

Appendix of “LegalAsst : Application of Human-Centered Machine on Enhancing Court Productivity and Legal Assistance”

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1 Human Evaluation of LegalAsst

Even though a similar case matching task is important for legal assistance and essential to assess an event graph, our LegalAsst does much more. We conduct experiments on user experience to assess if the whole system allows for 1) better interpretability of the decision process, and 2) clearer visualization of the case/legislation. We also split the humans into two groups (*i.e.*, the control group and the experimental group) to test the judicial decision-making.

1.1 Validation Setup

The experiments are conducted with 50 humans without using LegalAsst before as well as the law background. We recruit human subjects from Prolific¹. More specifically, we create a survey and provide detailed instructions that allow humans to understand what the system is. We ask humans to use LegalAsst to take judicial decision-making during the trial. During the survey, we show workers an interface for writing down their choices in terms of better interpretability and clear visualization. We released questionnaires (see Fig. 1 for details) to collect users’ feedback.

1.2 Results

94% users think that structured representations (*i.e.*, event graph, defendant graph, and legislation graph) are clearer visualization to navigate and understand. 92% users think LegalAsst brings better interpretability so they see what happened during judicial decision-making.

Moreover, LegalAsst helps users become more efficient and more productive. After the usage of this assistant system, the efficiency of human adjudication has been improved by 137%. Extracting key elements from texts helps users efficiently determine the terms for judgment. Then

LegalAsst makes laws and cases easier to navigate and understand by using the extracted terms to construct structured representations.

2 Human Evaluation of Modification Operation

We implement a modification manipulation for users to adjust. A user, for example, a judge, can trace the judgment results and then change the elements using the OWL interface. To validate how easy would it be for a human to change these elements, we conduct experiments with 20 humans and >85% of users recognize the ease of use (Yes/No Question). The average time of a modification operation is around 1.5s which is acceptable.

3 Automatic Evaluation of Each Component

We validate components in LegalAsst .

3.1 Results of Case Analysis

We evaluate the accuracy of the predicted event graph and predicted defendant graph. In 150 cases, the precision and recall and F1 are 100%, 81.3%, and 89.7%, respectively. Note that we adopt very strict metrics. As long as there is a node error in the case graph, the whole case graph is regarded as wrong.

3.2 Results of Legislation Analysis

We evaluate the accuracy of the predicted legislation graph. In 86 legal provisions, the precision and recall and F1 are 40%, 41.5%, and 40.7%, respectively.

3.3 Results of Judicial Decision-Making

To validate the capability of judicial decision-making, we collect 291 cases as the test set. We assess LegalAsst from five aspects: the principal type (*i.e.*, criminal detention, fixed-term imprisonment, death penalty), probation, fine, confiscation

¹<https://www.prolific.co/>

Case 2: Zhang Lei committed the crime of Smuggling,Selling,Transporting Or Manufacturing Drugs

Case Information: Defendant Zhang Lei, male, born on October 29, 1985 in Shenyang City, Liaoning Province, Han nationality, junior high school education, no occupation, registered address: Huanggu District, Shenyang City, Liaoning Province. In May 2014, he was sentenced to three months' detention by the Yuhong District People's Court of Shenyang City for the crime of accommodating others to take drugs. On June 11, 2018, he was criminally detained by the Shenhe Branch of the Shenyang Public Security Bureau on suspicion of drug trafficking. He was arrested on June 20 of the same year with the approval of the Shenhe District People's Procuratorate of Shenyang, and was arrested on the same day by the Shenhe Branch of the Shenyang Public Security Bureau. He is currently detained in the Heping District Detention Center of Shenyang City. The People's Procuratorate of Heping District, Shenyang City charged: At about 1 o'clock on June 11, 2018, the defendant Zhang Lei sold a bag of methamphetamine to Fan at a price of RMB 650 near Baimajiang KTV, Xita Street, Heping District, Shenyang City, weighing about 1, after which the public security authorities arrested the defendant Zhang Lei.

Compared with the text information of this case, It is more simple and intuitive for us to read the case information through the graph representation.

☒ I very much agree with the statement, I can more easily and intuitively obtain the content of the case.

☐ I agree with the statement, the graph representation shows the situation of the case very well, but there is still some important information in text that is not shown on graph

☐ I partly disagree with the statement. The graph representation is some unorganized and messy. Compared with textual representation, it is not easier to read the case.

☐ I disagree with the statement, the graph representation makes the case more complicated and unorganized, which is harmful to our reading

The Graph Representation of this Case

Graph representations allow a better understanding of the process of this case than text.

☒ I very much agree with the statement, the graph representation has high interpretability, and I can quickly understand the situation of the case.

☐ I agree with the statement, I can basically understand the process of this case through the graph representation, but I am not very clear in some details

☐ I partly disagree with the statement. there is no difference between understanding a case with the graph representation and case text.

☐ I disagree with the statement, The graph representation does not show the important information of the case, and it is not helpful for me to understand the whole case.

Figure 1: Interface of questionnaires.

	Pre.	Rec.	F1
<i>Principal</i>	67.77	79.93	73.34
<i>Deprivation</i>	85.68	89.79	86.44
<i>Suspension</i>	97.89	98.59	98.24
<i>Fine</i>	78.11	88.38	82.92
<i>Confiscate</i>	86.90	89.08	85.58

Table 1: Results of judicial decision-making. **Pre.:** precision. **Rec.:** recall.

of property, and deprivation of political rights. The precision, recall, and F1 score are shown in Tab. 1. The results reveal that after getting the key information of a case, LegalAsst can make a reasonable judgment.

4 Details of Judicial Decision-Making

LegalAsst adopts decision trees because of their interpretability, traceability, and controllability as well as superior performance. The decision tree is a tree-like structure (can be a binary tree or a non-binary tree). The decision tree represents the decision-making process of a class of cases. The non-leaf node represents the judgment condition, the leaf node represents the decision result, and the arrow represents the decision path under a different judgment condition.

Fig. 3 is a part of the decision tree. First, because the amount of drugs trafficked by the defendant is less than 1.505g, the decision tree will

select the left child node. Then LegalAsst further checks the fact whether the defendant is drug recidivism. According to the information from the case graph, the defendant does not satisfy the condition. Therefore, LegalAsst continues to move to the left child node to determine whether the number of drug grams sold is greater than 0. The right child node will be selected to determine if the number of trafficking is less than 1.5. After going through the step-by-step decisions, finally, we get the final judgment is “no more than three years of fixed-term imprisonment”.

The decision tree can also be generated by training a model on corresponding training data of legislation. First, we pre-specify several important features that possibly affect judicial decision-making (*i.e.*, age, drug quantity, and the number of sales) and use the cart generation algorithm² to learn the data distributions in the training set and choose the most significant features to generate a decision tree.

5 Fusion of Graphs

For multiple graphs (*e.g.*, NER result, SRL graph and SDP graph), we fused them by exact matching. If the node types are different, we adopt a voting mechanism. If the majority agrees, we keep this node/relation. Otherwise, we remove this node or relation.

²<https://www.scikitlearn.com.cn/>.

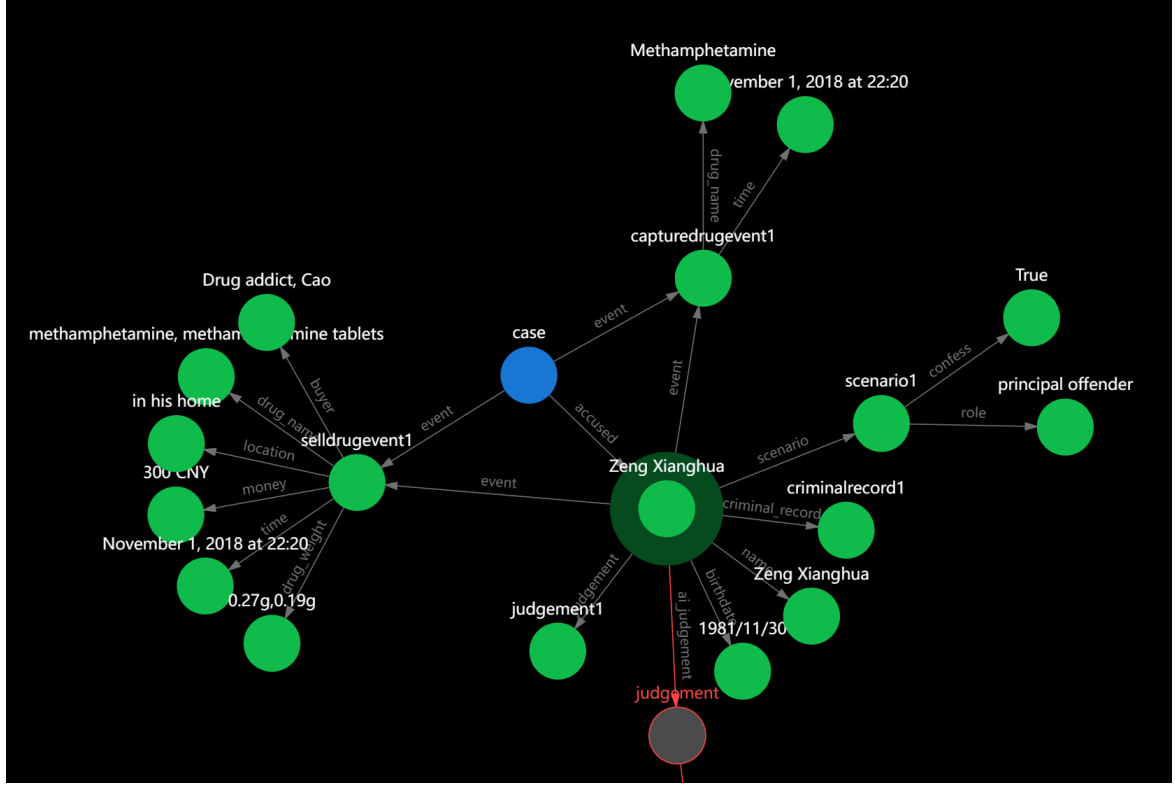


Figure 2: The defendant node labeled with “Zeng Xianghua” is associated with the **case** node labeled with “case”. The child nodes connected to the case node are facts about this case. These child nodes continue to spread out to describe the key details. If there exists a criminal record, the defendant node will be additionally associated with the criminal record node. These nodes correlate with each other and finally make up the entire defendant’s information.

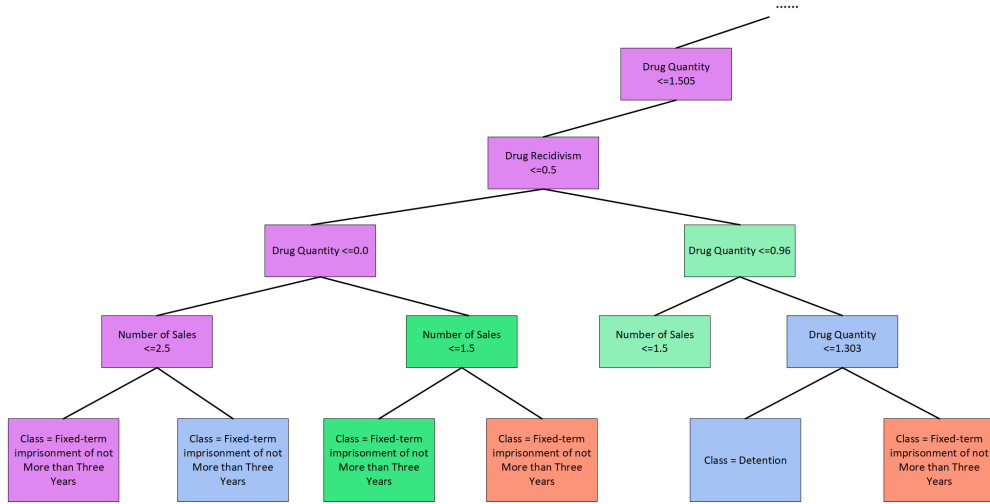


Figure 3: Illustration of part of the decision tree. When the case satisfies the condition of the node, the decision process moves to the left child node, otherwise moves to the right child node.

6 Case Study

We provide a case study to explain how the defendant’s information is organized in Fig. 2. Taking the defendant “Zeng Xianghua”³ as an example, the legal system will extract useful information

³“Zeng Xianghua” is a pseudonym, not a real name. All our examples use the same setting.

about the case for judgment after getting the case graph in Fig. 2. The defendant was 36 years old and sold 0.46g methamphetamine once. He was not a recidivist and had no aggravating circumstances. Furthermore, this significant information is fed into the decision tree to determine the result of punishment.

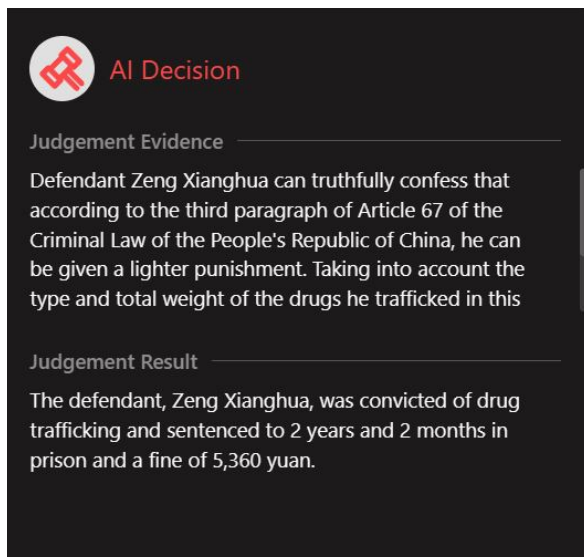


Figure 4: LegalAsst provides reasonable judicial decision-making provisions (“Judgment Result” panel on the bottom) as well as a reasonable piece of evidence (“Judgment Evidence” panel on the top).

As shown in Fig. 5, we illustrate a case: “The public prosecution alleged that at 18:00 on July 25, 2016, defendant Shi Lin was caught by the public security police after selling two red round tablets to Tian for 100 CNY at the fire escape on the 1st floor of Building 9 of Poly Champagne International District, Hanxi Road, Qiaokou District. After identification, the above items were detected drug methamphetamine components, weighing a total of 0.19 grams.”

We also use a case study to show how a provision looks like in Fig. 4. It shows a result predicted by LegalAsst. The “Judgment Result” panel on the bottom shows the result of judicial decision-making while the provision used as a piece of evidence is displayed in the “Judgment Evidence” panel on the top. It can be seen that the judgment result as well as the evidence is reasonable.

In the video, we provide an automatic judicial decision-making process. From the top down, LegalAsst transverses the whole AOG to check each element related to the case. You can see the nodes in the two graphs are blinking. Orange flashing nodes are legal provisions that are currently being processed. The green blinking nodes are the relevant facts involved in the corresponding case. The dark red nodes generated in this process are the new information predicted. Finally, after traversing the entire AOG, we will get a judgment result and the evidence for getting this result.

7 Extension beyond Existing Categories

We show two exemplary categories: drug trafficking events and drug seizure events. More categories are supported, as long as schemes are provided. When a new category comes out, only the different ontologies are required to be changed. One can modify, delete or add more ontologies of structured representations. This demonstrates that the LegalAsst system is designed to be extensible.

8 Ethics Statement

I testify on behalf of all co-authors that our article has not been published in whole or in part elsewhere. All authors have been personally and actively involved in substantive work leading to the manuscript and will hold themselves jointly and individually responsible for its content. Our research studies on humans are non-interventional studies (*i.e.*, surveys), where the ethical issue does not exist. Non-stigmatizing and non-discriminatory language are used when describing age, disease, disability, religion, sex, gender, sexual orientation, *etc.* Our experiments have not been categorized by such groupings. Except for the requirement that subjects have not used our tool before and without a legal background, we have no other requirements for the subjects.

References

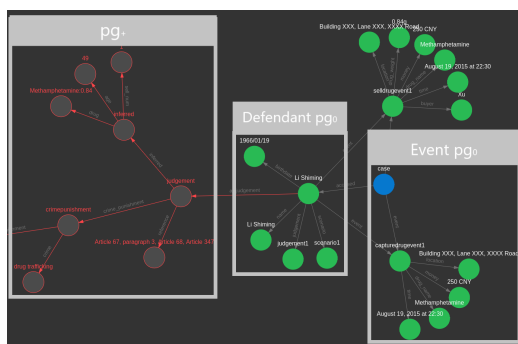


Figure 5: Structured representation of the case: the event graph and the defendant graph.

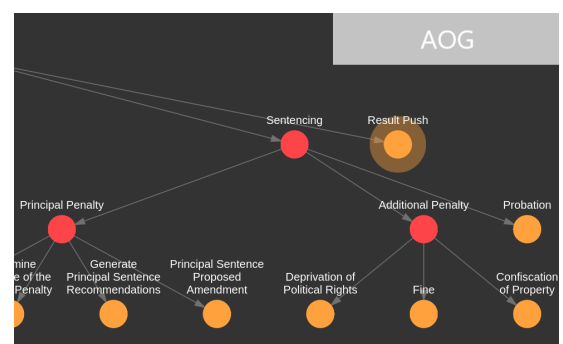


Figure 6: Structured representation of the legislation in the form of AOG.