



# Fall Detection in EHR using Word Embeddings and Deep Learning

**Henrique Dias** - PUCRS - Brazil



# Research Context

---

## **PUCRS**

Pontifical Catholic University - Rio Grande do Sul

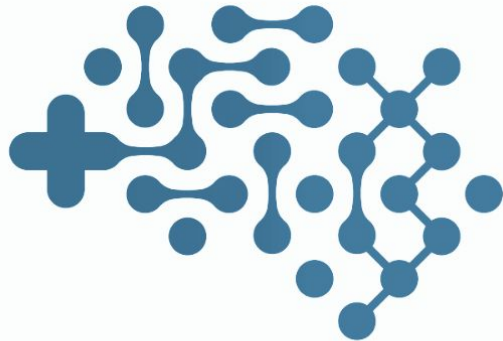
## **PPGCC and PPGGB**

Graduate program in Computer Science

Graduate program in Biomedical Gerontology



# Hospital Collaborations



Research Group on  
**Artificial Intelligence**  
in Healthcare



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



# Scope of this Project

---

## **Fall**

This 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



# 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.”



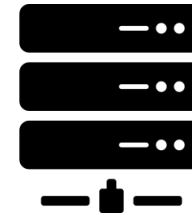
# Objectives



Generate  
algorithms and  
models for fall  
events  
detection



Make available  
fall events  
datasets for  
shared tasks



Evaluate  
models within  
Hospitals





# Annotation Process - WebAnno

Annotation

Home

Help

admin

Log out (automatically in 29 min)

Document

Open

Prev.

Next

Export

Settings

Page

First

Prev.

Go to 1

Next

Last

Script

LTR/RTL

Help

Guidelines

Workflow

Reset

Finish

mmw concs/demofile.txt

Showing 1-7 of 7 sentences [document 1 of 9]

Annotation

1

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

FIND

NN

PROP

JJ

2

Voorgeschiedenis Diabetes mellitus type 1 sinds 2011.

TIME

NN

TIME

NN

3

Patient is geincludeerd in een diabetesconventie.

TIME

NN

PROC

NN

4

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

TIME

NN

FIND

NN

5

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

COMP

NN

TIME

NN

PROC

NN

6

Insuline dag profiel toont schommelende waarden in de voormiddag.

TIME

NN

PROC

NN

7

Uitleg over belang van regelmatig ochtend meting gegeven

TIME

NN

PROC

NN

Layer

SemType

☐ Forward annotation

Annotation

Delete

Clear

Text

meting

Semtype

PROD

INT

METH

MORP

OCCU

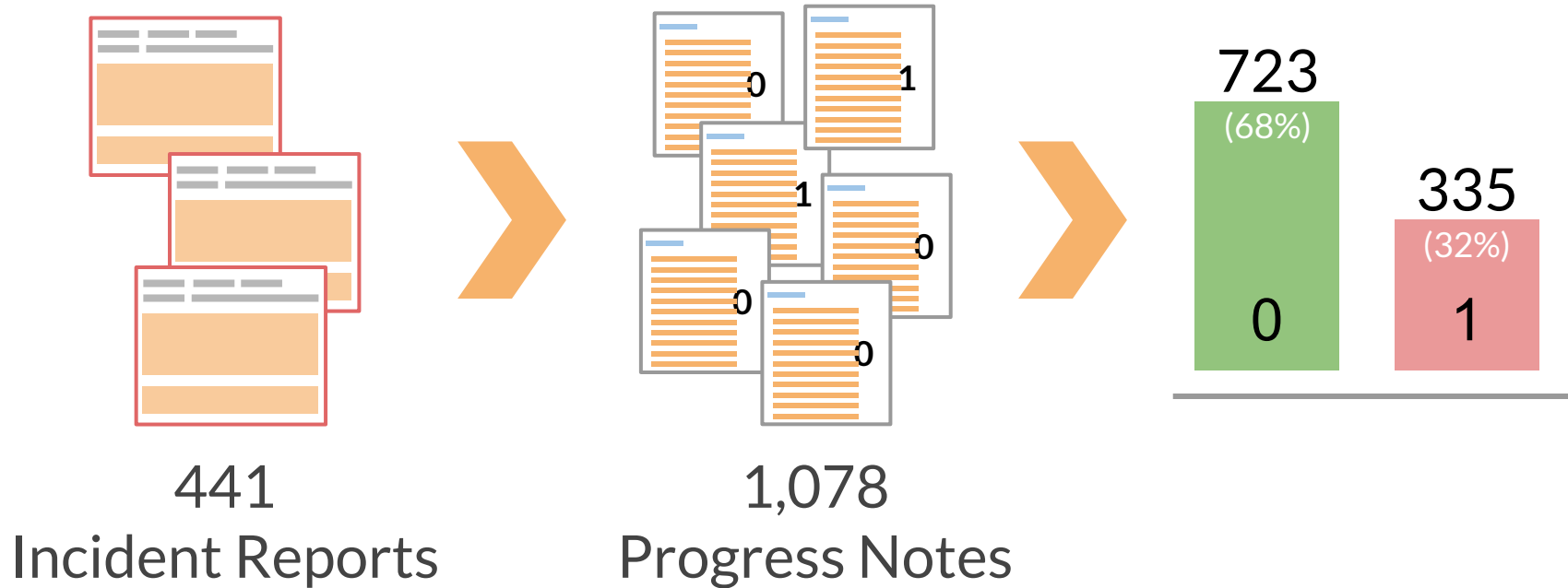
PATH

PERS

PROC



# Annotation Process - Results





# Fall Detection - Experiments

---

Annotation of 1,078 Clinical Notes

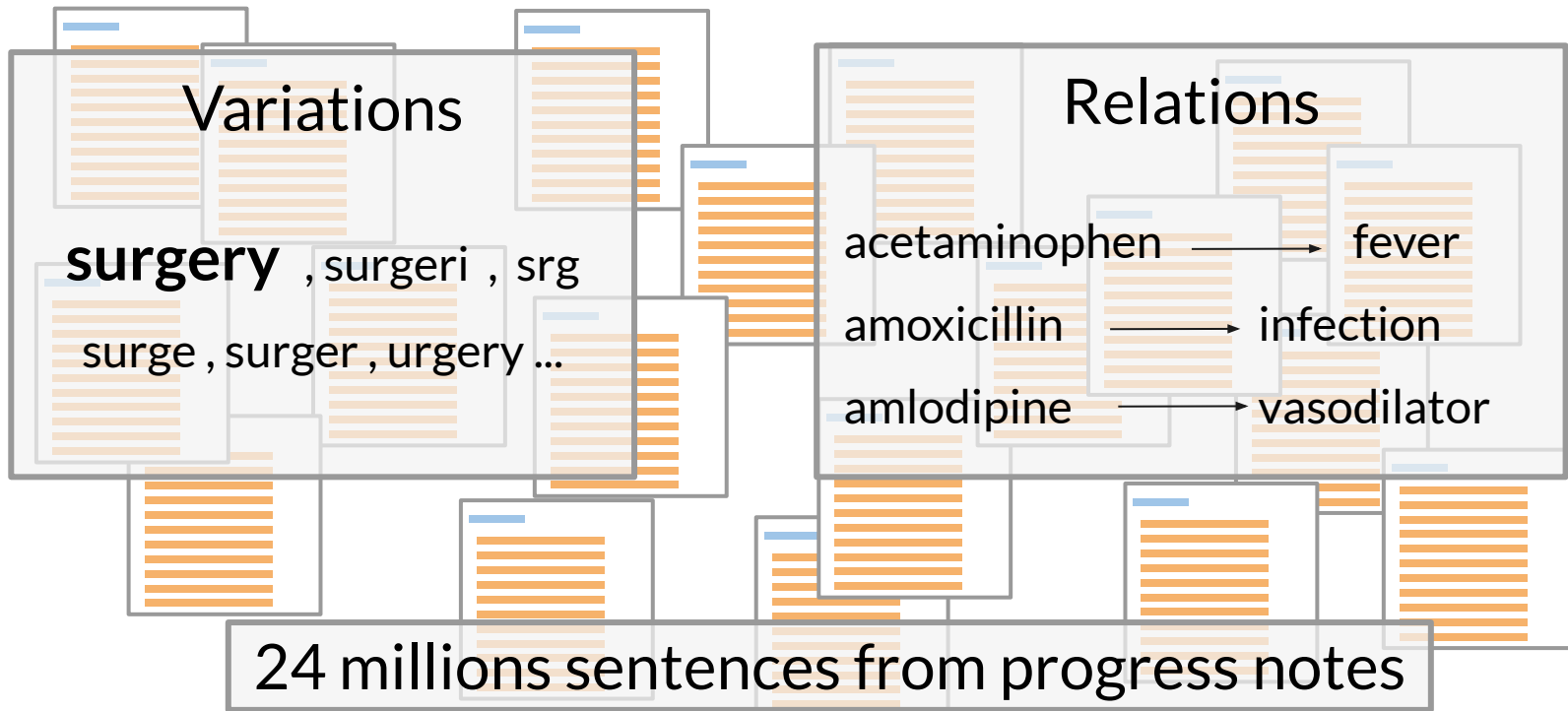
Evaluation of three Word Embedding Models

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

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

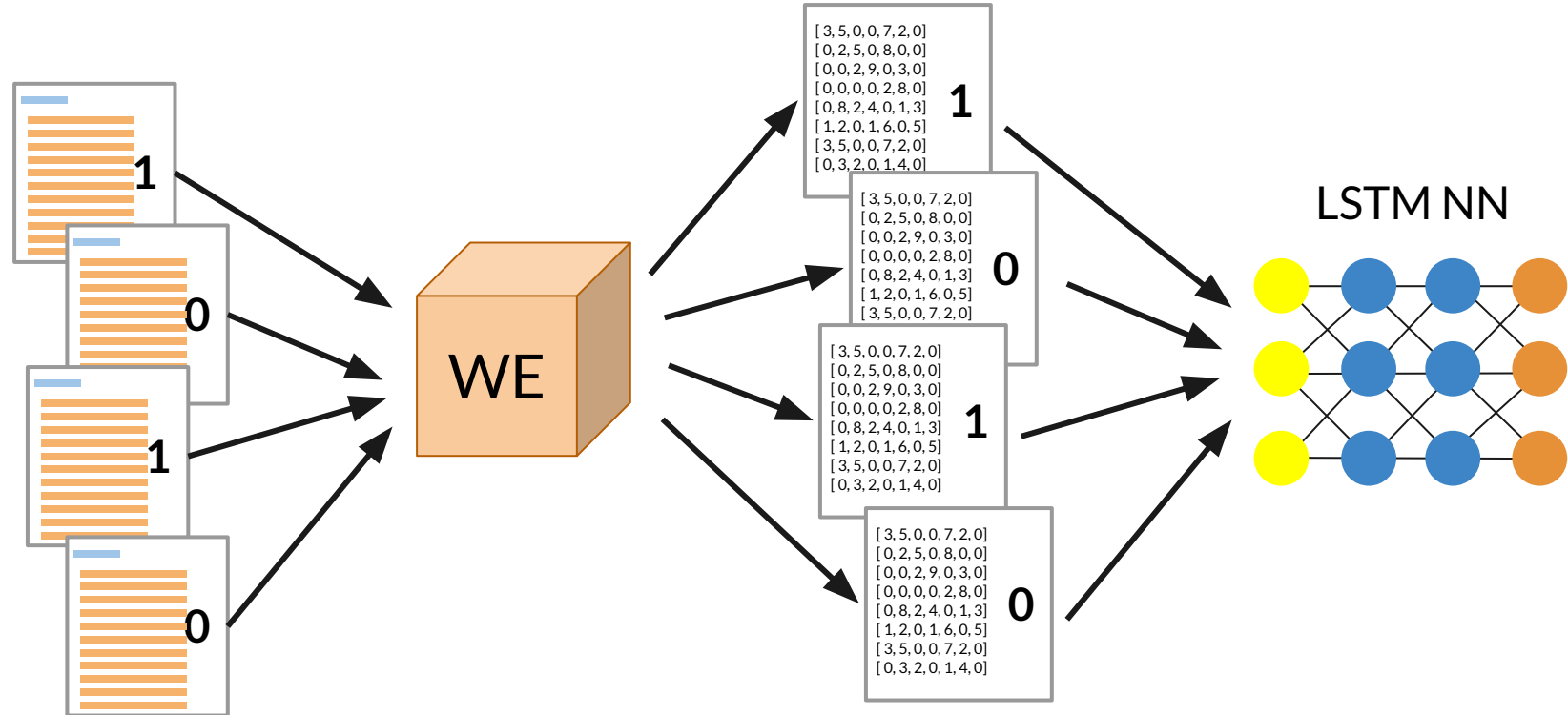


# Word Embeddings



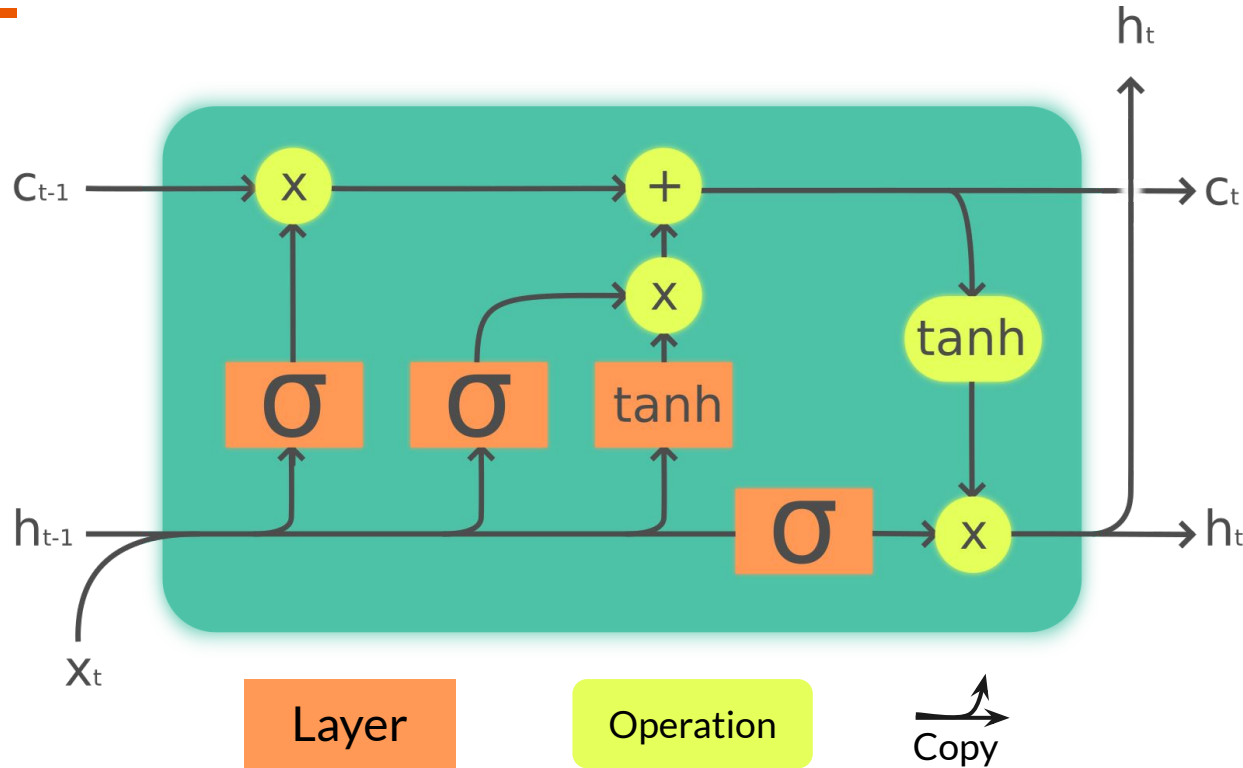


# Word Embeddings Encoding





# LSTM (Long Short-Term Memory)





# Fall Detection - Results

Embeddings 5-Fold Cross Validation: F-Measure

	Word2Vec	FastText
Wikipedia	$0.88 \pm 0.14$	$0.87 \pm 0.11$
NILC (broad-domain)	$0.77 \pm 0.06$	$0.89 \pm 0.13$
EHR (specific-domain)	$0.88 \pm 0.14$	<b><math>0.90 \pm 0.13</math></b>
Baseline (RandomForest)	$0.73 \pm 0.03$	



# 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



# Further Work

Sequence Tagging Task : F-Measure

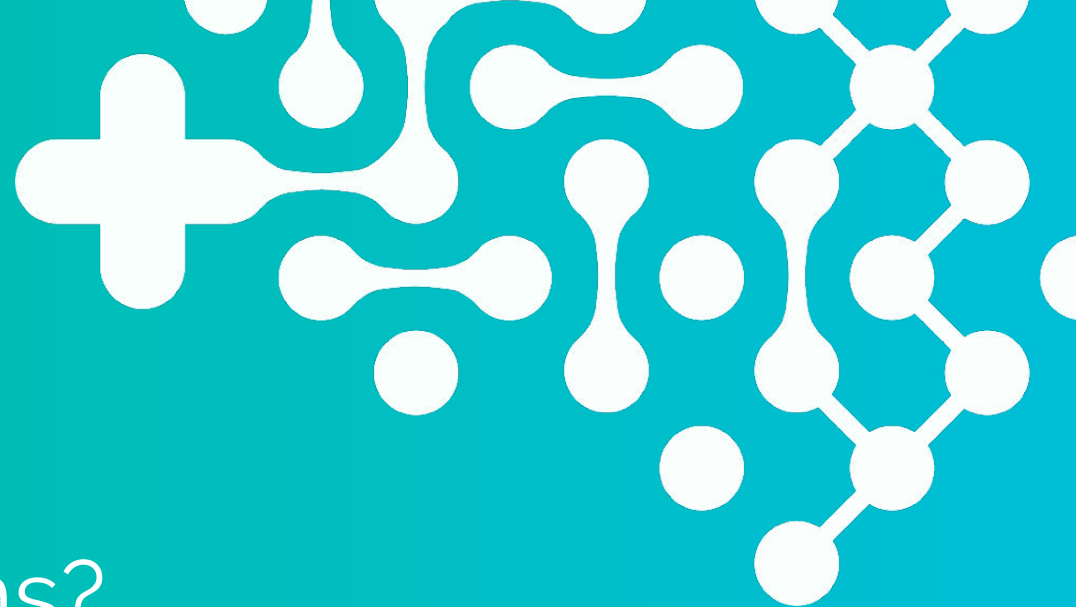
	FastText
Wikipedia	0.55
NILC (broad-domain)	0.67
EHR (specific-domain)	<b>0.80</b>



# Further Work

## Quality Embeddings - Analogies Task

	Specific	Broad
Wikipedia	1.38 %	79.00 %
NILC (broad-domain)	2.61 %	<b>82.38 %</b>
EHR (specific-domain)	<b>2.85 %</b>	0.00 %



# Thanks! Questions?

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

**Henrique Dias**

henrique.santos.003@acad.pucrs.br