Understanding the AI Development Workflow

Course: AI for Software Engineering
Duration: 7 days
Total Points: 100

Part 1: Short Answer Questions (30 points)

1. Problem Definition (6 points)

AI Problem: Predicting student dropout rates in universities

Objectives:

1. Identify students at risk of dropping out early.
2. Recommend interventions to improve retention.
3. Reduce overall dropout rate by targeted support.

Stakeholders:

- University administration
- Students

Key Performance Indicator (KPI):

- Accuracy of predicting at-risk students (% correctly identified)

2. Data Collection & Preprocessing (8 points)

Data Sources:

1. Student academic records (grades, attendance)
2. Student demographic surveys (age, financial background, engagement)

Potential Bias:

- Urban students may be overrepresented, biasing the model against rural students

Preprocessing Steps:

1. Handle missing data: Fill missing grades using median values
2. Normalize numeric features: Scale attendance percentages and grades
3. Encode categorical variables: Convert gender, course, and region into numerical codes

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3. Model Development (8 points)

Model Choice: Random Forest – robust to overfitting, interpretable via feature importance

Data Split:

- 70% training, 15% validation, 15% test

Hyperparameters to Tune:

1. `n_estimators`: Number of trees, impacts accuracy and speed
2. `max_depth`: Prevents overfitting

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4. Evaluation & Deployment (8 points)

Evaluation Metrics:

- Accuracy: Overall correctness
- F1-score: Balances precision and recall for imbalanced data

Concept Drift:

- When data distribution changes over time (e.g., new curriculum)
- Monitor by retraining periodically

Technical Challenge:

- Scalability: Ensuring real-time predictions for thousands of students

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Part 2: Case Study – Hospital Readmission Risk (40 points)

Problem Scope (5 points)

Problem: Predict patients at risk of readmission within 30 days post-discharge

Objectives:

1. Reduce unnecessary readmissions
2. Improve patient care
3. Optimize hospital resources

Stakeholders:

- Hospital administrators
- Doctors and nurses
- Patients

Data Strategy (10 points)

Data Sources:

1. Electronic Health Records (EHRs)
2. Patient demographics

Ethical Concerns:

- Patient privacy and HIPAA compliance
- Risk of biased predictions against some demographic groups

Preprocessing Pipeline:

1. Handle missing lab results with imputation
2. Encode categorical features (gender, disease type)
3. Feature engineering: Create "readmission risk score" from comorbidities and prior admissions

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Model Development (10 points)

Model Choice: Gradient Boosted Trees (XGBoost) – accurate, handles tabular data, interpretable via SHAP

Hypothetical Confusion Matrix:

	Predicted Readmit	**Predicted No Readmit**
Actual Readmit	80	20
Actual No Readmit	10	90

Calculations:

- **Precision:** 80 / (80 + 10) = 0.888
- **Recall:** 80 / (80 + 20) = 0.8

Deployment (10 points)

Integration Steps:

1. Convert model to API (Flask/FastAPI)
2. Integrate API with hospital EHR
3. Dashboard for doctors to view risk scores

Compliance:

- Encrypt patient data in transit and at rest
- Maintain access logs
- Follow HIPAA regulations

Optimization (5 points):

- Use cross-validation and regularization to reduce overfitting

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Part 3: Critical Thinking (20 points)

Ethics & Bias (10 points)

Impact: Biased data may misclassify high-risk patients, causing worse outcomes for underrepresented groups

Mitigation Strategy: Use re-sampling or weighting to balance training data across demographics

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Trade-offs (10 points)

Interpretability vs Accuracy: Complex models (XGBoost) are accurate but harder to interpret; simpler models are more understandable but less accurate

Computational Constraints: Limited resources may require simpler models (logistic regression, shallow trees)

Part 4: Reflection & Workflow Diagram (10 points)

Reflection (5 points)

- **Challenge:** Balancing accuracy, interpretability, and ethical considerations
- **Improvement:** More data and computational resources allow better tuning and fairness adjustments

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AI Development Workflow Diagram (5 points)

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Problem Definition
       ↓
Data Collection
       ↓
Data Preprocessing
       ↓
Feature Engineering
       ↓
Model Development
       ↓
Model Evaluation
       ↓
Deployment
       ↓
Monitoring & Maintenance
```