Understanding the AI Development Workflow

Part 1: Short Answer Questions (30 Points)

Step 1: Problem Definition (6 Points)

Hypothetical Al Problem:

Developing an AI model to predict the risk of patient readmission within 30 days after discharge.

Objectives:

- Prevent avoidable hospital readmissions to enhance patient outcomes.
- Improve efficiency in hospital resource allocation.
- Personalize post-discharge care plans based on readmission risk.

Stakeholders:

- Hospital clinicians, care coordinators, and administrators.
- Patients and their families.

Key Performance Indicator (KPI):

Reduction in 30-day hospital readmission rate over a given timeframe.

Step 2: Data Collection & Preprocessing (8 Points)

Data Sources:

- Electronic Health Records (EHRs): Clinical notes, lab results, diagnosis history, discharge summaries.
- Patient Demographics & Social Determinants: Age, gender, location, insurance type, socioeconomic status.

Potential Bias:

Underrepresentation of minority or underserved populations may result in unfair predictions. Historical disparities in healthcare access and treatment may embed systemic bias into the training data.

Preprocessing Steps:

- 1. Handling Missing Data: Impute missing values using statistical or model-based techniques.
- 2. Normalizing Numerical Features: Scale variables such as age, lab values, and hospital stay duration.
- 3. Encoding Categorical Variables: Use one-hot encoding for nominal features; apply label encoding or embeddings for ordinal data.

Step 3: Model Development (8 Points)

Model Choice:

Gradient Boosting Machine (e.g., XGBoost) - chosen for its performance on structured data, robustness to missing values, and interpretability via feature importance.

Data Splitting Strategy:

- 70% Training Set
- 15% Validation Set (for tuning hyperparameters such as learning rate and tree depth)
- 15% Test Set (for evaluating generalization)

Hyperparameters:

- Learning Rate
- Max Tree Depth

Step 4: Evaluation & Deployment (8 Points)

Evaluation Metrics:

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Precision =
$$80 / (80 + 15) = 0.842$$

Recall = $80 / (80 + 20) = 0.800$

Concept Drift:

Definition: A shift in the data distribution over time that reduces model accuracy.

Monitoring: Use tools like Alibi Detect or River for drift detection and retrain the model.

Scalability:

- Use Docker containers
- Host on AWS/GCP
- RESTful integration with hospital EHR systems

Part 2: Case Study Application (40 Points)

Problem Scope:

Build an Al solution to predict the likelihood of hospital readmission within 30 days of discharge.

Objectives:

- Decrease readmission rates by at least 15%.
- Enable more accurate, patient-specific discharge planning.
- Support efficient use of hospital resources.

Data Strategy:

Sources:

- EHRs, Demographics, Admission/Discharge Records

Ethical Concerns:

- 1. Patient Privacy (HIPAA)
- 2. Algorithmic Bias

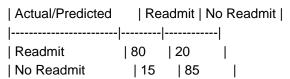
Preprocessing:

- Cleaning, Feature Engineering (comorbidities, readmissions), One-hot encoding & normalization

Model Development:

XGBoost selected for accuracy & interpretability.

Confusion Matrix:



Metrics:

- Precision = 0.842
- Recall = 0.800

Deployment:

- Docker, Flask/FastAPI, EHR Integration via REST API

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Compliance:

- Encryption, RBAC, HIPAA audits

Optimization:

- Cross-validation, L1/L2 Regularization, Early stopping

Part 3: Critical Thinking (20 Points)

Ethics & Bias:

Impact:

Bias in historical data may underpredict risks for minority groups, resulting in unfair treatment.

Strategies:

- Bias Audits
- Fairness-aware Algorithms
- Diverse Datasets
- Stakeholder Involvement

Trade-offs:

Interpretability vs. Accuracy:

- Simple models = transparency
- Complex models = accuracy + SHAP explanations

Resource Constraints:

- Model compression
- Lightweight models
- Edge deployment

Part 4: Reflection & Workflow Diagram (10 Points)

Reflection:

Most challenging part was preprocessing and bias mitigation.

Improvements would include better datasets, collaboration with clinicians, and access to compute resources.

Workflow:

Problem Definition -> Data Collection -> Preprocessing -> Model Development -> Evaluation -> Deployment -> Monitoring