



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

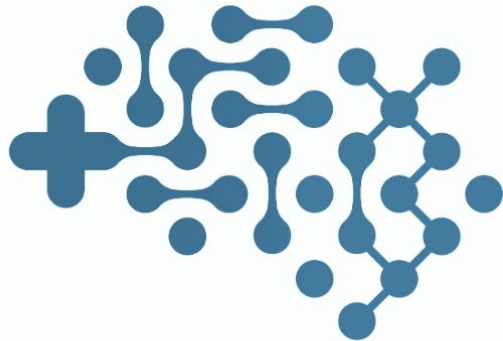
PPGCC and PPGGB

Graduate program in Computer Science

Graduate program in Biomedical Gerontology



... and Multicentric Group



Research Group on
Artificial Intelligence
in Healthcare



<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

io S/A - Terminal: 131.158.10.91/ Job: 988

Prescrição Acompanhamento Bloco Cirúrgico Linhas de Cuidado Consultorias Núcleo de Epidemiologia Agravos Notificação Rede Sentinela Arquivo Médico Cartão do Usuário

Registro de Evento - Farmacovigilância

Selecione o Conselho CRM Senha

CRM [] [] []

Registro do Paciente Medicamento

[]

Pesquisa Paciente

Evento

Erro de medicação

Tipo de erro de medicação

- ☐ Atraso na administração(superior a 30 min)
- ☐ Diluição incorreta
- ☐ Dose administrada incorretamente
- ☐ Medicamento dispensado incorretamente ou não dispensado
- ☐ Medicamento não administrado
- ☐ Paciente com alergia não considerada
- ☐ Paciente recebeu o medicamento incorreto
- ☐ Velocidade de infusão incorreta
- ☐ Via de administração incorreta
- ☐ Outros

Resumo do Evento:

[]

OK Cancela

GHCO
Grupo Hospitalar Conceição

Sistemas de Informações Médicas
Prontuário Eletrônico do Paciente



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.”



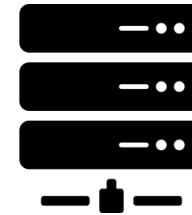
Objectives



Generate
algorithms and
models for fall
events
detection



Make available
fall events
datasets for
shared tasks



Evaluate
models within
Hospitals

Experiments ...



Annotation Process - WebAnno

The screenshot displays the WebAnno web interface for document annotation. The top navigation bar includes links for Home, Help, admin, and Log out (automatically in 29 min). Below this, there are tabs for Document, Page, Script, Help, and Workflow. The Document tab is active, showing options like Open, Prev., Next, Export, and Settings. The Page tab shows navigation controls (First, Prev., Go to, Next, Last) and a page number of 1. The Script tab has LTR/RTL options. The Help tab has Guidelines. The Workflow tab has Reset and Finish options. The main area shows a list of sentences with semantic annotations. The sidebar on the right contains a Layer dropdown (SemType), a checkbox for Forward annotation, an Annotation section with Delete and Clear buttons, a Text input field (meting), and a Semtype dropdown menu with a list of options (INT, METH, MORP, OCCU, PATH, PERS, PROC).

Annotation

1 Wij zagen uw patient @naam@ @voornaam@ op de raadpleging diabetes voor kinderen en adolescenten op 27-01-2015.

2 Voorgeschiedenis Diabetes mellitus type 1 sinds 2011.

3 Patient is geincludeerd in een diabetesconventie.

4 Huidige problematiek @voornaam@ zegt zelf dat het goed gaat met hem deze keer.

5 vorige keer matige hyperglycemien, nu een keer forse ochtend hypo gedaan.

6 Insuline dag profiel toont schommelende waarden in de voormiddag.

7 Uitleg over belang van regelmatige ochtend meting gegeven

Layer SemType

☐ Forward annotation

Annotation Delete Clear

Text meting

Semtype PROC x

- INT
- METH
- MORP
- OCCU
- PATH
- PERS
- PROC

* not a real fall report example



Annotation Process - Results





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

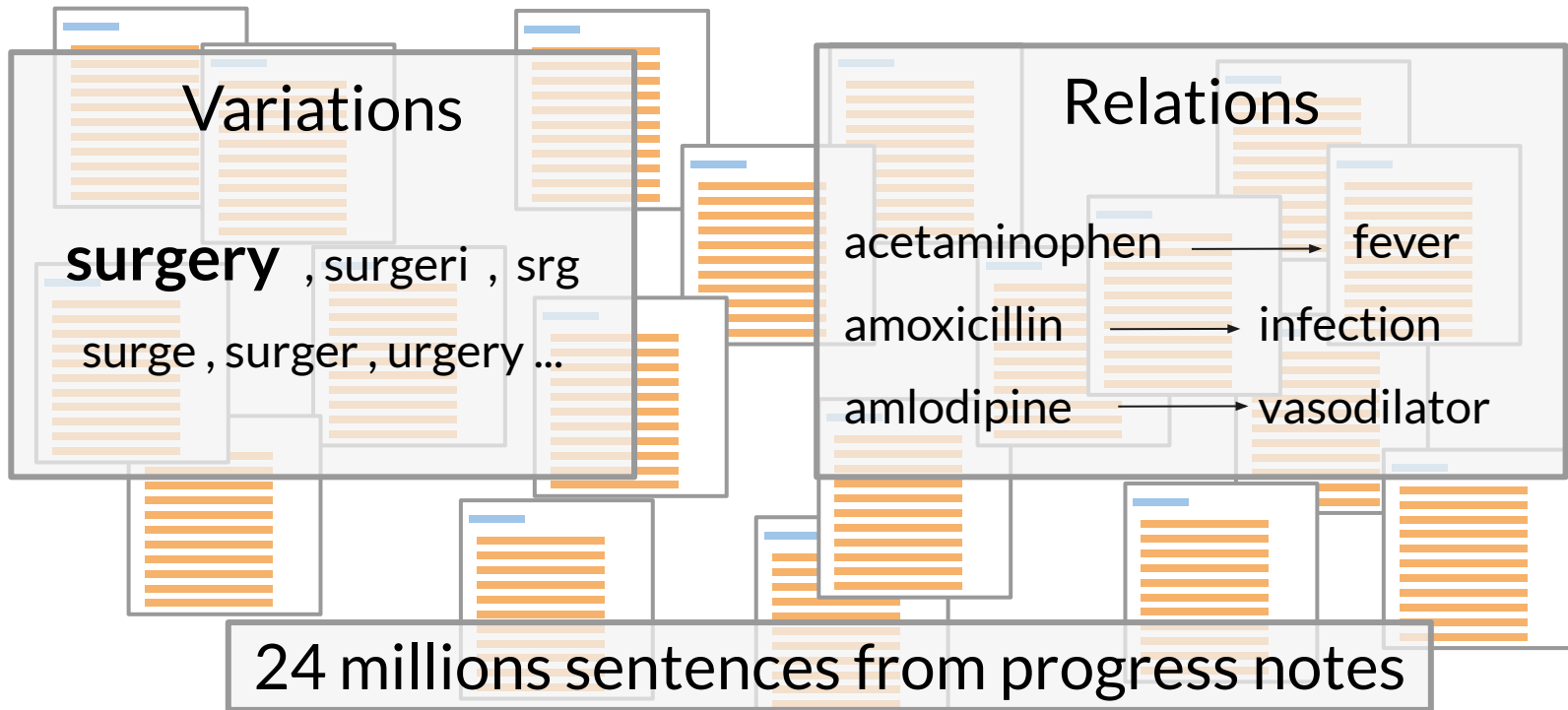
Evaluation of three Word Embedding Models

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

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

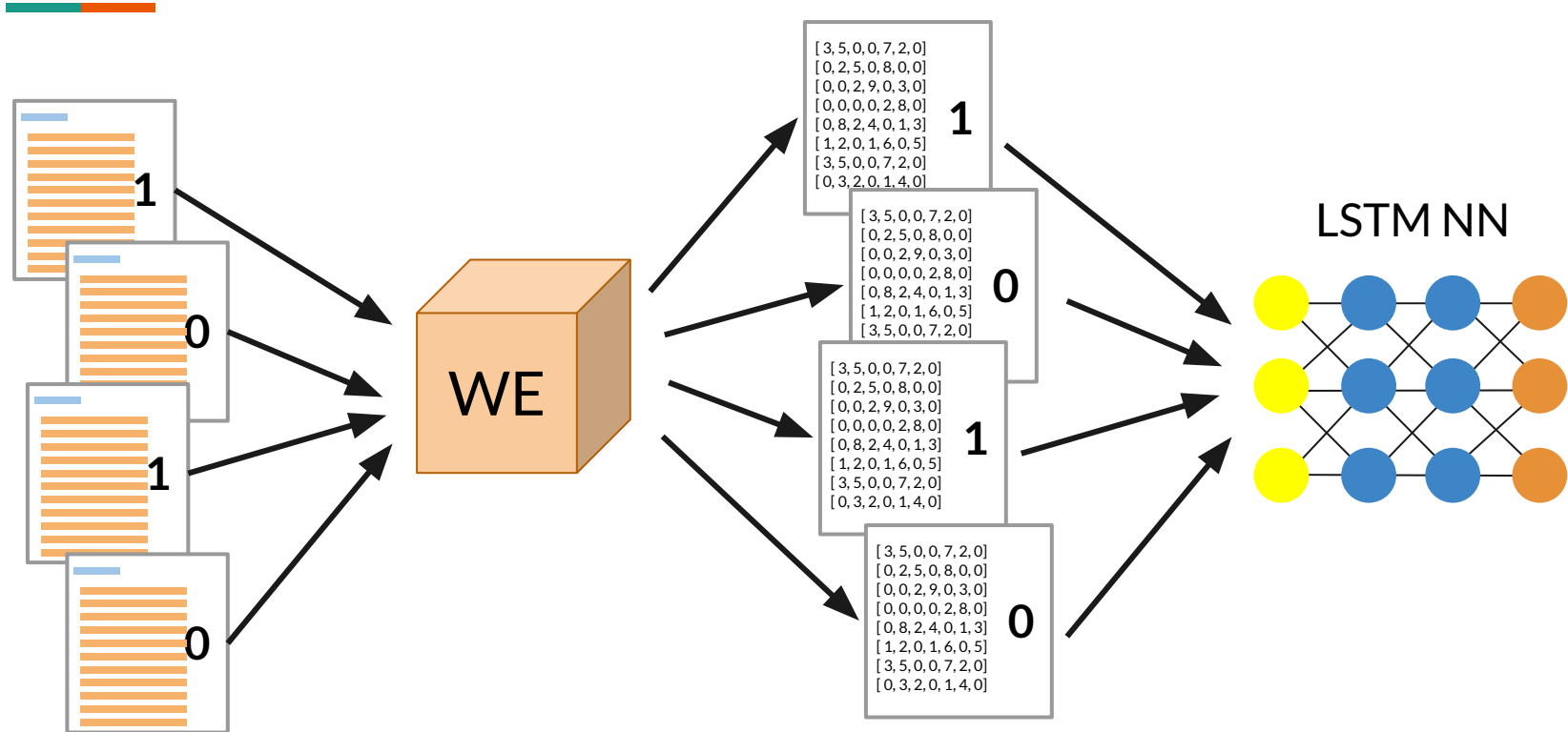


Word Embeddings



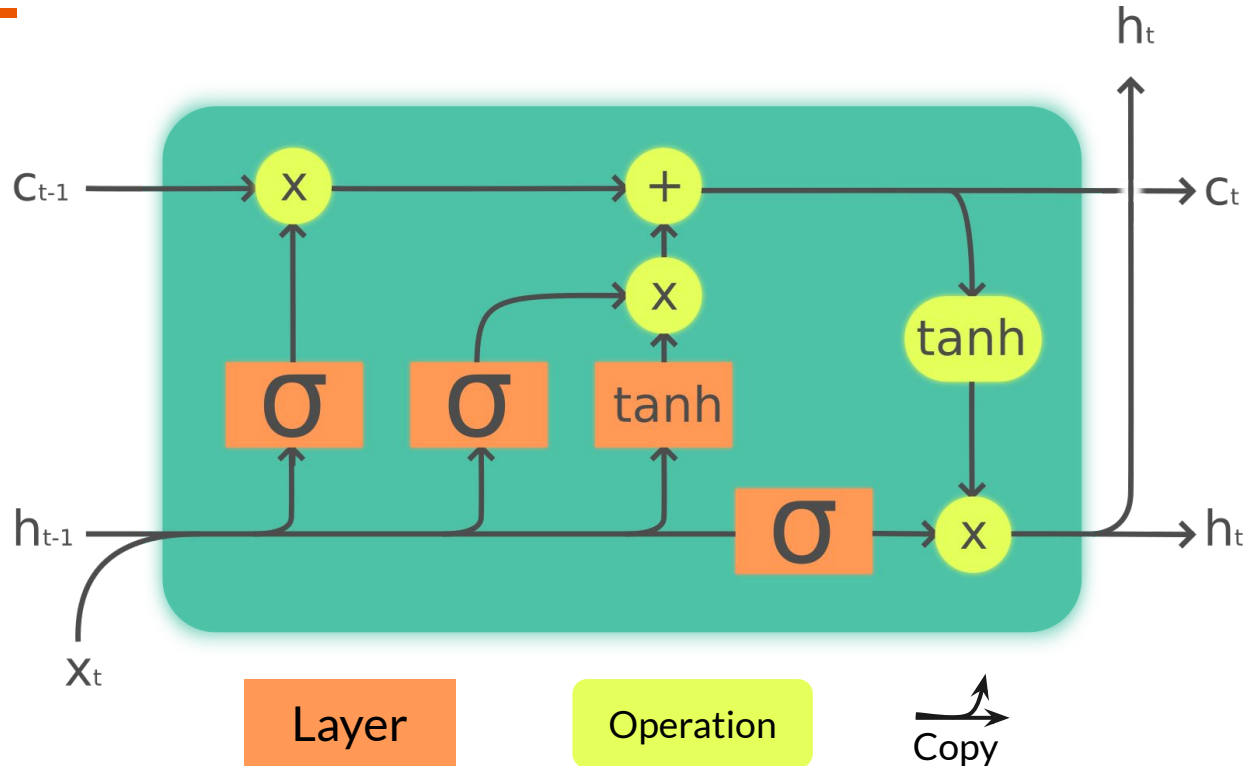


Word Embeddings Encoding





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-Attention Neural Network
- BERT, GPT-2, XLNet Embeddings
- Quality Evaluation (why right, why wrong)



Further Work

Sequence Tagging Task : F-Measure

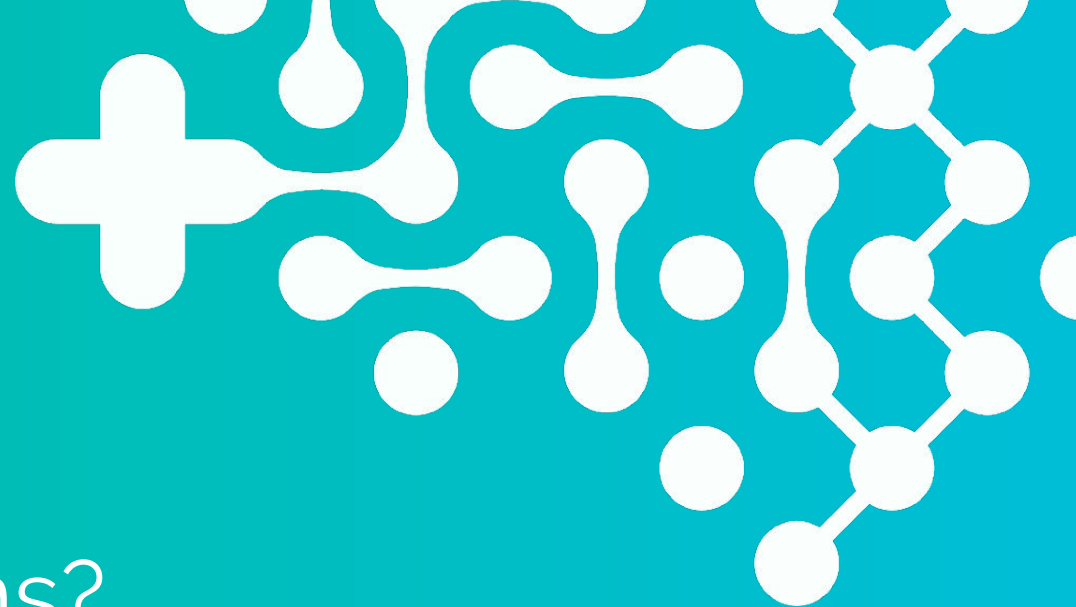
	LSTM + CRF
Wikipedia	0.55
NILC (broad-domain)	0.67
EHR (specific-domain)	0.80



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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