ChatCRS v0 – Rule-Based Baseline (Detailed Explanation)

1. Purpose of v0 Baseline

The **v0 rule-based baseline** was developed as the first step in building a ChatCRS-style conversational recommender system. The primary objective of this version is **architectural validation**, not performance optimization.

Specifically, v0 is designed to: - Validate the end-to-end **pipeline structure** of ChatCRS - Ensure correct **data flow** between components - Provide a **fully controllable system** for later robustness analysis - Serve as a stable reference point for incremental improvements

This version intentionally avoids complex models and large datasets so that each system component can be clearly understood, debugged, and modified.

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2. High-Level System Architecture

The v0 system follows the same **conceptual architecture** as the original ChatCRS, but with simplified internal implementations:

```
User Input
   ↓
Goal Planner (rule-based)
   ↓
Knowledge Retriever (toy KB)
   ↓
LLM Response Generator
```

Each module has a **single, well-defined responsibility**, which is critical for both research reproducibility and robustness experimentation.

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3. Component-Level Explanation

3.1 Conversational Agent (LLM)

Role: - Generate natural language responses - Produce recommendations conditioned on external signals

Implementation in v0: - A small instruction-tuned LLM (e.g., Qwen 1.5B Instruct) - Used strictly as a *response generator*, not a decision-maker

Key Design Choice: The LLM is *guided* using structured prompts that include: - Predicted dialogue goal - Retrieved external knowledge

This mirrors the ChatCRS philosophy that LLMs should be **controlled**, not left to reason freely.

3.2 Goal Planning Module

Role: - Predict the system's next conversational action

Examples of dialogue goals: - greeting - ask_preference - recommend - inform

Implementation in v0: - Deterministic, rule-based function - Uses keyword matching on user input

Why Rule-Based First: - Makes decision logic transparent - Eliminates training complexity - Allows easy analysis of failure cases

This module is a **placeholder** for later replacement with a learned (LoRA-finetuned) goal predictor.

3.3 Knowledge Retrieval Module

Role: - Supply factual, domain-specific information to the LLM

Implementation in v0: - A small, manually defined Python dictionary - Maps genres to movie titles

Example:

```
"sci-fi" → [Interstellar, Inception, Blade Runner 2049]
```

Why This Matters: - Separates factual knowledge from the LLM - Enables controlled corruption for robustness testing - Matches the function of the knowledge graph used in the original ChatCRS

This module will later be replaced with a **dataset-derived knowledge base**.

3.4 System Controller (Pipeline)

Role: - Orchestrate all components - Ensure consistent execution order

Pipeline Steps: 1. Receive user input 2. Predict dialogue goal 3. Retrieve relevant knowledge 4. Construct a structured prompt 5. Query the LLM 6. Return response and metadata

This controller is the **core of the system** and remains largely unchanged across future versions.

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4. Design Principles Followed in v0

1. **Modularity** – Each component can be replaced independently
2. **Interpretability** – All decisions are explicit and inspectable
3. **Reproducibility** – No stochastic training steps
4. **Extensibility** – Clean hooks for datasets, noise, and learning-based models

These principles are essential for robustness-oriented research.

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5. Limitations of v0 (Intentional)

The v0 baseline has several known limitations: - No real CRS dataset (toy knowledge only) - Rule-based goal prediction - No evaluation metrics - No robustness mitigation strategies

These limitations are **intentional** and define the scope of v0 as an architectural prototype rather than a final system.

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6. Role of v0 in the Overall Research Roadmap

The v0 baseline serves as: - A **reference system** for all future experiments - A sanity check before introducing learning-based complexity - The foundation for robustness studies

Future versions will incrementally add: - Real datasets (DuRecDial / TG-ReDial) - Learned goal planning - Knowledge graph retrieval - Noise injection and robustness evaluation

Each future result will be compared against this v0 baseline to quantify system improvements and degradation.

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7. Summary

The ChatCRS v0 rule-based baseline establishes a clear, functional, and controllable conversational recommender architecture. While simple by design, it faithfully reflects the structural principles of the original ChatCRS and provides a solid foundation for both academic research and practical system development.

This version marks the **starting point** of the project and will be preserved unchanged to ensure experimental traceability and reproducibility.