Explainable NLLP: Advancements in Explainable AI for Natural Legal Language Processing

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Motivation and contributions

- Increasing application of NLP in the legal domain
- But limited efforts to enhance their understanding

- We present a survey of explainable AI (XAI) applied to legal NLP:
  - Intersection of NLP, law and XAI
  - Essential intersection

- Main contributions:
  1. A **survey** on explainable natural legal language processing.
  2. **Taxonomy** based on the NLP task, explanation type and technique employed.
  3. Analysis of **research trends** in types of explanations and the utilisation of XAI.
  4. Discussion of **ethics in XAI** and the legal domain, **open issues and future work**.

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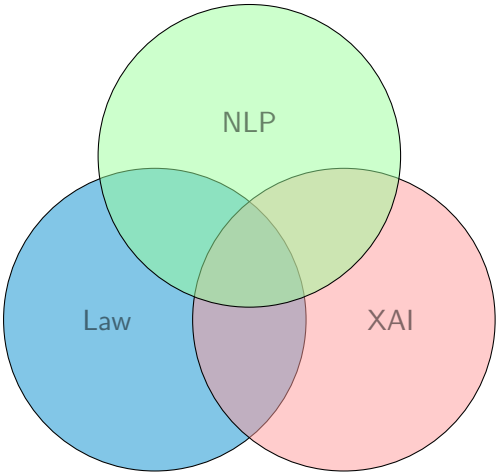
Previous surveys



We build on previous surveys:

- Danilevsky et al. [14] and Qian et al. [30]: survey on **XAI** applied to **NLP**.
  - Categorisation of explanation types and explainability methods employed.
- Katz et al. [21]: survey on **legal NLP**.
  - Categorisation of NLLP engineering tasks.

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Taxonomy

We propose the following taxonomy:

Explanation type [14, 30]:

- Local vs global
- Post-hoc vs self-explaining

Explainability technique [14]:

- Feature importance
- Surrogate model
- Provenance-based
- Declarative induction

NLP task [21]:

- Classification
- Text generation
- etc.

Ethical issues:

- Ethics mentions
- Ethics mentions in the context of XAI

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Local post-hoc

Explanation Type	Explainability Technique	NLP Task	Representative Works
Local post-hoc	Surrogate model	Classification, Information retrieval, Resources	**Benedetto et al. [4]**, Resck et al. [33], Bhambhoria, Dahan, and Zhu [6], Domingues [16], Górski and Ramakrishna [18], Rabelo et al. [32], Rabelo et al. [31], Chhatwal et al. [13]
	Feature importance	Classification, Information retrieval, Machine summarization, Resources	*Semo et al. [37]*, *T.y.s.s et al. [40]*, Górski and Ramakrishna [18], *Malik et al. [26]*, Norkute et al. [29], Mahoney et al. [25], Waltl et al. [41], Górski, Ramakrishna, and Nowosielski [19], Landthaler, Glaser, and Matthes [22]
	Declarative induction	Classification	de Arriba-Pérez et al. [15]

- **Notable XAI techniques:**
  - LIME [34, 33, 6]
  - Input gradients [39, 36, 4, 37]
- Combination of techniques [18, 29]

- Sentence-level instead of token-level [4]
- Information retrieval [33, 22]
- Machine summarisation [29]

Local self-explaining

Explanation Type	Explainability Technique	NLP Task	Representative Works
Local self-exp.	Provenance-based	Classification	Zhao, Gao, and Guo [45], Bhambhoria et al. [7], Li et al. [23], Lyu et al. [24], **Wu et al. [43]**, Branting et al. [9], **Zhong et al. [46]**, Branting et al. [8], *Chen et al. [12]*, Jiang et al. [20], Ashley and Brüninghaus [2]
	Feature importance	Classification, Machine summarization, Resources, Text generation	Bertalan and Ruiz [5], **Nielsen et al. [28]**, Wang et al. [42], *Zhou et al. [47]*, Branting et al. [9], Chalkidis et al. [11], *Malik et al. [26]*, Norkute et al. [29], Branting et al. [8], Caled et al. [10], Ye et al. [44]
	Declarative induction	Text generation	Ye et al. [44]
	Surrogate model	Classification, Information retrieval, Resources	Resck et al. [33]

- **Attention weights** [45, 28, 29]
- Classifier weights [47]
- Word- vs sentence-level [45]
- Summarisation [28, 29]
- Text generation [44]
- Intermediate labels [24, 43]

Global self-explaining

Explanation Type	Explainability Technique	NLP Task	Representative Works
Global self-exp.	Feature importance	Classification	Medvedeva, Vols, and Wieling [27], Strickson and De La Iglesia [38], Aletras et al. [1]
	Declarative induction	Classification	González-González et al. [17], de Arriba-Pérez et al. [15]

- **Classical machine learning:**
  - Feature importance of support-vector machines [1, 27]
  - Declarative induction of random forests [15, 17]
  - TF-IDF [38]

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Ethics mentions

- We identified papers that mention ethics:
  - **Nine** papers only
- A mere **four** papers leverage ethics in XAI:
  - How the explanations **ameliorate ethical issues** like fairness and non-discrimination [46, 4].
  - The framework being used to **auxiliate judges** rather than substitute them [43].
  - Ethics of one particular experimental result [28].
- Hypothesis: most works focus on the **technical aspects** of NLP and machine learning

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Role and value of explanations

- Value of explanations to various stakeholders:
  - Empower judges
  - Assist lawyers and other experts
  - Support the evaluation of AI systems by model creators
  - Provide users with the ability to understand model decisions ("right to explanation")
- Legal vs model explanation:
  - Some argue that explanations should elucidate the legal outcome only [3, 35].
  - We argue that model explanations are also valuable to other stakeholders.

Limitations and directions for improvement

Directions for improvement with XAI:

- Expose legal NLP systems limitations
- Incorporation of confidence scores

Limitations:

- Limited work on global explanations
- Limited evaluation of explanations

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Conclusion and takeaways

- A **survey** on explainable natural legal language processing:
  - **Taxonomy** based on the NLP task, explanation type and technique employed
  - **Trends** in how XAI is utilised in legal NLP
- Papers generally do not thoroughly examine or discuss:
  - **Ethical** implications
  - The **role and value** of explanations
  - The potential of explanations for pointing out **limitations** of legal NLP systems

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