AI-Powered Polypharmacy Risk Predictor

Project proposal & Statement of Work

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Revision History Table		Template Date 6/15/2022
Version	Summary of Changes	Date
V5	*Added a "Ground Rules" section*	*3/14/25*
V6	*Added Sponsor and Advisor requirements*	*3/14/25*
V7	*Moved the sponsor, advisor, and team requirements to an Appendix section*	*3/20/25*
V8	*Updated the Top Level Block Diagram example*	*3/25/25*
0.1	*Section Owners assigned; draft Introduction added*	*3/25/25*
0.5	*Template info removed; first draft of all sections completed*	*4/3/25*
0.9	*All sections updated during team review*	*4/3/25*
1.0	*Version submitted for signatures*	*4/3/25*

Contents

1. Executive Summary

Written by Rishab khatokar and Navyasree Madhu

Our product, the *AI-Powered Polypharmacy Risk Predictor*, is a web-based decision-support tool designed to identify and predict potential adverse drug-drug interactions (DDIs) in polypharmacy scenarios. It integrates a machine learning model with an intuitive user interface to assist healthcare providers in evaluating patient medication regimens. Key features include real-time risk assessments, intelligent alerting of high-risk drug combinations, and a user-friendly design that promotes accessibility and ease of use. The platform leverages graph neural networks (GNNs) to enhance its predictive accuracy, providing clinicians with data-driven insights to improve prescribing decisions.

Polypharmacy—defined as the concurrent use of multiple medications—is a significant and growing concern, especially among elderly or chronically ill populations. According to the CDC, nearly 40% of adults aged 65 and older take five or more medications, heightening their vulnerability to harmful DDIs[1]. While some electronic medical record systems offer DDI alerts, our product surpasses these by employing AI-driven models trained on comprehensive datasets like DrugBank, RxNorm, SIDER, and Synthea. By incorporating knowledge graphs and machine learning, the system offers higher precision and reduces alert fatigue common in conventional tools. Ultimately, our solution contributes to safer prescribing practices and improved patient outcomes.

Development will be carried out by a multidisciplinary student team working throughout the semester. Tasks include data collection, preprocessing, knowledge graph construction, AI model training (using frameworks like TensorFlow or PyTorch), and front-end/backend development using React and Flask/Django. The system will be deployed via cost-effective cloud platforms such as Firebase or GitHub Pages. Table 1 shows the preliminary division of responsibilities among team members. Since the user interface and AI model development are both substantial efforts, we have distributed them among multiple developers for efficiency and balance.

Team Member	**Feature responsibility**
Rishab Khatokar, Navyasree Madhu	Data Collection & Preprocessing
Tushar Shrivastava, Shashank Satish Kohade, Harsh Wasnik	AI Model Development
Rishab Khatokar, Navyasree Madhu	Knowledge Graph Integration
Tushar Shrivastava, Shashank Satish Kohade, Harsh Wasnik	Deployment & Testing

Table 1 Preliminary Subsystem Responsibilities

2. User/Market research

Written by Tushar Shrivastava, Shashank Satish Kohade and Harsh Wasnik

The *AI-Powered Polypharmacy Risk Predictor* operates within the digital health and clinical decision support systems (CDSS) market—an industry projected to reach $3.6 billion globally by 2027, driven by the increasing complexity of patient care and the adoption of AI in healthcare decision-making[2]. Within this market, tools that address medication safety and polypharmacy are emerging as essential solutions, particularly as the aging population grows and chronic disease management becomes more prevalent. Our product addresses a critical need within this expanding domain by focusing specifically on drug-drug interaction (DDI) risk prediction in polypharmacy scenarios.

Several commercial tools currently offer DDI-checking capabilities, including Medscape's Drug Interaction Checker and IBM Watson's Micromedex platform. However, these systems often lack transparency regarding how interaction risks are calculated, rely on outdated or limited rule-based engines, and are frequently cost-prohibitive for smaller clinics or individual providers. In contrast, our product offers a unique value proposition by combining explainable AI models, real-world training data, and open-access architecture. We emphasize affordability by using free-tier cloud platforms and open datasets, making our tool highly accessible, particularly in resource-constrained environments.

To better understand our users, we conducted empathy interviews with healthcare professionals across outpatient clinics and hospital settings. Several recurring pain points emerged: existing DDI tools often produce overly generic alerts, leading to alert fatigue; critical interactions are occasionally missed; and current systems rarely consider patient-specific context. Our solution addresses these concerns by leveraging machine learning and knowledge graphs to provide personalized, context-aware interaction risk predictions. These insights directly informed our system design, ensuring it meets real-world needs and integrates seamlessly into clinical workflows.

3. Product Features

Written by Tushar Shrivastava, Shashank Satish Kohade and Harsh Wasnik

Product Features and Scope

The *AI-Powered Polypharmacy Risk Predictor* is designed to support clinicians in identifying high-risk medication combinations using AI. The features below define what the product will deliver by the end of the term. Each feature is tied to a specific need in the healthcare setting, ensuring that development efforts remain targeted and practical. Stretch features may be explored if time and resources permit.

Feature 1: Medication Entry Interface

Written by Harsh Wasnik

This feature allows users to enter medications via a clean, intuitive web form. It supports text input (common names) and standardized RxNorm codes for greater accuracy.

Parameter	Min	Max	Comments
Medications per session	2	20	Typical polypharmacy cases fall within this range
Input methods	1	2	Accepts text or RxNorm identifiers
Input processing time	n/a	5 sec	Autocomplete to aid rapid entry

Business Need Addressed: Clinicians need a quick and reliable way to enter patient prescriptions. This feature minimizes effort while maximizing accuracy.

Feature 2: AI-Based Drug Interaction Risk Prediction

Written by Tushar Shrivastava

This engine processes the medication list and uses machine learning models to predict the likelihood and severity of drug-drug interactions.

Parameter	Min	Max	Comments
Drugs supported	1,000	10,000	Based on training dataset size
Prediction response time	0.5 sec	2 sec	Optimized for near real-time feedback
Accuracy (target range)	85%	95%	Evaluated via test sets and cross-validation

Business Need Addressed: Reduces reliance on rule-based systems, enabling more accurate, context-aware DDI predictions that minimize alert fatigue.

Feature 3: Clinical Alert System with Explanations

Written by Shashank Satish Kohade

This system generates clear, tiered alerts with brief explanations of why a drug combination may be risky.

Parameter	Min	Max	Comments
Severity levels supported	3	5	e.g., Low, Moderate, Severe
Explanation length	30 words	150 words	Includes class interactions, mechanism, etc.
Alert delivery delay	0.5 sec	2 sec	Alert shown after prediction engine completes

Business Need Addressed: Helps providers understand the *why* behind alerts, supporting trust and better decision-making.

4. Project Timeline & Gannt Chart

Written by Navyasree Madhu and Rishab Khatokar

The Project Timeline provides a structured overview of key milestones, tasks, and expected completion dates, ensuring efficient project execution and clear tracking of progress.

Milestone	Date
Team Formation	03/14/2025
Define project scope & objectives	03/21/2025
Literature review & background research	03/21/2025
Data collection & preprocessing	03/28/2025
Signed Proposal	04/04/2025
Feature selection & engineering	04/04/2025
Model selection & development	04/09/2025
Initial model training & validation	04/14/2025
Model performance evaluation	04/16/2025
System integration & prototype development	04/21/2025
Full function testing complete	04/25/2025
Final model optimization & documentation	04/30/2025
Poster Demo	05/02/2025

iShowcase	05/07/2025
Final report submission	05/08/2025

Table 2: Milestone Schedule

This Gantt diagram outlines the project's timeline, detailing key phases from team formation to final report submission, task durations, dependencies, and milestones, ensuring effective progress tracking. It highlights critical stages such as data collection, model development, testing, and final documentation, facilitating structured project execution.

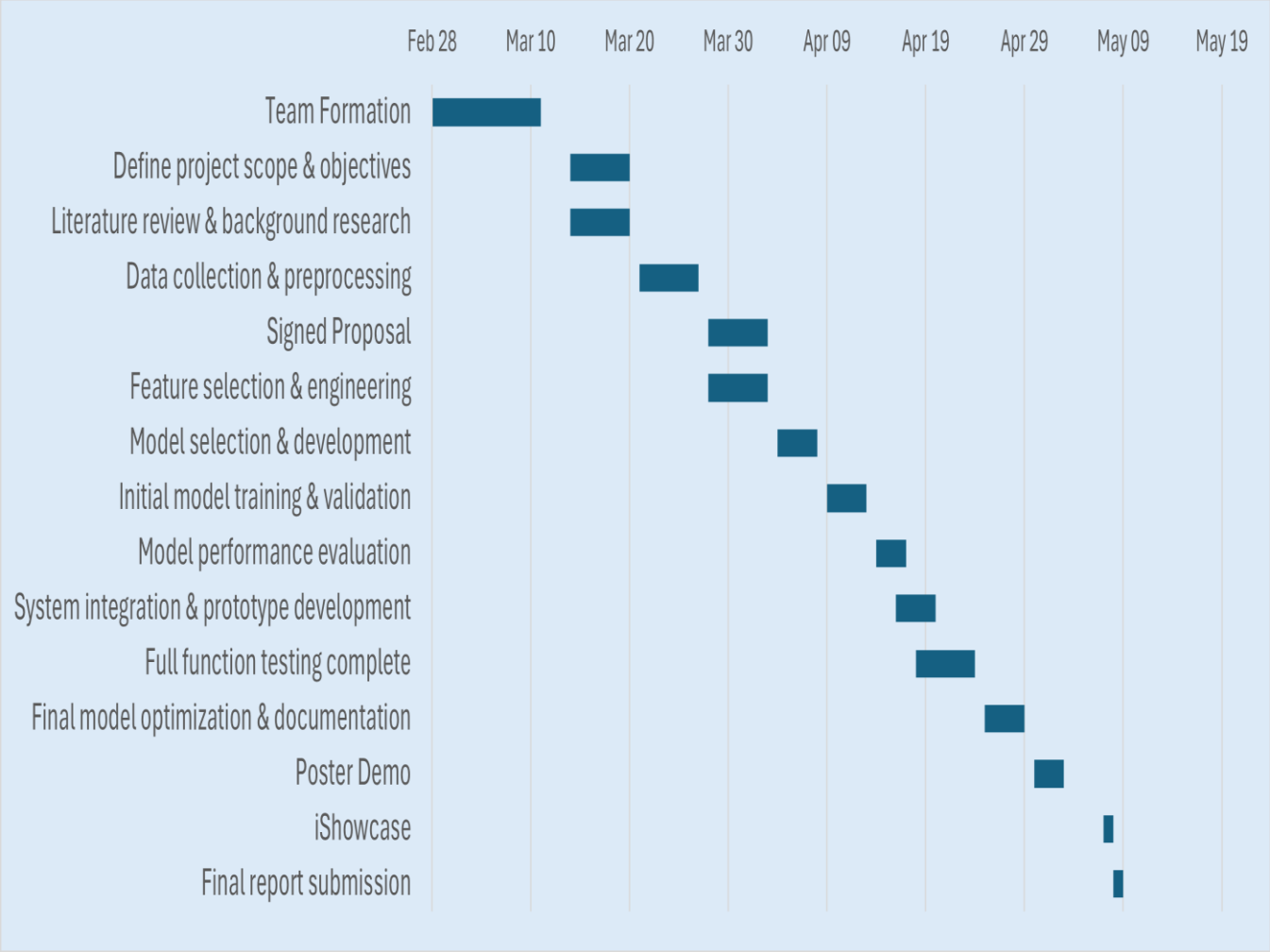

Figure: Gannt Diagram

5. Ethics

#	Question	Generally	Data Breach
1	Could a user sell drugs or other illegal items on your platform?	N	N
2	Could a user of your platform engage in sex trafficking?	N	N
3	Could a user sell class notes or cheat on their homework on your platform?	N	N
4	Could a stalker use your project to find someone?	N	N
5	Could your app be used to spy on or track individuals?	N	N
6	Could your app/software access the camera or microphone and record things without users being aware?	N	N
7	If someone uses your platform, could they be re-traumatized or have their mental health impacted in some way?	M	M
8	Could your algorithm promote material that would traumatize or upset individuals?	M	M
9	Would your users be upset if the data you collect was given to someone else?	Y	Y
10	Could a data leak potentially lead to identity theft?	M	M
11	If your site was hacked, would users of that product potentially lose their job, spouse, or family?	N	M
12	Should there be an age limitation on your product?	Y	Y
13	Could someone use your product to find, contact, and potentially commit elder abuse?	N	N
14	If the data on your platform was breached, could it be used to blackmail the users?	M	M

15	Does the existence of your project imply that a particular racial group, gender, religion or other protected category is inherently bad, gross, or unwanted?	N	N
16	Could your product be used to commit hate crimes against a specific group?	N	N
17	Does the primary content of your game or algorithm focus on something considered deeply unethical?	N	N
18	Does your game or software contain race, gender, or other stereotypes?	M	M
19	Could users of your app scam other individuals?	N	N
20	Is your particular algorithm biased towards predicting correctly only for one race, gender, or other group?	M	M
21	Are the users of your project, players of your game, or those being surveyed for your data aware of how their data will be used?	Y	Y
22	What are the possible misinterpretations of your results? For example - would a white supremacist or misogynist be stoked about your results if they misinterpreted it?	N	N
23	Does the use or purchase of your data potentially contribute to a dangerous group or regime?	N	N
24	Could your virtual reality environment cause injury to the user?	N	N
25	Are your study participants or game players aware that their data will be collected and used?	Y	Y
26	Does your game or app contain addictive design elements without benefit to the user?	N	N
27	Does your survey contain an aspect of compulsion or unusually large incentive, that would command users to take it even if it was to their detriment?	N	N
28	Could your research outcomes harm an individual or entity?	M	M

5.1 Ethical challenges

For YES (Y)

1) **Would your users be upset if the data you collect was given to someone else?**
   - Medical and prescription data is highly sensitive and protected under privacy regulations like HIPAA.
   - Users may not expect their prescription data to be shared, especially if it contains information on mental health or chronic illness.
   - Even anonymized data, if sold or leaked, could raise serious trust and ethical concerns.
2) **Should there be an age limitation on your product?**
   - The platform is designed for clinical professionals, not for use by minors or the general public.
   - Medical decision-support tools require a certain level of domain knowledge to interpret safely.
   - Uninformed use by underage individuals could lead to misuse or misinterpretation of serious clinical alerts.
3) **Are the users of your project aware of how their data will be used?**
   - Users must be explicitly informed of data usage to meet ethical and legal standards.
   - The application may log input medications or results to improve model performance; this must be disclosed.
   - Transparency builds user trust and avoids consent-related violations.
4) **Are your study participants or users aware that their data will be collected and used?**
   - If you're testing your app or collecting any user feedback, participants must be informed in advance.
   - Ethical practice requires clear consent procedures, especially in healthcare-related applications.

For Maybe(M)

1) **Could a user be re-traumatized or have their mental health impacted?**
   - An alert suggesting a patient's medication regimen is dangerous could induce anxiety or panic.
   - A user dealing with personal health conditions may find risk messages distressing.
   - Emotional impact depends on how warnings are phrased—clear, calm language and disclaimers are essential.
2) **Could your algorithm promote material that would traumatize or upset individuals?**
   - Severity levels (e.g., "Severe interaction") may sound alarming if not properly explained.
   - Risk of upsetting users increases if the app misclassifies benign combinations as harmful.
   - Visual indicators (like red alerts) can unintentionally escalate emotional reactions.
3) **Could a data leak potentially lead to identity theft?**
   - If patient data includes timestamps, age, gender, or medication list, it might be re-identifiable.
   - Even if not directly storing names, correlation with external data could allow re-identification.
   - Encrypted data storage and strict access controls are necessary safeguards.
4) **Could a data breach lead to blackmail?**
   - Medications for mental illness, HIV, or other stigmatized conditions could be exploited if leaked.
   - Users may fear personal or professional repercussions if sensitive drug info becomes public.
   - Blackmail risk increases with high-profile or vulnerable users (e.g., public figures, elderly).
5) **Does your app contain race, gender, or other stereotypes?**
   - Training datasets like SIDER or DrugBank may have embedded biases that affect predictions.
   - Disparities in prescription patterns by race/gender could lead to skewed risk estimates.
   - Requires model auditing and fairness testing to mitigate.
6) **Is the algorithm biased toward one group (race/gender)?**
   - Data sources may overrepresent some demographics while underrepresenting others.
   - Risk scores could perform less accurately for minority populations, leading to unequal treatment.
   - Ongoing validation is needed to identify and correct demographic imbalances.
7) **Could your research outcomes harm an individual or entity?**
   - Incorrect predictions might lead a clinician to modify or stop a critical medication.
   - If results are misinterpreted as a final diagnosis rather than decision support, it could harm patients.
   - Strong disclaimers and clinician-centered UX are necessary to mitigate misuse.

6. Approvals

The signatures of the people below indicate an understanding of the purpose and content of this document by those signing it. By signing this document, you indicate that you approve of the proposed project outlined in this Statement of Work, the division of work, the Ground Rules and that the next steps may be taken to create a Product Specification and proceed with the project.

This document is based upon and supersedes the *AI-Powered Polypharmacy Risk Predictor Version 1.0* Deviations, (versus clarifications), from the PDR have been clearly noted. For any requirements not listed in this SOW, the PRD requirements shall remain in effect.

Approver Name	Title	Signature	Date
Rishab Khatokar	Team Project Manager	Rishab Khatokar	04/03/2025
Shashank Satish Kohade	Team Member	Shashank Satish Kohade	04/03/2025
Navyasree Madhu	Team Member	Navyasree Madhu	04/03/2025
Tushar Shrivastava	Team Member	Tushar Shrivastava	04/03/2025
Harsh Wasnik	Team Member	Harsh Wasnik	04/03/2025
Dr. Greg Chism	Advisor	Greg Chism	2025 - Apr - 03
Dr. Greg Chism	Instructor	Greg Chism	2025 - Apr - 03

Author table

Section	Author	Word Count
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7. Appendix

A. Advisor Engagement

1) Project Team Responsibilities

- The Project Manager will set up and facilitate a weekly call/meeting with the Faculty Advisor. The Project Team will provide weekly status updates to the Faculty Advisor including upcoming deliverables, critical issues, and any adjustments to the Project Plan.
- Documents will be provided to the Faculty Advisor with adequate time for review and signature. The time necessary for review will be agreed with the Advisor. The minimum review time will be 3 days prior to the document due date.
- Design files will be provided to the Faculty Advisor as requested in a format agreed to with the Advisor.
- Support requirements will be clearly requested from the Faculty Advisor with the dates required and an adequate time for fulfilling the request.
- Modifications requests to the Project Plan by Faculty Advisor will be reviewed and agreed to within 1 week of the request.

2) Faculty Advisor Responsibilities

- The Faculty Advisor will provide knowledge and expertise to help the group stretch their skills.
- The Faculty Advisor will participate in a weekly or bi-weekly call/meeting with the Project Team to review the project status, upcoming deliverables, priorities, issues, and progress to the agreed Project Plan.
- The Faculty Advisor will provide document review, feedback and approval, rejection, approval with contingencies with adequate time for the Project Team to meet the course due dates.
- The Faculty Advisor will provide feedback to requested support requirements from the Project Team. This includes feedback and guidance on design implementations decisions, design files, test plans, test procedures and test results.
- The Faculty Advisor shall provide technical advice and guidance to the Project Team answering inquiries approximately 1 hour per week.
- Modifications to the Project Plan by the Project Team will be resolved and documented within 1 week of the request.
- Grade the finalized project using a skill-based rubric
- Attend iShowcase in May.

B. Ground Rules

As a team and as individual team members, we agree to:

1. **Stay focused on our objectives and goals.**
   Each time the team meets, we will clearly define our objectives and desired outcomes at the beginning of the meeting. We will politely remind team members if we are getting off track.
2. **"Sidebar" any issues that are relevant but not consistent with the immediate objectives.**
   Occasionally, important matters are raised that are not relevant to the immediate goals of the meeting. To keep the group on track, but avoid losing the issue, create a "sidebar" where these topics can be listed and discussed later.
3. **Listen when others are speaking.**
   We will listen and consider others' input before adding our own comments.
4. **All viewpoints will have an opportunity to be heard.**
   We understand that some team members may be quieter than others. We will make an effort to get each team member's viewpoint and that no one dominates the discussion.
5. **Differences of opinion will be discussed respectfully**
   We will identify areas of agreement before assessing areas of disagreement. We will encourage each other to look beyond our own point of view. We will discuss different ideas respectfully. As a team, we will weigh the merits of different opinions and agree on a process for choosing a direction. All team members will respect and follow the decision or direction.
6. **Look for the good points in new ideas.**
   We will endeavor to explore the value in each idea as we assess and select our path forward.
7. **Focus on the future, not the past.**
   We will use our past experience to inform our decisions, but focus the discussion on the future objectives. Blame for past performance is counterproductive, we will focus on finding solutions.
8. **Agree upon specific action items and next steps.**
   At the end of each meeting and discussion, we will summarize and agree on specific next steps, action items and assignments.
9. **Accountability**
   As team members, we will each be responsible for our individual assignments and contribution to achieving the team objectives and goals. We will honor our responsibilities and not let our team members down.