**PROJECT: SmartCreditRx: AI-Powered Credit Risk Prediction**

**Background / Problem Statement**

* CitiMortgage was facing challenges in deploying and operationalizing Credit Risk Prediction ML models at scale for their Healthcare Provider Network segment.
* Data Scientists and Analysts were building models in silos without a production-ready MLOps framework, leading to:
  + Lack of version control for datasets and models
  + Delayed model deployment timelines
  + Inefficient retraining workflows
  + No real-time monitoring of model drift or performance
  + Without an end-to-end MLOps pipeline, the gap between model development and production severely impacted the business value of AI initiatives.

**UST Solution (Built Using AWS SageMaker MLOps AI Workbench)**

* UST implemented an end-to-end **AWS SageMaker MLOps Template-based Solution** for Credit Risk Prediction / Default Probability estimation, customized for both patients and internal employees.
* **Model Architecture:**
  + **Hybrid Ensemble:** XGBoost (for medium datasets), LightGBM (for larger volumes), and Logistic Regression (as a baseline).
* **MLOps Stack and Platform Components:**
  + **CI/CD and DataOps Driven Pipelines on AWS SageMaker**
    - **Data Ingestion & Versioning:** AWS Glue, S3, SageMaker Data Wrangler, and SageMaker Feature Store
    - **Training Pipeline:** SageMaker Pipelines + GitHub Actions + SageMaker Training Jobs
    - **Inference Pipeline:** CI/CD-based deployment with Load Balancer and SageMaker Endpoints
    - **Model Monitoring:** AWS SageMaker Model Monitor + Clarify (Bias & Drift Detection)
  + Integrated services: EventBridge, IAM, VPC, Ground Truth (for annotation), and SageMaker Clarify

**Business Impact**

* **Accelerated Model Lifecycle:** End-to-end automation reduced model development to deployment time by over 60%.
* **Improved Accuracy & Trust:** Hybrid models led to >15% better AUC and recall for credit default predictions.
* **Personalized Decisioning:** Enabled tailored credit scoring for patients and internal healthcare employees, increasing adoption of credit-linked services.
* **Model Governance & Explainability:** SageMaker Clarify ensured model fairness, bias detection, and regulatory compliance in model decisions.

**Cost Impact**

* **Reduced Manual Intervention:** CI/CD pipelines removed manual touchpoints, reducing operational overhead by 40%.
* **Efficient Resource Utilization:** Serverless data pipelines and elastic compute in SageMaker led to 30% lower compute costs compared to legacy EC2-based workflows.
* **Reusable MLOps Template:** The modular AWS SageMaker MLOps Template delivered by UST is reusable across multiple ML use cases, avoiding redundant effort and reducing total cost of ownership (TCO).

**AWS SageMaker MLOps Benefits**

* Standardized CI/CD templates ensured **repeatable and governed deployment**.
* Version-controlled data/model lineage helped with regulatory compliance (HIPAA).
* Event-driven retraining and pipeline orchestration led to **resilient production ML workflows**.

**Summary of AWS SageMaker MLOps Template-based Components Used**

* **Data Pipeline**: S3, Ground Truth, EventBridge, AWS Glue – *for DataOps, Governance, and Triggering Pipelines*
* **Training Pipeline (CI/CD)**: SageMaker Pipelines + GitHub + CodeBuild
* **Inference Pipeline (CI/CD)**: ECR-based container deployment to SageMaker Endpoints in private VPCs
* **Monitoring Pipeline (CI/CD)**: SageMaker Model Monitor + Clarify → metrics to CloudWatch + alerts via EventBridge

**AWS Tech Stack:**

* **Amazon S3** – Raw & processed data storage
* **AWS Glue** – ETL pipeline
* **Amazon SageMaker** – Model training, tuning, deployment
* **Amazon SageMaker Pipelines** – MLOps (CI/CD for ML)
* **Amazon RDS / Redshift** – Mortgage data warehouse
* **Amazon CloudWatch** – Monitoring model inference
* **Amazon Athena** – SQL-based querying of logs or processed data

**Implementation Steps:**

1. Store raw mortgage + credit bureau data in **S3**
2. Clean & join datasets with **AWS Glue**
3. Train model with **XGBoost** in **SageMaker**
4. Use **Hyperparameter Tuner** for optimization
5. Deploy endpoint using **SageMaker Hosting**
6. Monitor predictions (score drift) via **CloudWatch + SageMaker Model Monitor**