



Lecture 8

Big Models X Legal Intelligence

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Outline

- Background
- Legal Artificial Intelligence Applications
- Data-Driven Methods
- Knowledge-Guided Methods
- Quantitative Analysis for Legal Theory
- Future Directions



Background

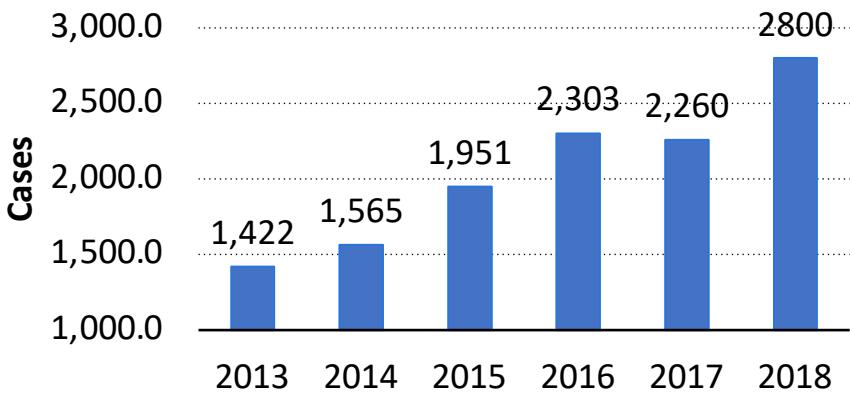
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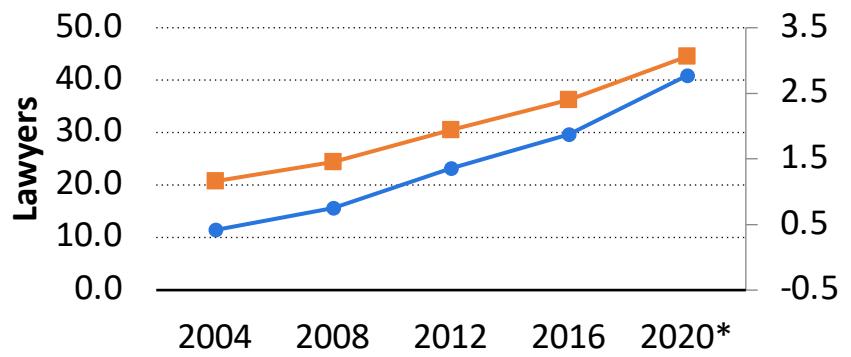
Background

- Challenges

- In US, roughly 86% of low-income individuals with civil legal problems report receiving inadequate or no legal help
- In China, roughly 80% of cases have no access to the support of lawyers



Number of cases (with a growth rate of 14.5%)

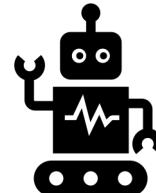


Number of lawyers (with a growth rate of 7%)

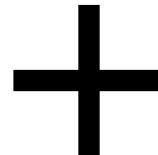


Background

- Legal Artificial Intelligence (LegalAI)
 - AI for Law: Apply the technology of artificial intelligence, especially natural language processing, to benefit tasks in the legal domain
 - Law for AI: Use laws to regulate the development, deployment, and use of AI
- AI for Law
 - Reduce the time consumption of tedious jobs and improve work efficiency for legal professionals
 - Provide a reliable reference to those who are unfamiliar with the legal domain



AI

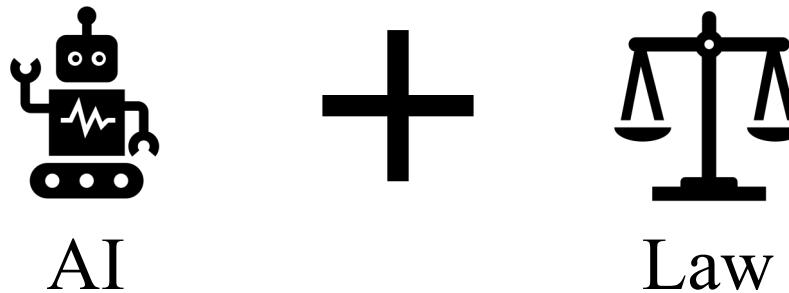


Law



Background

- Challenges
 - Lack of labeled data
 - There are only limited high-quality human-annotated data for legal tasks, and data labeling is costly
 - High demand for professional knowledge
 - Legal tasks usually involve many legal concepts and knowledge





Legal Intelligence Applications

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LegalAI Applications

- Legal Judgement Prediction
 - Given the fact description, legal judgement prediction aims to predict the judgement results, such as relevant law articles, charges, prison terms

Fact Description

Alice cheated the victim Bob 195 yuan on June 1st. After learning that Bob's Internet banking account has more than 305,000 yuan deposit and there is no daily payment limit, Alice premeditated to commit another crime. After Alice arrived at the Internet cafe, she sent Bob a transaction amount, which was labeled as 1 yuan and was actually implanted a false link to the computer program to pay 305,000 yuan. She falsely claimed that after Bob clicked on the 1 yuan payment link, he could view the record of successful payment ...



Related Law Articles

[1] Criminals who **steal** property in especially large amounts or have other particularly serious circumstances, shall be sentenced to **more than ten years of fixed-term imprisonment or life imprisonment** ...

[2] Criminals who **fraud** property in a relatively large amounts, shall be sentenced to **fixed-term imprisonment of no more than three years, criminal detention or public surveillance** ...

Charges

Crime of Theft

Crime of Fraud

Prison Term

Cumulative Punishment: **Ten years and three months**



LegalAI Applications

- Legal Judgement Prediction
 - Multiple subtasks
 - Criminal cases: relevant law article prediction, charge prediction, prison term prediction, fine prediction
 - Civil cases: relevant law article prediction, cause of action prediction,
 - Task formalization
 - Inputs: the fact description
 - Relevant law article: classification
 - Charge/Cause of action: classification
 - Prison term/Fine: regression
 - Challenges
 - Confusing charges
 - Interpretability



LegalAI Applications

- Similar Case Retrieval
 - Given a query case, similar case retrieval aims to retrieve relevant supporting cases

Query	Candidate
<p>Case Description: From January 3, 2017 to March 12, 2019, the defendant A has illegally sold Mark Six through WeChat and bank card transfers ...</p>	<p>Case Name: The case of B illegally opening a casino Case Description: On September 19, 2019, the defendant <i>B</i> used WeChat to sale the Mark Six Lottery in a supermarket illegally ... Judgment: Crime of opening a casino ... Label: 1 (Very relevant)</p>



LegalAI Applications

- Similar Case Retrieval
 - Task formalization
 - Query case: q
 - Candidate cases: $C = \{c_1, \dots, c_n\}$
 - Outputs: relevance score for each query-candidate pair (q, c_i)
 - Challenges
 - Long document matching
 - Relevance definition
 - Diverse user intention



LegalAI Applications

- Legal Question Answering

- Legal question answering aims to provide explanations, advice, or answers for legal questions

Knowledge-Driven Question: Which of the following belong to the “property” of Civil Law?

Option:

- ✗ A. Trademark. ✗ B. The star on the sky.
 - ✗ C. Gold teeth. ✓ D. Fish in the pond.
-

Case-Analysis Question: Alice owed Bob 3,000 yuan. Alice proposed to pay back with 10,000 yuan of counterfeit money. Bob agreed and accepted it. Which crimes did Alice commit?

Option:

- ✓ A. Crime of selling counterfeit money.
 - ✗ B. Crime of using counterfeit money.
 - ✗ C. Crime of embezzlement.
 - ✗ D. Alice did not constitute a crime.
-



LegalAI Applications

- Legal Question Answering
 - Task formalization
 - Inputs: question
 - Step 1: retrieve the relevant knowledge (law articles, legal concepts) from the knowledge base
 - Step 2: answer the question based on the relevant knowledge
 - Challenges
 - Concept-Fact Matching
 - Multi-hop reasoning
 - Numerical reasoning



LegalAI Applications

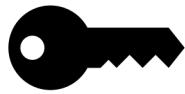
- Court View Generation

- Given the fact description and plaintiff's claim, court view generation aims to generate the rationales and results of the cases.
- Task formalization
 - Inputs: claim and fact description
 - Outputs: The decisions (Accept/Reject) and the corresponding reasons

PLAINTIFF'S CLAIM	The plaintiff A claimed that the defendant B should return the loan of \$29,500 <i>Principle Claim</i> and the corresponding interest <i>Interest Claim</i> .
FACT DESCRIPTION	After the hearing, the court held the facts as follows: The defendant B borrowed \$29,500 from the plaintiff A, and agreed to return after one month. After the loan expired, the defendant failed to return <i>Fact</i> .
COURT'S VIEW	The court concluded that the loan relationship between the plaintiff A and the defendant B is valid. The defendant failed to return the money on time <i>Rationale</i> . Therefore, the plaintiff's claim on principle was supported <i>Acceptance</i> according to law. The court did not support the plaintiff's claim on interest <i>Rejection</i> because the evidence was insufficient <i>Rationale</i> .



LegalAI Applications



Legal Cases
Retrieval



Legal Judgment
Prediction



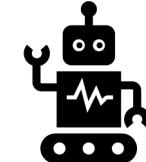
Legal Documents
Generation



Legal Information
Recommendation



Legal Documents
Translation



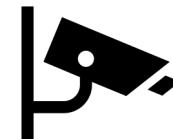
Legal Question-
Answering



Risk
Warning



Legal Text
Mining



Compliance
Review



Two Lines of Research

- Two lines of research



Legal Cases



Trademarks
Patents



Court Trial



Legal Regulations



Judicial
Interpretation



Legal Literatures

Data-Driven Methods

Knowledge-Guided Methods



Data-Driven Methods

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Data-Driven Methods

- Data-Driven Methods
 - Utilize deep neural networks to capture semantic representations from large-scale data
 - Large-scale open-source legal corpora
 - 130 millions legal case documents
 - 160 millions patents/trademarks documents
 - 19 millions court trial data
 - Typical data-driven methods
 - Word embeddings
 - Pre-trained language models



Legal Pretrained Language Models

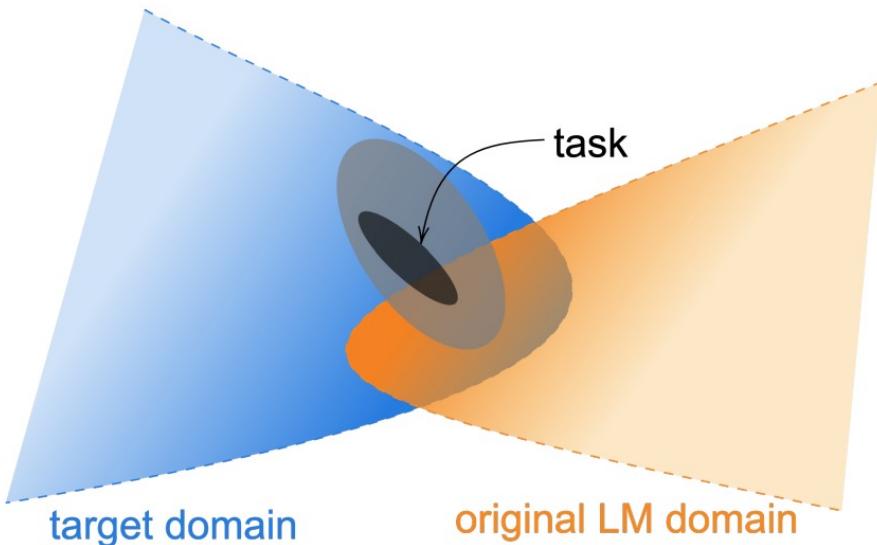
- Open-domain PLMs is suboptimal for the legal domain
 - Differences in narrative habits and writing styles
 - Many terminology and concepts in legal documents
- Train PLMs based on large-scale unlabeled legal documents
 - Masked Language Model

暴 力
↑ ↑
... 以 [MASK] [MASK] 、 威 胁 或 者 限 制 人 身 自 由 ...



Legal Pretrained Language Models

- PLMs in the legal domain
 - Don't stop pre-training!
 - Additional pre-training on target corpora can lead to performance improvement

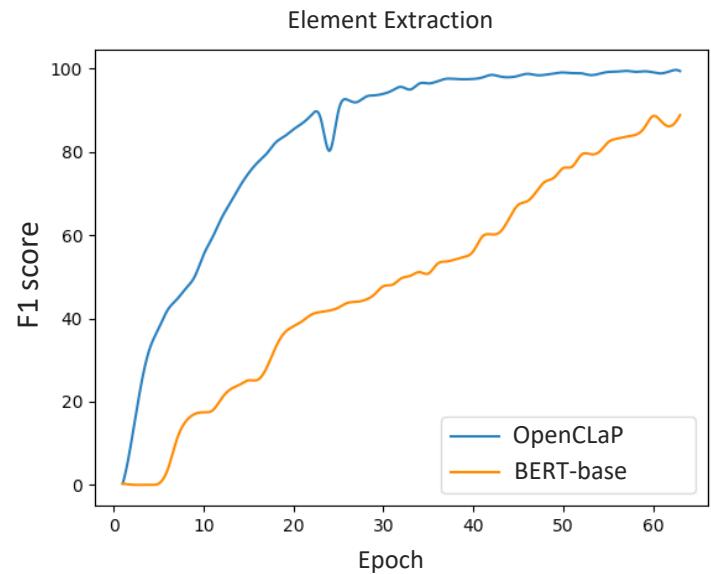
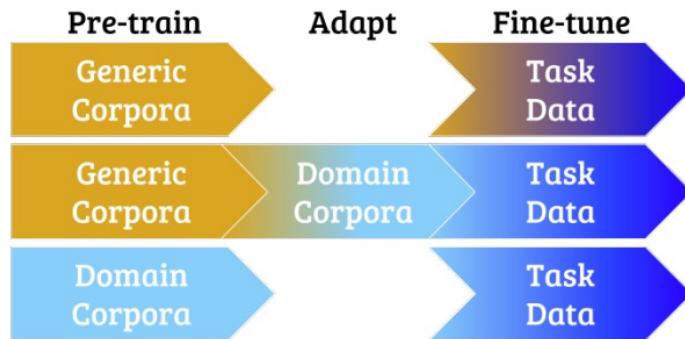


Dom.	Task	RoBA.	DAPT	¬DAPT
BM	CHEMPROT	81.9 _{1.0}	84.2 _{0.2}	79.4 _{1.3}
	†RCT	87.2 _{0.1}	87.6 _{0.1}	86.9 _{0.1}
CS	ACL-ARC	63.0 _{5.8}	75.4 _{2.5}	66.4 _{4.1}
	SCIERC	77.3 _{1.9}	80.8 _{1.5}	79.2 _{0.9}
NEWS	HYP.	86.6 _{0.9}	88.2 _{5.9}	76.4 _{4.9}
	†AGNEWS	93.9 _{0.2}	93.9 _{0.2}	93.5 _{0.2}
REV.	†HELPFUL.	65.1 _{3.4}	66.5 _{1.4}	65.1 _{2.8}
	†IMDB	95.0 _{0.2}	95.4 _{0.2}	94.1 _{0.4}



Legal Pretrained Language Models

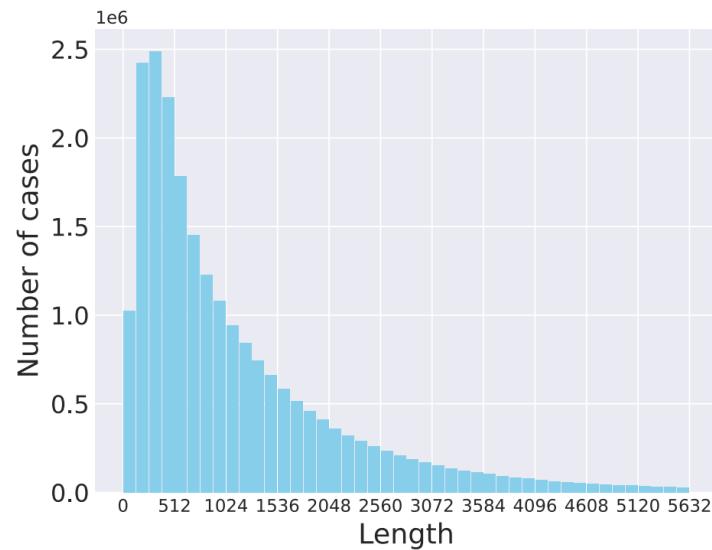
- PLMs in the legal domain
 - Legal-BERT: pretrained on English legal documents
 - OpenCLaP: pretrained on Chinese legal documents





Legal Pretrained Language Models

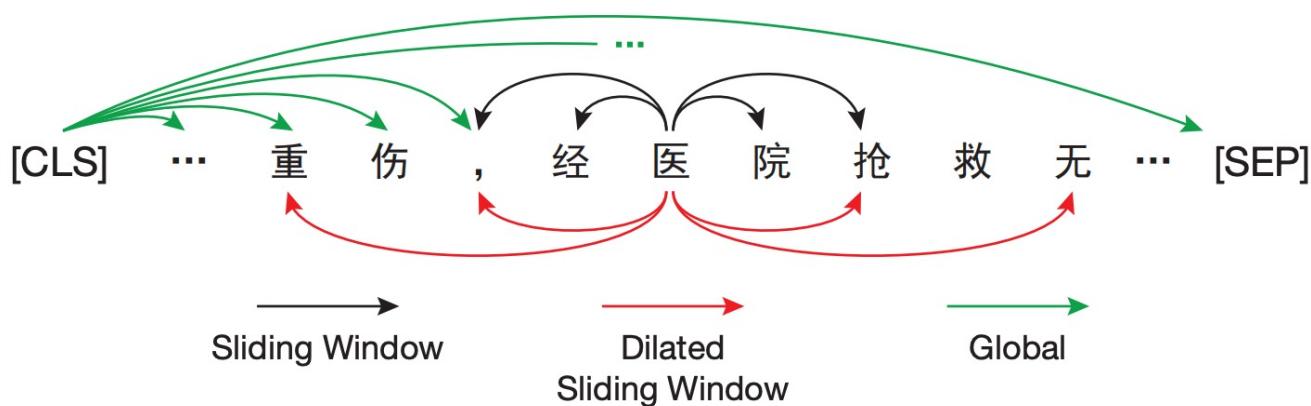
- PLMs for **long documents** in the legal domain
 - Legal documents usually involve complex facts and consist of 1260.2 tokens on average
 - Most existing PLMs can only handle documents with no more than 512 tokens





Legal Pretrained Language Models

- PLMs for **legal long documents** in the legal domain
 - Lawformer utilizes the sparse self-attention mechanism instead of full self-attention mechanism to encode the long documents





Legal Pretrained Language Models

- PLMs for legal long documents in the legal domain

Pre-training Data			Model Parameters	Tasks
Num. of Doc.	Avg. Length	Data Size	参数量 层数 隐向量维度 层注意力数 最大长度 训练步数	109M 12 768 12 4096 20w
Civil Documents				Judgement Prediction
1738w	1353.1	67G		Similar Case Retrieval
Criminal Documents				Reading Comprehension
542w	962.8	17G		Question Answering



Legal Pretrained Language Models

- PLMs for **legal long documents** in the legal domain
 - Lawformer can achieve significant performance improvement

Model	criminal					civil			
	Mic@c	Mac@c	Mic@1	Mac@1	Dis@t	Mic@c	Mac@c	Mic@1	Mac@1
BERT	94.8	68.2	81.5	52.9	1.286	80.6	47.6	61.7	31.6
RoBERTa	94.7	69.3	81.1	53.5	1.291	80.0	47.2	60.2	29.9
L-RoBERTa	94.9	70.8	81.1	53.4	1.280	80.8	49.4	61.2	31.3
Lawformer	95.4	72.1	82.0	54.3	1.264	81.1	50.0	63.0	33.0

Legal judgement prediction

Model	P@5	P@10	P@20	P@30	NDCG@5	NDCG@10	NDCG@20	NDCG@30	MAP
BERT	44.27	41.83	36.73	33.49	78.18	80.06	84.43	91.46	50.65
RoBERTa	45.93	41.71	36.53	33.40	79.93	80.57	84.99	91.82	50.77
L-RoBERTa	45.75	42.85	37.79	33.58	78.90	81.01	85.26	91.70	50.17
Lawformer	51.91	46.44	37.95	33.99	83.11	84.05	87.06	93.22	57.36

Similar case retrieval



Legal Pretrained Language Models

- Legal PLMs: Learning Responsible Data Filtering from the Law
 - Privacy Filtering
 - the law provides a number of useful heuristics that researchers could deploy to sanitize data
 - juvenile names, dates of birth, account, and identity number

被告人陆贵昌在商场附近，见到受害者 罗彩连

罗某某





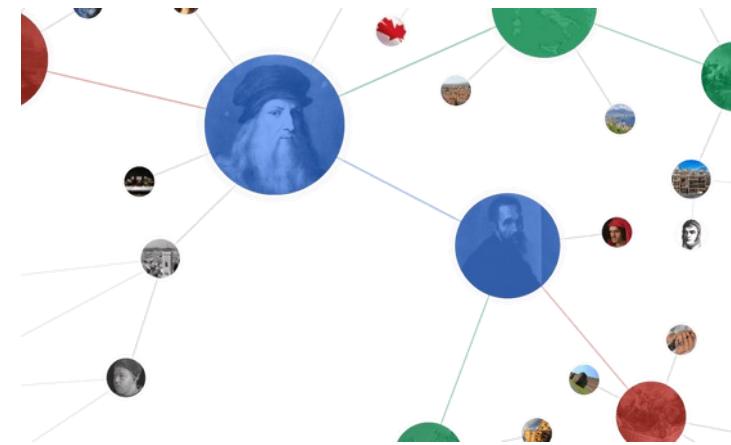
Knowledge-Guided Methods

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Knowledge-Guided Methods

- Knowledge-Guided Methods
 - Enhance the data-driven neural models with the legal domain knowledge to improve the performance and interpretability on downstream tasks
 - Knowledge in open-domain
 - Knowledge Graphs
 - Typical legal knowledge
 - Events occurred in the cases
 - Decision-making elements
 - Legal logic
 - Legal regulations





LegalAI Applications

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Charges

Crime of Theft

Crime of Fraud

Prison Term

Cumulative Punishment: **Ten years and three months**



Knowledge-Guided Methods

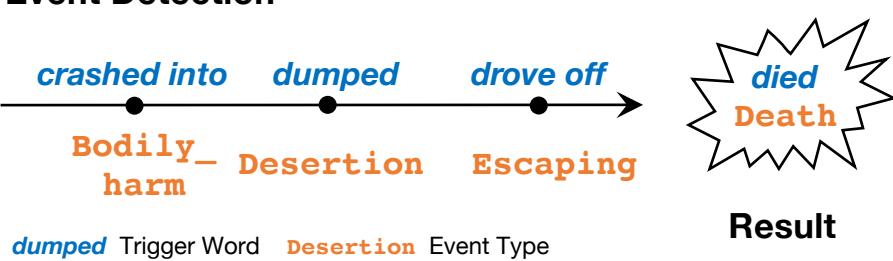
- Legal Event Knowledge

- Key of Legal Case Analysis: Identifying occurred events and causal relations between these events
- Legal events can serve as high-quality case representations

Fact Description

Alice drove a car at night and **crashed into** Bob, a pedestrian, on Green Avenue. To prevent being spotted, Alice took Bob away from the scene, **dumped** him under an isolated bridge and **drove off** in a panic. Two hours later, Bob **died** of excessive bleeding ...

Event Detection



Related Law Article

Traffic accident crime ... if the **hit-and-run** occurs, the crime should be sentenced to **imprisonment more than 3 years but less than 7 years** ... if the perpetrator **abandons** the victim, resulting in the **death**, he shall be convicted of Intentional homicide crime and sentenced to **death, life imprisonment or imprisonment of no less than 10 years** ...

Crime & Prison Term

Intentional homicide crime
10 years and 6 months



Knowledge-Guided Methods

- Existing Legal Event Datasets
 - Incomprehensive event schema
 - Limited coverage: only contain tens of event types with a narrow scope of charges
 - Inappropriately defined: only contain charge-oriented charges and ignore general events
 - Limited data annotations
 - Only contain thousands of event mentions



Knowledge-Guided Methods

- Our Goal

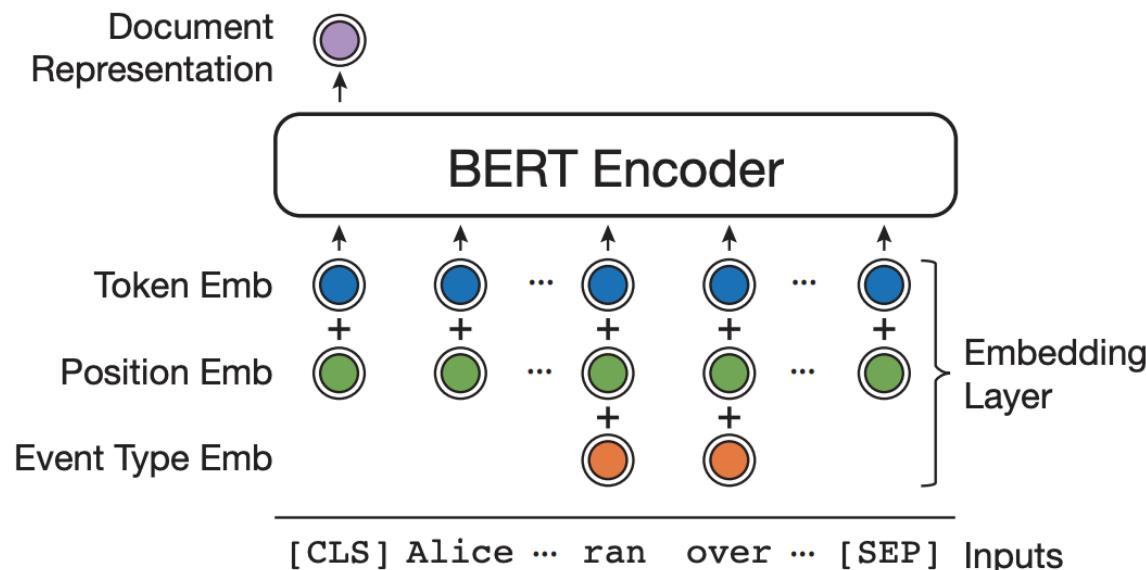
- Large-scale: 8,116 legal documents with 118 criminal charges and 150,977 mentions
- High coverage: 108 event types, including 64 charge-oriented events and 44 general events

Dataset	#Documents	#Tokens	#Sentences	#Event Types	#Event Mentions	Language	Domain
MAVEN	4,480	1,276k	49,873	168	118,732	English	General
ACE2005-zh	633	185k	7,955	33	4,090	Chinese	General
DuEE	11,224	530k	16,900	65	19,640	Chinese	General
DivorceEE*	3,100	–	–	13	–	Chinese	Legal
CLEE*	3,000	–	6,538	5	6,538	Chinese	Legal
DyHiLED*	–	–	–	11	2,380	Chinese	Legal
LEVEN	8,116	2,241k	63,616	108	150,977	Chinese	Legal



Knowledge-Guided Methods

- Legal Events for Downstream Tasks
 - Combine the pretrained models with the legal event knowledge
 - Add occurred events as additional features to generate the document representation





Knowledge-Guided Methods

- Legal Events for Judgement Prediction
 - Combine the pretrained models with the legal event knowledge
 - Utilize occurred events as features to represent legal cases

low-resource setting:

full-data setting:

Model	Charge			Law			Term Dis ↓
	P	R	F1	P	R	F1	
<i>50-shot</i>							
BERT + event	76.6 79.2	77.0 76.2	76.8 77.7	73.6 75.4	76.8 75.6	75.2 75.5	2.398 2.364
<i>full</i>							
BERT + event	88.2 88.2	89.4 89.7	88.8 88.9	83.7 83.8	86.8 87.7	85.2 85.7	1.895 1.878



Knowledge-Guided Methods

- Legal Events for Similar Case Retrieval
 - Combine the pretrained models with the legal event knowledge
 - Utilize occurred events as features to represent legal cases

	Model	MAP	NDCG@10	NDCG@20	NDCG@30	P@5	P@10
unsupervised setting:	BM25	48.40	73.10	79.70	88.80	40.60	38.10
	TFIDF	45.70	79.50	83.20	84.80	30.40	26.10
	LMIR	49.50	76.90	81.80	90.00	43.60	40.60
	Bag-of-Event	50.94	78.37	83.66	90.32	44.11	42.62
	Bag-of-Event _w	51.02	79.90	84.42	90.97	45.23	43.36
supervised setting	BERT	51.92	79.23	84.12	91.28	44.49	40.10
	+ event	51.99	80.10	84.92	91.73	44.63	41.22



Knowledge-Guided Methods

- Legal Element Knowledge
 - Legal elements refer to crucial attributes of legal cases, which are summarized by legal experts

Fact Description: One day, Bob used a fake reason for marriage decoration to borrow RMB 2k from Alice. After arrested, Bob has paid the money back to Alice.

Whether did Bob sell something? | ×

Whether did Bob make a fictional fact? | ✓

Whether did Bob illegally possess the property of others? | ✓

Judgment Results: Fraud.

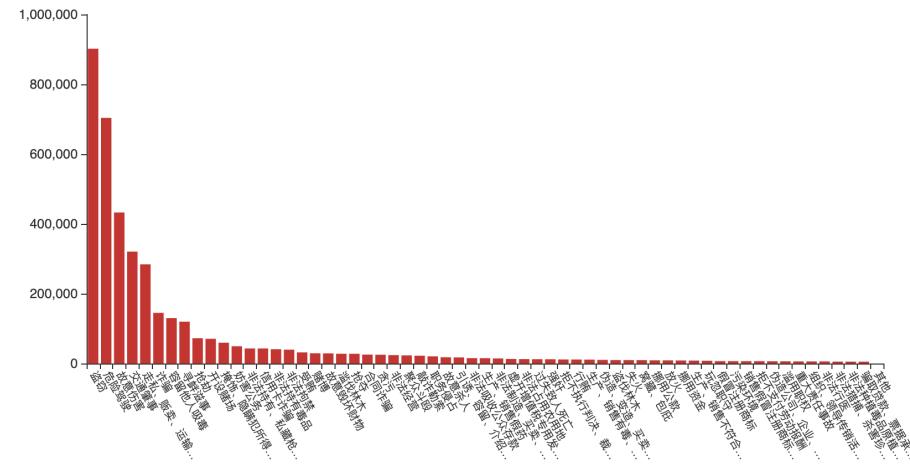


Knowledge-Guided Methods

- Legal Element Knowledge

- Long-tail distribution

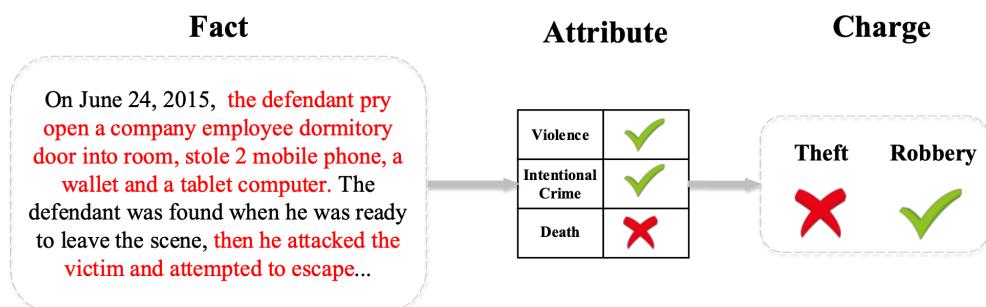
- Top 10 charges cover 78.1% cases



The number of cases for different charges

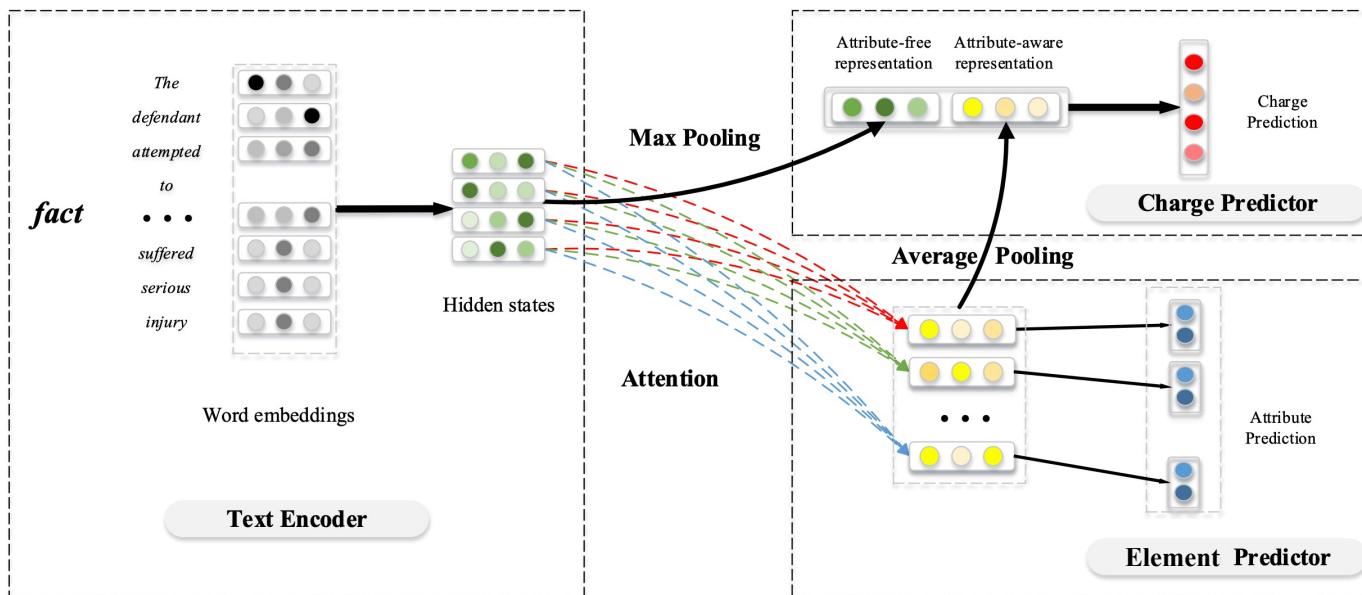
- Confusing charges

- Theft vs. Robbery



Knowledge-Guided Methods

- Legal Elements for few-shot and confusing charges
 - Combine data-driven deep learning methods with legal element knowledge
 - Utilize elements as additional supervision signals to improve the performance on low-frequency charges





Knowledge-Guided Methods

- Legal Elements for few-shot and confusing charges
 - Combine data-driven deep learning methods with legal element knowledge
 - Utilize elements as additional supervision signals to improve the performance on low-frequency charges

Datasets	Criminal-S				Criminal-M				Criminal-L			
Metrics	Acc.	MP	MR	F1	Acc.	MP	MR	F1	Acc.	MP	MR	F1
TFIDF+SVM	85.8	49.7	41.9	43.5	89.6	58.8	50.1	52.1	91.8	67.5	54.1	57.5
CNN	91.9	50.5	44.9	46.1	93.5	57.6	48.1	50.5	93.9	66.0	50.3	54.7
CNN-200	92.6	51.1	46.3	47.3	92.8	56.2	50.0	50.8	94.1	61.9	50.0	53.1
LSTM	93.5	59.4	58.6	57.3	94.7	65.8	63.0	62.6	95.5	69.8	67.0	66.8
LSTM-200	92.7	60.0	58.4	57.0	94.4	66.5	62.4	62.7	95.1	72.8	66.7	67.9
Fact-Law Att.	92.8	57.0	53.9	53.4	94.7	66.7	60.4	61.8	95.7	73.3	67.1	68.6
Our Model	93.4	66.7	69.2	64.9	94.4	68.3	69.2	67.1	95.8	75.8	73.7	73.1

Charge Type	Low frequency	Medium frequency	High frequency
Charge Number	49	51	49
LSTM-200	32.6	55.0	83.3
Our Model	49.7 (↑ 17.1 %)	60.0 (↑ 5.0 %)	85.2 (↑ 1.9 %)



Knowledge-Guided Methods

- Legal Elements for interpretable prediction
 - Existing methods usually suffer from the lack of interpretability, which may lead to ethical issues
 - Following the principle of elemental trial, QAJudge is proposed to visualize the prediction process and give interpretable judgments

Fact Description: After drinking alcohol, Bob was arrested by the police when driving a small car to the entrance of the expressway. After examination, the blood alcohol content of Bob was 173mg/100ml.

1. Is the case related to traffic? | ✓

2. Did an accident occur? | ×

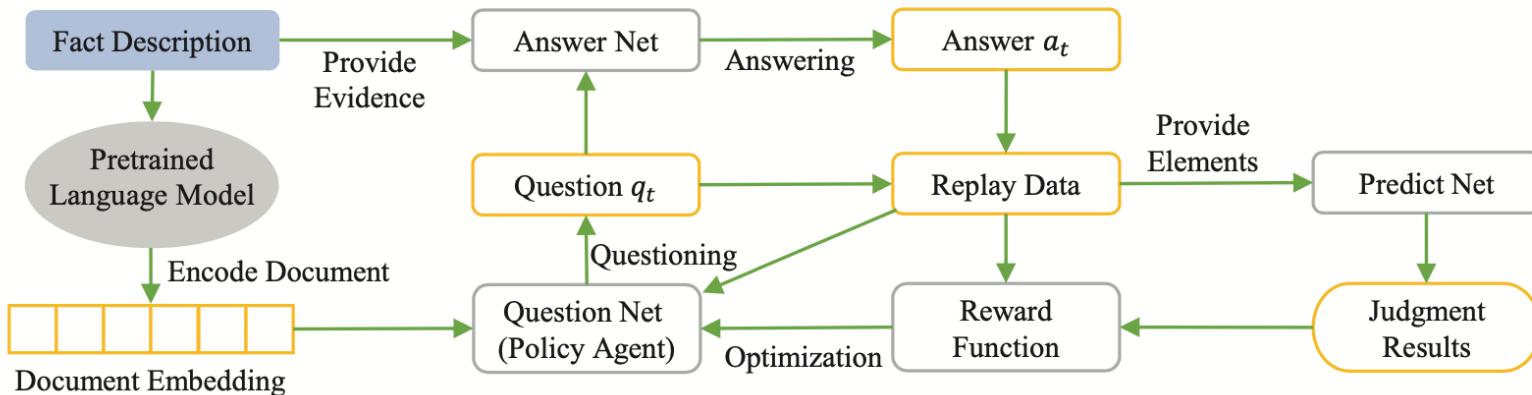
3. Did the party drink alcohol? | ✓

Judgment Results: Reckless Driving, Article 133.



Knowledge-Guided Methods

- Legal Elements for interpretable prediction
 - Existing methods usually suffer from the lack of interpretability, which may lead to ethical issues
 - Following the principle of elemental trial, QAJudge is proposed to visualize the prediction process and give interpretable judgments





Knowledge-Guided Methods

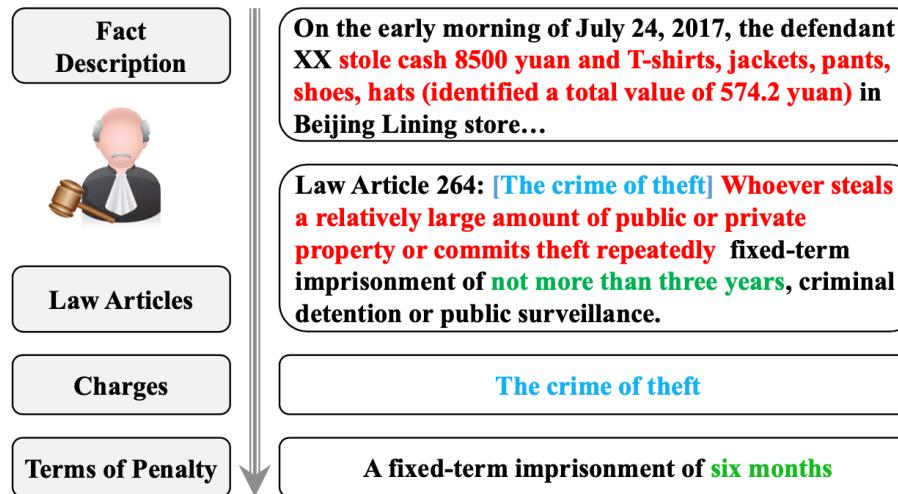
- Legal Elements for interpretable prediction
 - QAJudge can achieve comparable results with SOTA models, and provide explanation for the prediction results

Datasets	CJO				PKU				CAIL			
Metrics	Acc	MP	MR	MF	Acc	MP	MR	MF	Acc	MP	MR	MF
DPCNN	95.8	96.0	95.9	95.8	95.9	96.1	95.8	95.8	95.1	95.3	95.3	95.2
GRU	95.7	95.7	95.8	95.7	96.1	96.1	96.1	96.0	95.4	95.4	95.7	95.5
Bert	96.9	96.9	96.9	96.9	96.3	96.1	96.0	96.0	96.6	96.1	96.3	96.2
Fact-Law	96.6	96.5	96.8	96.6	98.4	96.7	95.6	96.0	95.8	95.8	95.8	95.8
Attribute-based	97.4	96.5	97.5	96.9	98.1	98.0	95.2	95.9	96.5	96.4	96.6	96.5
Topjudge	96.8	96.7	96.6	96.6	97.7	97.5	95.7	96.3	96.4	96.2	96.4	96.3
QAjudge($K = 3$)	88.2	88.8	88.2	87.8	88.1	89.0	88.1	88.0	88.7	89.2	88.9	88.5
QAjudge($K = 6$)	92.9	93.3	92.9	92.9	92.7	93.2	92.7	92.7	91.7	92.4	91.9	91.8
QAjudge($K = 9$)	94.1	94.4	94.1	94.1	93.3	93.5	93.3	93.3	92.3	92.6	92.5	92.3



Knowledge-Guided Methods

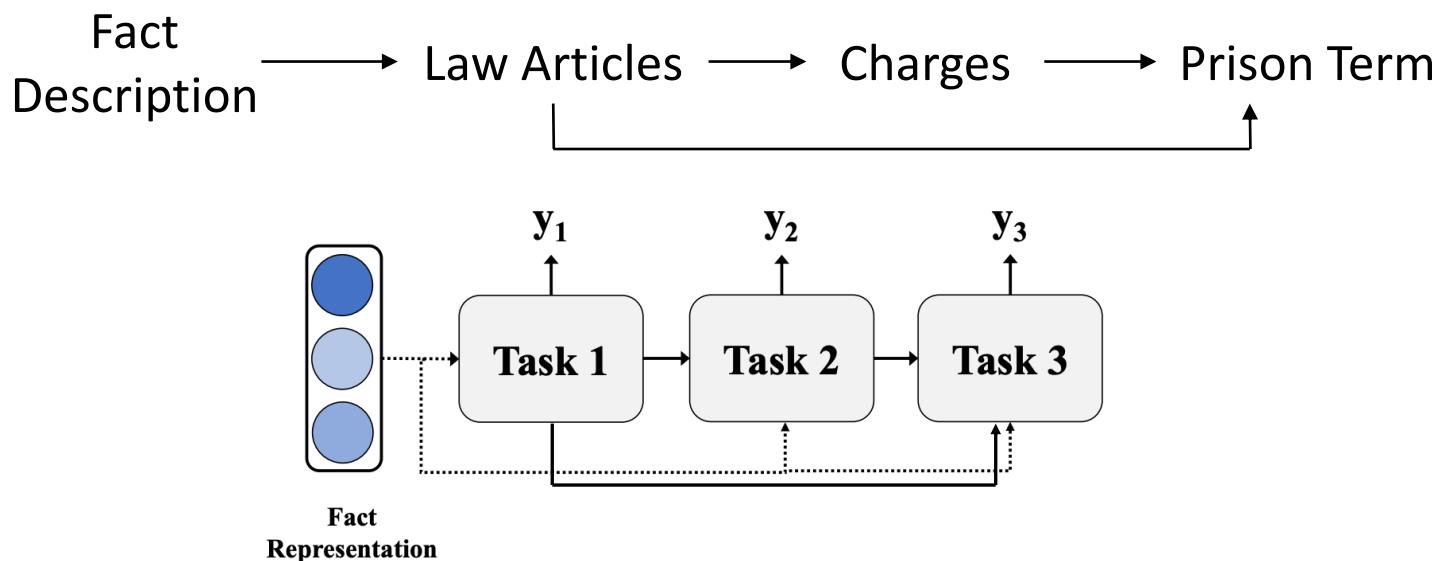
- Legal Logic Knowledge
 - Topological dependencies between subtasks
 - There exists a strict order among the subtasks of legal judgment





Knowledge-Guided Methods

- Legal Logic Knowledge
 - Topological dependencies between subtasks
 - Capture the dependencies with recurrent neural network unit





Knowledge-Guided Methods

- Legal Logic Knowledge
 - Topological dependencies between subtasks
 - Capture the dependencies with recurrent neural network unit

	Tasks	Law Articles				Charges				The Term of Penalty			
		Metrics	Acc.	MP	MR	F ₁	Acc.	MP	MR	F ₁	Acc.	MP	MR
Single	TFIDF+SVM	60.1	54.9	45.3	46.3	59.2	53.9	45.0	45.7	28.4	22.9	20.0	18.1
	CNN	81.4	74.4	64.1	65.7	80.7	77.3	65.5	67.2	28.8	34.7	27.8	28.6
	HLSTM	-	-	-	-	-	-	-	-	-	-	-	-
Multi	Fact-Law Att.	70.9	64.8	63.6	59.1	68.7	66.1	65.3	60.1	36.5	29.9	27.6	27.1
	PM	84.7	80.7	68.6	70.8	83.6	81.6	70.0	72.1	40.0	37.4	32.0	31.6
	CNN-MTL	84.5	80.0	68.1	70.3	83.4	81.6	69.1	71.6	39.5	37.2	32.3	31.3
	HLSTM-MTL	-	-	-	-	-	-	-	-	-	-	-	-
Ours	TOPJUDGE	86.3	81.9	71.1	73.4	85.7	83.4	76.0	78.3	38.3	36.1	33.1	32.1



Knowledge-Guided Methods

- Legal Regulations

- Legal regulations are one of the most important knowledge bases for legal intelligence systems
- Compared to structured legal knowledge, unstructured legal regulations do not require manual knowledge summarization, so the cost of acquiring such knowledge is much lower

... **经审理查明**, 2011年10月6日凌晨, 被告人AA携带改锥、扳手、破坏钳、刀等物品到尉氏县张市镇尹庄村BB家门口盗窃农用车上的电瓶时被被害人BB发现, 在逃跑过程中AA为抗拒抓捕持刀将BB致伤。 ...

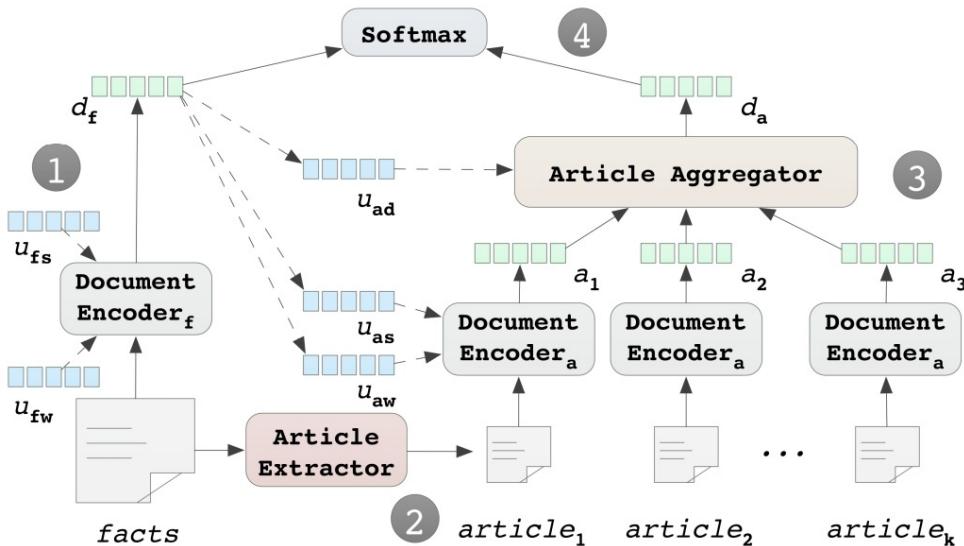
本院认为, 被告人AA在盗窃过程中携带凶器, 为抗拒抓捕而当场使用暴力致被害人BB轻微伤, 其行为已构成抢劫罪, ...
依照《中华人民共和国刑法》第二百六十三条、第二百六十九条、...之规定, **判决如下**:

被告人AA犯**抢劫罪**, 判处有期徒刑三年, 并处罚金人民币一千元。 ...



Knowledge-Guided Methods

- Legal Regulations for Judgement Prediction
 - The judgement results are predicted based on both the fact descriptions and relevant law articles
 - The aggregation is performed via the attention mechanism



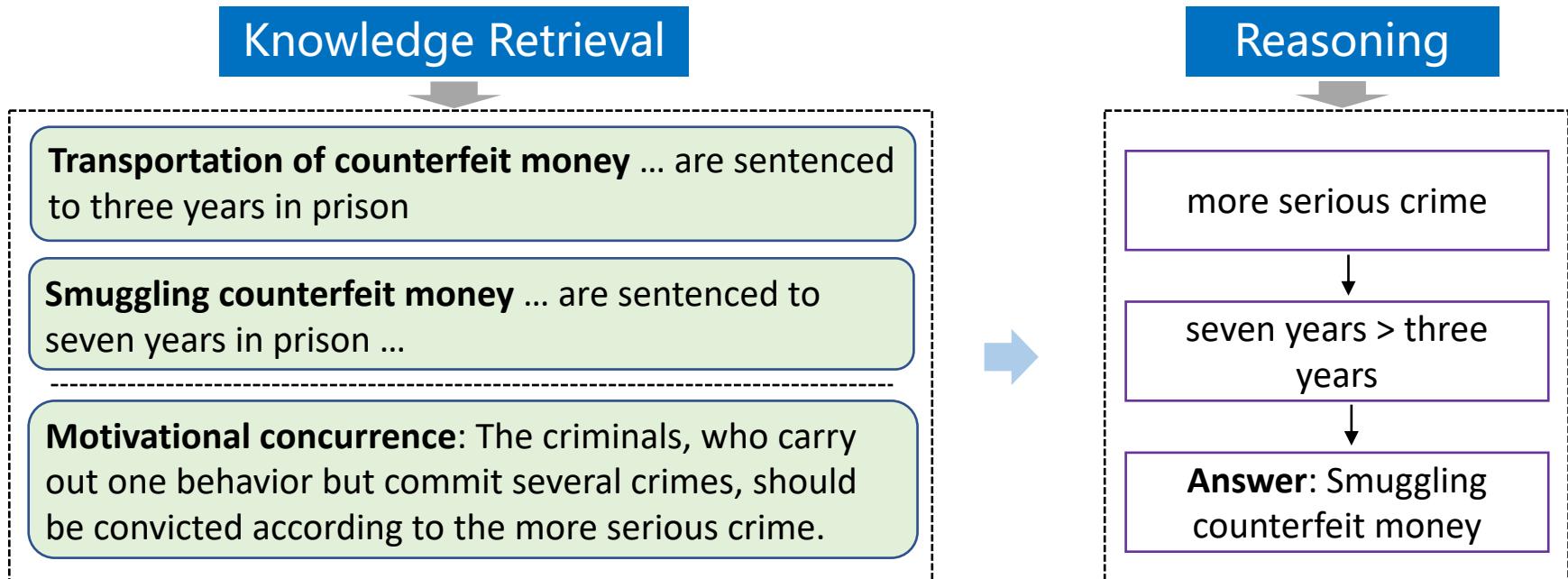
Model	Precision	Recall	F1
	(Micro-/Macro-)		
SVM_fact	93.94 /79.53	77.66/49.54	85.03/61.05
SVM_art	82.12/42.90	61.23/39.56	70.15/41.16
SVM_fact_art	91.77/71.33	72.10/45.85	80.76/55.82
NN_fact	91.30/ 83.32	87.39/74.99	89.31/78.94
NN_art	90.09/81.50	86.10/69.62	88.05/75.10
NN_fact_art	90.79/83.07	88.42/75.73	89.59/79.23
NN_fact_supv_art	91.80/82.44	88.67 / 78.62	90.21 / 80.48
SVM_fact_gold_art	98.97 /94.58	95.39/83.21	97.15/88.53
NN_fact_gold_art	98.78/ 95.26	98.24 / 95.57	98.51 / 95.42



Knowledge-Guided Methods

- Legal Regulations for Question Answering
 - Textual legal regulations and cognitive reasoning are required for legal QA

Question: Which crimes did Alice commit if she transported more than 10,000 yuan of counterfeit currency from abroad to China





Knowledge-Guided Methods

- Legal Regulations for Question Answering
 - Cognitive reasoning are required for legal QA

Reasoning Type	KD-Q	CA-Q	All	Examples
Word Matching	65.9%	23.9%	40.5%	<p>Question: Which option is a form of state compensation?</p> <p>Option: Monetary awards</p> <p>Paragraph: Monetary awards is a form of state compensation.</p>
Concept Understanding	36.4%	42.8%	40.2%	<p>Question: Who is the <i>principal offender</i> according to Criminal Law?</p> <p>Option: Bob, the leader of a robbery group, who ordered his subordinates to commit robbery on multiple occasions, but was never personally involved.</p> <p>Paragraph: The <i>principal offender</i> is the person in a group of offenders who leads, organizes, and carries out the main part of a criminal act.</p>
Numerical Analysis	4.6%	14.9%	10.8%	<p>Question: In which of the following circumstances should an extraordinary general meeting of shareholders be convened?</p> <p>Option: The registered capital of the company is <i>12 million yuan</i>, and the unrecovered loss is <i>5 million</i>.</p> <p>Paragraph: In the following circumstances, an extraordinary general meeting of shareholders should be convened: (1) When the unrecovered losses amount to <i>one-third of the total paid-up share capital</i>; ...</p>
Multi-Paragraph Reading	19.7%	29.4%	25.5%	<p>Question: Which statement is true about corporate crimes?</p> <p>Option: Corporates can be the subject of bank fraud.</p> <p>Paragraph 1: Article 200 of Criminal Law: The punishment of fraud offenses committed by corporates. If a corporate commits any crimes specified in <i>articles 192, 194, or 195 of this section</i>, it shall be fined.</p> <p>Paragraph 2: Article 194 of Criminal Law: <i>Bank fraud...</i></p>
Multi-Hop Reasoning	8.33%	66.2%	43.2%	Shown in Fig. 1.



Knowledge-Guided Methods

- Legal Regulations for Question Answering
 - Semantic retrieval and cognitive reasoning are required for legal QA

Type	AH	PM	AM
All questions	45.69	35.77	18.54
KD-questions	<u>59.55</u>	28.09	12.36
CA-questions	38.76	<u>39.61</u>	<u>21.63</u>
Word Matching	<u>62.22</u>	26.67	11.11
Concept Understanding	42.54	35.82	21.64
Numerical Analysis	38.89	33.33	<u>27.78</u>
Multi-Paragraph Reading	38.82	<u>48.24</u>	12.94
Multi-Hop Reasoning	38.89	37.50	23.61

	KD-questions		CA-questions		All	
	Single	All	Single	All	Single	All
Unskilled Humans	76.92	71.11	62.50	58.00	70.00	64.21
Skilled Humans	80.64	77.46	86.84	84.72	84.06	81.12
Co-matching (Wang et al. 2018a)	39.62	25.37	48.91	28.61	46.47	26.06
BERT (Devlin et al. 2018)	38.05	21.13	38.89	23.72	39.56	22.51
SeaReader (Zhang et al. 2018)	39.29	24.11	45.32	26.01	40.50	23.77
Multi-Matching (Tang, Cai, and Zhuo 2019)	41.96	23.63	46.18	29.06	42.98	28.63
CSA (Chen et al. 2019)	32.44	-	34.76	-	21.03	-
CBM (Clark and Gardner 2018)	40.35	22.54	37.37	22.50	38.69	22.53
DSQA (Lin et al. 2018)	34.15	18.41	42.72	23.25	42.63	22.69



Knowledge-Guided Methods

- Legal Knowledge-Guided Methods
 - Legal Event Knowledge
 - Legal Element Knowledge
 - Legal Logic Knowledge
 - Legal Regulation Knowledge
 -
- Advantages
 - Learn from limited labelled data
 - Improve the reasoning ability
- Demo
 - <https://law.thunlp.org/>



Quantitative Analysis for Legal Theory

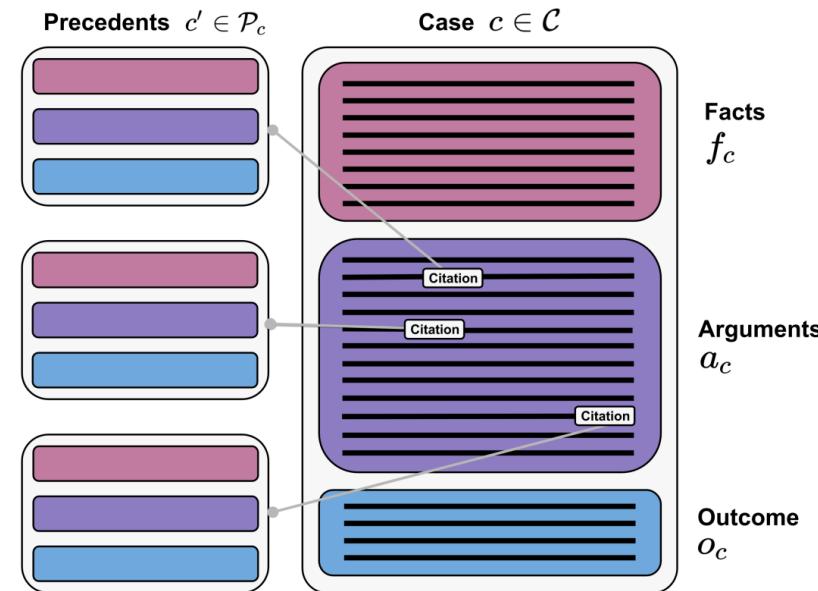
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Quantitative Analysis for Legal Theory

- Mining patterns from a large number of case documents to improve or supplement legal theory
- Common Law System
 - The outcome of a new case is determined mostly by precedent cases, rather than by existing statutes

- **Halsbury** believes that the **arguments** of the precedent are the main determinant of the outcome.
- **Goodhart** believes that what matters most is the **precedent's facts**.





Quantitative Analysis for Legal Theory

- Mutual information test

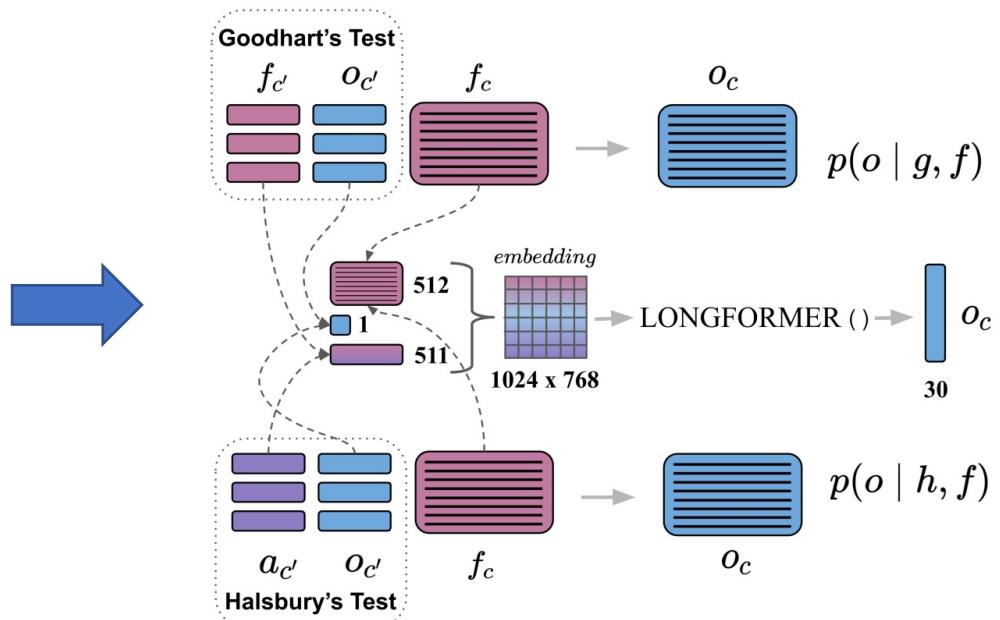
Halsbury's Test $MI(O; H | F) = H(O | F) - H(O | H, F)$

Goodhart's Test $MI(O; G | F) = H(O | F) - H(O | G, F)$

$$H(O | H, F) = - \sum_{o,h,f} p(o, h, f) \log p(o | h, f)$$

$$H(O | G, F) = - \sum_{o,g,f} p(o, g, f) \log p(o | g, f)$$

$$H(O | F) = - \sum_{o,f} p(o, f) \log p(o | f)$$





Quantitative Analysis for Legal Theory

- Mutual information test
 - **Halsbury** believes that the **arguments** of the precedent are the main determinant of the outcome
 - **Goodhart** believes that what matters most is the **precedent's facts**

Model Input	H_θ	MI	U
Facts	2.99	-	-
Goodhart	2.81	0.18	6%
Halsbury	2.68	0.31	10%

- These results suggest that the information contributed by the precedent arguments give us nearly 58% more information about the outcome of the case than the information contained in the facts of the precedent



Quantitative Analysis for Legal Theory

- Legal Fairness Analysis

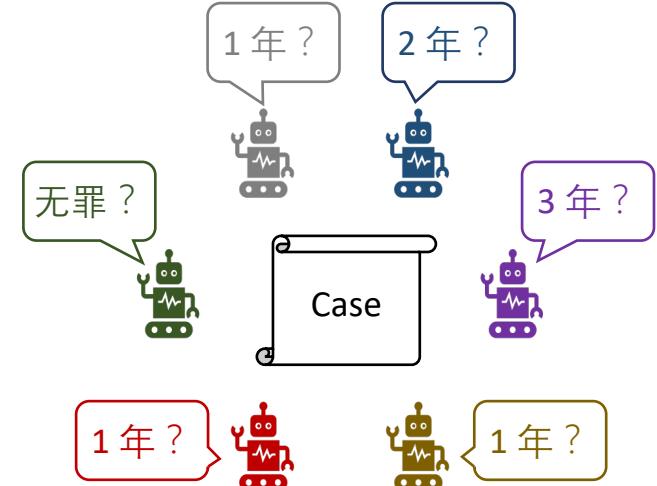
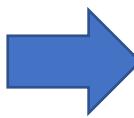
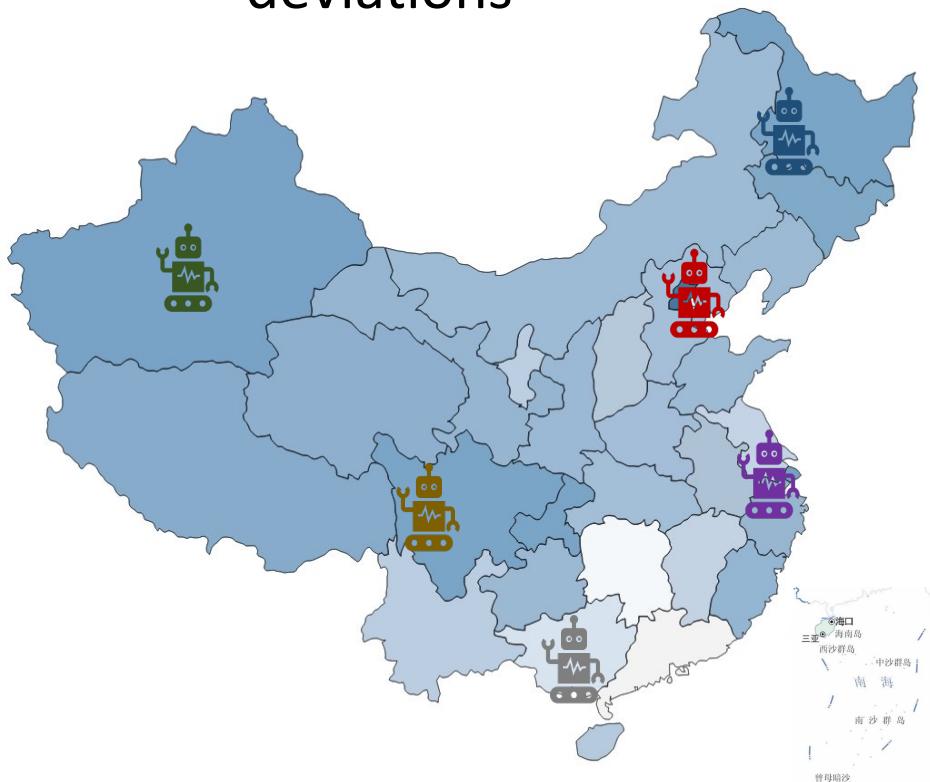
- **Motivation:** Fairness is one of the most important principles of justice. The ability to quantitatively analyze the fairness of cases can help to implement judicial supervision and promote fairness and justice
- **Goal:** To perform fairness analysis on large-scale real-world data
- Similar cases should be judged similarly!



Quantitative Analysis for Legal Theory

- Legal Fairness Analysis

- Train different virtual judges (sentence prediction models) and calculate their disagreements using standard deviations



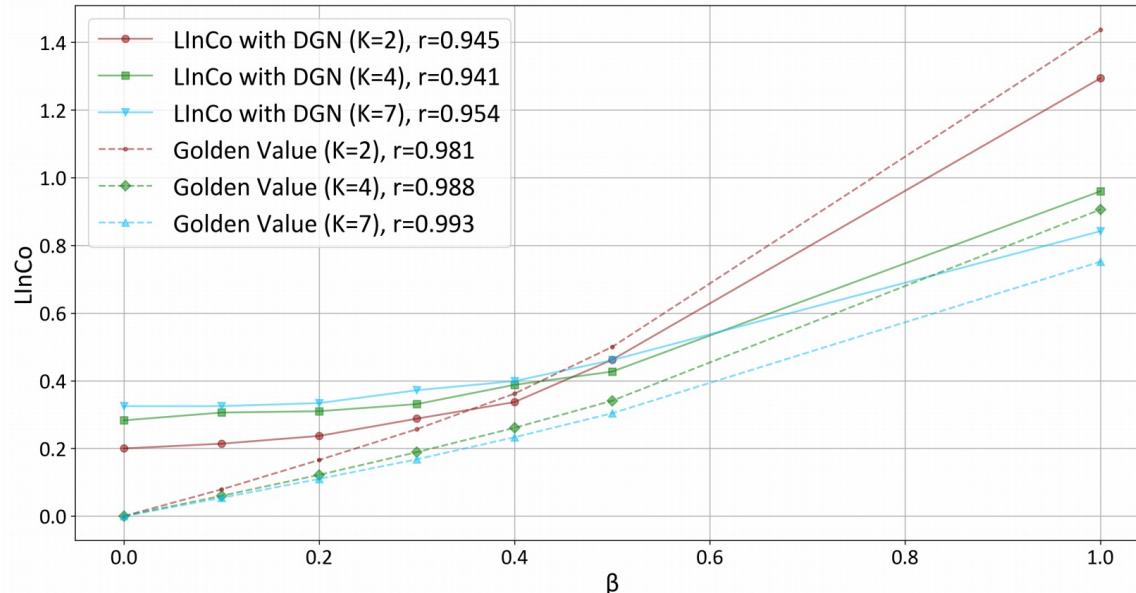
The disagreements of virtual judges
from different regions



Quantitative Analysis for Legal Theory

- Legal Fairness Analysis

- Synthetic datasets: we construct biased datasets by keeping facts the same and perturbing the term of penalty randomly with β as the inconsistency factor
- The proposed method can achieve high correlation between the golden inconsistency factor





Quantitative Analysis for Legal Theory

- Legal Fairness Analysis

- Inconsistency is negatively correlated with the severity of the charges, i.e., felonies are sentenced more consistently than misdemeanors

[0, 3)	[3, 10)	[10, ∞)	Crimes	LInCo
55%	34%	11%	Fraud	0.457
67%	25%	8%	Drug Trafficking	0.487
73%	22%	5%	Possession of Illegal Drugs	0.541
84%	14%	2%	Intentional Injury	0.274
86%	14%	0%	Traffic Offence	0.553
95%	5%	0%	Theft	0.376
97%	3%	0%	Picking Quarrels and Provoking Trouble	0.698
100%	0%	0%	Disrupting Public Service	0.725
100%	0%	0%	Providing Venues for Drug Users	0.870



Future Directions

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LegalAI: Future Directions



Legal Case Documents
120 Millions



Laws and Regulations
1000 +



Trademarks and Patents
Tens of millions



Judicial Interpretations
1000 +



Legal Consultation
Tens of millions of LegalQA



Legal Literature
Hundreds of legal journals

More Data

More Knowledge



LegalAI: Future Directions



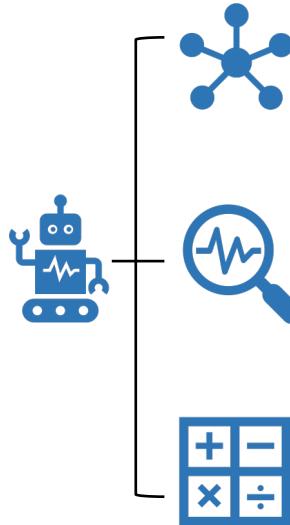
Q: Which crimes did Alice commit if she transported more than 10,000 yuan of counterfeit currency from abroad to China



A: According to the crime of transporting counterfeit currency, smuggling counterfeit currency and the principle of imaginary competition, it should be convicted of smuggling counterfeit currency

Providing explanation for answers

More Interpretability



Knowledge Graphs

Search Engine

Mathematical Calculators

Manipulating tools for cognitive intelligence

More Intelligence



Challenges of AI in Law

- Started in 2018, the competition has attracted a cumulative total of 4900+ teams from home and abroad
- CAIL 2022 is coming soon!
 - Legal Reading Comprehension
 - Legal Summarization
 - Legal Question Answering
 - Legal Similar Case Retrieval
 - Legal Argument Understanding
 - Legal Event Detection
 - Legal Information Extraction



<http://cail.cipsc.org.cn>



Challenges of AI in Law



Thanks!

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