



SECTION 2 · 15 min

Core Concepts

Fundamental concepts for representing, grounding, retrieving, and reasoning about temporal information.



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Temporal Dimensions of Information

Effective TQA aligns two interacting dimensions of temporality.

Corpus temporality

- **Diachronic:** time-stamped docs spanning years (news archives) — retrospective, event-based reasoning.
- **Synchronic:** a snapshot of the world at a particular time (e.g., a Wikipedia dump).

Question temporality

- **Explicitness:** explicit vs implicit temporal intent.
- **Orientation:** past, present or future.
- **Complexity:** simple lookup vs multi-hop reasoning.

Diachronic Vs Synchronic Collection

Different temporal views of the world require different retrieval strategies.

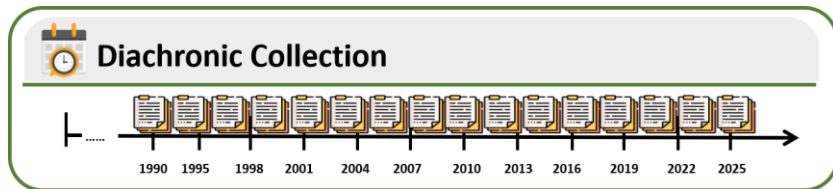
Diachronic Collections

Documents span months, years, or decades.

Characteristics

- Preserve how information evolves over time
- Multiple versions of facts may coexist
- Support historical and event-centric retrieval

Examples: News archives, Web archives, Historical document collections



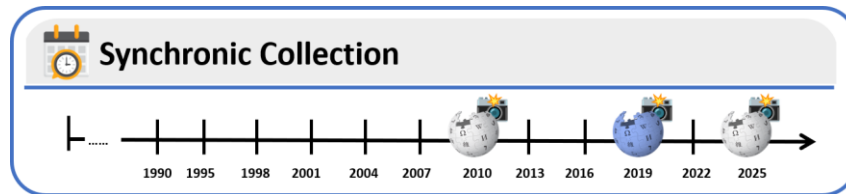
Synchronic Collections

Snapshot of information at a single point in time.

Characteristics

- Represents the world "at particular point of time"
- Typically contains one current version of facts
- Easier to do temporal reasoning

Examples: Wikipedia dump, Snapshot of websites at particular time



Diachronic collections support reasoning across time, while synchronic collections support reasoning within one snapshot of knowledge at a specific moment.

Temporal Expressions

Temporal expressions are the primary way users and documents refer to time. Correct detection and interpretation are essential for retrieval and reasoning.

Types of Temporal Expressions

- **Absolute Temporal Expressions**

Refer directly to a specific calendar date, time, or period.

Examples: April 24, 1916; 10:15 AM; the summer of 1977; the third quarter of 2006

- **Relative Temporal Expressions**

Refer to a time relative to a temporal anchor, such as the document creation time or another event.

Examples: yesterday, last week, next month

- **Duration Expressions**

Indicate the length of a time interval rather than its specific position on a calendar.

Examples: four hours; three weeks; six days

- **Set or Recurring Temporal Expressions**

Describe times or intervals that occur repeatedly.

Examples: hourly; daily; monthly; every Monday

The Temporal Grounding Challenge

- Relative and sometimes Event-based Temporal Expressions requires context for proper anchoring.
- They must be grounded using the reference time, surrounding context, or knowledge about relevant events.

“last year”



Reference Time

Depends on when the query is issued.



2024

(if query issued in 2025)

“during the Olympics”



Event Knowledge

Resolved using knowledge of which Olympics is being referred to.



26 Jul–11 Aug 2024

(if the query refers to the Paris 2024 Olympics)

“after World War II”



Historical Event

Resolved using knowledge of the historical event.



after 1945

(end of WWII)

Temporal grounding converts natural-language time expressions into explicit dates or intervals, enabling **accurate retrieval and reasoning**.

Temporal Granularity

Temporal information can be expressed and reasoned over different levels of resolution, from centuries to minutes or seconds.

Coarse

Fine



Why Granularity Matters

- Different questions need different resolution.
- Wrong granularity may miss relevant evidence.
- Reasoning may move between granularities.

Example:

Q: What happened during the Renaissance? → Century-Level

Q: Who won the Nobel Prize in 2020? → Year-Level

Q: What happened on Sept. 11, 2001? → Day-Level

Metadata Time vs Content Time

A document's **publication date** is not always the same as the **time period it discusses**.



Publication Time

When the document was written or published.
Used as a proxy for freshness.



Focus Time

What the document is primarily about.
Captures temporal relevance.

Example document: *"A retrospective analysis of the 2010 Academy Awards"*



Query: *"Who won Best Picture in 2010?"*

A system relying only on publication dates may miss relevant documents published years later.



Effective temporal retrieval reasons over both **when a document was written** and **what time it is about**.

Temporal Proximity

Focus time or publication time of documents closer to the target time are often more relevant.



Example:

- **Latest Apple earnings**

Apple earnings (2018)

✗ Too Old

Apple Q4 earnings (2024)

✓ Relevant

Apple Q2 earning (2026)

✓✓ Best Match

- **Covid-19 lockdown policies**

Government Directives (2020)

✓✓ Highly Relevant

Policy Update (2021)

✓ Relevant

Retrospective Analysis (2026)

✗ Likely Less Relevant

Temporal relevance depends not only on content, but also on proximity to the user's search intent's target time.

Explicit vs Implicit Temporal Intent

Temporal constraints may be directly stated or inferred from context.

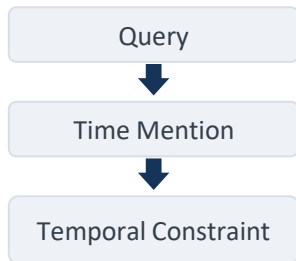
Explicit Intent



Time is directly mentioned.

Examples:

- Olympics 2024
- US Elections 2016
- Nobel Prize 2020



vs.

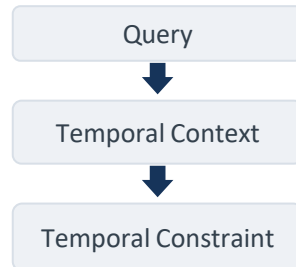
Implicit Intent



Time must be inferred.

Examples:

- Latest Apple earnings
- Current Prime Minister of India
- COVID-19 lockdown policies



Implicit temporal intent is often **more challenging** because the relevant time period is not explicitly stated.

Temporal Reasoning Types

Temporal IR/QA requires reasoning beyond retrieval.

