Visualizing and Understanding the Errors of Information Extraction Results

System Demonstrations: Data Science

S39

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Disclosure

I and my spouse/partner have no relevant relationships with commercial interests to disclose.

Learning Objectives

After participating in this session, the learner should be better able to:

- Learn a serverless architecture for designing web-based tools

- Learn the visual designs to support error analysis of information extraction results

Outline

1. Background - Error analysis for information extraction

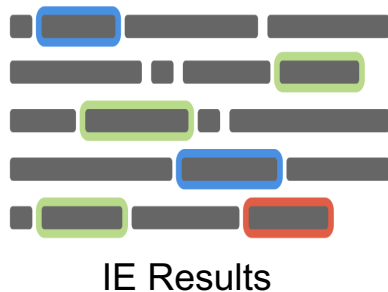2. System Design - Architecture and Visualization

3. Demo

Background - Information Extraction (IE)

Information extraction (IE) is the task of automatically extracting structured information from unstructured and/or semi-structured machine-readable documents and other electronically represented sources.
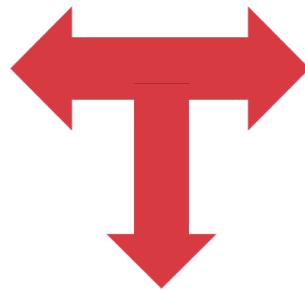
In our cases, the IE task is mainly processed by the natural language processing (NLP) techniques:

Named Entity Recognition (NER)	Relationship Extraction (RE)	Event Extraction	Sentiment Analysis

Topic Modeling	Summarization	Knowledge Graph Construction

Background - IE Errors

Comparison

IE Results

Gold Standard Corpus (GSC)

Most of the IE results may be correct …
but …

Errors!?

Background - Error Types

- **False Positives**: IE systems can sometimes identify information that is not actually present in the GSC, leading to false positives.

- **False Negatives**: IE systems can also miss relevant information in the GSC, leading to false negatives.

Background - Error Categories

- **Linguistic errors.** Synonymy, anaphora resolution errors, etc.

- **Contextual errors.** Negation, temporal, section, certainty, subject, exclusion, etc.

- **Annotation errors.** Missing annotation, incomplete annotation, inaccurate annotation, terminology, bias, etc.

- **Definition errors.** Ambiguity, inconsistency of definition, change of status, etc.

- **Other.**

Background - Error Analysis

Confusion matrix, categorize the errors by type and concepts

Evaluate the errors and analyze the causes of errors

Challenges in error analysis

1. Due to the complexity of the error types, it's hard to gain insights into errors
   1. FP / FN
   2. Linguistic, contextual, annotation, definition, others, etc.
   3. Annotation concepts
   4. Project related types

2. Manually labeling errors is time-consuming without assistance

	A	B	C	D	E	F	G	H
1	spans	tag	text	error	file_name	sentence_sp	sentence	label_1
2	206~212	VAX	PFIZER	FP	sys_doc_1.tx	47~53	A 61-year-old male patient received bnt162b2	Exclusion
3	265~271	VAX	EL1284	FP	sys_doc_1.tx	26~32	second dose (lot number: EL1284, expiry date	Exclusion
4	589~594	OTHER_AE	Sulfa	FN	G__doc_1.tx	43~48	Medical history included known allergies: Sulf	Exclusion
5	596~607	OTHER_AE	Hypothyroid	FN	G__doc_1.tx	50~61	Medical history included known allergies: Sulf	Exclusion
6	609~615	OTHER_AE	Asthma	FN	G__doc_1.tx	63~69	Medical history included known allergies: Sulf	Exclusion
7	617~631	OTHER_AE	Hi Cholesterol	FN	G__doc_1.tx	71~85	Medical history included known allergies: Sulf	Exclusion
8	692~698	MEDICATION	ZYRTEC	FP	sys_doc_1.tx	60~66	Concomitant medication included cetirizine h	Exclusion
9	666~690	MEDICATION	cetirizine hydrochl	FN	G__doc_1.tx	34~58	Concomitant medication included cetirizine h	Absence of Co
10	168~176	VAX	BNT162B2	FN	G__doc_2.tx	75~83	A female patient of an unspecified age (age:	Incorrect Ann
11	251~257	VAX	expiry	FN	G__doc_2.tx	158~164	A female patient of an unspecified age (age:	Incorrect Ann

System Design - Visual Error Analysis
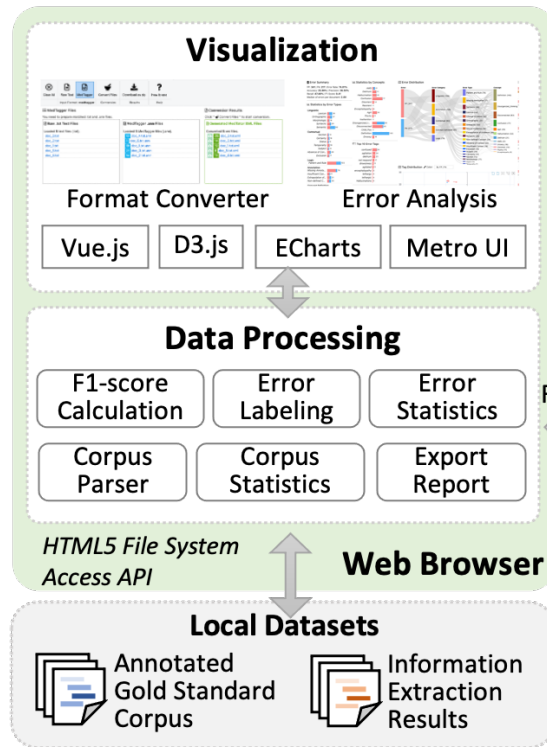
A web-based *serverless* visual error analysis tool that facilitates the exploration of IE errors

- Completely run in the user's web browser
- All features are implemented within the browser
- A server is **NOT** required
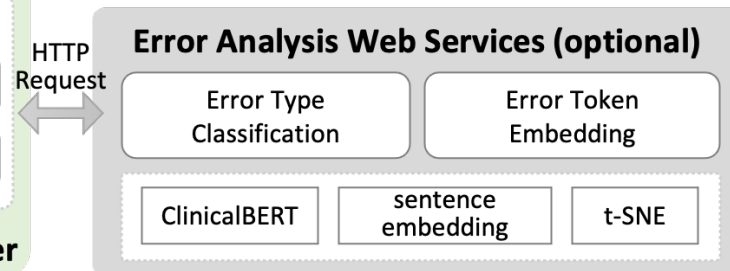
**Optional** server support for advanced features:

- Error type classification based on ML
- Error token embedding and dimension reduction

System Design - Visual Error Analysis
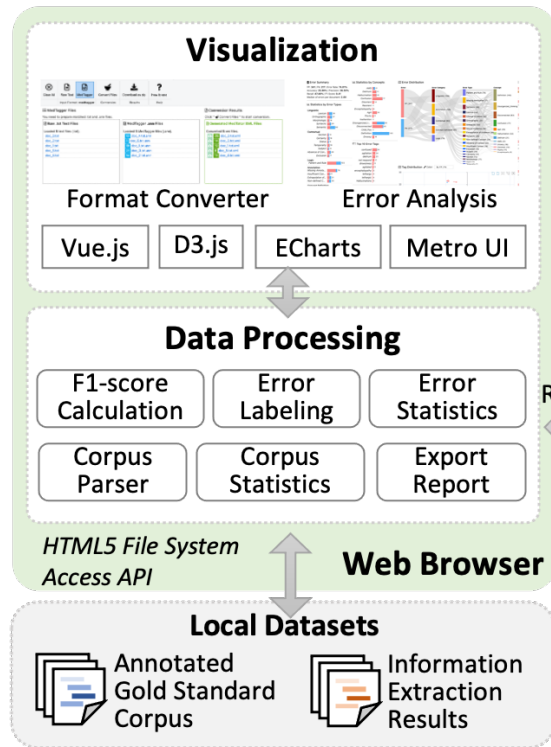
The advantages of "Serverless" architecture

1. No data is sent out:
   - Run locally in user's web browser
   - Operate text files on locally

2. No "install":
   - No need to install any runtimes (e.g., Java, Python, Nginx, etc.)
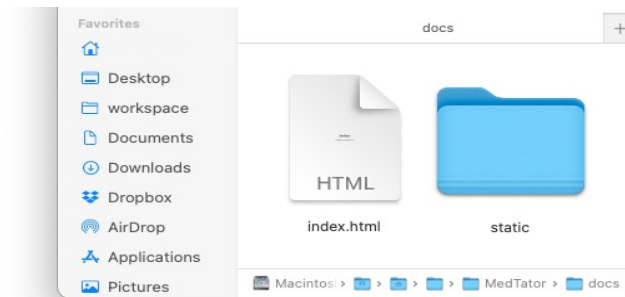
Demonstration - Sample Dataset

Vaccine Adverse Event Reporting System (VAERS) Dataset

The VAERS database contains information on unverified reports of adverse events (illnesses, health problems and/or symptoms) following immunization with US-licensed vaccines.

📁 raw_txt

📄 doc_1.txt

📄 doc_2.txt

📄 doc_3.txt

📄 doc_4.txt

📄 doc_5.txt

5 text files

```
1   Mildly feverish evening after vaccine; Soreness and tenderness at
    left arm injection site; This is a spontaneous report from a
    contactable physician (patient). A 61-year-old male patient
    received bnt162b2 (PFIZER-BIONTECH COVID-19 VACCINE; second dose
    (lot number: EL1284, expiry date: unknown) via an unspecified route
    of administration on 07Jan2021 07:00 at single dose (Left arm) for
    COVID-19 immunization. Patient took bnt162b2 first dose (lot
    number: EK5730, expiry date: unknown) on 17Dec2020  07:00 am (Left
    arm) for COVID-19 immunization. Medical history included known
    allergies: Sulfa, Hypothyroid, Asthma, Hi Cholesterol.  Concomitant
    medication included cetirizine hydrochloride (ZYRTEC),
    atorvastatin, levothyroxine. The patient previously took tamiflu
    and experienced allergies.  Facility type vaccine was hospital. The
    patient did not receive any other vaccines within 4 weeks prior to
    the COVID vaccine. Prior to vaccination, the patient was not
    diagnosed with COVID-19. Since the vaccination, the patient has not
    been tested for COVID-19. The patient experienced Mildly feverish
    evening after vaccine, Soreness and tenderness at left arm
    injection site on 07Jan2021. The patient took Motrin as treatment.
    Therapeutic measures were taken as a result of mildly feverish
    evening after vaccine, soreness and tenderness at left arm
    injection site. The outcome of the events was recovered on an
    unspecified date. The events were reported as non-serious.
```
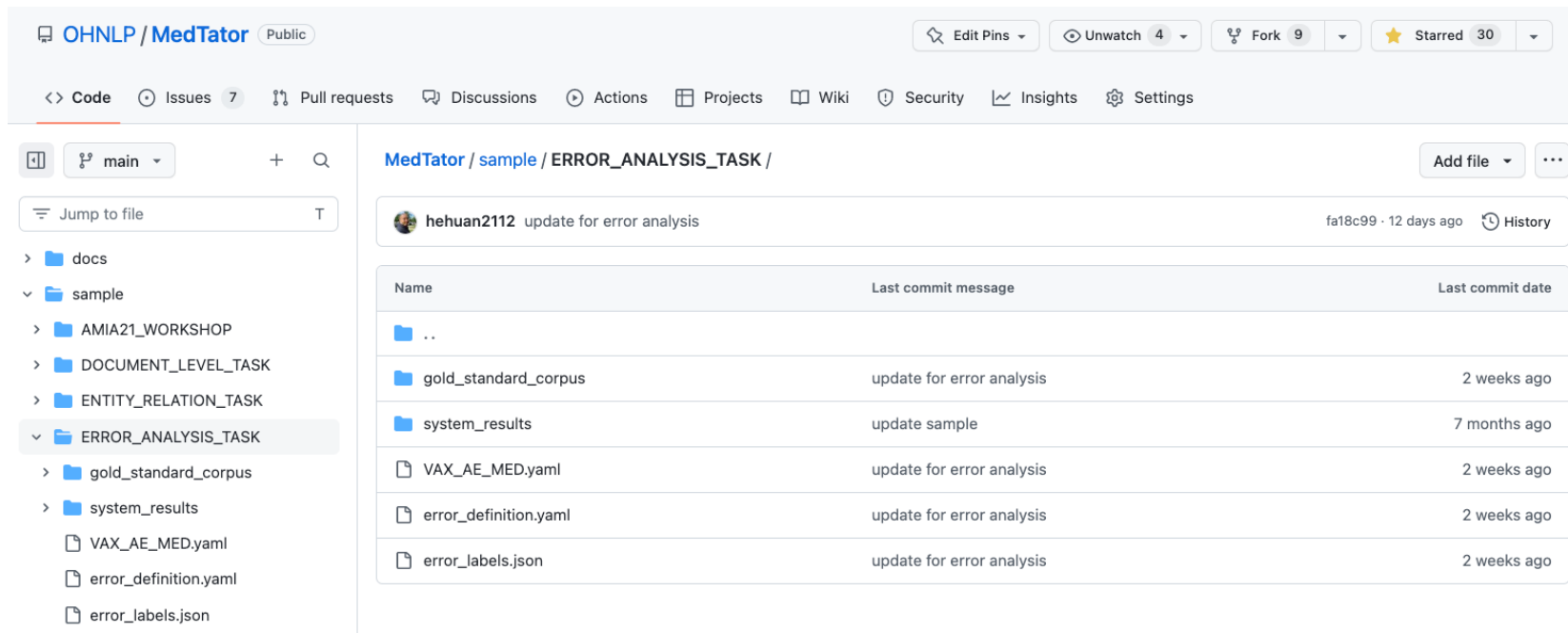
Raw text files

https://vaers.hhs.gov/

Demonstration - Sample Dataset
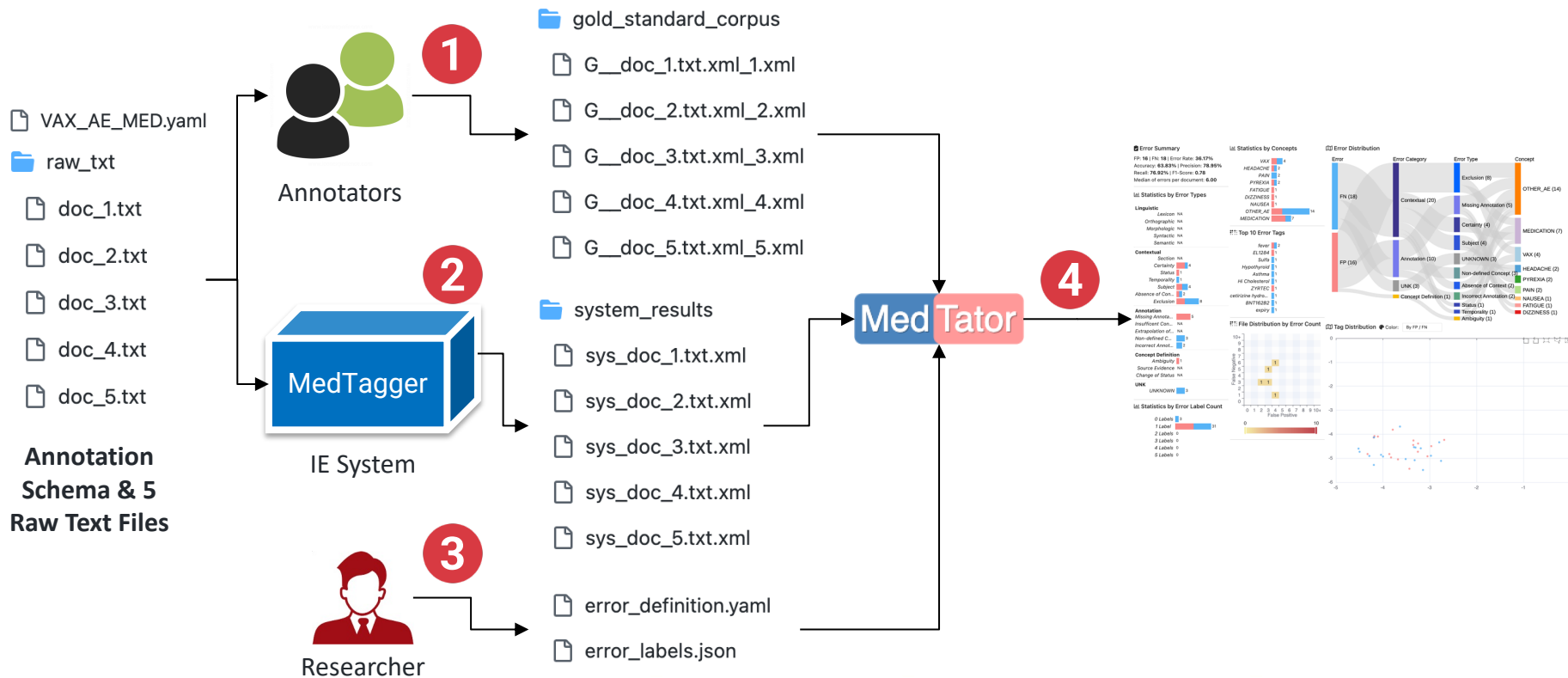
Demonstration

Live demo: https://ohnlp.github.io/MedTator/

A sample dataset: https://github.com/OHNLP/MedTator/tree/main/sample/ERROR_ANALYSIS_TASK
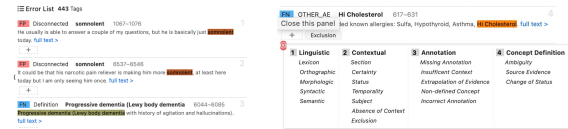
Takeaways

- Use multiple coordinated charts to visualize the errors from different perspectives to gain insights into the errors

  - Stacked bar charts

  - Sankey diagram

  - Scatter plot for texts
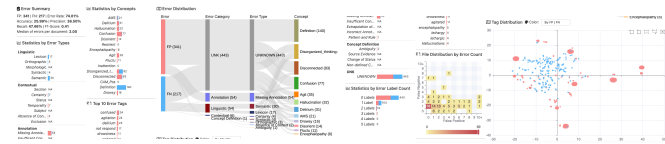
- Using a well-designed user interface to facilitate the manual labeling

  - Reduce cognitive load

  - Improve efficiency

- A serverless architecture that removes the need for an always-on server

  - Easy to deploy and distribute (by free static web servers)

  - No data will be sent out

Acknowledgments
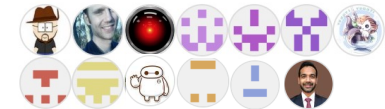
Thank you!

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