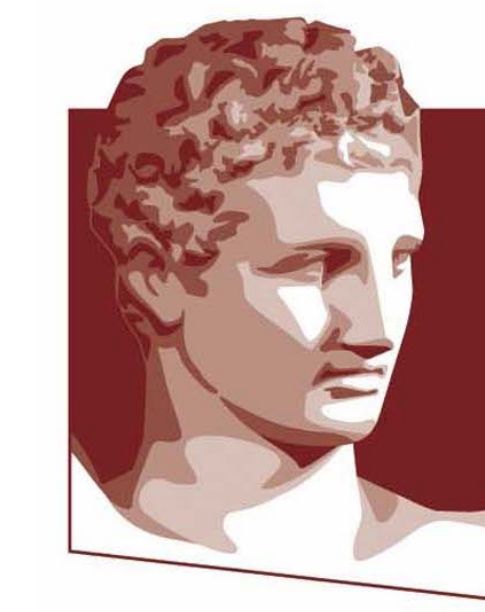


Neural Contract Element Extraction Revisited

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NCSR "Demokritos" and Athens University of Economics and Business



TASKS

Contract Header

This **PARTICIPATION AGREEMENT**, dated as of **May 1, 2005**, between **NEW YORK STATE ENERGY RESEARCH**, a body corporate and politic, constituting a public benefit corporation, established and existing under and by virtue of the laws of the State of New York (the "Authority") and **CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.**, a corporation duly organized and existing and qualified to do business as a public utility under the laws of the State of New York (the "Company").

Applicable Law

This agreement shall be governed and construed in accordance the laws of the state of Georgia. Each party hereby irrevocably submits to the exclusive jurisdiction of the district courts sitting in Atlanta, Georgia.

Lease Particulars

LEASE DETAILS

- Lessor:** California Estates B.V., a California company, with offices at 723 Regent Str, CA 18021.
- Lessee:** Yao Ming Inc.
- Property:** Unit 2, Gateway Drive, 100 Bethesda, CA 18023
- Term:** 24 months
- Base Rent:** Two Thousands and Four Hundred Dollars (2,400\$)

EXPERIMENTAL SETUP

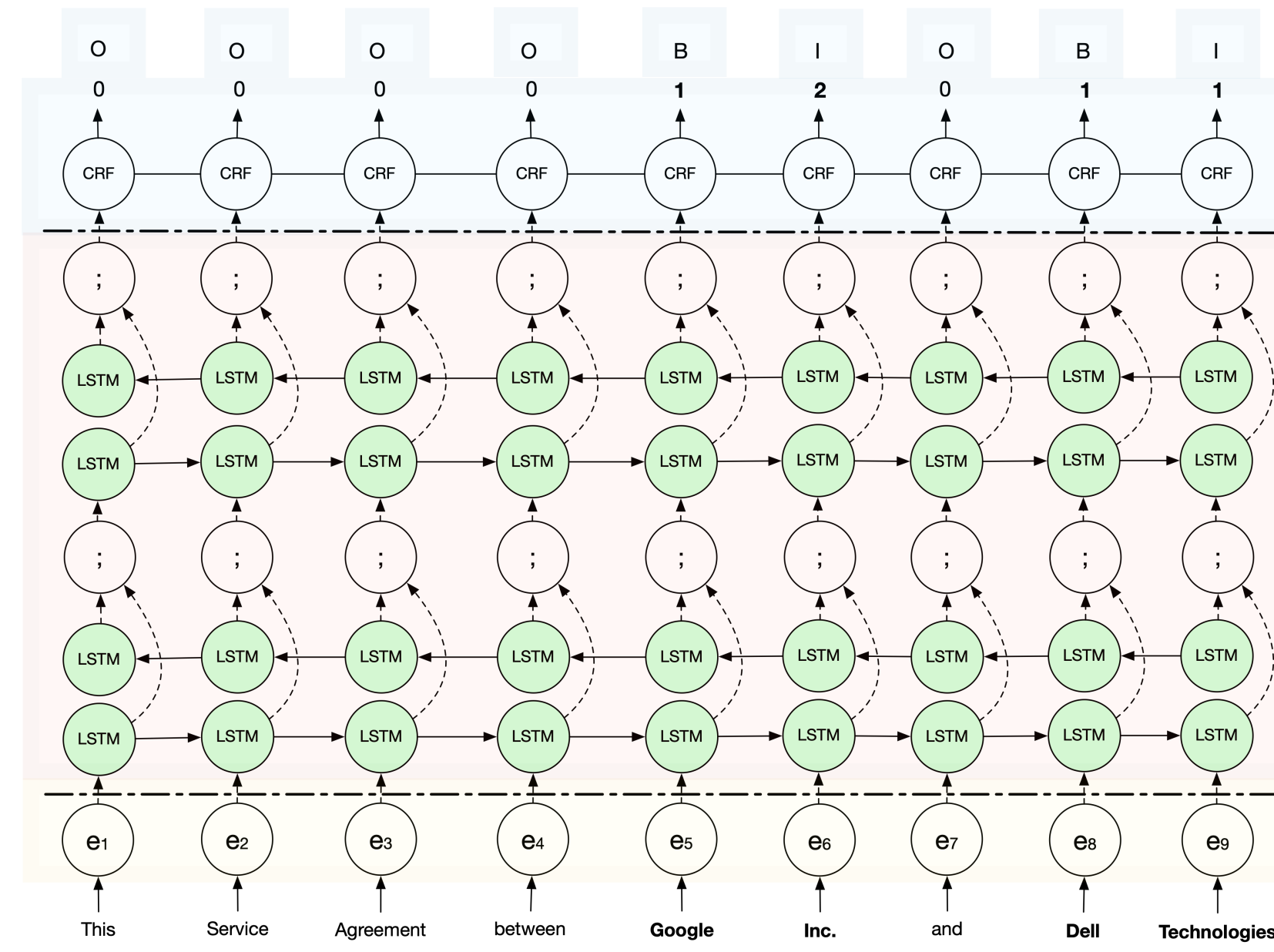
- Experiment with ~2,500 US contracts and ~2,500 US leases.
- Working with **multi-class classifiers**, one for **each contract zone** (Contract Header, Applicable Law, Lease Particulars).
- Hyper parameters: **ENCODER units** {100, 150, 200, 250, 300}, **ENCODER layers** {1, 2, 3, 4}, **batch size** {8, 12, 16, 24, 32}, **DROPOUT rate** {0.2, 0.3, 0.4, 0.5, 0.6}, **WORD DROPOUT rate** {0.0, 0.05, 0.1}, **learning rate** {0.001} for all except BERT {2e-5, 3e-5, 5e-5} using Adam optimizer.
- 5-fold **Monte Carlo cross-validation**.
- Report **mean scores** on **test set** over **5 repetitions** for best hyper-parameters.

FEATURES

- GLOVE:** 200D GloVe pre-trained embeddings on Gigaword 5 incl. news articles.
- W2V-WORD:** 200D Word2Vec pre-trained embeddings on ~750k US contracts.
- W2V-ALL:** 200D W2V-WORD + 25D pre-trained embeddings for POS tags (e.g., Noun, Verb, etc.) + 25D token shapes (e.g., JPM → XXX, This → Xxxx, Inc. → Xxx., 2019 → dddd, 1.5 → d.d)
- W2V-ALL + CHAR ENC:** 250D W2V-ALL + 50D Multi-filter CNN Character encodings
- W2V-ALL + ELMO:** 250D W2V-ALL + 1024D ELMo embeddings (Peters et al., 2018)
- BERT:** 768D BERT-BASE (Devlin et al., 2019) BPE embeddings, fine-tuned during training

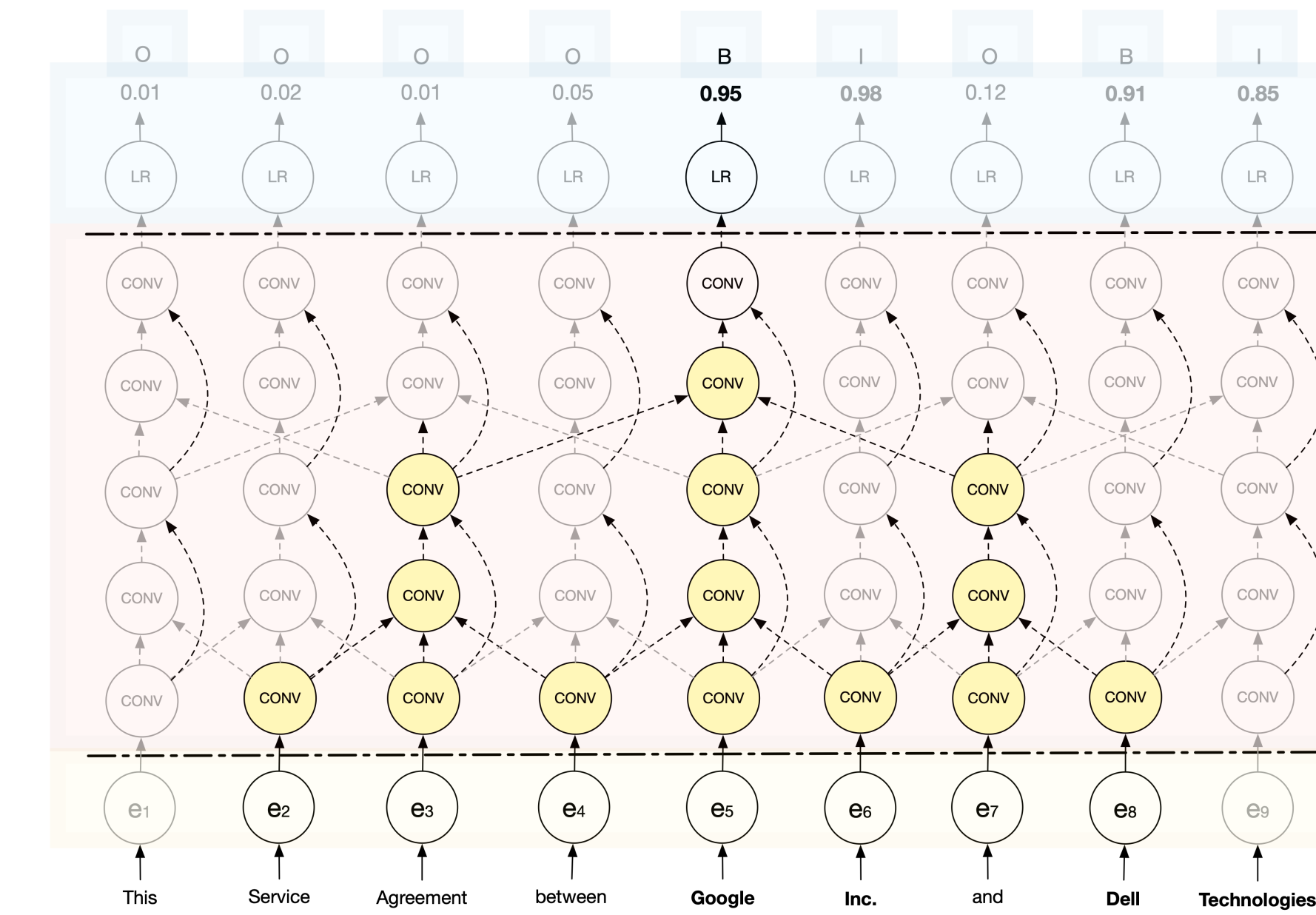
Method	CONTRACT HEADER			APPLICABLE LAW			LEASE PARTICULARS		
	P	R	F1	P	R	F1	P	R	F1
GLOVE	90.2	89.6	89.9	88.7	84.3	86.4	66.1	65.8	65.9
W2V-WORD (in-domain)	95.7	95.1	95.4	89.0	84.1	86.5	87.0	86.2	86.6
W2V-ALL (incl. POS, Shape)	95.7	94.9	95.2	88.9	84.4	86.5	86.7	86.2	86.4
W2V-ALL + CHAR ENC	96.1	94.0	95.0	89.3	82.2	85.5	87.8	86.1	86.9
W2V-ALL + ELMO	95.8	94.8	95.3	89.3	84.2	86.7	86.0	87.5	86.7
BERT (fine-tuned)	89.5	89.8	89.6	83.2	79.6	81.3	79.0	83.9	81.3
CONTRACT-BERT (fine-tuned)	92.1	91.7	91.9	83.3	79.2	81.5	78.2	81.9	79.9

BiLSTMs

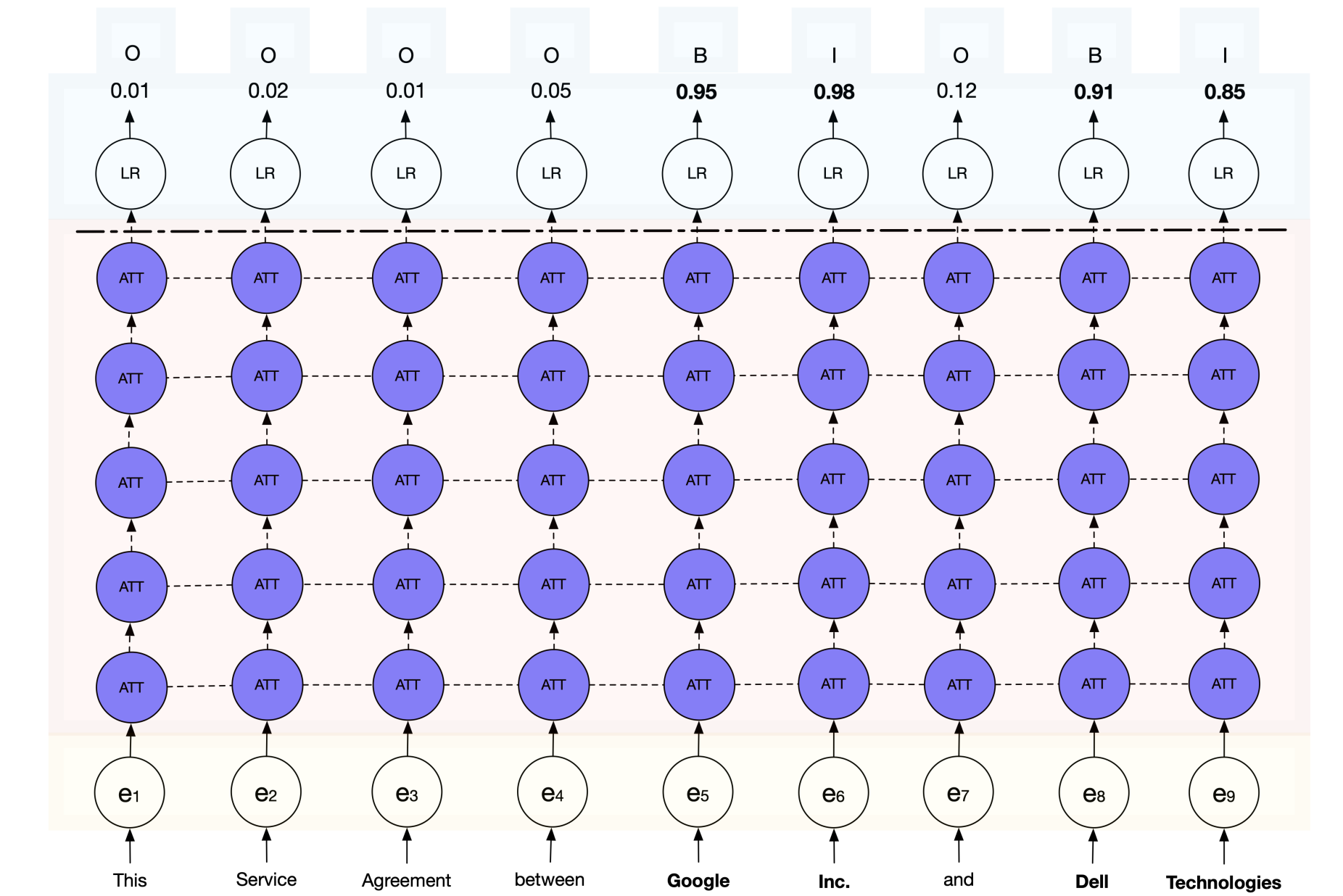


ENCODER

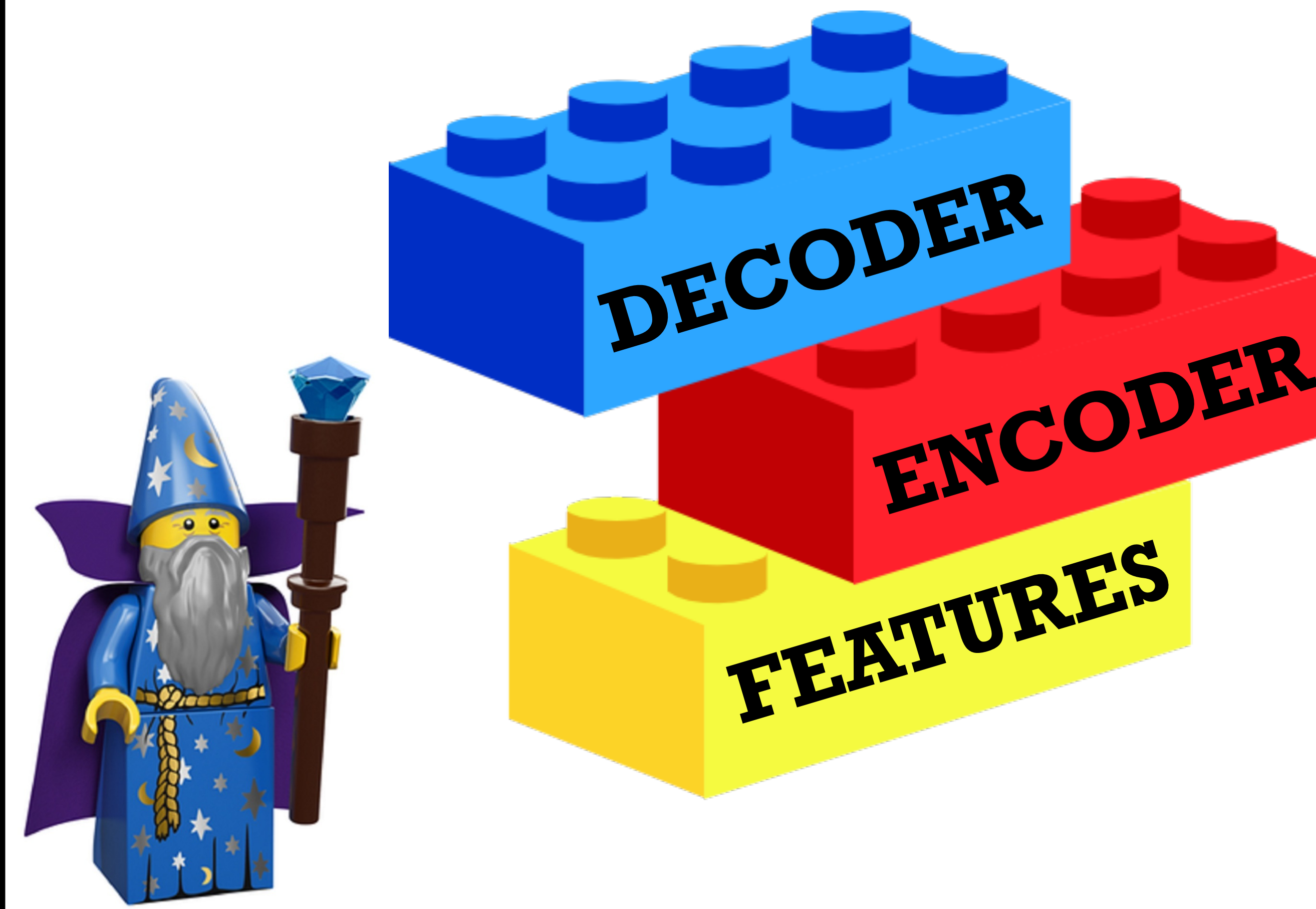
Dilated CNNs



Transformers / BERT



DNNs AS LEGOs - MIX AND MATCH!



LINEAR
greedy
fast

DECODER

CRFs
global
slow

Method	CONTRACT HEADER			APPLICABLE LAW			LEASE PARTICULARS		
	P	R	F1	P	R	F1	P	R	F1
BILSTMs	93.4	94.0	93.7	81.6	80.7	81.1	82.0	82.7	82.3
+ CRF	95.7	94.9	95.2	88.9	84.4	86.5	86.7	86.2	86.4
DILATED-CNNs	84.2	88.0	86.0	68.7	72.7	70.5	65.9	74.3	69.8
+ CRF	94.1	93.2	93.6	82.3	80.0	81.1	82.8	83.5	83.0
TRANSFORMERS	81.8	86.4	84.0	54.5	53.9	54.1	58.0	64.1	60.8
+ CRF	91.2	88.4	89.7	85.8	74.4	79.5	76.4	71.3	73.6
BERT	90.0	90.9	90.4	78.3	78.1	78.2	77.0	79.8	78.2
+ CRF	89.5	89.8	89.6	83.2	79.6	81.3	79.0	83.9	81.3

Contract Header

Element Type	BILSTM-CRF			DILATED-CNNs-CRF			TRANSFORMERS-CRF			BERT-CRF		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1
Title	96.0	96.4	96.2	94.7	94.9	94.8	93.1	93.2	93.1	92.4	93.4	92.9
Party	95.3	88.9	92.0	93.7	86.2	89.8	88.4	79.4	83.6	87.3	85.4	86.3
Start Date	96.8	97.4	97.1	91.3	96.6	93.8	91.3	92.7	92.0	94.3	95.7	95.0
Effective Date	94.6	96.9	95.7	96.9	95.1	95.9	92.0	88.5	90.1	83.9	84.7	84.3
Macro-AVG	95.7	94.9	95.2	94.1	93.2	93.6	91.2	88.4	89.7	89.5	89.8	89.8

Applicable Law

Element Type	BILSTM-CRF			DILATED-CNNs-CRF			TRANSFORMERS-CRF			BERT-CRF		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1
Jurisdiction	79.7	72.4	75.9	69.6	67.6	68.4	73.6	58.5	65.0	73.8	67.3	70.4
Governing Law	98.1	96.3	97.2	95.1	92.5	93.8	98.0	90.3	94.0	92.7	91.9	92.3
Macro-AVG	88.9	84.4	86.5	82.3	80.0	81.1	85.8	74.4	89.7	79.5	83.2	81.3

Lease Particulars

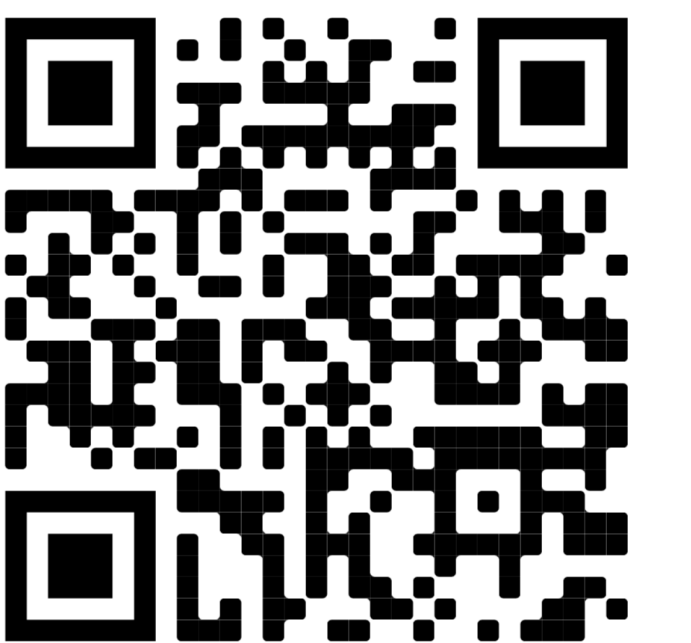
Element Type	BILSTM-CRF			DILATED-CNNs-CRF			TRANSFORMERS-CRF			BERT-CRF		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1
Property	67.0	65.8	66.2	61.8	61.8	61.8	53.9	50.1	51.8	51.6	52.8	52.1
Landlord	87.7	86.6	87.2	83.4	83.8	83.6	76.5	68.7	72.3	76.4	81.8	78.8
Tenant	90.7	90.9	90.8	89.7	87.8	88.7	81.5	72.4	76.6	84.8	87.3	86.0
Start Date	92.4	95.0	93.7	91.7	93.4	92.5	88.2	90.5	89.3	89.0	94.1	91.4
Effective Date	88.7	90.8	89.7	81.1	87.5	84.1	79.9	71.1	75.2	87.6	89.2	88.3
End Date	88.7	90.8	89.7	91.3	84.2	87.6	73.2	67.7	70.2	85.6	88.7	87.1
Term	86.6	89.1	87.8	81.9	87.0	84.3	76.5	75.5	75.8	80.3	86.2	83.1
Rent Amount	86.5	86.0	86.2	81.2	82.5	81.7	81.4	74.3	77.5	76.8	91.1	83.3
Macro-AVG	86.7	86.2	86.4	82.8	83.5	83.0	76.4	71.3	73.6	79.0	83.9	81.3

OTHER PUBLICATIONS

(nlp.cs.aueb.gr/publications.html)

- I. Chalkidis and I. Androutsopoulos, "A Deep Learning Approach to Contract Element Extraction". Proceedings of the 30th International Conference on Legal Knowledge and Information Systems (JURIX 2017), Luxembourg, pp. 155-164, 2017.
- I. Chalkidis, I. Androutsopoulos and A. Michos, "Obligation and Prohibition Extraction Using Hierarchical RNNs". Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (ACL 2018), Melbourne, Australia, pp. 254-259 (short papers), 2018.
- I. Chalkidis, M. Fergadiotis, M. Malakasiotis and I. Androutsopoulos, "Large-Scale Multi-Label Text Classification on EU Legislation". Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics (ACL 2019), Florence, Italy, (short papers), 2019.
- I. Chalkidis, I. Androutsopoulos and N. Aletas, "Neural Legal Judgment in English". Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics (ACL 2019), Florence, Italy, (short papers), 2019.

PAPER



SPOILER