CBMS Computer-Based Medical Systems 2021

APEHR: Automated Prognosis in Electronic Health Records using multi-head self-attention

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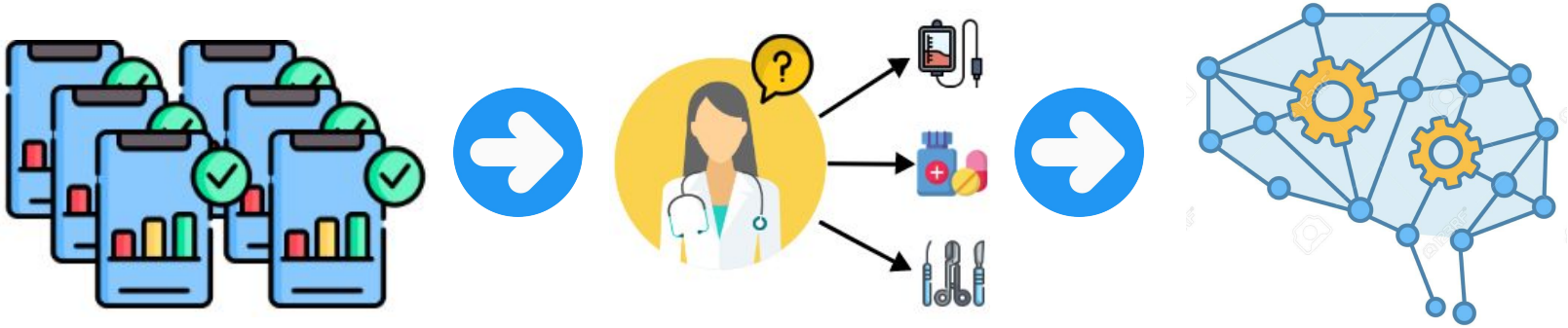
Lucas Scabora, Danilo M Eler, Jose F Rodrigues-Jr

Presentation outline

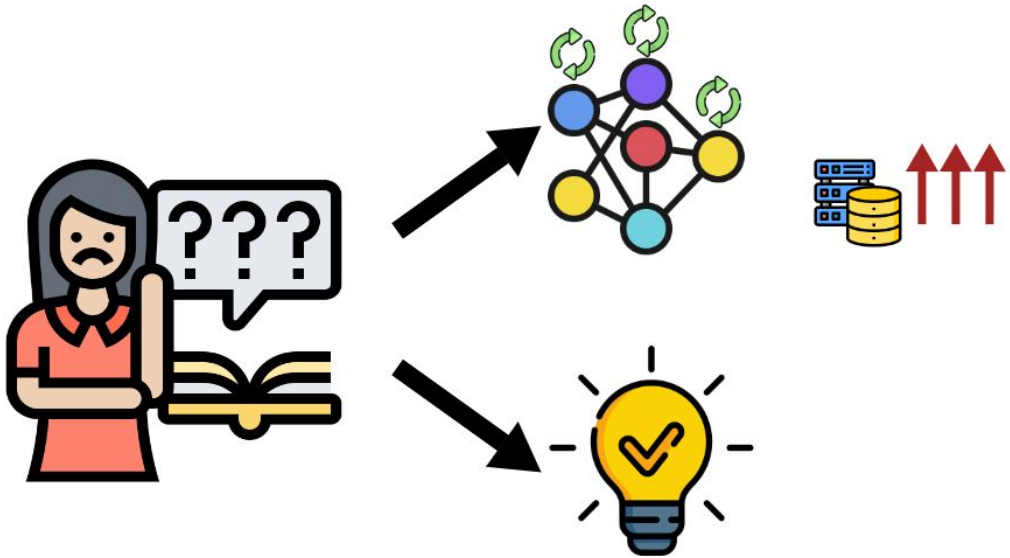
1. **Introduction and motivation**
2. Problem definition
3. Proposed methodology
4. Experiments and results
5. Conclusion

Introduction and motivation



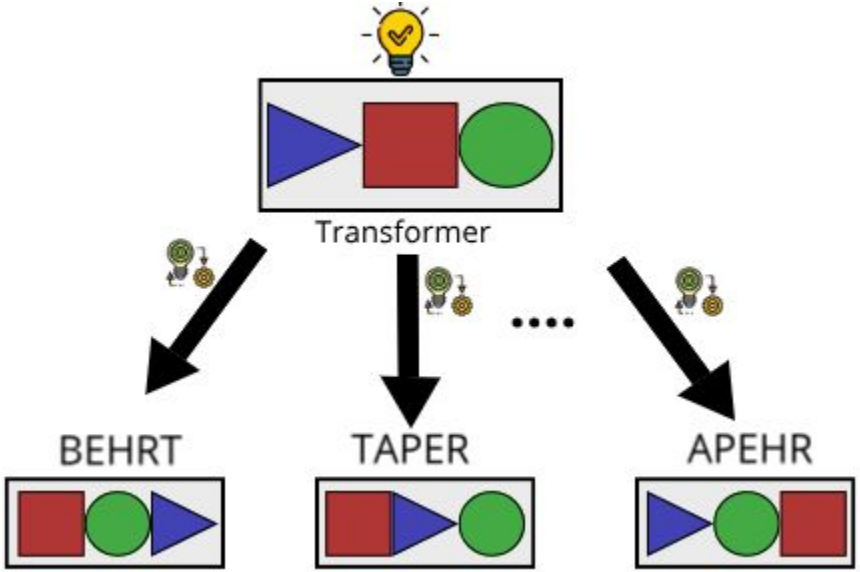
- Researchers have begun to focus on Clinical Decision Support Systems;
- The number of applications of DL in healthcare has increased in the last years.

Introduction and motivation



- Transformer was proposed in the NLP area, it avoids the use of recurrence and convolution;
- The use of Transformer has the potential for a better performance, since it is based on a different principle

Introduction and motivation



- Transformers have been applied successfully in different areas such as NLP, speech recognition, among others. It has initiated new architectures, each with specific benefits for certain domains.

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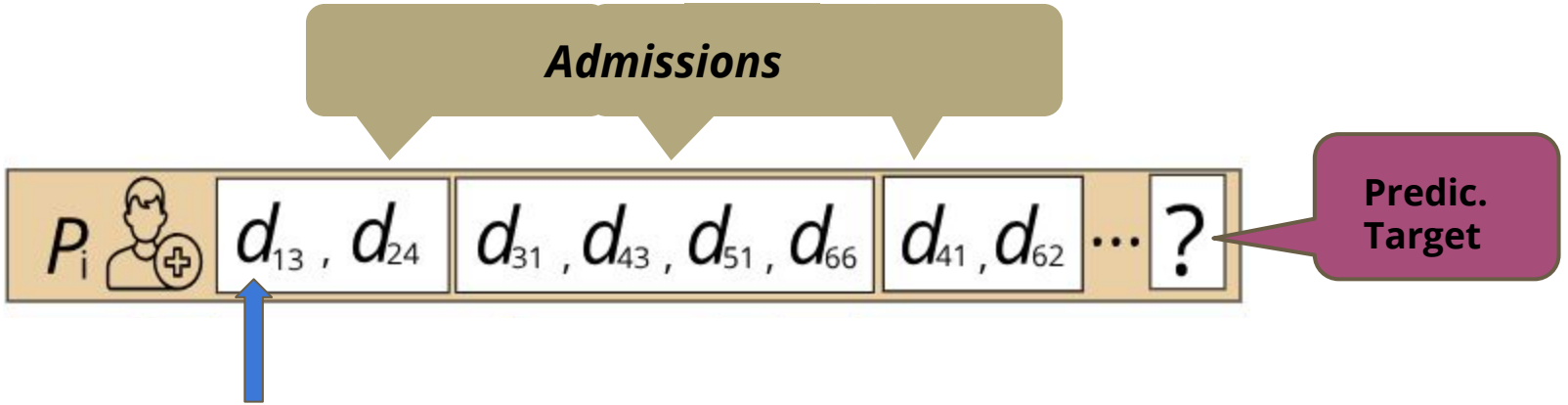
Problem definition

- Given a sequence of patient admissions to a hospital, we want to predict the most probable clinical events to which she/he is subject to in the future.

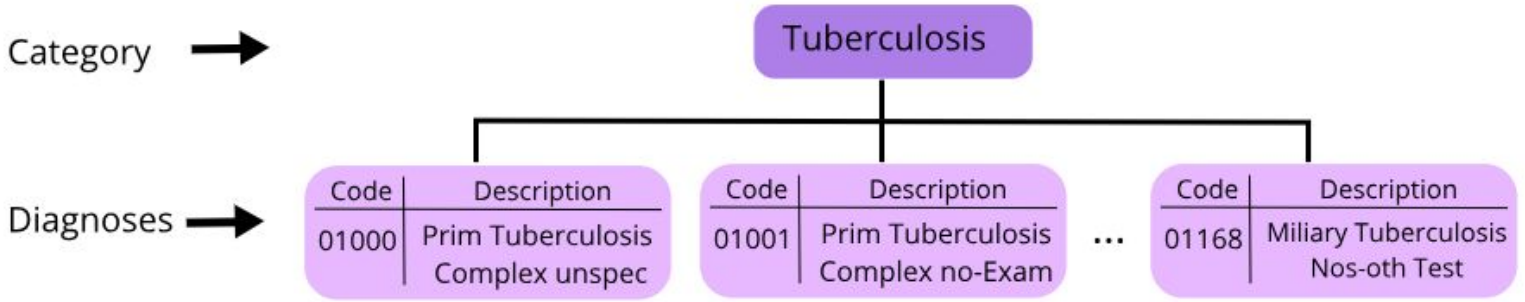
Problem definition

- Problem statement



Problem definition

- **Hierarchical structure of medical coding systems**



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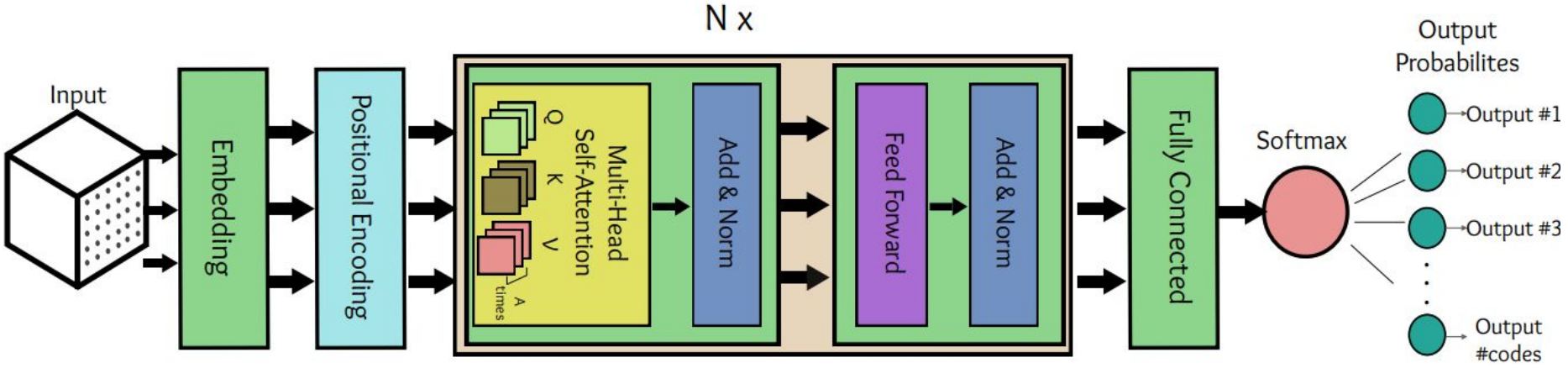
Proposed Methodology

- **We propose a new architecture that employs only the Decoder component**, since is sufficient for a one-direction classification task;
- In contrast to recurrent approaches, our method processes the entire clinical history at once.

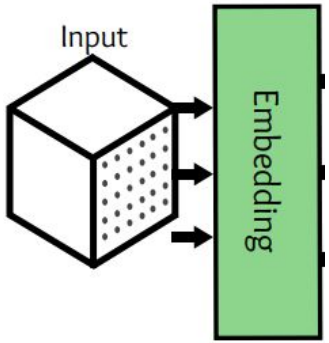
Proposed Methodology

- **Overview**



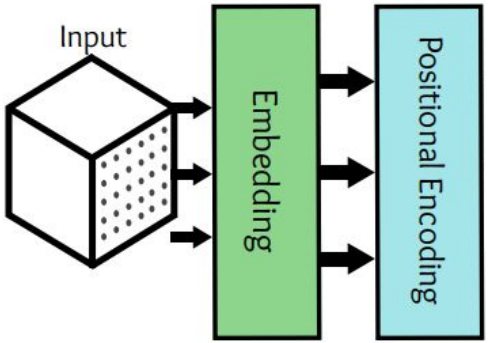
Proposed Methodology

- **Overview**



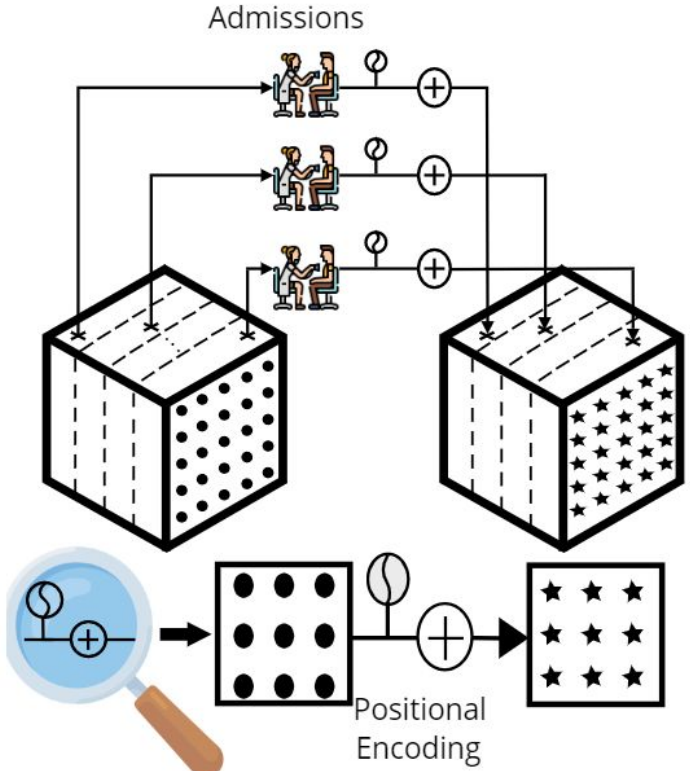
Proposed Methodology

- **Overview**



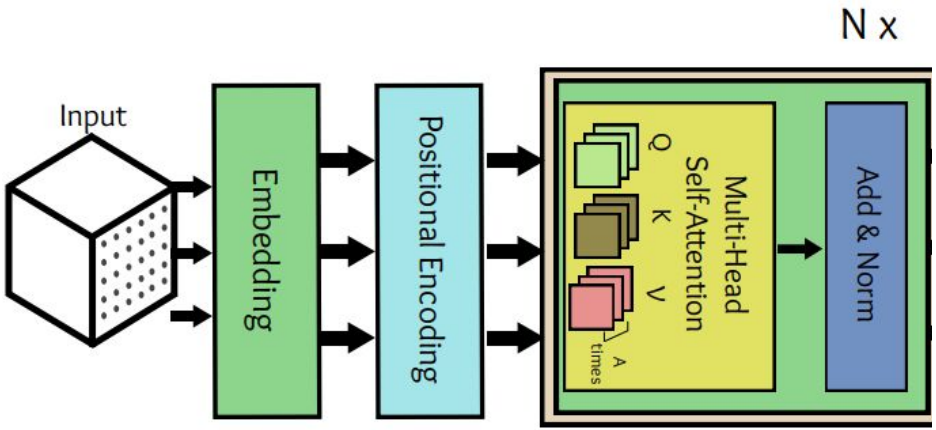
Proposed Methodology

- **Overview - Positional Encoding**



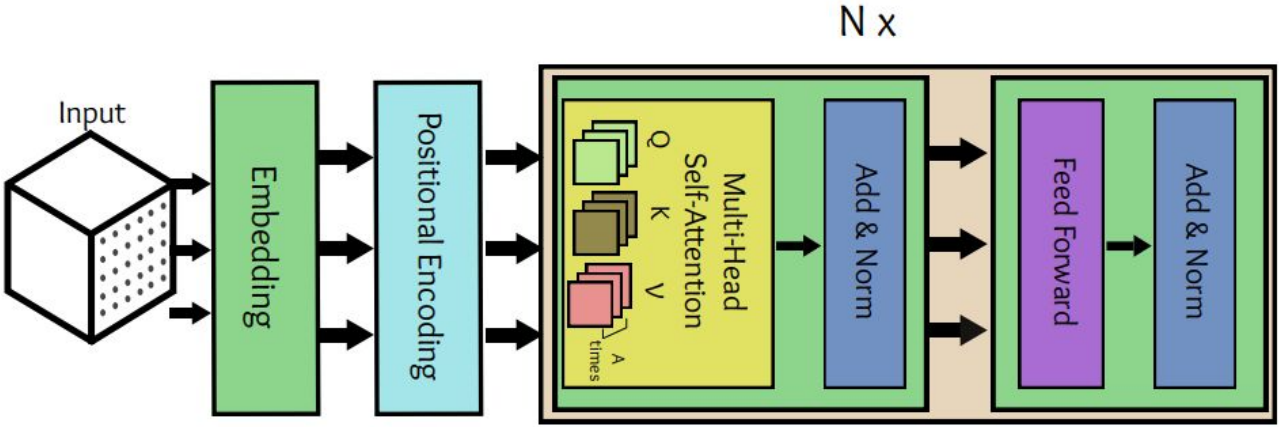
Proposed Methodology

- **Overview**



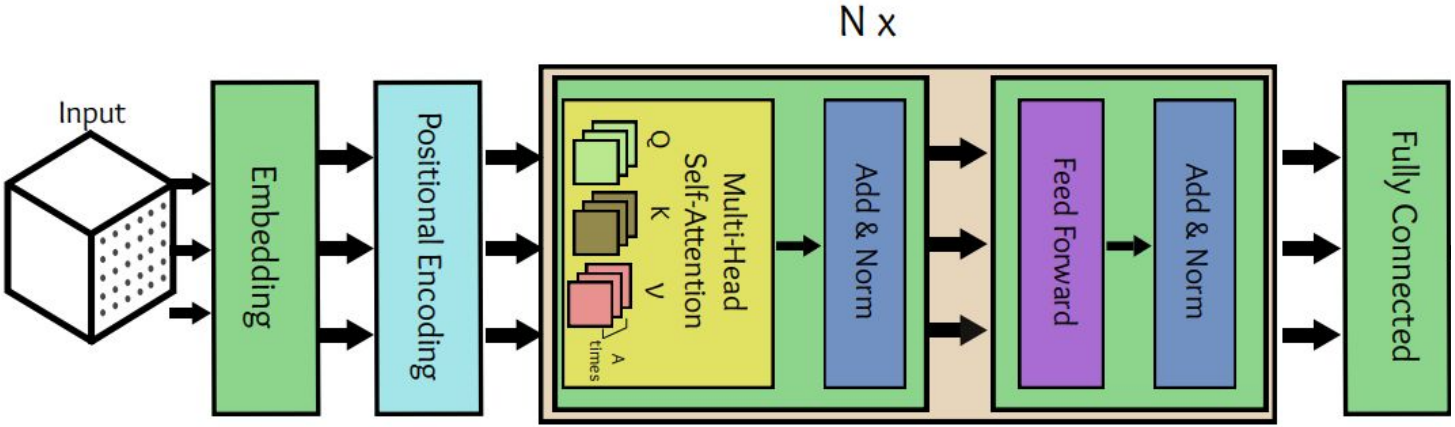
Proposed Methodology

- **Overview**



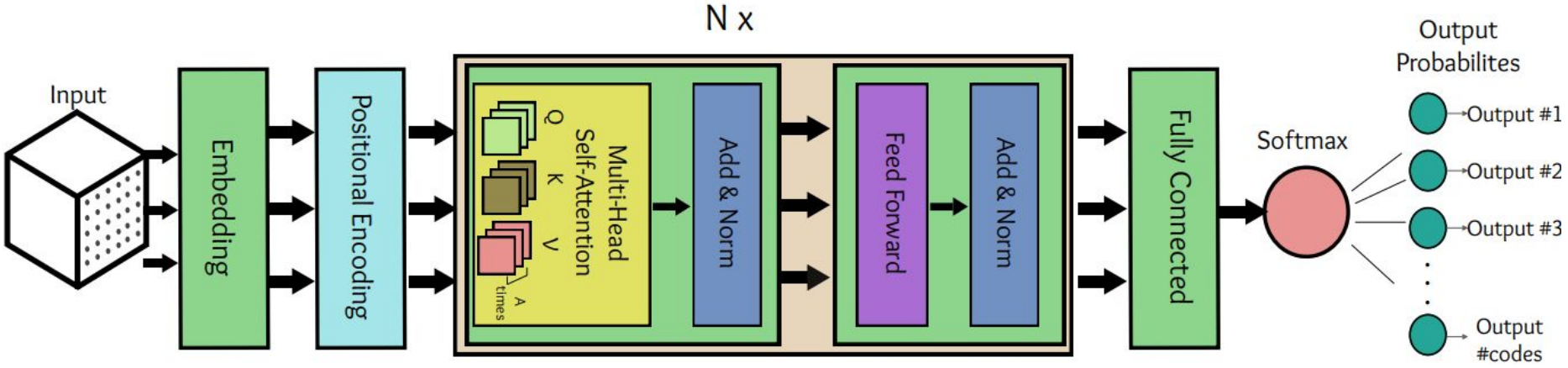
Proposed Methodology

- **Overview**



Proposed Methodology

- **Overview**



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Experiments and results

- Datasets

	Mimic-III	***InCor***
Country	Boston, Massachusetts	Sao Paulo, Brazil
Encoding	ICD-9/CCS	ICD-10
# admissions	58,976	820,819
# patients	48,520	89,048

Experiments and results

- We perform fine-tuning of the main hyperparameters;
- We also test our method against over state-of-the-art architectures

  (*DoctorAI*, *LIG-Doctor*) on *Mimic-III* public dataset.

Experiments and results

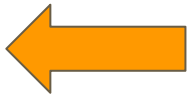
- Fine-tuning of parameters A and H_d

Dataset	A	H_d	R@10	R@20	R@30	P@1	P@2	P@3	AUC-ROC
MIMIC-III-*CCS*	10	30	**0.53**	**0.70**	**0.79**	**0.81**	**0.78**	**0.76**	**0.94**
MIMIC-III-*ICD9*	8	30	**0.45**	**0.62**	**0.70**	**0.78**	**0.76**	**0.73**	**0.95**
InCor	8	30	**0.71**	**0.75**	**0.77**	**0.65**	**0.40**	**0.25**	**0.97**
MIMIC-III-*CCS*	10	30	0.53	0.71	0.79	0.81	0.78	0.75	0.94
MIMIC-III-*ICD9*	10	15	0.46	0.61	0.70	0.79	0.76	0.72	0.95
InCor	10	30	0.70	0.74	0.77	0.64	0.39	0.28	0.97
MIMIC-III-*CCS*	10	30	0.53	0.71	0.79	0.81	0.78	0.76	0.94
MIMIC-III-*ICD9*	8	30	0.47	0.63	0.71	0.76	0.74	0.72	0.96
InCor	8	15	0.70	0.74	0.76	0.64	0.39	0.28	0.97

Experiments and results

- Comparison to related work

Metric	Rodrigues et al. [7] *LIG-Doctor*	LSTM	GRU	Choi et al. *DoctorAI*	*APEHR*
Recall@10	0.49	0.46	0.45	0.44	0.53
Recall@20	0.66	0.62	0.63	0.62	0.70
Recall@30	0.76	0.72	0.73	0.72	0.79
Precision@1	0.81	-	-	-	0.81
Precision@2	0.78	-	-	-	0.78
Precision@3	0.74	-	-	-	0.76
AUC-ROC	0.93	-	-	-	0.94



⇒ Our results were pronouncedly superior to those of former 4 works in the literature

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Conclusion

- We demonstrate Transformer's adaptability to the diagnostic problem using only diagnostic codes;
- The experiments over InCor dataset verify that our model is feasible in different medical settings;
- Our method surpasses other works by as much as 4% regarding metric Recall@k;
- Future work: extended to more techniques, such as Transformer XL.

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Thank you for your attention!

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