Digital Humanities

Lecture 11

May 5

2025

Mario Verdicchio

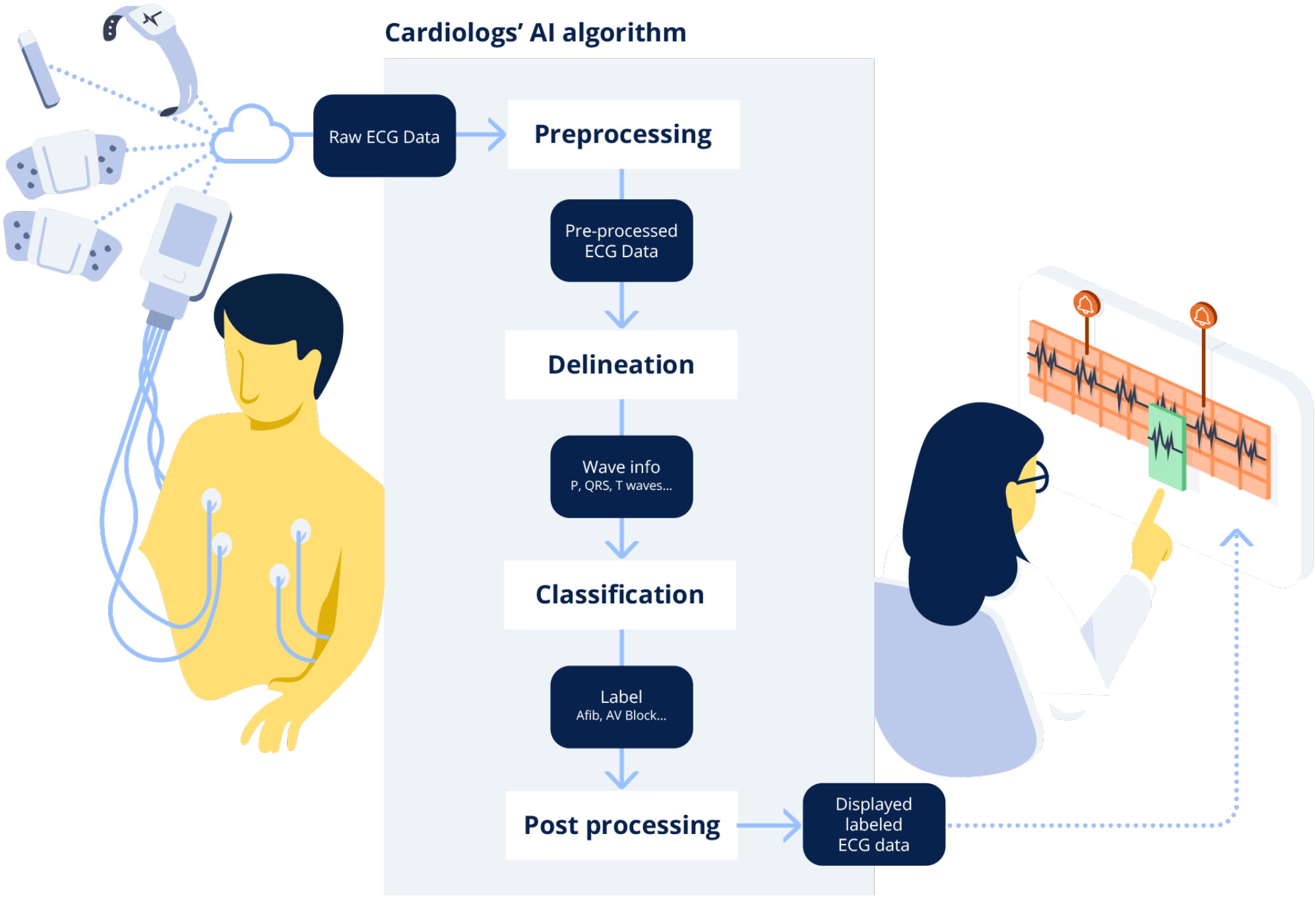
DIGITAL

HUMANITIES

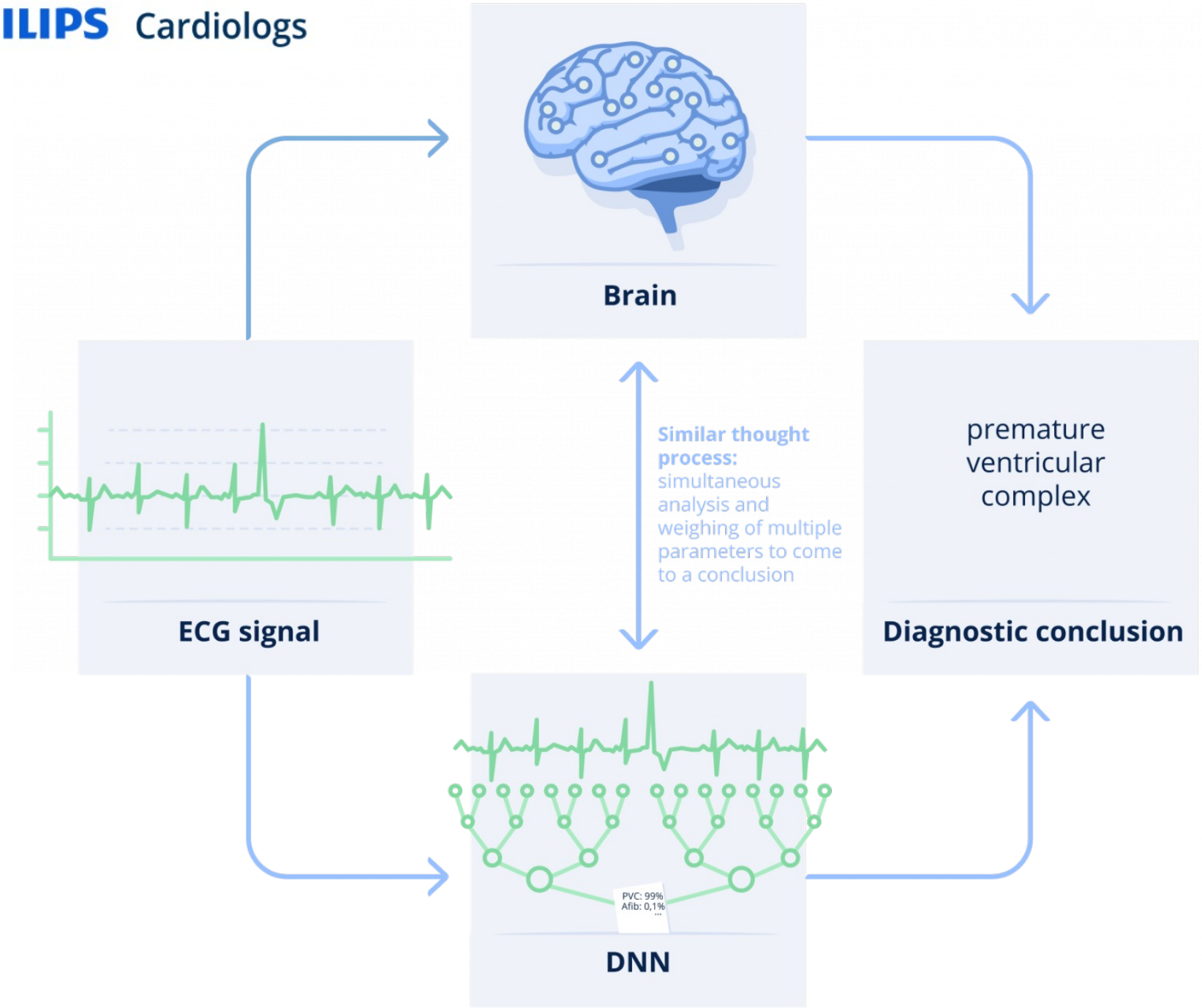
DIGITAL HUMANITIES

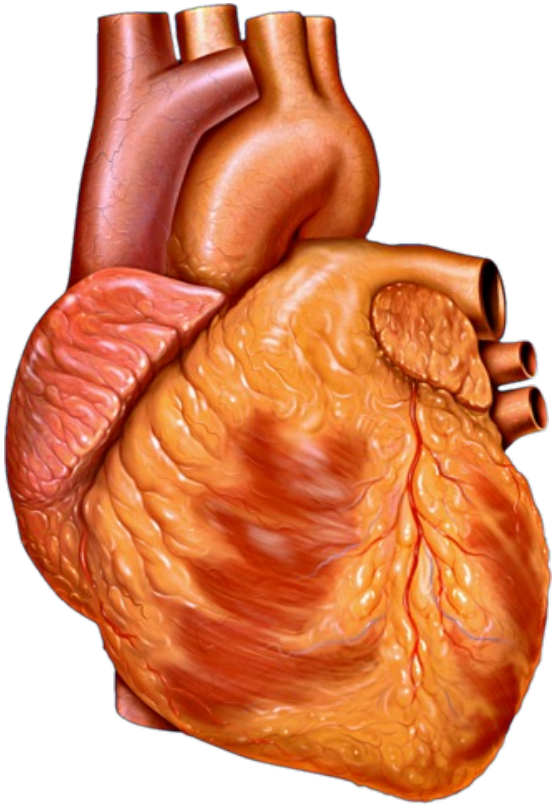
AFFECTIVE COMPUTING

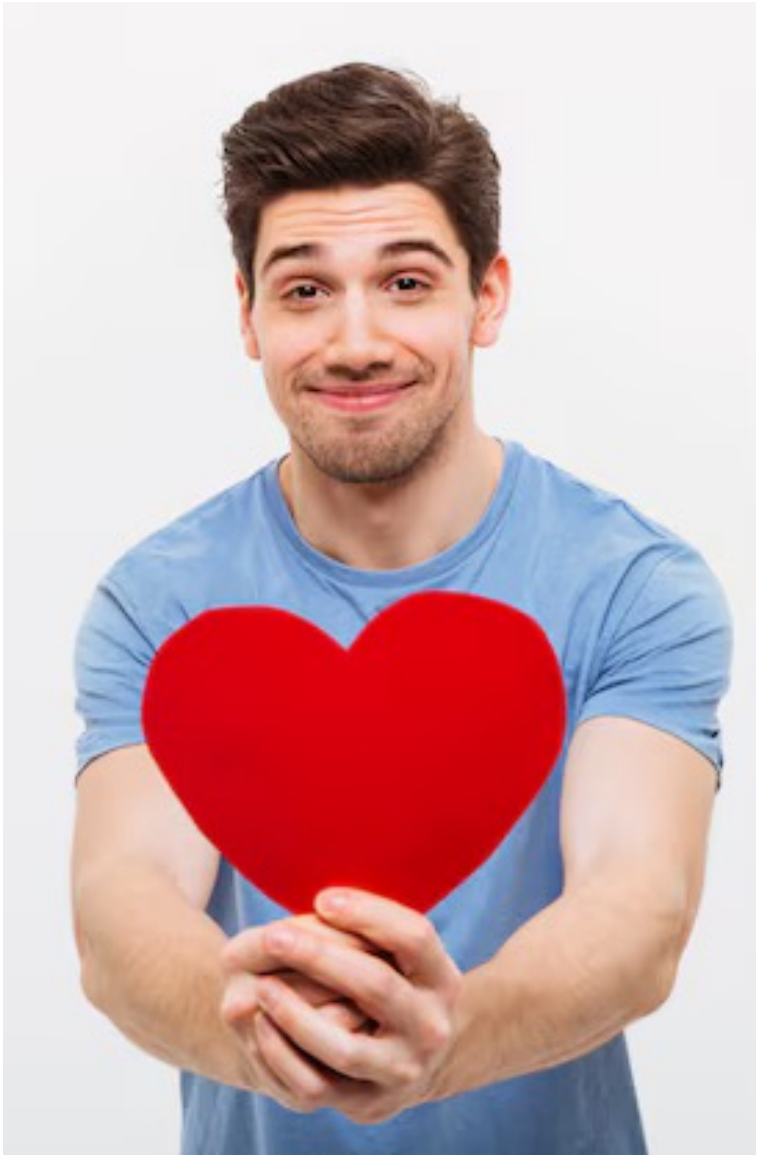
Affective Computing (AC) is an interdisciplinary field at the intersection of Computer Science, Psychology, and Cognitive Science. The aim is to design, develop, and analyze computational apparatuses capable of detecting, processing, interpreting, and simulating human emotion.


Cardiologs' AI algorithm
Raw ECG Data
Preprocessing
Pre-processed ECG Data
Delineation
Wave info
P, QRS, T waves...
Classification
Label
Afib, AV Block...
Post processing
Displayed labeled ECG data

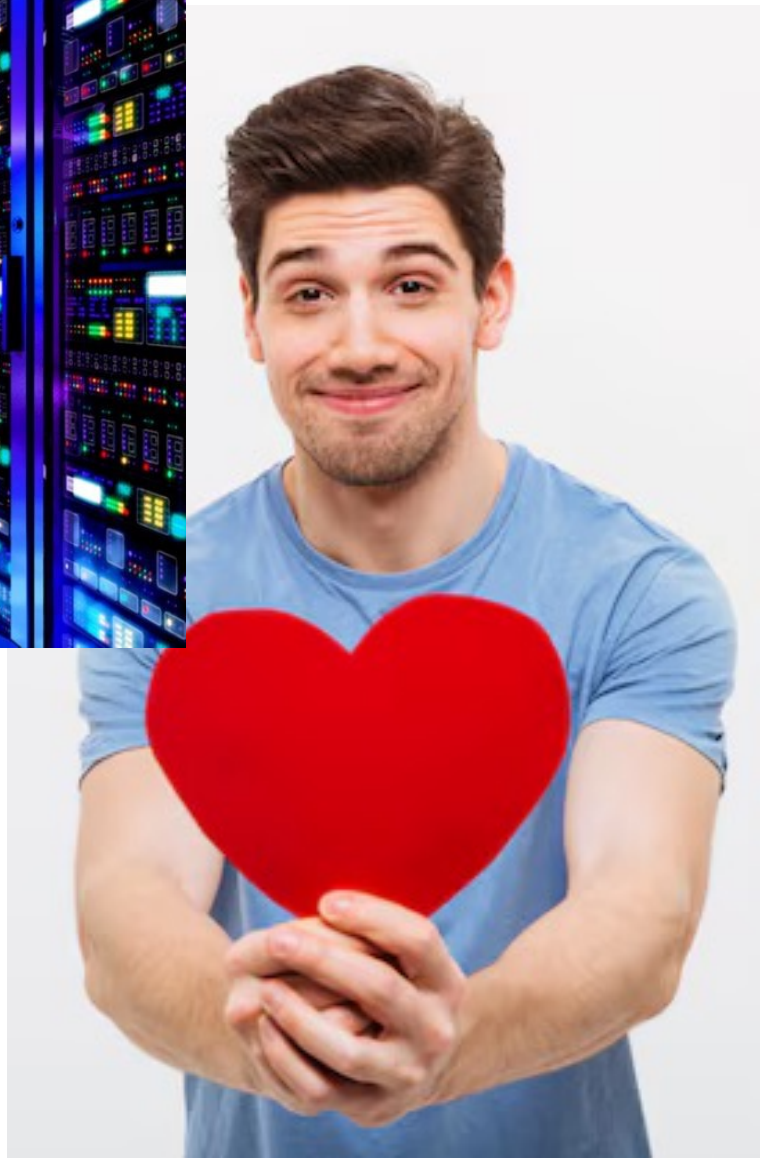
PHILIPS Cardiologs







Affective Computing



Since Affective Computing pursues its goals from a computational perspective, it relies on the core assumption that significant aspects of human emotion are amenable to a numerical description that is compatible with computing machines.

Questions arise regarding such compatibility, among which perhaps the most critical is about how to reconcile emotion's central feature of subjectivity, i.e., the first-person quality generated in and experienced by a human mind, with the nature of computational devices, which are objects in the external world.

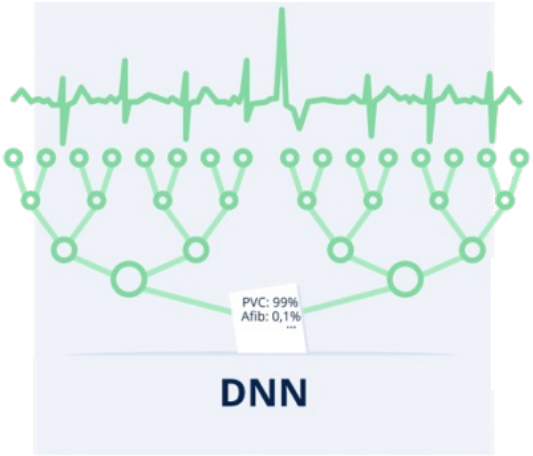
“Intelligence is the computational part of the ability to achieve goals in the world.”

John McCarthy
founder of the discipline of Artificial Intelligence (AI)

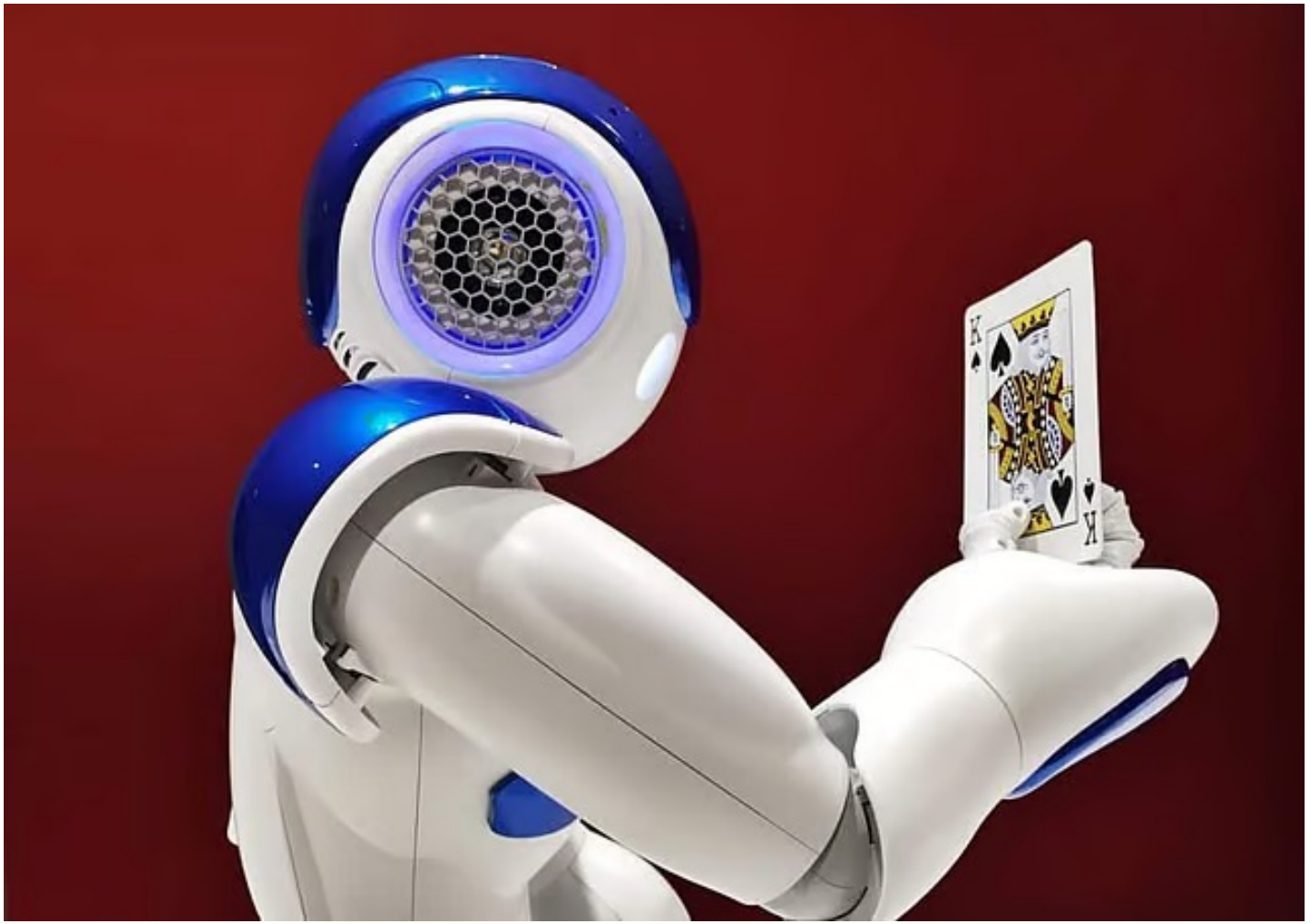
ARTIFICIAL INTELLIGENCE

McCarthy’s project of creating intelligent machines based on the rules of logic failed; however, a debate is still ongoing in this research field, where neural networks and Machine Learning (ML) systems based on statistics have taken center stage in cutting-edge AI technology.

Such debate is about the boundaries of what can be achieved with computing machines with respect to capabilities that are traditionally attributed exclusively to humans.
From this perspective, AC and AI seem to be similar, since both endeavors are about computational approaches to phenomena (emotion and intelligence, respectively) that are so intrinsic to a person's life as they are difficult to grasp and explain from an objective, scientific, and computational point of view.



Computers are now able to best humans at poker, but a machine does not seem to win at poker in the same way a consummate human poker player does.

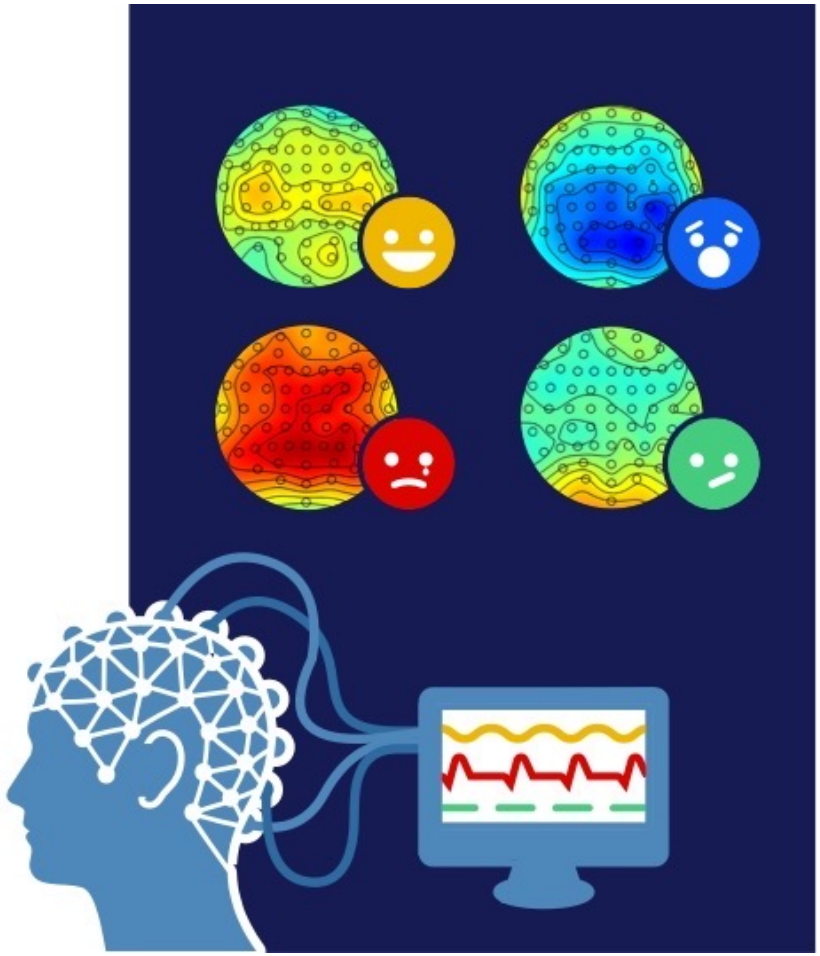


To be able to follow the rules of poker and to take probabilities into account is a facet, although a very narrow one, of what one may call “intelligence” and, in this specific sense, a computer winning at poker could be considered intelligent; the emotion-related side of the game, however, is missing from the machine.

This distinction between emotion-less machines and emotion-laden humans is reflected in two movements in AI research. “Strong AI” claims that one day AI technology will be able to overtake such distinction: computing machines will entertain thoughts in the same way humans do, with full-fledged, first-person, subjective, qualitative experience, also of emotion. “Weak AI”, on the other hand, relies on the conviction that there is an ontological barrier between the phenomena occurring in a human brain and the workings of a computing machine, and AI must be content with reproducing only the appearance and the results of human actions, giving up the ambitious goal of creating the subjective experience of human thought inside a machine.

Sophia the robot

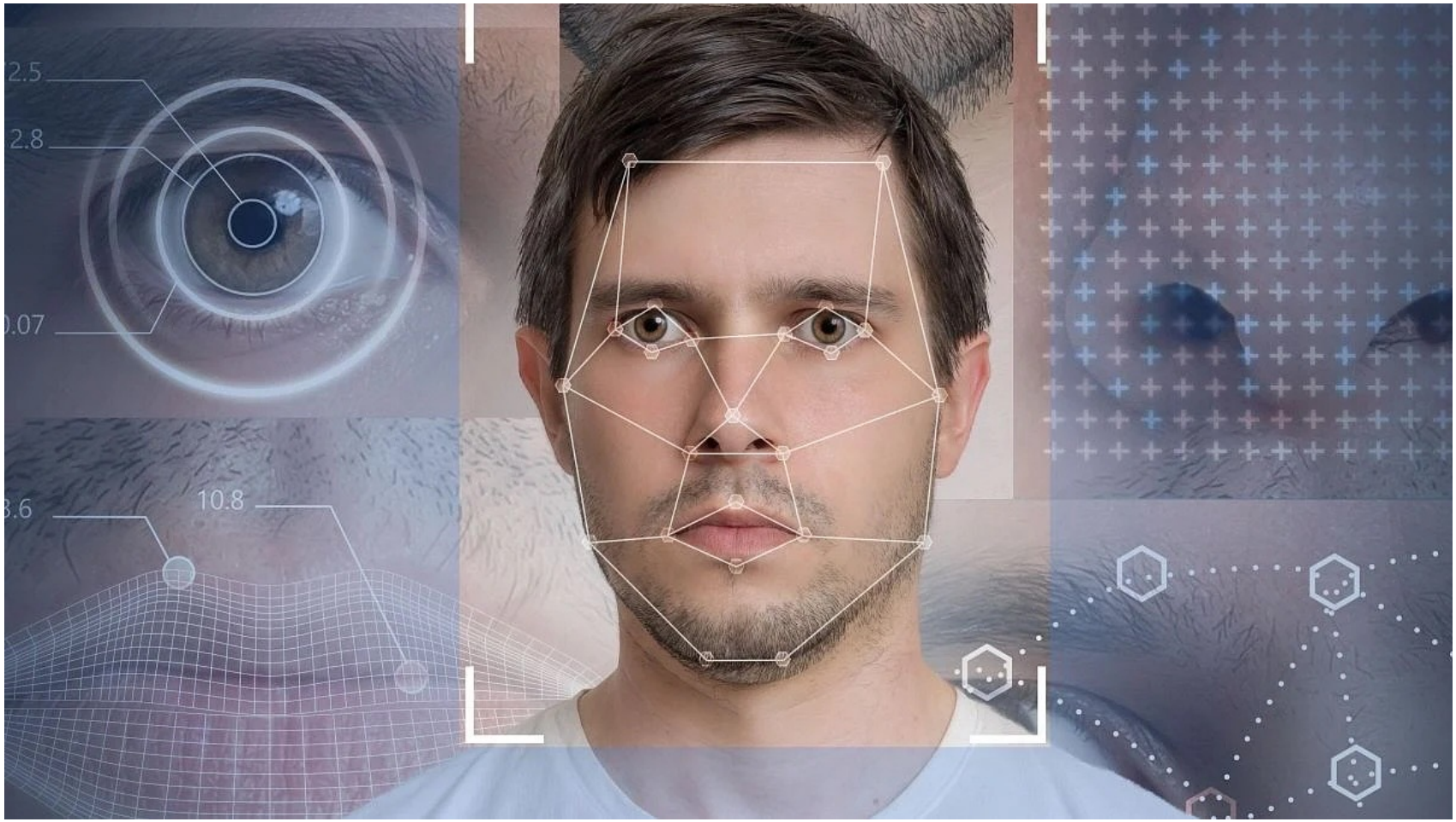
Even the most sophisticated robots express (simulated) emotions by means of words, actions, and appearance, exactly how a human would do. This constitutes the foundations of Affective Computing today: it does not matter whether computing can eventually become affective or not, it does not matter whether machines will one day entertain thoughts the way humans do because whether we are dealing with humans or machines or even fictional machines, the only emotions we can feel are our own, and when it comes to the emotions of others, human or not, real or not, we can only rely on our capability to make inferences based on the words and tones of voice we hear, and the actions and the appearances we see.



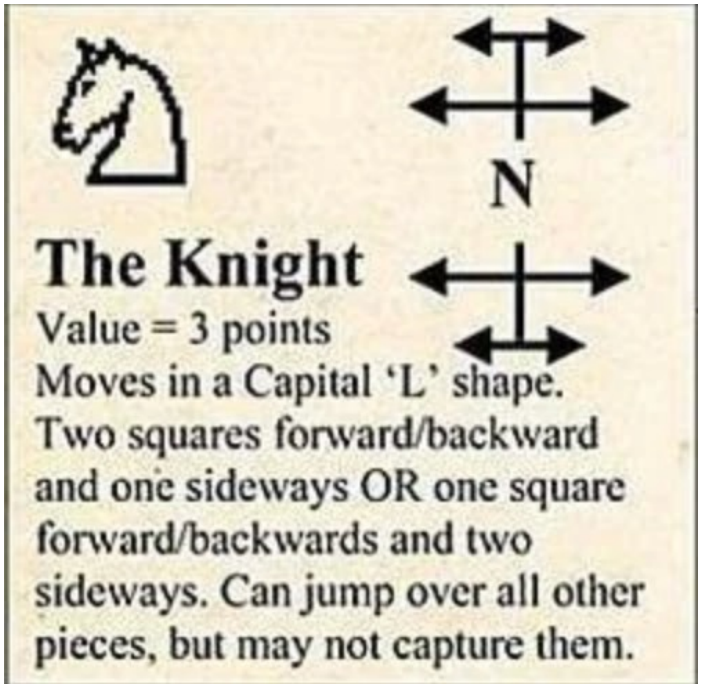
Since we are given access only to the expressions of the emotions of others, if computation in AC is to detect, process, interpret, and simulate something, that something is not emotion but expressions of emotion. Getting back to the game of poker, whether the machines of the future will have to put up a poker face or not, AC may help them already today read through ours.

Encoding phenomena means obtaining a relevant numerical description so that computing machines can transmit, elaborate, and transform these numbers. Of course, numbers alone are not enough to complete useful tasks: computing machines need to be accompanied by relevant encoding/decoding apparatuses that work as an interface between the physical world and the numerical world, creating numerical descriptions of physical phenomena on the one side, and transforming numerical data into physical phenomena on the other. A computer monitor, for example, transforms the numerical output of a computer into images on the screen, whereas a digital camera captures light from the external environment through its sensor and creates a numerical description of the captured view in the form of a digital image.

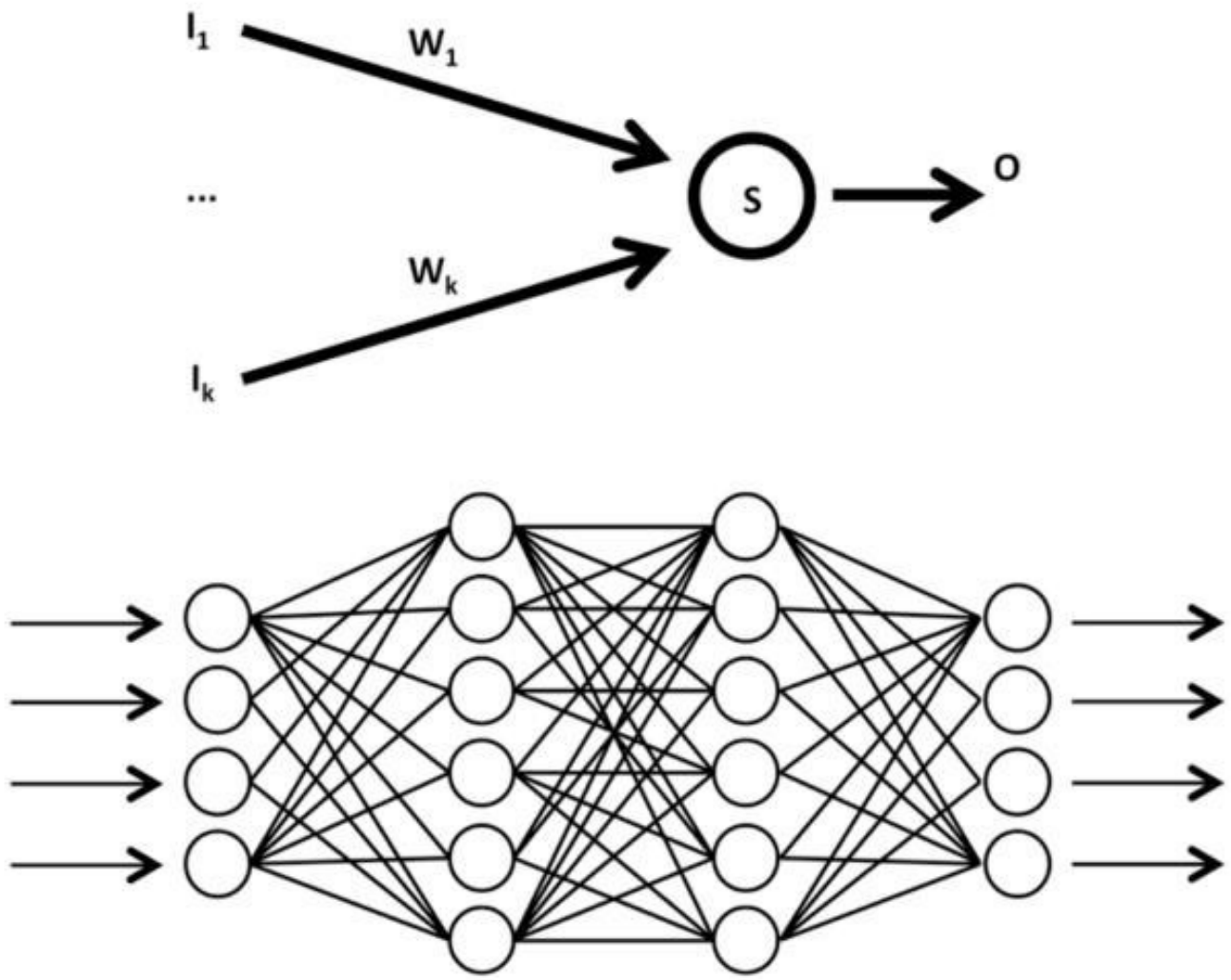
Emotions that AC aims at studying are treated along the same lines.
At its core, the computation in AC is based on the processing of digital signals, only this time, the signals are about how people express their emotions.



Capturing affective expressions in the form of digital signals and transforming them into numbers can create a massive amount of data, and this is where Machine Learning comes into play.



There is a 180-degree paradigm shift between traditional, logic-based, symbolic AI and ML. In the former, a top-down approach is taken, where axioms and general laws are encoded into a computing machine that is given the task of performing deductive reasoning; in the latter, computing machines are used with a bottom-up, data-driven approach where patterns, schemes, and laws are searched among a vast amount of data by means of statistical inductive processes.



An artificial neuron (above) and a neural network (below).

In the context of AC, this method might be used to automatically analyze photographic portraits of people to classify them with respect to the emotion shown by the portraited person. The emotion categories (e.g., happiness, anger, sadness) and the correct classification of the images are given by the human trainers, and once the training phase is completed successfully, the network should be able to classify new data correctly, that is, it should be able to “recognize” the emotion of people in photographs.

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happy face person

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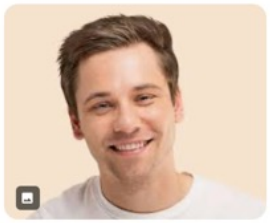
happy face human emotion and ...


Unsplash
500+ Happy Face ...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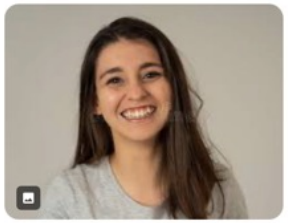
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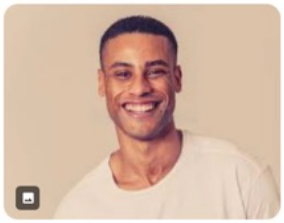
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Close Up Portrait of Smiling and...


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Unsplash
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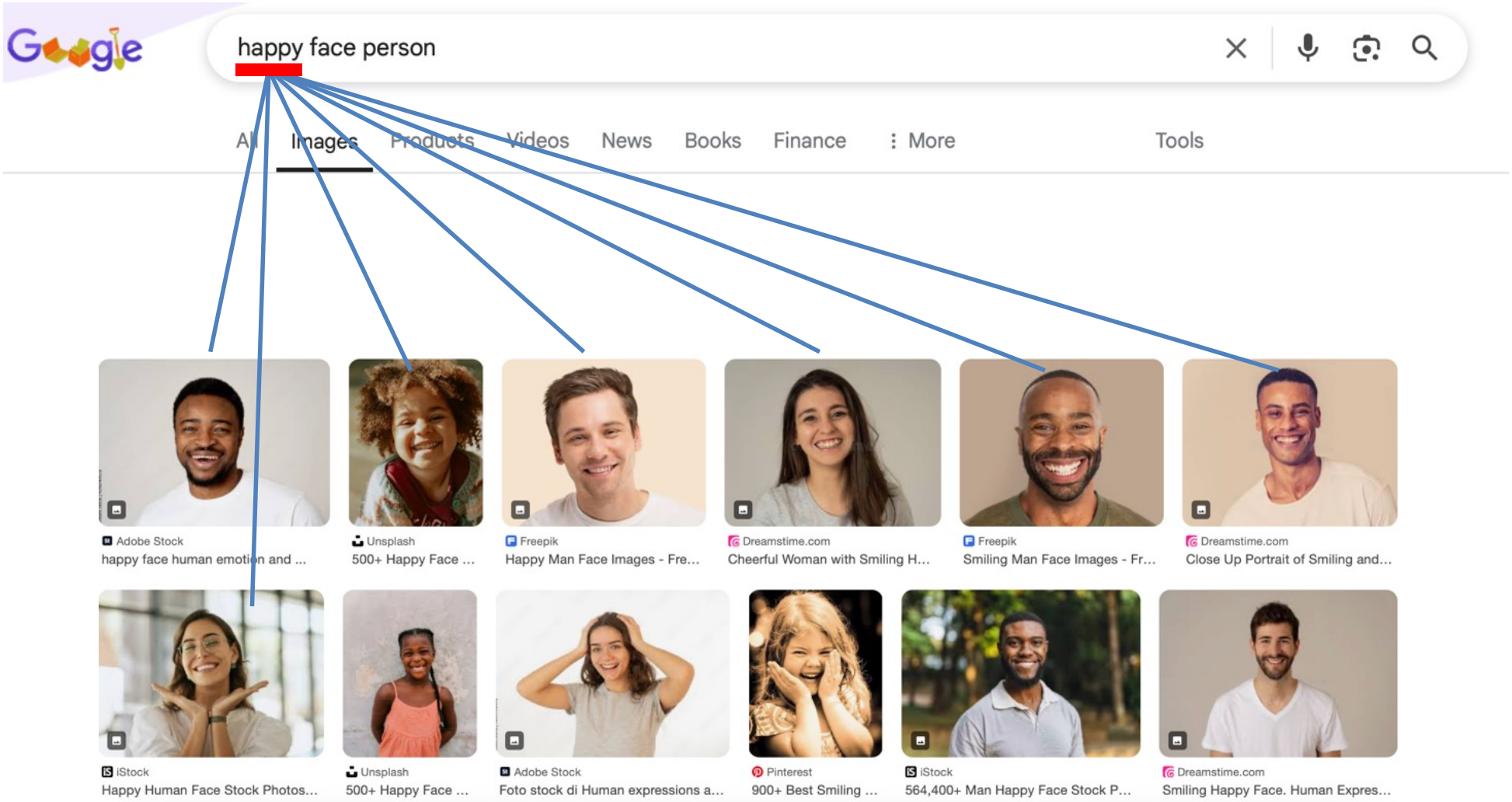
Adobe Stock
Foto stock di Human expressions a...


Pinterest
900+ Best Smiling ...

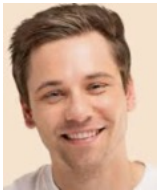

iStock
564,400+ Man Happy Face Stock P...

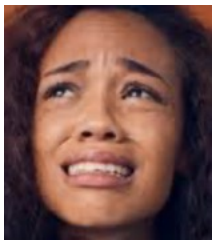

Dreamstime.com
Smiling Happy Face. Human Expres...



Supervised learning

The emotion categories (e.g., happiness) and the correct classification of the images are given by the human trainers



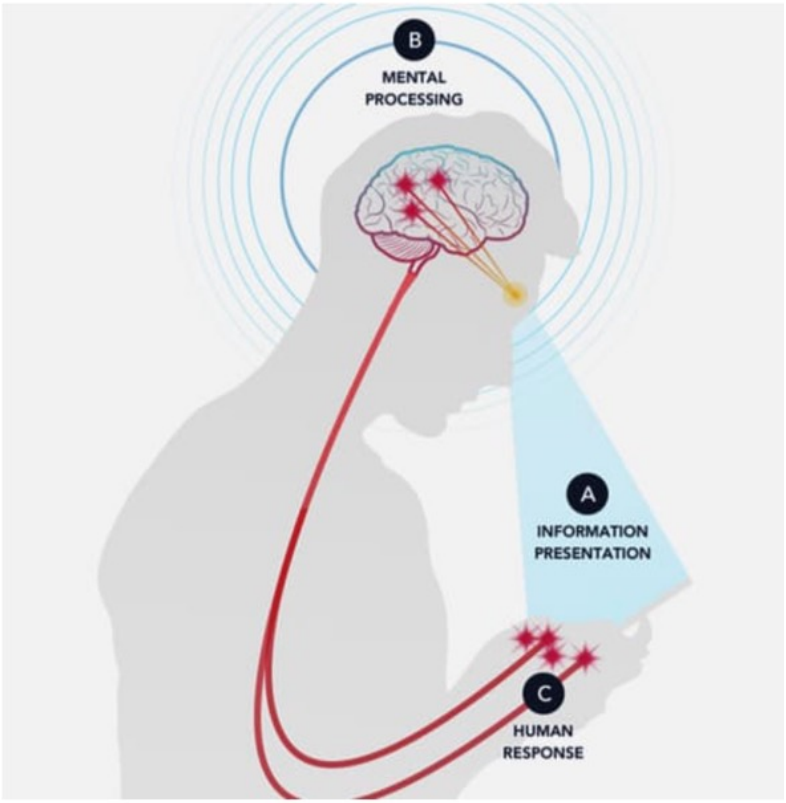


Unsupervised learning

Not based on training with data preprocessed by humans.
The neural network can only find patterns based on the data's values in terms of numerical relative distance in search of clusters of similar instances or outliers.

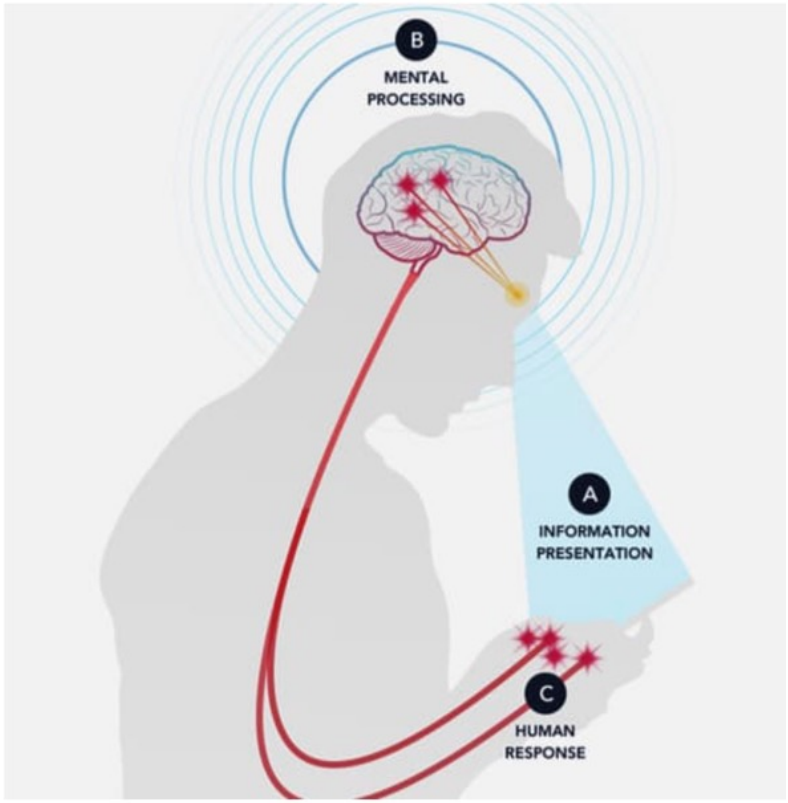
Mindstrong is a startup founded in the mid-2010s in Palo Alto, California, by three doctors, Paul Dagum, Tom Insel, and Rick Klausner. The goal of Mindstrong is to help treat medical problems related to mental health, including depression, schizophrenia, and bipolar disorder, by means of a platform used by the startup's clinical team to deliver "evidence-based therapy and psychiatry in structured, goal-oriented messaging sessions" with the aim of "lowering the inpatient readmission rate, E.R. admission rate, mental health costs, and physical costs."

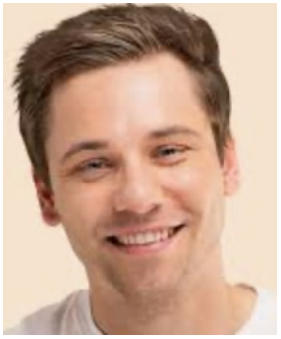
The basic idea is to “measure” human-computer interactions on a smartphone and analyze those measurements using ML to monitor the users’ mental health. The assumption is that how a person uses their smartphone provides significant indications of their mental state. In particular, Mindstrong is an app that monitors how the person types, taps, and scrolls while using other apps.



The app is based on ML, so if it is supposed to analyze such data and classify them as indications of good mental health or otherwise, this means that the neural network used for analysis and classification needs to “know” the connections between users’ gestures and their mental state.

In other words, there must be a computational model that describes those gestures in numerical terms (e.g., spatial coordinates of taps and swipes on screen, temporal measurements of the speed of typing, etc.) and relates them to emotions, moods, and states of mind.

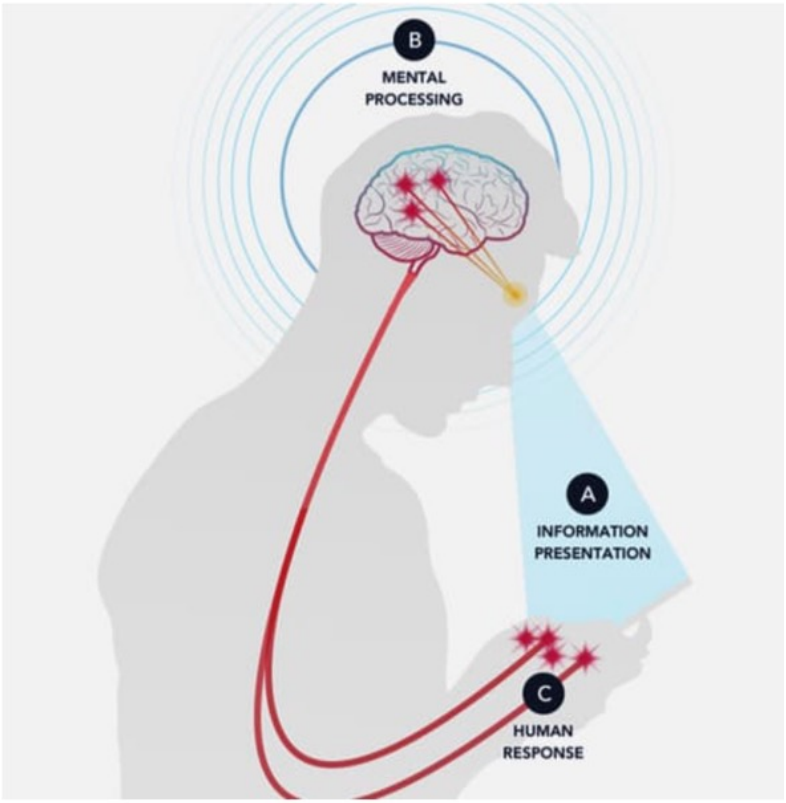




Where does that knowledge come from? In ML terms, how was the neural network of Mindstrong trained?

The starting point was a study based in the San Francisco Bay Area to verify the possibility of measuring a smartphone user's cognitive ability (or lack thereof) by means of checking how they use their device.

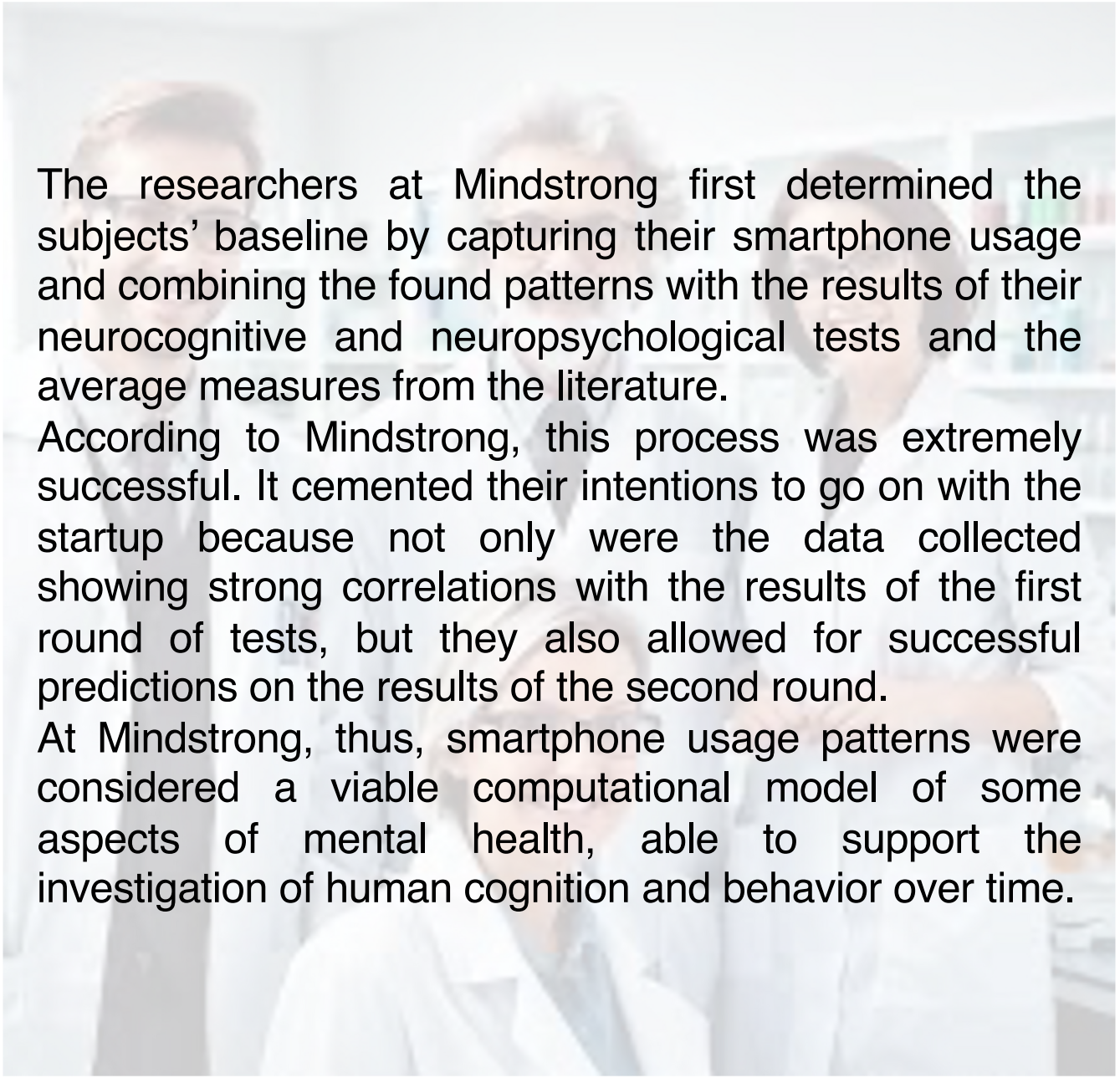
Based on the assumption that higher-order brain functions are weakened in people with mental illnesses, 150 research subjects were assessed with standardized neurocognitive and neuropsychological tests with respect to episodic memory and executive functions (e.g., impulse control, time management, focus).



After the test, an app was installed on the subjects' phones that tracked and measured how they interacted with their phone's display regarding swipes, taps, and typing on the on-screen keyboard. The subjects were sent back to their normal lives, and for one year, the app ran in the background, recorded and encoded their behavior on their mobile devices, and sent the relevant data to the Mindstrong servers.
After that, the subjects went back for another round of neurocognitive tests.

All the ingredients for a successful attempt at ML-based AC were there:

- Previous knowledge from psychology, cognitive studies, and psychiatry in the form of tests, which allow for the measurement of expressions of emotions and mental health by the subjects;
- New data acquired on smartphone usage by the subjects through Human-Computer Interaction techniques;
- An experiment designed to keep track of the subjects and the correspondence between the state of their mental health (assessed through traditional tests) and their smartphone usage (captured through the app);
- Finally, a neural network ready to be trained and aimed at “learning” what patterns in smartphone usage correspond to what aspects of a user’s mental health.



The researchers at Mindstrong first determined the subjects' baseline by capturing their smartphone usage and combining the found patterns with the results of their neurocognitive and neuropsychological tests and the average measures from the literature.

According to Mindstrong, this process was extremely successful. It cemented their intentions to go on with the startup because not only were the data collected showing strong correlations with the results of the first round of tests, but they also allowed for successful predictions on the results of the second round.

At Mindstrong, thus, smartphone usage patterns were considered a viable computational model of some aspects of mental health, able to support the investigation of human cognition and behavior over time.

Issues with Affective Computing

Sociotechnical issues

• An ML-based AC system like Mindstrong could be considered a "sociotechnical" system, that is, a technological system in tight connection with its human designers and users, who make the technology useful and meaningful.

– This private initiative has relied on significant investments on which investors expect a return.

– Costs lead to the exclusion of those segments of the population who are not able to afford it.

– Who owns the technology has the right to use it, manage it, and exploit its results.

– A huge database full of sensitive data about the population is affected by the inherent risk of falling into the wrong hands.

Automation issues

• There is the goal of automatizing tasks that humans traditionally perform. This is not about the displacement of humans due to the introduction of machines in the job market, which is an issue in other sectors, but

– automation bias: the tendency to over-rely on automated systems

– errors of commission, in which the human user follows incorrect advice coming from the computer

– errors of omission, where the human user fails to act because the computer did not prompt them to do so

– deskilling: the reduction or even complete loss of the capacity to perform a task due to the habit of relying on technological tools that automatize that task

Machine Learning issues

Machine Learning issues

Where are they now?

Affective Computing is still there

Beyond Verbal is an Israeli start-up company that has developed a tool for Emotion recognition using vocal intonation.

CrowdEmotion, based in the U.K. is an artificial intelligence company inspired by emotions that develops technology to see, hear, and feel how humans do.

Affectiva is an artificial intelligence software development company. In 2021, the company was acquired by SmartEye. The company claimed its AI understood human emotions, cognitive states, activities and the objects people use, by analyzing facial and vocal expressions.

nViso is a leading provider of emotion recognition software that interprets human facial micro-expressions and eye movements captured through video.

Email I received while I was preparing these slides:

Ludovica Marinucci Inbox - UniBG 09:30

(SILFS-L) divulgazione invito docenti a workshop online su eye tracking e AI

To: ludovica.marinucci@ethics.cnr.it

Gentilissimi/e,

scrivo per chiedervi di divulgare l'invito a partecipare al workshop online dal titolo "Workshop for Educators: Integrating Eye-Tracking & AI technologies for student support" nell'ambito del **progetto europeo EYE-TEACH**.

EYE-TEACH è un progetto di ricerca interdisciplinare che mira a sviluppare uno strumento di analisi di eye tracking assistito dall'intelligenza artificiale, che possa essere utilizzato dagli insegnanti per supportare la comprensione del testo degli studenti. I dati monitorati e analizzati da questo strumento forniranno informazioni immediate agli insegnanti in classe, aiutandoli a monitorare come gli studenti (singolarmente e come gruppo) interagiscono con un testo e dove incontrano difficoltà.

EYE-TEACH è implementato da un consorzio di ricercatori europei, accademici, innovatori tecnologici ed esperti di EdTech provenienti da 9 paesi europei.

Insegnanti ed educatori della Scuola primaria e secondaria possono svolgere un ruolo importante nello sviluppo di questo strumento, attraverso questo workshop virtuale che si terrà il 14 maggio alle ore 17:00 CET.
Il workshop consisterà in discussioni strutturate tra educatori provenienti da tutta Europa, per valutare preoccupazioni, pensieri e idee sull'uso dell'IA e degli strumenti di eye tracking. Il feedback fornito in questo workshop aiuterà direttamente i ricercatori di EYE-TEACH nello sviluppo dello strumento.

Email I received while I was preparing these slides:

Ludovica Marinucci Inbox - UniBG 09:30

Dissemination of invitation to teachers for online workshop on eye-tracking and AI

To: ludovica.marinucci@ethics.cnr.it

Dear all,

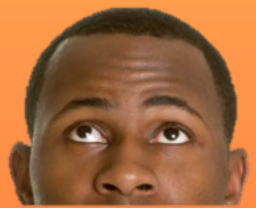
I am writing to ask you to share the invitation to participate in the online workshop titled **"Workshop for Educators: Integrating Eye-Tracking & AI technologies for student support"**, as part of the European project **EYE-TEACH**.

EYE-TEACH is an interdisciplinary research project aimed at developing an AI-assisted eye-tracking analysis tool that can be used by teachers to support students' reading comprehension. The data monitored and analyzed by this tool will provide teachers with immediate feedback in the classroom, helping them to track how students (both individually and as a group) interact with a text and where they encounter difficulties.

EYE-TEACH is carried out by a consortium of European researchers, academics, technology innovators, and EdTech experts from 9 European countries.

Primary and secondary school teachers and educators can play an important role in the development of this tool by participating in this virtual workshop, which will be held on **May 14 at 17:00 CET**.

The workshop will consist of structured discussions among educators from across Europe, to explore concerns, thoughts, and ideas about the use of AI and eye-tracking tools. The feedback provided during the workshop will directly support EYE-TEACH researchers in developing the tool.



For our last class, bring these