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ddidario@unisa.it
Dariucc7
https://dariodidario.github.io/

Collecting and Implementing Ethical Guidelines for Emotion Recognition in an Educational Metaverse

Dario Di Dario, Viviana Pentangelo, Maria Immacolata Colella, Fabio Palomba, Carmine Gravino

Software Engineering (SeSa) Lab - University of Salerno, Italy.

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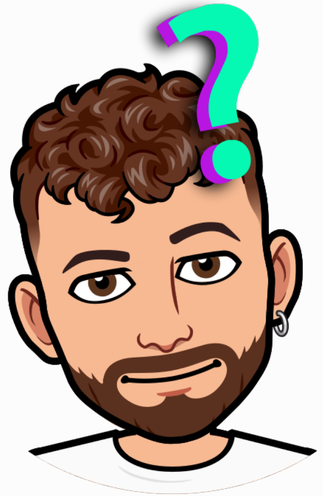
Introduction



What is the Metaverse?

Introduction

The Metaverse is an immersive 3D virtual environment where users, as avatars, engage in social and economic interactions. This persistent space supports creative collaboration and participation across various contexts, independent of the physical world.

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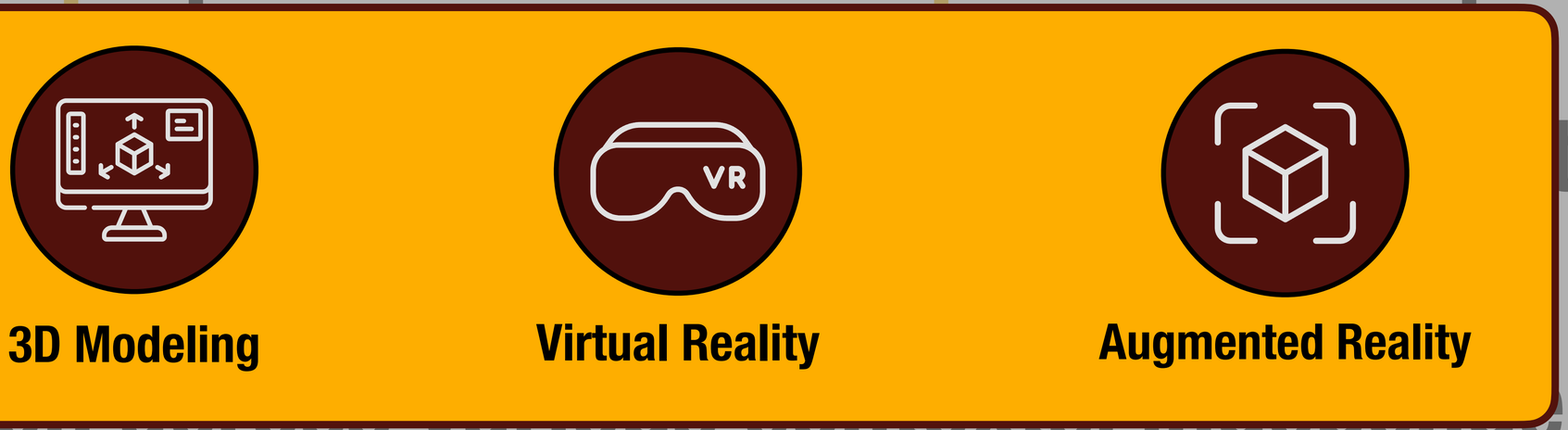

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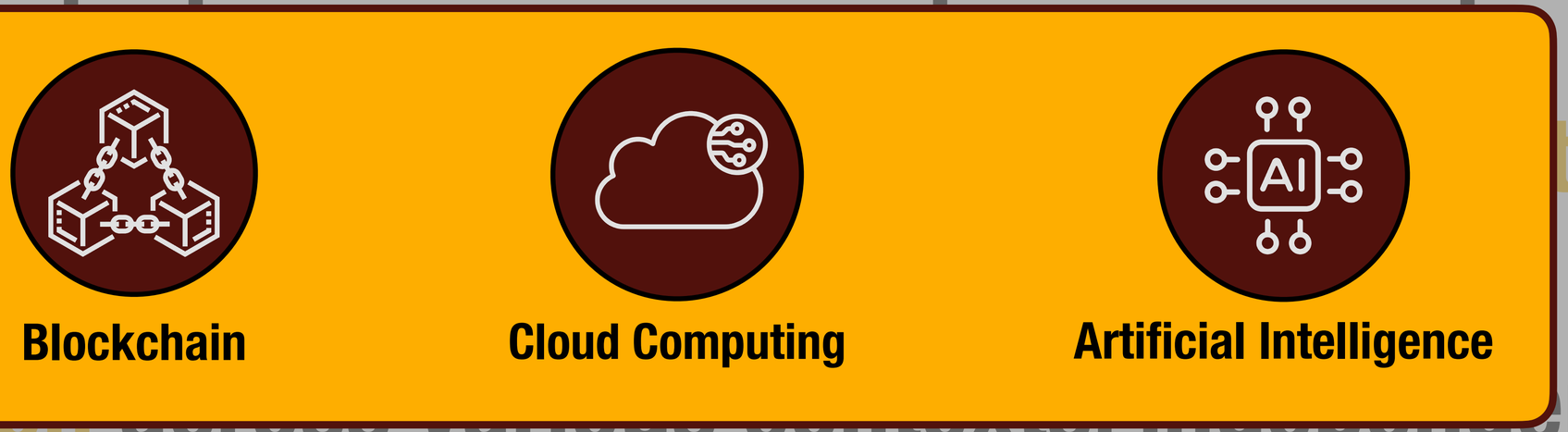

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Introduction

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How the Metaverse Can Transform Education

April 12, 2023
By Nick Clegg, President, Global Affairs

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Introduction

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How the Metaverse Can Transform Education

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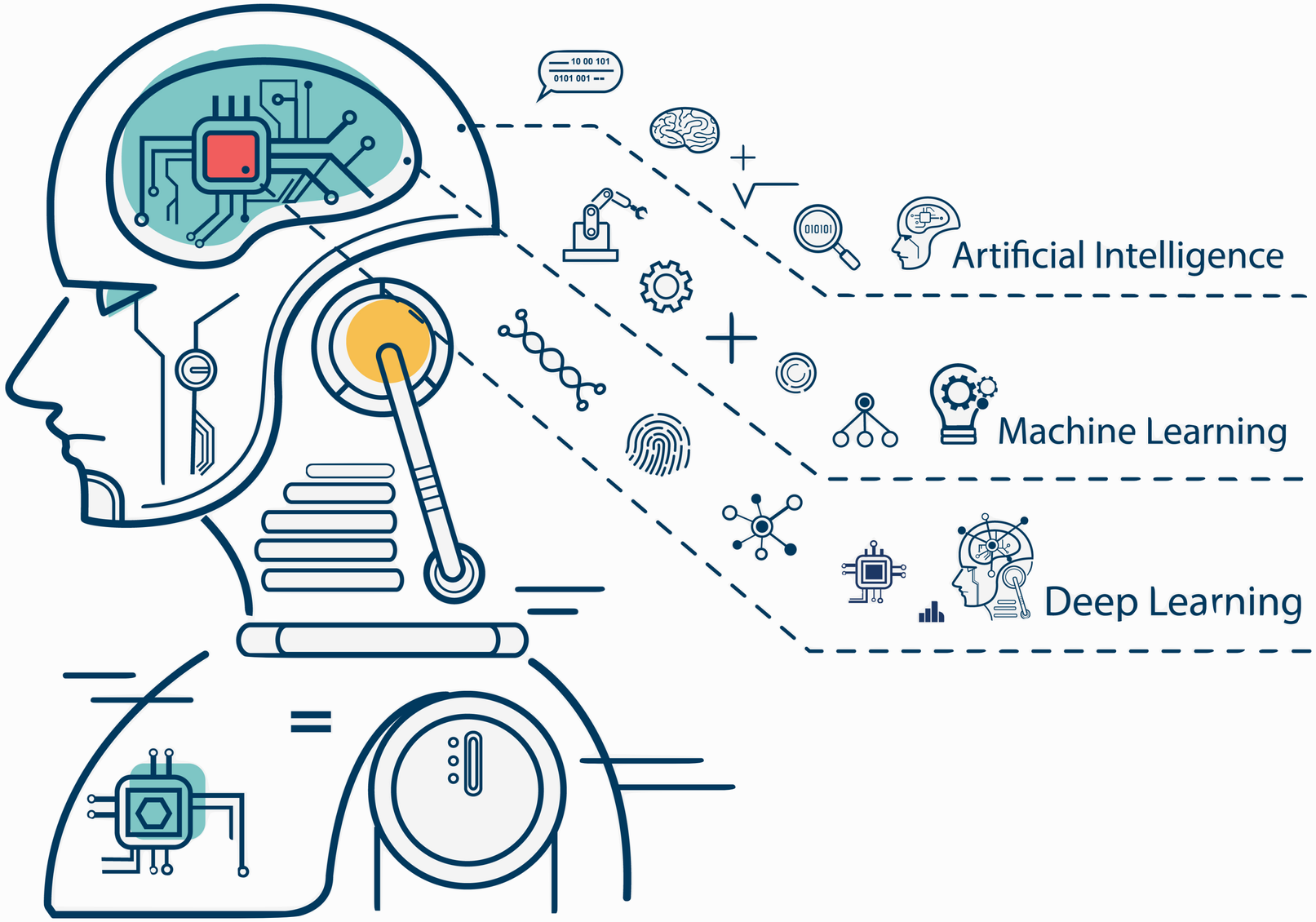
Introduction

Despite the interest in using the metaverse for education, there are still open educational challenges that may limit the widespread diffusion of the technology.

Introduction

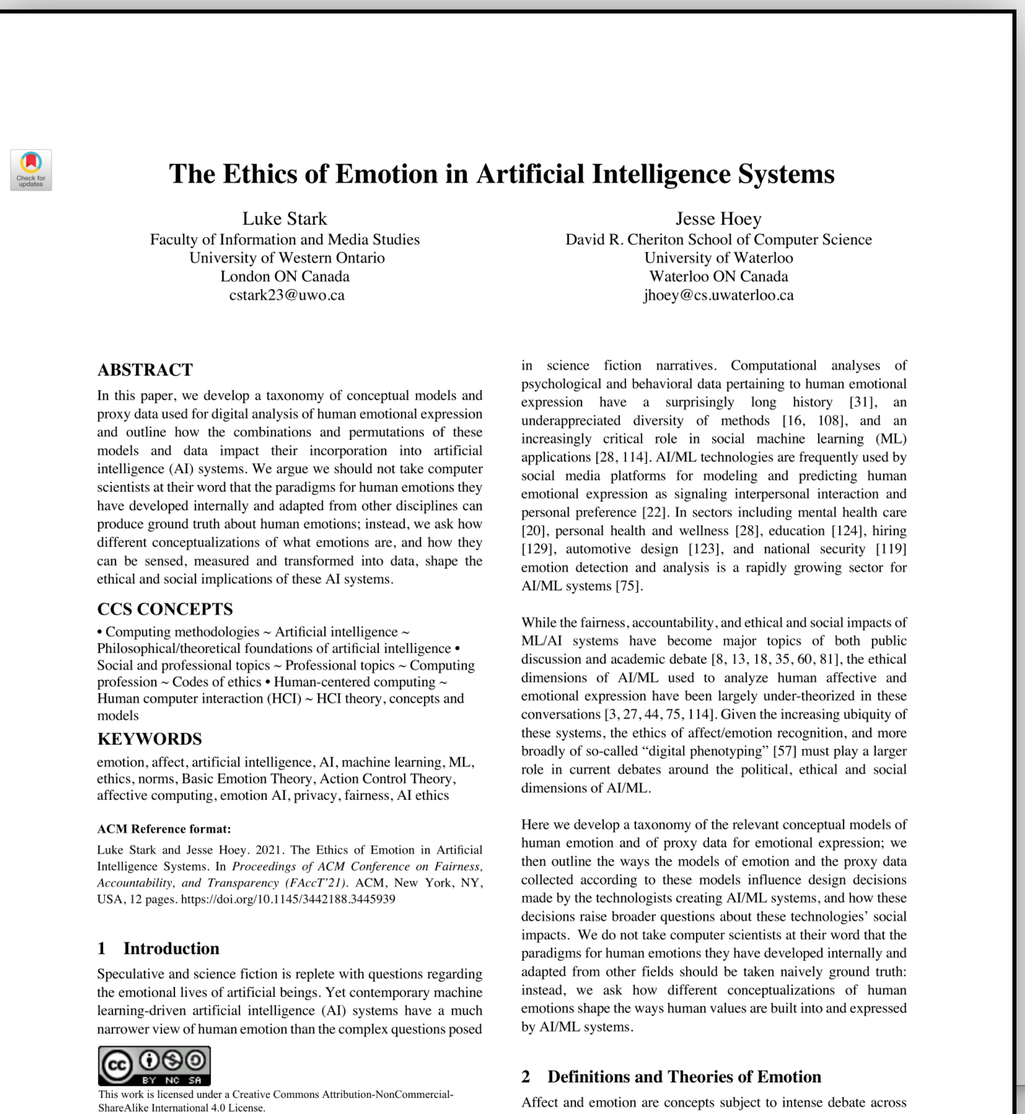
Introduction



Introduction

The use of data from users' emotional expressions with machine learning may present dilemmas regarding consent, privacy, and the potential for unintended consequences such as algorithmic bias or discrimination.

State of the art



The Ethics of Emotion in Artificial Intelligence Systems

Luke Stark
Faculty of Information and Media Studies
University of Western Ontario
London ON Canada
cstark23@uwo.ca

Jesse Hoey
David R. Cheriton School of Computer Science
University of Waterloo
Waterloo ON Canada
jhoey@cs.uwaterloo.ca

ABSTRACT

In this paper, we develop a taxonomy of conceptual models and proxy data used for digital analysis of human emotional expression and outline how the combinations and permutations of these models and data impact their incorporation into artificial intelligence (AI) systems. We argue we should not take computer scientists at their word that the paradigms for human emotions they have developed internally and adapted from other disciplines can produce ground truth about human emotions; instead, we ask how different conceptualizations of what emotions are, and how they can be sensed, measured and transformed into data, shape the ethical and social implications of these AI systems.

CCS CONCEPTS

• Computing methodologies ~ Artificial intelligence ~ Philosophical/theoretical foundations of artificial intelligence • Social and professional topics ~ Professional topics ~ Computing profession ~ Codes of ethics • Human-centered computing ~ Human computer interaction (HCI) ~ HCI theory, concepts and models

KEYWORDS

emotion, affect, artificial intelligence, AI, machine learning, ML, ethics, norms, Basic Emotion Theory, Action Control Theory, affective computing, emotion AI, privacy, fairness, AI ethics

ACM Reference format:

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1 Introduction

Speculative and science fiction is replete with questions regarding the emotional lives of artificial beings. Yet contemporary machine learning-driven artificial intelligence (AI) systems have a much narrower view of human emotion than the complex questions posed in science fiction narratives. Computational analyses of psychological and behavioral data pertaining to human emotional expression have a surprisingly long history [31], an underappreciated diversity of methods [16, 108], and an increasingly critical role in social machine learning (ML) applications [28, 114]. AI/ML technologies are frequently used by social media platforms for modeling and predicting human emotional expression as signaling interpersonal interaction and personal preference [22]. In sectors including mental health care [20], personal health and wellness [28], education [124], hiring [129], automotive design [123], and national security [119] emotion detection and analysis is a rapidly growing sector for AI/ML systems [75].

While the fairness, accountability, and ethical and social impacts of ML/AI systems have become major topics of both public discussion and academic debate [8, 13, 18, 35, 60, 81], the ethical dimensions of AI/ML used to analyze human affective and emotional expression have been largely under-theorized in these conversations [3, 27, 44, 75, 114]. Given the increasing ubiquity of these systems, the ethics of affect/emotion recognition, and more broadly of so-called "digital phenotyping" [57] must play a larger role in current debates around the political, ethical and social dimensions of AI/ML.

Here we develop a taxonomy of the relevant conceptual models of human emotion and of proxy data for emotional expression; we then outline the ways the models of emotion and the proxy data collected according to these models influence design decisions made by the technologists creating AI/ML systems, and how these decisions raise broader questions about these technologies' social impacts. We do not take computer scientists at their word that the paradigms for human emotions they have developed internally and adapted from other fields should be taken naively ground truth: instead, we ask how different conceptualizations of human emotions shape the ways human values are built into and expressed by AI/ML systems.

2 Definitions and Theories of Emotion

Affect and emotion are concepts subject to intense debate across

Models Fails to accurately Represent Human Emotion

State of the art

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Deep Learning-Based Facial Emotion Detection in the Metaverse

Brij B. Gupta*
Department of Computer Science and Information Engineering,
Asia University, Taichung 413, Taiwan,
& Lebanese American University, Beirut, 1102, Lebanon;
bbgupta@asia.edu.tw

Akshat Gaurav
Ronin Institute, Montclair, NJ, USA
akshat.gaurav@ronininstitute.org

Kwok Tai Chui
Hong Kong Metropolitan University (HKMU),
Hong Kong,
jktchui@hkmu.edu.hk

Varsha Arya
Asia University, Taichung, Taiwan
varshaarya2108@gmail.com

***Abstract*—The Metaverse is currently becoming a massive technology platform and is considered to be the next significant development in global technology and business landscapes. The metaverse is touted as an exciting new technology amalgamation facilitating next-level immersive experiences for users. It merges physical and virtual reality and provides channels for multisensory interactions and immersions in a variety of environments. As the metaverse is still in its early stages, there is very little research in the field of emotion recognition in the metaverse. In this context, we propsed a deep CNN-based emotion detection model for the metaverse. Our proposed approach efficiently detects the emotions of users in the metaverse.**

***Index Terms*—Metaverse, Augmented Reality, Virtual Reality, Deep Learning, CNN**

I. Introduction

Metaverse is a 3D virtual world [1]–[3] that gained popularity after Facebook renamed itself as Meta [4], [5]. We can say a metaverse is a place beyond time and space where people and virtual objects can interact [6], [7]. It is also considered a virtual universe where people can interact [8], [9].

Using augmented and virtual reality technology, Metaverse offers its customers a 3D virtual world to explore whenever they choose. Users are enabled to embody their wildest fantasies in the metaverse realm, which is made even more real by combining these two and other auxiliary technologies. Contrarily, "augmented reality" is a technology development that merges the actual and virtual worlds for the user. It enhances the real world by adding pictures, animations, or text. Augmented reality (AR) applications for mobile devices, including smartphones, tablets, and smart glasses, are a common tool for this. Virtual reality (VR) goggles, controllers, and gloves allow users to electronically interact with a three-dimensional environment. Additionally, Mixed Reality merges AR with VR. The goal is to bridge the gap between the real and virtual worlds. By fusing the digital and physical worlds, MR paves the way for augmented and virtual reality to interact in real time without any disruption [10].

The core of face emotion recognition research in the metaverse is the discovery and comprehension of the emotions expressed by virtual avatars, particularly in virtual reality and augmented reality contexts [11]. By using three-dimensional face recognition technology, this discipline enables the real-time analysis of facial emotions citeBronstein, which enriches user experiences with emotional depth and engagement. In particular, how facial expression detection affects user engagement and response has been the subject of many research that have sought to understand the psychological and emotional effects of spending time in virtual environments [12]. Early childhood education is one area where new opportunities for emotion-based interaction with augmented reality (AR) applications in the metaverse are emerging [9], [13], [14]. Also, cognitive performance assessments done in VR might be made more effective with the use of facial expression detection, which can reveal emotional responses while doing cognitive tasks [15]–[17]. Privacy concerns and the possibility of algorithmic biases are two major ethical issues in this field. Our study describes the development of a CNN model for detecting emotions in the metaverse [14], [18].

Rest of the paper is organized as follows; section II, presents the related work. Section III, gives a brief overview of our prospered approach. Results are represented in section IV. Finally, section V concludes the paper.

II. Related Work

The concept of the metaverse has gained significant attention in recent years, leading to the proposal of various frameworks aimed at exploring its potential applications and addressing associated challenges [19]–[21]. [22] proposed a

Models Fails to accurately Represent Human Emotion

Improving Emotion Recognition Techniques

State of the art

2021 9th International Conference on Affective Computing and Intelligent Interaction (ACII)

Guidelines for Assessing and Minimizing Risks of Emotion Recognition Applications

Javier Hernandez[*†1], Josh Lovejoy[*1], Daniel McDuff[1], Jina Suh[1], Tim O'Brien[1], Arathi Sethumadhavan[1], Gretchen Greene[2], Rosalind Picard[3], and Mary Czerwinski[1]

[1]Microsoft Research, Microsoft, Redmond, USA
[2]Harvard Kennedy School, Harvard University, Cambridge, USA
[3]Media Lab, Massachusetts Institute of Technology, Cambridge, USA

***Abstract*—Society has witnessed a rapid increase in the adoption of commercial uses of emotion recognition. Tools that were traditionally used by domain experts are now being used by individuals who are often unaware of the technology's limitations and may use them in potentially harmful settings. The change in scale and agency, paired with gaps in regulation, urge the research community to rethink how we design, position, implement and ultimately deploy emotion recognition to anticipate and minimize potential risks. To help understand the current ecosystem of applied emotion recognition, this work provides an overview of some of the most frequent commercial applications and identifies some of the potential sources of harm. Informed by these, we then propose 12 guidelines for systematically assessing and reducing the risks presented by emotion recognition applications. These guidelines can help identify potential misuses and inform future deployments of emotion recognition.**

***Index Terms*—ethics, guidelines, risk, emotion recognition**

Fig. 1. How should emotion recognition label each of these images? Example adapted from Barrett et al. [11] illustrating the importance of context.

I. Introduction

The field of Affective Computing has experienced significant growth since its original inception in 1997 with the book by the same name [1]. While most of the early research was performed in small, controlled laboratory experiments with custom-made and expensive sensing technologies [2], [3], we are now seeing an increasing number of real-life deployments that leverage low-cost, mass-produced sensors [4], [5]. This shift has been accompanied by a significant democratization and popularization of emotion sensing technologies, APIs and services that can extract emotional information from images [6], [7], voice [8], text [9] and vital signs [10]. Unfortunately, affective computing, and especially the area of emotion recognition, has been used in unexpected and potentially harmful settings by practitioners without sufficient understanding of its limitations or assumptions. We believe that the lowered barriers to entry for using emotion recognition, the increased agency of non-expert practitioners, and the gaps in regulating the usage of this technology create a demand for

may detect the mouth stretch and nose wrinkle, but if that same algorithm were to see the image on the right, it is likely to label it as "excitement" instead, as it may recognize that Serena is celebrating a victory with a fist pump. While one could potentially argue that the second prediction may be more accurate as it has access to more contextual information, we could all potentially agree that none of the algorithms can really know how Serena Williams was feeling at that precise moment without asking her. Even if we are able to ask her, we know she may still be biased by the way we framed our question [12], potential recall biases [13], and most likely some misattribution of arousal [14]. While these observations may seem obvious to the general affective computing researcher, we have observed that the terminology and the models used to represent emotion recognition technology can be confusing and that new practitioners might overestimate the predictive power of AI [15]. For instance, commercial facial expression analysis often adopts Ekman's theory of basic emotions [16] that

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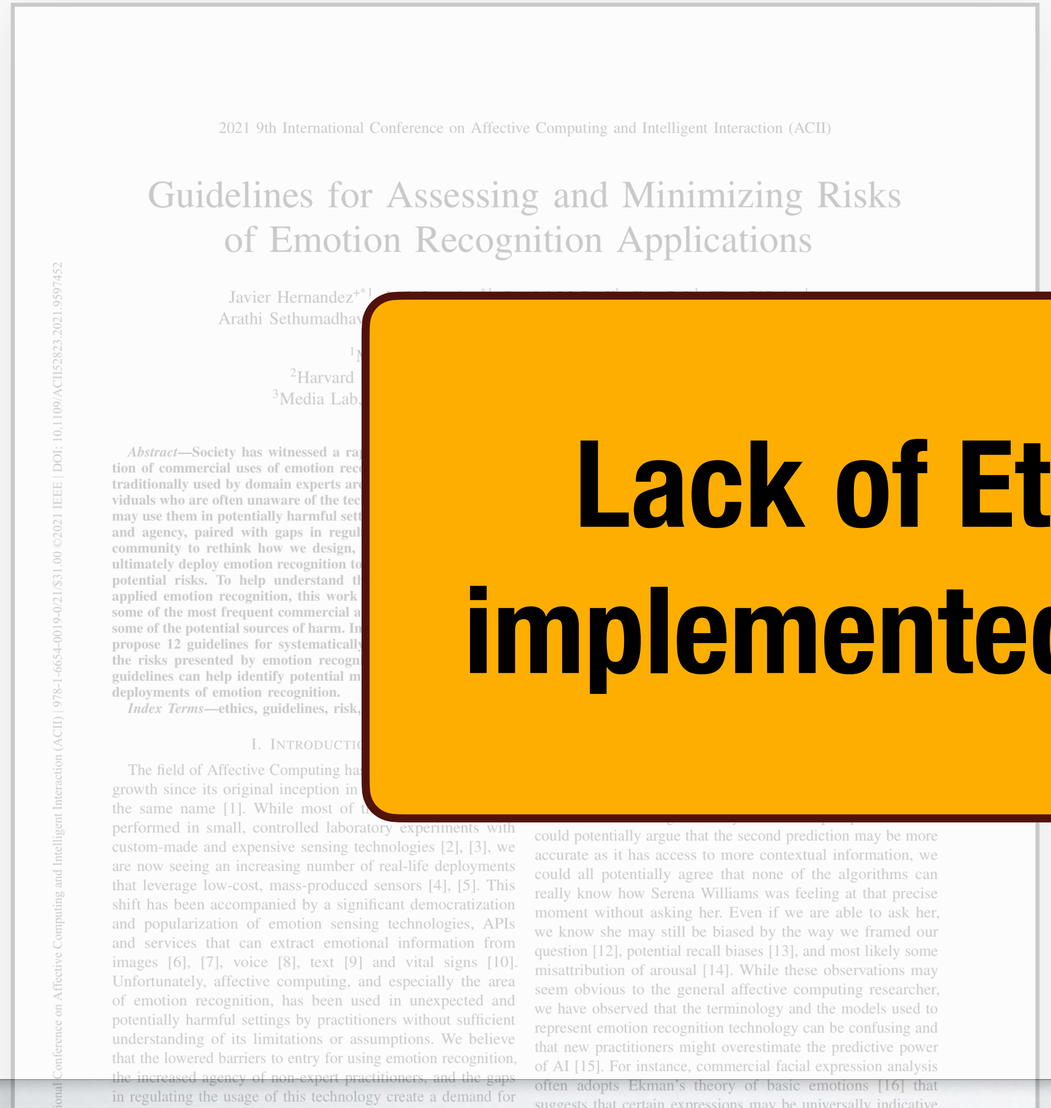
Models Fails to accurately Represent Human Emotion

Improving Emotion Recognition Techniques

Practices for Minimizing Risk in Emotion Recognition

State of the art



2021 9th International Conference on Affective Computing and Intelligent Interaction (ACII)

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Javier Hernandez[+1]
Arathi Sethumadhav

[2]Harvard
[3]Media Lab

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Studying Ethics of Emotion in Intelligence Systems

chniques

Practices for Minimizing Risk in Emotion Recognition

Lack of Ethical guidelines implemented in the Metaverse

Research Method

The aim is to collect ethical guidelines in literature and starting to develop an emotion recognition approach with the most critical guideline found, within an open source educational metaverse.

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The SENEM Metaverse

SENEM

Software **E**ngineering-E**N**abled **E**ducational **M**etaverse

The SENEM Metaverse

Information and Software Technology 174 (2024) 107512

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journal homepage: www.elsevier.com/locate/infsof

SENEM: A software engineering-enabled educational metaverse

Viviana Pentangelo *, Dario Di Dario, Stefano Lambiase, Filomena Ferrucci, Carmine Gravino, Fabio Palomba

Software Engineering (SeSa) Lab - Department of Computer Science, University of Salerno, Italy

ARTICLE INFO

Keywords:
Metaverse engineering
Virtual learning environments
Human-centered studies
Software engineering in practice

ABSTRACT

Context: The term metaverse refers to a persistent, virtual, three-dimensional environment where individuals may communicate, engage, and collaborate. One of the most multifaceted and challenging use cases of the metaverse is education, where educators and learners may require multiple technical, social, psychological, and interaction instruments to accomplish their learning objectives. While the characteristics of the metaverse might nicely fit the problem's needs, our research points out a noticeable lack of knowledge into (1) the specific requirements that an educational metaverse should actually fulfill to let educators and learners successfully interact towards their objectives and (2) how to design an appropriate educational metaverse for both educators and learners.
Objective: In this paper, we aim to bridge this knowledge gap by proposing SENEM, a novel software engineering-enabled educational metaverse. We first elicit a set of functional requirements that an educational metaverse should fulfill.
Method: In this respect, we conduct a literature survey to extract the currently available knowledge on the matter discussed by the research community, and afterward, we assess and complement such knowledge through semi-structured interviews with educators and learners. Upon completing the requirements elicitation stage, we then build our prototype implementation of SENEM, a metaverse that makes available to educators and learners the features identified in the previous stage. Finally, we evaluate the tool in terms of learnability, efficiency, and satisfaction through a Rapid Iterative Testing and Evaluation research approach, leading us to the iterative refinement of our prototype.
Results: Through our survey strategy, we extracted nine requirements that guided the tool development that the study participants positively evaluated.
Conclusion: Our study reveals that the target audience appreciates the elicited design strategy. Our work has the potential to form a solid contribution that other researchers can use as a basis for further improvements.

1. Introduction

Nowadays, the interest in the vast field of the metaverse has been steadily growing and is starting to find its place in various contexts and applications. A metaverse is a highly immersive three-dimensional digital world where users interact in real-time with the environment and others through their avatars, *i.e.*, digital representations of the users [1]. The rapid technological advances, the increasing digitization of numerous daily activities, ranging from work to entertainment, and, notably, the impact of the COVID-19 pandemic that led to the need for digital solutions have all contributed to the significant surge in research interest in this field [2]. Indeed, recently, researchers started to design and develop metaverse for a plethora of tasks, ranging from entertainment to software development, passing through medical simulations and education contexts. One of the most challenging use cases of the metaverse is education, where it may support educators and learners from many points of view. First, the remote nature of the metaverse could break down physical barriers between individuals, allowing geographically dispersed people to communicate and study together [3], letting individuals in less affluent living conditions to receive a good education. In addition, classrooms could benefit from students' diverse backgrounds by engaging in more interesting discussions [4]. Lastly, implementing artificial intelligence (AI) and visualization tools in the metaverse can further improve communication and collaboration, break down cultural and language barriers, and engage students with immersive instruments such as simulations and historical event reconstructions [4,5].

* Correspondence to: Via Giovanni Paolo II, 132 Fisciano (SA), Italy.

9 Functionalities

4 Categories

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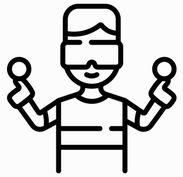
4 Categories

Virtual Environment

Communication



Avatar

Multimedia Content

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4 Categories

9 Functionalities

Virtual Environment

R1.1 **VE Exploration**

R1.2 **Multiple Sessions**

Communication

R2.1 Voice Channel

R2.2 Text Channel

R2.3 Emotes

Avatar

R3.1 Digital Replication

R3.2 Avatar Customization

Multimedia Content

R4.1 Multimedia Sharing

R4.2 Whiteboard Interaction

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ABSTRACT

Context: The term metaverse refers to a persistent, virtual, three-dimensional environment where individuals may communicate, engage, and collaborate. One of the most multifaceted and challenging use cases of the metaverse is education, where educators and learners may require multiple technical, social, psychological, and interaction instruments to accomplish their learning objectives. While the characteristics of the metaverse might nicely fit the problem's needs, our research points out a noticeable lack of knowledge into (1) the specific requirements that an educational metaverse should actually fulfill to let educators and learners successfully interact towards their objectives and (2) how to design an appropriate educational metaverse for both educators and learners.

Objective: In this paper, we aim to bridge this knowledge gap by proposing SENEM, a novel software engineering-enabled educational metaverse. We first elicit a set of functional requirements that an educational metaverse should fulfill.

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4 Categories

9 Functionalities

Virtual Environment

R1.1

VE Exploration

R1.2

Multiple Sessions

Communication

R2.1

Voice Channel

R2.2

Text Channel

R2.3

Emotes

Avatar

R3.1

Digital Replication

R3.2

Avatar Customization

Multimedia Content

R4.1

Multimedia Sharing

R4.2

Whiteboard Interaction

The SENEM Metaverse

Information and Software Technology 174 (2024) 107512

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SENEM: A software engineering-enabled educational metaverse

Viviana Pentangelo *, Dario Di Dario, Stefano Lambiase, Filomena Ferrucci, Carmine Gravino, Fabio Palomba

Software Engineering (SeSa) Lab - Department of Computer Science, University of Salerno, Italy

ARTICLE INFO

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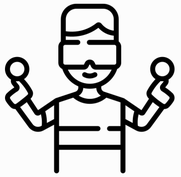

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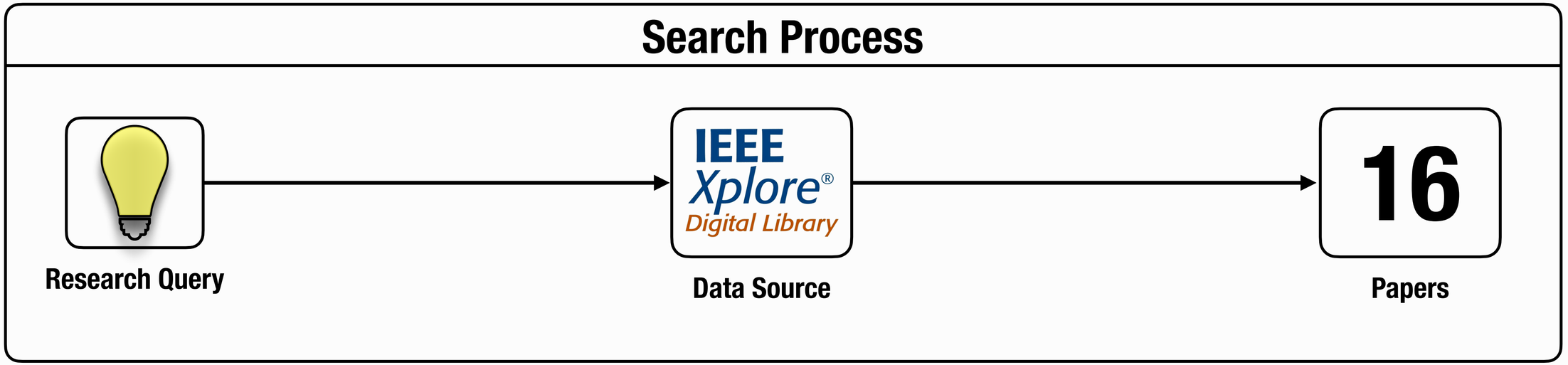
Research Method

The aim is to collect ethical guidelines in literature and starting to develop an emotion recognition approach with the most critical guideline found, within an open source educational metaverse.

Collection Ethical Guidelines for Emotion Recognition

RQ1: What ethical considerations and guidelines must be taken into account to ensure the secure deployment of emotion recognition technology in an educational metaverse?



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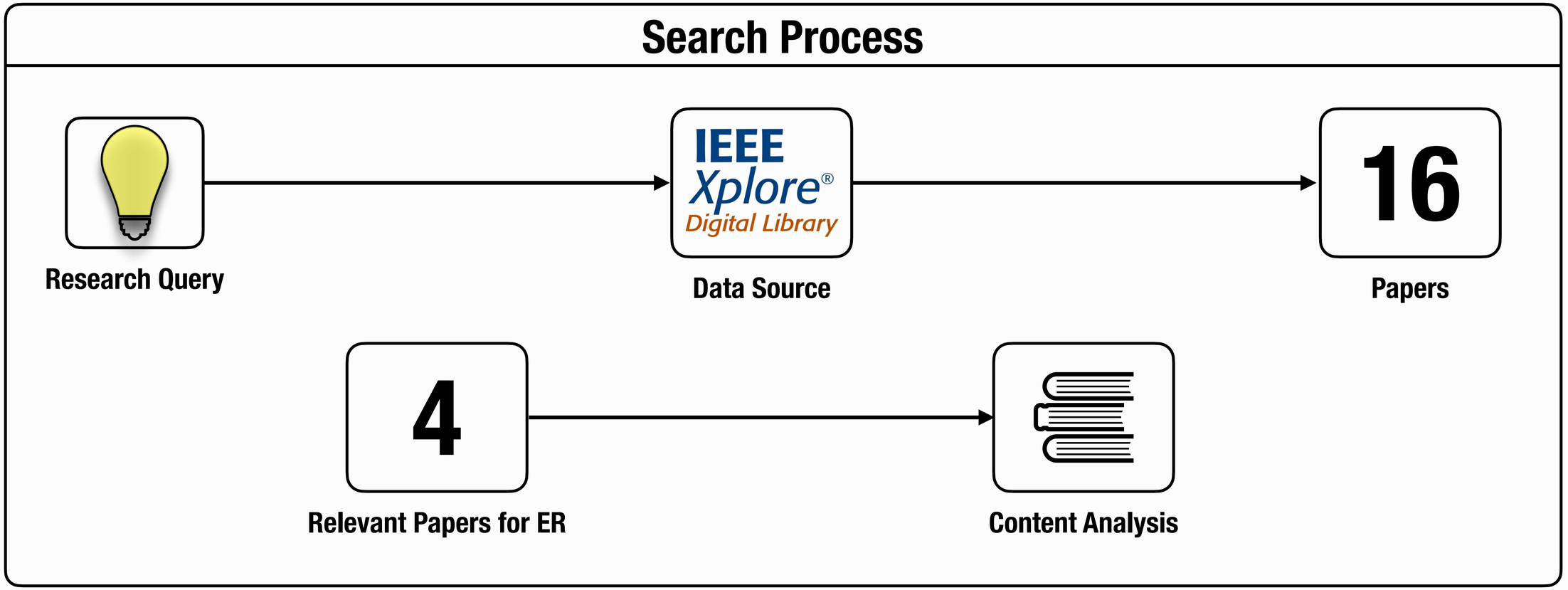

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Process Results

Protection of Privacy

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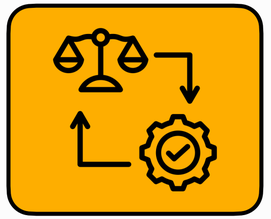
Process Results

Protection of Privacy

Transparency and Accountability



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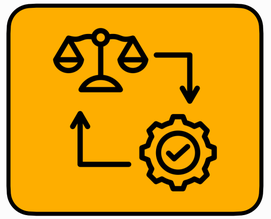

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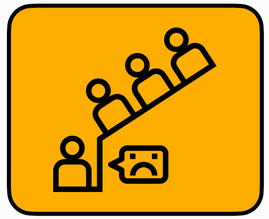

Biases and Fairness

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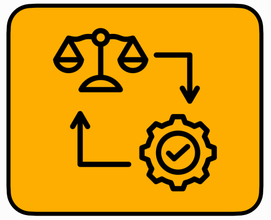

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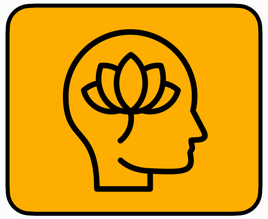

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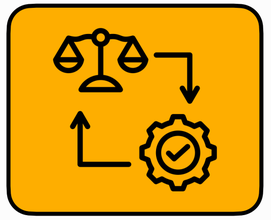

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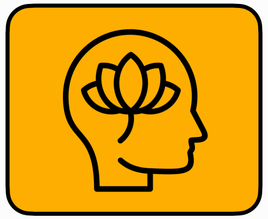

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Implementing Protection on Privacy for Emotion Recognition

Information Sciences 582 (2022) 593–617

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Keywords:
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Pattern recognition
Systematic literature review

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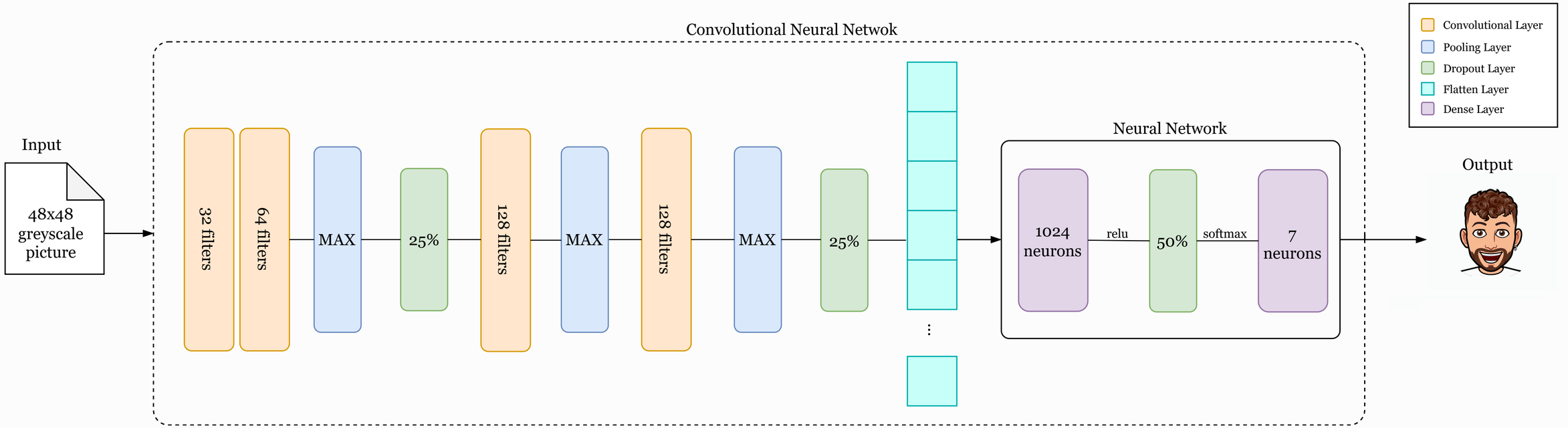
CNN

Convolutional Neural Network



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SENEM + User Privacy

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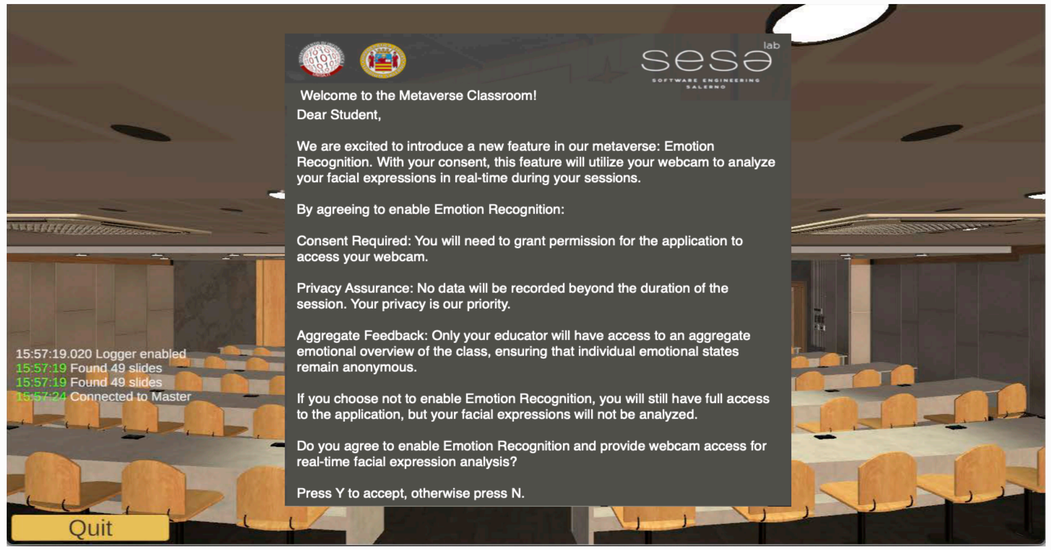

Users are informed about

HOW

WHY

Using the webcam to get real-time data about facial expressions, but data is not saved or stored to protect their privacy.

Implementing Protection on Privacy for Emotion Recognition

SENEM + User Privacy

Users are informed about

HOW

WHY

Emotional information is only for teachers, helping them to adapt their teaching methods making learning effective

Future Works

- Using a systematic approach exploring more digital libraries
- Implementing the other ethical considerations extracted
- Supporting the protection of privacy with the use of blockchain

sesa lab
SOFTWARE ENGINEERING SALERNO

ddidario@unisa.it
Dariucc7
https://dariodidario.github.io/

1919

THANK YOU FOR YOUR ATTENTION!

Dario Di Dario, Viviana Pentangelo, Maria Immacolata Colella, Fabio Palomba, Carmine Gravino

Software Engineering (SeSa) Lab - University of Salerno, Italy.

Italiadomani
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Ministero dell'Università e della Ricerca

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