AGENTS

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Purpose of this document

This file describes the two LangGraph agents contained in this repository and explains how they support the study design. The focus is on the **data-aware assistant** and the embedded **data-quality (DQ) evaluation** that operationalizes the indicator **TIMELINESS** as part of the study.

Agent overview

This repository contains two LangGraph agents:

1) **tavilyAgent (development template)**
   `tavilyAgent` is a small, generic template agent used during development to test concepts and new features on a simple graph workflow. It is not required to run the study system and exists mainly for prototyping and debugging.

2) **dataAwareLLMSystem (study agent)**
   `dataAwareLLMSystem` is the main study agent. It supports participants in formulating

correct, safe, and reproducible SQL queries against the dataset database and, in a second internal pass, computes a **TIMELINESS** assessment that can be shown in Study-Variant 2 via the side panel.

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dataAwareLLMSystem: research-oriented design goals

The `dataAwareLLMSystem` is designed for an interactive study context in which participants may have limited knowledge about SQL and limited experience with AI systems. The agent therefore aims to:

- **Reduce errors in indicator selection** by enforcing a structured "indicator resolution" step before running value queries.
- **Reduce erroneous aggregation and misinterpretation** by preferring clarifying questions over broad or speculative queries.
- **Maintain strict separation** between (a) user-facing analytical assistance and (b) internal data-quality evaluation, in order to support the study manipulation.

High-level workflow

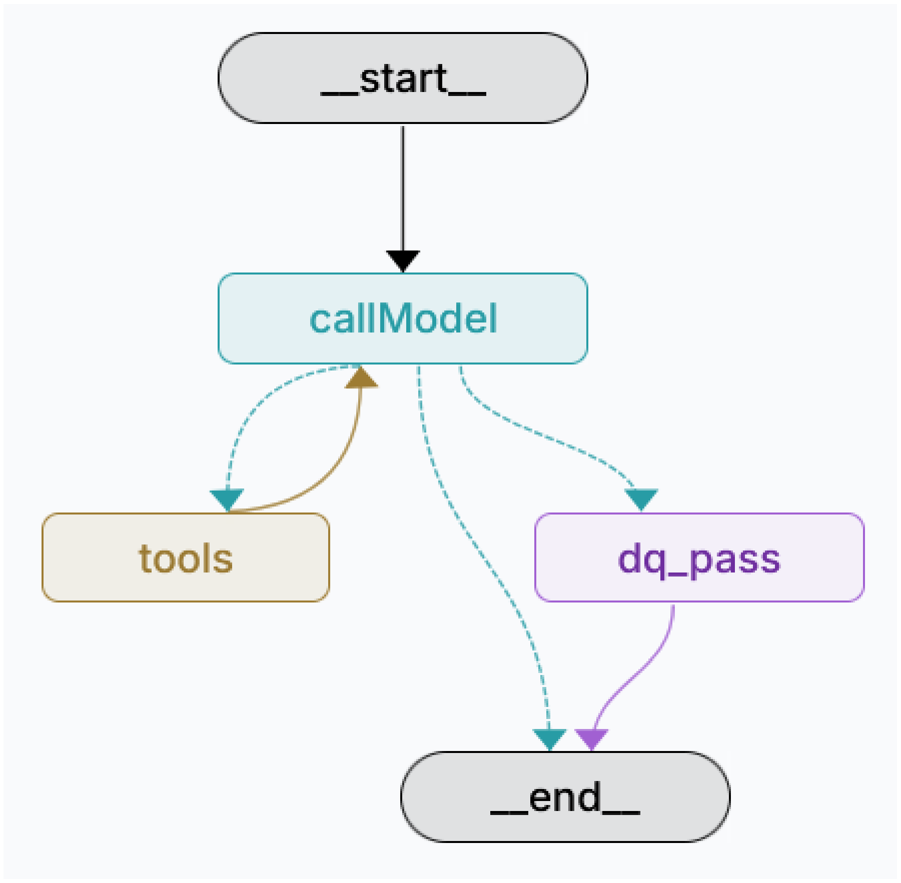
The agent run consists of two phases executed in a single graph run:

1) **Main assistant phase (user-visible)**
   A tool-augmented assistant generates clarifying questions and/or read-only SQL queries to answer the user's request. The produced answer is shown in the chat.

2) **DQ pass phase (not user-visible)**
   Immediately after the final user-visible answer, a second internal pass evaluates the **timeliness** of the *actually used data footprint* (based on all SQL queries executed in the main phase). The DQ result is persisted to the App database and can be displayed only in Variant 2.

Architecture and components (main assistant phase)

Workflow diagram (LangGraph)



Schema grounding (dataset schema summary)

At the beginning of a run, the agent loads a compact schema summary of the dataset database via introspection (`information_schema.columns`). This summary is injected into the system prompt as `{dataset_schema}`. The objective is to increase SQL correctness and reduce trial-and-error queries by providing the model with a structured view of available tables and columns.

Implementation anchor:

- `app/modules/langgraph/agents/dataAwareLLMSystem/utils/get-dataset-schema-summary.ts` (cached per process)
- `app/modules/langgraph/agents/dataAwareLLMSystem/tools/schema-introspect.ts` (explicit tool for schema exposure)

System prompt constraints and study rule (no timeliness hints)

The main assistant's system prompt is explicitly designed to support users in producing correct analytical queries while enforcing a critical study rule:

- **The assistant must not comment on the suitability of temporal coverage** (e.g., missing years/months, outdated data, insufficient range) in user-visible chat responses.

Example implication:
If the user requests an average "up to 2025" but the data coverage ends earlier, the assistant must still compute the result based on available data and **must not warn** that 2025 is missing. This restriction ensures that timeliness-related judgments remain exclusively part of the DQ pass and (depending on study condition) the side panel.

Implementation anchor:

- `app/modules/langgraph/agents/dataAwareLLMSystem/prompts.ts` (`SYSTEM_PROMPT_TEMPLATE`)

Indicator resolution (mandatory before value queries)

The agent enforces a structured process to resolve the **exact indicator(s)** used for analysis. Instead of guessing indicator names from natural language, the assistant first runs a bounded lookup query to identify candidate indicators that match the user's concept (keywords/synonyms). The user is then asked to confirm the correct indicator if multiple plausible matches exist.

This mechanism reduces the risk of:

- silently mixing similar indicators,
- selecting an unintended unit/definition,
- producing results that are irreproducible or misleading.

Design rationale:
In ESG settings, many indicator names are semantically close (e.g., emissions vs. scope-specific emissions, diversity variants, different denominators). Enforcing indicator disambiguation improves transparency and supports a broader user population.

Tool-augmented reasoning with a bounded ReAct loop

The main assistant runs in a ReAct-style loop:

- If the request is ambiguous, the agent asks clarifying questions.
- If sufficient constraints exist (indicator + entity scope + timeframe), the agent generates a read-only SQL query via `sql_query`.
- Returned rows are used to produce a natural-language answer.

The toolchain is intentionally minimal:

- `get_dataset_schema` (schema summary)
- `sql_query` (read-only dataset SQL)

Implementation anchor:

- `app/modules/langgraph/agents/dataAwareLLMSystem/tools/sql-query.ts` (Postgres pool + statement timeout + max rows)
- `app/modules/langgraph/agents/dataAwareLLMSystem/utils/sql-guard.ts` (read-only enforcement + sanitization)

Data-quality (DQ) pass: TIMELINESS evaluation (internal)

Purpose and separation from user-visible output

The DQ pass exists to compute a **TIMELINESS** assessment without contaminating the main assistant's user-facing behavior. The DQ output:

- is **not** appended as a chat message,

- is persisted to the App DB (append-only),
- is shown only when the study UI enables the side panel (Variant 2).

Definition of TIMELINESS used in this study

Timeliness refers to the extent to which data are sufficiently current and temporally appropriate for a specific task or decision context. It evaluates whether the available data cover the required time period without relevant gaps and whether their currency meets the user's analytical needs; because timeliness is task-dependent, data may be considered only partially timely if observed temporal coverage does not fully match the requested timeframe. (Wang & Strong, 1996)

Reference (APA 7):
Wang, R. Y., & Strong, D. M. (1996). Beyond accuracy: What data quality means to data consumers. *Journal of Management Information Systems, 12*(4), 5-33.

Inputs to the DQ pass

The DQ system receives:

- the user's request context, based on the **full chat history** (USER + ASSISTANT), to avoid losing timeframe constraints introduced in earlier turns,
- **all SQL queries** executed in the main assistant phase (`all_sql_used`),
- the dataset schema summary.

This design addresses a common conversational pattern: users may first specify a timeframe (e.g., "2018-2023") and later answer a clarification ("Adidas"), so the DQ system must see the full context to correctly infer the intended temporal requirements.

Coverage computation (not only MIN/MAX)

A key requirement of this study's timeliness measurement is **continuity checking** within the requested interval. The DQ pass must detect missing buckets inside a range (e.g., missing years between 2016 and 2023), not only evaluate observed minimum and maximum.

Operationally, the DQ pass:

1) infers the requested timeframe (explicit range, single bucket, or relative phrases resolved against `system_time`),
2) derives observed time buckets from the actually used data footprint,
3) computes expected buckets via `generate_series(...)`,
4) calculates missing buckets as expected minus observed.

This produces evidence for one of the following statuses:

- **OK:** requested interval is fully covered; no relevant missing buckets,
- **PARTIAL:** interval overlaps, but internal gaps exist or coverage is incomplete,
- **MISMATCH:** observed coverage is clearly outside the requested timeframe or overlaps meaningfully insufficient,
- **UNKNOWN:** SQL executed, but timeframe/buckets could not be derived confidently (or evidence is insufficient),
- **NOT_EVALUATED:** only if the main assistant did not execute any dataset query at all.

Persistence and linkage

The DQ pass persists exactly one log row per user turn to the App DB, linked by `langGraphThreadId` (LangGraph `thread_id`). Stored fields include:

- `indicators` (JSON containing TIMELINESS),
- `usedTables` (best-effort union of tables extracted from all SQL queries),
- `mainSql` and `dqSql` (optional audit/debug support).

This enables:

- transparent provenance display ("which tables contributed"),
- deterministic reconstruction for analysis,
- condition-specific UI display (Variant 2 side panel).

Implementation anchor:

- `app/modules/langgraph/agents/dataAwareLLMSystem/persist/write-thread-dq-log.ts`
- Prisma model: `ThreadDataQualityLog` (App DB)

Study condition integration (Variant 1 vs Variant 2)

Both study variants use the same core assistant capabilities for answering user requests and generating SQL. The key difference is **visibility** of the data-quality evaluation:

- **Variant 1:** No timeliness indicator is shown to participants (even though internal logging may still exist depending on configuration).
- **Variant 2:** The side panel can display the latest TIMELINESS result for the current thread by reading the newest `ThreadDataQualityLog` entry.

This separation is central to evaluating whether presenting a data-quality indicator (TIMELINESS) influences user perceptions such as trust and perceived transparency.

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