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REPORT-TASK 1("The CampusPulse Initiative")

Level 1: Variable Identification Protocol

- Used summary statistics, histograms, and correlation heatmaps to analysed anonymized features.
- Feature_1: First observed the overall data and observed that it is having median value of 17, plotted the distribution using box plot and histogram got that data lies in range of 15 to 22, related it with Dalc got increasing trend hence thought of it as AGE OF STUDENT.
- Feature_2: Analysed it first by Pie chart then related with health and other features and got to know it is not related to health etc, so related it with academic performance that is G3 and also related with failures so finally relating Feature_2 as Q rating or Overall academic performance or Study hours devoted by student.
- Feature_3: First tried to analyse with academic parameters then after not finding much relation plotted with parameters like go out Ratings, freetime and others and got it as – quality of relationship or ability to make friend or Extrovert rating of person or ability to socialise of the person.

Level 2: Data Integrity Audit

- Identified missing values using .is null () summaries.
- We So we get that the missing columns are -famsize, fedu, traveltime,higher,freetime,absences feature 1, feature 2, feature 3 for the given data frame during the level 1 and already provided the explanation for them.
- For each Numeric feature filled appropriately with proper logic by analysing the data like sometimes mode/median/mean and etc value.
- In categorial data type filled with appropriate value like mode in case of higher as yes frequency is more than 70 for higher column.
- Justified each imputation based on feature type and distribution.

Level 3: Exploratory Insight Report

- Formulated at 7 investigative questions about student life (e.g., relationship between screen time and relationship status, stress vs. extracurriculars).
- 1st question-Effect of internet access (basically the internet column of csv) on the academic perfomance of a high schooler and the romantic relationship

- 2nd point-investigating the final result G3 with sex and the type of school attended (GP OR MS)
- 3rd point- ANALYSING TRAVELTIME WITH ADDRESS (U OR R) AND ALSO ANALYSING THE EFFECT OF TRAVELTIME WITH GRADES
- 4th point-seeing the effect of romantic relationship of student with go out and freetime factor in the csv
- 5th-Relating Dalc with failures, health using heatmap and also observing effect of alcohol consumption with fam relationship
- 6th-relating parental status with absences from school
- 7th-Relating failures and absences from school.
- Created violin plots, bar charts, and scatterplots for each question.
- Provided clear, concise interpretations for each visualization.

Level 4: Relationship Prediction Model

- Plotted the correlation matrix and shown that on what features the involved in Romantic relationship column is dependent.
- Now experimented what model is best and what to select among the random forest and the logistic regression model
- Split the training set with test size of 0.2, scalded the data and applied both logistic regression and the random forest model
- For my data frame using logistic regression was getting the better accuracy value of 0.6384 as compared to the Random Forest with accuracy of 0.584 so I used the logistic regression model to implement the further Model.
- Then I plotted the top 10 features influencing the Model also told what the model is revealing and what not is revealed by the Model.

Level 5: Model Reasoning & Interpretation

- Visualized decision boundaries for meaningful feature pairs. Plotted decision boundary for both random forest and logistic regression.
- Used SHAP for global feature importance (social activity, club participation most influential).
- Generated local SHAP explanations for two students—one predicted "Yes," one "No"—and explained the key drivers in plain language.
- Emphasized that SHAP explains model logic.

Bonus Level: The Mystery Boundary Match

- Examined five unlabelled decision boundary plots.

- Matched each to likely model (e.g., linear for Logistic Regression, axis-aligned for Random Forest, elliptical and smooth to naïve bayes etc) and justified reasoning based on boundary shape and complexity.

Reflections and experiments

- Visual storytelling (plots with captions) made insights accessible and more appealing.
- Plotted decision boundary both for linear and logistic regression and also tried to hypertune the parameters to get the best results.
- Explored various types of models among random forest, logistic regression, naïve bayes and found the best one to use.

Task 2 : The Rise of the Weather Mind

-Level 1: Core Activation

- Objective: Build the foundational chatbot node using LangGraph, powered by Gemini LLM, and integrate a calculator tool. I used the model gemini-1.5-Flash as my large language model and integrated to the calculator tool.
- Implementation:
    - Installed necessary libraries and configured Gemini API.
    - Defined a GraphState for input/output.
    - Built a calculator tool using Python's eval function
    - Implemented a hybrid chatbot node: if the user input contains arithmetic operators, use the calculator; otherwise, invoke the LLM.
    - MY MODEL LOGIC- If the input contains the arithmetic operators (like +, -, /, *) or if it consists of number (1 to 9) then I will use the eval function and give the output to the User otherwise I will direct the LLM that is Gemini in this case.
    - Visualized the LangGraph with a single node, confirming the basic data flow.

Level 2: Senses of the World

- Objective: Extend Weather Mind's abilities to perceive external domains.
- Implementation:
    - Added a Weather Extractor Tool: fetches location from the user query and fetches current weather using the OpenWeatherMap API.
    - Developed a Fashion Recommender Tool: extracts location and uses the LLM to suggest trending styles. For recommending the Fashion I am directly referring to the Gemini (LLM) to answer the query.
    - Demonstrated both tools with sample queries (e.g., "What is the weather in Jaipur?", "What is trending in Jaipur?")

Level 3: Judgement and Memory

- **Objective:** Equip Weather Mind with autonomy, intent classification, and conversational memory.
- **Implementation:**
    - Till yet I have constructed tools like calculator, weather, fashion so How to decide on the basis of input which tool to use and whether to go to Gemini to answer the Query, so to implement it I have built a routing logic , based on specific words in input I decide what to choose between these.
    - Built a routing node in LangGraph, with conditional edges based on intent.
    - To add memory of previous conversation: I stored user-bot message pairs in a list and used the full conversation context for generating context-aware replies.
- **Results:**
    - The system could correctly identify user intent and select the right tool, while also maintaining dialogue continuity.

Level 4: The Architect's Trial – Multi-Agent Evolution

- **Objective:** Transform Weather Mind into a collaborative, multi-agent system.
- **Implementation:**
    - Defined four agent types: Researcher (for information gathering), Analyst (data analysis), Decision-Maker (strategic choices), and General Worker (task execution).
    - Each agent is a node in the LangGraph, with custom logic and tool access.
    - Added new tools (e.g., news, calendar) and mapped them to the appropriate agents.
    - I am routed the news tool under the Researcher agent as information gathering is work of the Researcher agent above the four of the agent and for others tools like fashion, weather , calendar I have kept them under the General agent as it is related to general queries.
    - Built a router node to classify queries and dispatch to the correct agent.
    - Ensured agents could collaborate, avoid conflicts, and fail gracefully (e.g., fallback to LLM if no tool matches).
    - Visualized the multi-agent graph and tested with diverse queries (news, weather, scheduling, fashion, general knowledge)1.
- **Results:**
    - The system could route complex queries to specialized agents, each leveraging its own tools and logic.
    - Demonstrated robust, modular, and extensible architecture, ready for further domain expansion.

Experiments and Results

- **Memory:** Simple list-based memory enabled context-aware responses.
- **Multi-Agent Collaboration:** Agents operated independently but within a unified graph, enabling division of labour and specialization
- **Tool Integration:** Successfully integrated API-based and LLM-based tools, verified with live data and LLM outputs.

Testing & Demonstrations

- Tested and thought of various models and tools which can I use like calendar tool, news tool .
- Tested how to implement calculator function and also implemented it.
- Example queries to showcase tool selection, agent routing, and memory
- Output inspection for each level

Justification for Decisions

- **Memory Approach:** Started with simple in-memory storage for clarity and ease of demonstration.

Summary Table: System Evolution

Level	Capabilities Added	Key Tools/Logic
Level 1	LLM-powered chatbot + calculator tool	Gemini LLM, calculator
Level 2	Weather & fashion domain awareness	Weather API, fashion tool
Level 3	Intent-based routing, conversational memory	Intent classifier, memory
Level 4	Multi-agent collaboration, expanded toolset	Researcher, Analyst, etc.

THANK YOU