to perform efficient big data analytics that supports real-time decisions and long-term forecasting.

This aligns with digital transformation initiatives in domains like healthcare, transportation, and smart governance.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for Scalable Data Mining

- Foundations of data science techniques – Regression, Decision Trees, and Random Forests for
- irrigation and yield prediction
- Computer Vision Techniques – Image preprocessing and CNNs for crop disease classification
- Time Series Forecasting – ARIMA, Prophet, and LSTM models for weather and yield prediction
- Cloud Computing Platforms – AWS or Google Cloud for model deployment and storage scalability
- Data Visualization Tools – Tableau, Power BI, or Matplotlib for trend analysis and insights display
- GIS & Remote Sensing – Geospatial data processing for precision agriculture
- APIs and Web Frameworks – Flask/Django for deploying user-friendly dashboards and alerts

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Challenges and Design Considerations in Scalable Data Mining.

- Designing data mining algorithms that scale efficiently across distributed cloud environments using frameworks like Hadoop or Spark is essential to handle large volumes of data.
- Ensuring that computation occurs near data storage (data locality) minimizes latency and reduces costly data movement across cloud nodes or regions.
- Traditional mining algorithms must be restructured for cloud-native environments using parallel, distributed, or stream-processing paradigms (e.g., MapReduce, micro-batching).
- Cloud platforms offer dynamic scaling, but efficient job scheduling, load balancing, and resource utilization are necessary to avoid over-provisioning or bottlenecks.
- Mining sensitive data in the cloud introduces risks—techniques like encryption, differential privacy, and federated learning are needed for secure, privacy-aware analytics.
- Cloud-based mining systems must handle node failures gracefully using replication, checkpointing, and recovery strategies to ensure uninterrupted processing.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Relevant Fields and Skills Development Through Project Execution

- Scalable Pattern Recognition and Outlier Detection
- Real-Time Analytics for IoT and Industry 4.0
- Data Lake Mining and Metadata Management
- Cloud Cost-Aware Data Mining Algorithms
- Optimization of Resource Usage in Cloud Analytics Pipelines

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Privacy-preserving and Explainable Medical AI Systems using GAN/Diffusion-based Counterfactuals for Disease Classification, Diagnostic Insight Generation, and Data De-identification

Ms. B. Lakshmi Prasanna, Assistant Professor, Dept. of Information Technology– Faculty Mentor

GOALS

To develop an innovative, privacy preserving, and explainable medical AI system that seamlessly integrates Generative Adversarial Networks (GANs) and diffusion based counterfactual image generation techniques with state-of-the-art deep learning classifiers for precise disease detection, comprehensive diagnostic insight generation, and robust sensitive data de-identification. The project aims to address the growing demand for trustworthy and interpretable AI systems in the medical domain, ensuring that healthcare professionals can not only rely on the accuracy of predictions but also understand the underlying decision-making processes through clear, visual counterfactual explanations.

Students will gain in-depth, hands-on experience in diverse areas, including medical image acquisition and pre-processing, advanced deep learning architectures such as Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs), the design and implementation of powerful generative models (GANs and diffusion models), explainable AI (XAI) frameworks for transparency, and privacy-preserving analytics techniques. They will acquire expertise in tackling real world challenges such as data imbalance, overfitting, and model interpretability, which are critical in healthcare AI applications.

As part of this project, students will design and build a comprehensive AI pipeline that encompasses the complete workflow of medical image processing starting from data augmentation, normalization, and feature extraction to disease classification, counterfactual visualization, and interactive decision-support dashboards. These dashboards will highlight prediction confidence, feature importance, and anonymized image outputs, thereby creating a user-friendly interface for clinicians.

By combining interpretability, privacy preservation, and reliable diagnostic capabilities, this project fosters both advanced technical mastery and practical problem-solving skills, preparing students to contribute effectively to healthcare AI innovation. Furthermore, this initiative aligns with Good Health and Well-being by enhancing diagnostic systems for better patient outcomes, and Industry, Innovation, and Infrastructure by advancing the adoption of cutting-edge AI technologies in medical systems.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on Generative AI and Explainable Deep Learning for Privacy-Preserving Medical Diagnostics.

- **Generative Modeling with GANs and Diffusion** – For counterfactual image generation, synthetic data creation, and privacy-preserving de-identification of sensitive medical images.
- **Advanced Deep Learning Classifiers** – Utilizing CNNs, Vision Transformers (ViTs), and hybrid models for high-accuracy disease classification from medical images.
- **Explainable AI (XAI) Frameworks** – Implementing Grad-CAM, LIME, SHAP, and counterfactual visualizations to provide transparent and interpretable diagnostic insights.
- **Medical Image Processing** – Techniques like augmentation, normalization, denoising, and feature extraction to enhance image quality and model performance.
- **Transfer Learning and Pretrained Models** – Leveraging architectures such as ResNet, DenseNet, and Swin Transformers to achieve efficient training on limited medical datasets.
- **Interactive Visualization Dashboards** – Developing real-time dashboards using Plotly, Dash, or Streamlit to display predictions, feature importance, and anonymized outputs.
- **Cloud and Edge AI Platforms** – Using AWS, Google Cloud, or NVIDIA Jetson for scalable model deployment, real-time processing, and secure data management.

- **Experiment Tracking and Optimization** – Tools like TensorBoard and Weights & Biases (WandB) for hyperparameter tuning, performance monitoring, and model explainability.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: Challenges in Designing Privacy-Preserving and Explainable Medical AI Systems

- Acquiring high-quality, annotated medical imaging datasets (e.g., X-rays, MRI, dermoscopy) while addressing class imbalance and limited data availability.
- Ensuring stability in training GANs and diffusion models, avoiding issues like mode collapse, vanishing gradients, or poor image quality.
- Balancing model accuracy with explainability through XAI techniques (Grad-CAM, SHAP, LIME) without compromising diagnostic performance.
- Designing robust privacy-preserving pipelines for de-identifying patient data while retaining clinical diagnostic features.
- Managing high-dimensional medical image data and computational complexity of deep learning models (CNNs, ViTs).
- Implementing efficient hyperparameter tuning and regularization methods to prevent overfitting on small or imbalanced datasets.
- Building intuitive, interactive diagnostic dashboards that visualize predictions, counterfactual images, and feature importance for clinicians.
- Ensuring compliance with healthcare standards (HIPAA, GDPR) and secure handling of sensitive patient information.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: Generative AI, Explainable Deep Learning, and Privacy-Preserving Medical Imaging.

- **Deep Learning & Neural Networks** – CNNs, Vision Transformers (ViTs), hybrid models for medical image classification.
- **Generative AI & Diffusion Models** – Counterfactual image generation, synthetic medical data creation, privacy-preserving modeling.
- **Explainable AI (XAI)** – Grad-CAM, SHAP, LIME, and interpretable diagnostics for trust in AI decisions.
- **Medical Image Processing** – Augmentation, normalization, segmentation, and feature extraction techniques.
- **Privacy & Compliance** – De-identification of patient data, HIPAA/GDPR standards, and secure model deployment.
- **Data Engineering & Visualization** – Interactive diagnostic dashboards, confidence scoring, and counterfactual visualization.
- **Cloud & GPU Computing** – Model training and scalable deployment using AWS, Google Cloud, or NVIDIA Jetson.
- **Experimentation & Model Optimization** – Hyperparameter tuning, regularization, and performance tracking with TensorBoard/WandB.

MENTOR CONTACT INFORMATION

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Crime Pattern Analysis and Prediction

Dr.Basetty Mallikarjuna, Professor, Department of IT-Faculty Member

GOALS

The main aim of this project is to analyze and predict crime patterns using historical data, enabling law enforcement and public safety organizations to make data-driven decisions.

- Analyze historical crime data for trends, patterns, and hotspots.
- Predict the type, location, and time of likely future crimes.
- Support law enforcement resource allocation and strategic planning.
- Visualize crime data using interactive dashboards and maps.
- Reduce crime through preventive analytics.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for Data mining and Machine Learning.

- Classification (crime type prediction): Decision Trees, Random Forest, Naive Bayes, XGBoost
- Time Series Forecasting: ARIMA, Facebook Prophet, LSTM
- Clustering (hotspot detection): K-Means, DBSCAN
- Anomaly Detection: Isolation Forest, Autoencoders

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest of Data Mining and Machine Learning.

- Language: Python / R
- ML Libraries: scikit-learn, pandas, XGBoost, Keras, TensorFlow
- Mapping & Visualization: Folium, GeoPandas, Matplotlib, Seaborn, Plotly
- Web App (Optional): Streamlit / Flask / Django
- Data Source: CSV, SQL, or open data portals (Kaggle, government sites)

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Relevant Fields and Skills Development Through Project Execution

- Predictive analytics, supervised learning, image classification
- Performance and Latency– Ensuring high performance for global users.
- Cloud & Edge Computing – Scalable deployment of models and services
- Geospatial Analytics – Spatial analysis using satellite and GIS data
- Software Development – Full-stack implementation of intelligent applications
- Sustainable Computing – Technology for environment-friendly, efficient agriculture

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Multi-Modal Deep Reinforcement Learning for Real-Time Decision-Making in Autonomous Healthcare Robots

Dr. A Karthik, Assistant Professor, Department of Information Technology– Faculty Mentor

GOALS

To develop a real-time, intelligent decision-making system for autonomous healthcare robots using multi-modal deep reinforcement learning (DRL). The goal is to enable these robots to interpret diverse sensor inputs such as visual, auditory, and physiological data for safe and efficient navigation and patient interaction.

The research aims to design a DRL framework that can dynamically adapt to changing healthcare environments, handle uncertainty, and make context-aware decisions without human intervention. Furthermore, the study seeks to improve decision latency and model generalizability across healthcare settings while ensuring patient safety and ethical AI behavior.

The proposed system should also be scalable and compatible with edge AI hardware for in-hospital deployment.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on integrates cutting-edge reinforcement learning techniques with multi-modal data processing to enable autonomous behavior in healthcare robots. The core components include:

- **Deep Reinforcement Learning (DRL)** – Algorithms such as Proximal Policy Optimization (PPO), Soft Actor-Critic (SAC), or Deep Q-Networks (DQN) are used to enable adaptive, reward-driven decision-making.
- **Multi-Modal Data Processing** – Fusion of camera feeds, speech/audio inputs, biomedical signals (e.g., ECG, temperature) using attention-based and transformer models.
- **Sensor Integration** – Combining visual, LiDAR, tactile, and voice recognition sensors for comprehensive environment understanding.
- **Neural Architecture Design** – Use of CNNs for visual input, RNNs or transformers for temporal patterns, and fully connected layers for action-value prediction.
- **Simulation & Robotics Platforms** – Training and validation using simulators like Gazebo, Webots, or real-world deployment on TurtleBot, Pepper, or ROS-based platforms.
- **Edge AI Acceleration** – Deployment of lightweight models on edge devices (e.g., NVIDIA Jetson Nano/Xavier) for on-device decision-making.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team should be interested in from the following majors or areas of interest:

- Processing heterogeneous, high-dimensional multi-modal inputs in real-time.
- Ensuring robust DRL convergence in non-stationary, dynamic healthcare environments.
- Maintaining safety and reliability of robot actions during patient interaction.
- Reducing inference latency for real-time response in emergency scenarios.
- Designing fault-tolerant architectures that handle missing or corrupted sensor data.
- Incorporating ethical constraints and explainability into reinforcement learning models.
- Handling edge deployment constraints like power, memory, and connectivity.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team should be interested interdisciplinary research areas that combine AI, healthcare, and robotics:

- **Reinforcement Learning in Robotics** – Autonomous control through learning-based approaches.
- **Multi-Modal AI Systems** – Integration of visual, speech, and sensor data streams for enhanced context-awareness.
- **Healthcare Robotics** – Intelligent agents for patient care, monitoring, and support.
- **Human-Robot Interaction (HRI)** – Designing responsive and adaptive systems that safely engage with humans.
- **Edge Computing for Medical Devices** – On-device AI processing for minimal latency and offline operation.
- **Responsible AI in Medicine** – Ethical, interpretable, and bias-free learning models in patient-critical applications.
- **Ambient Assisted Living (AAL)** – Supporting elderly or disabled individuals through intelligent automation.

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High Impact Practices (HIPs) – Cornerstone Projects Information Packet: 2025-26

Privacy-Preserving Data Mining for Ethical AI Systems

Ms. C S L Vijaya Durga, Assistant Professor, Information Technology – Faculty Mentor

GOALS

This research focuses on developing secure and privacy-preserving data mining techniques that align with ethical AI principles. As AI systems increasingly rely on sensitive data from healthcare, finance, and smart cities, there is a critical need to design algorithms that protect user privacy while ensuring accurate insights. The objective is to create trustworthy AI systems through privacy-aware mining methods that comply with data protection laws (e.g., GDPR).

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for Privacy-Preserving Data Mining.

- **Privacy Techniques** – Differential Privacy, k-Anonymity, Homomorphic Encryption
- **Secure Federated Learning** – Training models on decentralized data sources without
- data transfer
- **Ethical AI Frameworks** – Auditing models for fairness, bias detection, and
- explainability
- **Cloud & Edge Platforms** – Using secure cloud/edge environments for deployment
- (AWS, GCP, Jetson Nano)
- **Data Governance Tools** – Access control, audit logs, and policy-based sharing
- **Secure APIs and Web Interfaces** – Django/Flask with user consent management features

DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Challenges and Design Considerations in Privacy-Preserving Data Mining.

- Integrating privacy-preserving mechanisms into distributed data mining without sacrificing performance
- Handling heterogeneity in data sources across clients in federated setups
- Balancing model utility with privacy guarantees (e.g., epsilon selection in differential privacy)
- Addressing security threats like model inversion and data leakage in AI pipelines
- Ensuring compliance with privacy laws and ethical standards across domains

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Relevant Fields and Skills Development Through Project Execution

- Ethical and Trustworthy AI
- Privacy-Preserving Machine Learning
- Secure Cloud & Edge Analytics
- Federated & Decentralized Data Mining
- Data Compliance and Governance Technologies

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AI-Powered IoT System for Predictive Crop Health Monitoring and Automated Sustainable Farming

Ms. B. Lakshmi Prasanna, Assistant Professor, Dept. of Information Technology– Faculty Mentor

GOALS

This project develops an AI-powered IoT ecosystem that predicts crop health and triggers automated interventions for sustainable farming. IoT sensors will monitor environmental factors such as leaf wetness, soil nutrients, and humidity, while drone or camera modules will capture real-time crop images.

A combination of LSTM-based time series forecasting and CNN-based image classification will predict disease risks and detect early crop stress, enabling automated irrigation or targeted pesticide spraying only where needed. This precision approach reduces chemical usage, protects farm workers' health, and promotes eco-friendly agriculture.

Students will learn IoT-cloud integration, predictive ML modeling, real-time alerting, and dashboard visualization. They will also design an educational module for farmers to promote lifelong learning (SDG 4) in smart agriculture practices and sustainable resource management.

This project directly supports well-being through healthy agriculture, training for farmers and innovative agricultural infrastructure.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on Predictive Analytics and IoT-Based Smart Farming Automation.

- **IoT Sensor Networks** – Environmental monitoring of soil, humidity, and crop health metrics.
- **Time-Series Forecasting** – LSTMs and ARIMA for predicting crop health trends and disease risks.
- **Image-Based Disease Detection** – CNNs for classifying early crop stress or infection.
- **Automated Actuation** – IoT-controlled irrigation and pesticide systems for precision interventions.
- **Data Fusion & Analytics** – Combining environmental and image data for robust predictions.
- **Real-Time Dashboards** – Visualization of health status, risk scores, and intervention logs.
- **Cloud & Edge Deployment** – AWS, GCP, and NVIDIA Jetson for scalable and efficient smart farming.
- **Privacy & Compliance** – Secure handling of sensor and farm data with analytics pipelines.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: Challenges in Developing AI-Powered IoT Solutions for Sustainable Farming.

- Collecting accurate, multi-source IoT data for predictive modeling.
- Managing noisy sensor streams and missing environmental readings.
- Designing real-time ML pipelines that balance accuracy and low-latency inference.
- Integrating predictive insights with automated actuation systems.
- Ensuring sustainability by minimizing water and pesticide usage.
- Developing farmer-friendly dashboards and alerting systems.
- Scaling solutions for multi-location, large-scale farming environments.
- Maintaining data privacy and compliance with agricultural IoT standards.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: IoT, AI, and Sustainable Agricultural Automation.

- **Machine Learning & Time-**Series Modeling – LSTMs, ARIMA, CNNs for predictive crop health.
- **IoT Networks & Edge AI –** Environmental sensing and smart farm automation.
- **Agricultural Analytics** – Crop stress detection, risk prediction, and automated interventions.
- **Cloud & Edge Deployment** – Scalable model deployment for real-time applications.
- **Sustainable Smart Farming** – Precision resource usage for eco-friendly agriculture.

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Smart Healthcare: Disease Prediction System

Dr.Basetty Mallikarjuna, Professor, Department of IT-Faculty Member

GOALS

The Smart Healthcare Disease Prediction System enhances preventive care and diagnostic support through machine learning. With well-curated datasets, appropriate algorithms, and a secure design, this system can significantly impact public health, especially in remote and underserved areas.

- Predict diseases like **diabetes, heart disease, liver disease**, etc.
- Assist doctors and patients in early diagnosis.
- Reduce diagnosis time and healthcare costs.
- Build a user-friendly interface for real-time health prediction.
- Provide **personalized suggestions** or alerts for high-risk individuals.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for Data mining and Machine Learning.

- Classification (disease prediction): Logistic Regression, Decision Trees, Random Forest, Naive Bayes, SVM, XGBoost
- Multiclass Classification: Softmax Regression, Ensemble Methods
- Deep Learning (optional): Neural Networks, CNNs (for image-based diagnosis), LSTM (for sequential data)

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest of Data Mining and Machine Learning.

- Language: Python / R
- Libraries: scikit-learn, pandas, XGBoost, TensorFlow/Keras, NLTK (for text)
- Data Storage: CSV, SQL, Firebase, MongoDB, AWS RDS
- Visualization: Matplotlib, Seaborn, Plotly, Streamlit Dashboard
- Web/Mobile UI: Streamlit / Flask / Django / Android + Firebase
- Deployment: Heroku / AWS / GCP / Azure
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MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Relevant Fields and Skills Development Through Project Execution

- Predictive analytics, supervised learning, image classification
- Performance and Latency– Ensuring high performance for global users.
- Cloud & Edge Computing – Scalable deployment of models and services
- Geospatial Analytics – Spatial analysis using satellite and GIS data
- Software Development – Full-stack implementation of intelligent applications
- Sustainable Computing – Technology for environment-friendly, efficient agriculture

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Self-Supervised Deep Learning for Anomaly Detection in Medical Imaging with Limited Labeled Data

Dr. A Karthik, Assistant Professor, Department of Information Technology– Faculty Mentor

GOALS

To develop a robust and data-efficient self-supervised deep learning framework capable of detecting anomalies in medical imaging modalities such as X-rays, MRIs, and CT scans. Given the scarcity of annotated medical datasets and the high cost of expert labeling, the proposed approach aims to leverage large volumes of unlabeled medical images to learn meaningful representations through self- supervised pretext tasks. These representations are then fine-tuned using a small amount of labeled data for downstream anomaly detection tasks.

A key objective is to improve detection performance in low-data regimes, making the system suitable for rare disease diagnosis and under-resourced healthcare environments. The model must effectively generalize to unseen data and exhibit strong performance in terms of sensitivity and specificity.

Additionally, the research seeks to incorporate explainability into the anomaly detection process using visualization tools like Grad-CAM, enabling clinicians to trust and interpret model decisions. Another goal is to ensure the model is adaptable across different imaging modalities and institutions by learning domain-invariant features.

Finally, the research aims to evaluate the proposed framework across diverse benchmark datasets and validate its efficiency, scalability, and clinical usefulness for practical deployment in real-world medical systems.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for unlabeled medical imaging data, which are later fine-tuned on a smaller, labeled subset for anomaly classification or segmentation.

- **Self-Supervised Learning (SSL):**
- Utilizes pretext tasks such as image inpainting, rotation prediction, jigsaw puzzles, and contrastive learning (e.g., SimCLR, MoCo, BYOL) to learn high-level visual representations without labels.

- **Deep Convolutional Neural Networks (CNNs):**
- Architectures like ResNet, DenseNet, or U-Net are employed for feature extraction, anomaly segmentation, and classification during fine-tuning.

- **Vision Transformers (ViTs):**
- Transformers adapted for vision tasks are also explored for learning spatial relationships in high-resolution medical images.

- **Transfer Learning & Fine-Tuning:**
- After self-supervised pretraining, the network is fine-tuned on a small labeled dataset for tasks such as tumor classification, lesion detection, or lung abnormality identification.

- **Data Augmentation Techniques:**
- Random cropping, flipping, noise injection, and affine transformations are applied to improve generalization and robustness of the SSL models.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest:

- Label Scarcity in Medical Datasets:Obtaining large-scale, high-quality annotated datasets is costly and time-consuming in the medical domain, especially for rare diseases and edge-case anomalies.
- Designing Effective Pretext Tasks:Selecting or designing pretext tasks that align well with downstream anomaly detection is a non- trivial challenge. Tasks must extract semantically meaningful features that generalize across patient cases and imaging modalities.
- Heterogeneity of Imaging Modalities:Medical images vary greatly in resolution, modality (CT, MRI, X-ray), and anatomical structure, making it difficult to design a universal representation learning strategy.
- Handling High-Dimensional, Noisy Data: Medical images often contain noise, artifacts, or irrelevant background features. The SSL framework must learn robust features that ignore such distortions while focusing on clinical relevance.
- Training Stability and Convergence in SSL:Self-supervised methods, particularly contrastive learning, require large batch sizes and careful hyperparameter tuning to converge effectively. This poses technical constraints during training.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest:

- Self-Supervised Learning (SSL): Leveraging pretext tasks and contrastive techniques to learn meaningful representations from unlabeled data, especially relevant in low-annotation environments like healthcare.
- Medical Image Analysis: Applying AI techniques to analyze and interpret diagnostic images, with applications in radiology, oncology, pathology, and cardiology.
- Deep Learning in Healthcare: Utilizing CNNs, Vision Transformers, and generative models to enable automated diagnosis, anomaly detection, and medical decision support.
- Anomaly Detection:Developing models capable of identifying rare or irregular patterns in complex datasets, crucial for early disease detection.

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Temporal and Sequential Pattern Mining for Smart Systems

Ms. C S L Vijaya Durga, Assistant Professor, Information Technology – Faculty Mentor

GOALS

To develop temporal and sequential pattern mining for smart systems explores the discovery of temporal and sequential patterns from time-stamped and ordered data, which is critical for building intelligent smart systems. From smart homes and smart cities to healthcare monitoring and predictive maintenance, identifying frequent event sequences and time-based behaviors helps improve decision-making, automation, and anomaly detection. The objective is to build models that capture trends and predict future occurrences in time-evolving systems.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on core methods and technologies for temporal and sequential pattern mining for smart systems.

- Sequential Pattern Mining Algorithms – GSP, PrefixSpan, SPADE for discovering
- frequent sequences
- Temporal Pattern Mining Techniques – T-Patterns, Time-Interval Mining, Episode
- Mining
- Time Series Data Processing – Using ARIMA, LSTM, and CNN-LSTM models for
- prediction
- Smart System Platforms – IoT integration with smart home/smart city datasets
- Real-Time Stream Processing – Apache Kafka, Spark Streaming for online pattern
- discovery
- Visualization Tools – Time-based dashboards using Plotly, Tableau, or D3.js

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Challenges and Design Considerations in temporal and sequential pattern mining for smart systems.

- Handling high-dimensional, noisy, and irregular time-stamped data
- Defining appropriate time windows and thresholds for meaningful pattern detection
- Managing scalability for mining large-scale temporal sequences from sensor or log data
- Integrating real-time data streams for dynamic pattern updating
- Designing interpretable models that explain the temporal dependencies clearly

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team interested in from the following majors or areas of interest: Relevant Fields and Skills Development Through Project Execution

- Smart Systems and IoT Analytics
- Sequential and Temporal Data Mining
- Predictive Maintenance and Behavior Modeling
- Real-Time Stream Mining
- Time Series Forecasting and Deep Learning

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IoT-Driven Leaf Disease Detection and Precision Pesticide Management using Machine Learning

Ms. B. Lakshmi Prasanna, Assistant Professor, Dept. of Information Technology– Faculty Mentor

GOALS

This project aims to develop a smart agriculture system that ensures healthy crop production and safe food supply by detecting leaf diseases early and recommending precision pesticide use. IoT-enabled cameras and environmental sensors will continuously monitor crops, collecting real-time images and data on temperature, humidity, and soil conditions.

Using Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs), the system will classify disease-affected leaves and predict the severity and spread of infections. Machine learning models like Random Forest and Gradient Boosting will recommend minimum effective pesticide dosage, reducing excessive chemical use and supporting sustainable agriculture.

Students will gain hands-on experience in IoT-based data acquisition, ML-driven image classification, and smart agricultural decision systems. They will also design cloud dashboards that visualize disease hotspots, pesticide recommendations, and environmental insights, enabling farmers to improve crop yield, reduce costs, and promote food safety.

This project aligns healthier food production, enhancing farmer income, innovative smart farming, and sustainable resource use and Infrastructure by advancing the adoption of cutting-edge AI technologies in medical systems.

METHODS & TECHNOLOGIES

Cornerstone Project (CoP) team will focus on IoT-Enabled Computer Vision and ML for Smart Agriculture.

- **IoT Sensor Integration** – Real-time collection of environmental and crop data. **Deep Learning Classifiers** – CNNs and Vision Transformers for leaf disease detection.
- **Supervised ML Models** – Random Forest and Gradient Boosting for disease spread and pesticide recommendation.
- **Image Processing** – Augmentation, normalization, and feature extraction for accurate disease detection.
- **Cloud Dashboard** – Visualization of disease hotspots, predictions, and recommended interventions.
- **Data Analytics & Visualization** – Using Plotly, Dash, or Streamlit for farmer-friendly decision support.
- **Edge Computing** – Deploying models on NVIDIA Jetson or Raspberry Pi for on-field analysis.
- **Experiment Tracking** – TensorBoard and WandB for performance monitoring and optimization.

RESEARCH, DESIGN, & TECHNICAL ISSUES

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: Challenges in Building IoT-Enabled Precision Agriculture Systems.

- Collecting diverse and high-quality leaf image datasets from real farm conditions.
- Handling sensor noise, missing data, and environmental variability in crop fields.
- Designing accurate ML models while preventing overfitting in small or imbalanced datasets.

- Implementing sustainable pesticide recommendations to reduce chemical usage.
- Ensuring low-latency edge processing for real-time disease detection.
- Building interactive dashboards that present actionable insights to farmers.
- Integrating multi-source IoT data (image, weather, soil) for improved predictions.
- Addressing system scalability and cost-efficiency for deployment in large farms.

MAJORS & AREAS OF INTEREST

Cornerstone Project (CoP) team should be interested in the following majors or areas of interest: IoT, Machine Learning, and Sustainable Smart Agriculture.

- Machine Learning & Deep Learning – CNNs, ViTs, Random Forest, Gradient Boosting.
- IoT and Edge Computing – Real-time data collection and edge AI deployment.
- Agricultural Data Analytics – Disease prediction, pesticide optimization, and yield impact assessment.
- Cloud Computing & Visualization – Interactive dashboards for farmer decision support.
- Sustainable Agriculture & Automation – Precision pesticide use for eco-friendly farming.

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