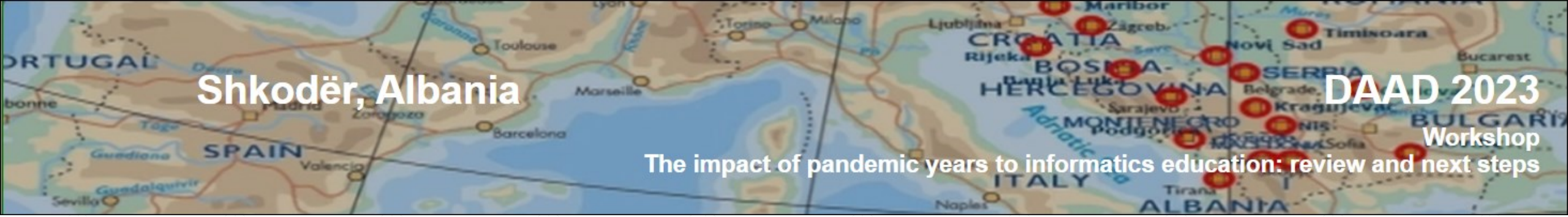


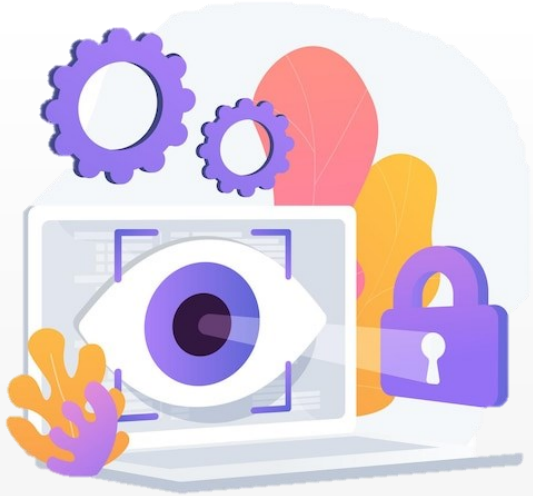
Investigating human language processing by integrating eye-tracking and NLP techniques

ALBA HAVERIKU
alba.haveriku@fti.edu.al

Faculty of Information Technology
Polytechnic University of Tirana
Tirana, Albania

OUTLINE OF PRESENTATION

1. Introduction
2. Motivation
3. The eye-tracking concept
4. Integrating eye-tracking & NLP
5. Methodology
6. Conclusions & Future Work



INTRODUCTION

Eye-Tracking

- The detection of eye-movements
- Useful information to detect human visual attention.

Natural Language Processing (NLP)

- Subfield of Artificial Intelligence
- The combination of linguistics and computer science.

Imitating human language processing comes with problems and there is room for improvement.

MOTIVATION

Why study eye-tracking technologies?

1. NLP models still need improvement to achieve better accuracy.
2. Eye-tracking data can be used to improve or evaluate the accuracy of neural network models.

Which is the current situation in Albania and the World?

1. Lack of eye-tracking research and corpus for Albanian language texts.
2. European projects such as MultiplEYE give focus to multi-lingual eye-tracking.

THE EYE-TRACKING CONCEPT

TYPES OF COGNITIVE DATA

Eye Tracking

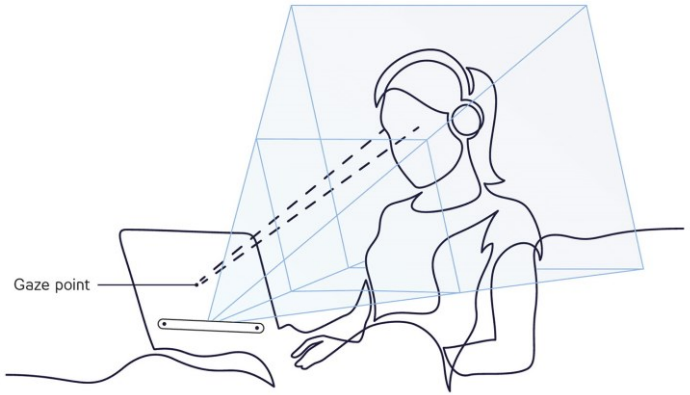
- Focus points
- Gaze duration
- Saccades

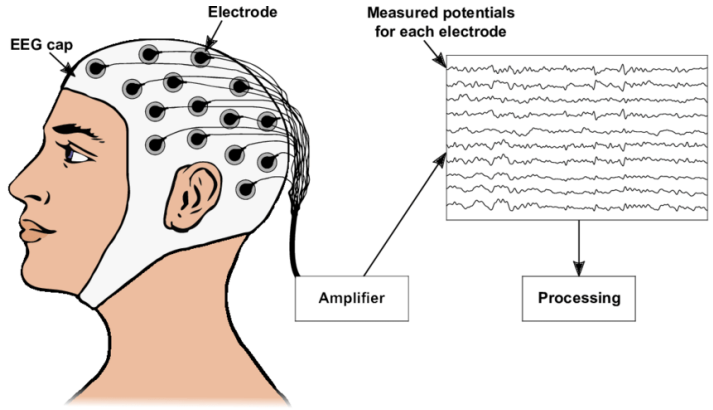
Keyboards clicks

- Saving the time of typing, selection etc.

Electromagnetic signals

- EEG (Electroencephalograph)
- MEG (Magnetoencephalography)
- fMRI (functional Magnetic Resonance Imaging)

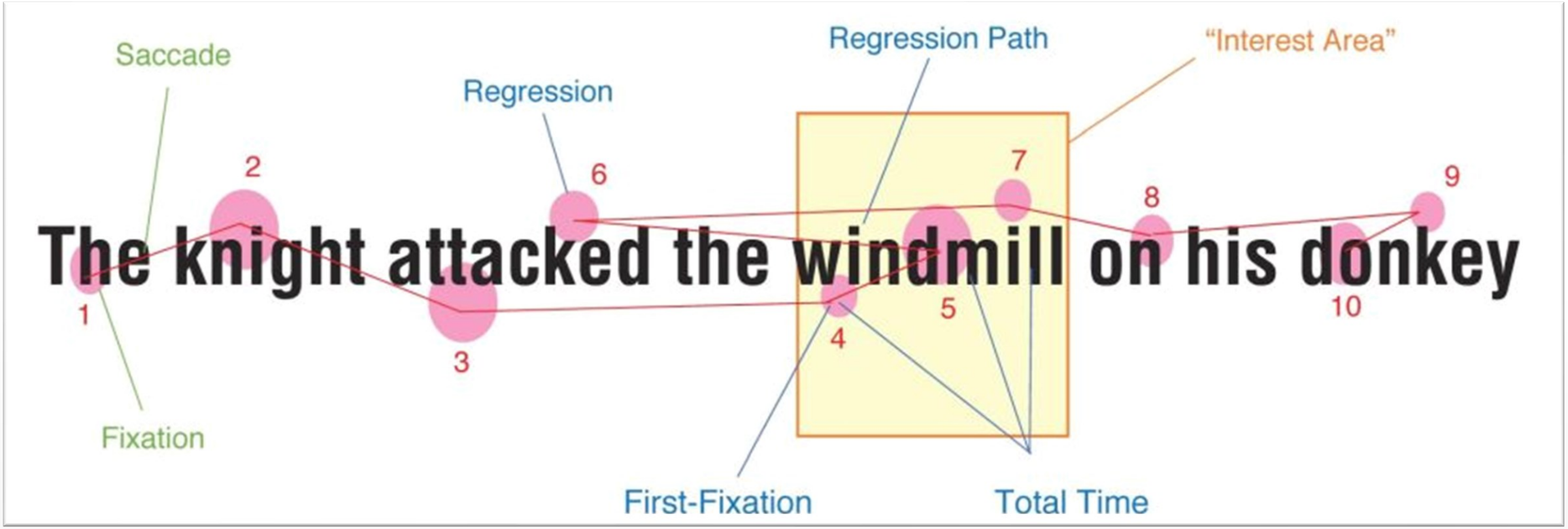




Eye-Tracking Features

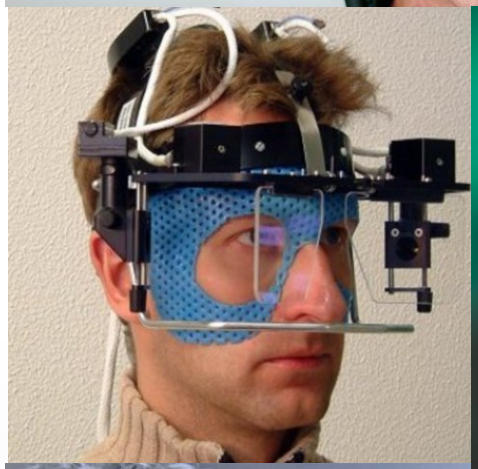
FEATURES	DESCRIPTION
Fixation	A long observation in an object (word) in the screen.
Point of fixation	The position where the eye is fixated on the screen.
Saccade	A rapid eye shift from one point of fixation to another.
Scanpath	A linear graph where: ▫ Points of the fixation are nodes; ▫ Saccades are considered as edges.
Gaze duration	The total amount of time of all the possible fixations that are made to a word before a saccade to another word in the text.
Total viewing time	The sum of all fixations in a specific word, including regressions.

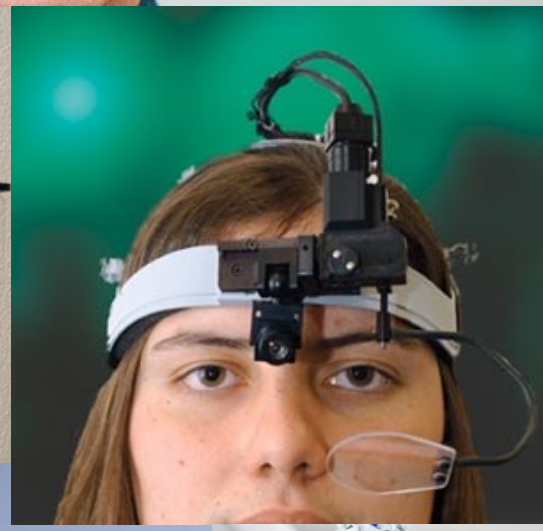
EXAMPLE


Saccade
Regression
Regression Path
"Interest Area"
The knight attacked the windmill on his donkey
1
2
3
4
5
6
7
8
9
10
Fixation
First-Fixation
Total Time

EYE-TRACKING DEVICES

- EyeLink 1000/1000+
- Pupil Neon/Core
- Tobii eye-trackers
- GazePoint GP3





EYE-TRACKING SOFTWARE

WebGazer.js

- Eye-tracking library
- Web camera usage
- Autocalibration
- Acceptable accuracy
- Real-time integration

PACE

- Personalized Automatically Calibrating Eye-tracking
- No extra devices necessary
- Autocalibration
- Easily integrated with computer systems

Python packages

- Pymovements
- PyGaze
- PyEyeTrack

WebGazer

pymovements

INTEGRATING EYE-TRACKING & NLP

EYE-TRACKING IN NLP

FIELD	AUTHORS
Part of speech tagging	Barret et al. (2016)
Sentiment Analysis	Mishra et al. (2017), Chen et al. (2022)
Named Entity Recognition (NER)	Hollenstein & Zhang (2019), Iida Mitsuida & Tokunaga (2013)
Dependency parsing	Strzyz et al. (2019), Klerke & Plank (2019)
Multiword expressions	Rohanian et al. (2017)

EXISTING CORPUSES

	Dundee	GECO	ZuCO
Number of sentences	2367	5424	700
Average sentence length	24.75	12.65	22.12
Number of words	58 598	68 606	15 237
Unique words	9131	5283	4408
Average word length	4.29	3.76	4.44
Fixation time (ms)	202	214	226
Gaze time (ms)	237	232	265
Language	English, French	English, Dutch	English

NLP related corpuses in Albanian

CORPUS 1

Nelda Kote, Elinda Kajo Meçe, Evis Trandafili, Alba Haveriku, Anila Çepani Sema, Albana Ndoja, Rozana Rushiti, Elsa Skënderi Rakipllari, Lindita Xhanari

- Based on Universal Dependencies
- Morphological features
- Syntactic parsing
- Lemmas
- 85,000 tokens
- 45000 sentences

CORPUS 2

Nelda Kote, Marenglen Biba, Jenna Kanerva, Samuel Rönnqvist and Filip Ginter

- Based in Universal Dependencies
- Morphological features
- Lemmas
- 118,000 tokens
- 92.74% accuracy in PoS tagging
- 85.31% in morphological annotation
- 89.95% in lemma identification

CORPUS 3

Marsida Toska, Joakim Nivre, Daniel Zeman

- Based on Universal Dependencies
- Morphological features
- Syntactic parsing
- Lemmas
- 60 sentences
- 922 tokens

Burimi: Kote, N. (2021). SISTEMET INTELIGJENTE PËR PËRPUNIMIN E INFORMACIONIT: ALGORITME PËR PËRPUNIMIN E GJUHËS SHQIPE DHE GJETJEN E INFORMACIONIT NË TEKSTE NË SHQIP.

Burimi: Kote, N., & Biba, M. (2019). PREPROCESSING TOOLS FOR THE ALBANIAN LANGUAGE: A STATE-OF-THE-ART SURVEY AND AN ANNOTATION SCHEMA PROPOSAL. ICFAS 2019

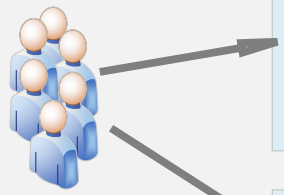
EYE-TRACKING & ALBANIAN LANGUAGE

- There is a lack of research for eye-tracking in Albanian language;
- Readers in different languages differ in the time of concentration in specific part of speech:
  - Syntactic rules;
  - The length of word distribution.

METHODOLOGY

MAIN STEPS

FIRST STEP
DEFINE THE STANDARDS



Working Group

Creating an annotating team

Collecting stimuli

Experimental setup

SECOND STEP
EYE-TRACKING DATA COLLECTION

Positioning the camera

Instructions

Practice text

Reading the sentence/ paragraph

N times

Comprehension Questions

THIRD STEP
RETRAIN THE MODEL

Current NLP model + Eye-tracking data

Newly trained model

Comparing accuracy levels

EXPERIMENTAL SETTINGS

- Stimuli Selection: *institutional documents, literature texts;*
- Determine the length of the experiment *(60-90 min)*
- Determine the length of breaks in between readings *(every 30 min)*
- Decide for *monocular* or *binocular* data:
  - Difficulties in calibration of devices
  - Difficulties in processing the information
- Determine the characteristics of each *participant*: age, mother language, sight (with glass, contact lenses), the level of language knowledge.

CONCLUSIONS & FUTURE WORK

- There is still work to do in expanding annotated corpuses in Albanian language;
- The necessity to work further in collecting eye-tracking data in low-resource languages, such as Albanian;
- Setting up a proper eye-tracking laboratory is linked with large costs;
- Creating an annotation group and gather data accurately;
- Estimating the accuracy of the low-cost devices (web/mobile camera) and Python packages;

THANK YOU!

QUESTIONS?