Learning to Check Contract Inconsistencies

Shuo Zhang, Junzhou Zhao, Pinghui Wang, Nuo Xu, Yang Yang, Yiting Liu, Yi Huang, Junlan Feng

MOE KLINNS Lab, XJTU, China **JIUTIAN Team, China Mobile Research**

Paper Link

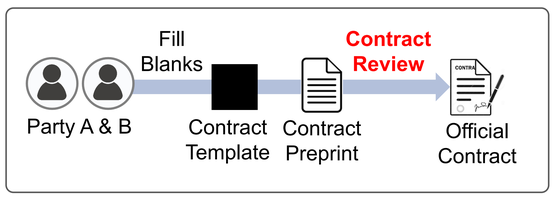
Shuo Zhang
zs412082986@stu.xjtu.edu.cn

SUMMARY

- Formulated the Contract Inconsistency Checking (CIC) problem that has not yet been studied in the AI community
- A novel Pair-wise Blank Resolution (PBR) framework to address CIC with a `BlankCoder` that extends Transformer encoder to model meaningless blanks
- Collected and labeled a large-scale Chinese contract corpus for CIC. The experimental results show the promising performance of our PBR method

INTRODUCTION

What is Contract Review ?



- In real-world scenarios, a standard contract is often prepared by filling blanks in a template
- Contract review corrects errors before final confirmation, which is essential to assure the legal validity of the contracts.
- Contract review is labor-intensive and costly, that costs big companies billions annually

What to Review ?

- ***Compliance:*** Against written regulations
  E.g., "Private equity fund" must be marked in the title of a contractual fund contract
- ***Legality:*** Against the law
  E.g., Conceal cancer in an insurance contract to defraud insurance money
- ***Consistency***
  Two blanks that should be filled with the same (or different) content are incorrectly filled with different (or same) content (see Fig. 1)

TASK

Contract Inconsistency Checking (CIC)

SALES CONTRACT

This Contract for the Sale of ***Name A*** is made effecive on ***Date*** .
...
Seller hereby agrees to sell ***Name B*** at a total price of RMB ***Number A*** (excluding 5%VAT) on the Closing Date.
...
The total contract price is RMB ***Number A*** only including all taxes.

Same reference, Different content
Different reference, Same content

Figure 1: Examples of contract inconsistencies. The two blanks with red background refer to the same item for sale but incorrectly filled with different content. The two blanks with yellow background refer to two different prices (one with tax and the other without tax) but incorrectly filled with the same price.

- ***Aim:***
  Automatically detect contract inconsistencies as shown above in a data-driven and End2end way with high accuracy.

CIC as Pair-wise Binary Classification

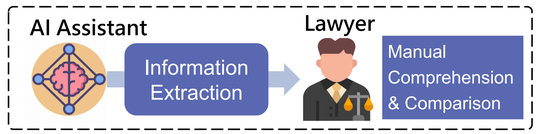
Given a pair of blanks occurred in the contract document, we want to predict whether they should be filled with the same content or not

Towards Data Scarcity

- Easy to label, do not need to predefine classes for the filled contents
- Comparative ➔ Data Efficient to Train

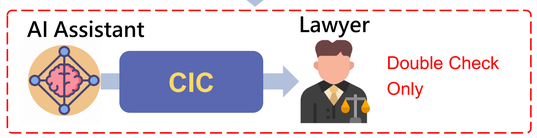
Comparison to Existing AI-based Tasks

Existing Contract Review Tasks



End2End

Our CIC Task



METHOD

Pair-wise Blank Resolution Framework

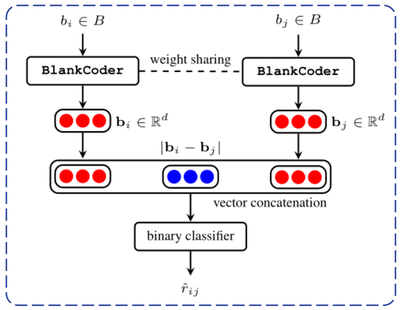


Figure 2: The PBR Framework

- Fully Data-driven and End2End Framework
- Siamese Architecture with a novel `BlankCoder` to efficiently encode meaningless blanks
- FFNN-based binary classifier to predict consistency relation label (1➔should fill with the same content)

BlankCoder

Semantic Encoding for Blanks

For final payment, buyer shall pay the sum of ___ dollars in ten days ...

Relevant Descriptions Irrelevant Descriptions

- Blanks are Meaningless themselves
- Blanks can refer to a concept / entity , not just a word

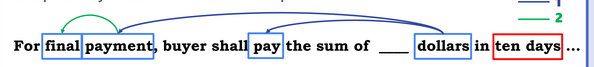
➔ Hard to correlate blank to its relevant descriptions

Two-stage Blank Modeling Strategy

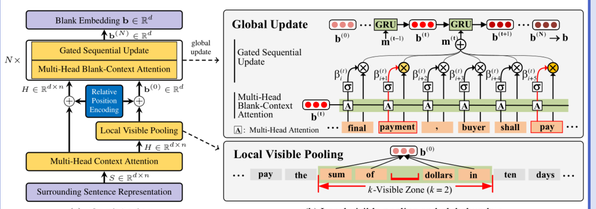
1. Initialize the Blank representation with nearby relevant descriptions

For final payment, buyer shall pay the sum of ___ dollars in ten days ...

2. Update by recurrent semantic comparison



BlankCoder Architecture



(a) `BlankCoder` (b) Local visible pooling and global update

- Extends the Transformer Encoder architecture with two-stage modeling strategy as shown above to generate blank-centered sentence representation
- ***Multi-Head Context Attention*** to associate relevant context words
- ***Local Visible Pooling*** to initiates the blank representation with local keywords
- ***global update*** to refine and update the blank representation with related context words

EXPERIMENTS

Dataset

contract dataset	# contracts	# blank-pairs	pos : neg
Chinese Contracts	281	299, 621	1 : 59
ICAIL Contracts	1, 526	67, 765	1 : 48

- Chinese Contracts:
  Manually collected 246 open source business contract templates and 35 real contracts from a company
- Highly Imbalanced: focus comparing F1 & MCC

Overall Performance

model	Chinese Contracts AUC	accuracy	precision	recall	F1	MCC	ICAIL Contracts AUC	accuracy	precision	recall	F1	MCC
BiLSTM	98.26	92.58	88.24	86.11	87.16	86.96	96.06	84.86	79.22	70.11	74.39	74.03
Transformer	94.45	88.51	79.47	77.36	78.40	78.04	93.37	83.09	74.36	66.67	70.30	69.82
Transformer-seg	97.15	92.32	85.15	86.90	86.01	85.78	95.26	83.99	77.78	68.39	72.78	72.40
CenteredLSTM	98.35	92.68	88.96	86.59	87.76	87.56	96.15	85.71	78.62	71.84	75.08	74.66
AttnLSTM	98.62	92.85	90.83	85.51	88.09	87.93	96.19	85.76	80.92	70.69	75.46	75.16
CorefBERT	93.06	90.20	53.85	81.58	64.87	65.61	—	—	—	—	—	—
PBR	**98.73**	**94.05**	**93.74**	**88.22**	**90.90**	**90.77**	**96.25**	**86.01**	**81.22**	**72.08**	**76.38**	**76.09**
%Improvement	0.11	1.29	3.20	1.88	3.19	3.23	0.06	0.29	0.37	0.33	1.22	1.24

- PBR outperforms others in all evaluation metrics
- Significant improvements over Transformer-based methods
- Performance decline on ICAIL Contracts
  - Attribute this to data anonymity and the ambiguous blank pair samples (see chapter 5.3 in our paper)

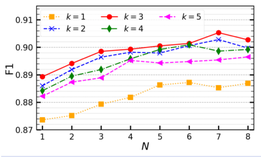
Ablation Study

Metrics	AUC	accuracy	precision	recall	F1	MCC
PBR	98.73	94.05	93.74	88.22	90.90	90.77
-no local	97.76	92.31	81.51	87.86	84.57	84.36
-no update	98.14	92.95	87.81	86.11	86.95	86.74
-no cmp	98.38	93.43	93.57	86.96	90.14	90.04

-no cmp : no $|\mathbf{b}_i - \mathbf{b}_j|$

- local visible pooling is more critical
- contrastive supervision helps

Hyper-parameter sensitivity



- Bigger N ➔ Better performance
- Proper k is necessary

Case Study

- Transformer encoder incorrectly highlighted irrelevant descriptions
- BlankCoder generates an accurate and expressive blank representation without noise information through two-stage blank modeling strategy

Transformer Encoder
For final payment, Buyer shall pay the sum of ___ dollars in ten days of Seller's delivery of the Goods.

BlankCoder
- **Local Visible Pooling** ($k = 2$)
  ... Buyer shall pay the sum of ___ dollars in ten days...
- **Global Update** ($N = 3$)

T0 For final payment, Buyer shall pay the sum of ___ dollars in ten days of Seller's delivery of the Goods.

T1 For final payment, Buyer shall pay the sum of ___ dollars in ten days of Seller's delivery of the Goods.

T2 For final payment, Buyer shall pay the sum of ___ dollars in ten days of Seller's delivery of the Goods.

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