9th LASIGE WORKSHOP

10 APRIL 2024 WEDNESDAY

POSTER SESSION

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Mixed-Visual Ability Collaboration for Children in Computational Thinking

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LASIGE inclusive human--computer interaction

Inclusive education includes children with visual impairments in the classroom with their peers to have **equal opportunities** to participate, learn, be autonomous, and feel supported.

However **mixed-visual ability classrooms do not guarantee** that all children feel included. Assistive technology prioritize accessibility over inclusion, creating barriers to a collaborative environment.

An interdependent coding environment with audio-augmented tangibles will equally promote autonomy, competence, self-efficacy, and relatedness in groups of mixed-visual ability children.

Computational Thinking benefits children's cognitive, social, and creative development.

Awareness and interdependence are essential for a successful collaboration by valuing communication and everyone's contribution.

How can we ensure equitable participation and engagement in mixed-visual ability groups?

RQ.1 How effective is an interdependent coding environment in promoting awareness in collaboration in a mixed-visual ability group?

RQ.2 How effective is a coding environment with audio-augmented tangibles for mixed-visual ability children to train their computational thinking skills?

RQ.3 How successful is a resource-sharing tangible coding environment in fostering equitable mixed-visual ability participation?

RESEARCH

WP1: Mixed ability collaboration in coding environments ➡RQ.1

Study 1 We leveraged interdependent asymmetric roles in computational thinking activities with mixed-visual ability dyads, focusing on the benefits and challenges of remote and co-located settings.

Takeaways: Puzzles and spatial challenges fostered children to apply CT concepts with both roles; Diverse workspace awareness levels between settings led to a balanced collaboration in remote (more verbal communication) while allowing dominating physical access in co-located.

Study 2 We ran an exploratory study with a mixed-visual ability group of children in a mainstream school focusing on accessible coding kits to support collaborative learning and maintain long-term engagement.

Takeaways: Interdependent roles have the potential to promote shared interest, but also lead to moments of congested participation; Exclusive asymmetric information can promote communication and participation.

WP2: Prototyping inclusive coding environment

We are iterating the prototype to leverage audio-augmented tangibles and collaboration mechanisms focused on training CT concepts.

WP3: Shared awareness ➡RQ.3

We aim to conduct a study to explore different awareness levels and assess how each affects children's perceived engagement, participation, and task performance.
The different levels of awareness are achieved by manipulating audio feedback. regarding the actions, the robot moves, and the obstacles, etc.

WP4: Learning and social outcomes ➡RQ.2

We plan on conducting two studies to assess the learning and social benefits of our approach. Our goal is to understand if self-efficacy, relatedness, and competence are equally promoted for both children.

CONTRIBUTIONS

Empirical results on collaborative coding activities for mixed-visual ability groups of children;
Insights on inclusive computational thinking learning;
Insights on the long-term engagement of mixed-visual ability groups of children during collaborative activities;
Design of a robotic coding environment with audio-augmented tangibles.

PUBLICATIONS

Coding Together: On Co-located and Remote Collaboration between Children With Mixed-Visual Abilities
CHI'23 - https://doi.org/10.1145/3544548.3581261

Accembly at Home: Accessible Spatial Programming for Children with Visual Impairments and Their Families
IDC'21 - https://doi.org/10.1145/3459990.3460699

Fostering Collaboration with Asymmetric Roles in Accessible Programming Environments for Children with Mixed-Visual-Abilities
ASSETS'21 Poster - https://doi.org/10.1145/3441852.3476553

Acknowledgements: This work was supported by FCT scholarship SFRH/BD/06589/2021, and the LASIGE Research Unit, ref. UIDB/00408/2020 (*https://doi.org/10.54499/UIDB/00408/2020*) and ref. UIDP/00408/2020 (*https://doi.org/10.54499/UIDP/00408/2020*).

On the Path to Buffer Overflow Detection by Model Checking the Stack of Binary Programs

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LASIGE dependable and secure decentralized systems

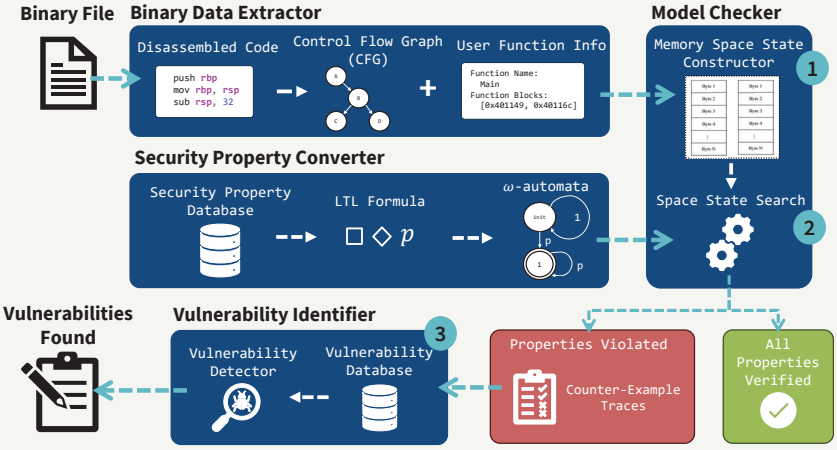
Motivation

Despite advancements in compiler and operating system security, vulnerabilities in C binaries persist. Conventional analysis methods struggle with accuracy and scalability, highlighting the need for an improved approach to detect vulnerabilities in binary code.

Approach

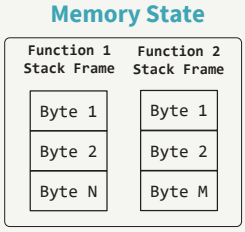
Utilize Model Checking to detect Buffer Overflows in C binaries

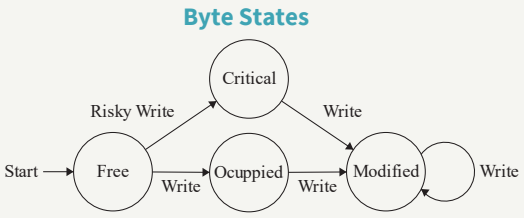
1. **Construct a memory model** representing the stack memory of the binary
2. **Validate security properties** against the modeled memory space
3. **Analyze produced counter-example** traces to locate the specific vulnerabilities



Memory Model

The Stack Memory is modeled through **Memory States** which are composed of function stack frames made containing **Bytes States**





Model Checking Process

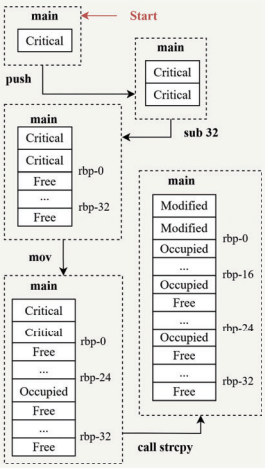
Verifying that the first byte of the stack is **never overwritten** involves checking the following **Security Property** in Linear Temporal Logic

$$\square \left(\bigwedge_{x} Byte\left(Stack\left(x\right), 0\right) = Critical \right)$$

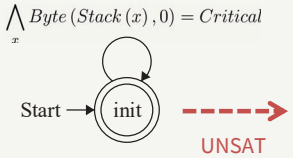
Binary Program

```
push    rbp
mov     rbp, rsp
sub     rsp, 32
mov     QWORD PTR [rbp-24], rdi
mov     rdx, QWORD PTR [rbp-24]
lea     rax, [rbp-16]
mov     rsi, rdx
mov     rdi, rax
call    strcpy
```

Construct State Space



Check Security Property



UNSAT

Counter-Example Trace

```
push;
sub 32;
mov;
call strcpy;
```

Buffer Overflow Caused by strcpy

Found Vulnerability
CWE-120: Buffer Copy without Checking Size of Input

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (*https://doi.org/10.54499/UIDB/00408/2020*) and ref. UIDP/00408/2020 (*https://doi.org/10.54499/UIDP/00408/2020*).

Analysis of domain shift in prostate gland and lesions segmentation and detection

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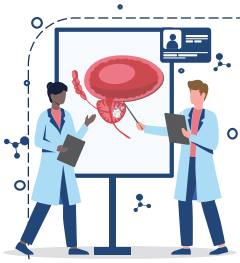
LASIGE data and systems intelligence

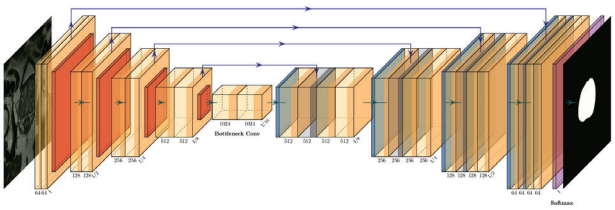
Background



Prostate segmentation models are often trained on limited data (**few scanner manufacturers** and **single institution**)

This results in the models suffering from **domain-shift** and not being **transferable** to data acquired from **different scanners**, **protocols** or even **institutions**

We define the most up to date **heterogeneous** dataset and train **robust domain-shift invariant** models for **whole gland**, **zones** and **lesion** segmentation.

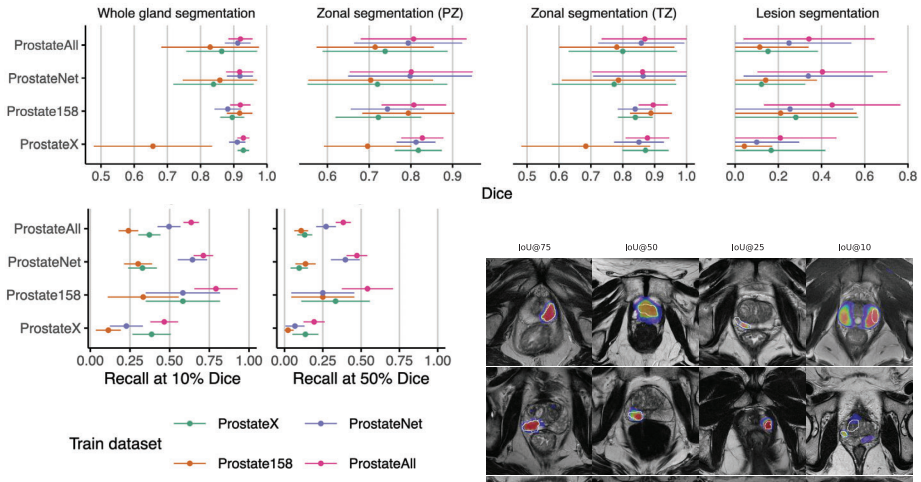


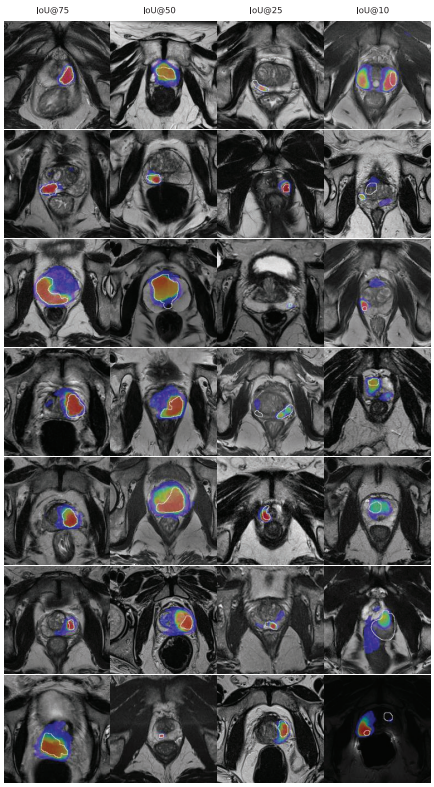
Data

	Total	Siemens	Philips	GE
Gland				
Prostate158	139	139	-	-
ProstateX	182	182	-	-
ProstateNet	638	152	245	239
ProstateAll	959	473	245	239
Zones				
Prostate158	139	139	-	-
ProstateX	181	181	-	-
ProstateNet	638	152	245	239
ProstateAll	958	472	245	239
Lesions				
Prostate158	82	82	-	-
ProstateX	190	190	-	-
ProstateNet	461	136	184	136
ProstateAll	733	408	184	136
ProstateNet mpMRI	417	131	178	107

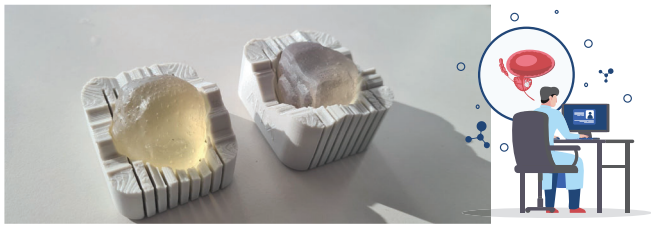
- 5-fold cross validation
- Hold-out test set
- Additional Prospective cohort

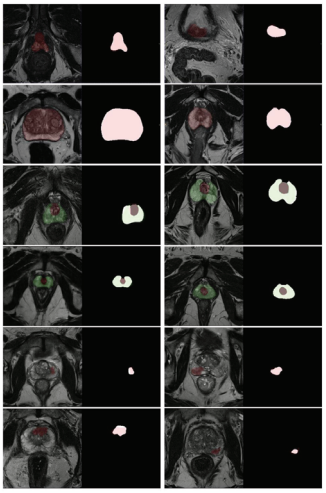
Results

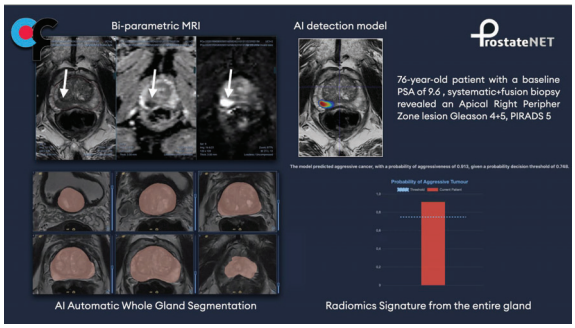




Clinical applications







Full paper

*Authorship: Ana Sofia Castro Verde, Ana Mascarenhas Gaivão, Carlos Bilreiro, Inês Santiago, Joana Ip, Sara Belião, Raquel Moreno, Celso Matos, Manolis Tsiknakis, Kostas Marias, Daniele Regge, ProCAncer-I Consortium

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Towards a Web Application Attack Detection System based on Network Traffic and Log Classification

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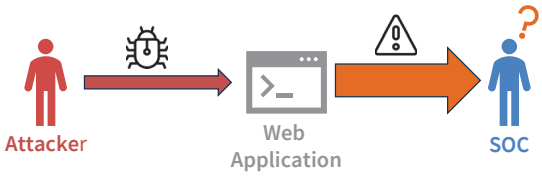
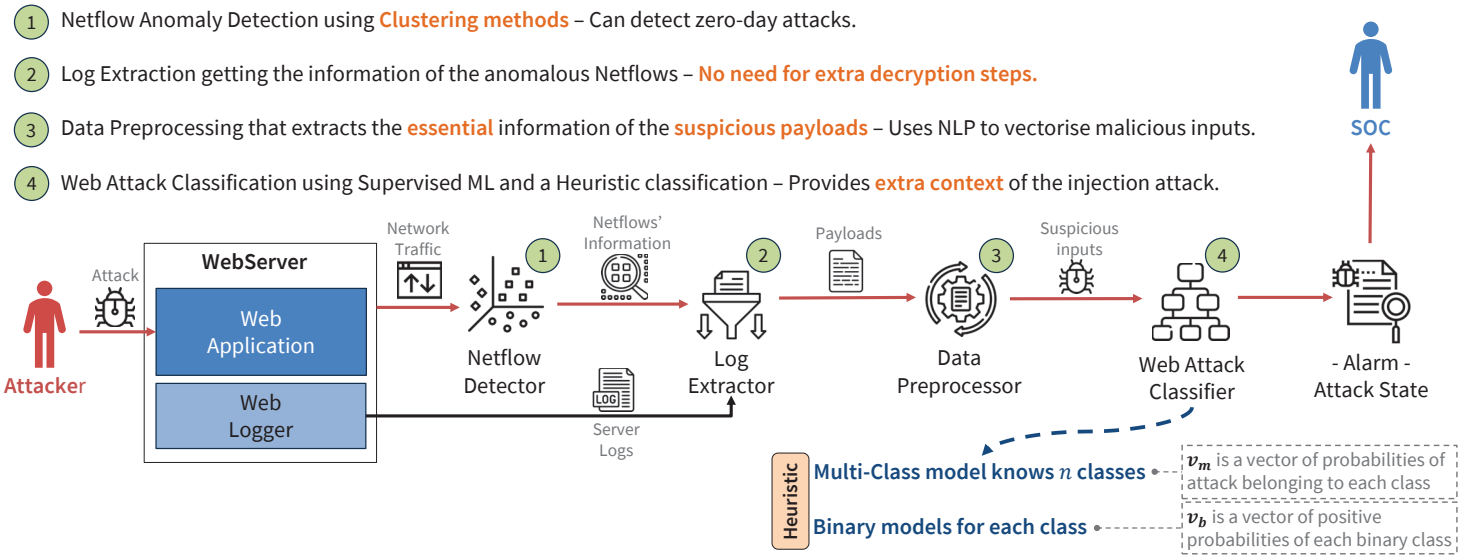
Motivation

- Injection vulnerabilities pose a major problem to web applications leading to data leaks and availability issues.
- Network Intrusion Detection System (NIDS) being the standard mechanism to detect network attacks, generates numerous alarms per attack.
- These alarms are analysed by the Security Operation Center (SOC) team, that cannot gather sufficient information and perform a correct risk assessment and mitigation.



A System that **Detects** and **Classifies** Web Injection Attacks

1. Netflow Anomaly Detection using **Clustering methods** – Can detect zero-day attacks.
2. Log Extraction getting the information of the anomalous Netflows – **No need for extra decryption steps.**
3. Data Preprocessing that extracts the **essential** information of the **suspicious payloads** – Uses NLP to vectorise malicious inputs.
4. Web Attack Classification using Supervised ML and a Heuristic classification – Provides **extra context** of the injection attack.



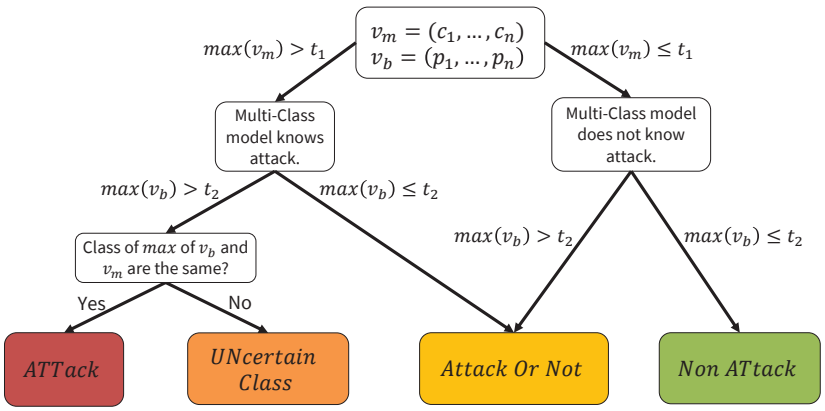
Evaluation and Results

t_1 controls **multi-class** model classification: $\frac{1}{n} \leq t_1 \leq 1$

t_2 controls **binary** model classification: $0.5 \leq t_2 \leq 1$

t_1	t_2	*ATT*	*UNC*	*AON*	*NAT*	*FP*
0.45	0.5	**272**	5	3	0	6
0.5	0.75	266	2	11	2	5
0.75	0.5	262	0	17	3	**3**
0.65	0.7	265	0	10	7	4

Classification of 286 known attacks for 4 different threshold sets



Heuristic created to classify a suspicious payload

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UID/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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THE TRICK IS TO STAY BEHIND?:
Defining and Exploring the Design Space of Player Balancing Mechanics

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LASIGE inclusive human--computer interaction

You're playing a competitive video game with your best friend.

But your friend has less experience and ends up losing every match.

You feel **bored and unchallenged** while your friend simply feels **frustrated and powerless**.

THAT'S NO FUN!

PLAYER BALANCING MECHANICS

To accomodate disparate skill levels, some games present mechanics that give **advantages to low-performing players** or provide additional **obstacles to high-performing players**.

Examples:

Aim assist in shooting games

Automatically adjusts the aim for players who use a controller and struggle with aiming.

Rubberbanding in racing games

Keeps players behind near the front of the race by increasing their speed and power-ups.

How are these perceived by players and how do they affect the experience?

Research shows it **depends on the design decisions behind the mechanic**, such as timing (e.g., when it activates) and visibility of the effect.

To comprehensively understand the impact of these, we first need to develop a shared understanding of the **design possibilities within this space.**

We make a **two-fold contribution**:

1. The **design space** of player balancing mechanics
2. **User study** focused on the impact of **TARGETING DIRECTION** and **EFFECT DEPENDENCY ON SKILL**.

1) DESIGN SPACE OF PLAYER BALANCING

We built a design space that captures the **range of possible approaches** when designing a player balancing mechanic.

Our procedure consisted of:

Reviewing research + **Analyzing balancing in commercial games** + **Researchers' expertise**

It consists of various dimensions within six main categories:

DETERMINATION **TIMING** **TARGETING**
EFFECT **FEEDBACK** **INFORMATION**

2) USER STUDY

Eight pairs of participants — **Questionnaires + Interviews**

We focused on the impact of two design dimensions:

TARGETING DIRECTION
Which side is affected by the balancing mechanic.

Assisting OR **Hindering**

EFFECT DEPENDENCY ON SKILL
How much the effect is dependent on the skill of the players.

SPECTRUM FROM **Independent** TO **Dependent**

We developed a competitive racing game with **seven player balancing mechanics**, manipulating these two dimensions.

Boost w/ shield | **Boost w/o shield** | **Obstacle reduction** | **Obstacle addition** | **Wall with tunnel** | **Timed gate** | **Forced handbrake**

We outline implications under three core concepts:

- **Sense of merit**
- **Sense of agency**
- **Obtrusiveness**

Published at **CHI 2024**. Check the **full paper**:

Acknowledgements: This work was supported by FCT through project "Plug n' Play: Exploring Asymmetry and Modularity for Inclusive Game Design" ref. 2022.08895.PTDC (https://doi.org/10.54499/2022.08895.PTDC), the institutional CEEC (https://doi.org/10.54499/CEECINST/00032/2018/CP1523/CT0004), scholarships ref. UI/BD/151178/2021 and ref. 2022.12448.BD, and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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EVOBOARD

Geoboard-inspired Evolved Typefonts

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LASIGE data and systems intelligence

Motivation

Type design deals with the creation of visually appealing designs for written language. While font design must be able to draw attention by itself, it must always be legible so that the intended message can be conveyed. Typefonts design is a time-consuming task whose target aesthetic is highly influenced by the target audience and the medium in which it is displayed.

The quick brown fox jumps over the lazy dog

The quick brown fox jumps over the lazy dog

The quick brown fox jumps over the lazy dog

The quick brown fox jumps over the lazy dog

ᴛʜᴇ ϙᴜɪᴄᴋ ʙʀᴏᴡɴ ғᴏx ᴊᴜᴍᴘs ᴏᴠᴇʀ ᴛʜᴇ ʟᴀᴢʏ ᴅᴏɢ ✗

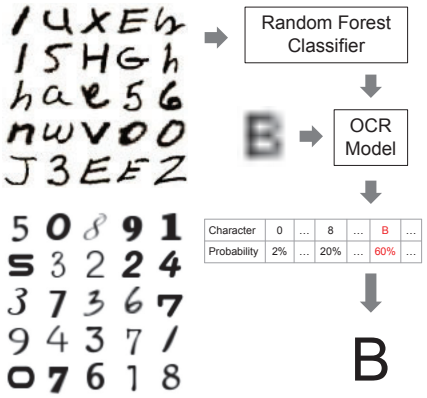
Evoboard

Evoboard [1,2] is an automatic typefont creation algorithm that intends to help the designers by making the design task less time-consuming while also providing a diverse range of solutions with a similar aesthetic from which the final designs can be picked.

This algorithm relies on three components: a representation that will dictate the aesthetic of the font, a Genetic Algorithm (GA) that will evolve an image to resemble the target character, and an Optical Character Recognition (OCR) model to inform the GA of how much the image resemble the target character.

Optical Character Recognition

Training data: EMNIST (top) and TMNIST (bottom) datasets



Conclusions and Future Work

Evoboard consistently obtained good representations for all 36 alphanumeric characters, although it was more difficult to obtain good results for the digit 8 and letter B.

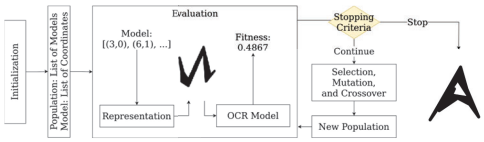
For future work, we intend to explore other representations besides the geoboard, increase the number of polygons in the the geoboard representation to facilitate learning complex characters and to apply Evoboard in other design tasks.

Full paper

Evoboard GitHub

Geoboard Representation

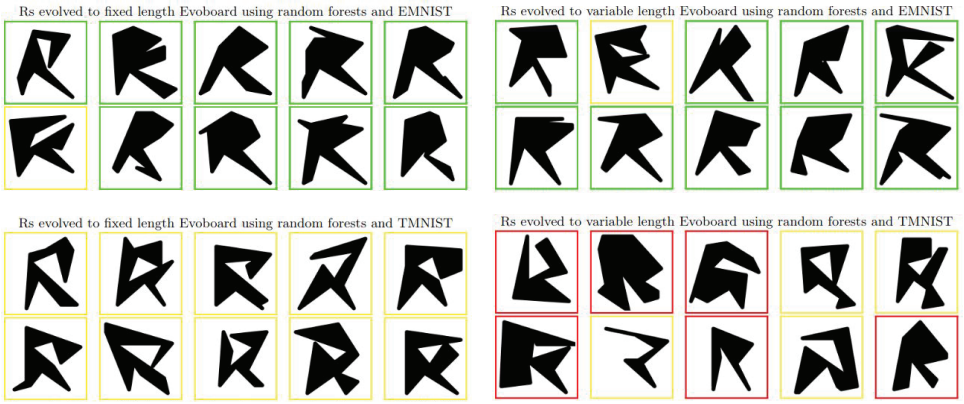
Genetic Algorithm



Evolution

Typefont Diversity

Best Rs obtained in each experiment. Green / yellow / red borders represent a probability of recognition of 75-100 / 50-75 / 25-50%, respectively.



Evolved Typefont

References:
[1] Batista, J.E., Garrow, F., Huesca-Spairani, C., Martins, T. (2024). Evoboard: Geoboard-Inspired Evolved Typefonts. In: Johnson, C., Rebelo, S.M., Santos, I. (eds) Artificial Intelligence in Music, Sound, Art and Design. EvoMUSART 2024. Lecture Notes in Computer Science, vol 14633. Springer, Cham. https://doi.org/10.1007/978-3-031-56992-0_2
[2] Implementation available at www.github.com/jespb/Evoboard

Acknowledgements:
Work funded by FCT through the LASIGE R&D Unit, UIDB/00408/2020[1] and UIDP/00408/2020[2] — CISUC R&D Unit, UIDB/00326/2020 and UIDP/00326/2020; ValgrAI: Valencian Graduate School and Research Network for Artificial Intelligence; and Generalitat Valenciana.
We would also like to thank the Society for the Promotion of Evolutionary Computation in Europe and its Surroundings (SPECIES) for the opportunity to participate in the SPECIES Summer School 2023, which took place in Moraira, Spain, between the 3rd and 9th of September, where this work originated.

[1] https://doi.org/10.54499/UIDB/00408/2020
[2] https://doi.org/10.54499/UIDP/00408/2020

SolAR II – A Tool to Support the Placement of Photovoltaic Modules in Facades using Augmented Reality

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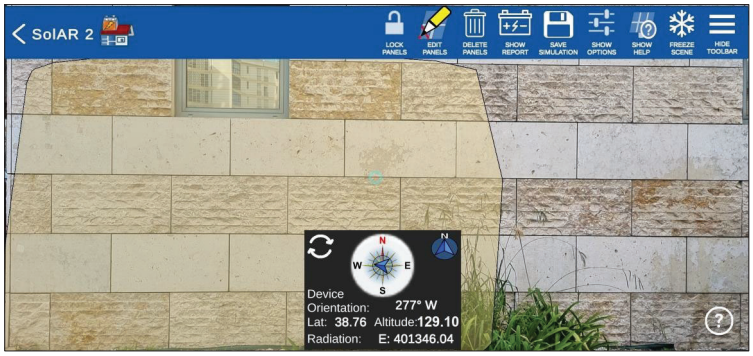
LASIGE data and systems intelligence

SolAR II

- The SolAR II app is a mobile application developed in Unity to simulate the placement of photovoltaic modules in buildings' facades using Augmented Reality. AR offers real-time interaction with a 3D space where the real world is combined with virtual objects.

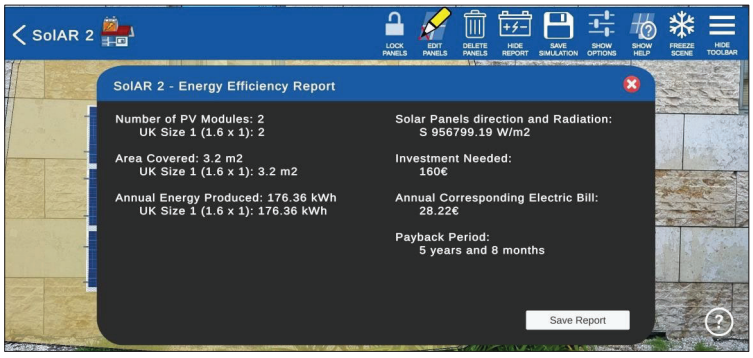
Facade Detection

- The app makes use of a built-in SLAM algorithm from AR Core to detect the target facade, allowing the placement of virtual photovoltaic modules.



Functionalities

- It allows users to place virtual modules on detected facades and edit their color, size and rotation.
- After placing at least 1 module, it will be available a report with energy efficiency and financial information.
- It offers a functionality to freeze the camera view, allowing the user to work on a comfortable position after detecting the facade.
- The reports can be saved and stored in the device's memory, to be shared with other people, as well as the simulations, to be loaded back in the app.



Acknowledgements: This work was supported by the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

Web Augmented Reality applied to Cultural Heritage

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LASIGE data and systems intelligence

CONCEPTS

WEB ▶ cross-platform no installations

AUGMENTED REALITY (AR) ▶ virtual objects overlaid the real world

MOTIVATION

allows for an accessible and cross-platform solution for enhacing the visiting experiences without interfering with the site

▲

APPLIED TO CULTURAL HERITAGE

OBJECTIVES

1. provide research on Web Augmented Reality
2. develop a Web based Augmented Reality application for a Cultural Heritage site, namely Monte dos Castelinhos

1 WEB AUGMENTED REALITY

PROS

accessibility
- does not require installation;
- integrated text-to speach, translation and text search

cross-platform
- runs on different devices, with different OS

CONS

memory
- memory is limited and browsers accumulate a lot of resources

needs internet connection

usability
- web has additional UI elements

WEB AR FRAMEWORKS

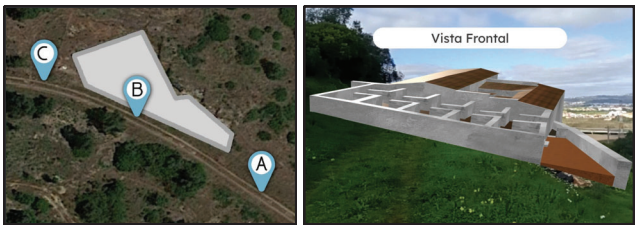
	FEATURES	COMPATIBILITY
ARKit	Passive Infrared Markers, Intertial Sensors	Safari
ARCore	Passive Infrared Markers, Intertial, Geolocation and Magnetic Sensors	Google Chrome, Opera, Samsung Internet
babylon.js	Passive Infrared Markers Intertial, Geolocation and Magnetic Sensors	Google Chrome, Opera, Samsung Internet
AR.js	Passive Markers, Natural Markers, Geolocation Sensors	Google Chrome, Opera, Samsung Internet, Mi, Firefox, Safari, Edge
MindAR	Natural Markers	Google Chrome, Opera, Samsung Internet, Mi, Firefox, Safari, Edge

2 WEB AR APPLICATION

Monte dos Castelinhos is an archeological site in Castanheira do Ribatejo, with remains of a Roman settlement from the 1st century BC. It was created a Web application for this site containing AR and VR components using AR.js and A-Frame.

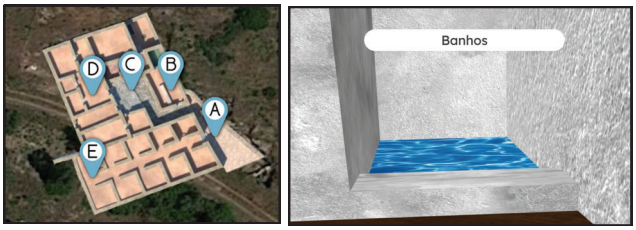
APP

AUGMENTED REALITY



contains three viewpoints where the model can be viewed superimposed on the ruins

VIRTUAL REALITY



contains five viewpoints where the model can be seen in a 360º view

CONCLUSION

Web AR and VR are still in their initial phases, with improvements and the emergence of new frameworks being expected in the next years. The complexity of this project, be it in precision of alignment, to the complexity of the models, to storage, highlighted the need for these improvements. Nonetheless, **Web AR technologies are still capable of employing solid experiences, with various features, that are accessible and cross-platform**.

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Acknowledgements:
This work was supported by LASIGE Research Unit, ref. UIDB/00408/2020 (*https://doi.org/10.54499/UIDB/00408/2020*) and ref. UIDP/00408/2020 (*https://doi.org/10.54499/UIDP/00408/2020*).

AR POSTER

Guardians of Privacy:
Privacy and Security in Assistive Technologies for Dementia Therapy

Ana Luísa Brito[1], Soraia M. Alarcão[1], Vânia Mendonça[1], Way Kiat Bong[2]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] OsloMet – Oslo Metropolitan University, Norway

LASIGE inclusive human--computer interaction

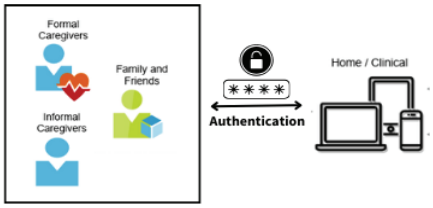
KeepsakeBox

- A reminiscence therapy platform developed at LASIGE to:
  - Manage and deliver personalized reminiscence therapy sessions for people with dementia;
  - Reduce caregivers' workload while improving the quality of therapy sessions;
  - Allow the sharing of data between caregivers, family and friends.
- The personal information stored may be **highly** sensitive:
  - Patients' and caregivers' personal details;
  - Images utilized in the reminiscence sessions along with specific information regarding them and their effects on the patient;
  - Session and image feedback including emotional information, chat conversations, and observations.

What is inside the Box? Privacy and Security Mechanisms

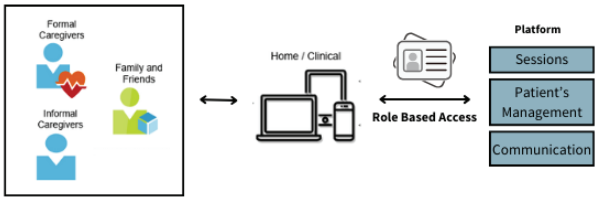
Mechanisms originally implemented:

- Password authentication and encryption;



Mechanisms to be implemented:

- **Role Based Access Control:**
  - Define distinct roles for users with access to the platform, including administrators and formal and informal caregivers;
  - Assign privileges to each role considering the specific data or resources that each role should be authorized to access and modify.



- **Attribute Based Encryption:**
  - Specify the attributes required for users to access particular data or resources, attributes such as user roles and associated privileges;
  - Implement a key management system to generate encryption and decryption keys for the data.

Evaluation

- Functional Testing
  - Assess factors such as response time and operational efficiency.
- Usability Testing
  - Cover key interactions within the platform, such as access to data regarding the role of the user;
  - Collect user feedback through interviews and observation.

Acknowledgements: This work was supported by the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Investigating Virtual Reality Locomotion Techniques with Blind People

Renato A. Ribeiro, Inês Gonçalves, Manuel Piçarra, Letícia S. Pereira, Carlos Duarte, André Rodrigues, João Guerreiro

LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE inclusive human-computer interaction

MOTIVATION

Locomotion enables users to **navigate** and **explore** the virtual world. Offering a diverse range of experiences, such as:

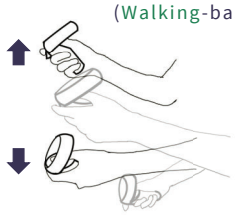
Walking-in-Place | Teleport

Current VR experiences have a major focus on visual feedback, posing significant challenges for blind people to both UNDERSTAND and NAVIGATE the environment.

OBJECTIVES

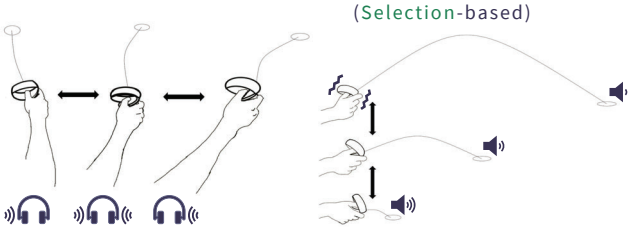
Understanding the **potential** that the **most popular locomotion techniques** have to support **accessible experiences may increase** and **diversify** blind people's **access to mainstream VR experiences**.

Arm Swinging (Walking-based)



Linear Movement (Steering-based)

Point & Teleport (Selection-based)



AUGMENTATIONS

Video

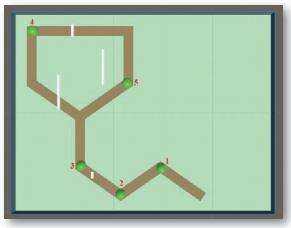
FEEDBACK	AS	LM	P&T
Footsteps	🎧	🎧	🎧
Collision	🎧 + 〰	🎧 + 〰	🎧 + 〰
Veering Prevention		🎧	
Direction & Proximity			🎧
Distance Travelled			🎧

AFTER LANDING

AUDITORY FEEDBACK 🎧 HAPTIC FEEDBACK 〰

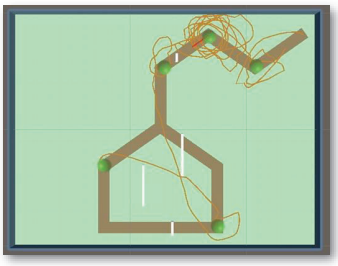
METHODOLOGY

14 Blind Participants executed a **navigation task** with the **3 techniques:** Reach 5 objectives as quickly as possible, with each objective having a **3-minute time limit.** These tasks were followed by **semi-structured interviews**.



LESSONS LEARNED

- **AS**, **LM**, and **P&T** - with careful audio and haptic design - can support accessible VR Experiences.
- Body rotation makes interactions even simpler.
- **AS** is perceived to provide greater awareness and control of movement.
- **P&T** has great potential for efficiency but may require additional training.
- Specific body language may affect performance.
- **P&T** can be designed to support scanning the surroundings.
- Veering is also a problem in virtual navigation.



Published at CHI 2024.

Check the full paper:

Acknowledgements: This work was supported by FCT through the AccessiVR project, ref. 2022.08286.PTDC (http://doi.org/10.54499/2022.08286.PTDC), the Institutional CEEC, CEECINST/00032/2018/CP1523/CT0003 (https://doi.org/10.54499/CEECINST/00032/2018/CP1523/CT0003), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Supporting Therapists in Authoring Virtual Reality Exposure Therapy for Children

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LASIGE inclusive human-computer interaction

Motivation

Virtual reality is already being used for exposure therapy (VRET) in various areas, such as post-traumatic stress disorder, obsessive-compulsive disorder, fear of public speaking, and phobias. However, the VRET systems are often not designed in collaboration with clinicians and do not cater to their needs. They usually offer a "one size fits all" solution, being monolithic and not flexible.

Approach

- **Give more authoring control** to the therapists to customise therapy.
- **Participatory approach** during development.
- **Close communication** with therapists from PIN (Partners in Neuroscience).
- Prototype features **two applications** (i.e., VRTherapist) that communicate:
  - **Computer application** - the therapist can control the VR environments.
  - **VR application** - the patient is immersed within the VR environments.

Fear of Public Speaking

- **Theatre** and **classroom** environments.
- The therapist can control the audience, including:
  - Make people **enter** or **leave** the room
  - **Specific actions** (e.g., clap, cheer)
  - **Display emotions**

Fear of Spiders

- **Living room** and **office** environments.
- The therapist can control the spiders, including:
  - **Create** them in **different areas**
  - **Change their size** in real-time
  - Provide **haptic feedback**

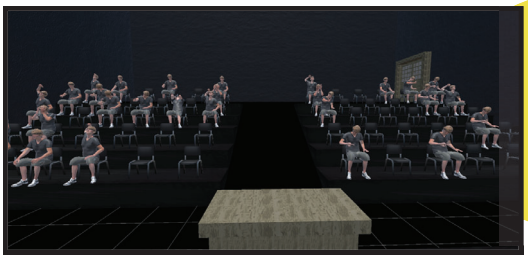

Fig. 1 - VRTherapist - Theatre environment

Fig. 2 - VRTherapist - Living room environment

Study and Findings

We conducted interviews and a mock-up therapy session with our system with 10 therapists from PIN.

A thematic analysis revealed:

- **Current practices**
- The **therapist-patient dynamic**
- How **progress** is evaluated
- **Stereotypical realism** in VR applications
- **Customisation** and **authoring**
- The **role of VR**

Study Opportunities

- Explore **the role of the therapist in VR.**
  - Will the dynamic change?
  - How should the therapist be represented?
- Explore **different control vectors** for the therapist.
  - Gestures
  - Voice
  - Others?

Future

Continue the work during the PhD:

- Explore **online VR sessions**' feasibility.
- **Share saved sessions** among therapists.
- Study different representations and interactions of the therapist in VR.
- Develop **new scenarios** and **authoring possibilities.**

Acknowledgements: This work was supported by FCT through project LASIGE&Now, ref. UIDP/04408/2020 (https://doi.org/10.54499/UIDP/04408/2020), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/04408/2020 (https://doi.org/10.54499/UIDP/04408/2020)

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Deep learning to optimize viral vector production for human gene therapy

Lucas Ferraz[1], Ana Filipa Rodrigues[1,2], Cátia Pesquita[1]

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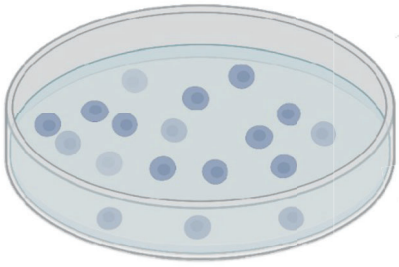
[2] iBET - Instituto de Biologia Experimental e Tecnológica, Portugal

LASIGE health and biomedical informatics

Viral vectors are used in Gene therapy to deliver genetic material into patient cells, but designing them is very labor and cost intensive.

Machine learning can significantly reduce this burden, but despite recent advances there are two major challenges:



We need specific vector functions and diversity

Increased thermal stability | **Viability** | **Reduced immunogenicity**

Inefficient search + Enormous search space → **Labor-intensive and time consuming**

Current sequence representations are inadequate

Representation of vectors using **One Hot Encoding**

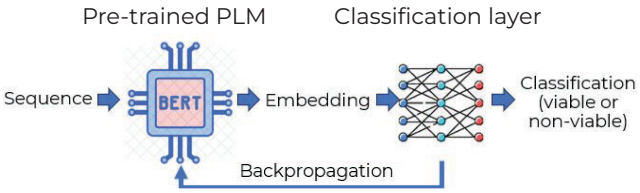
↓

Limitation: **Not context-sensitive**

Accounts for:	Does not account for:
✓ Individual AA presence	✗ Other AAs' presence
✓ Individual AA position	✗ Other AAs' position

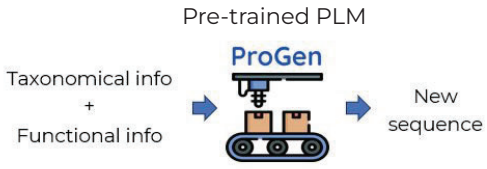
Idea: Use Protein Language Models to design / generate new viral vectors for Gene Therapy

RQ1: Can PLM embeddings improve the classification of viral proteins regarding their viability over existing approaches?



Classification model architecture

RQ2: How can desirable viral protein properties be represented for conditional PLMs to generate high-quality candidates?



Generative model architecture

Fine-tuning dramatically improves the identification of viable sequences.

Fine-tuning	Accuracy	Precision	Recall	F1	ROC AUC
Before	0.5175	0.2488	0.5000	0.3410	0.5000
After	0.9489	0.9488	0.9489	0.9488	0.9489

As research moves to the development of the generative model, we are hopeful it will also achieve satisfactory results and the complete project will allow researchers to **generate new and diverse vectors** and pave the way for an **improvement of viral vector research methodologies**.

Acknowledgements: *This work is supported by the KATY project, funded by the European Union's Horizon 2020 research and innovation program (GA 101017453)*

Can I give you my opinion? Building an accessible online survey tool

Cristiana Modesto, Letícia Seixas Pereira, Carlos Duarte

LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE inclusive human-computer interaction

Context

Surveys are a fundamental means of collecting information

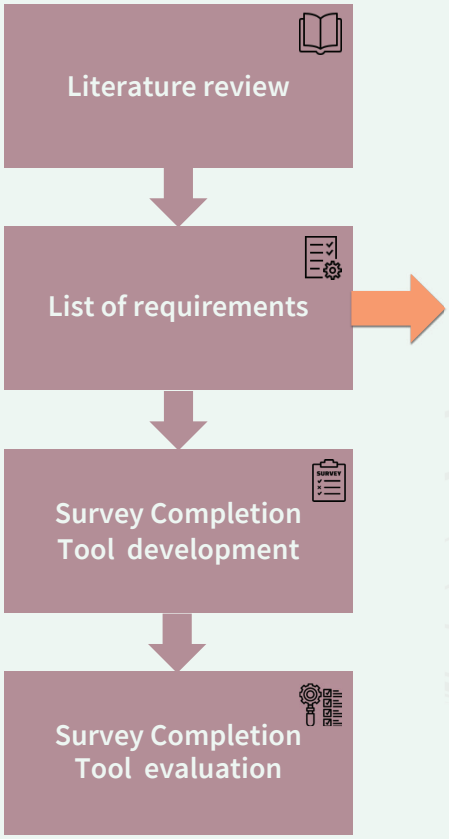
Literature highlights the inaccessibility of surveys, their components, and creation tools

This situation can hinder people with disabilities from being able to express their opinions

Goal

Build an accessible Survey Completion Tool

Methodology



46 requirements categorized in 12 distinct themes

Prefaces and context: e.g., General instructions should be placed at the top of the forms and instructions for each field should be placed throughout.

Navigability: e.g., Include buttons to move between questions ("Back" and "Next").

Assistance tools: e.g., Ensure compatibility with assistive technologies.

Audios: e.g., Use recorded voice instead of synthesized voice so that audios are more understandable.

Graphics: e.g., Include alternative text on images.

Clarity and visual adjustments of text: e.g., Avoid using complex language, confusing terms or figures of speech and employ more direct terms.

Types of questions: e.g., Use questions like "Images with numerical scales as visual aids".

Minimize external influences: e.g., Do not use ableist concepts throughout the survey text.

Error handling: e.g., Error messages should be made available in red.

Internationalization: e.g., Promote the internationalization of the tool to be developed.

Data protection, privacy and conformance with accessibility guidelines and legislation: e.g., When CAPTCHA is to be used, the system must provide audio CAPTCHA.

Accessible informed consent: e.g., Supplement consent forms by adding images.

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Effective but Unfeasible:
Addressing NIDS Challenges in the Real World

Allan Espindola[1, 2], Eduardo Viegas [2], António Casimiro[1], Pedro M. Ferreira[1], Altair Santin [2]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] SeCPLab, Escola Politécnica, Pontifícia Universidade Católica do Paraná

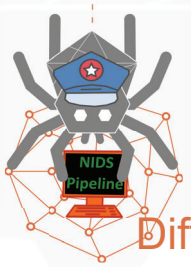
LASIGE cyber-physical systems

What is an Adversarial Evasion Attack?

An **Adversarial Evasion Attack** (AEA) is a type of cyber attack that, in the scope of this work, refers to subtly altered Denial of Service (DoS) inputs designed to deceive machine learning models. These AEAs aim to evade detection while maintaining their harmful intent. Most of these techniques come from Computer Vision (CV).

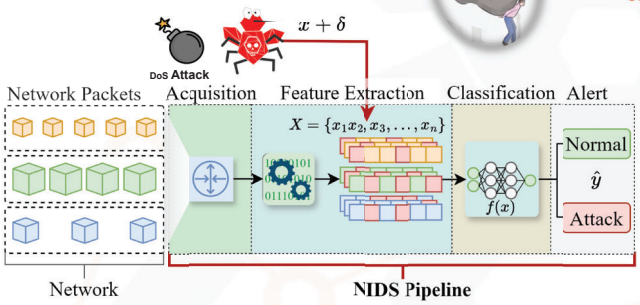
Are Computer Vision AEAs feasible in the network security domain?

1. **High Attack Capability Required:** An attacker needs a high level of control over the **NIDS pipeline** to manipulate feature vectors but, with such capability, the adversary could execute more severe attacks than just altering the feature vector.

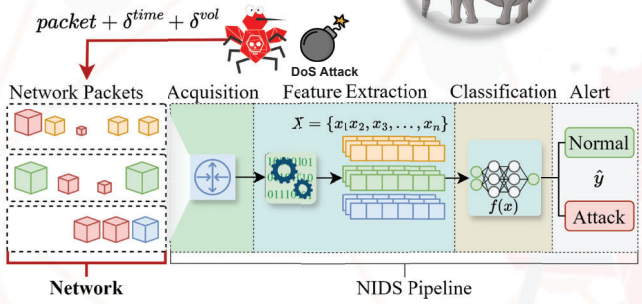


2. **Feature Interdependence:** Identified feature vulnerability may be unexploitable. Attacks in the CV domain **target individual features**. This is not feasible in the network domain due to feature interdependence.

Unfeasible Attack

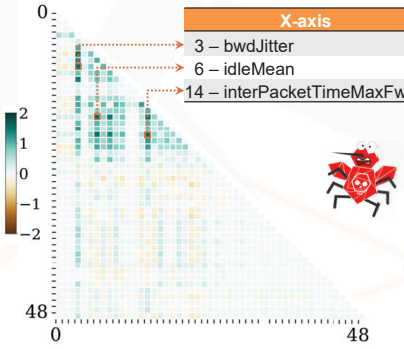


Feasible Attack



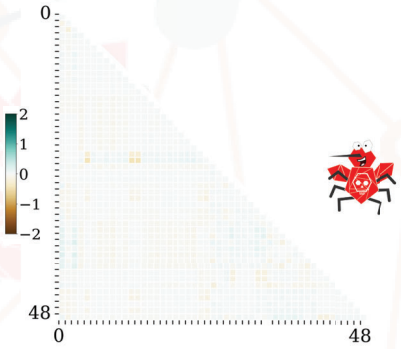
Differential Correlation Analysis

X-axis	Y-axis
3 – bwdJitter	8 – interPacketTime
6 – idleMean	16 – interPacketTimeMean
14 – interPacketTimeMaxFwd	19 – interPacketTimeStdev



In **unfeasible** attacks, feature correlations are notably disrupted.

Baseline – Unfeasible PGD Attack - Perturbation Factor 0.1

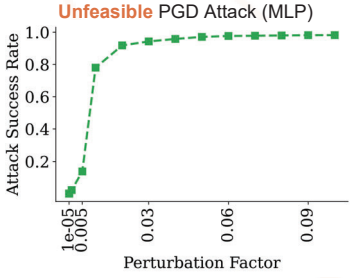


While **feasible** attacks minimally affect these established interdependencies.

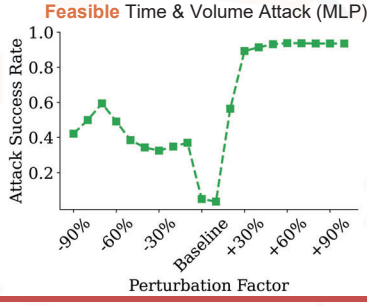
Baseline – Feasible Time & Volume Attack - Perturbation Factor 100%

Effective, but…

Unfeasible PGD Attack (MLP)



Feasible Time & Volume Attack (MLP)



Targeting Real-World Network Threats

This study identifies **real-world network threats**, thereby enabling a targeted approach in **designing robust defense mechanisms** to enhance the efficacy of models against such threats within the network security domain.

Acknowledgements: LASIGE is supported by national funds through FCT within the framework of projects UIDB/00408/2020 and UIDP/00408/2020. Additionally, the project is funded by the European Union's Horizon 2020 research and innovation program under grant agreements Nos. 871259 and 957197.

A Living Framework for Understanding Cooperative Games

Pedro Pais[1], David Gonçalves[1], Daniel Reis[1], João Godinho[1], João Morais[1], Manuel Piçarra[1], Pedro Trindade[1], Dmitry Alexandrovsky[2], Kathrin Gerling[2], João Guerreiro[1], André Rodrigues[1]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] Human-Computer Interaction and Accessibility, KIT, Karlsruhe, Germany

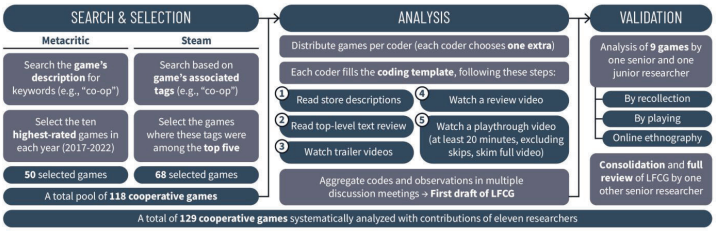
LASIGE inclusive human--computer interaction

MOTIVATION

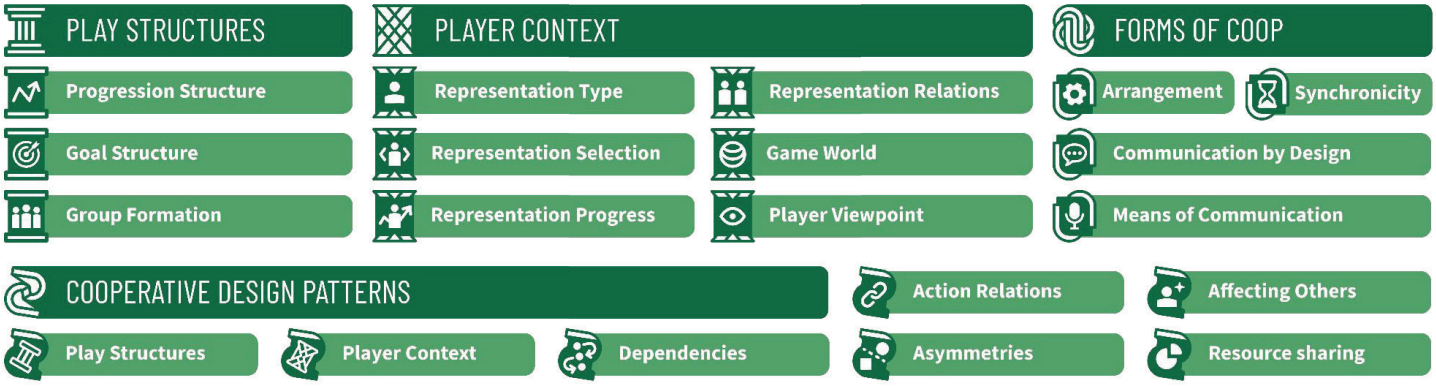
We have **limited means to rigorously define the game design structures**, **hindering attempts at consolidating knowledge** and limiting the potential of design efforts.

How is the collaboration in these games different?

METHODS



FRAMEWORK



EXAMPLES

Game World: Shared
Player Viewpoint: Shared

All players act in the same world and see it from the same perspective

Dependencies: Task, Spatial, Scaling difficulty

Players have to complete tasks that generate other tasks while avoiding collisions with each other. The game also becomes increasingly harder with the number of players in the party.

Game World: Shared
Player Viewpoint: Distinct

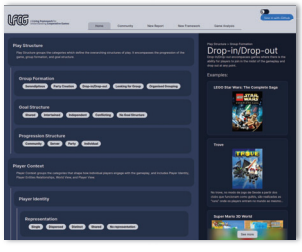
All players act in the same world but see it from their own, distinct, perspectives.

Dependencies: Task
Asymmetries: Information

While players have to accomplish different tasks that depend on each other, the game only gives different pieces of information to different players

WEB APP

The web app allows users to **consult LFCG**, and **browse game reports and framework extensions**. It provides an interactive navigation between categories and values with a detailed view of the selected category/value with its description.



GAME REPORTS

Create a **game specification**
- Framework Values
- Analysis Details
- Game Mode
- Game Familiarization

Contribute to **shared compendium**
- Examples for identified values
- Public browsable reports

Published at CHI 2024. Read the full paper:

Acknowledgements: This work was supported by FCT through project "Plug n' Play: Exploring Asymmetry and Modularity for Inclusive Game Design" ref. 2022.08895.PTDC (http://doi.org/10.54499/2022.08895.PTDC), the Institutional CEEC (https://doi.org/10.54499/CEECINST/00032/2018/CP1523/CT0003), scholarships ref. UI/BD/151178/2021 (https://doi.org/10.54499/UI/BD/151178/2021) and ref. 2022.12448.BD, and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

Multi-Party Computation as a Service for Privacy-Preserving Distributed Applications

Miguel Carvalho[1], Alysson Bessani[1], Bernardo Ferreira[1]

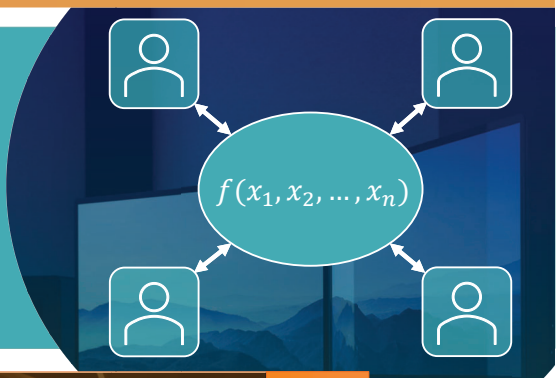
[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE dependable and secure decentralized systems

Context

As people use the internet to store and share information, it becomes important to manipulate this data in a **private** and **meaningful** manner

Multi-party computation (MPC) helps with this by supporting collaborative computation of ANY function on decentralized data – from linear equations to AI model training - without exposing the user's individual inputs



Problem

Many existing **MPC Frameworks** present several limitations that make them unpractical

No dynamism due to fixed participants limits practicality in prolonged computations

Lack of fault-tolerant mechanisms to prevent crashes and other malicious behavior

Resorting to **synchronous networks** deviates from real-life scenarios

Lack of **server** support limits usability and scalability

Our Solution

MPCServe

Dynamic: Parties are allowed to join and leave the computation when desired

Fault-tolerance: elevates the traditional BGW[1] MPC protocol with fault-tolerant mechanisms

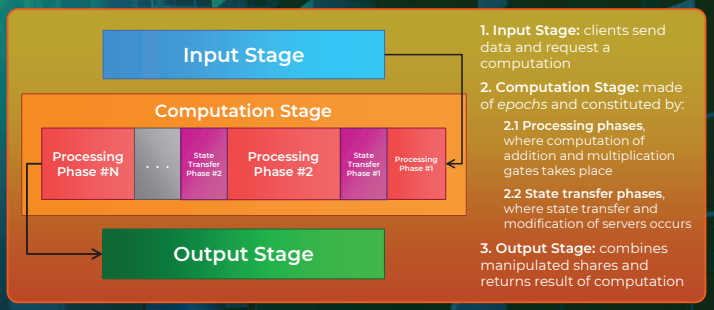
MPC-as-a-Service: follows a client-server model where clients request operations and servers compute the specified operation

Secure: leverages **COBRA's** [2] **Dynamic Proactive Secret Sharing** to protect against adaptive adversaries

MPCServe Protocol Stack

- MPCServe — Multi-Party Computation
- COBRA — Dynamic Proactive Secret Sharing
- BFT-SMaRt — Byzantine Fault-Tolerant State Machine Replication

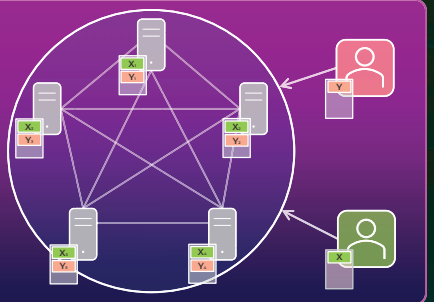
MPCServe Service Model



1. **Input Stage:** clients send data and request a computation
2. **Computation Stage:** made of *epochs* and constituted by:
   - 2.1 **Processing phases**, where computation of addition and multiplication gates takes place
   - 2.2 **State transfer phases**, where state transfer and modification of servers occurs
3. **Output Stage:** combines manipulated shares and returns result of computation

MPCServe System Model

- **MPC Share Storing:** Uses **COBRA's** Key-Value Store to maintain shares of client data
- **MPC Operations:** Leverages Shamir's Secret Sharing and Linear Algebra operations to add and multiply shares of stored client data
- **MPC Security:** Uses **commitments** to verify validity of shares and uses **COBRA's Proactive Secret Sharing** to provide share refreshing for long-lived computations



References:

[1] M. Ben-Or, S. Goldwasser and A. Wigderson. Completeness Theorems for Non-Cryptographic Fault-Tolerant Distributed Computation. In the 20th STOC, pages 1–10, 1988.

[2] R. Vassantlal, E. Alchieri, B. Ferreira, and A. Bessani, "Cobra: Dynamic proactive secret sharing for confidential bft services," in IEEE Symposium on Security and Privacy (SP), pages 1335–1353, 2022

Acknowledgements: This work was supported by FCT through project SMaRtChain, ref. 2022.08431.PTDC (https://doi.org/10.54499/2022.08431.PTDC), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Make It Less Complex: Autoencoder for Speckle Noise Removal—Application to Breast Ultrasound

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LASIGE health and biomedical informatics

PROBLEM

- The presence of Speckle noise (SN) is a downside to the use of ultrasound (US) imaging, decreasing lesion conspicuity.
- Current denoising techniques are either too complex (deep learning (DL) models with >150k parameters), or need parameter tuning and are time-consuming (Lee filter; median filter).
- Research in this area lack in clinical application focus.

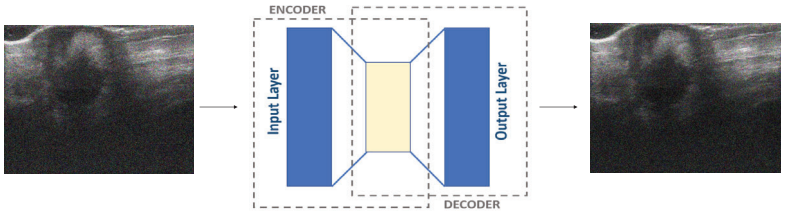
Check Journal Publication

OUTCOME

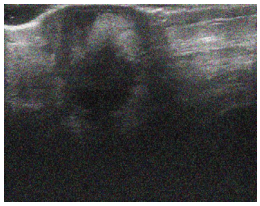
- A simpler DL model (<30k parameters) is capable of removing SN successfully for different noise levels, and 300x faster than Lee and median filters.
- The removal of SN with our model reduces the misclassifications of malignant breast lesion, in comparison with original images

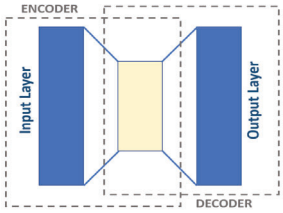
1) Simulated SN was added to original images (σ = 0.05, 0.1, 0.2, 0.5), which were used to train a denoising CNN-AE model, for each σ.

CNN-AE trained to reconstruct original images, after simulated Speckle addition

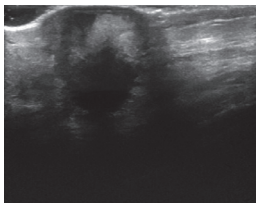


Original US Image

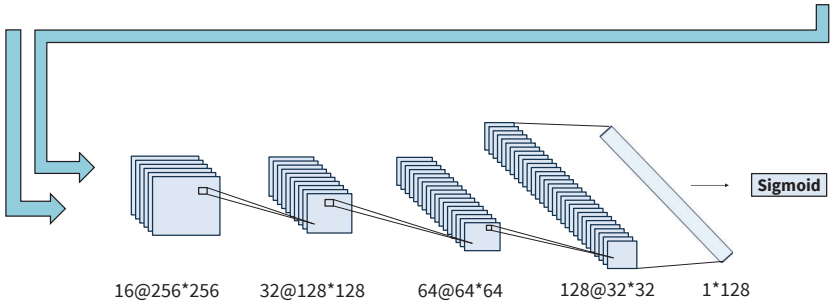




Denoised US Image



2) The previously trained CNN-AE models were used to remove inherent SN from original images, resulting in 4 sets of denoised images.



3) Classification of breast lesions (benign vs. malignant) for each denoised image set and for the original images.

RESULTS

- The correct diagnosis of malignant lesions is improved with the use of the denoising CNN-AE (σ = 0.2), when compared to original images (sensitivity: 75.9% vs 71.6%),and is comparable with the Lee filter (76.0%).
- Nonetheless, denoising CNN-AE is faster than the Lee filter, does not require parameter tuning, and achieves higher accuracy (86.4% vs 85.4%)

Acknowledgements: This project was supported by Fundação para a Ciência e a Tecnologia (FCT): (FCT- IBEB Strategic Project UIDB/00645/2020), (EXPL/CCI-COM/0656/2021), (UIDP/00408/2020), (UIDB/00408/2020), (DSAIPA/AI/0083/2020), Bolsa de Investigação para Doutoramento (2022.12271.BD), and Bolsa de Investigação para Doutoramento Maria de Sousa (2022.15319.BD).

Multi-organ Self-supervised Contrastive Learning for Breast Lesion Segmentation

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LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

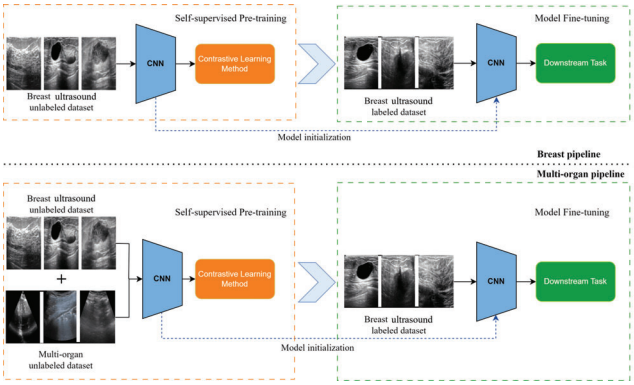
LASIGE data and systems intelligence

1. Introduction

- Breast cancer is the **most frequent malignancy in women** and ranks as the **second learning cause of cancer-related mortality** in this demographic [1].
- Machine learning task performance **depends on labeled images**, particularly **challenging in medical image** analysis.
- **Self-supervised learning** (SSL) methods, using **unlabeled data**, offer pre-training strategies for downstream tasks with limited labeled data.
- We hypothesize that **pre-training** models with **data from various organs** from the same modality (ultrasounds) **provides benefits** compared to pre-training with images from the target organ (the breast) and natural images.

2. Methodology

- We use three contrastive learning methods to pre-train the models: **SimCLR** [2], **MoCo** [3] and **SimSiam** [4].
- In the **breast pipeline**, we pre-train the model using the **breast ultrasound dataset** and fine-tune it on the same dataset.
- In the **multi-organ pipeline**, we pre-train the model using the **multi-organ dataset**, which includes breast ultrasounds, and fine-tune it on the breast ultrasound dataset .



3. Datasets

Dataset	Nº of Samples	Usage*
BUSI(◯)	780	P|F
CAMUS	2 000	P
COVID-19 LUS	228	P
Multi-organ (△)	2 852	P
Mini-ImageNet	60 000	P

* The usage of each dataset in our experiments is denoted with P for pre-training and F for fine-tuning

5. Conclusions

- Multi-organ pre training is **beneficial** for breast ultrasound segmentation.
- It **boosts performance**, even surpassing supervised baselines, while **requiring fewer labeled data**.
- **Enhances** the model's ability to **segment** malignant lesions and their **irregularities**.

4. Results

Table 1: ResNet-50 backbone pre-trained and fine-tuned using 64x64 images

Method	Dataset	DC (100%)	DC (50%)	DC (25%)	DC (10%)
Supervised	◯	0.710±0.041	0.629±0.075	0.630±0.036	0.531±0.061
MoCo		0.678±0.040	0.627±0.041	0.469±0.187	0.320±0.163
SimCLR	Mini-ImageNet	0.693±0.066	0.625±0.037	0.611±0.040	**0.561**±0.047
SimSiam		0.686±0.040	0.627±0.051	0.519±0.196	0.313±0.163
MoCo		0.695±0.025	0.640±0.038	0.541±0.083	0.406±0.217
SimCLR	◯	0.691±0.050	0.624±0.053	**0.624**±0.035	0.523±0.060
SimSiam		0.693±0.028	0.624±0.032	0.445±0.163	0.408±0.108
MoCo		0.693±0.040	0.646±0.042	0.435±0.175	0.368±0.150
SimCLR	◯ + Mini-imageNet	0.694±0.026	0.615±0.058	0.615±0.037	0.523±0.055
SimSiam		**0.714**±0.034	0.638±0.038	0.525±0.076	0.466±0.183
MoCo		0.686±0.031	**0.658**±0.027	0.453±0.182	0.360±0.189
SimCLR	△	0.694±0.053	0.626±0.038	0.608±0.054	0.538±0.036
SimSiam		0.703±0.033	0.653±0.042	0.490±0.137	0.305±0.180

Figure 1: Generated masks of the pre trained ResNet-50 backbones. The first column shows the masks of benign tumours, and the second column shows the masks of malignant tumours. (a) Ground truth; (b) SimSiam — BUSI + Mini-imageNet; (c) SimSiam — Multi-organ

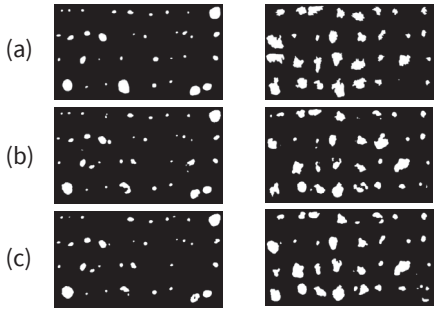
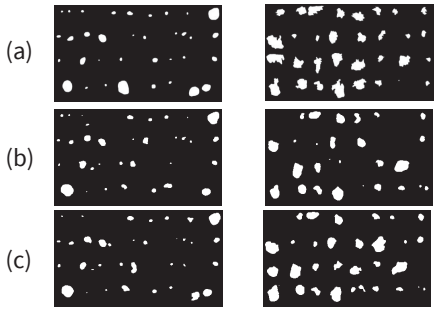


Table 2: U-Net pre trained and fine tuned using 50x50 images

Method	Dataset	DC (100%)	DC (50%)	DC (25%)	DC (10%)
Supervised	◯	0.606±0.040	0.574±0.017	0.544±0.014	0.505±0.031
MoCo		0.637±0.050	0.591±0.036	0.535±0.014	0.484±0.045
SimCLR	Mini-ImageNet	0.594±0.022	0.569±0.028	0.465±0.154	0.364±0.162
SimSiam		0.597±0.042	0.559±0.040	0.463±0.121	0.449±0.040
MoCo		0.701±0.035	0.687±0.057	0.697±0.065	0.406±0.217
SimCLR	◯	0.595±0.010	0.581±0.010	0.582±0.015	0.568±0.010
SimSiam		0.573±0.012	0.535±0.034	0.502±0.015	0.444±0.027
MoCo		0.617±0.044	0.588±0.045	0.539±0.040	0.482±0.035
SimCLR	◯ + Mini-imageNet	0.599±0.032	0.532±0.178	0.393±0.219	0.264±0.233
SimSiam		0.639±0.038	0.587±0.039	0.544±0.028	0.506±0.037
MoCo		**0.723**±0.032	**0.720**±0.021	**0.714**±0.029	**0.688**±0.041
SimCLR	△	0.647±0.036	0.645±0.017	0.637±0.024	0.611±0.040
SimSiam		0.573±0.012	0.520±0.037	0.468±0.021	0.440±0.036

Figure 2: Generated masks of the pre trained U-Nets. The first column shows the masks of benign tumours, and the second column shows the masks of malignant tumours. (a) Ground truth; (b) MoCo — BUSI; (c) MoCo — Multi-organ



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[1] The Global Cancer Observatory (2021). World Health Organization (WHO). Health Statistics and Information Systems
[2] Chen et al. A simple framework for contrastive learning of visual representations, in: Proceeding of the 37th International Conference on Machine Learning, ICML 2020
[3] He et al. Momentum contrast for unsupervised visual representation learning, in: 2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition, CVPR 2020
[4] Chen et al. Exploring simple siamese representation learning, in: IEEE Conference on Computer Vision and Pattern Recognition, CVPR 2021

Acknowledgements: This work was supported by Fundação para a Ciência e a Tecnologia (FCT) under project EXPL/CCI-COM/0056/2021 and the LASIGE research unit, ref. UIDB/00408/2020 and UIDP/00408/2020.

Digital Accessibility: an Overlooked Right in Higher Education?

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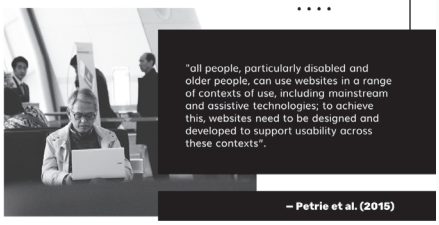
LASIGE inclusive human-computer interaction

What is it?

define_accessibility.js

```
const disability = interact(impairment, contextual_factor)

if (disability && ["internet", "digital"].includes(contextual_factor)) {
```



"all people, particularly disabled and older people, can use websites in a range of contexts of use, including mainstream and assistive technologies; to achieve this, websites need to be designed and developed to support usability across these contexts".

– Petrie et al. (2015)

```
}
```

Why it matters…

1 300 000 000

people estimated by the WHO to live with an impairment

A Human right - the UDHR (1948)

Article 1

"All human beings are born free and equal in dignity and rights"

Convention On The Rights Of Persons With Disabilities (2006):

Article 9
Accessible information and communications technologies

Article 21
The right to exercise freedom of speech, and to seek information on an equal basis with everyone.

Article 23

"Everyone has the right to work"

30%

of the people employed in the EU use digital devices for most or all their working hours.

Article 26

"Everyone has the right to education"

Children with impairments are

49%

more likely to have never attended school.

57%

of employment, among those that, at best, attained lower secondary education.

Demystifying the notion of "other"

SITUATIONALLY - INDUCED

- Today, the user can be in an ample variety of situations, contexts and environments.
- Navigating them while interacting with, for instance, a smartphone, can be analogous to the experience of someone with a physiological impairment.

AGEING

- Ageing is an inevitable phenomenon.
- In OECD countries, the population over 65 has been on a steady climb.
- From the degenerative effects of ageing, several impairments may arise.

TEMPORARY

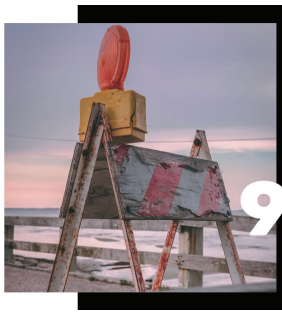
- During a lifetime, one is likely to have to live with a temporary impairment such as a broken limb, or the short-term effect of a medical intervention like an eye surgery.

The business side

Implementing digital accessibility:

- Extends Market Reach
- Drives Innovation
- Enhances the Brand
- Minimizes Legal Risk

In practice



96.3%

of the 1 million pages tested by the WebAIM violated some guideline

It's importance in higher education

Higher education completion

5.4% living **with** an impairment

21.7% living **without** an impairment

finished higher education in Portugal

At risk of poverty or social exclusion

28.8% living **with** an impairment

18.3% living **without** an impairment

Sentiments towards it

	Inal et al. (2020)	Yesilada et al. (2012)
Being ethical	X	X
Comply with the law	X	X
Being inclusive	X	X
Design better products	X	X
Increase revenue	X	-

It benefits all; The business side; A Human right

Bi et al. (2022)

- Accessibility needs to be incorporated into all software projects.
- It is not only for people who are unable to use standard software.
- It is a marketing strategy.

Vollenwyder et al. (2019)

- User advocacy
- Self-perception as specialist.
- Product quality.

Barriers

Cao and Loiacono (2022)

Guidelines →

Inal et al. (2020)

- Time and cost constraints.
- Placing the focus on other users.
- It not being a requirement neither for their organization nor for the client.
- Work overload.

What we're doing

conduct_study.js

```
// The aim of this study is to identify the potentially disabling experiences arising
// from the interaction between students with impairments and the digital
// practices of their higher education institutions
const conduct_study = () => {
    // Trough the application of a questionnaire and interviews, we will gather experiences of
    // those at risk of marginalization and of those that can tackle the underlying issues that
    // might result in that marginalization.
    const questionnaire_answers =
        invite_candidates(public_forums)
            .map(student_with_impairment => apply_questionnaire(student_with_impairment))

    const interviews_transcriptions =
        identify_candidates(institutional_websites_and_documents)
            .map(interested_stakeholder => {
                if (invite(interested_stakeholder)) {
                    return transcribe(interview(interested_stakeholder))
                }
            })

    // We will analyse that data quantitatively and qualitatively...
    const analysis_questionnaire_answers =
        questionnaire_answers
            .map(answers => {
                return answers
                    .map(answer => quantitative_analysis(answer) || qualitative_analysis(answer))
            })

    const analysis_interviews_transcriptions =
        interviews_transcriptions
            .map(transcription => qualitative_analysis(transcription))

    // ... to provide an understanding of the general landscape
    // of digital accessibility in the context of higher education
    // and clues on how it can be improved.
    return derive_understanding_and_provide_improvement_hypothesis(
        analysis_questionnaire_answers,
        analysis_interviews_transcriptions
    )
}

conduct_study()
```

Questionnaire and interviews

Quantitative and qualitative analysis

Understand the paradigm and suggest improvements

References:

Bi, T., Xia, X., Lo, D., Grundy, J., Zimmermann, T., Ford, D.: Accessibility in software practice: A practitioner's perspective. ACM Trans. Softw. Eng. Methodol. 31(4) (2022). https://doi.org/10.1145/3503508

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Inal, Y., Guribye, F., Rajanen, D., Rajanen, M., Rost, M.: Perspectives and practices of digital accessibility: A survey of user experience professionals in nordic countries. In: Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society. NordiCHI '20, Association for Computing Machinery, New York, NY, USA (2020). https://doi.org/10.1145/3419249.3420119

Petrie, H., Savva, A., Power, C.: Towards a unified definition of web accessibility. In: Proceedings of the 12th International Web for All Conference. W4A '15, Association for Computing Machinery, New York, NY, USA (2015). https://doi.org/10.1145/2745555.2746653

Vollenwyder, B., Iten, G.H., Br¨uhlmann, F., Opwis, K., Mekler, E.D.: Salient beliefs influencing the intention to consider web accessibility. Computers in Human Behavior 92, 352–360 (2019). https://doi.org/10.1016/j.chb.2018.11.018

Yesilada, Y., Brajnik, G., Vigo, M., Harper, S.: Understanding web accessibility and its drivers. In: Proceedings of the International Cross-Disciplinary Conference on Web Accessibility. W4A '12, Association for Computing Machinery, New York, NY, USA (2012). https://doi.org/10.1145/2207016.2207027

Acknowledgements:

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Beyond Semantic Richness: Comparing Link Prediction and Classification for Gene-Disease Association Discovery

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LASIGE health and biomedical informatics

1. Context and Motivation

The discovery of gene-disease links is an important challenge in biological and biomedical domains, as it presents opportunities in tasks such as disease detection and drug repurposing.

Gene-Disease Associations from DisGeNET

Ontologies: GENEONTOLOGY Unifying Biology; DISEASE ONTOLOGY; human phenotype ontology

Logical Definitions

Mappings

Annotations for genes (from Gene Ontology and Human Phenotype Ontology)

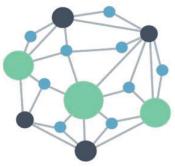
Annotations for diseases (from Disease Ontology and Human Phenotype Ontology)

in Link Prediction

2. Objective

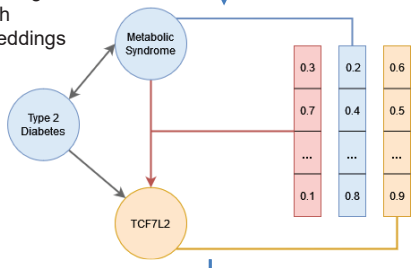
This work aimed at investigating the differences between approaching the gene-disease association problem as a *link classification* task and a *link prediction* task.

Knowledge Graphs



Vector Operations:
Concatenation
Average
Hadamard
Weighted-L1
Weighted-L2

Knowledge Graph Embeddings



Gene-Disease Pair Vector	Relation?
0.1, 0.3, 0.5, 0.7, 0.9, 0.2, 0.4, 0.6, 0.8	Yes
0.8, 0.3, 0.6, 0.1, 0.9, 0.4, 0.7, 0.2, 0.5	No
... , ... , ... , ... , ... , ... , ... , ... , ...	...
0.2, 0.6, 0.4, 0.9, 0.1, 0.7, 0.3, 0.8, 0.5	Yes

Supervised Learning Classifiers:
Naive Bayes
MLP
XGBoost
Random Forest

Link Classification

Link Prediction

Scoring Function

$$\| h + r - t \|_{1/2} = 0.715$$

List of candidate entities for a gene/disease → Filter candidate entities to just diseases/genes → Get the Top 100 candidate entities → Get the ranks of truly associated entities

Evaluation metrics specific to the task

3. Sample Results Table

Task	Link Classification	Link Prediction
Metric	Median WAF	Hits@10
Method	RDF2Vec + Random Forest	TransE
GO+HPO	**0.758**	0.399
GO+HPO+LD	0.739	0.369
GO+HPO+Map	0.743	0.403
GO+HPO+DO	0.745	0.400
GO+HPO+LD+DO	0.742	0.411
GO+HPO+LD+Map+DO	0.733	**0.426**

4. Conclusion

- **Link prediction** methods are better at exploring the semantic richness encoded in knowledge graphs through various ontologies and additional links between ontology classes;
- Link prediction **leverages** relationships between target entities within knowledge graphs and **does not** require the synthetic generation of negative examples;
- While link prediction methods offer an **end-to-end** approach, link classification methods require integrating various machine learning algorithms with vector operations;

What are ontologies?

An ontology consists of a set of conceptual definitions that model domains. This includes a set of classes, domain entities, and semantic links that describe relations between classes/entities or properties of classes.

What are Knowledge Graphs?

Directed labeled graphs that represent real-world entities, organizing and interconnecting the data in a way that incorporates the semantic meaning from ontologies.

Acknowledgements: This work was supported by FCT through KATY project, which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101017453, and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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C-KEE: Classification with Knowledge Graph Embeddings Explained

Filipe Paulino, Catia Pesquita

LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE data and systems intelligence

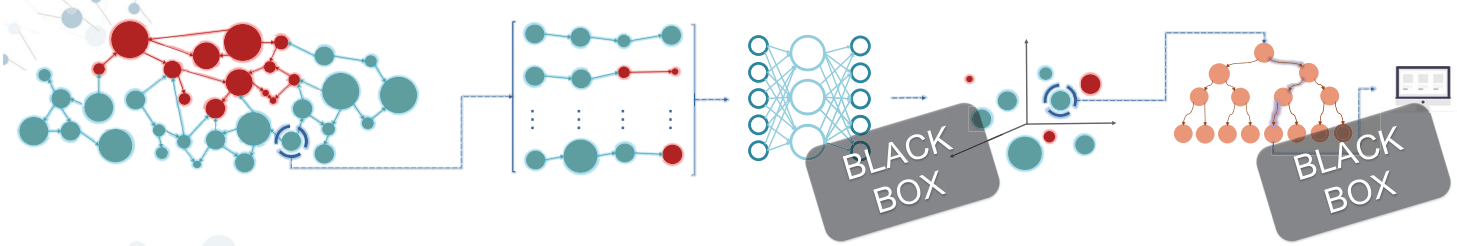
Context and Motivation

Knowledge Graphs combine **ontologies** of concepts with **data** on real world entities

Knowledge Graph Embeddings project graph nodes into a **dense vector format**

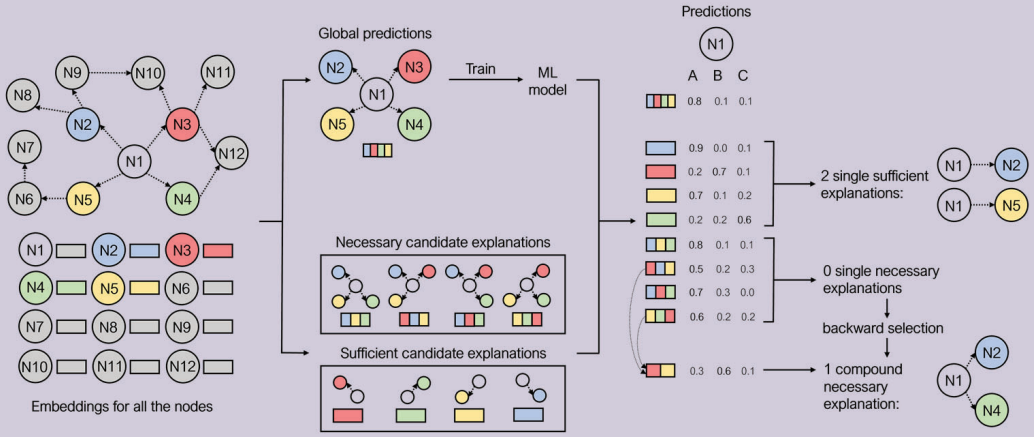
Explainable AI makes AI results more understandable to humans, considered critical in high-risk applications

Perturbation-based methods analyse how small changes in the input data impact the outcome of the system



Methodology

Counterfactual explanations answer the questions: *"what would happen to the entity classification if it was not linked to these neighbours?"* (necessary) and *"what would happen to the entity classification if it was only linked to these neighbours?"* (sufficient)

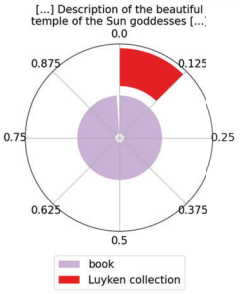


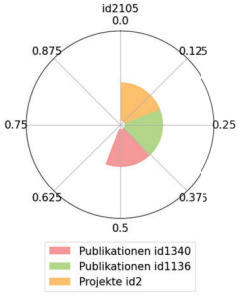
i. Learn representations for all entities in the KG

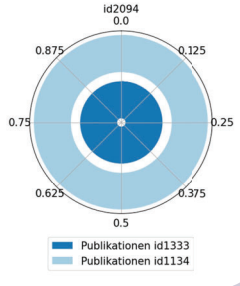
ii. Train ML model using entities as aggregate representations of their neighbours

iii. Explanation generation by removing a small set of neighbours (necessary) or only considering a small set of neighbours (sufficient)

Outcome





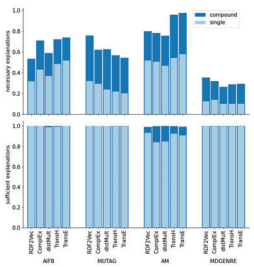


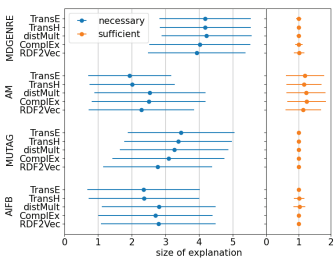
Tested in **4** datasets, **5** KGE models, **3** ML models

Classification performance vs baseline is same in **38%**, better in **62%** of cases

C-KEE explanations vs random is better in **90%** of cases

C-KEE explanations vs baseline is better in **ALL** cases





Acknowledgements: This work was supported by FCT through project KATY, ref. 101017453 (https://cordis.europa.eu/project/id/101017453), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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ClusTric: Unraveling Disease Progression Patterns for Patients Stratification in Amyotrophic Lateral Sclerosis

Daniela Amaral[1], Diogo F. Soares[1], Marta Gromicho[3], Mamede de Carvalho[3], Sara C. Madeira[1], Pedro Tomás[2], Helena Aidos[1]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
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[3] Instituto de Medicina Molecular and Faculdade de Medicina, Universidade de Lisboa, Portugal

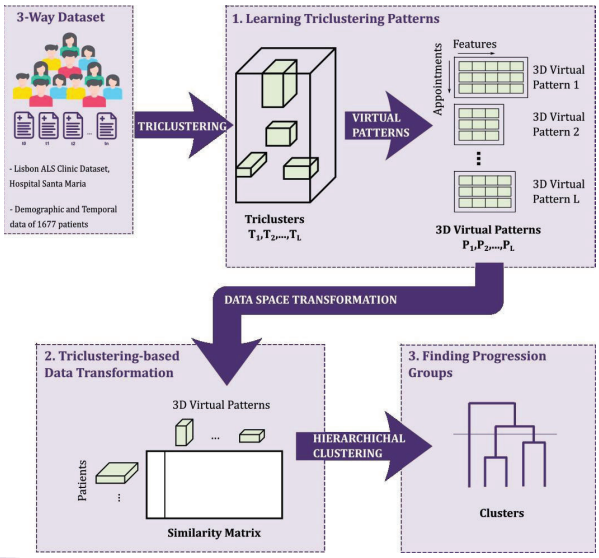
LASIGE data and systems intelligence

Amyotrophic Lateral Sclerosis (ALS)

- **Amyotrophic Lateral Sclerosis (ALS)** is a neurogenerative disease that affects motor neurons, causing a progressive muscular paralysis and leading to the patient's death due to respiratory failure.
- No known cure; treatments try to improve the quality of life and the life expectancy of patients.
- **Highly heterogeneous disease** – difficult to determine when a certain treatment should be applied.

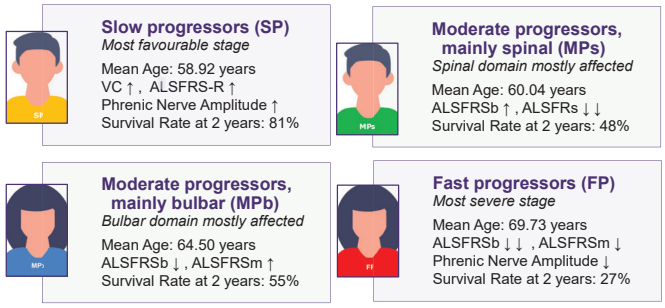
- **Stratification** allows to **find disease-specific subgroups** with similar characteristics and progression.
- **Prognostic** models can be **enhanced** by adding a preliminary **stratification** step to cluster patients.

Methods

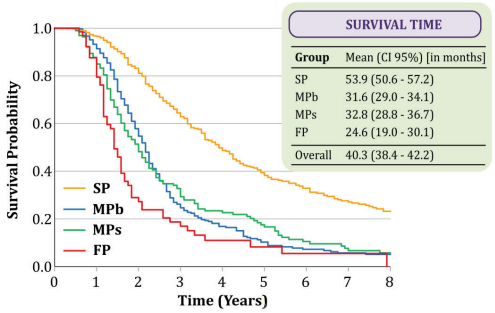


AI MODEL UNCOVERS PATIENT PROFILES AND IMPROVES PRECISION MEDICINE

Results

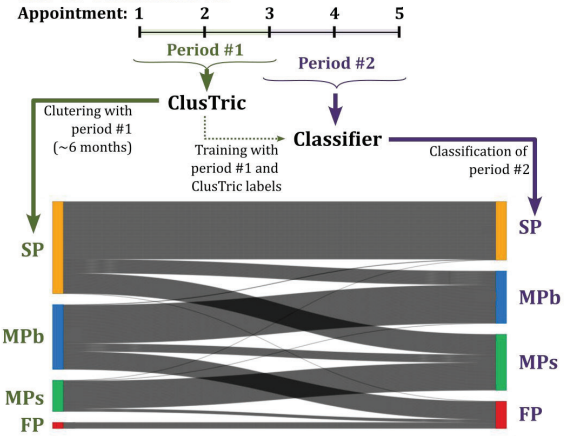


SURVIVAL CURVES



SURVIVAL TIME	
Group	Mean (CI 95%) [in months]
SP	53.9 (50.6 - 57.2)
MPb	31.6 (29.0 - 34.1)
MPs	32.8 (28.8 - 36.7)
FP	24.6 (19.0 - 30.1)
Overall	40.3 (38.4 - 42.2)

GROUP TRANSITIONS



ClusTric allowed to...

FIND RELEVANT DISEASE SUBGROUPS

PROVIDE CLINICIANS WITH INSIGHTS

SUPPORT MEDICAL DECISIONS

Acknowledgements: This work was supported by FCT through project AIpALS ref. PTDC/CCI-CIF/4613/2020 (https://doi.org/10.54499/PTDC/CCI-CIF/4613/2020), the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020), and a PhD research scholarship (ref. 2020.05100.BD) to DFS.

Ghost Dance: A methodology to analyse dance movement in interaction with virtual reality

José Siopa[1], Ana Paula Cláudio[1], Beatriz Carmo[1], Rui Antunes[2], Cecília de Lima[3], João Carrilho[2]

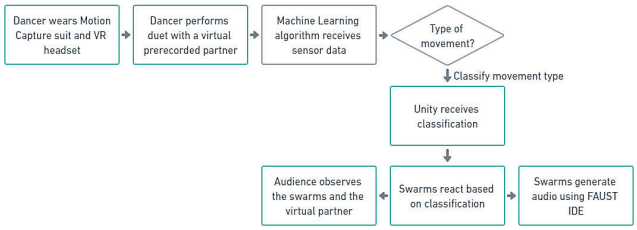
[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] CICANT, Universidade Lusófona
[3] Escola Superior de Dança, Instituto Politécnico de Lisboa/ INET-md

LASIGE data and systems intelligence

Objectives

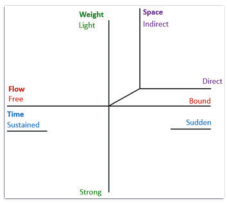
- Explore changes in the dancer's body perception when dancing with flesh-and-blood partners and when they are replaced by virtual avatars.
- Create a multimedia performance transcending traditional boundaries.
- Duet with a human dancer and an avatar mimicking the absent person's movements using virtual reality and the Unity 3D engine.
- Use a motion capture suit to create a body resembling a swarm of virtual entities.
- Sonification of dancer's movements.

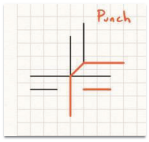
System Architecture



Movement Analysis

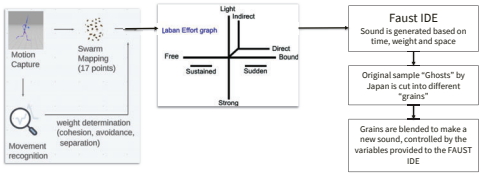
- Laban's Movement Analysis (LMA) framework consists of four essential components: Body, Space, Effort, and Form.
- Effort component includes: Weight, Spatial relationship, Time, and Flow.
- Laban's "action impulse" comprises eight fundamental actions: Punch, Cut, Dab, Flick, Press, Twist, Slide, and Float.
- Parallel project uses machine learning to decode dancer's real-time movements to LMA effort actions.





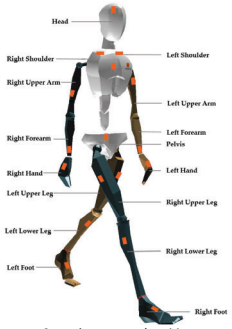
Immersive Audio Generation

- Mass of sound or sonic cloud, resembling real-time composition transformed into a granular texture.



Duet Creation & Motion Capture Process

- Duets choreographed by Cecília de Lima and performed by many dancers.
- Each dancer wears the Xsens Awinda suit with 17 sensors, capturing its movements and position.
- XSens Awinda program exports skeletal structure for 3D avatar re-targeting.

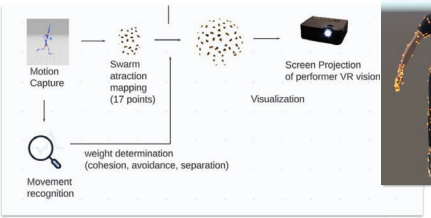


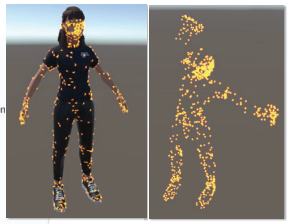
Sensor's names and positions

Image source: https://www.researchgate.net/figure/The-definition-of-the-23-segments-in-the-kinematic-model-of-Xsens-MVN-An-inertial_fig2_312036960 [accessed 4 Apr, 2024]

Body Swarm

- Virtual swarm, consisting of graphic elements, reacts to the dancer's movements and gestures.





Current Work

- Video recordings showcased adaptations needed when dancing without a physical partner.
- Observed that dancers sometimes were confused due to the inability to see their own bodies in VR or the low field of view of the VR headset.

Performance at InShadow Festival, in Teatro do Bairro, Lisbon, Portugal

WEBSITE

Find more about the project at:

https://ghostdance.ulusofona.pt

Acknowledgements: This work was supported by FCT through project GhostDance: A Methodology to analyse dance movement in interaction with virtual reality, ref. PTCE/EPL/IAT-PER/1238/2021; the LASIGE Research Unit, ref. \ UIDB/00408/2020 and ref. \ UIDP/00408/2020; and FilmEU - European Universities Alliance for Film and Media Arts and supported in part by funding from FILMEU_INT - Research | Innovation | Transformation project, European Union GRANT_NUMBER: 101035820, Ref-101035820, from FilmEU - The European University for Film and Media Arts project, European Union GRANT_NUMBER: 101004047, EPP-EUR-UNIV-2020.

Co-designing Customizable Clinical Dashboards with Multidisciplinary Teams: Bridging the Gap in Chronic Disease Care

Diogo Branco[1], Margarida Móteiro[1], Raquel Bouça[2,3], Joaquim Ferreira[2,3], Tiago Guerreiro[1]

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[2] Faculty of Medicine, University of Lisbon
[3] CNS—Campus Neurológico

LASIGE inclusive human--computer interaction

Background

→ Chronic Diseases affect an ever-increasing proportion of the global population
→ Multidisciplinary care teams contribute to provide patient-centered care
→ Technological devices advancements can revolutionize chronic disease monitoring

→ Communication challenges in multidisciplinary teams

→ Dashboards for multidisciplinary care teams face unique challenges that are overlooked in traditional ones

Goal

Explore the challenges and opportunities of multidisciplinary clinical dashboards as tools to support clinicians caring for people with chronic diseases

Methods

→ Two-phrase study

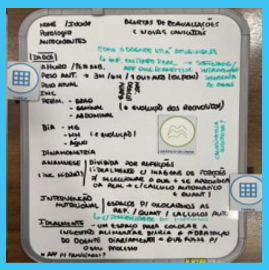
→ Participants from different clinical areas and a tertiary private clinical institution focusing on neurological conditions

Focus Group

→ 11 participants
→ 1 session + post-session activities
→ Affinity Diagram

Workshop

→ 15 participants
→ 6 sessions
→ Group Discussion + Co-design
→ Thematic Analysis



Findings

→ Current Clinical Practices and Technological Tools
→ Values in Technology
  Monitor at-home scenarios
→ The Role of Visualization
  Two-level Dashboards
  Customization
  Dynamic Dashboards
→ Sharing in Multidisciplinary teams

Implications

→ Dashboards as Trigger for Action
  Stimulate discussions with patients
→ Multidisciplinary Teams Collaboration
  Adaptable feature and mechanisms to support individual needs
→ Customizable Dashboards
  Adapt real-time data exploration during appointments

Published at CHI 2024

SCAN ME

For dashboards to be useful for clinical practice, we need to consider the tradeoffs between empowering patients while upholding the clinical utility for healthcare professionals

Acknowledgements: This work was supported by FCT through scholarship SFRH/BD/144242/2019, and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020), Project 41, HfPT: Health from Portugal, funded by the Portuguese Plano de Recuperação e Resiliência, and IDEA-FAST project, which has received funding from the Innovative Medicines Initiative 2 Joint Undertaking under grant agreement No. 853981. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and EFPIA and associated partners.

Essential-functions mobile app as a cognitive training tool for elderly people

Rafaela Rodrigues[1], Vânia Mendonça[1], Soraia M. Alarcão[1], Way Kiat Bong[2]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] OsloMet, Oslo Metropolitan University, Norway

LASIGE inclusive human-computer interaction

Increase in elderly population
+
Greater smartphone usage
=
Need to improve smartphone accessibility for the elderly

+

Elderly may face cognitive decline
+
Cognitive training can be effective
=
Elderly can benefit from it

=

Smartphone ownership uprising
+
Cognitive training apps could be effective
=
Combining smartphone usage and cognitive training

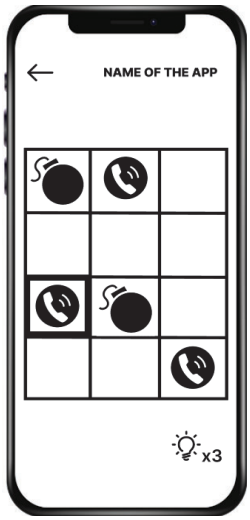
Goal

To develop a smartphone application that helps removing barriers to basic smartphone usage among the elderly by incorporating such kinds of usage into cognitive training exercises

How?

Through an app with cognitive training exercises focused on:

- ❑ Practicing relevant gestures (swiping and tapping movements to mirror smartphone functions)
- ❑ Enhancing elderly engagement through gaming elements (e.g., scoring)



Evaluation

- ❑ Heuristic evaluation of initial prototype
- ❑ Gathering caregiver's and elderly's feedback and iteratively improve prototype
- ❑ Evaluation of the final prototype with the elderly in terms of acceptance and ease of use

Work in progress

- ❑ Conducted informal interviews with the elderly to better understand what they find useful and/or engaging
- ❑ Developed a medium functionality prototype of the application and proposed games

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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AMBER: Automated Mammography & Breast Exam Report Generation

José Domingues[1,2], Nuno Matela[2], Nuno Cruz Garcia[1]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] IBEB, Instituto de Biofísica e Biomédica

LASIGE data and systems intelligence

Motivation

Screening to diagnosis can take up to 30 days

Supervised learning: Labeling data is costly and time-consuming, and so is text supervision for self-supervised methods

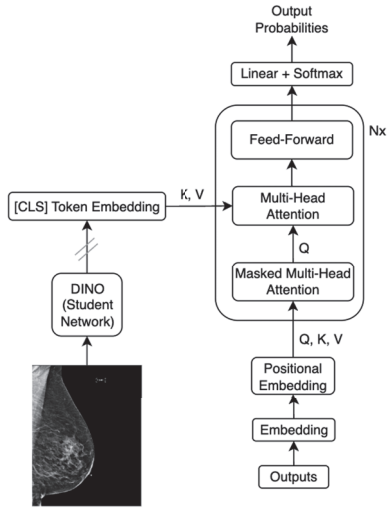
Ultrasound data is often overlooked due to high manual effort required by doctors for analysis and labelling despite high valuable information

Methodology

2 datasets of breast cancer images:
- EMBED Dataset (2D mammograms + clinical csv + metadata csv)
- BUSI Dataset (Ultrasounds)

- Artifact Removal with Spaghetti Labeling
- Cropping images to remove black background
- Resizing to 256^2 pixels
- Image normalisation
- Reports created from CSVs clinical data – Only for 2D mammograms

- Frozen pre-trained Vision-Transformer (DINO Student model)
- Standard Decoder



Preliminary Results

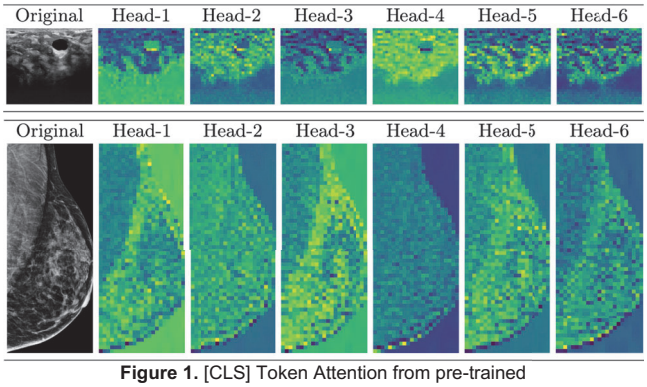
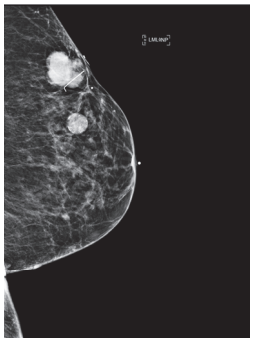


Figure 1. [CLS] Token Attention from pre-trained Vision Transformer using DINO

Table 1. AMBER NLP Evaluation Metrics

Method	BLEU-1 ↑	CIDEr ↑	METEOR ↑	ROUGE-L ↑	WER ↓	CER ↓
AMBER	**0.612**	–	**0.760**	**0.785**	0.8871	0.349
Ratchet	0.232	0.493	0.101	0.240	–	–
RGRG	0.373	0.495	0.168	0.264	–	–
KERP	0.482	0.280	–	0.339	–	–

Image	Target Report	Inferred Report
	mg diagnostic bilateral w/tomosynthesis view. it's benign according to birads. has no severity. has an round mass shape, an circumscribed margin, density characterized by: high density. has an rim calcification, with an unknown distribution. is consistent with: oil cyst. no recommendation at the moment.	mg screen bilat w/tomo/cad stnd protocol view. it's benign according to birads. has no severity. it is also not possible to analyse the mass shape. no calcification analysis. no recommendation at the moment. no recommendation at the moment.

Future Work

- New data preparation mechanisms e.g. augmentation
- Temporal data incorporation (OPTIMAM dataset)
- Assess gains from using DINOV2 approach

Acknowledgements: This work was supported by FCT PhD scholarship with ref. 2023.00273.BD and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020)

G-bic: generating synthetic benchmarks for biclustering

Eduardo N. Castanho[1], João P. Lobo[1], Rui Henriques[2], Sara C. Madeira[1]

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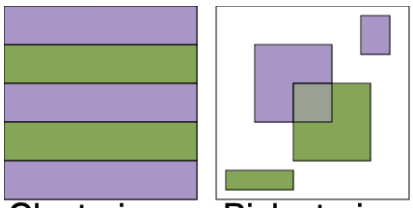
[2] INESC-ID, Instituto Superior Técnico, Universidade de Lisboa

LASIGE data and systems intelligence

G-Bic is a parametrizable **data generator** for biclustering analysis, enabling to **assess biclustering solutions** according to internal and external metrics.

Why Biclustering?

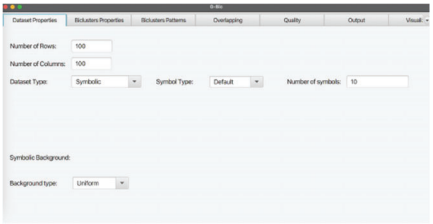


Biclustering is **more flexible** than clustering!

- Groups both Observations (rows) and Features (columns) of the data matrix
- Observations can belong to multiple groups
- Detects complex relationships

How can we generate synthetic data for Biclustering evaluation?

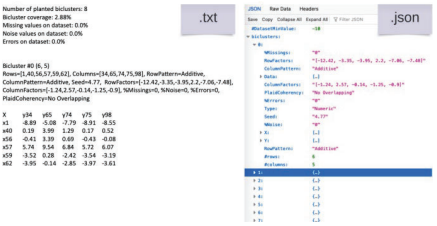
The G-Bic Approach



A GUI for easy usability

Dataset | Bicluster | Overlapping | Quality

Highly parametrizable options



.txt and .json outputs

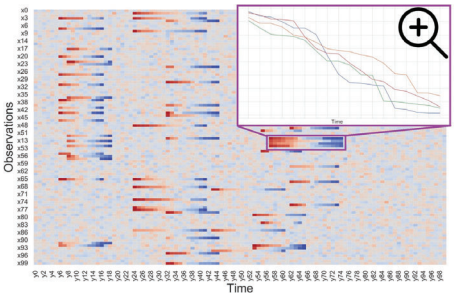
G-Bic is flexible

Coherencies	Plaid Models
Constant	Additive
Coherent	Multiplicative
Order Preserving	Interpoled

Bicluster Solutions with multiple properties

	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6
X_1	e	a	a	5	1	1
X_2	b	a	a	2	2	2
X_3	e	a	a	5	2	2
X_4	d	a	b	1	3	3
X_5	b	e	e	1	1	1
X_6	e	b	b	1	1	1

Multiple data types
numeric, categorical, mixed, heterogeneous



Options to simulate temporal profiles

Acknowledgements: Funding was provided by Fundação para a Ciência e a Tecnologia (Grant Nos. 2021.07810.BD, DSAIPA/AI/0033/2019 and PTDC/CCI-CIF/4613/2020), H2020-RIA (Grant No. 818290), INESC-ID Research Unit (Grant No. UIDB/50021/2020), LASIGE Research Unit (Grant No. UIDB/00408/2020 and UIDP/00408/2020).

A framework for taking the census of star clusters in the Milky Way

Ariana Dias [1,2], André Moitinho [2], Márcia Barros [1]

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[2] CENTRA, Faculdade de Ciências, Universidade de Lisboa, Portugal

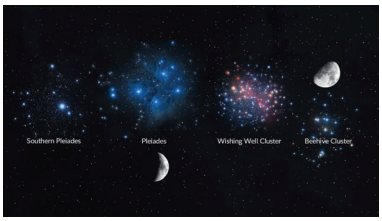
LASIGE data and systems intelligence

Motivation

- The ESA Gaia mission's extensive data has fuelled a surge in identifying new open clusters.
- Advances in machine learning and accessible software have supported this increase.
- Yet, catalogues often contain inaccuracies, leading to duplicated reports and misidentified clusters.

Problems

- Open clusters are groups of stars with irregular shapes.
- Catalogues are diverse and there is no platform centralizing all the data.
- Current cross matching approach (centre + radius) does not produce optimal compilations of OCs.



Goals

- Create a framework for merging published catalogues into a Master Catalogue of unique OCs
- Develop cross matching algorithms
- Generate statistical reports
- Offer framework as a web service as well as open-source software

Data

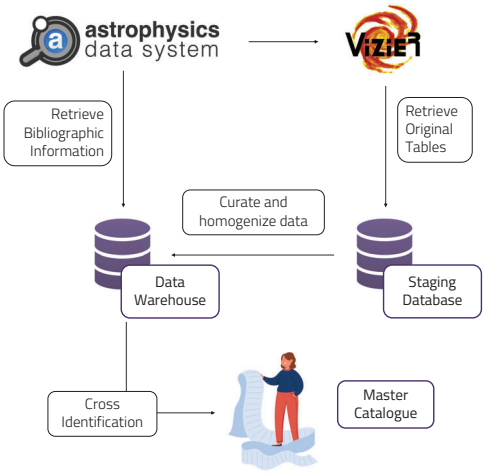
- 20 Catalogues
  - Table of Clusters (over 18K clusters)
  - Table of Members (over 10M stars)
- Bibliographic Data
  - First Author
  - Title
  - Date of Publication
  - Digital Object Identifier
  - Bibcode

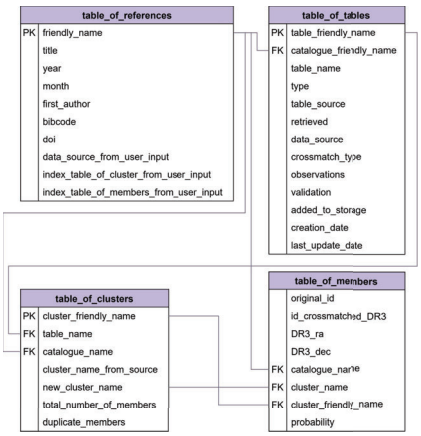
Pipeline

- To handle all the data, we will create a system of two databases (staging database and data warehouse) that will follow an ETL process.
- Within this system we can find an architecture that resembles a medallion architecture, where we can see three different layers: bronze, silver and gold.

Framework

1. **Identification**: Use ADS bibcodes to identify Open Cluster publications
2. **Bibliographic Retrieval**: Extract First Author, Title, Year, and DOI using the ADS API
3. **Data Retrieval**: Use VizieR API to get cluster tables and individual memberships
4. **Database Creation**: Compile a database with cluster and membership tables
5. **Membership Uniformity**: Identify memberships using Gaia DR3 source ids, crossmatching other identifiers
6. **Merging Order**: Define an order (e.g., by publication year) for merging catalogues
7. **Merging Process**: Compare and merge catalogues using assessed algorithms
8. **Final Product**: Obtain a master catalogue of Open Clusters and members, with statistical reports





Preliminary Findings

- Some catalogues have non-existent source IDs or identify their clusters with ordered numbers only
- We are producing a list of OC aliases across different catalogues
- We found reported OC discoveries with a significant number of common members (>60%) concerning previously known clusters

Future Work

- Integrate and develop crossmatching and set-to-set matching algorithms
- Generate comprehensive statistical reports on catalogue comparisons
- Create the master catalogue
- Create a dedicated website

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020) and through the Strategic Programme UIDB/FIS/00099/2020 and UIDP/FIS/00099/2020 for CENTRA.

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AWEsome Portal: A Digital Solution for Awe-on-Demand

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LASIGE data and systems intelligence

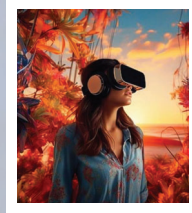
MOTIVATION

The project AWEsome Portal consists on the development of a web application capable of eliciting the emotion known as «Awe» -on-demand in a freely available, easy to use, and scientifically supported way. It is intended to be developed responsively so that anyone with access to the internet can use it, regardless of the device one is using.

AWE

AWE, as defined by Dacher Keltner (2023) can be conceptualized as the emotion of being amazed by something outsider yourself. It's a complex and still to be fully understood emotion, and it can be triggered by many different sources, one of the main ones being impressive and vast natural landscapes.
Benefits of daily exposure to AWE include pro-social behavior, environmental consciousness, improved mood, creative thinking and perception of time.

Studies have shown those feelings can also be created through digital experiences with a focus on immersion and simulation, both with and without using VR technology.
This research is what informed the conception of this project.



TECHNOLOGICAL SOLUTIONS

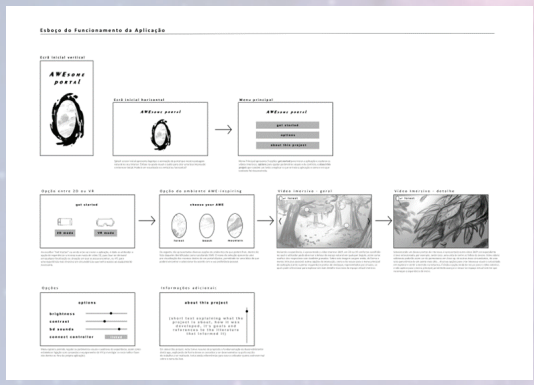
Responsive web application so it's accessible from any device with a connection to the internet, regardless of operating system and with no need to install.

HTML + CSS, combined with Javascript for the interactive functionalities.

Graphics and UI/UX elements self produced
Immersive videos purchased from stock footage websites or adapted from freely available material, edited to suit the purpose of this project.

PROTOTYPING

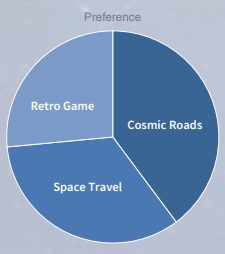
Early sketches of what a possible use flow of the web application were made, and from those low fidelity prototypes were then created through Figma in order to better visualize the idea and refine UI/UX elements:



A further developed prototype can be found through the QR code printed on the right:

Based on this experiment, user studies were then conducted between different interface options in order to test for satisfaction and ease of use and choose the more adequate option, as well as to validate the AWE inspiring videos to be included in the project.

PRELIMINARY RESULTS AND FURTHER WORK



Users showed preference for a "Cosmic Roads" themed interface, with a space inspired color identity and UI elements, as well as for the following 3 environments: Forest, Underwater, and Space Travel.

The project will be fully developed and implemented grounded on this information obtained.

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Personalised Emotion-based Image Recommendation System

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[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE data and systems intelligence

Motivation

In today's digital age, how we capture our personal memories has evolved significantly, encompassing videos, music, and specially images. However, this abundance of content has contributed to an information overload problem, where, within such vast amount of data, searching for personalised content becomes increasingly complex.

To address the problem stated, image recommendations systems become fundamental to facilitate the navigation through the vast visual content, by leveraging advanced, providing personalised recommendation tailored to individual preferences.

By integrating emotions into image recommendation systems, it allows for the analysis of emotional reactions provoked by the images and distinguishes them, offering emotionally more appealing suggestions.

Problems & Goals

Problems:

? How can an emotion-based image recommendation system address the challenges posed by information overload?

? What impact does it have on the efficacy and accessibility of relevant resources in diverse domains?

Goals:

★ Develop a collaborative filtering emotion-based image recommendation system.

★ Understand the impact of emotions when recommending images.

Data

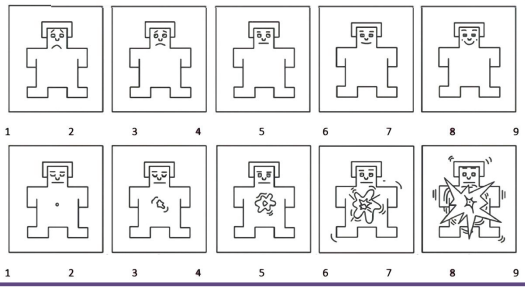
The dataset contains both users' information (gender, age, hobbies, medical conditions) and the ratings (categorical and dimensional) provided by them.

Help us improve our dataset by answering a survey!

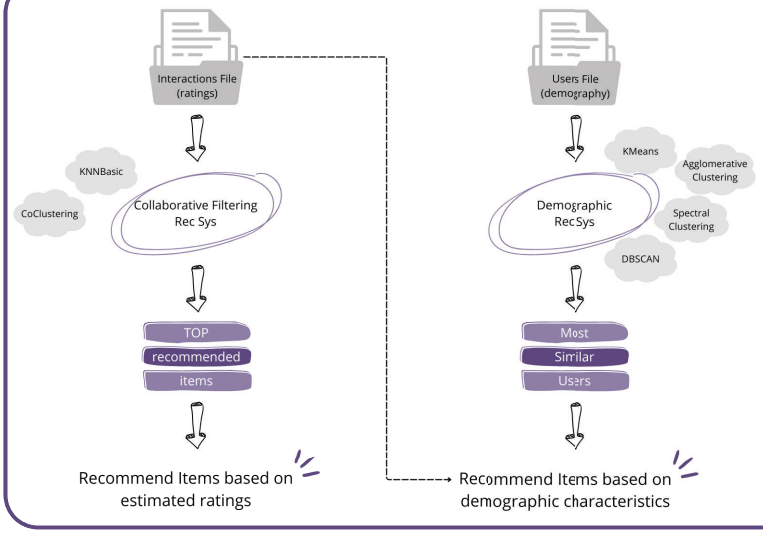
Emotions

Categorical — Are recognisable through specific facial expressions.

Dimensional — Perceive emotions as occurring along continuous dimensions, considering varying degrees – Self-Assessment Manikin.



Methodology



Collaborative Filtering Recommendation System:

→ This system allows us to retrieve the top recommended items for each user, based on rating estimates.

→ The models are from *Surprise* library.

Demographic Recommendation System:

→ This system allows us to find the most similar users for each user, based on their characteristics.

→ With the most similar users identified, we can then recommend items based on the favourite items of those similar users.

→ The models are from *Scikit-learn* library.

Acknowledgements: This work was supported by FCT through LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

Development of a knowledge graph for a recommender system for biological control agents against plant pathogens

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[2] InnovPlantProtect, Elvas, Portugal

LASIGE data and systems intelligence

Motivation

Food production faces challenges due to climate change that impact directly in the rise of new plant pathogens, leading to diseases impacting crop yield and food security.

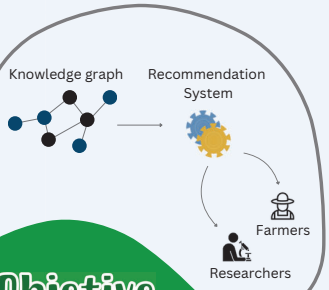
Chemical Pesticides

- Negative impact on human and environmental health
- Negative impact on pathogen resistances

Biological Control Agents (BCA's)

Problem

- The process to identify BCA's is quite time-consuming and expensive
- Farmers have lack of information about products

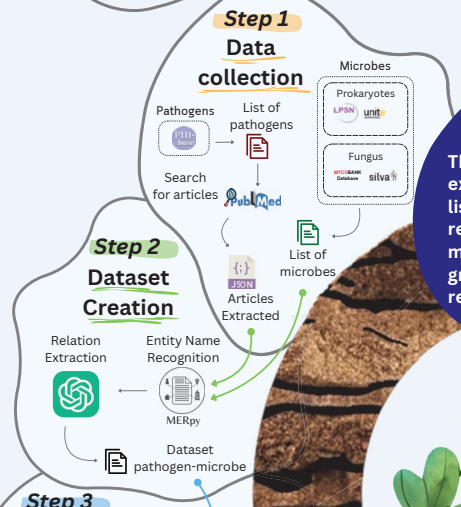


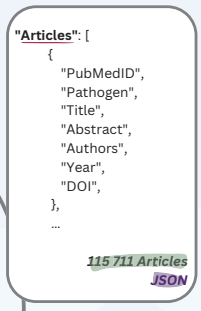
Objetive

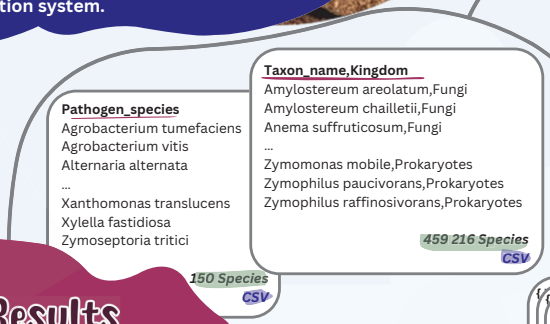
Extract all the relationships known between pathogens and microbes into a knowledge graph and use it to build a recommendation system that tells which microbes are likely to be able to inhibit particular types of pathogens.

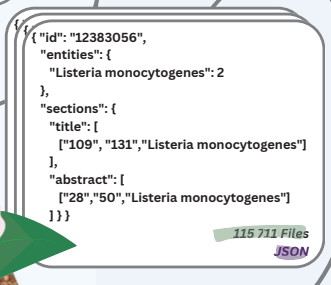
Methodology

The relationships between pathogens and microbes will be determined by retrieving scientific articles from the PubMed database, searching for each plant pathogen.
The tools for named entity recognition and relationship extraction make use of the extracted articles as well as a list of microbes from different databases. The extracted relations will be saved in a document with pathogen-microbe-classification and used to build the knowledge graph in Neo4j. This graph will serve as the base recommendation system.









Results

Microbe data from four different databases yielded a dataset containing 459,216 species, while pathogen data contained 150 different species. This resulted in 115,711 articles about plant pathogens that included the pubmedID, described pathogen, title, abstract, authors, year, and DOI.

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (*https://doi.org/10.54499/UIDB/00408/2020*) and ref. UIDP/00408/2020 (*https://doi.org/10.54499/UIDP/00408/2020*).

Path Authorization at Terabit Speed for the SCION Internet Architecture

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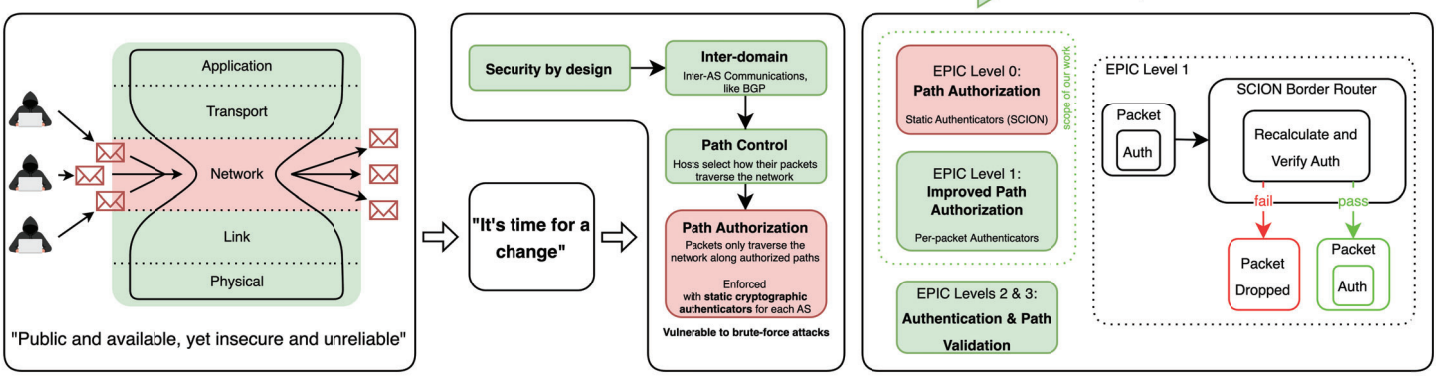
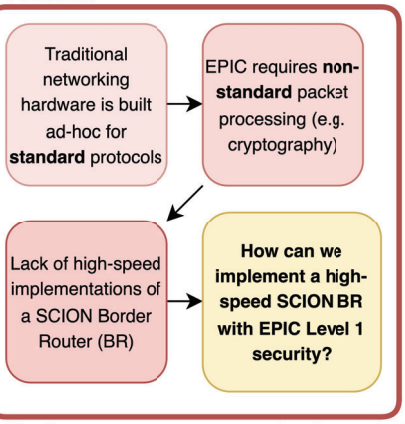
[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2] Telefónica Research, Barcelona, Spain

LASIGE dependable and secure decentralized systems

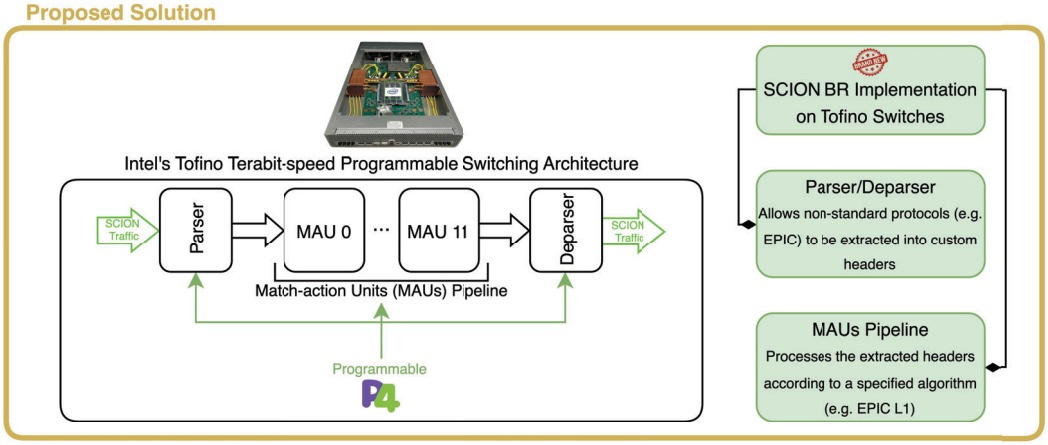
Context and Motivation



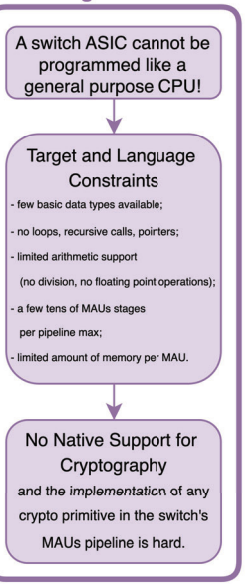
Problem



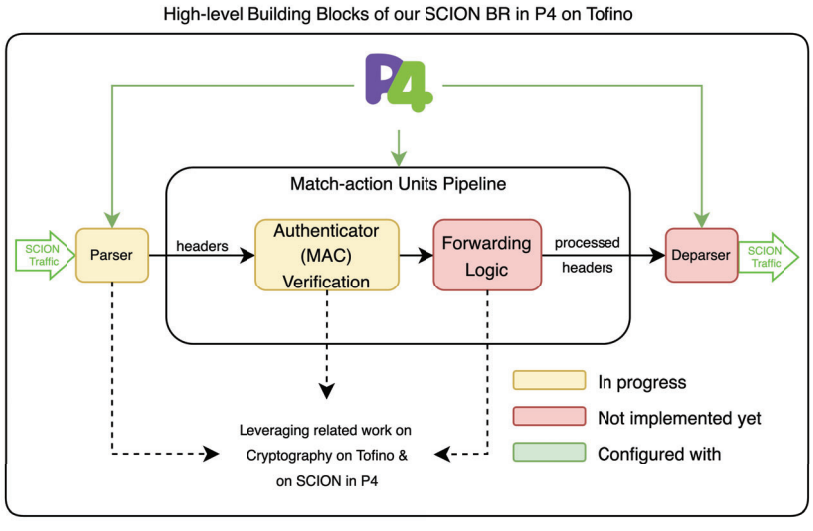
Proposed Solution



Challenges



Implementation



Cryptography on Tofino
Algorithms with 16-Byte input

Algorithm	Max. MAC Length (Bytes)	Pipeline Passes (lower is better)
HalfSipHash Yoo et al.	4	3
Chaskey-8	16	2

Acknowledgements: This work was supported by FCT through project Mylanch, ref. 2022.09325.PTDC (https://doi.org/10.54499/2022.09325.PTDC), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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VA|PREVENTION - web application to prevent type 2 diabetes

Henrique Barata, Renato Ramires, Ana Paula Cláudio, Maria Beatriz Carmo, João Balsa da Silva

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE data and systems intelligence

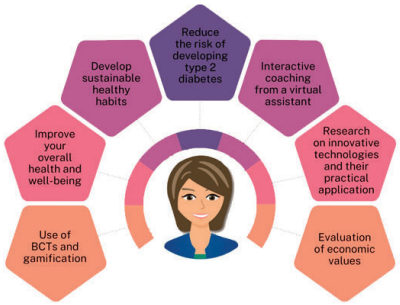
PROBLEM

1 OUT OF 10
people worldwide live with diabetes

4 OUT OF 10
people with diabetes are unaware of it

The number of people with type 2 diabetes is growing all around the world appearing as a big problem nowadays!

OBJECTIVES



WEB APP

1. Informative Quizzes

Designed to educate and instruct individuals about crucial aspects of food and exercise related to preventing type 2 diabetes.

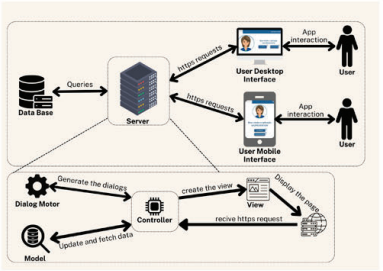
2. Avaliation Phase

Delve deeper into understanding the unique food and exercise habits of individuals. Through comprehensive assessments, we analyze patterns and behaviors to provide tailored recommendations for preventing type 2 diabetes.

3. Follow Up Phase

Involves interactive dialogues with a virtual assistant, guiding users through six essential steps based on Behavior Change Techniques (BCTs)

ARCHITECTURE



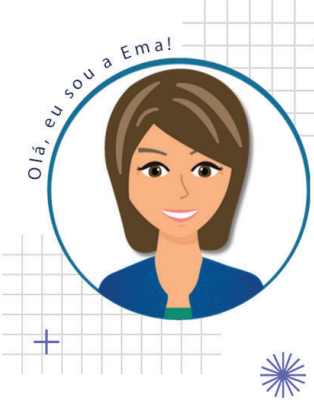
Our web application architecture revolves around seamless user interaction and efficient backend processing. Users access the application via desktop or mobile interfaces, which communicate with our server through HTTPS requests. These requests are handled by the server, which mediates interactions with the database.

On the backend, we employ the Model-View-Controller (MVC) design pattern. This divides our application into three interconnected components: the Model for data and business logic, the View for presentation, and the Controller for managing interactions between the Model and the View.

VA|PREVENTION
DIABETES RESEARCH

Control of type 2 diabetes

VAPREVENTION.ORG



SCAN ME

Acknowledgements: This work was supported by FCT through project VAPREVENTION, ref. 2022.02969.PTDC (https://doi.org/10.54499/2022.02969.PTDC), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020)

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Language embeddings are all you need*

* for complex multi-ontology alignment

Marta C. Silva[1], Daniel Faria[2], Catia Pesquita[1]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
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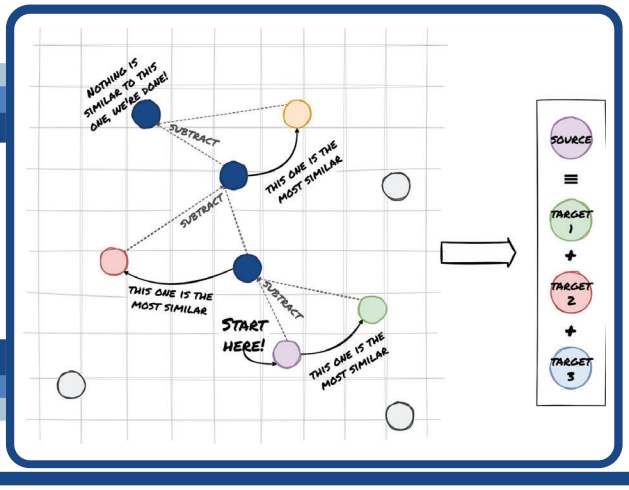
LASIGE health and biomedical informatics

One ontology is not enough!

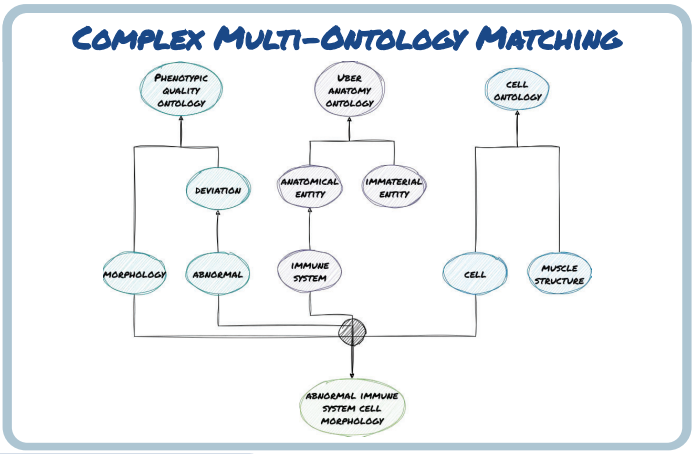
Getting the full picture of a domain requires harmonizing ontologies of different scopes and granularities.

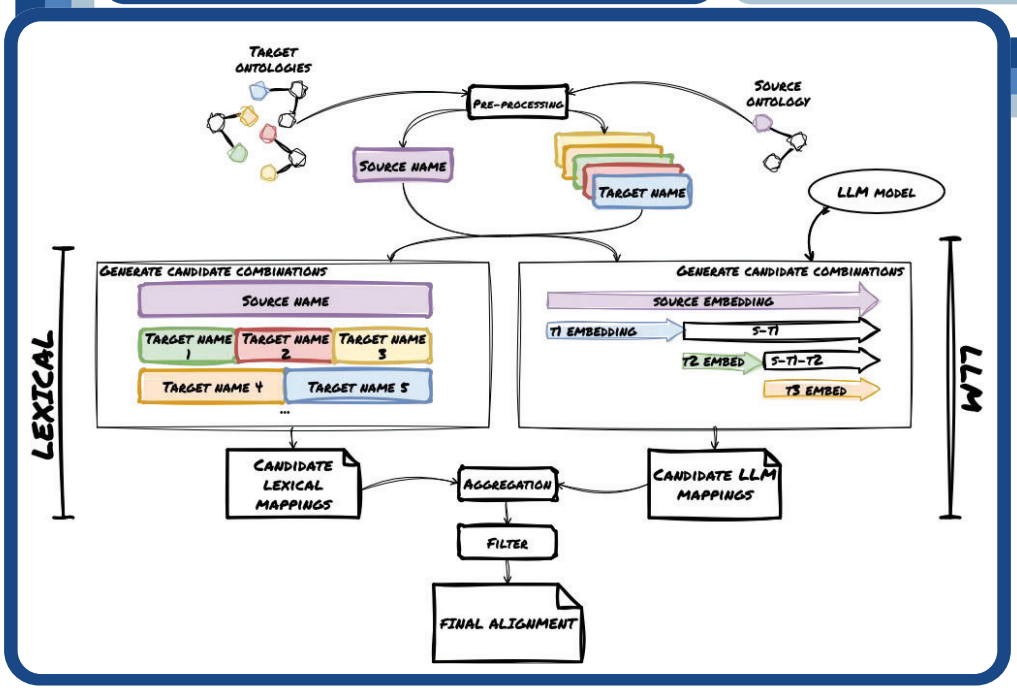
Large Language Models are the solution!

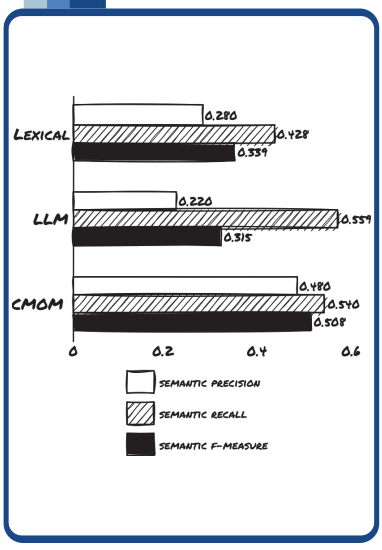


But just multiple ontologies is also not enough!

Purely lexical approaches rely on information being outright stated in the ontology, such as labels and synonyms, and are incapable of representing the semantic relationships between concepts.







Acknowledgements: This work was supported by FCT through the fellowship 2022.11895.BD, and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

The KATY project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017453.

FREESQLI: a SQL Injection Vulnerability Detector Based on Session Types

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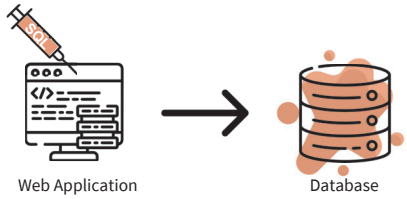
LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

reliable software systems

MOTIVATION

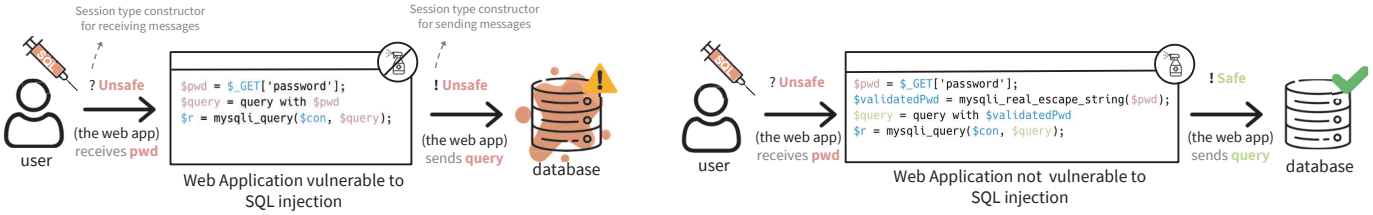
SQL injection vulnerabilities are still very present in web applications. They allow attackers to access and alter the database by injecting **SQL commands** and **metacharacters** in unsanitised entry points.

To prevent this kind of attack, programming languages created mechanisms to validate or sanitise the application input, but they are still **susceptible to human error**. This leads to the need for tools that detect SQL injection vulnerabilities, but despite being extensively researched, they still **produce many false positives and false negatives**.



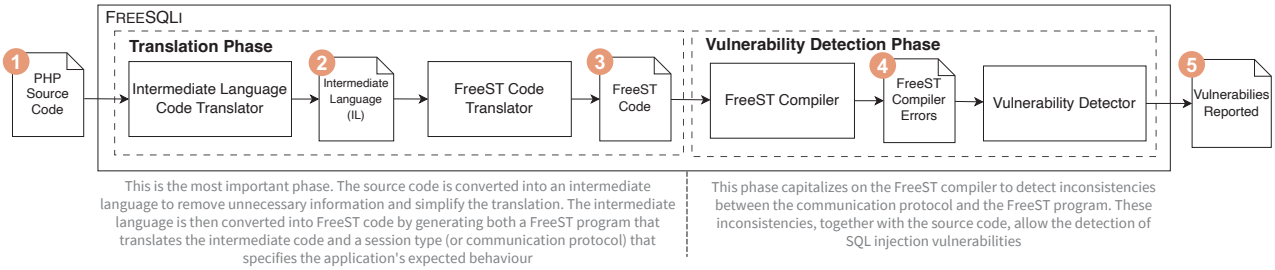
WEB APPLICATION COMMUNICATION

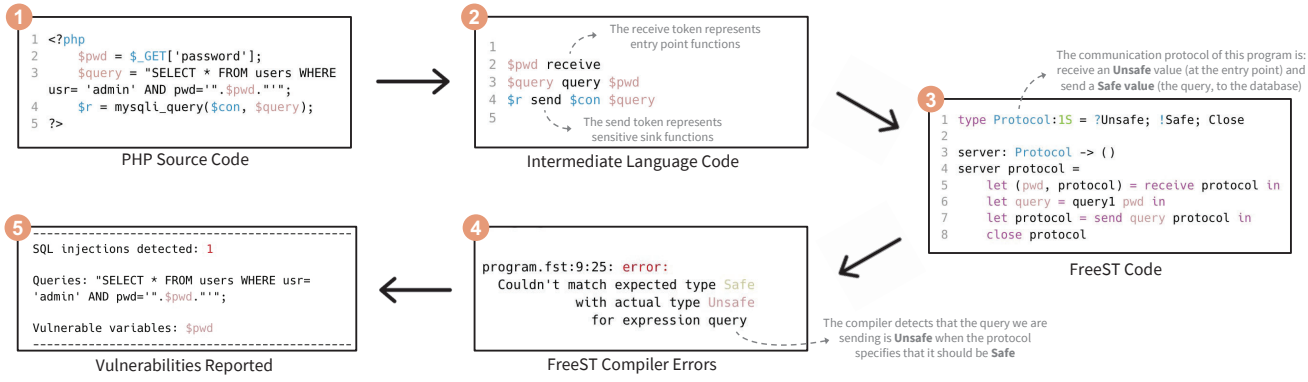
Web applications exchange different messages, such as inputs and queries, with both users and databases. To detect SQL injection vulnerabilities, we propose to **specify the web application behaviour as a communication protocol** based on the exchanged messages. To simplify this specification, **we do not focus on the specific type of messages**. Instead, we focus on keeping track of whether its values are **Safe** (untainted) or **Unsafe** (tainted):



FREESQLI: SQL Injection Vulnerability Detector

FREESQLI is a novel tool to detect SQL injection vulnerabilities, which relies on FreeST, a strongly typed programming language based on session types. FREESQLI looks into a PHP application and identifies points where data communication is vulnerable to SQL injections.





Acknowledgements: This work was supported by FCT through project SafeSessions, ref. PTDC/CCI-COM/6453/2020 (http://doi.org/10.54499/PTDC/CCI-COM/6453/2020), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Boosting graph neural networks with knowledge for personalized medicine

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LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE health and biomedical informatics

Background:

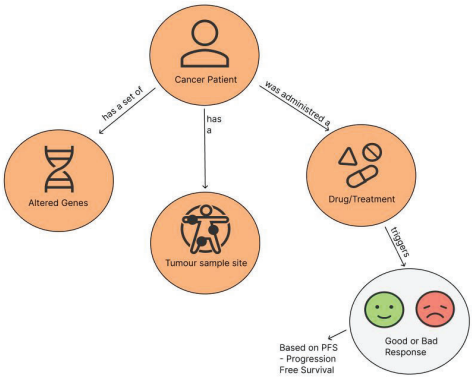
Cancer is one of the leading causes of death around the globe. **Personalized medicine** research has been increasing in popularity in the last years due to advances in technology such as Machine Learning. However, clinical datasets often have a high number of features, requiring complex processing for ML such as feature extraction, and have limited size which is a problem with Deep Learning methods.

Objective:

This work aims to construct a patient-drug response prediction model using **knowledge-infused ML methods** and to explore the underlying **semantics** of the data. To achieve this goal, a baseline approach based on **knowledge graph embeddings** and classical machine learning will be developed and compared with a **GNN-based approach** with Knowledge Graph semantics.

Data:

Number of patients:	Number of genes:	Number of drugs:
1035	18355	4

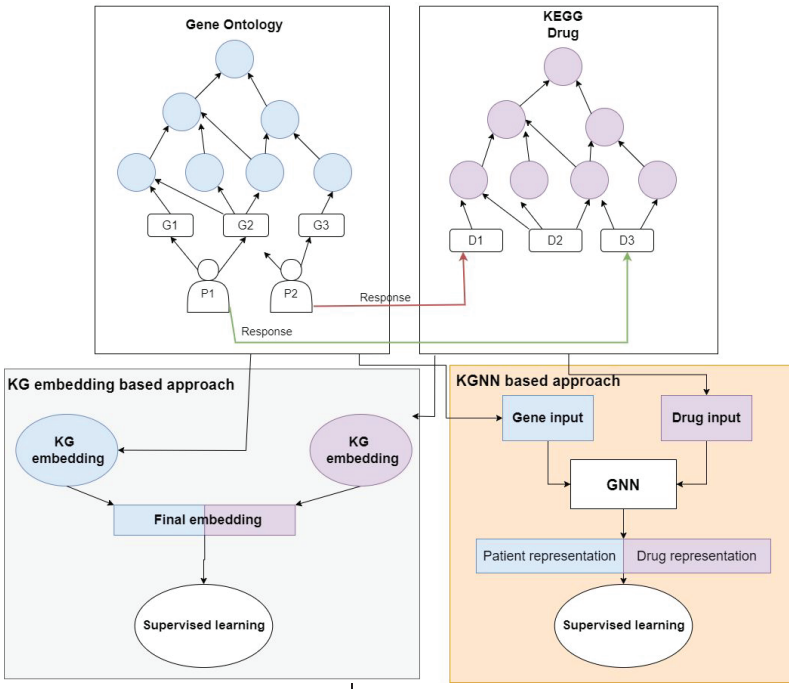


Challenges:

- **Low data size**
- **Unbalanced data**
- **Drug representation**

Methodology:

Patients and drugs are represented through **Knowledge Graph embeddings** according to an **ontology**. With the baseline approach, patients are represented through the concatenation of said embeddings according to their altered genes and the drug administered, this representation then used as input to **supervised learning models**. With the GNN-based approach, a **Knowledge Graph Neural Network** (KGNN) learns entity representations considering high-order structure and semantic relation by aggregating and integrating topological neighbourhood information according to the entity's KG.



Preliminary results:

	WAF	Accuracy	ROC-AUC
Random Forest	0.65	0.68	0.62
Naive Bayes	**0.67**	**0.67**	**0.63**
XGBoost	0.59	0.66	0.58
MLP	0.54	0.66	063

New dataset with cancer cell lines

Future Work

Acknowledgements: This work was supported by the Fundação para a Ciência e a Tecnologia (FCT) through the LASIGE Research Unit, ref. UIDB/00408/2020 and ref. UIDP/00408/2020. It was also supported by the KATY project which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101017453.

Machine Learning for Attack Tracking in Cyber-Physical Honeynets

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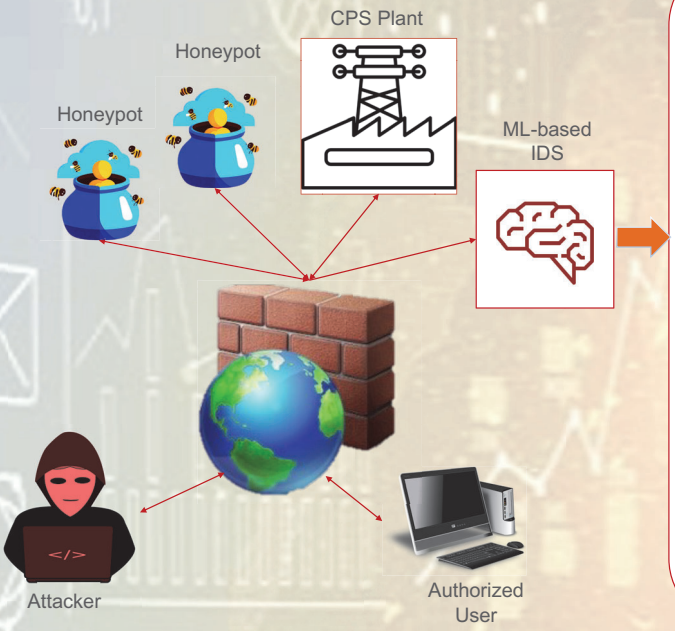
LASIGE cyber-physical systems

Objectives

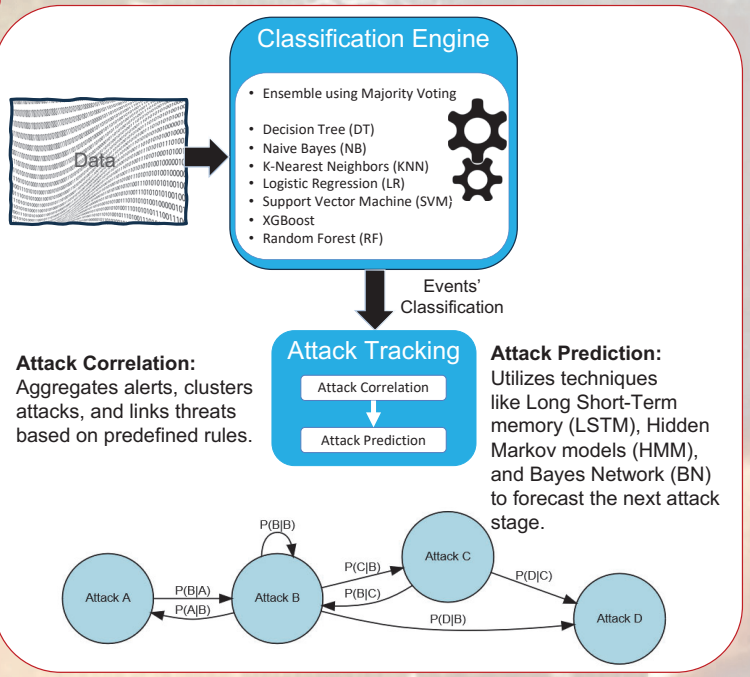
Develop an accurate and efficient ML-based Intrusion Detection System (IDS) to detect and classify diverse types of attacks on Cyber-physical Systems (CPS) using ensembles.

Prediction of attack actions within an attack chain in CPS environments.



ML-based Intrusion Detection System

- **Classification Engine**: receives the pre-processed network connection data. This block is composed of an ensemble and outputs the attack classification.
- **Attack Tracking:** Comprising Attack Correlation and Attack Prediction models. The Attack Correlation determines if a correlation exists between the attack events received from the Classification block. If a correlation exists, this information is passed to the Attack Prediction model, which determines the attacker's next step associated with a certain probability.



Preliminary Results

class	DT	KNN	SVM	LR	NB	RF	XGB
Normal	97.08	96.77	95.07	96.09	42.95	98.09	98.2
RDOS	99.95	99.95	99.87	99.9	98.74	99.96	99.96
Scanning vulnerability	98.61	99.3	80.34	86.32	58.02	99.59	99.7
Generic scanning	98.96	99.26	90.17	90.4	76.15	99.45	99.57
Brute Force	99.83	99.64	98.8	97.98	89.5	99.97	99.96
MQTT cloud broker subscription	90.25	89.39	82.18	85.56	53.08	94.64	96
Discovering Resources	87.09	88.61	65.27	68.52	22.87	91.14	83.98
Exfiltration	96.38	94.5	95.1	91.94	74.04	97.8	98.56
Insider Malcious	95.75	88.96	96.17	93.03	72.91	98.2	98.43
Modbus Register Reading	82.61	87.88	88.97	89.81	1.75	90.86	91.37
False Data Injection	56.75	23.73	81.6	75.4	4.63	56.21	76.03
Command and Control	69.97	72.07	71.59	53.06	16.07	70.79	78.15
Dictionary	86.05	85.03	66.67	22.93	6.62	90.72	96.25
TCP Relay	47.43	45.81	14.37	46.71	4.6	49.03	67.51
Fuzzing	36.33	52.11	0	2.88	3.97	55.34	59.22
Reverse shell	61.86	65.36	38.06	77.25	5.63	65.56	84.68
Crypto Ransomware	92.05	95.6	86.49	79.27	19.44	96.59	97.18

F1-score for 16 classes

class	DT	KNN	SVM	LR	NB	RF	XGB
Normal	96.95	96.72	93.65	94.62	65.86	97.98	97.91
Reconnaissance	95.79	96.84	81.67	85.27	55.47	97.32	95.69
Weaponization	98.35	96.43	94.96	92.04	60.59	99.27	99.28
Exploitation	63.9	61.49	30.77	78.11	4.52	63.3	79.42
Lateral Movement	85.76	86.94	76.54	81.51	17.87	92.17	92.6
Comand and Control	69.63	71.59	69.25	55.51	14.53	72.18	78.44
Exfiltration	96.44	93.93	95.21	90.72	50.33	97.65	98.32
Tampering	53.27	21.36	80.21	76.65	5.77	52.08	76.03
Crypto-ransomware	83.98	91.21	73.12	70.59	13.9	97.75	97.21
RDOS	99.94	99.93	99.82	99.87	98.81	99.97	99.97

F1-score for 10 classes

Each ML technique predicts a specific attack class well, but no single technique performs well for all classes.

A more robust approach is needed to improve the coverage of the classification engine.

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (*https://doi.org/10.54499/UIDB/00408/2020*) and ref. UIDP/00408/2020 (*https://doi.org/10.54499/UIDP/00408/2020*).

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Reconfigurable and Scalable Honeynet for Cyber-Physical Systems

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LASIGE cyber-physical systems

Motivation

- The number of attacks on cyber-physical systems (CPS) is growing
- Honeynets can be used to fool attackers into thinking they are attacking actual infrastructure and, at the same time, monitor their activities
- The challenge is to produce a honeynet platform that is scalable and reconfigurable, which can be easily used to instantiate different CPS architectures and evaluate attacker behaviours

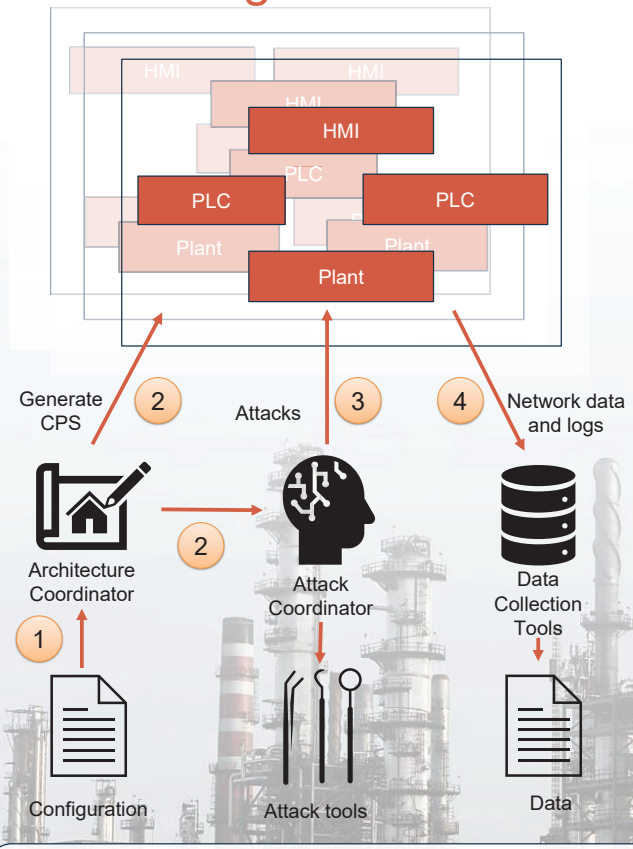
Objectives

O1 - Develop a cyber-physical honeynet capable of being scalable and reconfigurable

O2 - Produce an automatic attack generation tool to validate and test the honeynet

O3 - Using the results obtained in O1 and O2, create datasets for ML-based IDSs in cyber-physical honeynets.

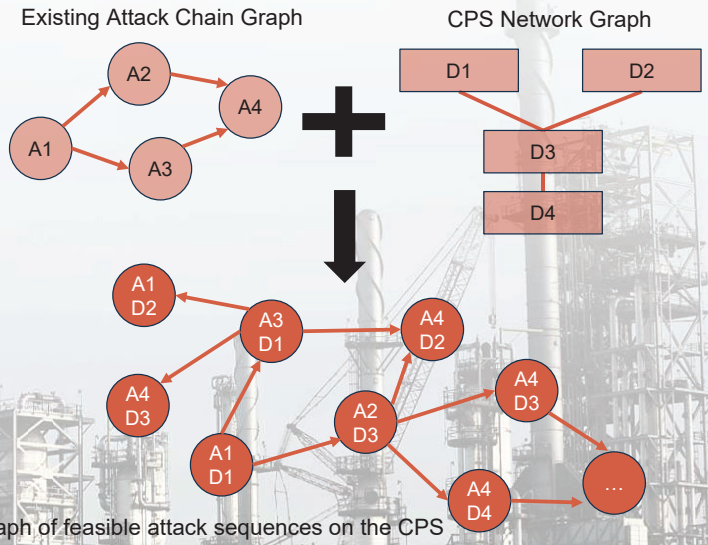
Scalable and reconfigurable CPS



Attack Generation Model

The Attack Coordinator generates orchestrated attack combining information from two:

- Existing Attack Chain Graphs: represent known attack sequences that can be performed in real-world CPSs.
- CPS Network Graph: represents the architecture of the instantiated CPS, including information about its network links, protocols, and services running in each of its components.



A scalable and reconfigurable CPS based on virtual devices.

A Coordinator responsible for the generation and instantiation of CPSs and an Attack Module responsible for autonomously executing different attack sequences.

A Data Collection module that captures all the information about the attacks executed in the CPS.

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (*https://doi.org/10.54499/UIDB/00408/2020*) and ref. UIDP/00408/2020 (*https://doi.org/10.54499/UIDP/00408/2020*).

Full Polymorphism in Context-Free Session Types

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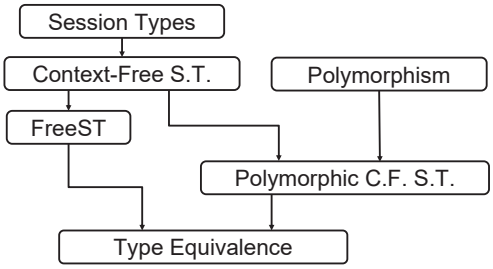
reliable software systems

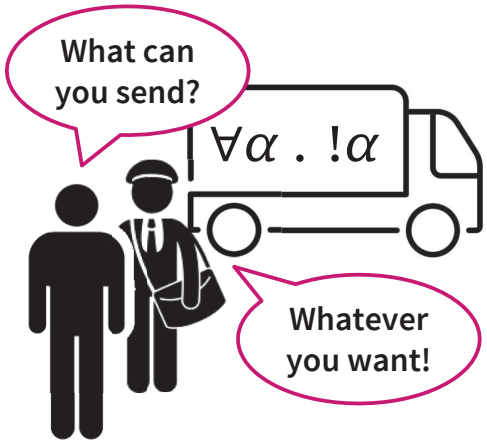
Context-free session types allow syntactic validation of communication protocols. These offer an extension over regular session types in making it possible to have nested protocols. With the introduction of polymorphism in the language of context-free session types, the addition of abstraction over types takes expressiveness a step further.

This project focuses on extending context-free session types to full polymorphism with the design of a novel type equivalence system, based on canonical renaming and conversion of types to simple grammars, to be implemented in the FreeST language.



Polymorphism in Session-Types

With polymorphic session-types, communication protocols can be parameterized with the types of the messages and channels they are working with. This enables the programmer to abstract over operations that send or receive data, without being tied to having a different implementation for each supported type.



Check out FreeST @ freest-lang.github.io

Example: Sending a Polymorphic Tree

Taking advantage of polymorphic context-free session-types, a session type to send a Tree with nodes of any type can be defined as:

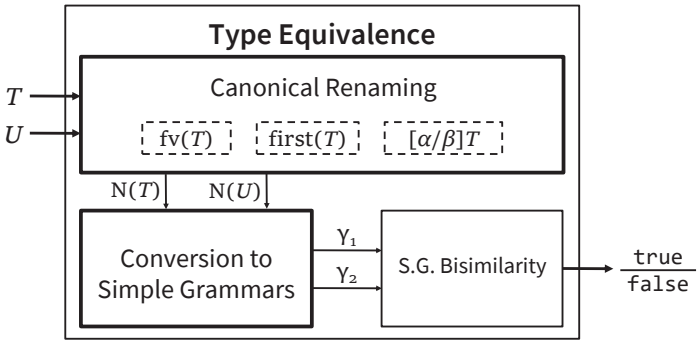
$$\forall \alpha{:}T \,.\, \mu X \,.\, \oplus\{\text{Node: } X;!\alpha;X,\ \text{Leaf: Skip}\}$$

Type Equivalence

One big step for achieving full polymorphism in context-free session types in FreeST, is to implement a type equivalence system. As such, the scope of this project includes:

1. Defining and implementing a canonical renaming system for FreeST's type system.
   The idea behind canonical renaming $N(T)$, is to rename type $\forall \alpha{:}\kappa \,.\, T$ into the c-type $\alpha_i \forall_\kappa T_o$, where α_i is chosen in a 'canonically' (i.e., the smallest choice possible) and T_o is the renaming of $[\alpha_i/\alpha]T$.

2. Defining algorithms for type equivalence based on the conversion of types into simple grammars.



Example: High-Performance Server

A server that receives a computation and returns the result of said computation could be implemented as:

high-performance-server.fst

```
type HPServer = forall a:T . ?(() 1-> a) ; !a ; Close

server : HPServer -> ()
server c = let (a, c) = receiveType c in
           let (comp, c) = receive c in
           fork (\_ 1-> send (comp()) c) |> close)
```

Acknowledgements: This work was supported by FCT through project SafeSessions, ref. PTDC/CCI-COM/6453/2020 (https://doi.org/10.54499/PTDC/CCI-COM/6453/2020), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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GDHelper: Tools to help the Diagnosis of Gaming Disorder

Daniela Jorge[1], Ana Paula Afonso[1], Manuel J. Fonseca[1], Joana Cardoso[2]

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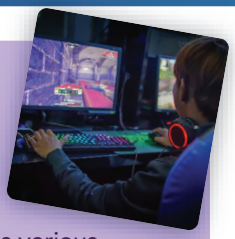
[2] Center for Psychology at the University of Porto, Porto, Portugal

LASIGE health and biomedical informatics

Motivation



Video games are globally popular across various demographics. Though they have benefits, concerns like **Internet Gaming Disorder** (IGD) exist, marked by uncontrollable gaming and neglect of other activities. Health organizations recognize IGD, but current diagnostics, mainly self-report questionnaires, are flawed due to biased recall and inaccurate reflection of gaming behavior.

Objective

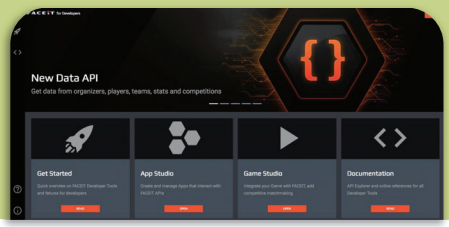
Develop an **interactive web application** for healthcare professionals to enter a gamer's nickname and get metrics and visuals, such as play hours, session frequency, and match count, from Counter-Strike data, online platform telemetry, and gamer's emotional state from video during play. This tracks gaming behavior over time to spot possible IGD patterns.

Methodology

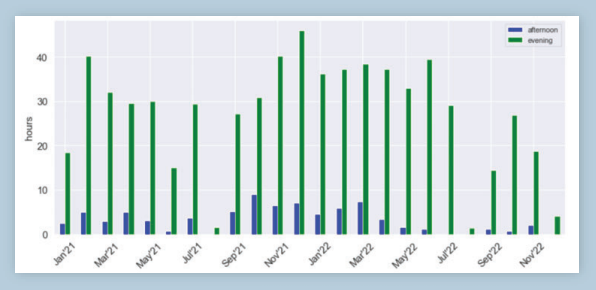
- Data Collection
- Iterative Design and Development
- Testing
- User Feedback

Data Collection

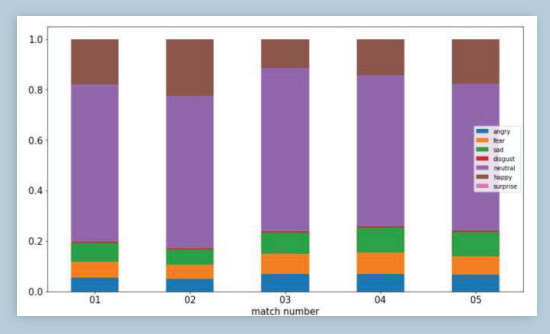
Telemetry data for CS2 gamers and matches is sourced from the **FACEIT API** and **demofiles**, aiding in the identification of IGD-related patterns and behaviors for health professionals. The emotions videos will be recorded in sessions provided by the gamers.



Metrics and Visualizations



Participant monthly hours during afternoon and evening.



Participant average emotion felt by match

Analyzing FACEIT gaming data involves defining **metrics** such as total games and sessions per player to capture **relevant gaming behavior**. The first chart displays a gamer's playing hours per month. Twitch provided live-streaming video for emotion analysis. The second chart displays a gamer's emotions across five matches in a session, offering an overview without capturing sudden emotional shifts during gameplay.

Acknowledgements: This work was supported by the Fundação para a Ciência e a Tecnologia (FCT) under LASIGE Strategic Project UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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LET'S AGREE TO DISAGREE

Neuro-Symbolic AI for conflict-aware learning over Knowledge Graphs

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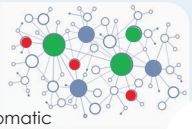
LASIGE health and biomedical informatics

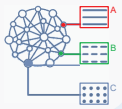
Background

Knowledge Graphs (KG) confer a semantic description to real-world entities and the relationships between them.



Large KGs are commonly built though automatic information extraction methods or through crowd-sourcing.

These methods commonly integrate data from different sources, which can introduce inaccurate and/or **conflicting** information.



KG-based **Machine Learning** (ML) methods can perform prediction tasks over KG data, requiring the encoding of the KG's components into low-dimensional representations, whether this is obtained through KG Embedding methods or through its own model representations (GNNs, ...).

Neuro-Symbolic AI refers to the field of AI that seeks to combine symbolic AI methods and neural networks to address their individual limitations.

Conflict-aware machine learning methods can identify and address contradictions within the data they are trained on.

contextual layer

e.g. conflicting facts

< Jerusalem (Q1218), capital of , Israel (Q801) >

< Jerusalem (Q1218), capital of , State of Palestine (Q219060) >
retrieved from Wikidata

< preferred by > < United Nations (Q1065) >

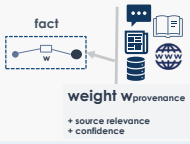
< disputed by > < United States of America (Q30) >
< Israel (Q801) >

Conflict-detection refers to the process of identifying and addressing conflicts, controversies and inconsistencies.

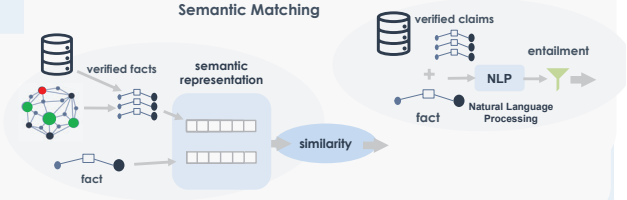
Human-in-the-loop

Reasoning

Probabilistic



Semantic Matching



Motivation

KGs add a semantic data layer that provides a structure for data to be processed by machine learning methods.

Most ML assume KGs to be deterministic despite modeling uncertain knowledge and contradictions explicitly → fail to properly handle and represent such conflicts.

HYPOTHESIS

Development of novel neuro-symbolic (NeSy) AI approach able to properly exploit conflicting knowledge on KG entities when learning their representations to enhance a model's predictions.

Objectives

- Development of a symbolic method to detect contradicting facts even when not logically detectable;
- Development of a mechanism to modulate the representation of a KG entity involved in contradictory statements;
- Investigation of the inclusion of facts' relevance scores according to their provenance.

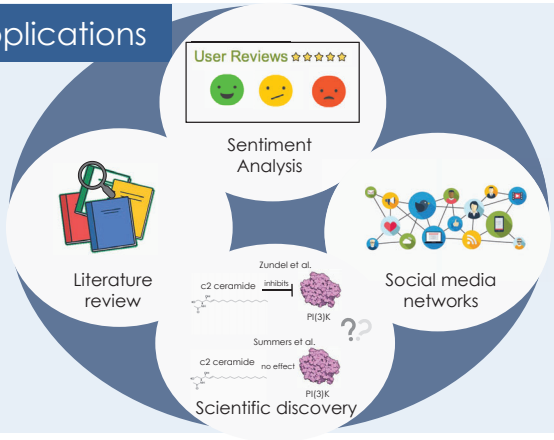
Research Questions

- What is the impact of contradictions in the performance, robustness, reliability and transparency of state-of-the-art KG-based machine learning?
- Does explicitly modeling contradiction improve ML performance over KGs with contradictory facts?
- Can external sources of knowledge be explored to detect **tacit contradictions**?

Ask me about this!

- Does assigning a relevance score to facts according to their provenance improve the handling of contradictory facts by NeSy methods as reflected by predictive performance and usefulness?

Applications



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Exploring Fairness in Asymmetric Competitive Gaming For Mixed-Visual-Ability Pairs

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LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

LASIGE inclusive human--computer interaction

Games often overlook disabilities, rendering them **inaccessible** to a big portion of the population.

For blind players, this typically results in a **segregated** community based on visual ability.

LEVERAGING ASYMMETRY

Asymmetry has created engaging cooperative mixed-ability games.
However, for competitive mixed-ability games, asymmetry raises concerns about **fairness** and **balance**.

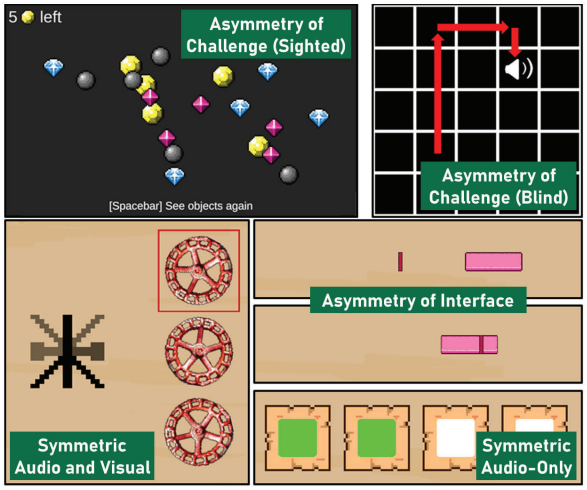
We explored how to create a **fair** and **engaging** mixed-visual-ability competitive game by leveraging:

- Asymmetry of Interface - refers to how players engage with the game, i.e., input and output
- Asymmetry of Challenge - players face different challenges/obstacles

OUR TESTBED GAME

We developed a testbed game to explore mixed-ability competition and different asymmetric design approaches.

	Symmetric Audio-Only	Symmetric Audio and Visual	Asymmetry of Interface	Asymmetry of Challenge
Challenge	=	=	=	≠
Interface	=	=	≠	≠
	audiogame	only sighted can leverage the visual feedback	visual-only or audio-only feedback	



A race between magical chefs: **navigate** to gather ingredients, utilize cooking **stations** (i.e., moments of a/symmetric play), and fulfill **orders**.

USER STUDY

6 Sighted vs 4 Blind

Questionnaires + Interviews

We focused on players' perceptions of **fairness** and **engagement**.

1. Engage in an online 1v1 competition without knowing opponents' visual abilities.
2. Exposed to the opponent's mechanics and informed of their visual abilities.
3. Reflected on competitive mixed-ability asymmetric game design.

FINDINGS

- Asymmetry of Challenge considered **fair** and **engaging** by all.
- Symmetric Audio-Only rated fair but lacked engagement for sighted players.
- Some sighted felt **guilt** upon learning opponents' visual abilities.

Acknowledgements: This work was supported by FCT through project "Playfem", ref. 2022.00088.PTDC (http://doi.org/10.54499/2022.00088.PTDC), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Virtual and Distributed Hardware Security Module for Secure Key Management

Diogo Novo[1], Alysson Bessani[1] , Bernardo Ferreira[1]

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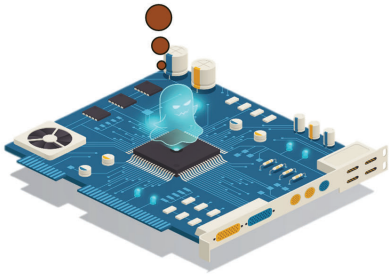
LASIGE dependable and secure decentralized systems

PROBLEM

What is an HSM?

A Hardware Security Module (or HSM) is a dedicated physical device that is specialized in **safeguarding the protection of cryptographic keys** during their whole life-cycle and **performing major cryptographic operations** (including key generation, signatures and encryption).

Why not simply use physical HSMs?

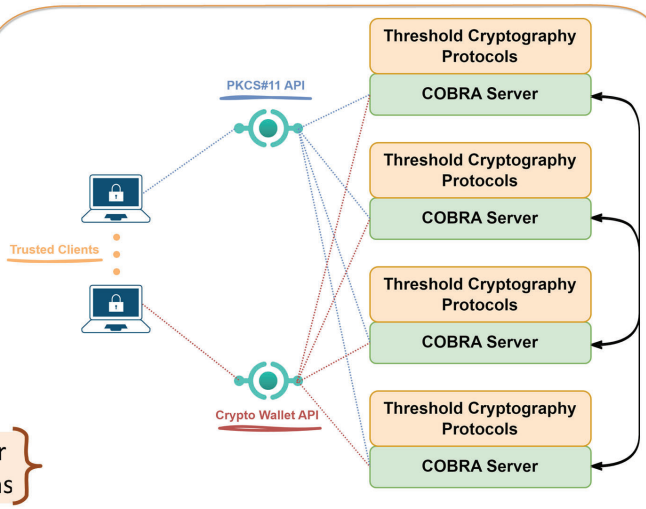


- **Costly** and often impractical for smaller companies
- Difficult to **secure at large scale**
- Offer **limited flexibility** in supported operations
- Difficult to **deploy and use**

Can we build a software-only HSM with the same level of security as hardware-based HSMs?

OBJECTIVES

- Achieve high levels of **availability, integrity,** and **confidentiality**
- Implement **efficient and secure protocols** for the main cryptographic operations
- Distributed protocols for the operations of **key generation, signatures**, and **encryption**
- Implement the PKCS#11 API and a Crypto Wallet API



SOLUTION

- **Virtual** and **distributed** HSM (only using software)
- **Threshold cryptography** for the cryptographic operations
- **Byzantine Fault-Tolerant State Machine Replication system**, namely **COBRA**, to implement fault-tolerant mechanisms, and to coordinate and maintain the state between replicas

What is COBRA?

It's a protocol stack based on **dynamic proactive secret sharing** for implementing **confidentiality** in practical BFT SMR systems.

Threshold Cryptography Protocols Implementation

Distributed Key Generation (DKG)	Leverage **COBRA's DKG**, which allows a group of servers to collectively create a random polynomial *P*, where the point *P(0)* will be the secret/private key
Distributed Signatures and Encryption/Decryption	Leverage efficient threshold protocols, where the **servers produce and send partial results to the client**, who then **aggregates them into the final result** (i.e. a signature or an encryption/decryption)

Acknowledgements: This work was supported by FCT through project SMaRtChain, ref. 2022.06431.PTDC (https://doi.org/10.54499/2022.06431.PTDC), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Program Synthesis with Refinement-Typed Genetic Programming

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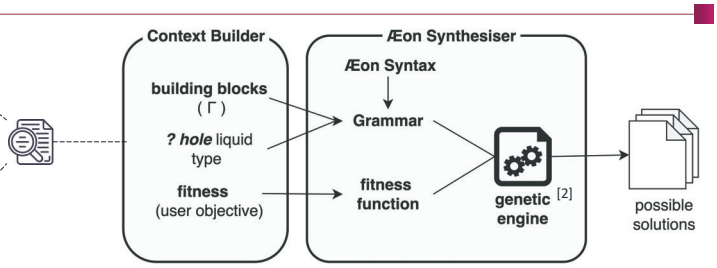
LASIGE reliable software systems

Introduction

Program Synthesis transforms high-level specifications into code, simplifying software development. Despite its potential, the enormous search space for solutions presents a significant challenge. This work developed Æon[1], a programming language to narrow down the search space with Refinement-Typed Genetic Programming (RTGP), automating the process of writing type-safe code, something that is not guaranteed with LLMs.

Program Synthesis flow in Æon

```
1 @ensures(isSubset toBuy ps)
2 @maximize(len toBuy)
3 def knapsack (ps : List[Int] | len ps >= 1)
4              (balance : Int | balance > 0) :
5              (toBuy : List[Int] |
6                  balance >= sum toBuy) {
7     ?hole : List[Int]
8     }
```



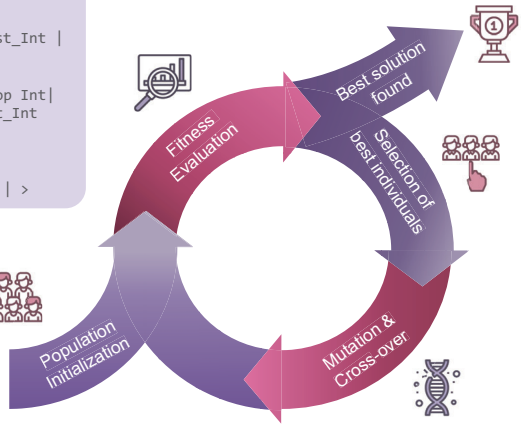
The Æon Language

- Designed for program synthesis with RTGP
- Translates to ÆonCore featuring liquid type checking
- Features lambda functions, type definition and native functions
- Allows users to express intent through function refinements
- Distinguishes Hard and Soft refinements:
  - Hard refinements are statically verifiable using an SMT Solver
  - Soft refinements require runtime verification

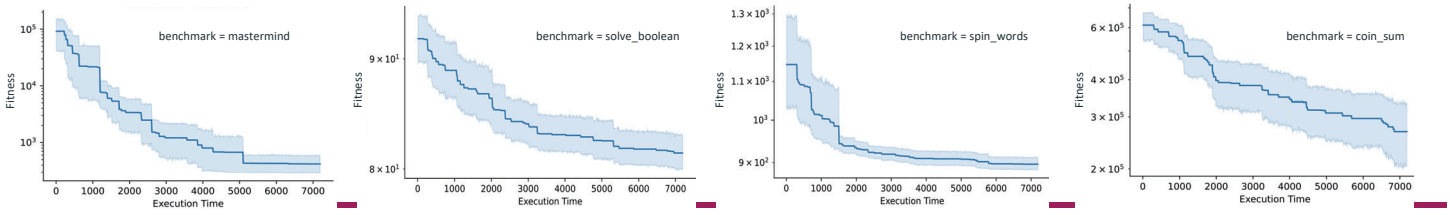
Solution Search (genetic engine)

BNF Grammar:

```
List ::= List_new | List_add List Int |
         List_remove Int | var_ps

Int  ::= value | Int op Int |
         len List_Int | sum List_Int |
         var_balance

Bool ::= True | False | Int l_op Int|
         isSubset List_Int List_Int

op   ::=  + | - | * | / |

l_op ::= != | == | >= | >= | < | >
```



Preliminary Evaluation (minimizing fitness)



References [1] https://github.com/alcides/aeon
[2] https://github.com/alcides/GeneticEngine

Acknowledgements: This work was supported by the Fundação para a Ciência e a Tecnologia (FCT) in the LASIGE Research Unit under the ref (UIDB/00408/2020 UIDP/00408/2020 and UI/BD/151179/2021), and the RAP project under the reference (EXPL/CCI-COM/1306/2021).

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Learning with uncertainty: improving supervised learning of protein-protein interactions with lower quality examples

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LASIGE health and biomedical informatics

PPI Prediction Problem

PPI data gathering

Direct Assay Methods
- Time-consuming
- Expensive
- Reliable

The use of uncertainty is crucial to have a better prediction model

Indirect Assay Methods
- Fast
- Cheap
- **Uncertain**

Machine learning models use data from these methods to predict PPI

Machine Learning

Possible solutions:
1. Application of uncertainty into the ML model
2. Filtering the data based on the confidence score

Negative samples

Most **PPI databases just have positive labels**, so there is a need to generate negative samples, but is it possible to use the confidence score to generate them?

Predict PPI

Research Questions

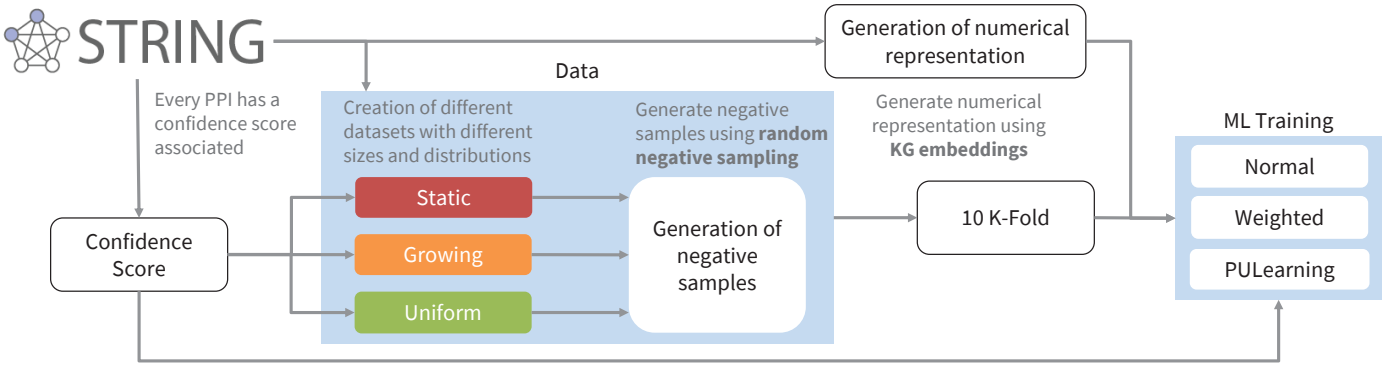
RQ1: What are the strategies that can be applied to **handle label uncertainty**?
RQ2: How is it possible to **generate negative samples** based on uncertain labels?

Goal: Investigate how the application of label uncertainty in machine learning can help predict PPI

Data

For the PPI data, the STRING DB is utilized, where different distributions and sizes are applied throughout the thresholds:
- **Static**: The same size for every threshold applied
- **Growing**: The size of the dataset grows for each threshold with the same distribution as the whole dataset
- **Uniform**: The size of the dataset grows for every threshold with a uniform distribution

Methodology



Results

	Normal			PU			Weighted		
	Growing	Uniform	Static	Growing	Uniform	Static	Growing	Uniform	Static
800	0,87018	0,85535	0,85535	0,79595	0,87653	0,87587	0,86969	0,84552	0,84552
600	0,84633	**0,94189**	0,88929	0,74592	0,89577	0,82778	0,84367	**0,94403**	0,88994
400	0,80177	0,89207	0,81455	0,65474	0,83107	0,68814	0,80191	0,89392	0,81696
200	0,73767	0,84001	0,71963	0,52762	0,74260	0,49432	0,73733	0,84184	0,72099
0	0,71399	**0,80054**	0,68879	0,48682	0,67952	0,45142	0,71093	**0,80120**	0,68558

Table 2: The median of the 10 Weighted average of f1-scores obtained with the methodology, using the Random Forest Classifier

To answer RQ1 , we can see through the results that working with **higher confidence** data generates a better prediction model, be it by threshold and distribution of the data, but the use of **weighted** ML model does not affect the performance.

Future Work

- Apply the methodology to different datasets
- Apply different strategies to generate the negative samples

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020). It was also partially supported by the KATY project which has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101017453.

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Creation of a Predictive Model of Malaria Outcome

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LASIGE health and biomedical informatics

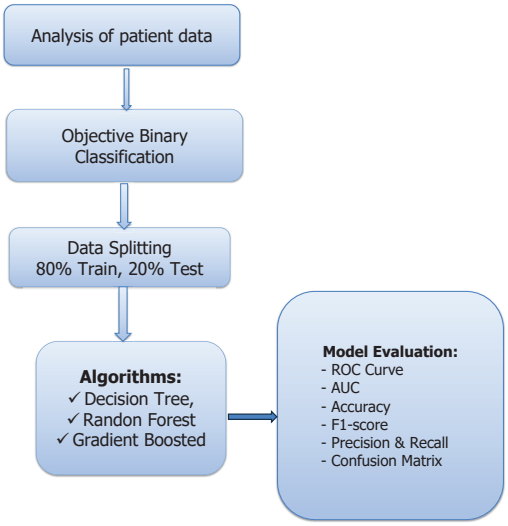
Motivation

Malaria is prevalent in Angola, with high mortality due to the lack of effective treatments. Variation in the severity of symptoms and response to treatment makes it difficult to predict outcomes. The lack of adequate healthcare resources worsens the situation. Developing a predictive model can improve early identification of at-risk patients, improving disease management.

Goal

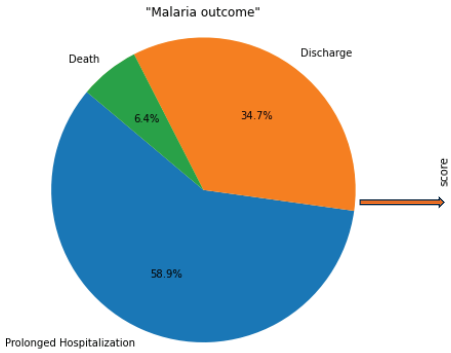
The goal is to develop a predictive model to anticipate and predict malaria outcomes based on various clinical, epidemiological, and demographic variables.

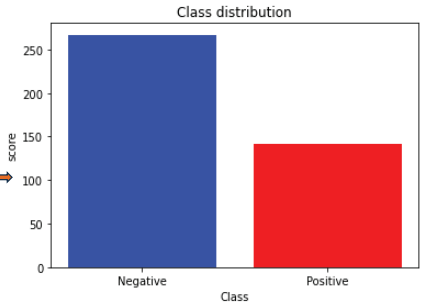
Preliminary Methodology



Data Analysis

The dataset consists of information from 410 patients, with the dependent variable "outcome" having three categories: "Discharge", "Death" and "Prolonged hospitalization". A new dataset was created for binary classification, combining the variables "hospitalization" and "death". Two main classes were defined: "Positive outcome" (Discharge) and "Negative outcomes" (Hospitalization and Death).

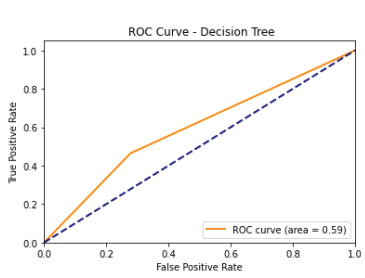


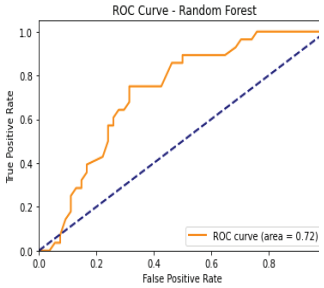


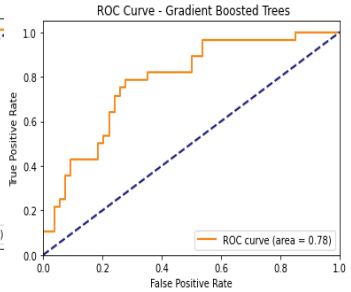
Preliminary Results

After processing the data and implementing the Decision Tree, Random Forest, and gradient-boosted trees algorithms, the results highlight that the Gradient Boosted Trees model presented greater accuracy and F1 score. This indicates its effectiveness in classifying patients compared to Decision Tree and Random Forest models.

Model	Accuracy	F1-score by classes	Precision by Classes
Random Forest	0.6585365853658537	Positve:0.75 Negative:0.4615384615	Positve:0.72413793 Negative:0.5
Gradient Boosted Trees	0.6951219512195121	Positve:0.7826087 Negative:0.4897959592	Positve:0.73770492 Negative:0.57142857
Decision Tree	0.6341463414634146	Positve:0.722222 Negative:0.4642857571	Positve:0.72222222 Negative:0.46428571







Acknowledgements: This work was supported by FCT through project <title>, ref \, <project reference> (<project DOI>), and the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Enhancing Emotional Awareness & Regulation in Movies & Music Based on Personality

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LASIGE health and biomedical informatics

MOTIVATION

Music and movies have an undeniable ability to evoke profound emotions in their audiences. However, despite their widespread accessibility enabled by technology, the emotional impact of these mediums often goes overlooked and lacks adequate support. To address this gap, this project introduces advancements through the **integration of emotional regulation techniques** and **personalized recommendations tailored to individual user personalities.**

RELATED WORK

Understanding emotions involves recognizing their complexity, which can be both dimensional and categorical. To grasp these intricacies, **Information Visualization Techniques** are employed to identify trends, patterns, and progress in emotional responses. Leveraging **Affective and Positive Computing Methodologies**, the focus is on enhancing overall **Wellbeing**. Through recommendation systems tailored to individual user preferences, personalized experiences are crafted, facilitated by the principles of **Personality Computing.**

CONCLUSIONS

This paper has **introduced novel mechanisms aimed at fostering emotional awareness and regulation within the realms of movies and music**, all grounded in the intricacies of individual personality traits. Through the extension of existing features within the framework of a research project, our findings can offer valuable contributions to the ongoing discourse surrounding the intersection of emotions, media, and individual characteristics.

FUTURE WORK

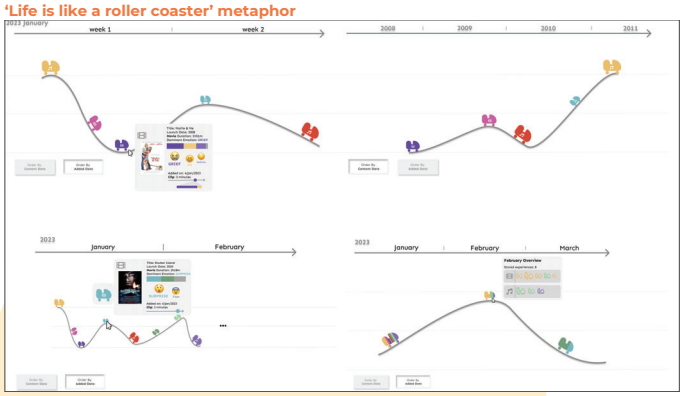
Focus on the **refinement**, **evaluation**, and **development** of key features within our research framework.

Exploring various perspectives:

- **Automatic assessment of personality** using sensor data and users contents preferences;
- **Balancing hedonic and eudaimonic emotions** to increase and sustain **wellbeing.**

Learn More — Published Article IMX'23

'Life is like a roller coaster' metaphor



Capture, Observe, and Track Emotionally Impactful **Movie and Music Experiences** Over Time Continuously

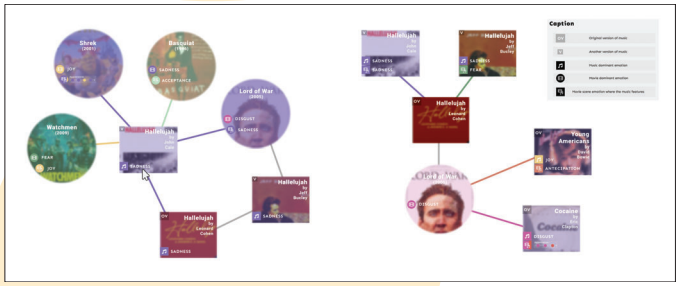
Track represents time (X-axis), **Carriages represents content experiences** and are defined and placed over the track according to:

- **Valence** (Y-axis, color)
- **Type of content** (icon)
- **Percentage of dominant emotion** (size)

Order, Search, Filter Content by:

- **Date,**
- **Title,**
- **Dominant Emotion,**
- **User Emotion**
- (among others)

COLLECTING & REVISITING

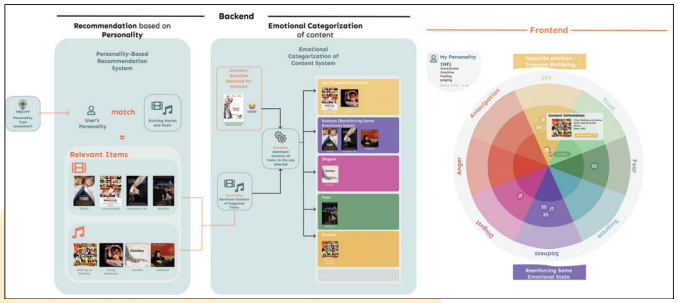


Analyze the **Emotional Impact of Music within Films**

Compare Various Songs across different Cinematic Moments and Movies

Explore the **Emotional Relation between Songs - Versions - Movies**

MUSIC IN MOVIES



Opportunity for **Emotional State Regulation in Content Recommendations**

Access **User Personality Information**

Framework of Two Systems: **Recommendation (with Emotional Categorization)** and **Display**

AFFECTIVE RECOMMENDATION

Acknowledgements: This work was partially supported by Fundação para a Ciência e a Tecnologia (FCT) under LASIGE Strategic Project UIDB/00408/2020 and UIDP/00408/2020, and the FCT grant PTDC/CCI/ 29234/2017 funding the AWESOME Project.

Client and Optimized Hotspot Placement in Drone Based Ad hoc Networks

Ricardo Gonçalves, Alan Oliveira, Luís Pinto

LASIGE cyber-physical systems

Motivation

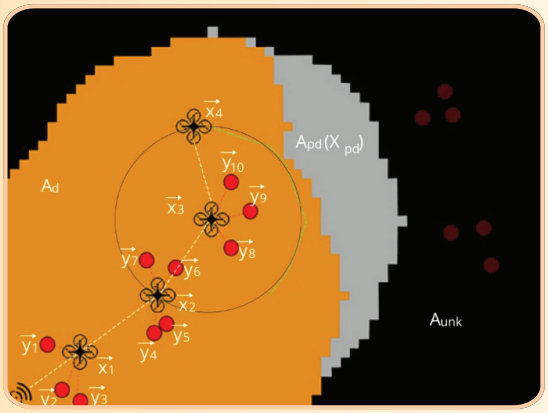
In natural disasters, drones offer a quick and efficient solution for setting up communication networks, aiding in reaching affected clients

Challenges

Challenges include the efficient exploration of uncharted territories in search of clients with communication needs, and finding optimal landing positions while ensuring continuous drone connectivity to the base station

Goal

The end-goal is to establish an emergency communication network within a given Area of Interest (AoI)



- Drones equipped with wireless access points establish connections with clients using WiFi technology within their radio frequency (RF) range
- Ground clients are active and willing to engage with drones
- Drones can create ad-hoc connections among themselves using WiFi, forming a multi-hop ad-hoc network
- Establish an emergency communication network within a designated Area of Interest (AoI)
- Identify all clients and provide them networking service

Exploration

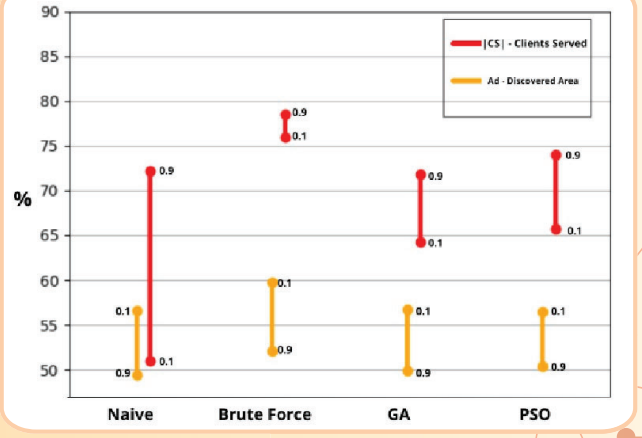
- Maximizing coverage of unexplored areas within the AoI while maintaining a connection to the currently deployed network
- Identifying all clients present in the designated exploration area

Positioning

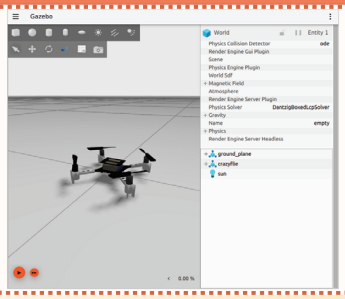
- Drones have the flexibility to land at any location within the AoI, with no obstacles taken into account
- The chosen landing spot must ensure continuous connection to the existing network
- The positioning of drones aims to maximize different objectives, adjustable according to the purpose of the mission (explore the area and/or serve clients)

$$o_i(\vec{x_i}) = k \cdot |C_s(\vec{x_i})| + (1-k) \cdot A_{pd}(\vec{x_i})$$

Where k defined the priority of serving more clients or searching more area



Future work



- Develop a multi-drone simulation environment in Gazebo for testing and validation purposes
- Implement realistic drone dynamics and sensor models within the Gazebo simulation
- Analyze simulation results to identify strengths and weaknesses of proposed algorithms and strategies
- Design scenarios to evaluate the performance of communication networks established by multiple drones
- Test developed algorithms with field experiments

Acknowledgements: This work was supported by FCT through the LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020).

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Images Recommendation System based on Emotions

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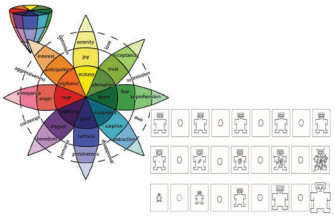
LASIGE data and systems intelligence

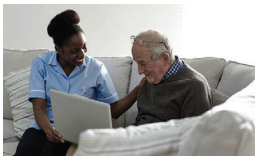
Motivation

Multimedia is present in everyday life.

Images represent reality and evoke emotions.



The interpretation of each image is personal.



The image selection is of the utmost importance

Problems

- How to select the best images to show to each user.
- Predicting user reactions to images.
- Personalization of predictions.

Objectives

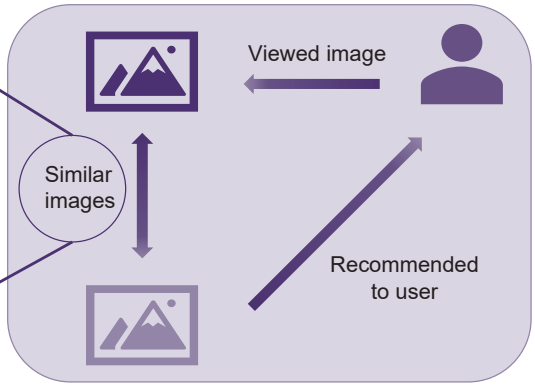
- Develop **image similarity techniques** based state-of-the-art algorithms using existing datasets for training;
- Development of a **recommendation system** based on the features of the images (**Content-Based Recommendation System**) and the emotions they arouse in users.
- Development of a **hybrid recommendation system** based on the previous recommendation system with the incorporation of a collaborative filtering RS done by external work.

Methodology

1st Step

1. **Pixel-based**: exploring their visual characteristics;
2. **Emotions-based**: focuses on the emotional responses evoked;
3. **Metadata-based**: considers descriptive information associated (e.g. tags).

Content-Based Filtering

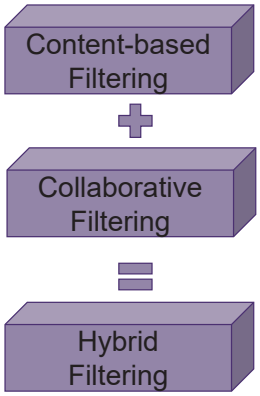


1. **Pixel-based**: different techniques can be used, including the use of Euclidean distance, convolutional neural networks, local descriptors, among others.
2. **Emotion-based**: in this case, we can obtain similarity of emotions with the classification of emotions in images, with the analysis of visual content, with the extraction of multimodal characteristics and using a clustering algorithm.
3. **Metadata-based**: in some cases, images have annotations or tags. The objective is to use text-mining algorithms for annotations (e.g. tf-idf) and in the case of tags we can use grouping by tags, or tag co-occurrence analysis.

The objective is to test different approaches and choose the best one.

2nd Step

Hybrid Filtering



3rd Step

Evaluate both recommendation systems using **accuracy metrics** (e.g. Mean Absolute Error and Correlation and **support accuracy metrics** (e.g. precision and recall).

Acknowledgments:
This work was supported by FCT through LASIGE Research Unit, ref. UIDB/00408/2020 (https://doi.org/10.54499/UIDB/00408/2020) and ref. UIDP/00408/2020 (https://doi.org/10.54499/UIDP/00408/2020)

Answer our survey and help us improve our dataset!

Wi-Fi-based buildings occupancy detection, estimation, and location

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LASIGE cyber-physical systems

Introduction

Obtaining the occupation of a building and localization of the people inside is one of the most problematic and essential parts of the creation of Smart Buildings.

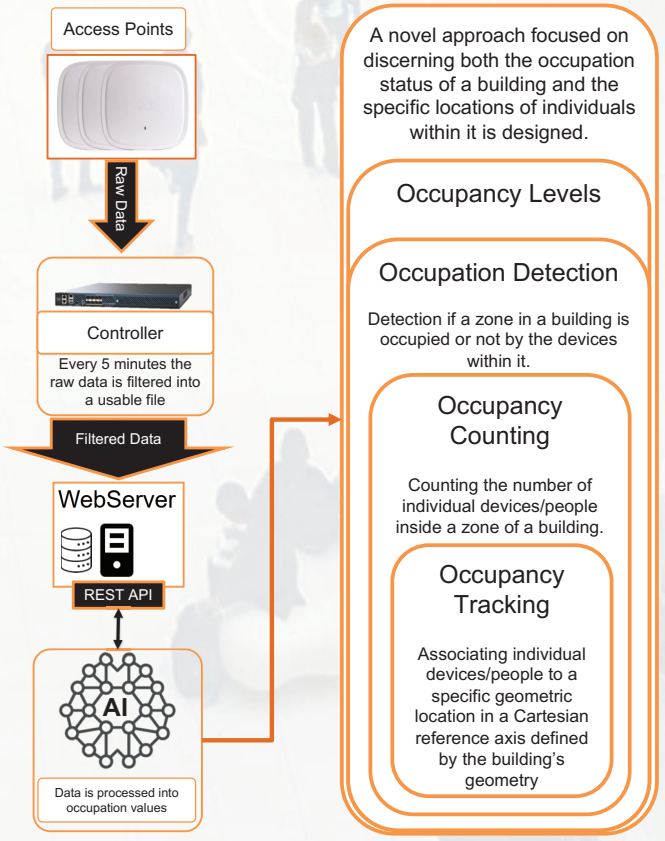
Problem

Previous solutions usually depend on applying ML models, but this can only be done over static networks.

The training dataset cannot be transferred between different deployments.

The base problem hinges on the fact that an easier system deployment could be achieved if we didn't depend on the static nature of the network, which prevents us from reusing models between deployments.

System Architecture



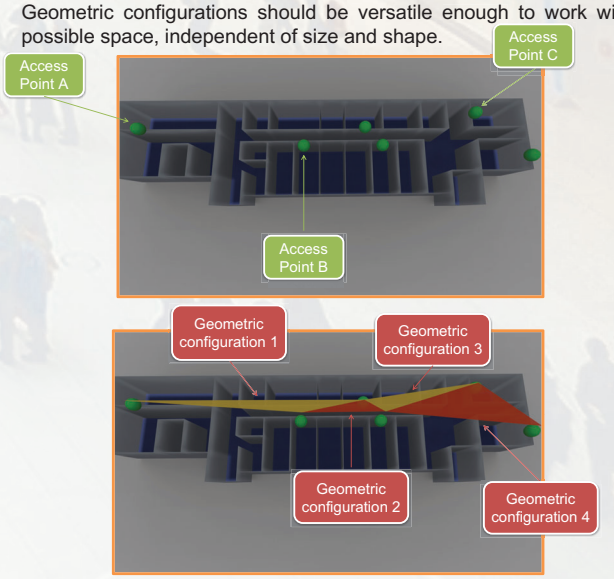
Goal

Design a system adaptable to networks of different shapes and sizes so that deploying the network doesn't require an intermediate step of re-training the required ML models.

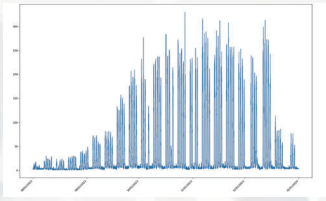
Space Mapping

Geometric configurations whose vertices are the positions of the Access Points (APs) within the building should be used, and the people should be tracked within a cartesian frame comprised of the APs.

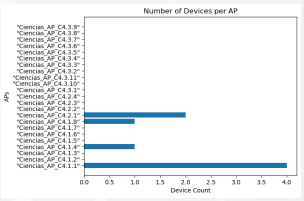
Geometric configurations should be versatile enough to work with any possible space, independent of size and shape.



Preliminary Results



Device Count Between August 2023 and January 2024



Device Spread during August 1st 2023

Conclusions

A novel approach is proposed for indoor location within its specific geometric shape. These models' advantage is that they can be reused between deployments, removing the fingerprinting step.

The findings will empower building managers to optimize resources, fostering improved efficiency within the building environment.

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