



SECTION 5 · 15 min

Temporal Information Extraction and Prediction Tasks

Methods for recognizing temporal expressions and inferring missing temporal information from text.



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SUTime: A library for recognizing and normalizing time expressions

Core idea

- Deterministic rule-based temporal tagger for English.
- Implemented as a Stanford CoreNLP annotator and Java library.
- Uses TokensRegex to express patterns over tokens, POS tags, and existing annotations.
- Maps text to temporal objects, then outputs TIMEX3 annotations.

Supported temporal objects

Object	Example	Normalized Form
Time	Last Friday	2011-09-16
Duration	3days	P3D
Interval	From July to August	Begin/end interval
Set	Every third Sunday	XXXX-WXX-7

Recognition pipeline



Rules are applied in stages: first simple expressions, then composite intervals, then filters for ambiguous candidates.

Example normalization

Document date: 2011-09-19
"last Friday" → DATE 2011-09-16

Angel X. Chang and Christopher Manning. 2012. **SUTime: A library for recognizing and normalizing time expressions**. In Proceedings of the Eighth International Conference on Language Resources and Evaluation (LREC'12), pages 3735–3740, Istanbul, Turkey. European Language Resources Association (ELRA).

HeidelTime: High Quality Rule-Based Extraction and Normalization of Temporal Expressions

Core idea

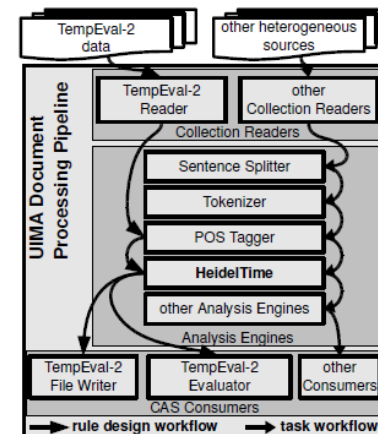
- Hand-crafted rules organized by TIMEX3 type: Date, Time, Duration, Set.
- Extraction mainly uses regular-expression patterns plus POS constraints.
- Normalization uses knowledge resources for months, seasons, holidays, etc.
- Post-processing resolves underspecified values using document creation time or a previously mentioned date.

Rule structure

expression pattern + normalization function + type

Example: “Independence Day 2010” → DATE 2010-07-04

UIMA-based pipeline



- Sentence splitting, tokenization and POS tagging feed the temporal tagger.
- Post-processing resolves underspecified values and removes invalid overlaps.

Jannik Strötgen and Michael Gertz. 2010. **HeidelTime: High Quality Rule-Based Extraction and Normalization of Temporal Expressions**. In Proceedings of the 5th International Workshop on Semantic Evaluation, pages 321–324, Uppsala, Sweden. Association for Computational Linguistics.

Temponym Tagging: Temporal Scopes for Textual Phrases

Core idea

- Standard temporal taggers identify explicit TIMEX3 expressions: dates, times, durations, and sets.
- Temponyms are textual phrases that are not temporal expressions themselves, but still denote a temporal scope.
- Extends HeidelTime to recognize explicit temponyms and normalize them to dates or intervals.

Examples: from phrase to temporal scope

Phrase	Type	Temporal Scope
WWW Conference 2016	Event-style	2016-04-11 to 2016-04-15
FIFA World Cup Final 1998	Event-style	1998-07-12
Hillary Clinton's term as Secretary of State	Role/fact - style	2009-01-21 to 2013-02-01

Why it matters

Plain phrase

"WWW Conference 2016"



Temporal interval

[2016-04-11, 2016-04-15]

- Useful for temporal IR and exploration.
- Captures event-style and fact-style scopes.
- Bridges tagging and knowledge-base grounding.

not every temporal clue looks like a date.

Erdal Kuzey, Jannik Strötgen, Vinay Setty, and Gerhard Weikum. 2016. **Temponym Tagging: Temporal Scopes for Textual Phrases**. In Proceedings of the 25th International Conference Companion on World Wide Web (WWW '16 Companion). <https://doi.org/10.1145/2872518.2889289>

tieval: An Evaluation Framework for Temporal Information Extraction Systems

tieval is an open-source Python library for the development and evaluation of Temporal Information Extraction (TIE) systems — identifying events, time expressions, and the temporal links between them.



An open-source library

A pip-installable Python package — MIT-licensed and available on PyPI & GitHub.



Built for temporal IE

Focused on events, temporal expressions (timex), and the temporal relations (tlinks) that connect them.



One unified interface

Replaces per-corpus parsers and ad-hoc metrics with a single, consistent API.



`pip install tieval` — its goal: make TIE benchmarking fair, comparable, and reproducible.

Hugo Sousa, Ricardo Campos, and Alípio Mário Jorge. 2023. **Tieval: An Evaluation Framework for Temporal Information Extraction Systems**. In Proceedings of the 46th International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR '23). <https://doi.org/10.1145/3539618.3591892>

tieval: An Evaluation Framework for Temporal Information Extraction Systems

It supports the entire TIE pipeline through three modules — datasets, models, and evaluation.



datasets

- Reads 18+ corpora across 11+ languages
- Unifies them in one object model
- Loads a full corpus in a single line



models

- Baselines for timex & event ID
- HeidelTime and CogCompTime2
- Train from scratch or just predict



evaluation

- Scores four TIE subtasks
- P / R / F1, macro and micro
- Temporal awareness via closure

Hugo Sousa, Ricardo Campos, and Alípio Mário Jorge. 2023. **Tieval: An Evaluation Framework for Temporal Information Extraction Systems**. In Proceedings of the 46th International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR '23). <https://doi.org/10.1145/3539618.3591892>

Temporal Prediction Tasks

A family of tasks that infer implicit or missing temporal information directly from text — anchoring documents, queries, and events in time.

- **Bridge the gaps**

Critical when explicit temporal metadata is sparse, noisy, or unavailable.

- **Align the pieces**

Improve alignment between queries, documents, and the events they describe.

- **Enable applications**

Power historical search, timeline construction, and time-sensitive retrieval.

HOW THE METHODS HAVE GROWN

1

Rule-based

Handcrafted normalization & decay functions

2

Statistical LMs

Time-period language models, ranking features

3

Neural

Transformer encoders, temporal embeddings, graph-based reasoning

Document Dating



DEFINITION

Estimate a document's creation time (e.g., publication date) from its textual content — especially when metadata is missing, unreliable, or absent.

INPUT

Full document text



OUTPUT

Timestamp (year / month)



EXAMPLE

A historical newspaper page with no reliable header date is placed on the timeline using the vocabulary and style of its era.

KEY APPROACHES

de Jong et al. (2005)

Unigram language models over distinct time periods locate when a document's vocabulary was most prevalent.

Kanhabua & Nørvåg (2008)

Add POS tags, tf-idf scores, and collocations to capture temporal patterns.

Dalli (2006) · Kumar et al. (2012)

Unsupervised periodic word usage; LMs over "chronons" from Wikipedia biographies.

Niculescu (2014) · Vashishth (2018)

Pairwise ranking via logistic regression; neural GCNs over syntactic & temporal relations.

Jong, F. M., Henning Rode, and Djoerd Hiemstra. "Temporal language models for the disclosure of historical text." (2005).
Kanhabua, Nattiya, and Kjetil Nørvåg. "Improving temporal language models for determining time of non-timestamped documents." In International conference on theory and practice of digital libraries, 2008.
Dalli, Angelo. "Temporal classification of text and automatic document dating." In Proceedings of the Human Language Technology Conference of the NAACL, 2006.
Kumar, Abhimanu, Jason Baldridge, Matthew Lease, and Joydeep Ghosh. "Dating texts without explicit temporal cues." arXiv preprint arXiv:1211.2290 (2012).
Niculescu, Vlad, et al. "Temporal text ranking and automatic dating of texts." Proceedings of the 14th Conference of the European Chapter of the Association for Computational Linguistics. 2014.
Vashishth, Shikhar, et al. "Dating documents using graph convolution networks." Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers). 2018.

Document Focus Time Estimation



DEFINITION

Identify the historical period(s) a document discusses — its narrative scope — which may differ from when it was written.

INPUT

Full document text



OUTPUT

Temporal interval(s)



EXAMPLE

An article published in 2021 that analyzes the 9/11 attacks has a focus time centered on September 2001, not 2021.

KEY APPROACHES

Jatowt et al. (2013)

Graph-based method modeling co-occurrences between terms and dates to surface salient temporal associations.

Jatowt et al. (2015)

Estimates focus time from statistical evidence in external corpora, even when explicit time expressions are sparse.

Shrivastava et al. (2017)

Links documents to Wikipedia concepts and leverages their temporal relations to infer focus times.

Jatowt, Adam, Ching-Man Au Yeung, and Katsumi Tanaka. "Estimating document focus time." Proceedings of the 22nd ACM international conference on Information & Knowledge Management. 2013.

Jatowt, Adam, Ching Man Au Yeung, and Katsumi Tanaka. "Generic method for detecting focus time of documents." Information Processing & Management 51.6 (2015): 851-868.

Shrivastava, Shashank, Mitesh Khapra, and Sutanu Chakraborti. "A concept driven graph based approach for estimating the focus time of a document." *International Conference on Mining Intelligence and Knowledge Exploration*. Cham: Springer International Publishing, 2017.

Temporal Query Profiling



DEFINITION

Determine a query's temporal intent and time of interest — whether it refers to the past, the future, or is atemporal.

INPUT

Short keyword query



OUTPUT

Inferred time /
distribution



EXAMPLE

The query "Ukraine–Russia war" is profiled into an inferred time of interest or a distribution over candidate periods.

KEY APPROACHES

Kanhabua & Nørvåg (2010)

Estimate query time from the timestamps of the top-k retrieved documents.

Dakka (2008) · Jones & Diaz (2007)

Model the temporal distributions of relevant documents to characterize intent.

Kanhabua & Nørvåg (2011)

Compare five temporal ranking methods (LMT, LMTU, TS, TSU, FuzzySet).

Gupta & Berberich (2014)

Combine timestamp metadata with in-content temporal expressions for precise intervals.

Kanhabua, Nattiya, and Kjetil Nørvåg. "Determining time of queries for re-ranking search results." International conference on theory and practice of digital libraries. Berlin, 2010.

Dakka, Wisam, Luis Gravano, and Panagiotis G. Ipeirotis. "Answering general time sensitive queries." Proceedings of the 17th ACM conference on Information and knowledge management. 2008.

Jones, Rosie, and Fernando Diaz. "Temporal profiles of queries." ACM Transactions on Information Systems (TOIS) 25.3 (2007): 14-es.

Kanhabua, Nattiya, and Kjetil Nørvåg. "A comparison of time-aware ranking methods." Proceedings of the 34th international ACM SIGIR conference on Research and development in Information Retrieval. 2011.

Gupta, Dhruv, and Klaus Berberich. "Identifying time intervals of interest to queries." Proceedings of the 23rd ACM international conference on conference on information and knowledge management. 2014.

Event Occurrence Time Estimation



DEFINITION

Predict the specific date an event occurred from a short textual description — focusing on the event mention itself, at high granularity.

INPUT

Short event description



OUTPUT

Fine-grained date (day / month)



EXAMPLE

Given “Plane crash in Armenia kills 36,” the system infers the day- or month-level date of the event.

KEY APPROACHES

Das et al. (2017)

Time vectors combining word and global temporal embeddings; estimate dates via cosine similarity.

Morbidoni et al. (2018)

Use structured KBs (DBpedia, Wikipedia) to link descriptions to grounded entities.

Honovich et al. (2020)

Sentence extraction + LSTM with attention + an MLP classifier for date prediction.

Wang et al. (2021b) — TEP-Trans

Transformer framing event-time prediction as multivariate time-series forecasting.

Das, Supratim, et al. "Estimating event focus time using neural word embeddings." Proceedings of the 2017 ACM on Conference on Information and Knowledge Management. 2017.

Morbidoni, Christian, Alessandro Cucchiarelli, and Domenico Ursino. "Leveraging linked entities to estimate focus time of short texts." Proceedings of the 22nd International Database Engineering & Applications Symposium. 2018.

Honovich, Or, et al. "Machine reading of historical events." Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics. 2020.

Wang, Jiexin, Adam Jatowt, and Masatoshi Yoshikawa. "Event occurrence date estimation based on multivariate time series analysis over temporal document collections." Proceedings of the 44th international ACM SIGIR conference on research and development in information retrieval. 2021.