Generative Named Entity Normalization for Astronomical Facilities

Yan Shao

2024.5.22

Outline

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Introduction
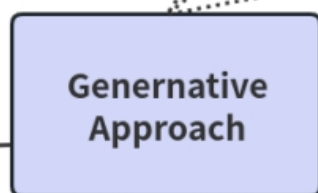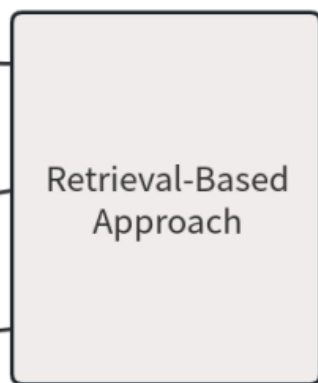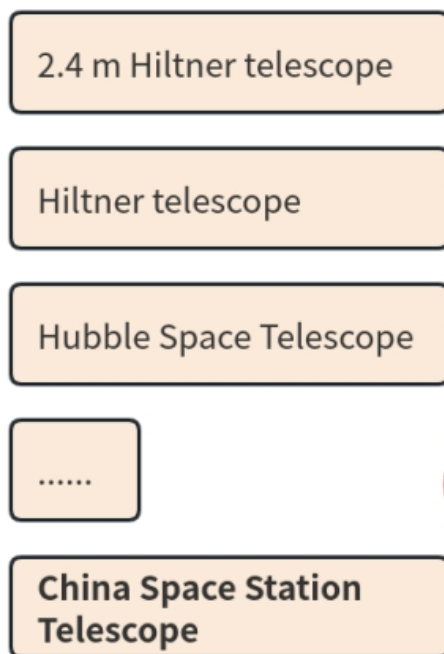
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        "transient_dec": ""
    },
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,
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        "transient_ra": "",
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        "detected_transient_type": "Supernova",
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        "transient_dec": "10:32:21.24"
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```

Introduction
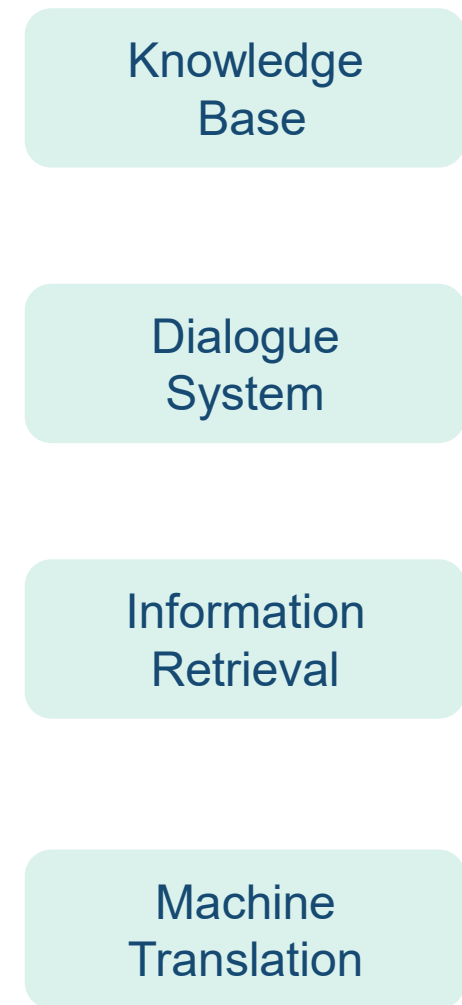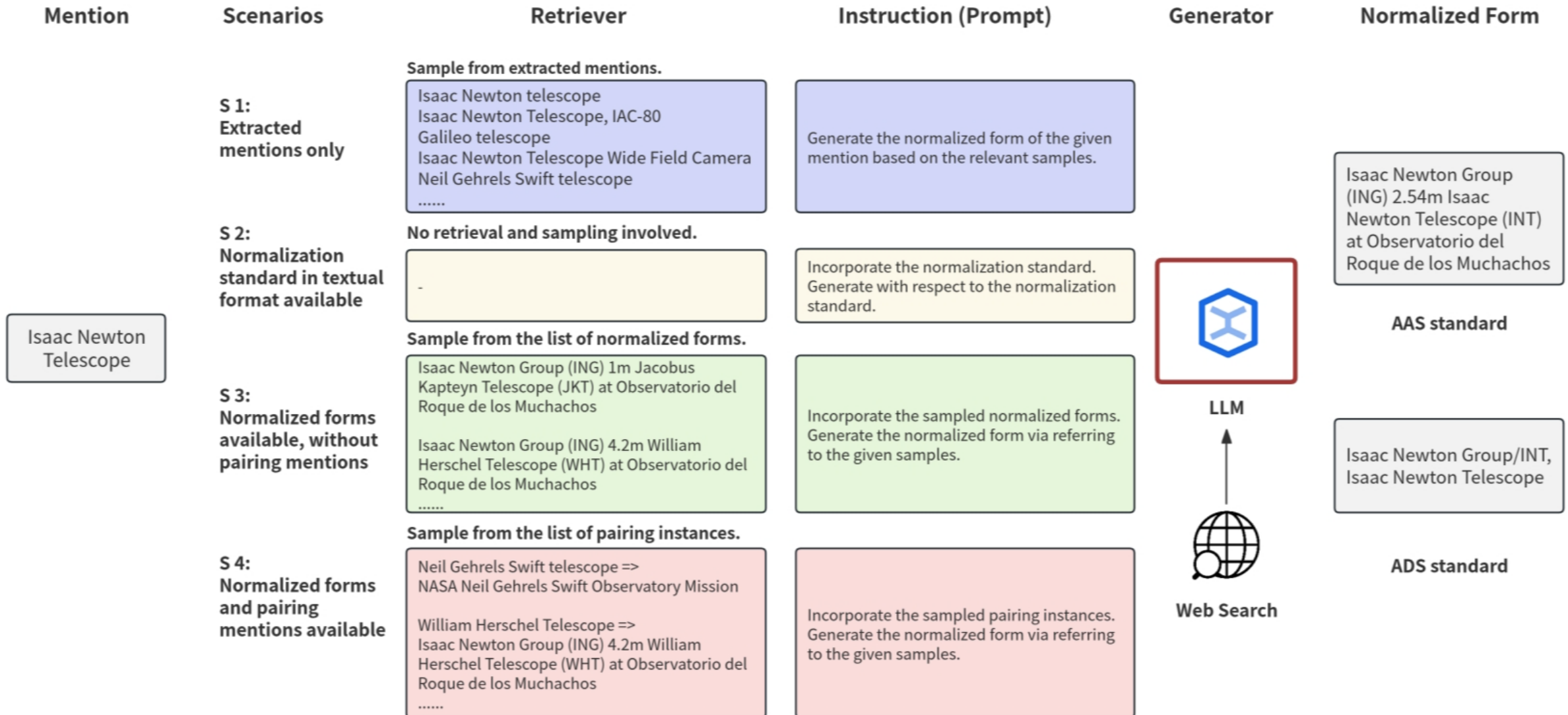
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TelescopeNorm Dataset

American Astronomical Society (AAS)

Astronomer's Telegram (ATEL)

Astrophysics Data System (ADS)
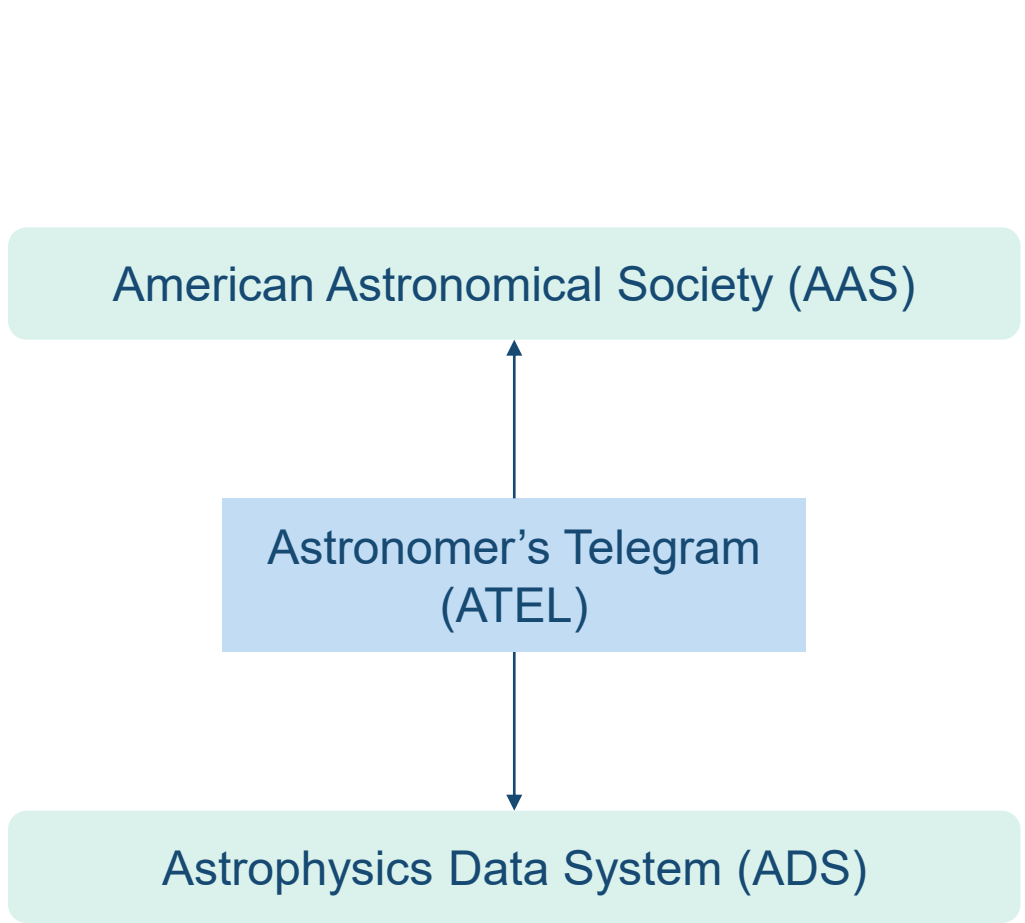
AAS
The NRAO 300-foot Green Bank Telescope
European Space Agency (ESA) Newton-XMM X-Ray Multi-Mirror Mission Satellite
NASA Neil Gehrels Swift Observatory Mission
NASA High Energy Transient Explorer 2 (HETE-2) Satellite Mission

ADS
National Radio Astronomy Observatory/Green Bank Telescope
XMM-Newton, X-Ray Multimirror Mission Newton satellite
SWIFT, Multi-wavelength Observatory
HETE-2, High Energy Transient Explorer 2 satellite

Elasticsearch

GPT4

Human Annotation

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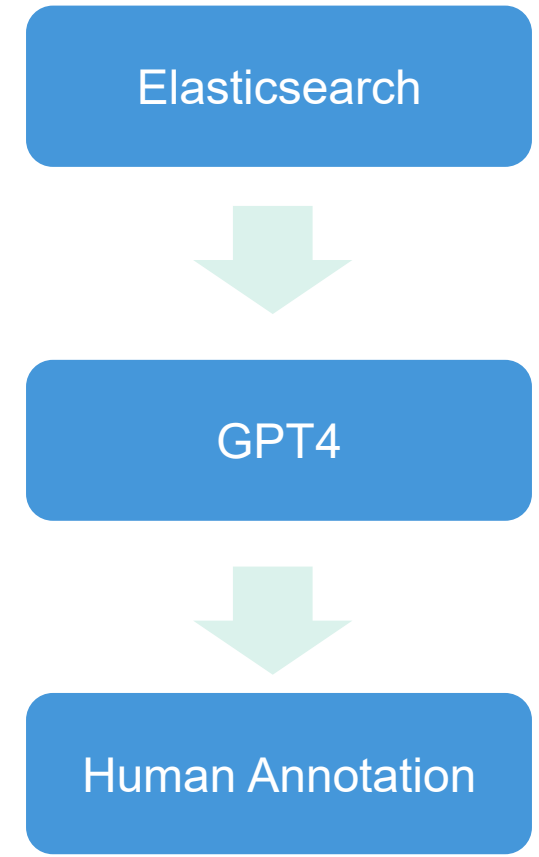
Source	Standard	Support	Development	Test
ATEL	AAS	30	100	365
	ADS	30	100	125

Table 1: Detailed statistics of the TelescopeNorm dataset for generative NEN evaluation, presented in the form of mention-normalized pairs count.

TelescopeNorm Dataset

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Mention	Scenarios	Retriever	Instruction (Prompt)	Generator	Normalized Form
	S 1: Extracted mentions only	**Sample from extracted mentions.** Isaac Newton telescope / Isaac Newton Telescope, IAC-80 / Galileo telescope / Isaac Newton Telescope Wide Field Camera / Neil Gehrels Swift telescope /	Generate the normalized form of the given mention based on the relevant samples.		
Isaac Newton Telescope	**S 2:** Normalization standard in textual format available	**No retrieval and sampling involved.** -	Incorporate the normalization standard. Generate with respect to the normalization standard.	LLM	Isaac Newton Group (ING) 2.54m Isaac Newton Telescope (INT) at Observatorio del Roque de los Muchachos **AAS standard**
	S 3: Normalized forms available, without pairing mentions	**Sample from the list of normalized forms.** Isaac Newton Group (ING) 1m Jacobus Kapteyn Telescope (JKT) at Observatorio del Roque de los Muchachos / Isaac Newton Group (ING) 4.2m William Herschel Telescope (WHT) at Observatorio del Roque de los Muchachos /	Incorporate the sampled normalized forms. Generate the normalized form via referring to the given samples.		Isaac Newton Group/INT, Isaac Newton Telescope
	S 4: Normalized forms and pairing mentions available	**Sample from the list of pairing instances.** Neil Gehrels Swift telescope => NASA Neil Gehrels Swift Observatory Mission / William Herschel Telescope => Isaac Newton Group (ING) 4.2m William Herschel Telescope (WHT) at Observatorio del Roque de los Muchachos /	Incorporate the sampled pairing instances. Generate the normalized form via referring to the given samples.	Web Search	**ADS standard**

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1. **Include the Organization or Entity Name**: Typically, the name begins with the name of the organization, university, or agency managing or associated with the telescope.

2. **Telescope Aperture Size and Name**: If applicable, include the aperture size followed by the telescope's specific name or type.

3. **Incorporate the Observatory or Location Name**: The name of the location or observatory where the telescope is hosted should be included, often at the end of the name.

4. ......

Figure 3: Normalization standard of AAS in text format, generated by GPT4.

Outline

Experimental Results

Evaluation Metrics:

- Exact Match (EM)

- Edit Distance Similarity (ES)

$$ES(p, r) = 1 - \frac{dist(p, r)}{\max(|p|, |r|)}$$

- ROUGEL

LLMs	Scenarios		Mentions Only			Norm. Standard			Norm. Forms			Mention-Norm. Pairs		
	Standard	Metrics	EM	ES	ROUGEL	EM	ES	ROUGEL	EM	ES	ROUGEL	EM	ES	ROUGEL
Baseline	AAS		0.27	16.72	30.72	0.27	16.72	30.72	0.27	16.72	30.72	0.27	16.72	30.72
	ADS		0.00	17.54	32.47	0.00	17.54	32.47	0.00	17.54	32.47	0.00	17.54	32.47
GPT	AAS		0.00	16.92	30.30	0.55	38.66	53.82	19.18	61.11	73.16	25.21	65.19	75.97
	ADS		0.00	21.32	29.20	0.00	26.94	37.02	28.00	62.85	67.32	45.60	72.98	76.81
Ernie	AAS		0.00	15.63	28.44	0.55	25.89	41.64	4.11	33.32	47.69	27.95	61.85	72.61
	ADS		0.00	15.58	23.42	0.00	29.74	39.75	13.60	44.68	50.75	42.40	67.36	71.46
Llama	AAS		0.00	13.83	25.97	0.55	39.49	55.49	15.07	55.56	69.13	21.37	61.99	72.55
	ADS		0.00	18.03	25.27	0.00	26.73	35.55	21.60	55.82	60.85	36.00	64.95	69.65
Mixtral	AAS		0.00	13.24	26.03	0.55	26.93	42.04	10.68	42.93	58.17	14.52	50.91	64.10
	ADS		0.00	17.06	27.00	0.00	19.27	31.29	9.60	41.00	47.09	28.00	54.13	58.23

Table 8: The full evaluation results in EM, ES and ROUGEL on the test sets in four scenarios, with the best settings derived from the experiments on the development sets.

Experimental Results

Source Mentions in ATEL	Prediction	Reference (AAS)
Mount Abu 1.2 meter telescope	Mount Abu Astronomical Observatory, Physical Research Laboratory (PRL) 1.2m Telescope at Gurushikhar	Indian Space Research Organization 1.2m InfraRed Telescope at Mount Abu InfraRed Observatory (MIRO)
AMI Large Array	Cavendish Astrophysics Group Arcminute MicroKelvin Imager (AMI) Large Array at Mullard Radio Astronomy Observatory (MRAO)	Cavendish Astrophysics Group Arcminute MicroKelvin Imager (AMI) at Mullard Radio Astronomy Observatory (MRAO)
SAAO 74\ telescope	South African Astronomical Observatory (SAAO) 1.9m Radcliffe Telescope at South African Astronomical Observatory (SAAO)	National Research Foundation of South Africa 0.75m Telescope at South African Astronomical Observatory (SAAO)
Arizona Radio Observatory's Submillimeter Telescope	University of Arizona 10m Submillimeter Telescope (SMT) at Arizona Radio Observatory (ARO)	Arizona Radio Observatory (ARO) 10m Heinrich Hertz Submillimeter Telescope at Mount Graham International Observatory
188-cm telescope at Okayama Astrophysical Observatory	National Astronomical Observatory of Japan (NAOJ) 1.88m Telescope at Okayama Astrophysical Observatory (OAO)	National Astronomical Observatory of Japan (NAOJ) 1.88m Telescope at Okayama Astrophysical Observatory (OAO)
2.0-m RCC telescope of the Bulgarian Rozhen National Astronomical Observatory	Bulgarian Academy of Sciences (BAS) Institute of Astronomy (IA) 2m RCC Telescope at Rozhen Observatory (also known as Bulgarian National Astronomical Observatory)	Bulgarian Academy of Sciences (BAS) Institute of Astronomy (IA) 2m Telescope at Rozhen Observatory (also known as Bulgarian National Astronomical Observatory)

	Annotator 1		Annotator 2	
	AAS	ADS	AAS	ADS
True Positive	15	15	15	19
True Negative	12	7	13	12
False Positive	12	11	11	6
False Negative	11	17	11	13

Table 9: Manual evaluation results of generative NEN by GPT with mention-normalization pairs.

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Conclusion

- LLM-based generative NEN performs well even when the normalization cues are very limited.

- In a few-shot setup utilizing mention normalization pairs, the generated results are virtually indistinguishable from those produced by humans.

- Under the extreme cold-start scenario, where only source mentions are provided, the model struggles to outperform a naive baseline.

- The generative normalization approach effectively remedies the shortcomings of the retrieval-based methods.

Thanks!