Fall Detection in EHR using Word Embeddings and Deep Learning

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Brief context …

Multidisciplinary Group and ...

PUCRS
Pontifical Catholic University - Rio Grande do Sul

PPGCC and PPGGB
Graduate program in Computer Science
Graduate program in Biomedical Gerontology

… and Multicentric Group

GHC
Grupo Hospitalar Conceição

HOSPITAL
MÃE DE DEUS
SISTEMA DE SAÚDE MÃE DE DEUS

HOSPITAL
MOINHOS
DE VENTO

SANTA CASA
DE MISERICÓRDIA
PORTO ALEGRE

SOCIEDADE BENEFICENTE DE SENHORAS
SÍRIO·LIBANÊS

HOSPITAL
SÃO LUCAS
DA PUCRS

http://www.inf.pucrs.br/ia-saude/

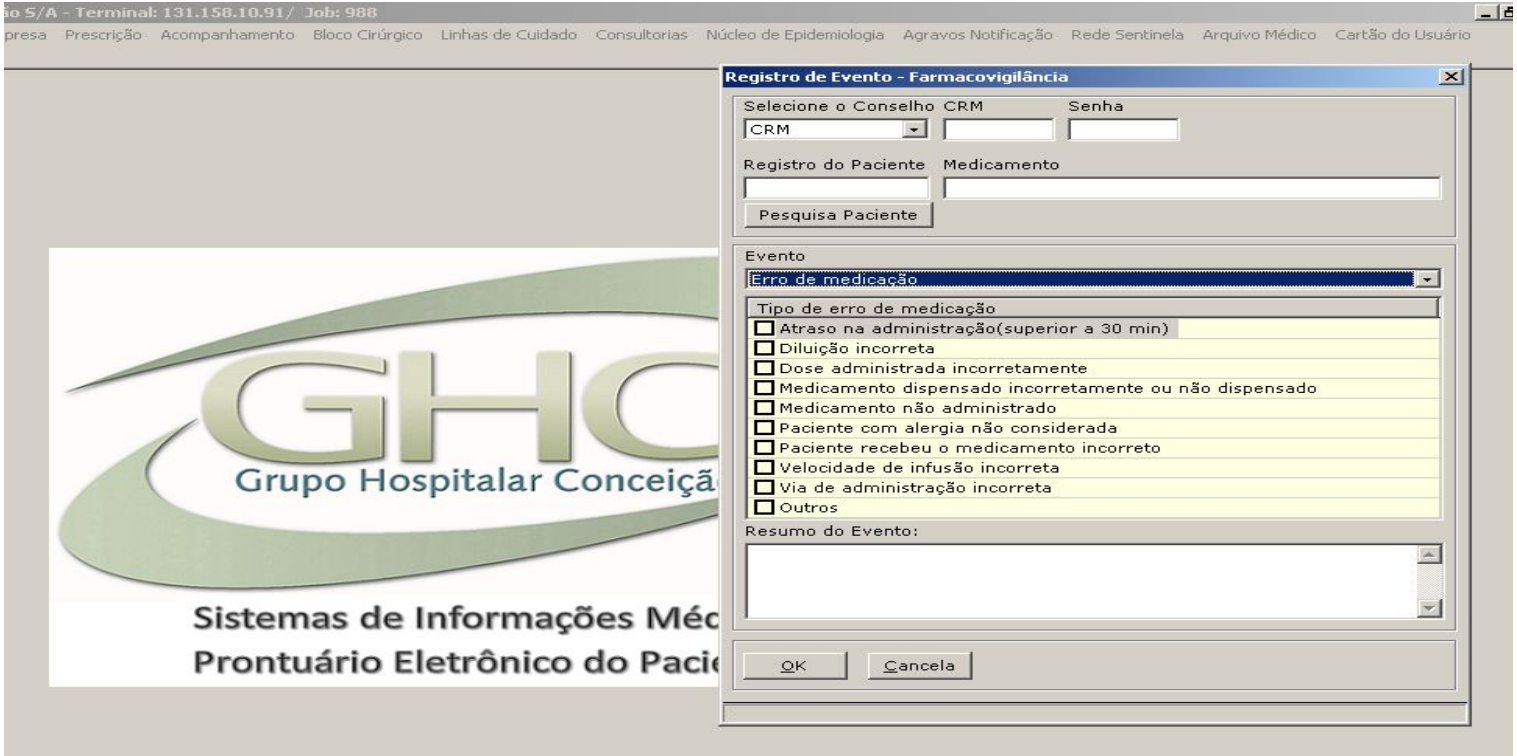
Scope of this Research

Fall

This adverse event is very common in the hospital environment. The Morse Fall Scale measure the risk of patient fall.

There is a underreport number of fall event notifications.

Report System



Underreported Events

Events are notified voluntarily in the system

Source of useful information to improve care and subsidize continuing education!

Due to lack of knowledge, forgetfulness or lack of time, it is underreported. Only 10-20% of these events are reported.

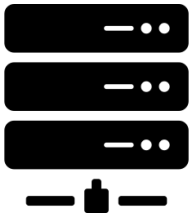
IHI Global Trigger Tool

"This tool includes a list of known AE triggers as well as **instructions for selecting records**, training information, and appendices with references and common questions."

Objectives

Generate algorithms and models for fall events detection

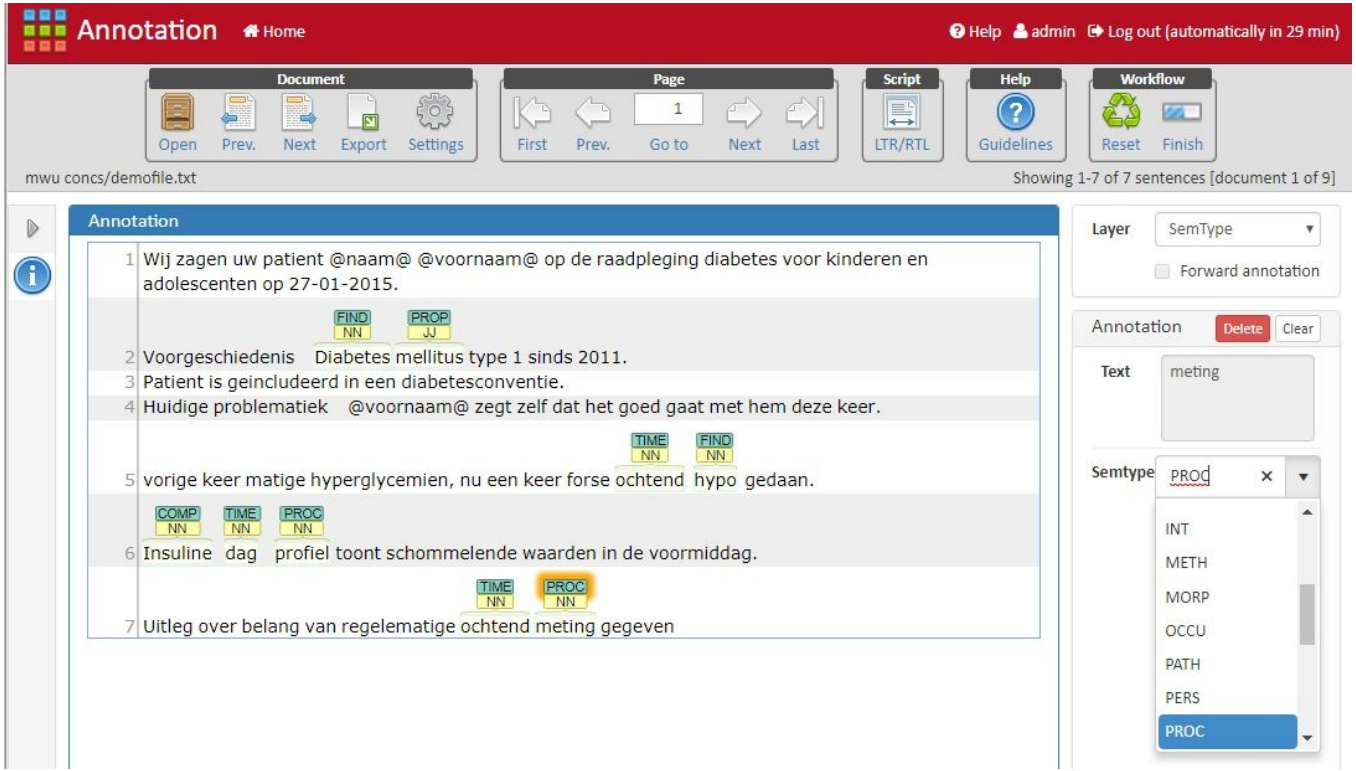
Make available fall events datasets for shared tasks



Evaluate models within Hospitals

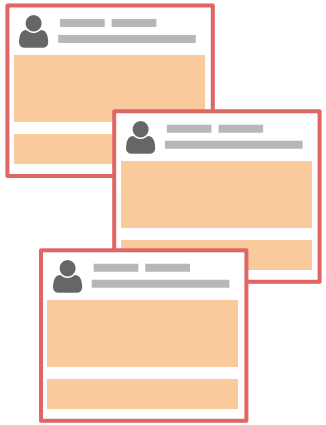
Experiments ...

Annotation Process - WebAnno



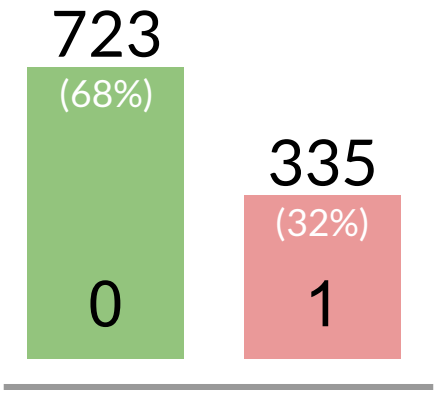
* not a real fall report example

Annotation Process - Results



367
Patients

441
Incident Reports



1,078
Progress Notes

Annotation Process - Results

Fall per Patient in Annotated Dataset

# of Patients	% of Total	# of Falls
316	87.0 %	1 fall
36	10.0%	2 falls
11	3.0 %	3 falls
1	0.3 %	4 falls
…	…	…

Fall Detection - Experiments

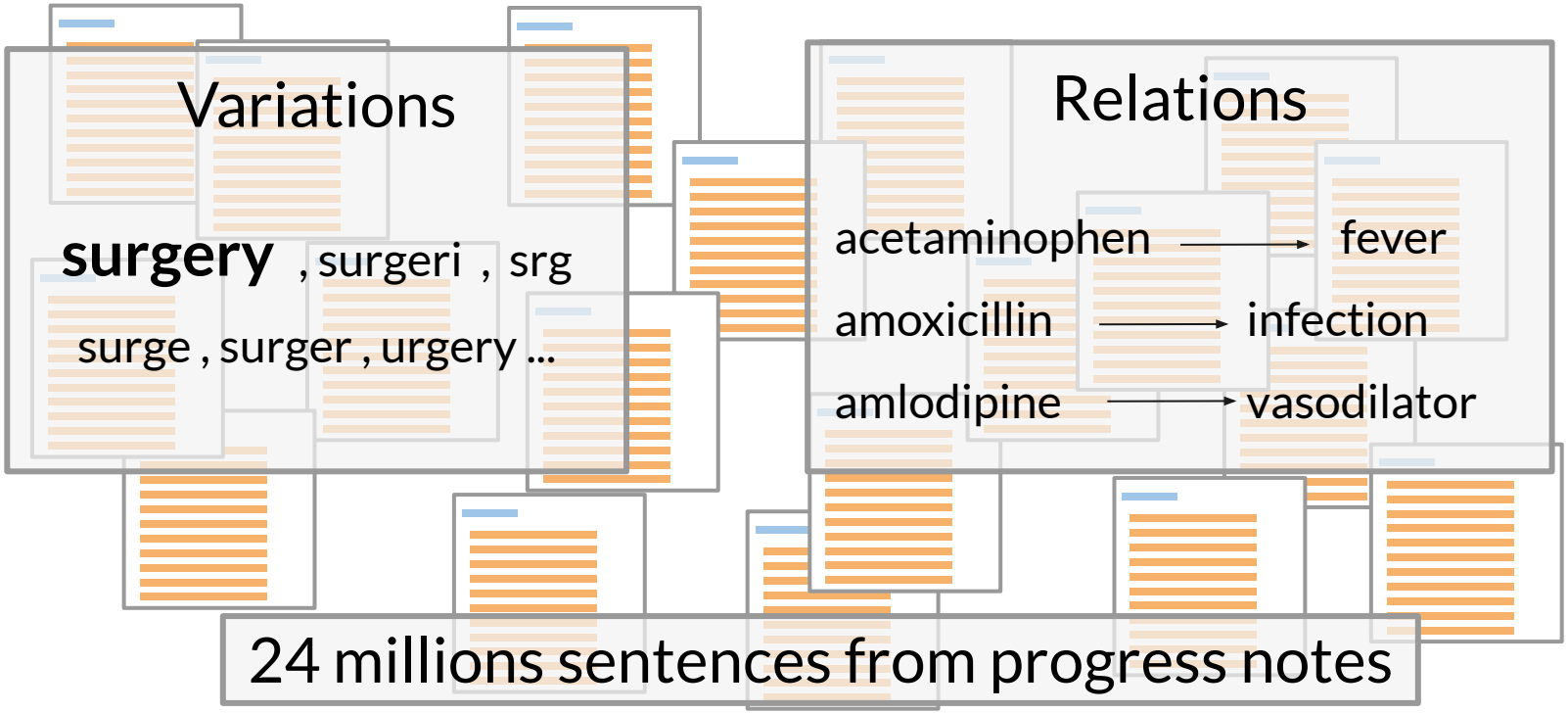
Annotation of 1,078 Clinical Notes

Evaluation of three Word Embedding Models

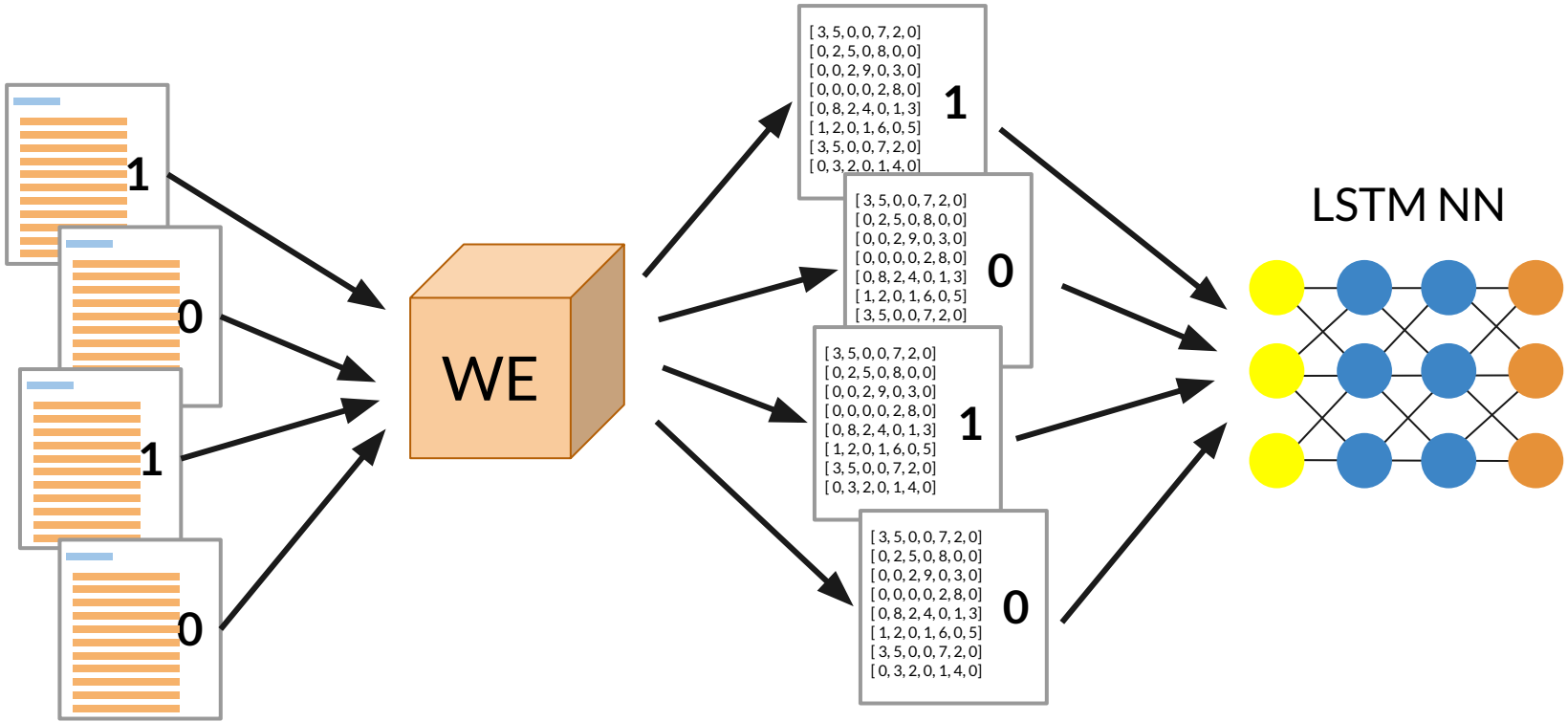
- Wikipedia-PT
- NILC (Wikipedia + 20 sources)
- GHC: 23 millions sentences from Clinical Notes

State-of-the-art NLP Neural Network (LSTM)

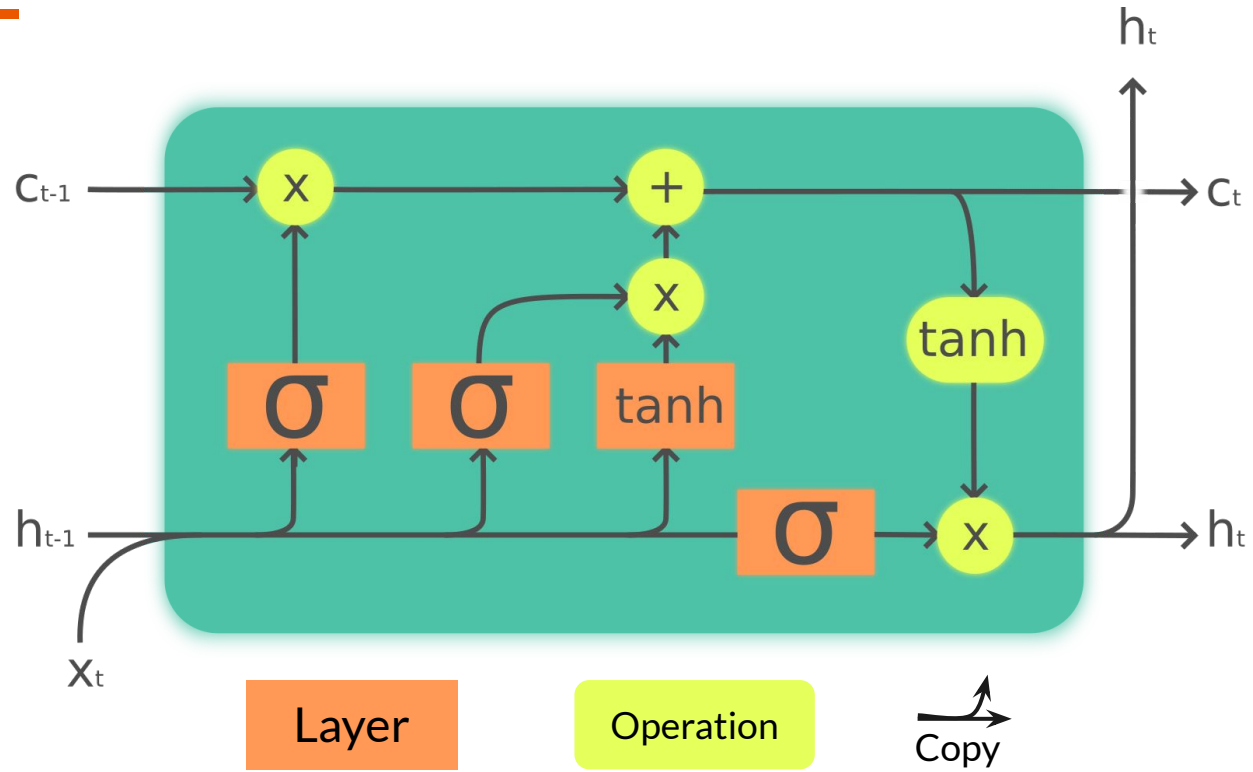
Word Embeddings



Word Embeddings Encoding



LSTM (Long Short-Term Memory)



Results ...

Fall Detection - Results

Embeddings 5-Fold Cross Validation: F-Measure

	Word2Vec	FastText
Wikipedia	0.88 ± 0.14	0.87 ± 0.11
NILC (broad-domain)	0.77 ± 0.06	0.89 ± 0.13
EHR (specific-domain)	0.88 ± 0.14	**0.90 ± 0.13**
Baseline (RandomForest)	0.73 ± 0.03	

Fall Detection - Source Code

- Experiments scripts
- Annotated Dataset (1,078 records)
- Pre-trained Word Embeddings

https://github.com/nlp-pucrs/fall-detection

Research Limitations

- Clinical Notes Sampling (natural distribution)
- Self-Attettion Neural Network
- BERT, GPT-2, XLNet Embeddings
- Quality Evaluation (why right, why wrong)

Further Work

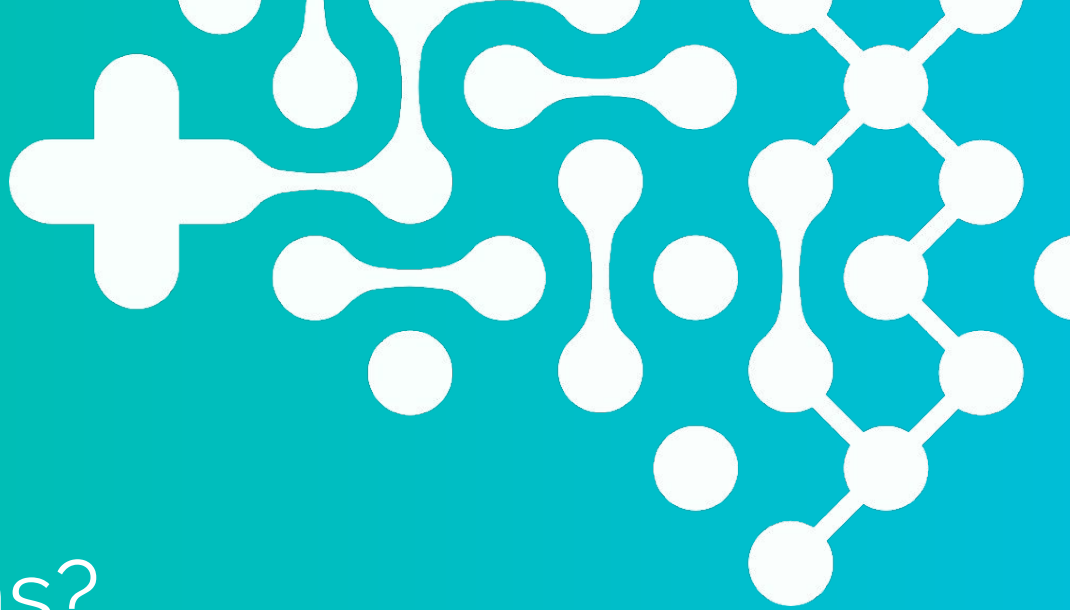
Sequence Tagging Task : F-Measure

	LSTM + CRF
Wikipedia	0.55
NILC (broad-domain)	0.67
EHR (specific-domain)	**0.80**

Further Work

Quality Embeddings - Analogies Task

	Specific	Broad
Wikipedia	1.38 %	79.00 %
NILC (broad-domain)	2.61 %	**82.38 %**
EHR (specific-domain)	**2.85 %**	0.00 %



Thanks! Questions?

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