Mapped System Functionalities against knowledge, techniques and skills of modular courses: MR, RS, CGS

Decision automation	• **Rule-Based Pre-Filtering (Business Rules & Process):** The recommendation engine initially applies Hard Condition Filtering using defined business rules. It automatically excludes properties failing to meet the user's explicit constraints (e.g., budget, commute time, room type) specified via questionnaire or natural language, streamlining the initial selection. • **Conversion from Natural Language to Structured Constraints (Business Rules & Process):** The Cognition Layer employs LLM Tool Calling to process natural language input. Prompt Engineering defines rules that enable the LLM to convert ambiguous user descriptions (e.g., "near MRT") into precise, structured query constraints. • **Recommendation Rationale Generation (Knowledge-Based Reasoning):** Adopting a RAG-like approach, the system generates explanations by providing the LLM with retrieved context (user query features and property data). The LLM reasons over this information to produce personalized rationales justifying the recommendation based on the user's needs.
Business resource optimization	• **Multi-Objective Optimization (Evolutionary Computing):** The recommendation engine employs a Multi-Objective Optimization (MOO) model to balance conflicting user objectives (cost, commute, neighborhood score). Using NSGA-II inspired methods like non-dominated sorting and crowding distance, it identifies Pareto optimal properties. This offers users diverse recommendations representing optimal trade-offs, applying evolutionary computing to find best-matching properties.
Knowledge discovery & data mining techniques	• **Recommendation System Construction (Recommendation):** The project directly applies recommendation technology by building an intelligent system that generates a Top-K list of rental properties based on user preferences. • **Data Collection and Feature Extraction (Data Mining):** Integrating diverse data sources (property, geographic, POI, safety), the system cleans and processes raw data. Key features like commute time, safety scores, and facility convenience are extracted through feature engineering, forming the basis for scoring and recommendation models via data mining.

	• **Scoring Model (Data Mining):** Established through analysis of historical data and regional knowledge, the recommendation engine's scoring model quantitatively evaluates properties against user needs across dimensions like rent, commute, and neighborhood environment.

System designed with cognitive techniques or tools	• **Natural Language Interface:** Powered by an LLM, the system allows users to describe needs conversationally. The cognitive layer performs Semantic Analysis and User Intent Identification, converting unstructured input into structured data (slot filling) for the system.
	• **Knowledge Base Application:** While lacking an explicit knowledge graph, the system uses implicit knowledge components:
	  ◦ **Structured Mapping:** Predefined JSON mappings (school ID, district, etc.) serve as contextual knowledge, guiding the LLM in accurate entity linking during natural language understanding.
	  ◦ **RAG (Retrieval-Augmented Generation):** For explanation generation, retrieved user queries and property details augment the LLM's input context, enabling personalized, fact-based rationales, reflecting the core RAG concept.
	• **Explanation Generation:** The system provides natural language explanations for recommendations, illustrating the reasoning. This cognitive system feature aims to enhance transparency and user trust.