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Design Documentation
(Version 2.0)

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Design Documentation for Smart Class Planning Tool

This design documentation provides a comprehensive blueprint for implementing the Smart Class Planning Tool, a Python-based standalone GUI application for academic advising. It enables developers to code the software without referencing the original requirements. The design is guided by the 13 user stories (e.g., Plan Setup Wizard, Track Selection, Export to Excel), the architecture, the data flow diagram (processes P1-P10), the program structure diagram (hierarchical components), and the five UML diagrams (Use Case, Activity, Sequence, Class, and State) that model the tool's key components and behaviors.

Key design priorities include modularity, configurability, and extensibility. Inputs such as DegreeWorks PDFs, study plans, and program maps are separated from the core software and parsed into structured repositories, allowing future tracks or input formats to be supported without code rewrites. Parsers are directly connected to repositories, ensuring extracted data (courses, prerequisites, offerings, sequences) is centralized for use by planning and validation modules.

The design emphasizes user-guided workflows and data-driven planning, supporting both students and faculty. The application will reduce advising time, prevent prerequisite errors, and ensure students can graduate on schedule. The GUI will be implemented using Tkinter for its simplicity, portability, and alignment with the standalone requirement.

This version follows professor's feedback and provides **strong implementation-level clarity** by emphasizing *key components* instead of all five UML diagrams.
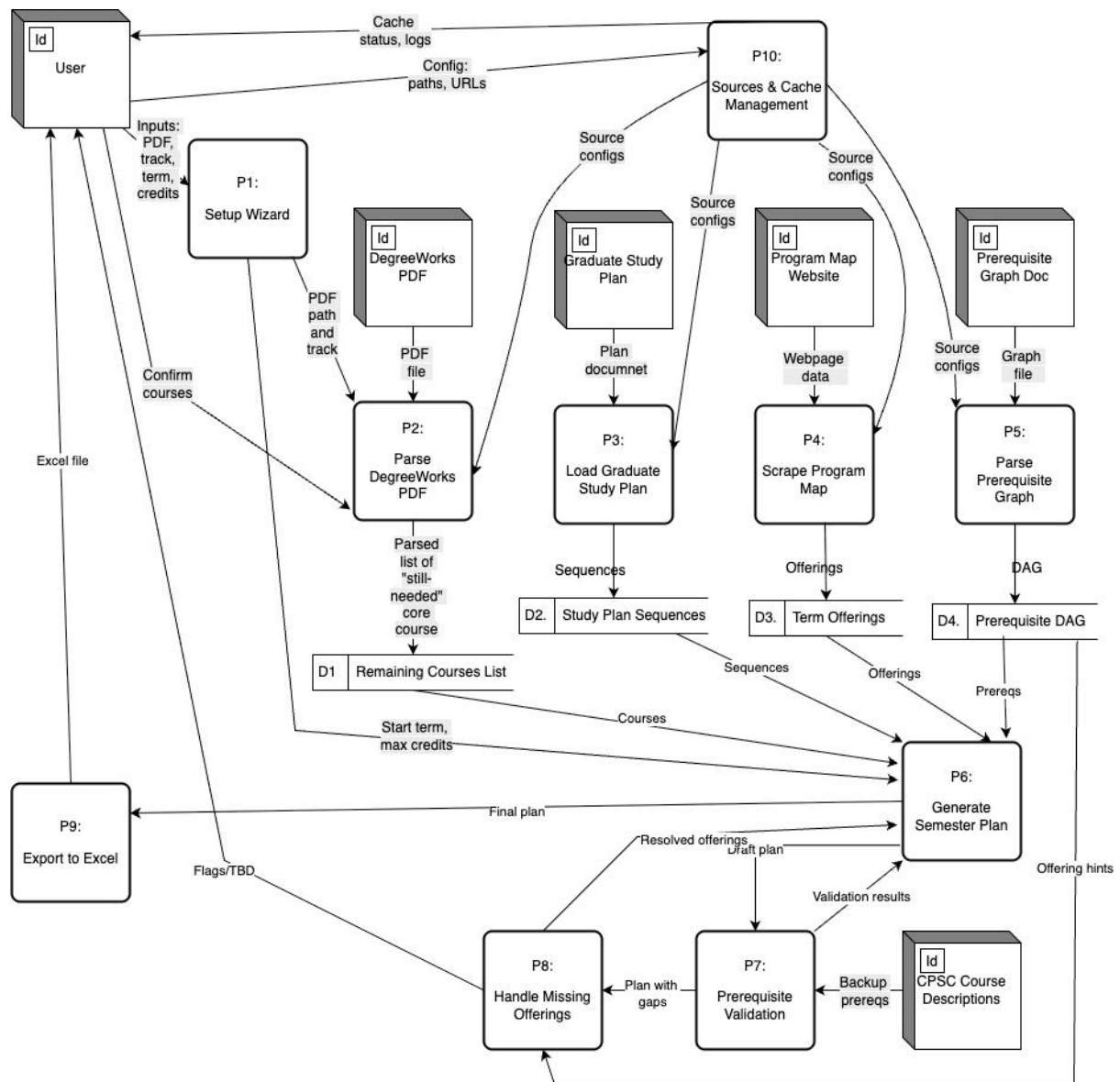
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1. User Stories

The design is driven by the following user stories, which define the functionality and user interactions for the Smart Class Planning Tool:

- **User Story 1: Plan Setup Wizard** - As a user, I want a wizard to input a DegreeWorks PDF, select a track, choose a start term, and set max credits, so I can initiate a personalized class plan.
- **User Story 2: Track Selection** - As a user, I want to select a track (e.g., Software Systems), so the tool limits planning to core courses for that track.
- **User Story 3: Student Info Form** - As a user, I want to enter my student ID and name, so the exported plan includes these details as labels.
- **User Story 4: DegreeWorks PDF Parser** - As a user, I want the tool to parse my DegreeWorks PDF, so it identifies courses still needed for graduation.
- **User Story 5: Graduate Study Plan Loader** - As a user, I want the tool to load a graduate study plan document, so it provides course sequencing guidance.
- **User Story 6: Program Map Scraper** - As a user, I want the tool to scrape a program map URL, so it retrieves term-specific course offerings.
- **User Story 7: Prerequisite Graph Parser** - As a user, I want the tool to parse a prerequisite graph file, so it builds a dependency structure for course planning.
- **User Story 8: Prerequisite Validator** - As a user, I want the tool to validate prerequisites, so it ensures the plan respects course dependencies with a backup web crawl if needed.
- **User Story 9: Semester Plan Generator** - As a user, I want the tool to generate a semester-by-semester plan, so I can see a complete schedule based on inputs.
- **User Story 10: Missing Offerings Handler** - As a user, I want the tool to handle missing offerings, so it flags or skips unavailable courses with hints from the graph.
- **User Story 11: Excel Exporter** - As a user, I want the tool to export the plan to an Excel file, so I can share or archive it with (Term, Courses, Credits, Total).
- **User Story 12: Sources & Cache Panel** - As a user, I want a panel to manage config files and cache, so I can set paths/URLs and view last fetch details.
- **User Story 13: Track Config** - As a user, I want the tool to support new tracks via configuration, so I can plan for different programs without code changes.

These stories guide the design's focus on interactive setup, data parsing, plan generation, and export functionality.

2. Data Flow Diagram

The Data Flow Diagram illustrates how data moves through the Smart Class Planning Tool and how the different modules interact with one another.

- **User Interaction (Id: User):**
  The system begins with the user providing necessary inputs, such as the DegreeWorks PDF, selected track, start term, and maximum credits. The user also confirms course selections and eventually receives the final Excel file output.

- **Setup Wizard (P1):**
  The wizard serves as the entry point for user inputs. It collects configuration

details (PDF path, track selection, term, credits) and passes them to the relevant parsers.

- **PDF and Plan Parsers (P2, P3, P4, P5):**
    - **P2: Parse DegreeWorks PDF** extracts the list of "still-needed" courses.
    - **P3: Load Graduate Study Plan** loads predefined sequences from the official graduate plan.
    - **P4: Scrape Program Map** gathers term offerings by crawling the CSU program map website.
    - **P5: Parse Prerequisite Graph** builds a Directed Acyclic Graph (DAG) of prerequisites.
- **Supporting Data Stores (D1–D4):**
    - D1: Remaining Courses List.
    - D2: Study Plan Sequences.
    - D3: Term Offerings.
    - D4: Prerequisite DAG.
- **Core Logic (P6: Generate Semester Plan):**
  This module merges all sources — remaining courses, study plan sequences, term offerings, and prerequisite DAG — to generate a semester-by-semester plan. It outputs a "draft plan," validates prerequisites, and adjusts as needed.
- **Validation and Exception Handling (P7, P8):**
    - **P7: Prerequisite Validation** ensures no course is scheduled before its prerequisites are completed, pulling backup data from course descriptions if needed.
    - **P8: Handle Missing Offerings** resolves scheduling gaps by marking TBD terms or suggesting alternatives.
- **Final Output (P9: Export to Excel):**
  Produces an Excel file with the recommended class plan by semester, including courses and credit totals.
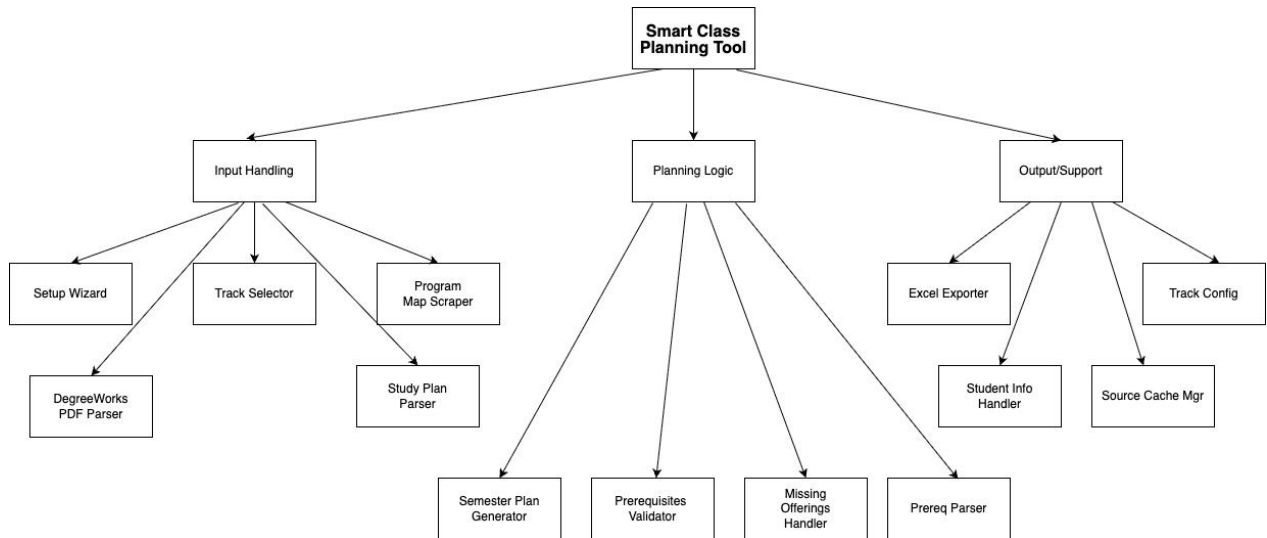- **Support Module (P10: Sources & Cache Management):**
  Maintains paths, configurations, URLs, logs, and caches for reusable inputs, ensuring extensibility and consistency across runs.

Although the DFD appears pipeline-like, this does not imply a pipe-and-filter architecture. Instead, these processes are implemented within a layered architecture:
- Parsers and scrapers (Infrastructure Layer).
- Data stores (Domain Layer).
- Planning and validation (Application Layer).
- Export and interaction (Presentation Layer).

Thus, the DFD provides a process view, while the layered architecture provides a structural view of the system.

3. Program Structure Diagram

The Program Structure Diagram depicts the logical grouping of system modules into three main categories: Input Handling, Planning Logic, and Output/Support.

- **Input Handling:**
  This group is responsible for ingesting and preparing all the raw input data.
    - **Setup Wizard**: Guides users to provide DegreeWorks PDF, track selection, start term, and credits.
    - **Track Selector**: Restricts scope to the appropriate degree track.
    - **DegreeWorks PDF Parser**: Extracts remaining required courses.
    - **Program Map Scraper**: Collects course offering details from the website.
    - **Study Plan Parser**: Loads sequencing guidance from the graduate study plan.

- **Planning Logic:**
  This group contains the core computational and validation modules.
    - **Semester Plan Generator**: Creates the term-by-term plan by merging prerequisites, offerings, and study plans.
    - **Prerequisites Validator**: Ensures that prerequisite constraints are respected.
    - **Missing Offerings Handler**: Flags or manages unavailable courses.
    - **Prereq Parser**: Translates prerequisite documents into a usable DAG format.

- **Output/Support:**
  This group ensures persistence, configurability, and presentation of results.
    - **Excel Exporter**: Produces the final recommended class plan in spreadsheet format.
    - **Student Info Handler**: Manages metadata such as student name/ID for labeling.

- o **Track Config**: Stores reusable configurations for tracks, enabling extensibility.
- o **Source Cache Manager**: Manages input sources, caches data, and provides logs for traceability.

This structure complements the layered architecture by showing how modules are grouped functionally. It ensures **modularity** and **clear responsibilities**.

4. Architecture

4.1 Overview

The system is structured using a **Layered Architecture with MVC principles**. This pattern was chosen because it ensures clear separation of concerns, enhances maintainability, and allows for future extensibility (e.g., new tracks or input formats).

- **Presentation Layer (View):** Provides user interaction via a Tkinter GUI (Setup Wizard, Track Selector, Student Info Form) and exports plans to Excel.

- **Application Layer (Controller):** Implements the core business logic, including the Semester Plan Generator, Prerequisite Validator, and Missing Offerings Handler.

- **Domain Layer (Model):** Maintains structured data models such as Course Repository, Study Plan Sequences, Term Offerings, and the Prerequisite DAG.

- **Infrastructure Layer:** Contains parsers and scrapers (DegreeWorks PDF Parser, Study Plan Parser, Program Map Scraper, Prerequisite Graph Parser) as well as cache management.

Decisions:
The layered design isolates GUI logic from data parsing and validation, making the system modular. Adding a new parser affects only the infrastructure layer, while adding a new track involves updating configuration in the domain layer.
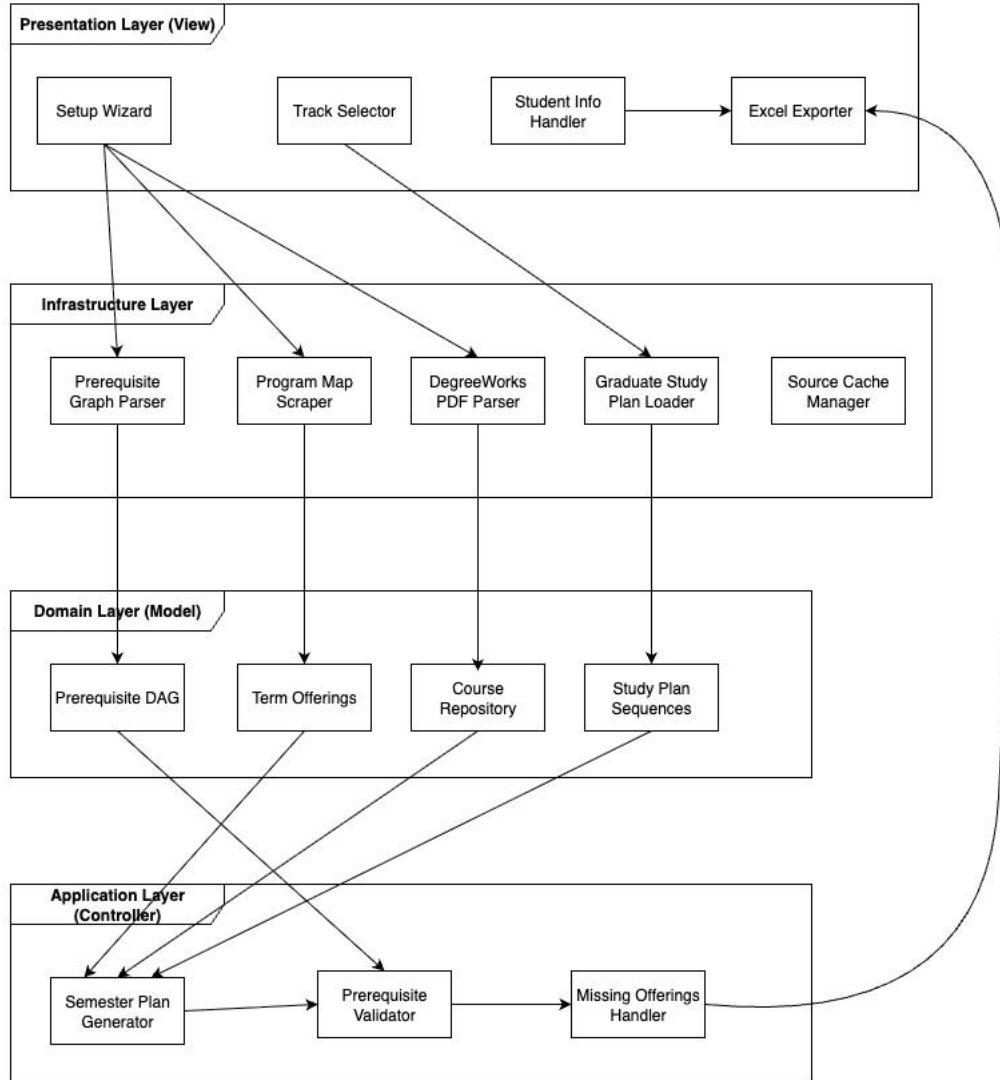
Trade-offs:
The separation of layers requires well-defined interfaces, which adds some upfront complexity. However, the long-term benefits in testability, extensibility, and maintainability outweigh the initial cost.

Alternatives Considered:

- **MVC:** Useful for GUI-heavy apps, but Tkinter's event model already blends view/controller behavior.
- **Pipe-and-Filter:** Matches the DFD's sequential data flow but does not reflect user interaction loops.
- **Repository & Client-Server:** Rejected because the tool processes diverse local files and runs as a standalone application.

4.2 Architecture Diagram

Smart Class Planning Tool- Layered Architecture (with MVC)

The Architecture Diagram highlights the four layers and their dependencies. The Presentation Layer interacts with the Infrastructure Layer for input parsing. Parsed data is stored in the Domain Layer, which the Application Layer consumes to generate validated plans. Finally, the Presentation Layer delivers the result to the user as an Excel file.

5. Design Diagrams

This section presents the design models that define the **structure**, **interaction**, and **key subsystems** of the Smart Class Planning Tool.
The diagrams and explanations provided here offer the level of detail required to guide actual implementation — including class relationships, component collaboration, and data management patterns.

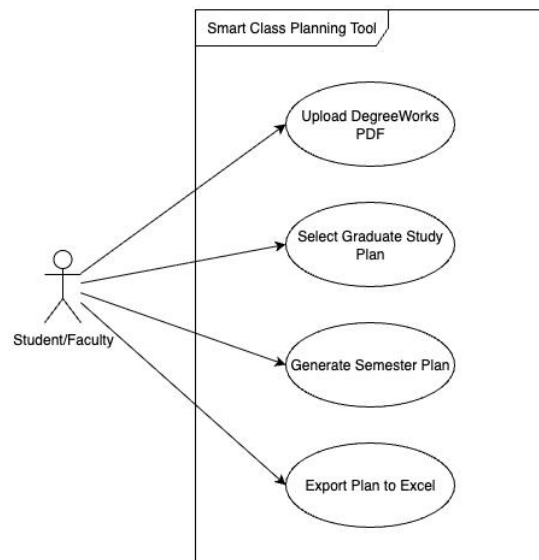## 5.1 System Interactions and Primary Use Cases

The Smart Class Planning Tool supports both **students and faculty**, who share identical access to the system's core capabilities.
The purpose of this diagram is to illustrate how external users interact with the system to complete course planning tasks.

Primary Use Cases:
- Upload DegreeWorks PDF
- Select Study Plan
- Generate Recommended Course Plan
- Validate Prerequisites
- Export the Final Plan to Excel

(Figure 5.1: UML Use Case Diagram for Core System Interactions)

When a user uploads input files, the system automatically extracts information, validates prerequisites, and generates a plan until graduation.
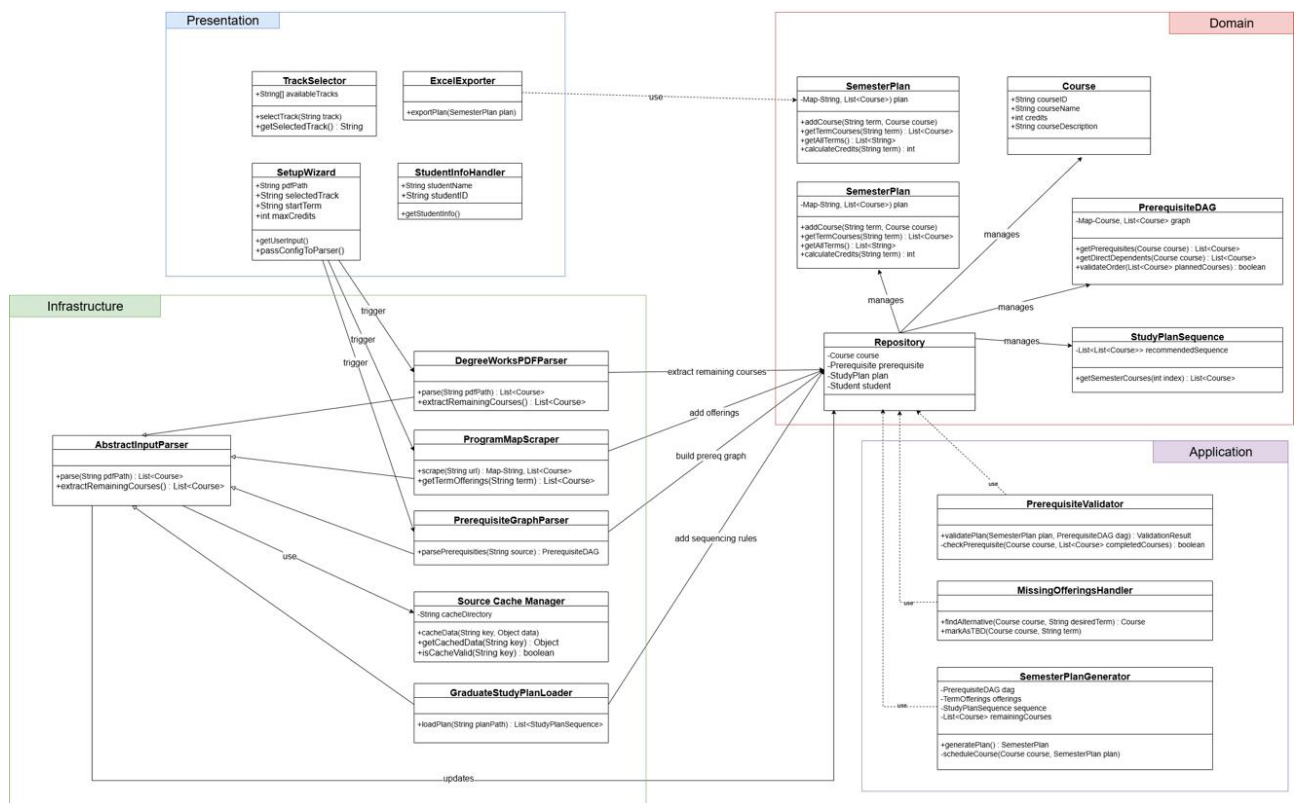The interface ensures that both students and faculty can access identical functionalities without requiring additional administrative steps.

5.2 System Structure and Class Relationships

This diagram describes the **object-oriented structure** of the system and how the major components relate across layers of the architecture.

Core Classes and Responsibilities:
- **SetupWizard / GUIController** – Collects inputs and triggers the workflow.
- **SemesterPlanGenerator** – Implements the logic to assemble multi-semester course plans.
- **PrerequisiteValidator** – Ensures each course in the plan satisfies dependency conditions.
- **Repository** – Central data source that manages all parsed and validated academic data.
- **ExcelExporter** – Produces the final output in Excel format.
- **Parsers (PDFParser, StudyPlanParser, ProgramMapScraper, PrereqGraphParser)** – Convert external inputs into structured data.

(Figure 5.2: UML Class Diagram of Core System Structure)

Design Insight:
- The **Repository** is the hub that connects all layers.
- **Parsers** isolate data extraction from business logic.
- The **Application Layer** consumes validated data from the Repository.
- **ExcelExporter** ensures consistent output formatting for the end user.
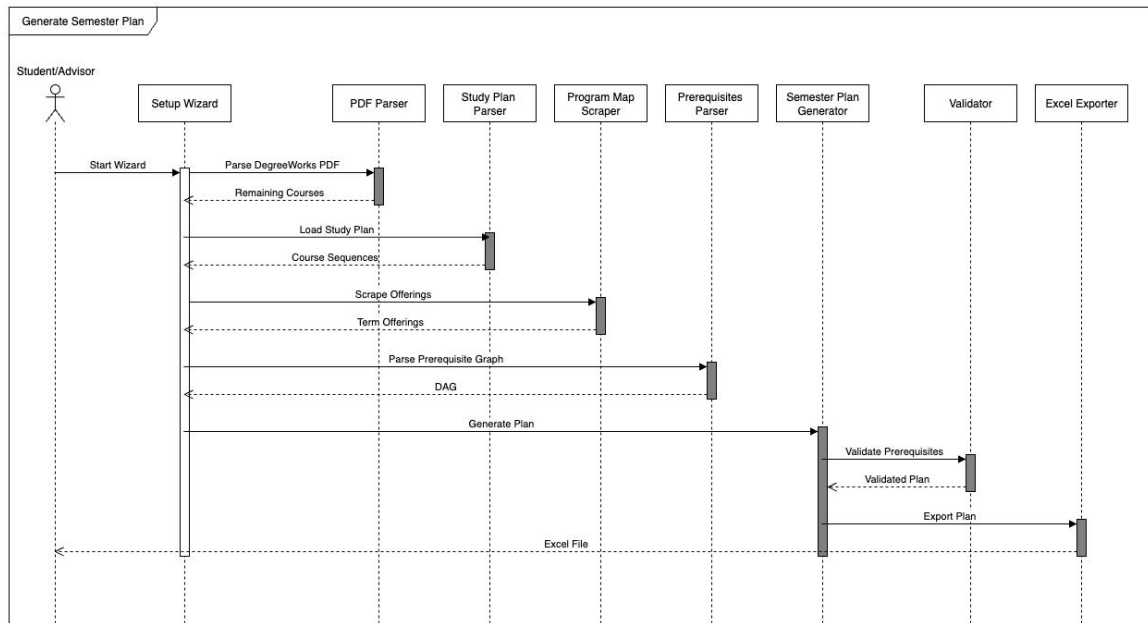
5.3 Runtime Flow for Plan Generation Process

This diagram shows how the system components interact dynamically when a user requests a class plan.

Execution Sequence:
1. The user initiates the process through the **SetupWizard** interface.
2. The wizard calls the **parsers** to extract information from the uploaded files.
3. The **Repository** stores and organizes this data.
4. The **SemesterPlanGenerator** requests course and prerequisite information.
5. The **PrerequisiteValidator** checks constraints and returns feedback.
6. The validated plan is exported using **ExcelExporter**.

This sequence clarifies how control and data flow through the system and specifies which classes exchange messages at runtime.

Sequence Diagram - Generate Semester Plan

(Figure 5.3: UML Sequence Diagram for Course Plan Generation)
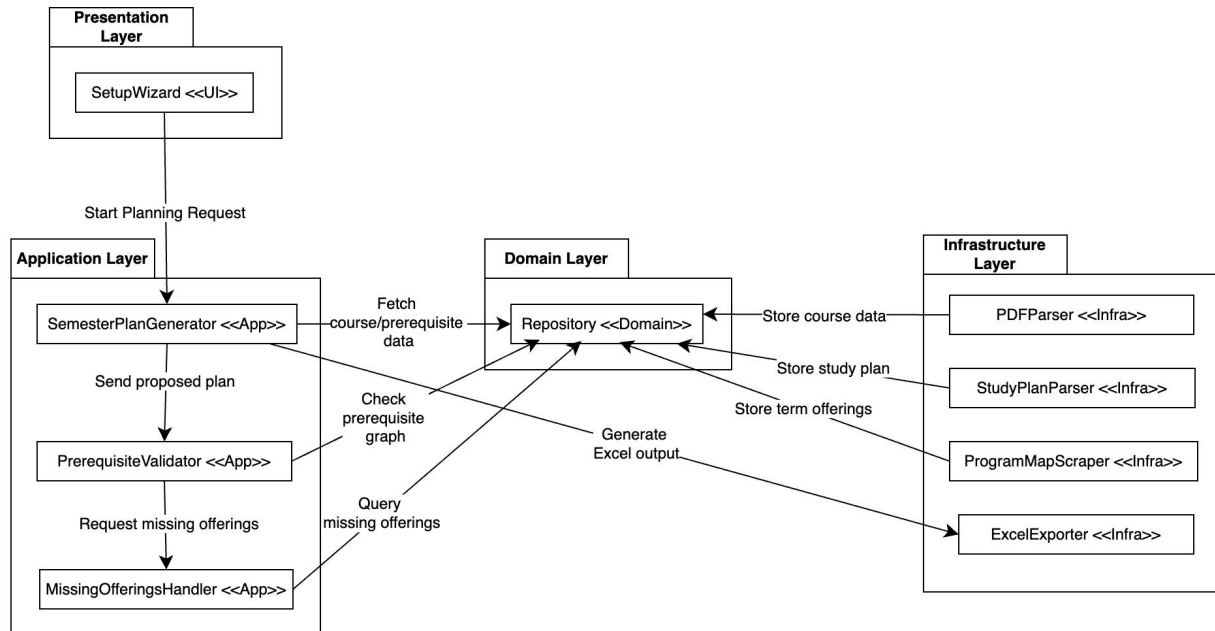
5.4 Overall Component Integration View

The Overall Component Integration View illustrates the end-to-end flow of control and data between the system's main components.

- The **Presentation Layer** (SetupWizard) initiates the process when the user uploads inputs and requests a plan.

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- The **Infrastructure Layer** components (PDFParser, StudyPlanParser, and ProgramMapScraper) extract course and schedule information, storing it in the **Repository**.

- The **Application Layer** modules—**SemesterPlanGenerator**, **PrerequisiteValidator**, and **MissingOfferingsHandler**—consume this data from the Repository to create a validated study plan.

- Once validated, the **ExcelExporter** produces the final output file for the user.

The layered interactions ensure that parsing, storage, logic, and presentation remain independent, promoting modularity, scalability, and maintainability.
This view complements the layered architecture diagram by illustrating how those layers collaborate during actual execution.

Overall Component Integration View - Smart Class Planning Tool

(Figure 5.4: Overall Component Integration View)

This high-level component diagram shows how major modules within the Smart Class Planning Tool collaborate across layers to process input data, generate validated study plans, and export the final result.
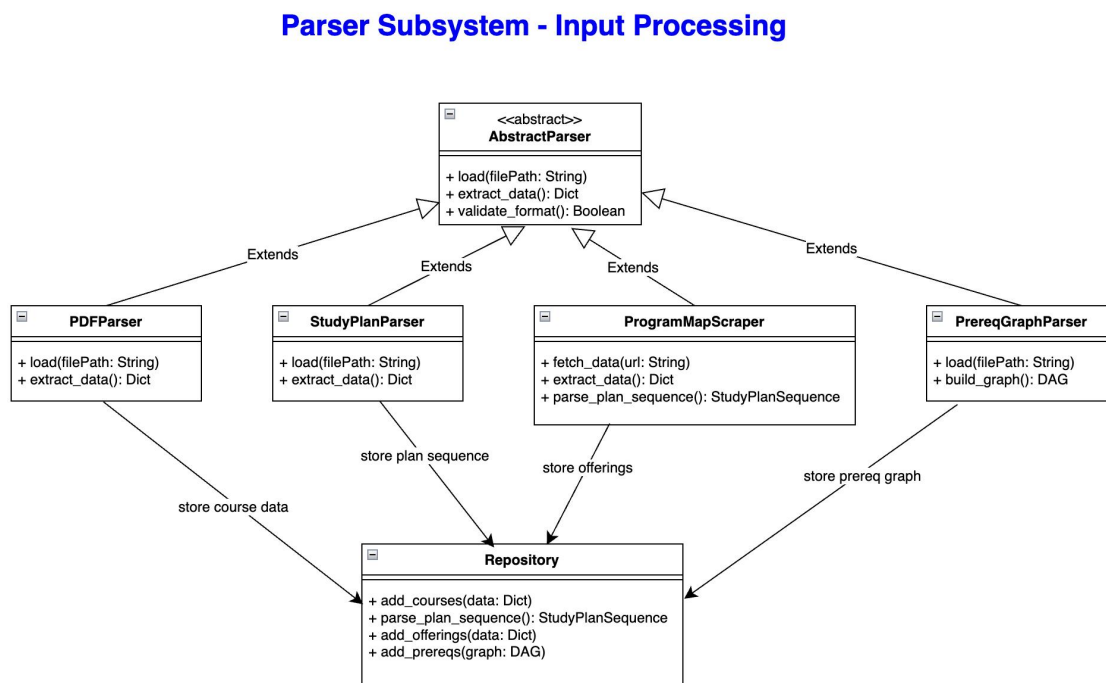
6. Component-Level Design

The following component-level diagrams present the **internal structure and logic** of the system's key subsystems.
Each diagram explains how its respective module supports the overall layered architecture, ensuring modularity and extendibility.

6.1 Design of Parser Subsystem for Input Processing

This subsystem processes all external inputs (DegreeWorks PDFs, study plans, course schedules, and prerequisite data).
Its design emphasizes modularity, inheritance, and direct integration with the Repository.

Parser Subsystem - Input Processing

(Figure 6.1: UML Diagram of Parser Component Structure)

This diagram shows how all parsers inherit from a unified AbstractParser interface, ensuring consistency in input handling.
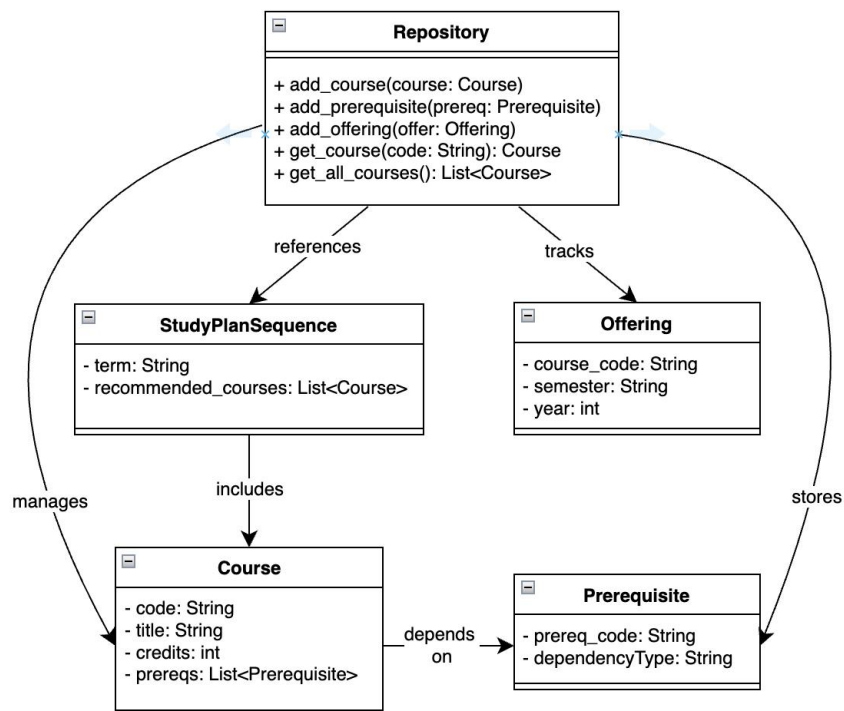Each specialized parser targets a specific data source and feeds structured data into the Repository, allowing new file types or sources to be integrated easily without code changes in higher layers.

6.2 Design of Repository and Domain Data Management Subsystem

This subsystem manages the internal data representation for courses, prerequisites, and academic plans.
It provides the foundation for all business logic modules.

Repository and Domain Model - Data Management Subsystem

(Figure 6.2: UML Diagram of Repository and Domain Model)

This diagram illustrates how the Repository organizes data within the Domain layer.
All entities (Course, Prerequisite, Offering, StudyPlanSequence) represent validated academic information.
The Repository ensures consistency and provides interfaces for data retrieval by the Generator and Validator components.

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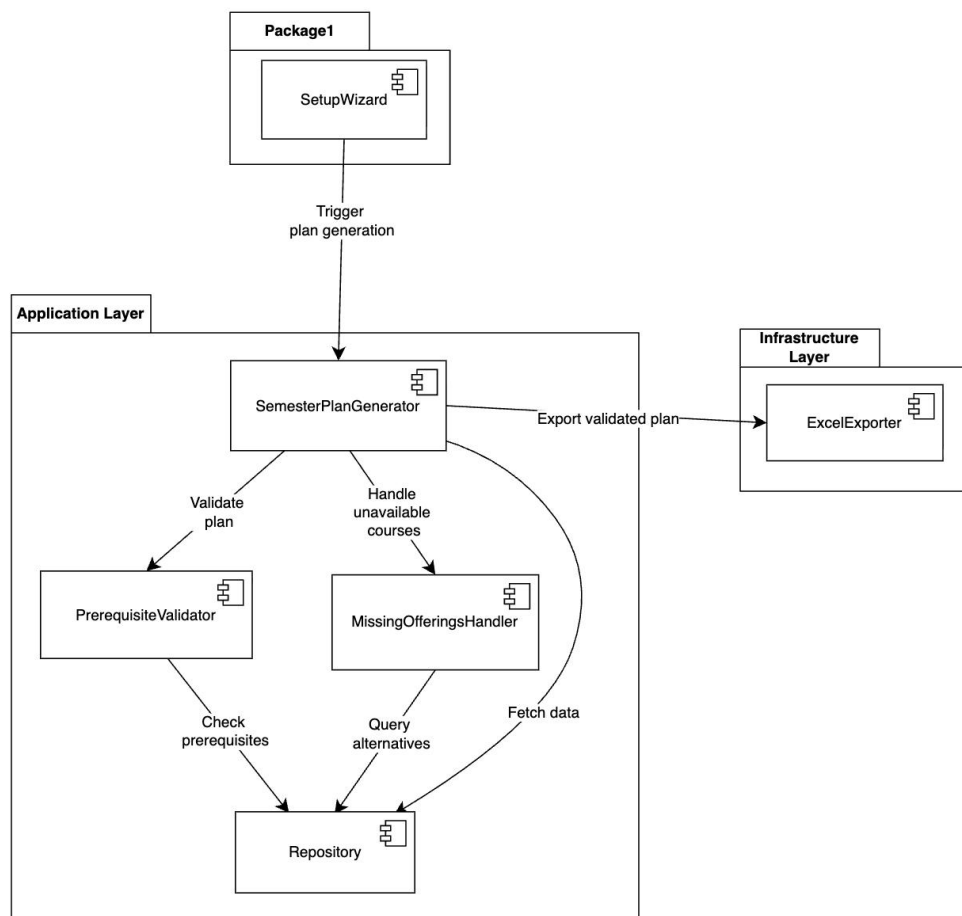# 6.3 Design of Application Logic Components

The application logic integrates the planning and validation features.
Each component performs a specific function and communicates through the
Repository interface.

Components:
- **SemesterPlanGenerator** – Generates semester-by-semester recommendations.
- **PrerequisiteValidator** – Checks course dependencies before scheduling.
- **MissingOfferingsHandler** – Suggests alternatives when required courses are not available.

Each component operates independently, promoting modular testing and future
scalability.

(Figure 6.3: Component Collaboration in Application Layer)

References

- Lecture resources
- Sommerville, I. (2016). *Software Engineering* (10th Ed.). Pearson.
- IBM. *Data Flow Diagram – Topic Guide*. https://www.ibm.com/think/topics/data-flow-diagram
- https://www.atlassian.com/work-management/knowledge-sharing/documentation/software-design-document
- https://creately.com/blog/software-teams/component-diagram-tutorial/

Acknowledgement of AI Assistance

This document was refined with the assistance of **ChatGPT**, an AI language model developed by OpenAI. The tool was used to improve grammar, clarity, and structure, and to provide suggestions for more professional phrasing where appropriate. All AI-generated content was carefully reviewed, edited, and adapted to ensure accuracy, originality, and alignment with the objectives of this work.