Dolore e AI

Marco Cascella, MD, PhD

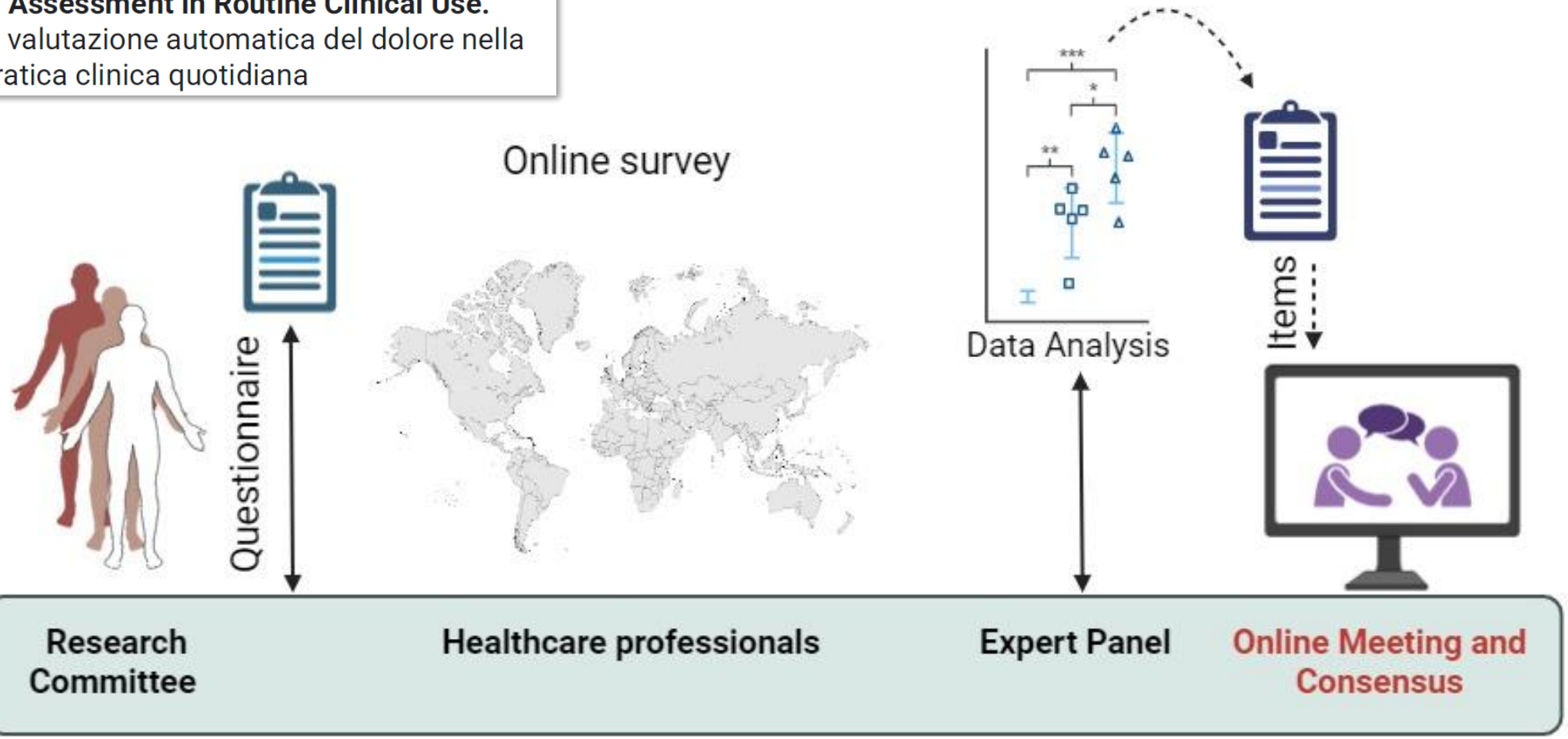
DipMed. Università di Salerno

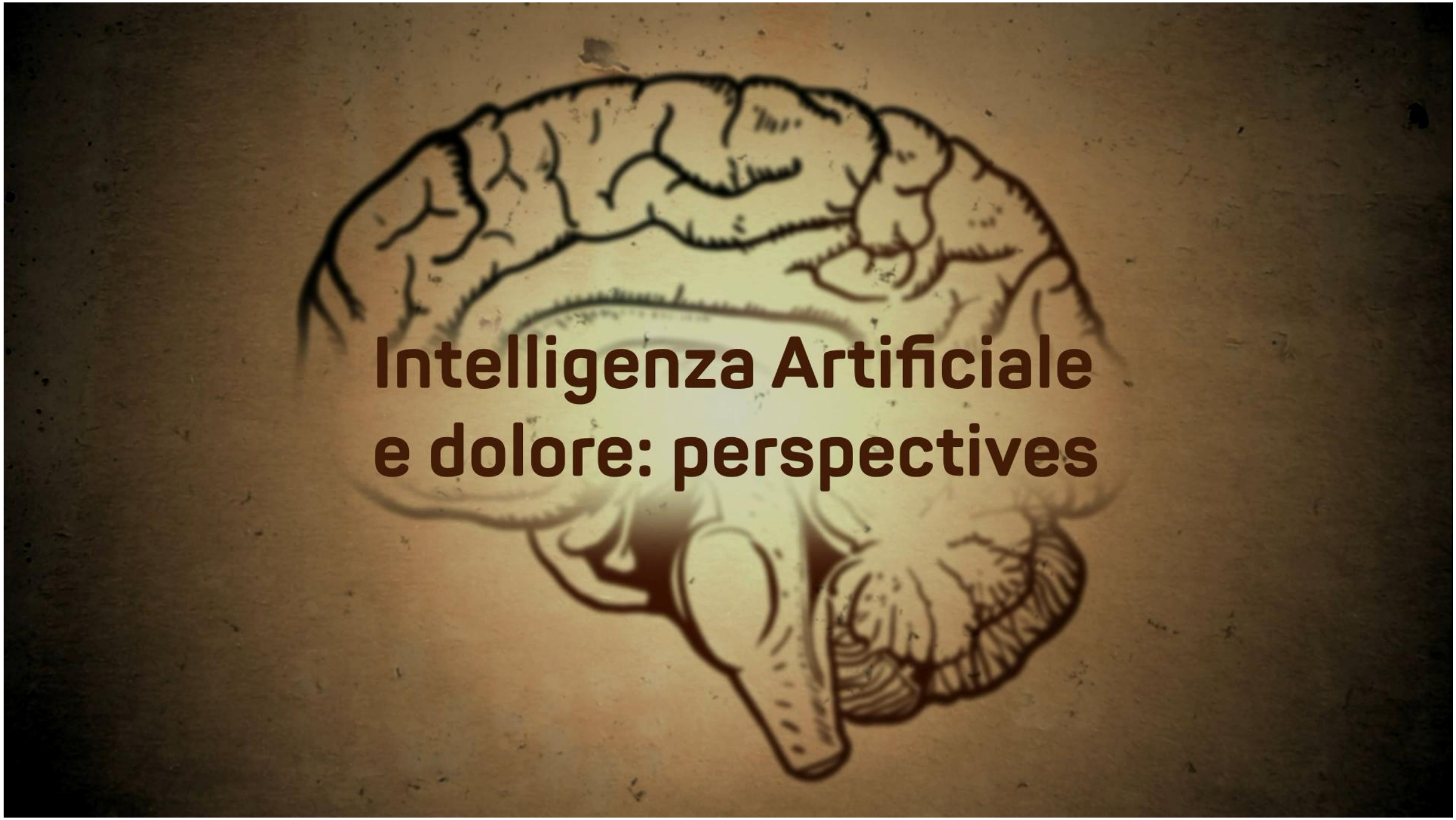
R.U.G.G.I. STUDY

Informativa e consenso informato per la partecipazione alla Consensus

Expert Consensus on Feasibility and Application of Automatic Pain Assessment in Routine Clinical Use.

Questionario sulla valutazione automatica del dolore nella pratica clinica quotidiana




Intelligenza Artificiale
e dolore: perspectives

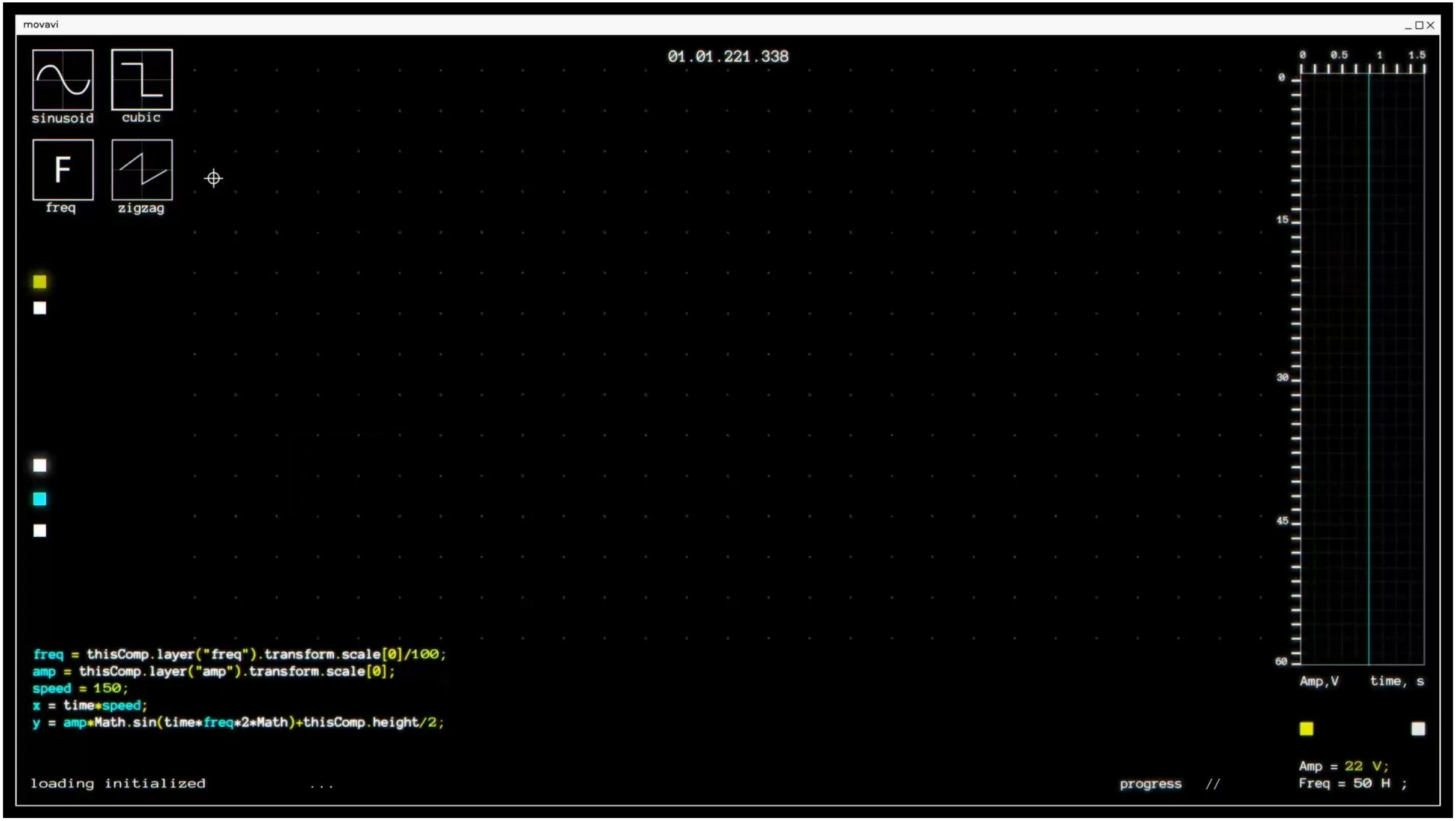

Alan
Mathison
Turing

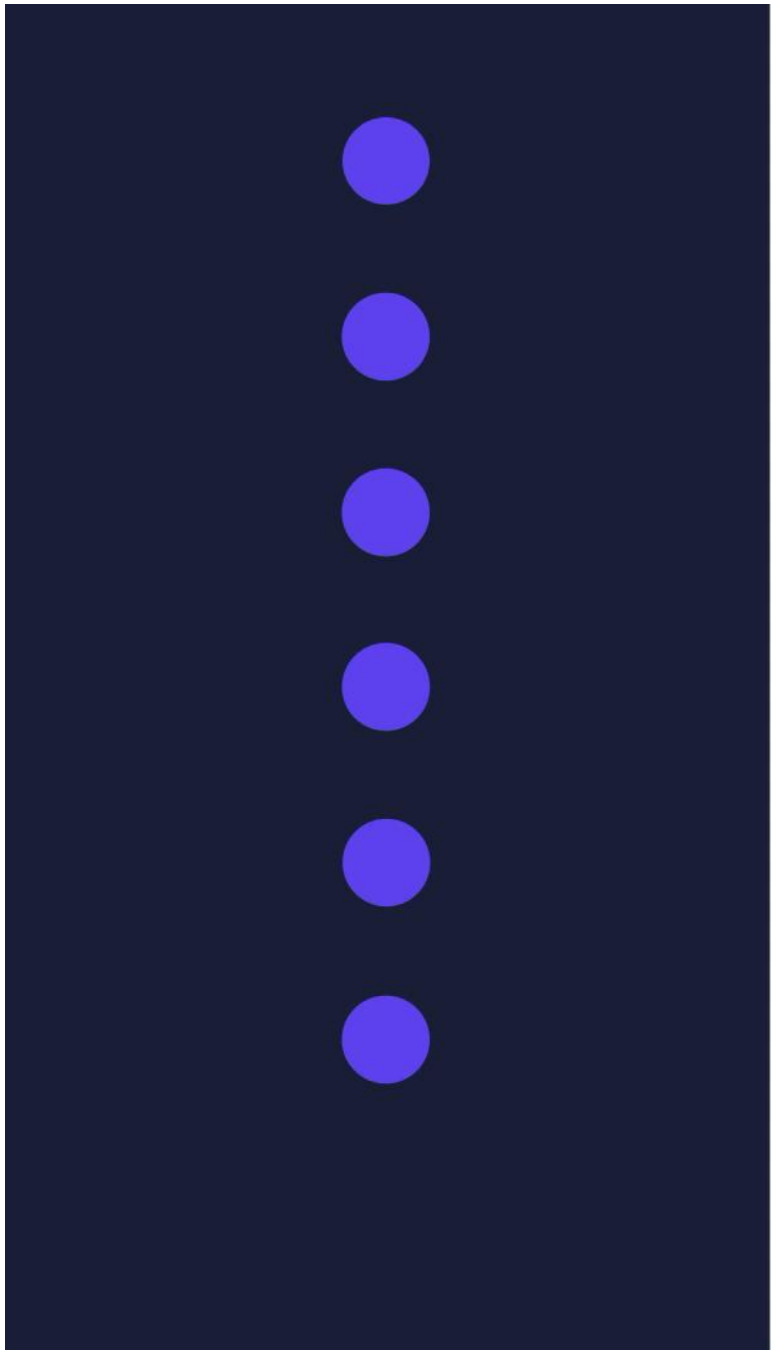
A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence

August 31, 1955

John McCarthy, Marvin L. Minsky,
Nathaniel Rochester,
and Claude E. Shannon

"Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."


movavi
01.01.221.338
sinusoid
cubic
F
freq
zigzag
0
0.5
1
1.5
0
15
30
45
60
Amp,V
time, s
freq = thisComp.layer("freq").transform.scale[0]/100;
amp = thisComp.layer("amp").transform.scale[0];
speed = 150;
x = time*speed;
y = amp*Math.sin(time*freq*2*Math)+thisComp.height/2;
loading initialized ...
progress //
Amp = 22 V;
Freq = 50 H ;



Hype Cycle for AI

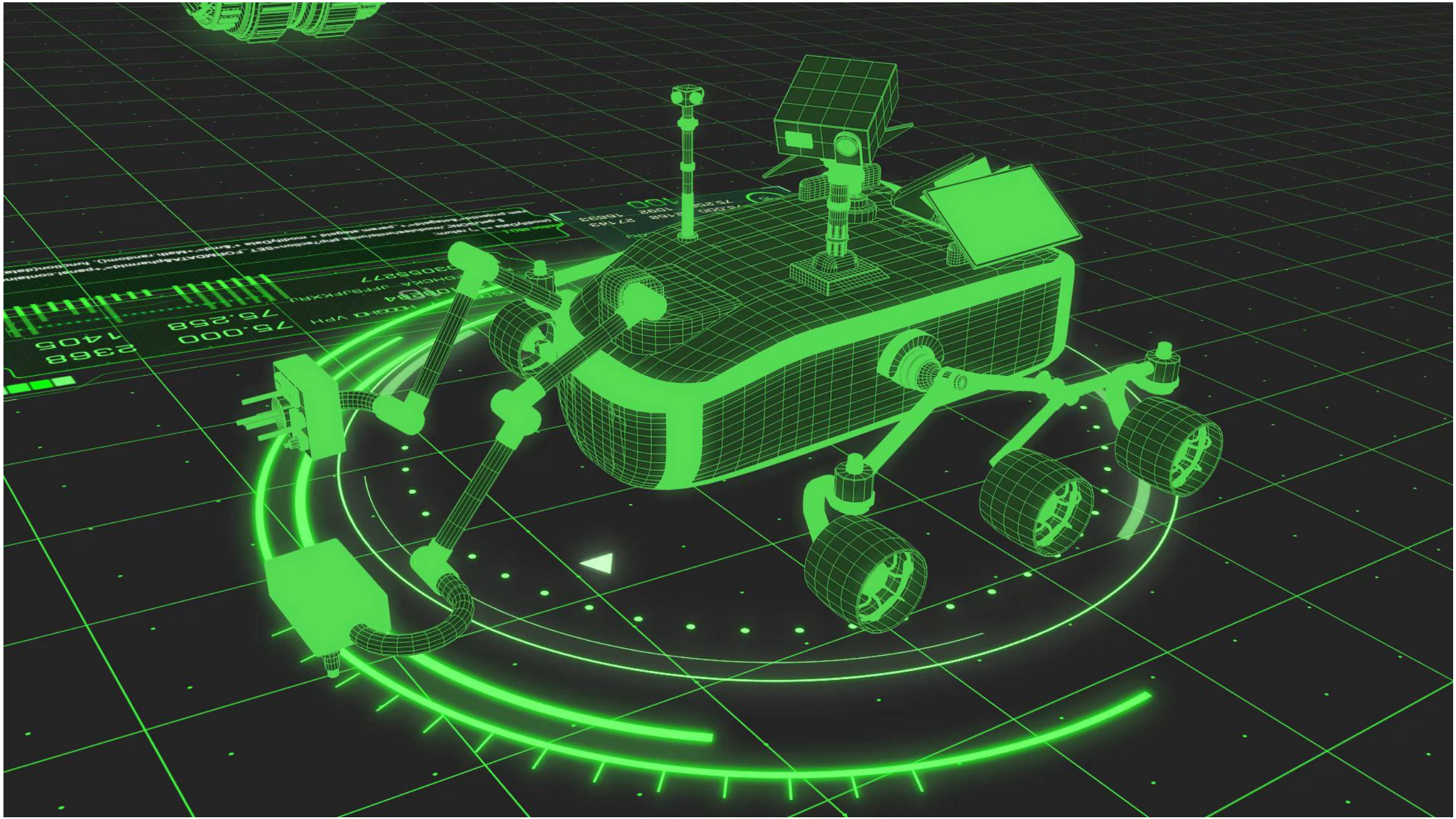
2023


Intelligenza
Umana

- Percezione sensoriale (prospettive visive)
- Valutazione tecnica (gesto Atletico)
- Focalizzazione (interesse: memoria)
- Impatto emotivo →
- ….. Intuito

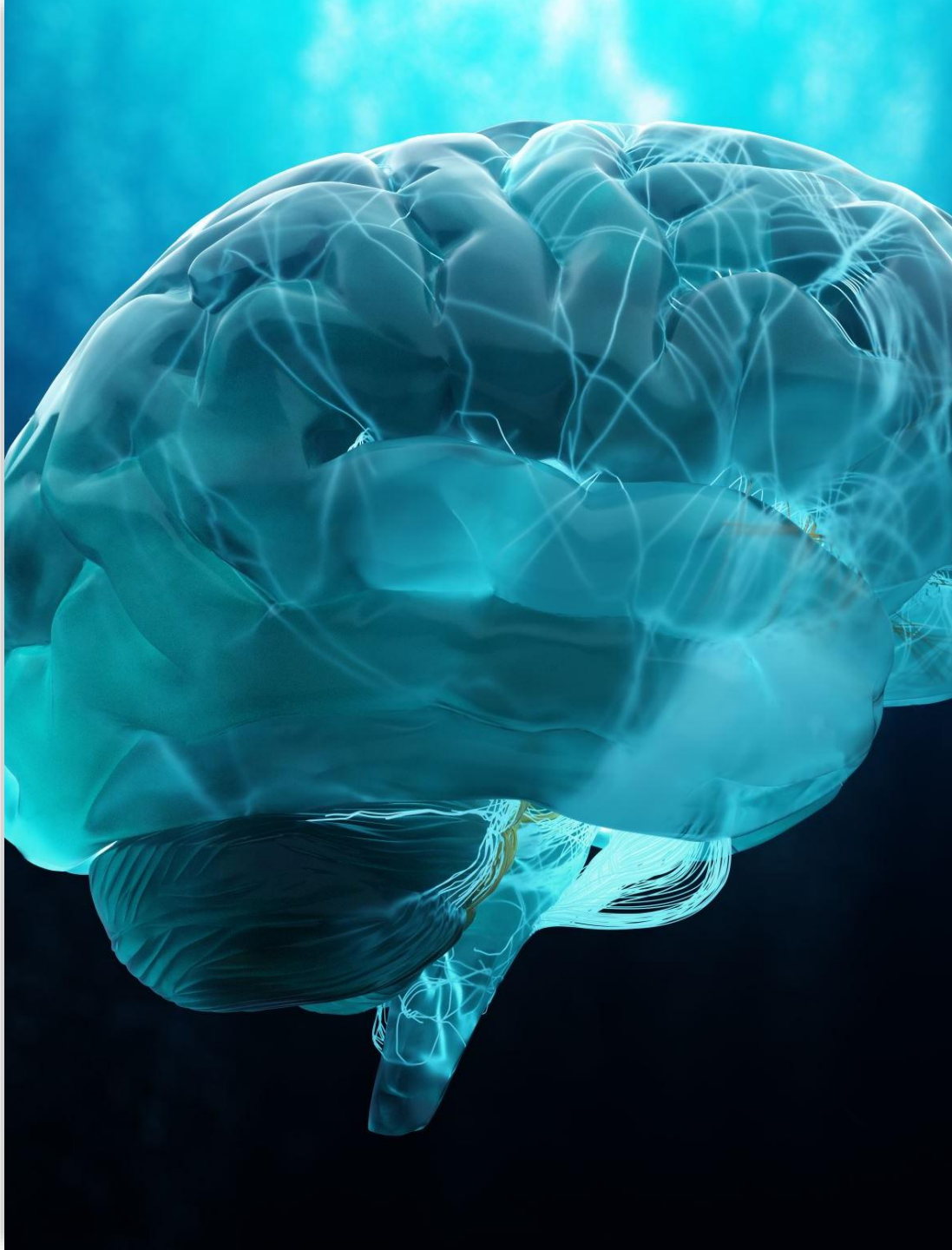
Può una macchina imitare il nostro cervello?


Grigorij Jakovlevič Perel'man



Cervello e Macchina

- Il nostro cervello pianifica anche sul lungo tempo … non siamo solo risposte a stimoli.
- La nostra risposta non è sempre e solo logica … non siamo macchine.
- Senza coscienza non avremmo alcuna sensazione di fame, sete, desiderio sessuale, fatica e paura…. sopravvivenza.
- Il nostro essere è frutto di interazione sociale.
- Il colpo di genio è solo nostro



Article

Data-driven Machine Learning Models for Risk Stratification and Prediction of Emergence Delirium in Pediatric Patients Underwent Tonsillectomy/Adenotonsillectomy

Alessandro Simonini[1], Jeevitha Murugan[2], Alessandro Vittori[3], Roberta I
Elena Giovanna Bignami[4], Maria Grazia Calevo[5], Ornella Piazza[6], Marc

Ann. Ital. Chir., 2024 95, 5: 944–955
https://doi.org/10.62713/aic.3485

Results

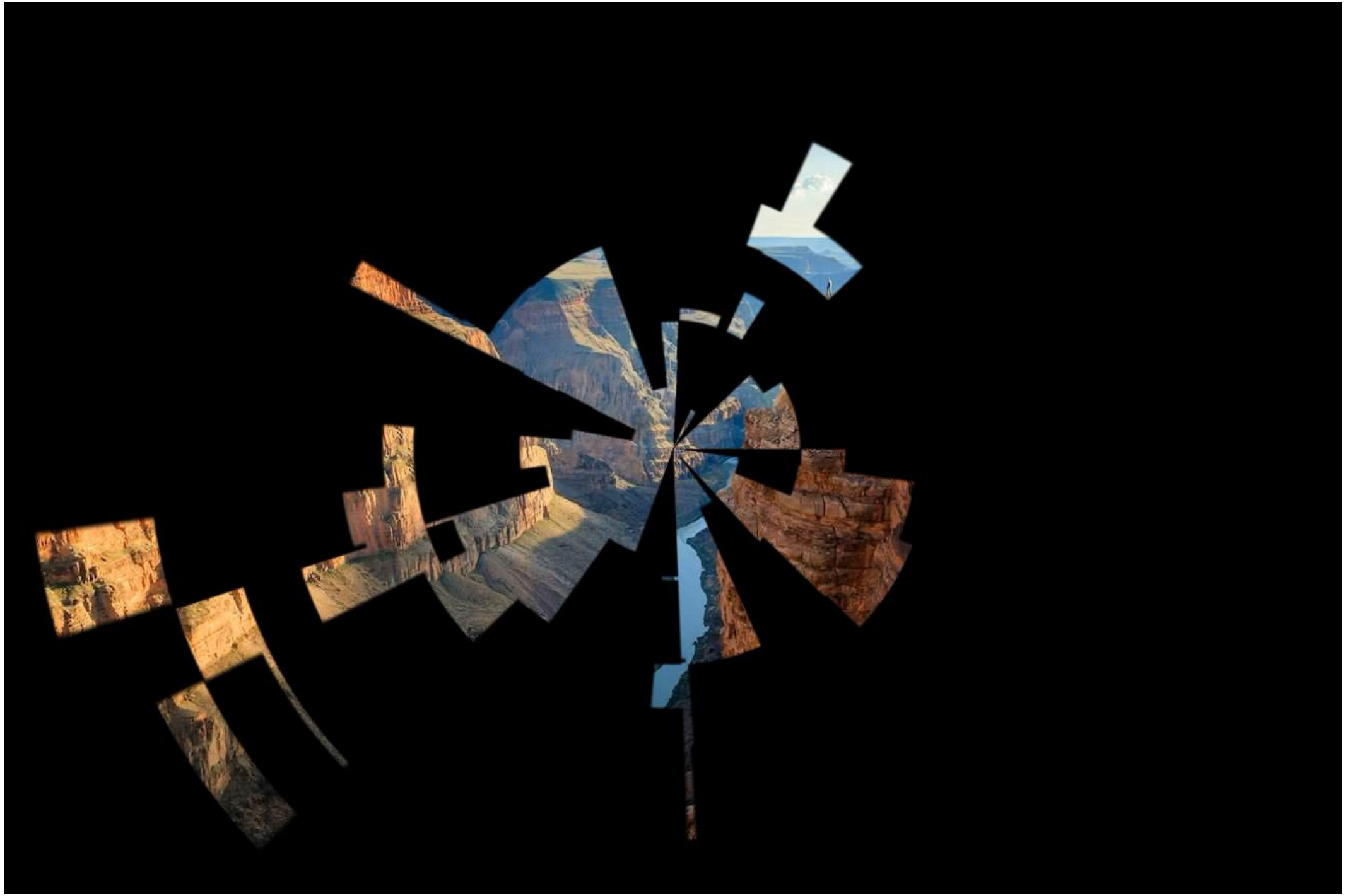
Exploratory Data Analysis Results

The exploratory data analysis provided insights into the variable distributions and relationships within the dataset. Given the original dataset [13], we analyzed data from 423 children (184 females, 239 males). The patients' ages range from 1.5 to 10.1 years old at the time of the procedure, based on their birth dates (mean 3.66 years; SD 1.33). Weights ranged from a minimum of 9.5 kg to 40 kg, with a mean weight of approximately 18 kg (SD 5). Most patients had an ASA score of 1 or 2, n = 211 (49.9%) and n = 207 (48.9%), respectively. The surgery duration spanned from short outpatient procedures of less than 10 minutes to cases lasting 50 minutes (mean 19.8 minutes, SD 5.08) (Fig. 1).

3. Results

3.1. Exploratory Data Analysis Results

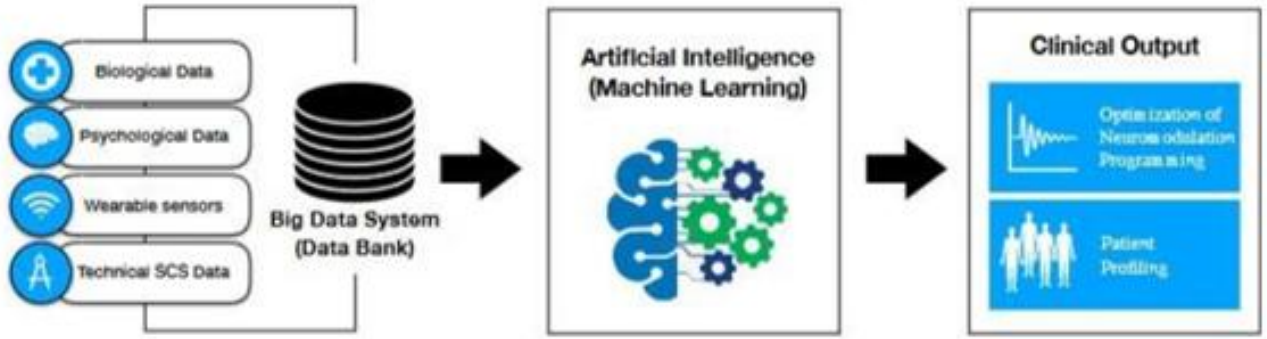
The exploratory data analysis provided insights into the varia
the medical dataset. The summary statistics showed the age
(describe() output). Weight ranged from 40-150 kg with a m
range from 0.5 hours to over 12 hours
Moreover, the age histogram showed a bimodal distribut
variable surgery duration was heavily right-skewed with a long tail of longer procedures (Figure 1).




Intelligenza Artificiale e Dolore

Clinical Applications of AI in Pain Medicine

- Computed-Aided Diagnosis (e.g., **Fibromyalgia**)
- Predictive Models for Disease Progression (e.g., **Low Back Pain?)**
- AI-Based Pain Treatments … **PREDICT-AI SIAARTI**



SIAARTI

Figura 1. Obiettivo dello studio. La raccolta e l'analisi dei dati multiparametrici consentirà di personalizzare il percorso di SCS.

- Real Time Monitoring (**Telemedicine**)
- Opioid Use Disorders?
- Pain in special populations

Automatic Pain Assessment

IASP
INTERNATIONAL ASSOCIATION FOR THE STUDY OF PAIN

Pain. 2020;161(9):1976-1982

Pain

An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage.

Pain is ALWAYS a personal experience… it is influenced by biological, psychological, and social factors

It is the main reason for the lacking possibility to make a diagnosis based on pain descriptors.

PAIN
- Subjective
Phenomenon

ARTIFICIAL INTELLIGENCE
- Objective
processes

*Created by **Marco Cascella** and **Federico Semeraro** (Midjourney)*

Automatic Pain Assessment

Pain Research and Management
Volume 2023, Article ID 6018736, 13 pages
https://doi.org/10.1155/2023/6018736

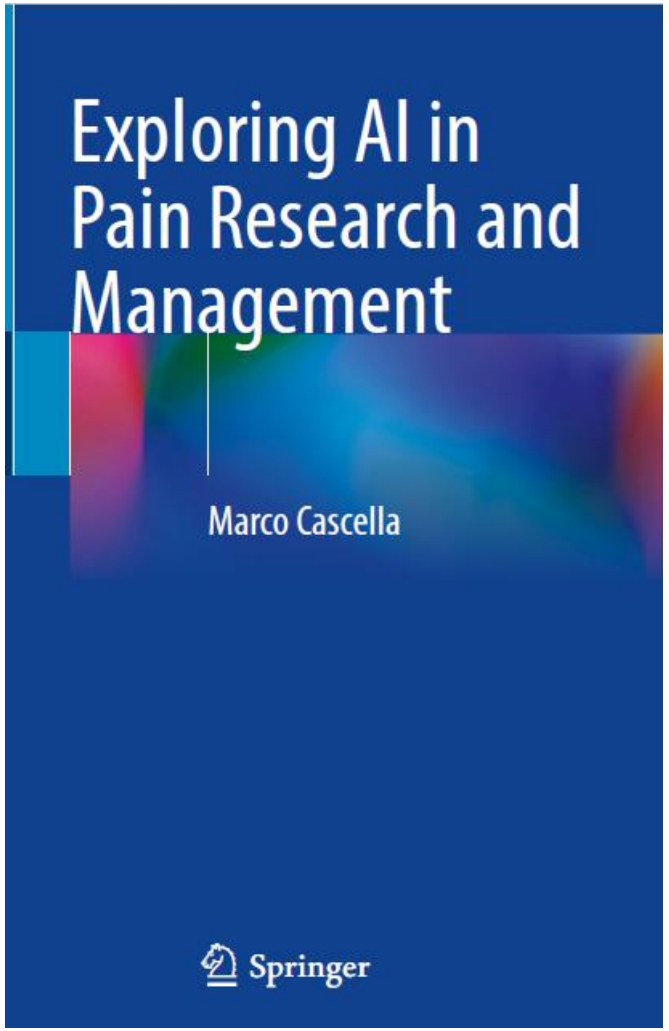
Review Article

Artificial Intelligence for Automatic Pain Assessment: Research Methods and Perspectives

Marco Cascella,[1] Daniela Schiavo,[1] Arturo Cuomo,[1] Alessandro Ottaiano,[2] Francesco Perri,[3] Renato Patrone,[4,5] Sara Migliarelli,[6] Elena Giovanna Bignami,[7] Alessandro Vittori,[8] and Francesco Cutugno[9]

APA methods provide objective measurements of pain and span an interdisciplinary research field that combines aspects of medicine, psychology, psychobiology, biomedical engineering, and computer science.

Brain regions targeted for APA



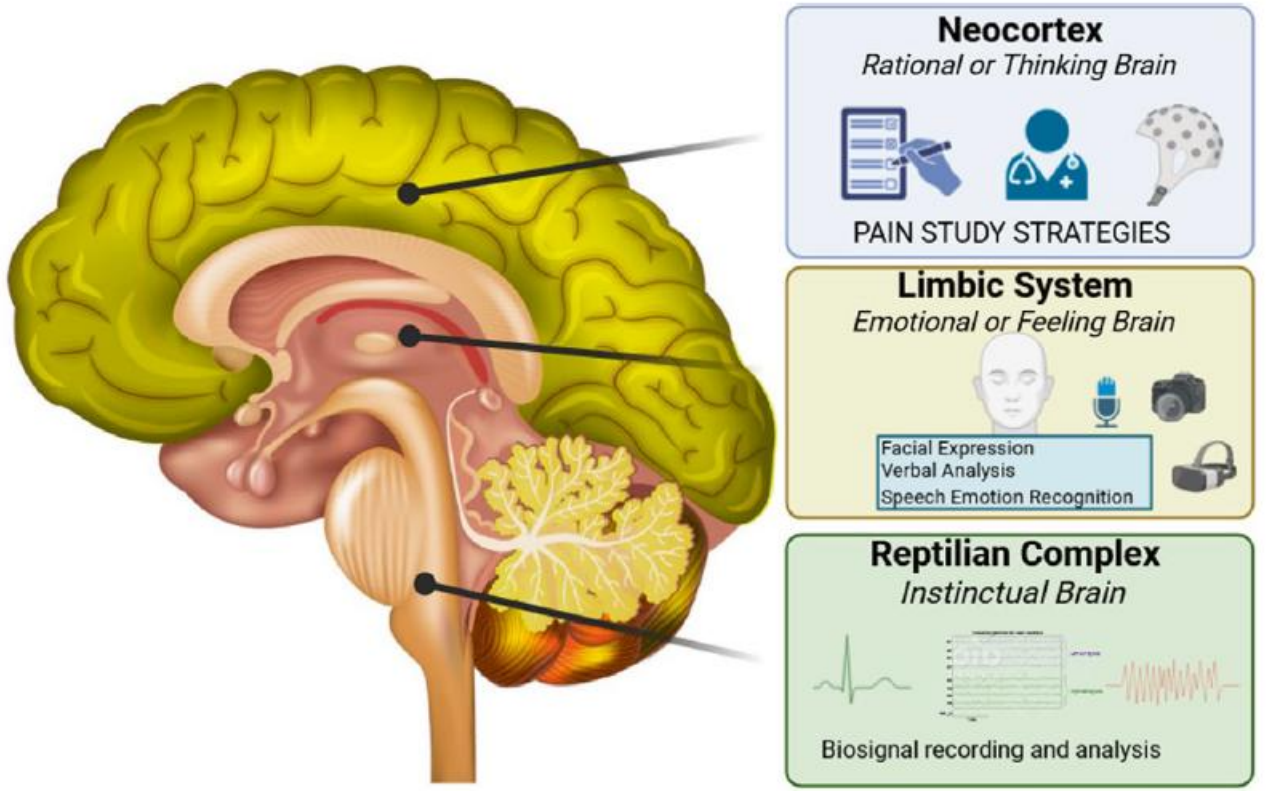
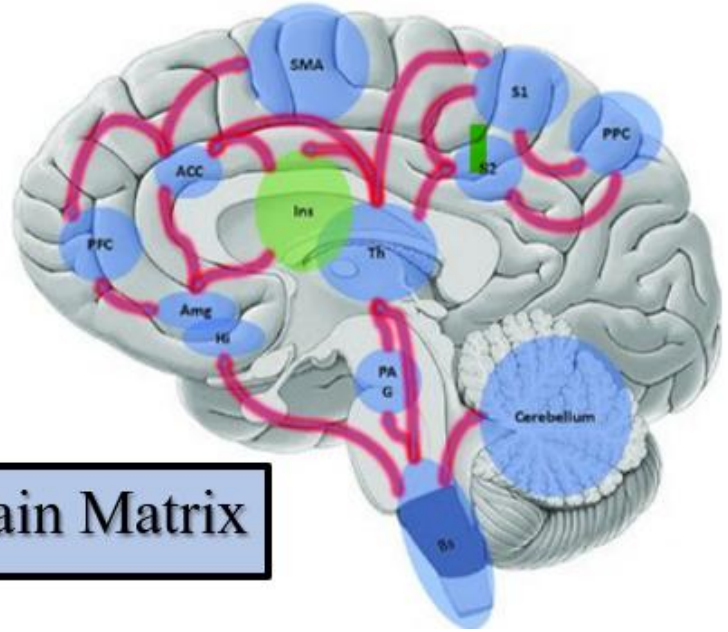
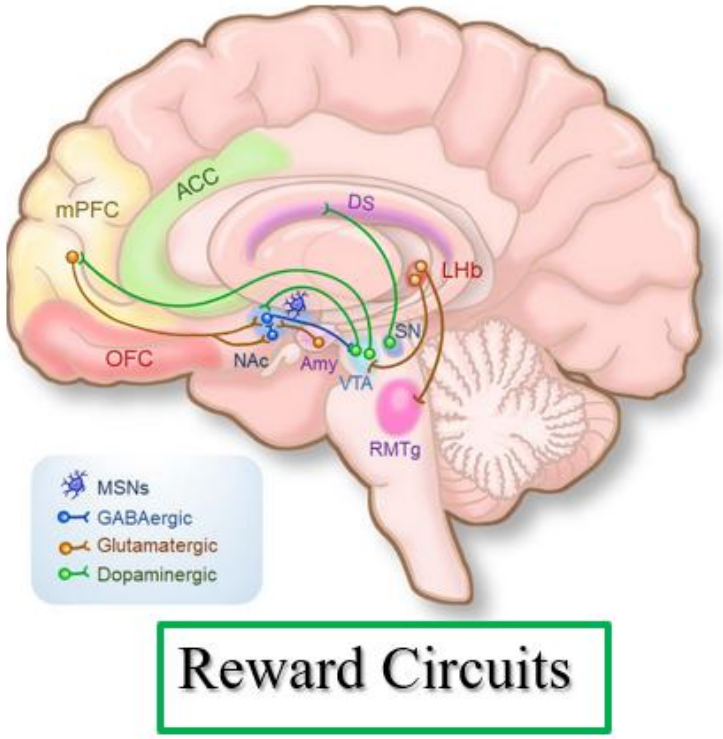


Fig. 3.1 Brain targets for APA research. Strategies for studying pain are categorized by the targeted brain regions and their processing mechanisms. The neocortex, particularly the somatosensory area, is crucial for understanding pain's location, intensity, and quality. Techniques such as imaging, EEG, and clinical examinations are used to investigate these mechanisms. The limbic system, the emotional center of the brain, is studied through behavioral approaches like facial expressions and speech emotion recognition. Lastly, the brainstem, the most ancient brain part, controls instinctual responses, with pain studies here focusing on recording and analyzing various biosignals

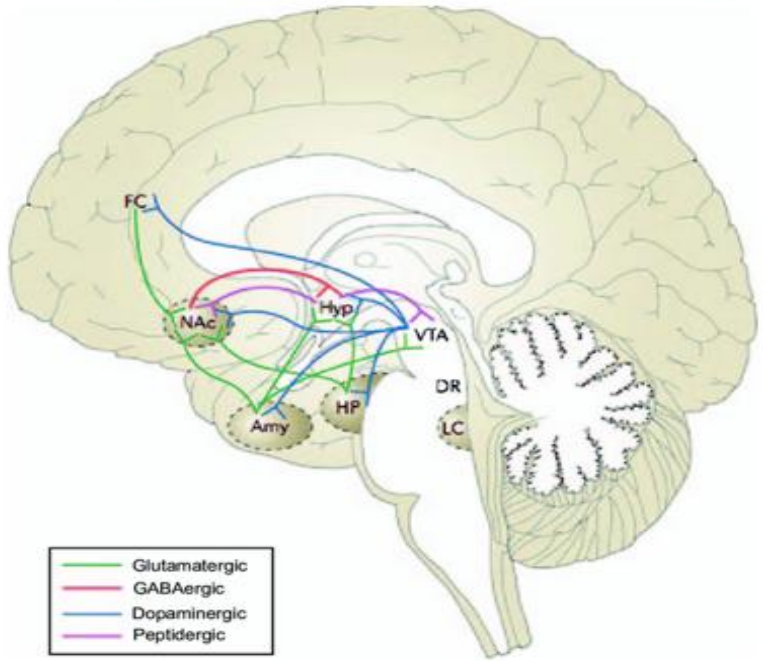


SISTEMA LIMBICO

Nucleo del setto: Piacere
Ippocampo: Memoria, Apprendimento
Amigdala: Emozioni (paura)
Nucleo Accumbens: Reward, piacere, addiction
Ipotalamo: processi autonomici
Talamo (n. anteriori): sensory processing
Gangli Basali: Movimenti



Depression Circuits



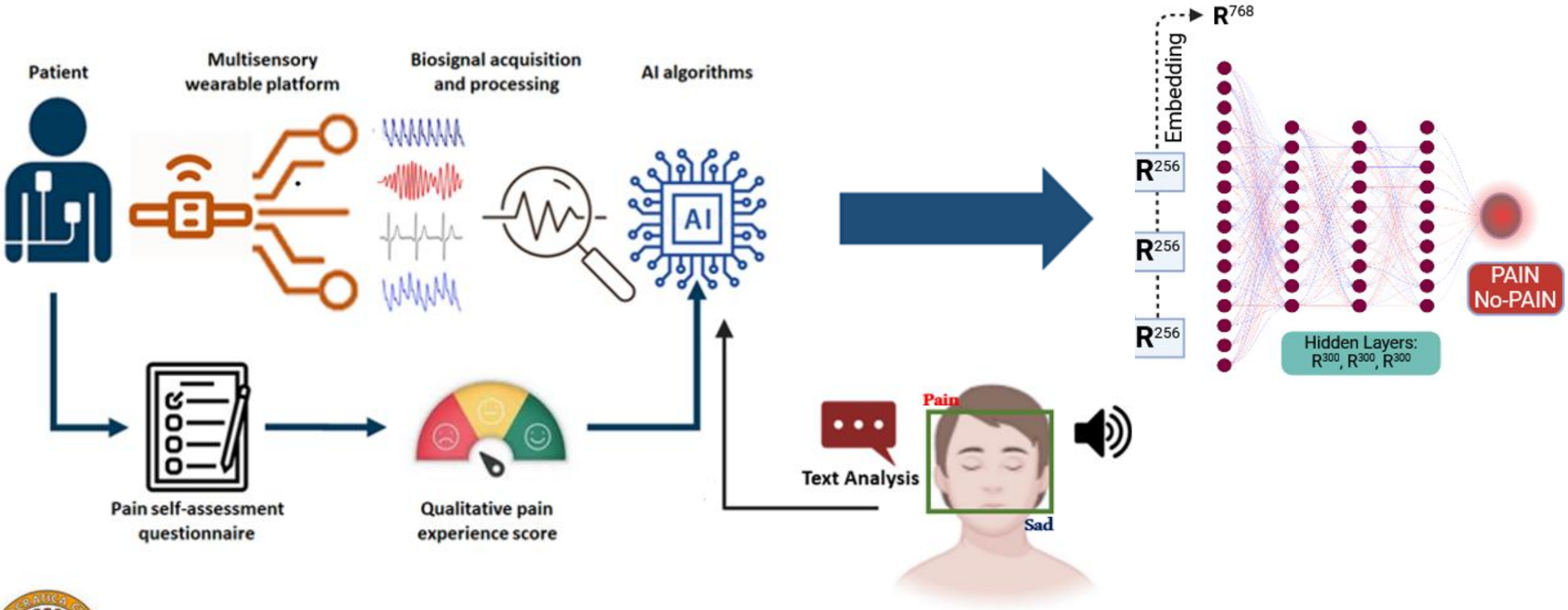
Framework for APA investigation

Pain ASsessment in CAncer Patients by Machine LEarning (PASCALE) (PASCALE)

ClinicalTrials.gov ID NCT04726228

Sponsor National Cancer Institute, Naples

Information provided by National Cancer Institute, Naples (Responsible Party)

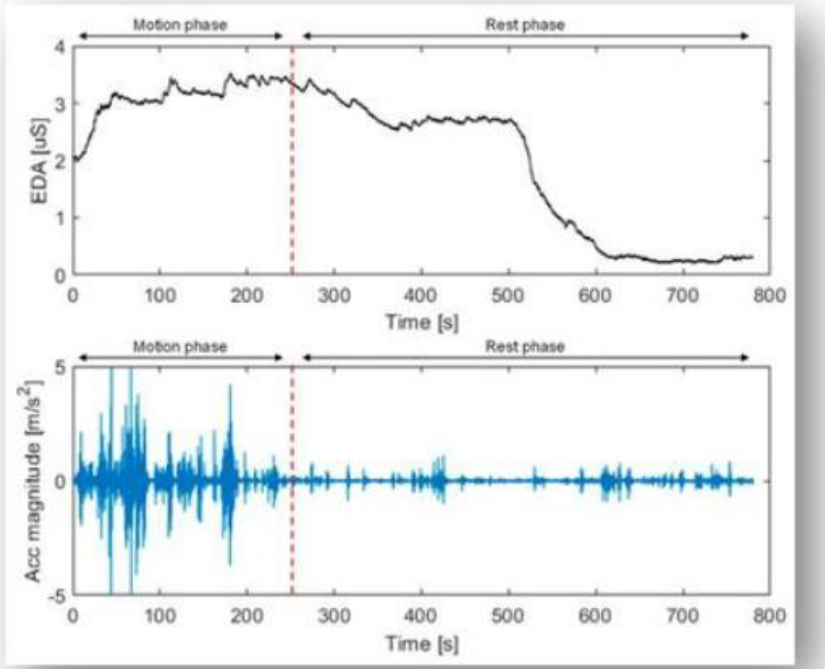


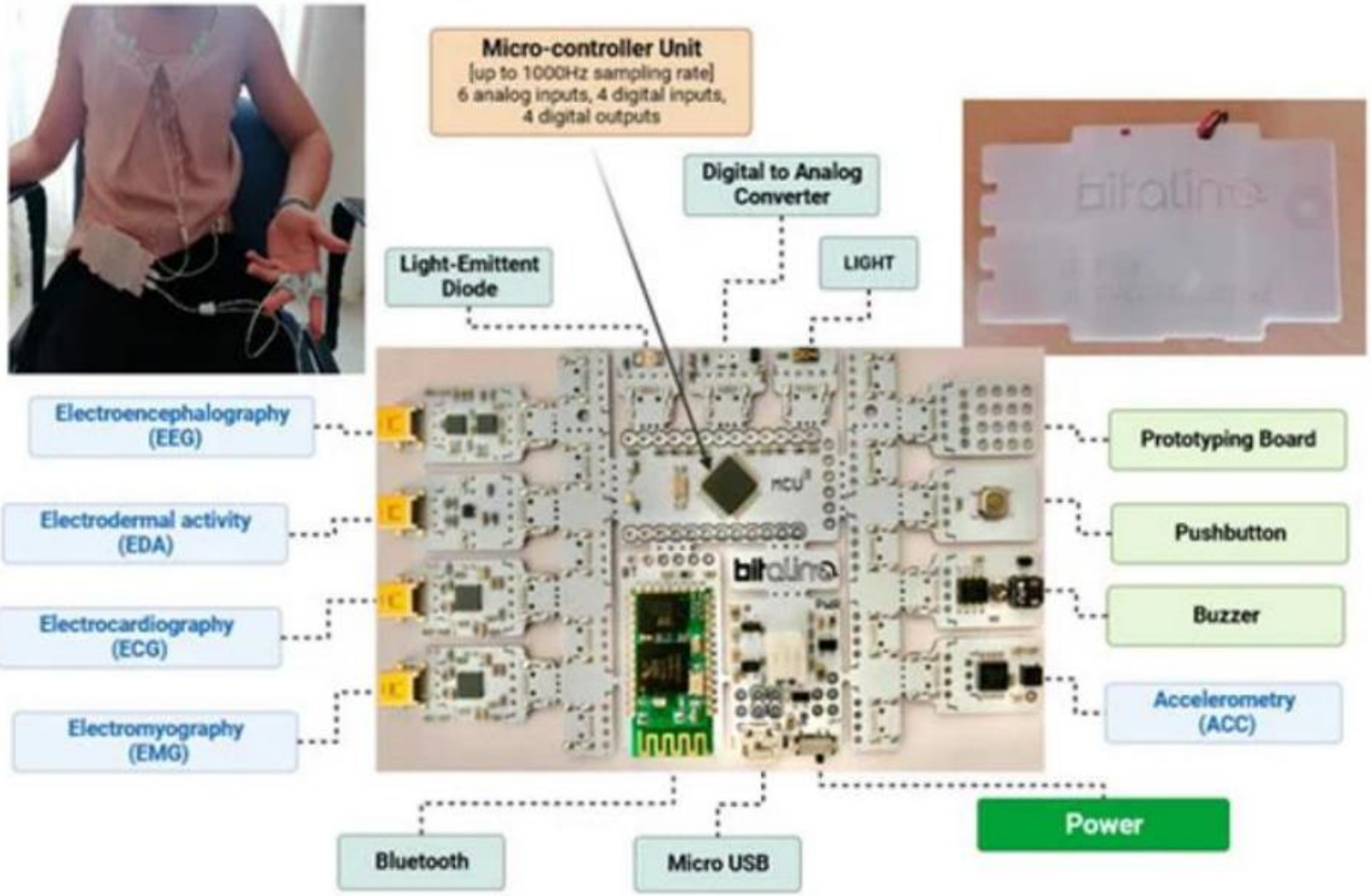
electronics

Article

Exploring Biosignals for Quantitative Pain Assessment in Cancer Patients: A Proof of Concept

Marco Cascella [1], Vincenzo Norman Vitale [2,3], Michela D'Antò [1], Arturo Cuomo [1], Francesco Amato [3], Maria Romano [3,*] and Alfonso Maria Ponsiglione [3]





Electronics **2023**, *12*(17), 3716; https://doi.org/10.3390/electronics12173716

Biosignals & Pain

electronics

Submit to this Journal

Review for this Journal

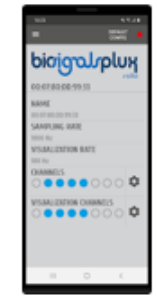
Propose a Special Issue

Open Access Article

Exploring Biosignals for Quantitative Pain Assessment in Cancer Patients: A Proof of Concept

by Marco Cascella [1], Vincenzo Norman Vitale [2,3], Michela D'Antò [1], Arturo Cuomo [1], Francesco Amato [3], Maria Romano [3,*] and Alfonso Maria Ponsiglione [3]

EDA signal increases with motion □□ Motion-Related Pain



Simultaneous registration of EDA and motion through Wearable Sensors and Smartphone Accelerometer

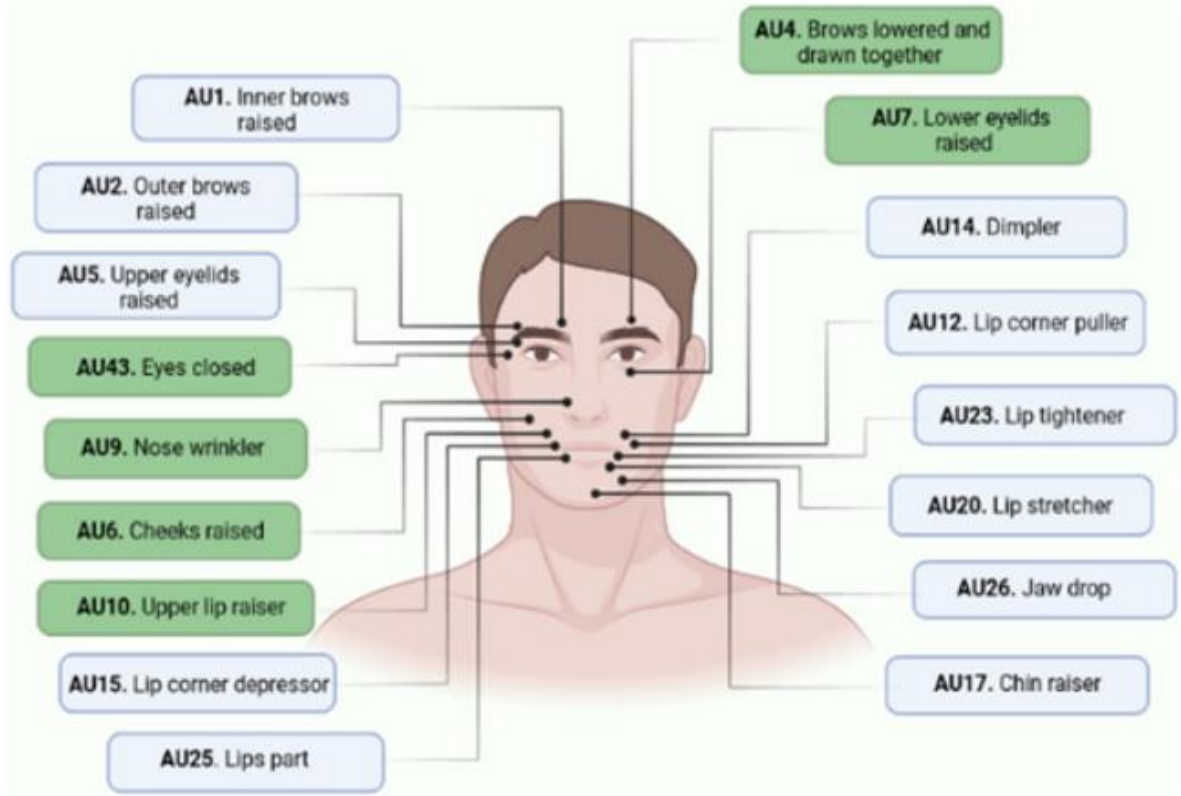
Facial Video for Cancer Pain Classification

Scand J Pain 2023; 23(4): 638–645 DE GRUYTER

Clinical Pain Research

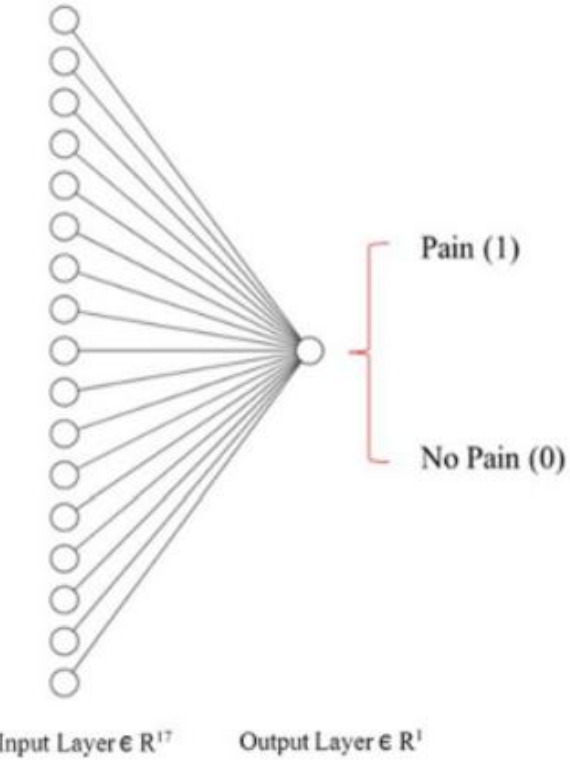
Marco Cascella*, Vincenzo Norman Vitale, Fabio Mariani, Manuel Iuorio and Francesco Cutugno

Development of a binary classifier model from extended facial codes toward video-based pain recognition in cancer patients

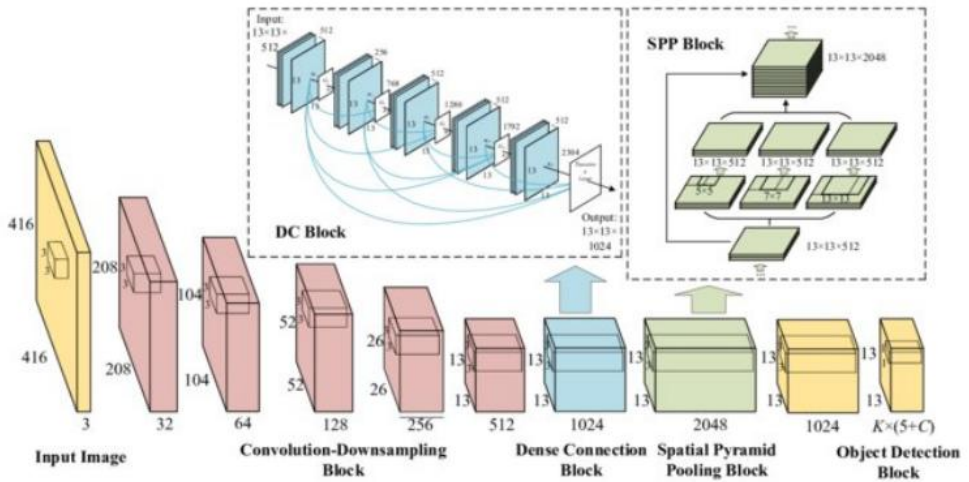


Action Units Extraction

- Brow Lowering (AU4)
- Orbital Tightening (AU6 and AU7)
- Levator Contraction (AU9 and AU10)
- Eye Closure (AU43)
- Inner Brow Raiser (AU01)
- Outer Brow Raiser (AU02)
- Upper Lid Raiser (AU05)
- Lip Corner Puller (AU12)
- Dimpler (AU14)
- Lip Corner Depressor (AU15)
- Chin Raiser (AU17)
- Lip Stretcher (AU20)
- Lip Tightener (AU23)
- Lips Part (AU25)
- Jaw Drop (AU26)



REC


DC Block
SPP Block
13×13×2048
13×13×512
13×13×512
13×13×512
13×13×512
416
416
208
208
104
104
52
52
26
26
13
13
13
13
13
13
13
13
3
32
64
128
256
512
1024
2048
1024
K×(5+C)
Input Image
Convolution-Downsampling Block
Dense Connection Block
Spatial Pyramid Pooling Block
Object Detection Block


www.Bandicam.com
LIVE AIR7HD
SKYMAP7
13M/h
BREAKING NEWS
POLICE CHASING STOLEN VEHICLE
EYEWITNESS NEWS
5:55
71°

Journal of Pain Research

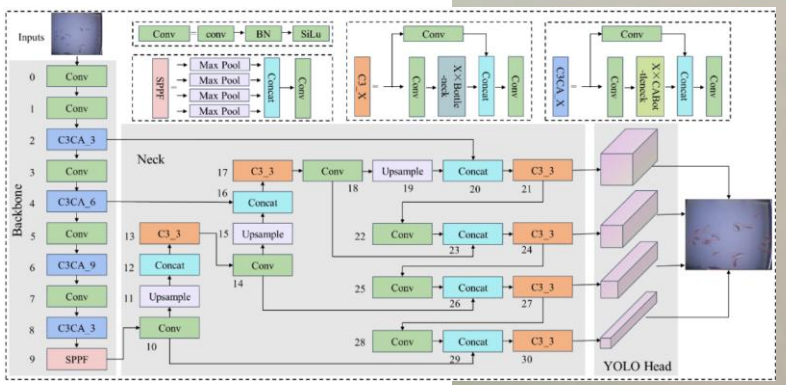
Dovepress

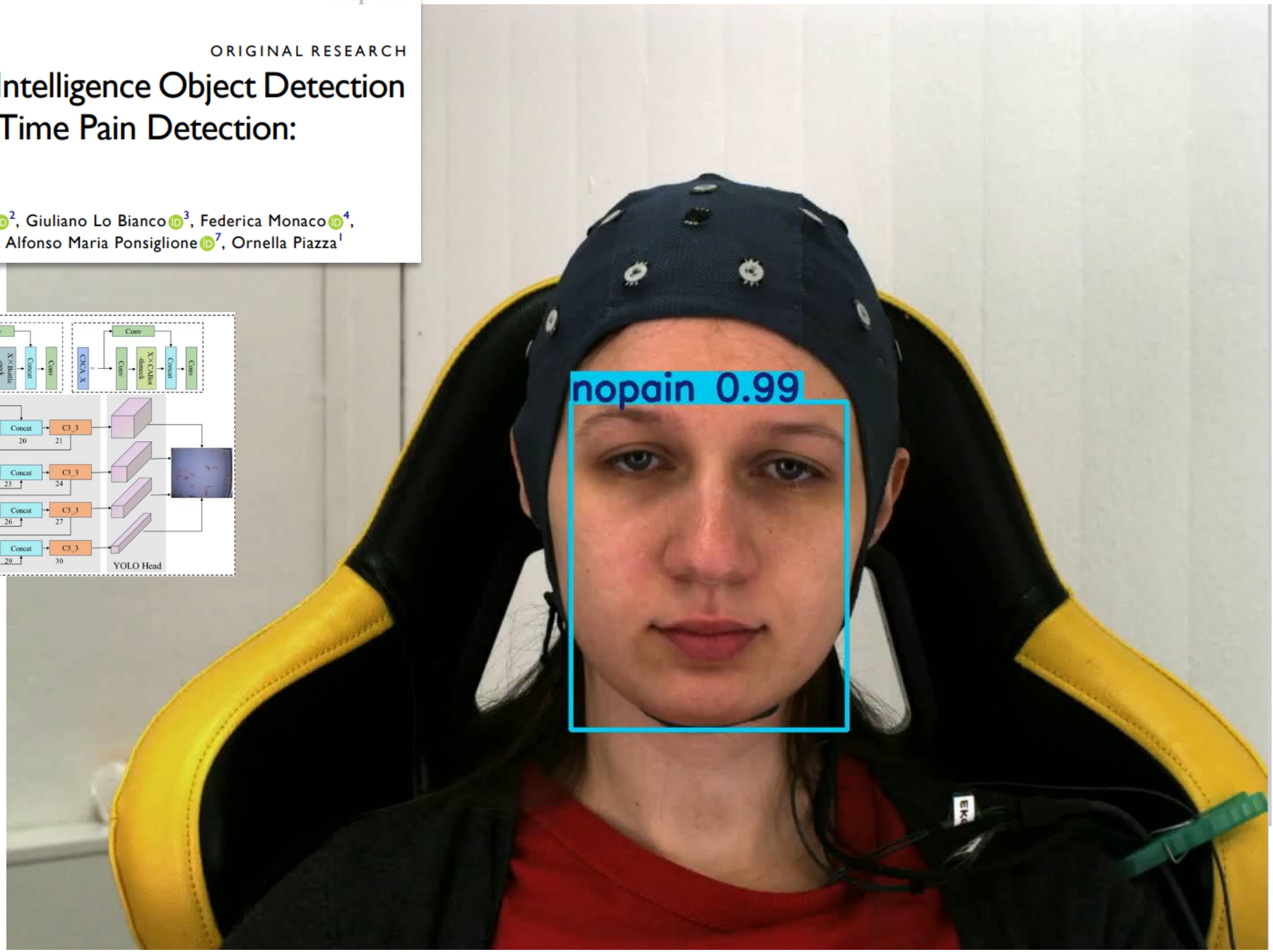
Open Access Full Text Article

ORIGINAL RESEARCH

Employing the Artificial Intelligence Object Detection Tool YOLOv8 for Real-Time Pain Detection: A Feasibility Study

Marco Cascella[1], Mohammed Naveed Shariff[2], Giuliano Lo Bianco[3], Federica Monaco[4], Francesca Gargano[5], Alessandro Simonini[6], Alfonso Maria Ponsiglione[7], Ornella Piazza[1]





REC

Speech Emotion Recognition (SER)

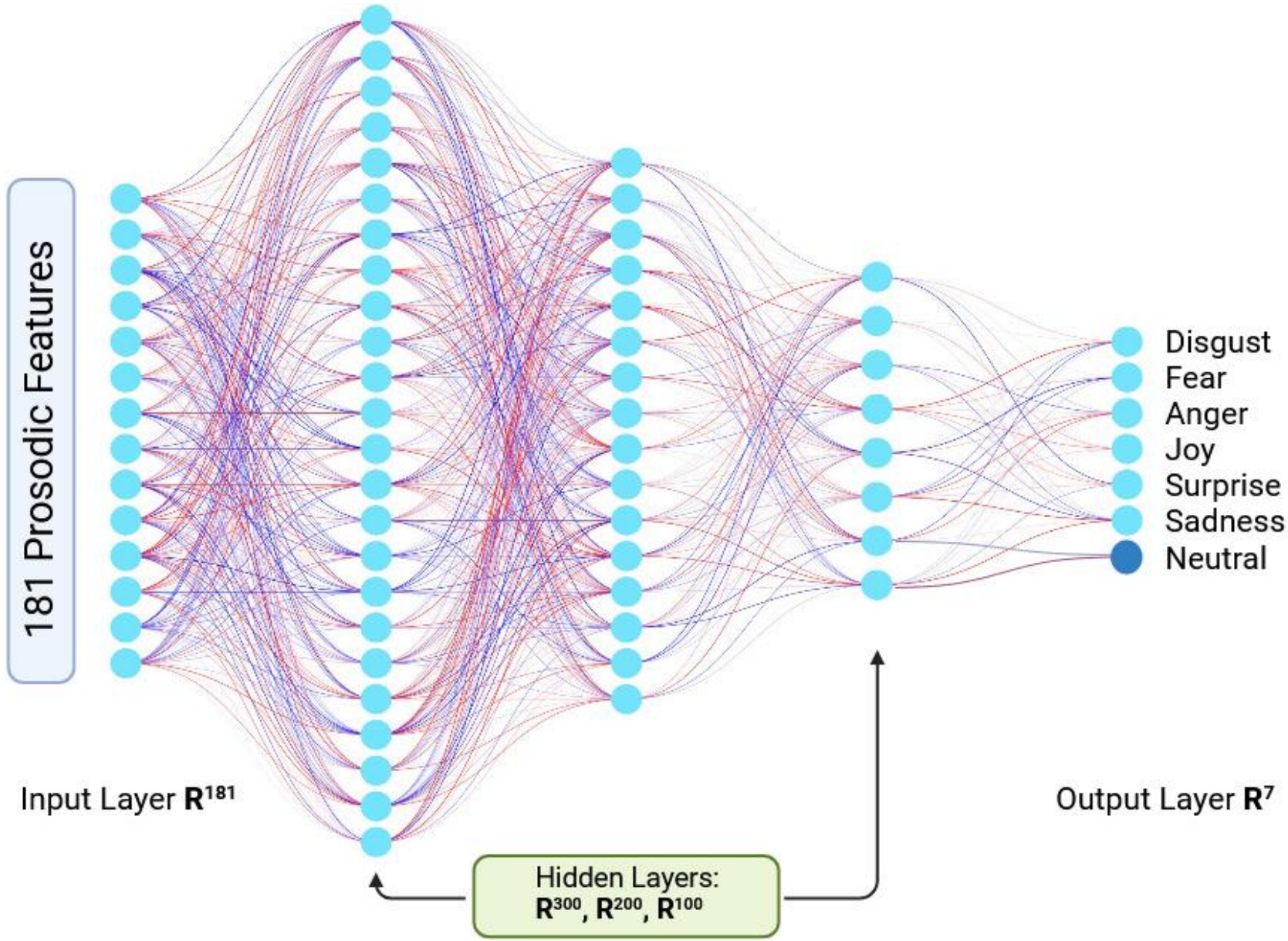
It is a typical pattern recognition problem consisting of two major stages:

- Feature extraction: capturing emotion-relevant features from voice
- Classification: training and a testing phase for detecting the type of emotion

BIG SIX: disgust, fear, anger, joy, surprise, sadness plus the neutral state

Figure 4 Makesense.ai implementation to manually label images based on the Prkachin and Solomon Pain Intensity (PSPI) score. The four images in the figure show different facial expressions of a subject, with bounding boxes drawn around the face. In each image, a bounding box is drawn to highlight the face, and different colors of boxes indicate different labels or levels of pain intensity assigned during the manual annotation process. There is a progression from a neutral expression (top row) to more intense facial expressions associated with pain (bottom row).

Notes: Images adapted from Mende-Siedlecki P, Qu-Lee J, Lin J, Drain A, Goharzad A. The Delaware Pain Database: a set of painful expressions and corresponding norming data. *Pain Rep*. 2020;5:e853.[22]

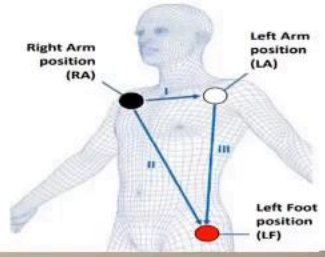

181 Prosodic Features
Disgust
Fear
Anger
Joy
Surprise
Sadness
Neutral
Input Layer $\mathbf{R}^{181}$
Output Layer $\mathbf{R}^{7}$
Hidden Layers:
$\mathbf{R}^{300}$, $\mathbf{R}^{200}$, $\mathbf{R}^{100}$

REC

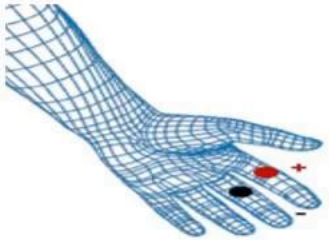
R.U.G.G.I. STUDY

DEVICE POSITIONING

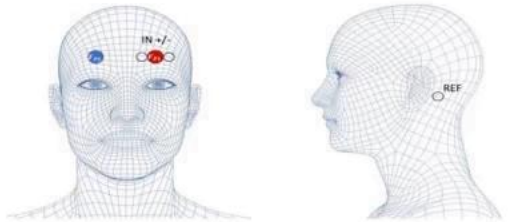
ECG



EDA



EEG



HIPPOCRATICA CIVITAS STUDIUM SALERNI

UNIVERSITÀ DEGLI STUDI DI SALERNO

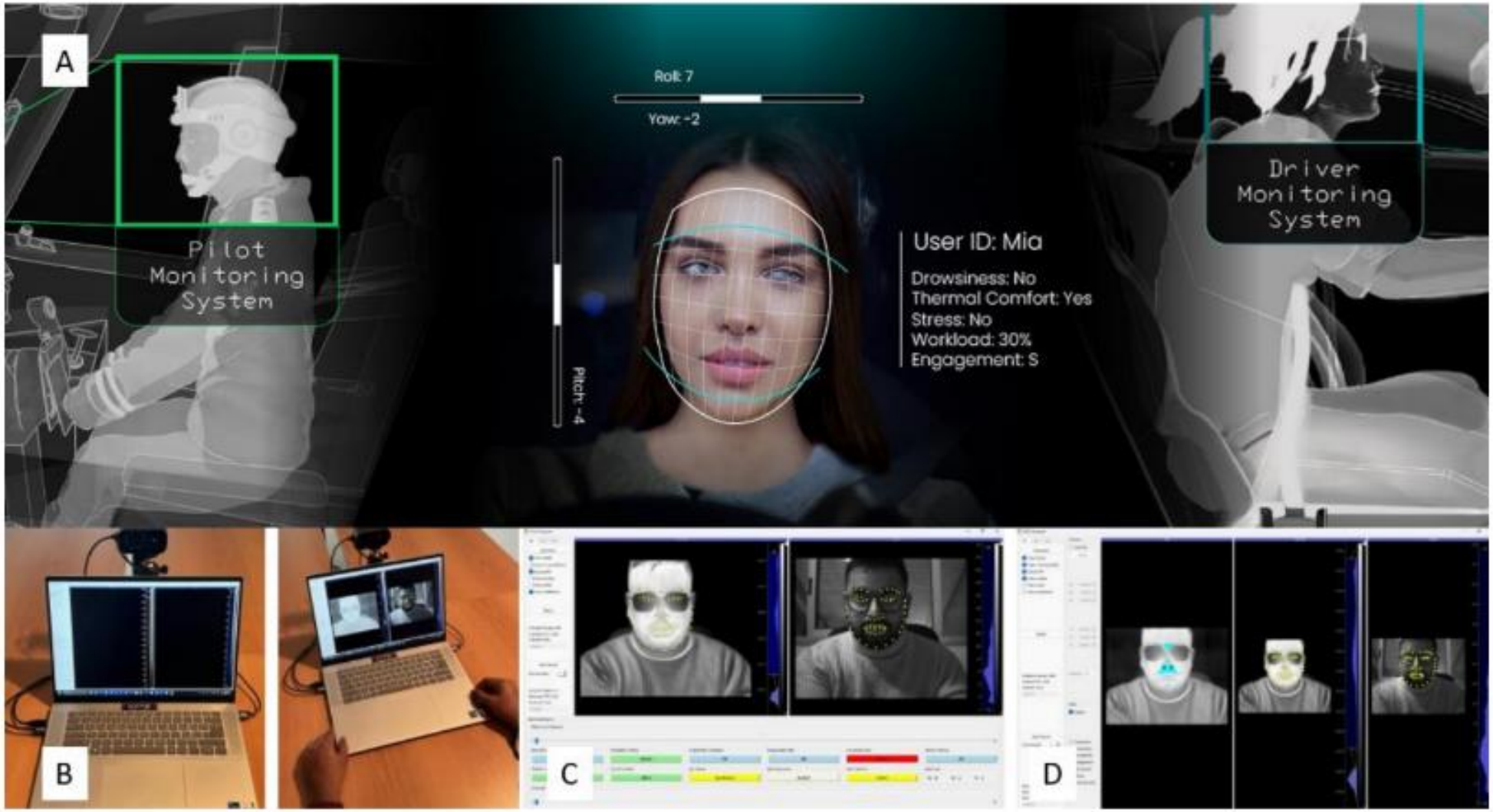
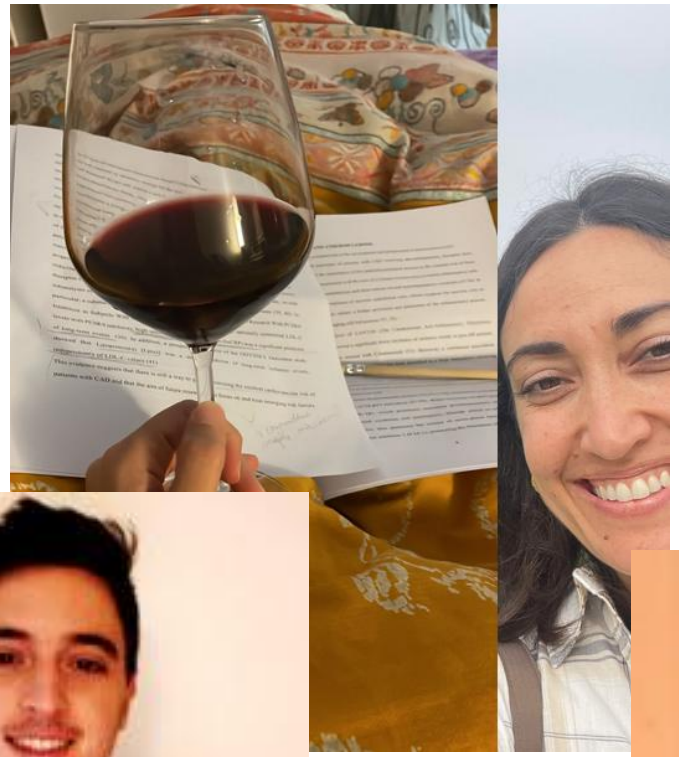


Figura 3. Analisi termografica su infrarosso con tecnologia HIRA. A. Applicazioni in ambito aerospaziale; B. Sistema inizializzato e pronto all'uso ed acquisizione; C. Analisi termografica in tempo reale con tracking del landmark facciali e processamento; D. Landmark e regioni di interesse facciali utilizzate per l'elaborazione.

Grazie per l'attenzione …



NO

Dear Marco,

I have seen Data Manager Job role in the Linkedin and moreover, I am completing my bachelors in Data Science and Artificial Intelligence so would I be fit for the Job role sir