University of Naples
Federico II

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SMART TECHNOLOGIES & COVID-19

The contribution of digital and cognitive technologies to the fight against COVID-19

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The year 2020 will enter into the history books as the year of the coronavirus pandemic. The World Health Organization declared the health emergency on January 30, 2020, and officially introduced the expression COVID-19 on February 11 (www.who.int).

Beginning with Wuhan in Hubei (China), different states throughout the world, at different times, and with different modalities, have taken actions to contain the COVID-19 outbreak and limit the damage from it. Some countries have found partial containment measures insufficient to stem the spread of the virus completely. Consequently, nations such as Italy have declared a state of lockdown, defined as the progressive interruption of economic activities except for those that are of a high social and strategic necessity. Such measures have been taken in an attempt to slow the spread of the virus and 'flatten the contagion curve'.

The severe measures of isolation and social distancing, intended to reduce contact and social interaction, present serious risks to the well-being of people, and its extent is not yet fully known. To reduce the unknowns and overcome adversity, new solutions must be found. In this scenario, technology seems to be able to play an important role, though it is not yet well defined. The new solutions represent resources to be explored, and their effectiveness cannot be limited only to specific activities such as social connection (e.g., smart working, e-learning) but also must be understood as possible tools to deal with the many difficulties that may emerge after the pandemic.

Digital and cognitive technologies have rapidly evolved in the last 20 years, concretely affecting our lives and habits. A multiplicity of devices surrounds us. The spread of smartphones, tablets, and smart objects has contributed to the exponential increase in connectivity. Today, there are eight billion devices connected to the Internet, and that number is expected to increase to one trillion interconnected devices by 2030 (World Economic Forum, 2019). The growing number of connected smart devices is part of the future Internet paradigm, which includes the concept of the Internet of Things (IoT), a complex ecosystem in which objects interact and communicate with each other through the exchange of data and access to a multiplicity of previously shared information. Networking provides greater ability to process available information by assigning specific meaning to smart objects. (IoE), a phenomenon that connects people, processes, data, and objects. The aim is to make interconnections more effective, while transforming information into actions, creating new capacities, enriching experiences, and offering unprecedented economic opportunities for companies, individuals, and countries.

Technology seems to be advancing faster than ever. Multiple intelligent solutions—powered by machine learning, artificial intelligence, conversational agents, augmented reality, and the

like—promise solutions capable of dealing with the pandemic. As the context around us evolves, it becomes possible to develop scenarios never explored before and to realize them. The possible applications of structured algorithms, capable of understanding, interacting, and learning "autonomously", are endless and becoming increasingly numerous—for example, the wide Internet access, the diffusion of mobile technologies and intelligent objects, and the availability of a huge amount of information.

In the current pandemic, smart technologies (e.g., artificial intelligence, machine learning, cognitive computing, chatbot, wearables, blockchain) can adequately support the collection, analysis, and processing of big data and the decision-making processes of citizens, entrepreneurs, managers, and policy makers. The challenge for companies, institutions, and public administrators is to make the most out of the large amount of data and objects available to offer new solutions for the creation of value for the various subjects involved. Digital innovation is born more and more from the connections between companies and technology providers as well as with lead users and intermediaries; in this interconnected context, new open and interactive spaces for collaboration and participation are created, overcoming traditional models led by single innovators.

The world is moving toward hyper-technological and increasingly integrated scenarios, but the real value is in human experience and people's ability to understand changes and imagine a near future. Technology evolves and allows them to carry out activities faster and more efficiently, promoting access to opportunities and information in real time, in the places and times that best suit their needs. However, the emerging phenomenon described is not simply a technological story but a human story about the imagination—that is, about the actors and their ability to configure and create a new possible reality.

Both the advancement of knowledge and the updating of specialist and professional preparation require new paths of knowledge and new tools for analysis. On the one hand, the specialized press is full of new concepts and terminologies typical of disciplines such as engineering and information technology that contaminate the field of knowledge in medicine, economics, and psychology; on the other hand, the unpublished experiences of cases and practical applications contribute to raising the character of the discontinuity with which innovations in new digital scenarios manifest themselves. The peculiarities of a new technological solution, with its characteristics of innovation and uniqueness, detailed analysis, and identification of a turning point—introduced in the operations of institutions and firms and in daily social routines—create a database of knowledge and experiences to be presented and shared.

The path outlined in this report aims to respond to these needs through an in-depth analysis that outlines the contribution of smart technologies to address the current pandemic. Four macro areas are identified: prevention, diagnosis, treatment, and research. Each is defined by two specific application actions, for which application technologies and experiences are presented. Some of these are already in use, while others are in the design and development phase, capable of providing a first picture of the complexity of the phenomenon being analyzed.

The analysis is suitable as a tool to provide a current reading of the areas of use and development of smart technologies in relation to the emergency of COVID-19. This proposal goes beyond a mere list or abstract elaborations, avoids any attempt or claim of exhaustiveness, and is also in consideration of the continuous emergence of new solutions. The case studies reported are the result of a robust analysis and selection process, which also took into account the limits of resources that condition any analysis process as well as the need to produce an outcome in a time that is congruous with the actuality of the topic at hand. Indeed, the work intends to offer a concrete, albeit preliminary, witness to the innovations and the actual diffusion of practices and innovative solutions driven by technologies useful in facing the challenges of the current health emergency.

Considering the chosen theme, the novelty of the analysis, and the contents presented, we propose the report as a particularly useful reading for enthusiasts and interested parties who want to reflect on the exploration of new technologies and their applications. The report also offers an interesting field for comparison and dialogue with entrepreneurs, managers, and researchers who also want to contribute through the testimony of their experiences to enrich the contribution of the product created here.

PREVENTING

*Being able to implement effective measures to fight against the onset and spread of the coronavirus is of crucial importance for citizens, companies, healthcare institutions, and public administrators. The use of **smart technologies** offers a valid tool for the **prevention** of COVID-19. Support for prevention is expressed in the **monitoring** of data related to the health conditions and location of patients and other citizens and in the **protection** from infection.*

PREVENTION & COVID-19

PREVENTING: MONITOR

The first challenge in the fight against COVID-19 with smart technologies is prevention. The elaboration of a large database provides information and insights for predictive analyses and guides decision-making processes. It is also possible to prioritize and suggest behaviuors deemed most appropriate. With innovative technologies, prevention is carried out in two ways: monitoring and protection. With monitoring, artificial intelligence, big data analysis, geolocation, machine learning, wearables, and thermal and infrared cameras allow authorities to monitor the movements and activities of people in the shortest possible time. Through prevention, companies and health institutions will find it easier to adequately treat those who become ill and to ensure safety conditions in the workplace, and citizens will have ways to protect themselves from contagion, by reducing interpersonal contacts and avoiding potentially risky actions. The subjects this challenge addresses are health **institutions, citizens**, and **public administrators.** Innovative technologies allow institutions, patients, citizens, and authorities to connect at any time and without spatial limits. The application of artificial intelligence to the enormous amount of data produced by health structures in an emergency can result in significant benefits with various possibilities of contributions. With the presence of the tools offered, healthcare personnel can actively follow the evolution of the disease in a patient and adopt the appropriate protective measures. Citizens are able to perform behavioral analyses to implement protective actions from contagion by reducing interpersonal contacts and avoiding risky actions. Public administrators are able to carry out rapid control operations on a large scale and with immediate responses to favor the appropriate interventions. The contemporary control of more subjects by local authorities allows identifying high-risk areas, thus decreasing the time required to trace the interactions, and creating a map useful to anticipate the further spread of the virus.

ACTIONS

MONITOR:

- Systematically observe and verify the evolution of the phenomenon
- Check the physiological/vital parameters of citizens

PROTECT:

- Protect from viral agents
- Protect citizens by reducing the risk of contagion

PREVENTING: MONITOR

TECHNOLOGIES

ARTIFICIAL INTELLIGENCE (AI)

- AI Thermometer
- Alipay Health Code
- EngDE4Bios
- Hits
- IBM Watson assistant
- Social Distancing
- Smart Cameras
- Thermal Imagers

BLUETOOTH

- Aarogya Setu
- COVIDSafe
- eRouska
- Immuni
- Rakning C-19
- StopCovid
- StoppCorona
- ViruSafe

CHATBOT

- Covid-19 app

WEARABLES

- Smart Helmet N901 Wearable ‘anti-Covid’

In the current pandemic, innovative technologies enable contagion prevention through continuous, extensive, and in-depth monitoring of all data related to the health conditions and location of patients and citizens. New solutions for continuous tracking of people and timely control of the degree of exposure enable more effective analysis and evaluation of the evolution of the disease in an area. Big data analytics tools, hardware, and software technologies can help identify contagion risk behaviors and situations, also linked to specific contingent factors such as risky lifestyles, particularly critical environmental context conditions, and/or genetic predisposition factors.

Artificial intelligence combined with digital devices allows monitoring people's vital signs, detecting and reporting anomalies, and working to overcome critical issues in advance. Artificial intelligence includes, for example, smart apps for self-monitoring of health conditions, for all citizens or those subject to fiduciary isolation.

ARTIFICAL INTELLIGENCE

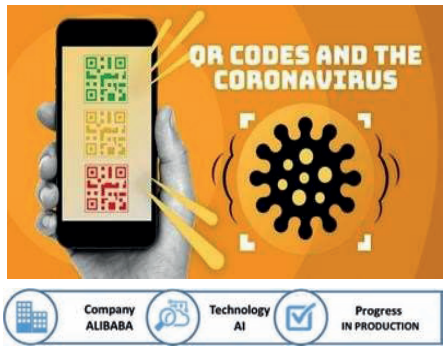
AI Thermometer

Intelligent software supported by OpenPose technology to "increase" the capabilities of thermal imaging cameras, enabling them to detect the position and posture of individuals in the frame. This software can identify people through a standard detector that reads the body shape of the subjects and then locates a point on the face on which to measure the temperature. Its thermal imaging camera captures an automatic reading of people's body temperature. Thus, the AI Thermometer allows the monitoring of health data quickly and without human intervention.

ARTIFICAL INTELLIGENCE

Alipay Health Code

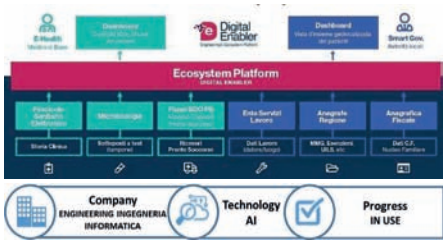
Smart application supported by artificial intelligence for the processing of health data. Owing to machine learning, this application can analyze citizens' health data and create new information. It can help limit access to places and services in a more precise way, identifying places at high risk of infection. Alipay Health Code assigns each citizen a color—green, yellow, or red—like a traffic light. The color is used to indicate who can freely visit public spaces, who has health problems and needs to be monitored, and who must remain at home in quarantine. The app also has a prediction function for new contagion areas.



ARTIFICAL INTELLIGENCE

EngDE4Bio

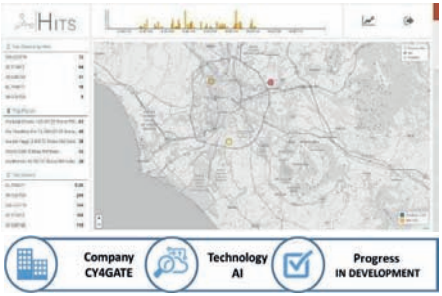
Smart platform based on artificial intelligence and machine learning. This integrated biosurveillance system enables a process of collection, aggregation, interpretation, and communication of information related to possible dangers to human health, such as COVID-19. EngDE4Bio maps and geolocates infected subjects and those who came into contact with them, allowing a reduction in the time needed to monitor the spread of the disease.



ARTIFICAL INTELLIGENCE

Hits

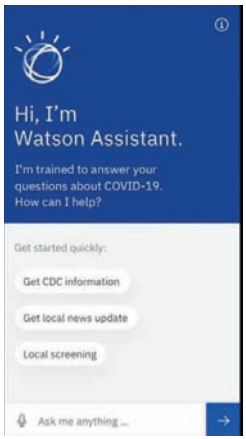
Software platform supported by artificial intelligence and GPS tracking. This platform can collect, process, and aggregate geolocation data of patients and other citizens coming from multiple mobile devices. The tool examines the current movements of the various subjects and those that occurred between two and four weeks before the infection. It keeps track of the paths followed and then draws maps of differentiated risk areas. Hits aid in promptly identifying new potential outbreaks and monitoring the evolution of those already known.



ARTIFICAL INTELLIGENCE

IBM Watson assistant

Conversational platform supported by artificial intelligence for the processing of data. Through the IBM cloud, this platform can analyze different forms of data and create new information. It is able to understand and respond to common questions about COVID-19. The Watson assistant answers agents' questions and automates workflows via web and mobile chat. It supports companies by providing responses to common employee questions and shares relevant resources around the clock, alleviating the burden on internal help and IT desks.



Company IBM | Technology AI | Progress IN USE

ARTIFICAL INTELLIGENCE

Social Distancing

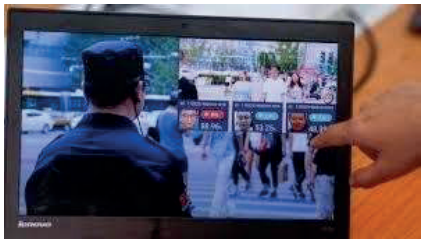
Intelligent software that supports uncalibrated RGB cameras to evaluate effective safety distances. The algorithm behind the operation first identifies people using a standard detector that recognizes body figures and estimates their height by measuring the distance of their body's actual joints. In a second moment, the algorithm estimates the area of one meter around all the identified figures. In essence, social distancing monitors the behavior of individuals to avoid any dangerous conduct and gatherings.

Company Istituto Italiano di tecnologia (IIT) | Technology AI | Progress IN DEVELOPMENT

ARTIFICAL INTELLIGENCE

Smart Cameras

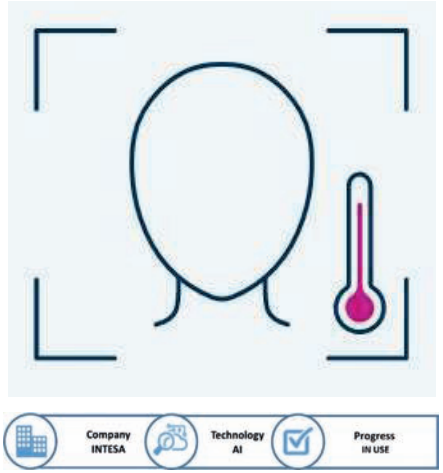
Solution based on AI camera technology. Cameras allow real-time thermal scans to detect data such as body temperature, store it, and classify it during emergency situations. Smart cameras can recognize faces, even if the scanned citizens wear masks. They can also trace the specific characteristics and situations that affect people in movement, such as body temperature and the correct use of masks.



ARTIFICAL INTELLIGENCE

Thermal Imagers

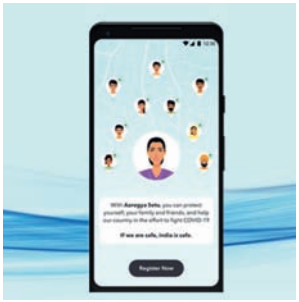
Intelligent software, supported by IBM Watson, capable of detecting temperature, analyzing data in real time, and triggering alerts. This software can detect the body temperatures of several people at the same time, excluding other heat sources, and process the data in real time. The data then allow companies to activate warning systems thanks to the intelligent face recognition, the measurement of thermal temperature, and big data analysis. Thermal imagers allow companies to monitor health data of clients quickly and without human intervention.



BLUETOOTH

Aarogya Setu

It's a mobile app seen as mandatory by the Indian Government. The app traces social interactions to verify the risk of infection. It represents an evolution of a previous version, named Corona Kavach.



Company Government of India | Technology Bluetooth | Progress IN USE

BLUETOOTH

COVIDSafe

COVIDSafe is an app launched by the Australian Government to help in identifying people at risk. The app is installed on mobile phones and used via Bluetooth to contact people who may have been exposed to the virus. Data security is ensured by an encrypting system with data stores erased every 21 days.

Company Australian Government Department of Health | Technology Bluetooth | Progress IN USE

BLUETOOTH

eRouska

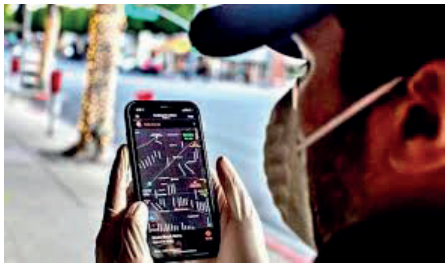
eRouska tracks people movements through Bluetooth. In case of an infected person, everyone get informed through the app interface about the risk. Data are stored and anonymized, therefore the notification of risk is not revealing who has the covid-19.

Company Ministry of Health Of the Czech Republic | Technology Bluetooth | Progress IN USE

BLUETOOTH

Immuni

Smart application supported by Bluetooth. This app can trace movements and process the information necessary to identify citizens' contacts with people who are positive for COVID-19. The app records interactions with other smartphones by assigning each phone an anonymous, temporary identification code. This smart application detects the proximity between two phones within one meter and therefore can identify all the encounters of a person who tests positive for COVID-19, so that the potentially infected people can take the necessary measures for health. Immuni helps reduce the spread of the virus.



Company: BENDING SPOONS | Technology: BLUETOOTH | Progress: IN DEVELOPMENT

BLUETOOTH

Rakning C-19

It's a mobile app based on location data. Icelandic Government chose not to use the bluetooth technology due to its instability and opted for location data. People are encouraged to download the app in order to have as more people as possible in the monitoring system.

Company: Icelandic Government | Technology: Location Data | Progress: IN USE

BLUETOOTH

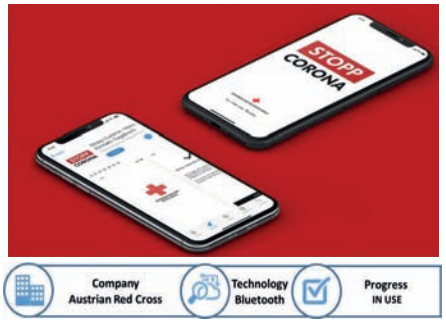
Stop Covid

WebTech launched StopCovid a mobile app tracing the interactions with other people and sending a notification should anybody among the acquaintences be positive. The app has been launched in several countries, as France, UK, and Norway.

BLUETOOTH

StoppCorona

Itis an app launched by the Austrian Red Cross; it offers a digital handshake, thus it gives the chance to track encounters among friends, families and colleagues to detect risky conditions. When a doctor detects covid-19, the user can notify the people he/she has been in touch with.



BLUETOOTH

ViruSafe

It's an application for mobile phones to support society and governments in tracking symptoms and monitoring the health conditions. Due to that the central institutions may have the national data under control to stop the spread of the pandemia. Governments can send relevant news and suggest best practices through the app.

CHATBOT

COVID-19 App
Intelligent application that incorporates a virtual assistant and is supported by GPS systems. This app can map movements and process citizens' health data; after analyzing the data, the app allows citizens to promptly communicate possible symptoms of the disease to local authorities, so as to keep the evolution of the disease in an area under control. The COVID-19 app facilitates communication between healthcare professionals, citizens, and local authorities for continuous monitoring of possible symptoms.

WEARABLE

Smart Helmet N901
Intelligent instrument integrated with an IR chamber to measure the temperature of people within a radius of five meters. This instrument uses algorithms necessary to learn health information iteratively and, at the same time, to analyze new data acquired independently. In addition to limiting human contact during control activities, Smart Helmet N901 decreases the time needed to monitor COVID-19 symptoms.

PREVENTING: PROTECT

TECHNOLOGIES

ARTIFICIAL INTELLIGENCE (AI)

- Chinese health code system
- IBM Digital Platform

BLUETOOTH

- Corona App
- CovTracer
- GH COVID-19 Tracker
- Ketju
- Private Tracer

COMPUTER-AIDED DESIGN (CAD)

- Simulgens Infections

DRONE

- Terradrone

ROBOT

- InTouch Vita
- Little Peanut
- Tommy
- UVD Robot ApS
- Xenex

WEARABLE

- Smart Proximity
- Wearable 'anti-Covid'

Smart technologies enable the prevention of contagion by facilitating ways to take appropriate protective actions in an effort to curb the spread of the virus. Smart technologies, devices, and solutions for social distancing, alerting, and the timely adoption of protective measures allow people to safely share the spaces necessary for carrying out collaborative activities, limiting physical interactions.

Technological tools and automated solutions are useful for activating remote support modes and, together with the use of intelligent instruments, make it possible to control and carry out care, assistance, and/or remote surveillance activities, reducing the risks from human contact.

Robots, combined with remotely piloted devices, help protect healthcare workers, patients, and other people by reducing physical contact and accelerating assistance and transport services. For example, drones are capable of transporting medical samples and small supplies to quarantined areas.

ARTIFICAL INTELLIGENCE

Chinese health code system

Alipay proposed the health code system to set a unified prevention control based on the integration of service platforms. It is created thanks to the experience in setting health codes in cities in China to report to the E-Government Office.

ARTIFICAL INTELLIGENCE

IBM Digital Platform

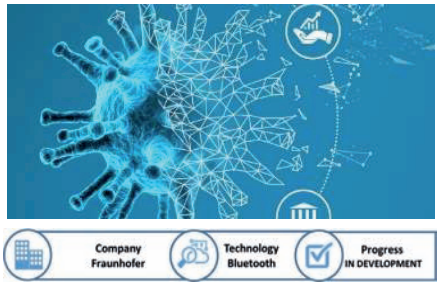
An open platform based on artificial intelligence, consisting of broad core services that contain micro-services for the digitalization of business processes. These innovative digital solutions are intended to improve business operations both during and after the pandemic.

The use of these services by companies is possible via API or user interfaces provided by Intesa.

BLUETOOTH

Chinese health code system

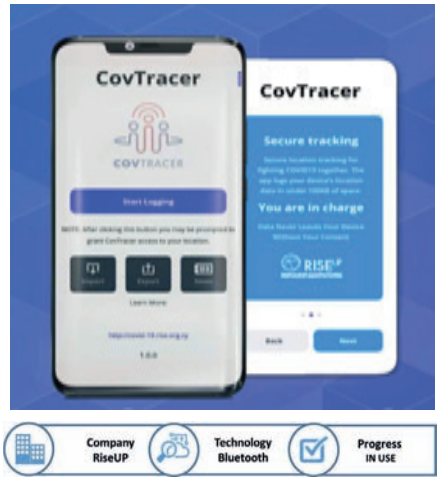
Alipay proposed the health code system to set a unified prevention control based on the integration of service platforms. It is created thanks to the experience in setting health codes in cities in China to report to the E-Government Office.



BLUETOOTH

Corona app

The German company Fraunhofer developed Corona App, a mobile application based on bluetooth to trace the interactions, measure the distance and time of these interactions and notify about potential risky conditions. The app was created through a set of partners, both German and from abroad.

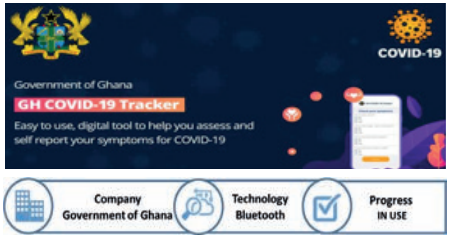


BLUETOOTH

GH COVID-19

It is the new app designed to trace infected people in Ghana. The availability of data in Ghana already showed its relevance in the first phases of the pandemic.

The mobile app can also link people to health professionals, should an urgent action be needed.



BLUETOOTH

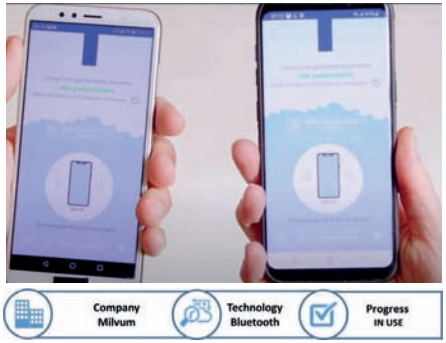
Ketju

It is a mobile app to trace the potential transmission chains. The Finnish Government adopted it since the beginning of May and ensured citizens' rights, including data protection and security. Its use is planned to be stopped at the end of the pandemic.

BLUETOOTH

PrivateTracer

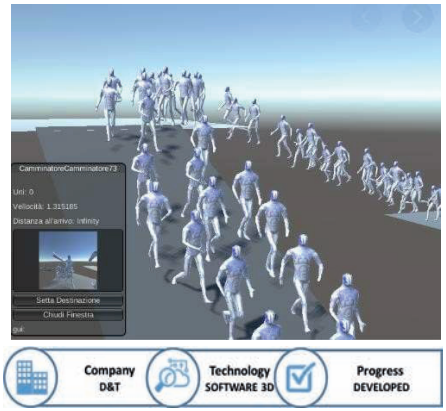
It's an app designed by Milvum and adopted by the Dutch Government. It is an open source tool to allow further improvements. Privacy is ensured while data collection takes place to trace people movements and potentially suggest the need for quarantine due to interactions with infected people.



COMPUTER-AIDED DESIGN (CAD)

Simulgens Infections

Software platform supported by a 3D-modeling program. This platform can combine decisions and movements of thousands of individuals, extracting the overall behavior of the crowd in normal or emergency conditions. It can help prevent infection by simulating the spread of the virus among people. The software takes into consideration the distance between people, the time of exposure to risk, and even infectious objects or surfaces, calculating the spread rate of the virus over time. With the creation of 3D models, Simulgens infections identifies spaces at high risk of contagion with a virtual illustration of the environment.



DRONE

Terradrone
Remotely piloted technological device supported by a UAV (unmanned aerial vehicle) system and GPS tracking. A drone is able to fly automatically, allowing an operator to remotely control the device along its way. Terradrone helps transport medical samples and small supplies to quarantined areas, limiting personal access to risk areas and reducing delivery times.

ROBOT

InTouch Vita
Robotic device with AutoDrive functionality. This device is able to move automatically, allowing a remote healthcare professional to control it and guide its movement. Doctors and nurses can use it to interact with patients and to visually evaluate them. InTouch Vita provides and collects clinical information while limiting interpersonal contacts.

ROBOT

Little Peanut

Automated solution integrated with SLAM (simultaneous localization and mapping), localization technology, and simultaneous mapping. This device delivers food and water to people in quarantine thanks to real-time mapping of the environments. It is able to interact with users via the integrated microphone. Little Peanut provides remote assistance services.

ROBOT

Tommy

Robotic technology supported by Vivaldi, artificial intelligence that controls and adapts the behavior of robots to humans and the environment. Tommy is able to collect, process, and aggregate data related to the status of patients and to interact with them. The integration of a webcam and microphone on the instrument allows doctors to carry out an effective visual evaluation of patients remotely and to interact with them to provide and collect further clinical information. Tommy helps limit the number of direct contact of doctors and nurses with patients, thus reducing the risk of infection.

ROBOT

UVD Robot ApS

Robotic device supported by ultraviolet rays and artificial intelligence. This device is able to move autonomously in settings and to spread UVC rays at 360-degrees Celsius, destroying the genetic material of viruses, bacteria, or fungi present in hospital environments. UVD Robots ApS disinfects hospital environments, providing greater protection from the spread of infection and reducing time spent on sanitization activities.

ROBOT

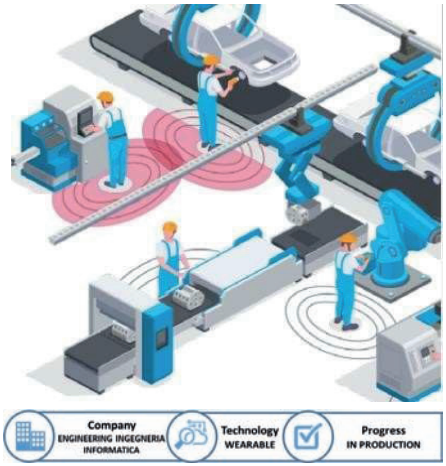
Xenex

Robotic equipment supported by a xenon lamp that generates UVC rays and SLAM technology. Xenex can destroy germs by breaking down their DNA through UVC impulses. Xenex allows healthcare professionals to sanitize the premises quickly, with guaranteed results and without putting staff at risk.

WEARABLE

Sensor Proximity

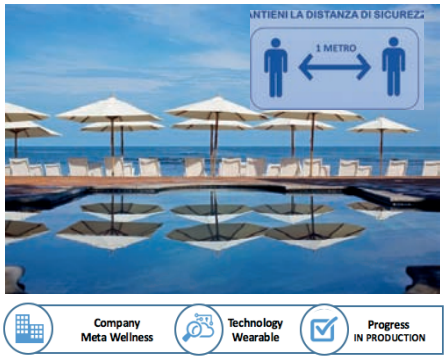
Wearable device supported by the Proximity Analytics application for data analysis. This device can analyze, monitor, and predict risky behavior of personnel in the workplace. Sensor proximity intervenes in real time with warning messages addressed to those who exceed the safety distances necessary to prevent contagion. To protect themselves and limit contagion, operators are equipped with a sensor that records distance to others and issues a warning when that distance is exceeded.



WEARABLE

Wearable 'anti-Covid'

MetaWellness is an Italian start-up launching a wearable to track people movements and to help in respecting social distancing. Thewearable buzzes to notify people interacting at less than one meter one from the other. It is available even as a stick to be carried in a bag or in a pocket.



DIAGNOSING

*The co-presence of skills and tools can play a key role in **diagnosing** the symptoms of the coronavirus and limit the transference of the disease. **Smart technologies** assist doctors and healthcare institutions in quickly identifying patients with COVID-19 and detecting and classifying aspects of the disease. Support for diagnosis is expressed in the **self-evaluation** of symptoms and in the **acceleration** of the diagnostic process.*

DIAGNOSIS & COVID-19

DIAGNOSING

The second challenge in the fight against COVID-19 with smart technologies is diagnosis. The autonomous processing of a large database of information and clinical data supports doctors in the diagnostic evaluation of the virus with an accurate analysis of patients' health conditions and symptoms. Smart technologies allow doctors to formulate diagnoses quickly and provide patients with timely and accurate information to facilitate rapid interventions. With innovative technologies, diagnosis support comes from two actions: self-evaluation of symptoms (self-diagnosis) and acceleration of diagnostic procedures (early diagnosis). AI and chatbots are just two of the innovations that can help doctors and healthcare institutions quickly identify patients with COVID-19 and, at the same time, detect and classify patient characteristics independently.

ACTIONS

SELF-EVALUATE:

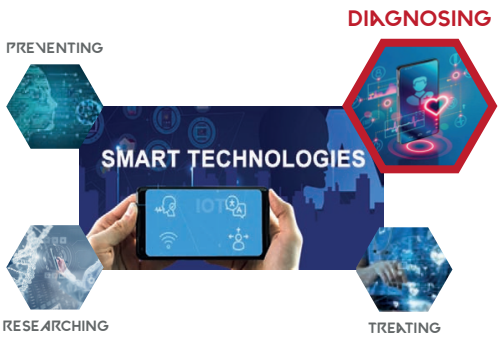
- Identify the symptoms simply and independently

ACCELERATE:

- Make the analysis process faster

The subjects this challenge addresses are health institutions and citizens.

In emergency situations, the amount of information that must be managed by health institutions is high. By obtaining reliable and detailed data, thanks to the use of smart technologies, health institutions can define complete and precise diagnoses quickly, ensuring greater accuracy in achieving the objectives to quickly diagnose the disease and avoid errors that could interfere with the procedures following the diagnosis. Furthermore, the need to contain the spread of the virus makes the circulation of a flow of information suitable for understanding and directing the behavior and actions of citizens mandatory. Tools such as virtual assistants or chatbots play a vital role in this situation.



DIAGNOSING: SELF-EVALUATE

TECHNOLOGIES

CHATBOT

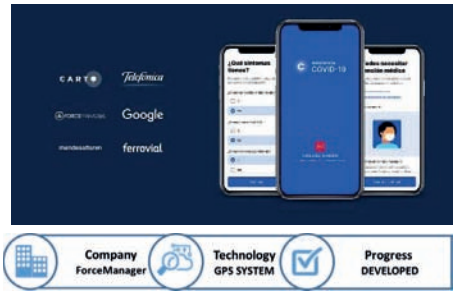
- Asistencia Covid-19
- Buoy Health
- Info-Chat App
- Memora Health
- Microsoft's Healthcare Bot
- Your.MD

During the current pandemic, smart technologies have demonstrated their potential to help fight the disease through the self-evaluation of symptoms made possible through virtual doctor–patient contacts. Diagnostic self-assessment offers more possibilities to obtain timely and accurate diagnostic findings. Artificial intelligence combined with bots and software collects and analyzes individual data received from citizens and provides detailed information on the appropriate behaviors to adopt. AI-based solutions allow evaluating the vital parameters of patients and/or other citizens, to identify symptoms of contagion. This includes, for example, chatbots for the self-assessment of health conditions for all citizens who need a medical consultation. Solutions make the assistance offered by local health actors more effective, in that they can give quick answers to basic issues and ensure that the medical staff is fully focused on complex problems.

CHATBOT

Asistencia Covid-19

Information platform supported by GPS systems. This platform can facilitate the flow of information between citizens and geolocate their positions to connect with local authorities. This platform also helps correctly diagnose the symptoms of the infection. With Asistencia Covid-19, citizens receive reliable feedback on the evaluation of symptoms and information on what to do in case of infection. The app provides the right information to citizens, relieving the load of health systems.



CHATBOT

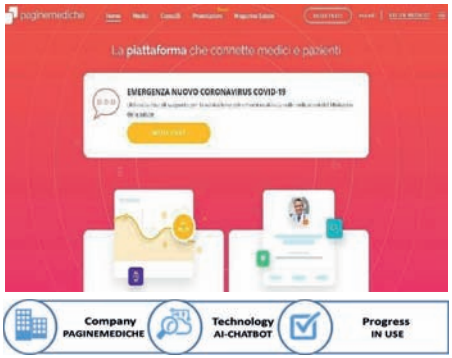
Buoy Health

Interactive chat based on artificial intelligence tools. By focusing on healthy parameters, the app can help people interpret any symptoms and suggest the type and level of care to be taken. Buoy Health supports citizens in the quick and easy evaluation of symptoms, mitigating the risk of underestimations or ineffective approaches to therapy.

CHATBOT

Info-Chat App

Intelligent chat supported by a virtual assistant. This app allows citizens to self-diagnose COVID-19 symptoms. The digital health platform, Paginemediche, connects doctors, patients, and services, to offer a personalized health experience. The virtual doctor completes the diagnosis, informs the patient about the degree of the symptoms, and lists any subsequent steps the patient should take. The Info-Chat app allows the reduction of interpersonal contacts and provides greater simplicity in obtaining diagnostic feedback.



CHATBOT

Memora Health

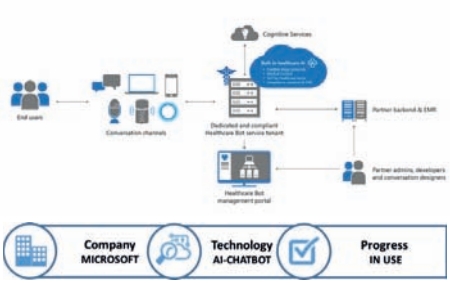
App supported by artificial intelligence. This app can conduct a risk assessment based on patients' symptoms and exposure profile. It allows patients who want to get detailed information about the virus to send their questions directly to doctors remotely. The goal is to help patients avoid waiting in clinics, reducing crowding in hospitals and lessening the risk of contagion.

CHATBOT

Microsoft's Healthcare Bot

A solution based on artificial intelligence that can independently diagnose the symptoms of people potentially infected by the coronavirus. This chatbot answers questions about the disease and its spread and suggests either contacting a doctor or managing the disease at home.

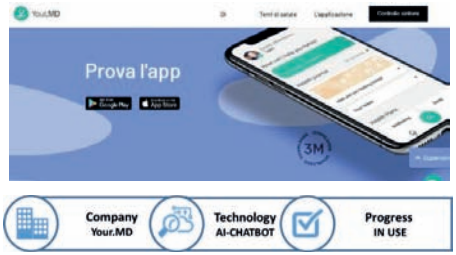
Artificial intelligence aims to simplify the diagnosis process, while allowing medical service providers to focus on patients who need critical care.



CHATBOT

Your.MD

Information hub supported by artificial intelligence to aggregate all official sources into a single dataset. This chatbot is designed to independently diagnose possible symptoms of COVID-19 and to help people assess whether they are in situations that expose them to greater risk of contracting the virus. Your.MD also helps people avoid unnecessary visits to doctors and emergency departments.



DIAGNOSING: ACCELERATE

TECHNOLOGIES

ARTIFICIAL INTELLIGENCE (AI)

- Alibaba
- Qure.ai
- Seegene (Allplex™ 2019-nCoV Assay)

The use of intelligent innovative technologies during the current pandemic allows more rapid diagnosis. The acceleration of diagnostic processes limits the spread of the virus by promptly identifying the symptoms. Artificial intelligence can analyze the vital and physiological parameters of patients and other citizens, facilitating healthcare workers in diagnosing the disease. Considering the high amount of data gathered, diagnostic analyses and subsequent choices in the delivery of care can be generated not only automatically but also with increasing accuracy.

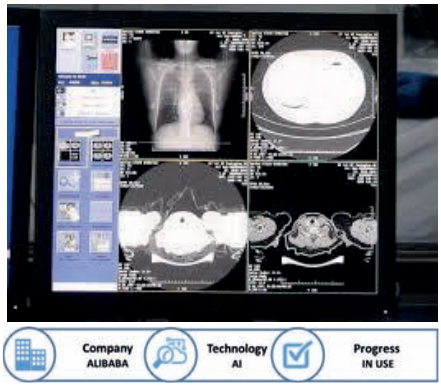
These technologies include, for example, intelligent apps and AI software to speed up the analysis process with consequent positive effects on the effectiveness of the various therapeutic paths to be implemented.

CASE STUDIES

ARTIFICAL INTELLIGENCE

Alibaba

A COVID-19 diagnosis system based on artificial intelligence that allows detection, through computerized tomographic scans, of new cases of COVID-19 with an accuracy rate of up to 96%. The software takes 20 seconds, thus significantly reducing the time of diagnosis compared with traditional swabs. The innovative diagnosis system enables healthcare professionals on the front lines to detect the disease efficiently and quickly.



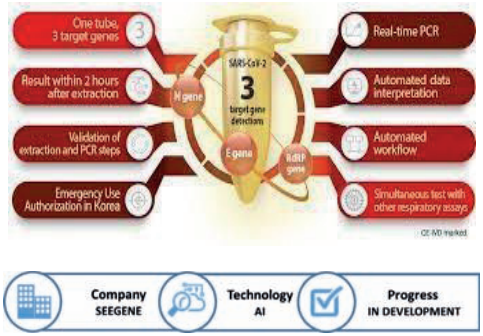
ARTIFICAL INTELLIGENCE

Qure.ai

Artificial intelligence–based software for medical imaging and learning technology for image analysis. Qure.ai assists healthcare professionals in analyzing X-rays and computed tomography. It also allows healthcare professionals to quickly interpret results indicative of COVID-19 contagion and quantify the percentage of lung capacity affected by the virus.

ARTIFICAL INTELLIGENCE

Seegene (Allplex™ 2019-nCoV Assay)
Intelligent molecular test that can be performed in automation thanks to the support of innovative technologies. This intelligent system can interpret genetic material, allowing medical personnel to quickly diagnose symptoms. Artificial intelligence also supports the design of the molecular test by decreasing the time required to get it on the market. The production of this test was carried out in a record time of only 20 days, due to the new algorithm based on artificial intelligence patented by Seegene.



TREATING

*The **treatment** of infected subjects is an activity as crucial as it is complex, given the widespread contagion and pressure on healthcare structures.*
***Smart technologies** favor the implementation of suitable solutions to support therapy in emergency conditions. Support for treatment is expressed in the **improvement** of knowledge and in the **management** of therapeutic processes.*

TREATMENT & COVID-19

The third challenge in the fight against COVID-19 with smart technologies is finding a cure. First, the use of machine learning techniques in environments characterized by an abundance of data enables the analysis of complex systems. Second, predictive models are used to investigate, with advantageous advances, some phenomena and to more effectively evaluate priorities in triage and therapy. With smart technologies, support for care comes from two actions: improvement and management. Improvement refers to the capabilities of innovative technologies to enrich medical knowledge, to increase the management skills of care, and to identify best practices in this area. Smart technologies also serve to support and enforce the caring process and the provision of medical devices.

The subjects this challenge addresses are the health institutions, as actors of the care pathways, and the patients, as recipients of the care.
Innovative technologies support healthcare institutions in managing the current pandemic thanks to the ability to make information available for the personalized care of patients. The traditional medical process is thus supported by new high-tech solutions that can speed up and make the treatment process more efficient, in a phase in which time has become even more critical.

ACTIONS

IMPROVE:

- Enrich medical knowledge related to drug therapies
- Enhance the ability to deliver care
- Identify best practices

HANDLE:

- Avoid the dangers of managing care due to lack of medical tools
- Strengthen the supply network of medicine and medical material

TECHNOLOGIES

ARTIFICIAL INTELLIGENCE (AI)

- AlphaFold
- DynaMed
- Jvion Algorithm
- Micromedex

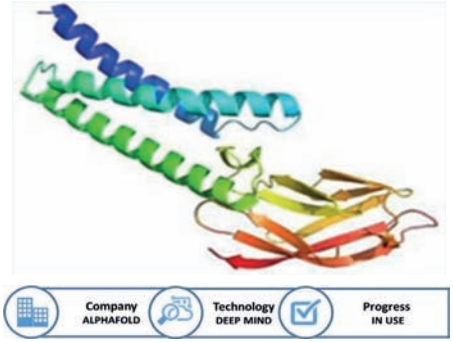
At the time of the current pandemic, smart technologies can support care through the improvement of interventions for the treatment of patients, the continuous updating of all data related to the progress of the disease and its related characteristics, and the testing of drug therapies useful to stem the severity of the disease.

Artificial intelligence that analyzes a multiplicity of data from different sources (e.g., drug monographs, reports based on therapeutic evidence, disease monographs, scientific articles) helps increase knowledge on the phenomenon and its evolution in different contexts, highlighting fundamental results for the treatment and care of patients. The new knowledge, brought to the attention of doctors and/or those in charge of defining drug therapies, provides significant added value, lowering the risk of therapeutic errors. The software useful for collecting data from similar health experiences, as well as those from reports or scientific articles, falls within this logic. The software also helps categorize and analyze sources to make the required information available and more usable.

ARTIFICAL INTELLIGENCE

AlphaFold

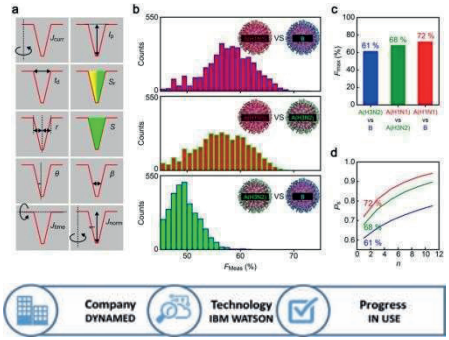
Software based on deep mind technology, able to perform predictive analyses. This software can analyze the protein structure of SARS-CoV2 to improve and advance understanding of possible therapies to support the treatment process. It helps healthcare professionals uncover the composition of the virus quickly. AlphaFold favors the identification of targeted treatments



ARTIFICAL INTELLIGENCE

DynaMed

Software based on AI technology to provide tracing and aggregation of data from scientific research. This software can promptly combine data to identify specific treatments for different patients. It allows healthcare professionals to make the right decisions when defining care. DynaMed helps improve health outcomes and decrease decision times.



ARTIFICAL INTELLIGENCE

Jvion Algorithm

Algorithm based on AI technology for the automatic learning of health data. This algorithm can determine the social risk factors that make people more likely to contract the virus. It also allows healthcare professionals to identify suitable strategies to combat the virus. Jvion takes a proactive approach to manage patient populations in an outpatient setting.

ARTIFICAL INTELLIGENCE

Micromedex

AI technology–based software to support drug therapy decisions. This software is able to generate detailed information about the dosage of drugs, warnings, and precautions. It gives healthcare professionals better clarification on medications used to treat COVID-19 with clear and verifiable evidence. Micromedex allows for greater safety and validation of the therapeutic pathways.

TREATING: HANDLE

TECHNOLOGIES

COMPUTER-AIDED DESIGN (CAD)

- Breami Valve
- Charlotte Valve

VIRTUAL REALITY

- XR Health

The management of the emergency health situation due to the rapid and global spread of the coronavirus has forced health institutions to use up much of the stock of medical supplies, running the risk of not having enough to treat the high numbers of infected patients. Personal protective equipment has become scarce and sometimes not obtainable, not least because of the buying frenzy that has occurred in many countries.

Robotics, the IoT, and the IoE allow management of the supply chain in emergency situations. These solutions help issue medical supplies quickly and effectively, ensuring the protection of medical staff and patients and also limiting the risks from the lack of equipment necessary to treat patients in certain conditions. The absence of protective material represents one of the causes of additional infections, making treatment ineffective in overall terms.

The 3D printer is one of the instruments that support the preparation of protection devices. This tool can be used to quickly create medical protection devices for those who must provide the treatments, as well as for those who receive the cares.

COMPUTER-AIDED DESIGN (CAD)

Breami valve

Medical device created with Additive Manufacturing technology. This device can transform the Decathlon Easybreath mask into an emergency respirator, improving its air flow. 3D printing has allowed the creation of an adapter designed to be sealed with silicone on the body of the mask to ensure its seal. The time and costs of implementation have decreased, assisting medical personnel in managing treatments.

COMPUTER-AIDED DESIGN (CAD)

Charlotte valve

Medical instrumentation created with 3D-printing technology. This instrument can transform full face snorkeling masks into emergency respiratory masks. 3D printing has enabled the rapid production of special valves for assisted ventilation, generating a hospital C-PAP mask for sub-intensive therapy. With the 3D printer, construction time and costs have decreased, facilitating the use and installation of the mask.

VIRTUAL REALITY

XR Health

Technological device supported by virtual reality combined with therapeutic software. This device allows the rehabilitation of COVID-19 patients through an engaging experience in the comfort of their own homes. It can increase patients' participation in the prescribed therapeutic treatments. With XR Health, it is possible to continuously monitor people in quarantine while maintaining limited physical contact.

RESEARCHING

*The activity of **research** is important for identifying disease countermeasures.*
***Smart technologies** support the research process by making it more efficient and effective, given the importance of time in obtaining a valid solution. Research support is expressed in the **study** of the information available and in the **development** of new drugs.*

RESEARCH & COVID-19

The fourth challenge in the fight against COVID-19 with smart technologies is research. Prior knowledge, new information collected, and new ways to identify a vaccine can be combined through new technologies. Doing so can help optimize the research process and reach a solution in a shorter time at lower costs and with a greater chance of success.

With the help of innovative technologies, research can be carried out in two ways: study and development. Artificial intelligence and blockchain and cloud computing support traditional medical and pharmaceutical research tools in identifying specific solutions to combat COVID-19. In detail, the intervention of smart technologies enables the use of a vast array of information collected both in the scientific literature and in hospitals and laboratories during the emergency periods. The processing capabilities of artificial intelligence–based equipment can reduce the length of the pathway for developing drugs and vaccines.

The subjects this challenge addresses are public and private entities, research centers, and universities.

Innovative technologies allow medical and pharmaceutical research institutions to obtain clear, constantly updated and analyzed information with greater rapidity. In detail, the selection of molecules and compounds useful for the identification of pharmaceutical solutions becomes faster when research institutions and universities are involved. The outcomes with the most direct impact are the reduction of time due to the large processing capacity, the presence of simulation models based on the comparison between alternatives, and an overall reduction in costs.

ACTIONS

STUDY:

- Analyze the characteristics of the disease
- Find the information needed

DEVELOP:

- Define the characteristics of molecules and compounds
- Create new drugs to start testing

TECHNOLOGIES

ARTIFICIAL INTELLIGENCE (AI)

- Antidote Match
- Iktos
- IBM Summit
- Frontera supercomputer

BLOCKCHAIN

- Innoplexus

CLOUD COMPUTING

- Benevolent AI

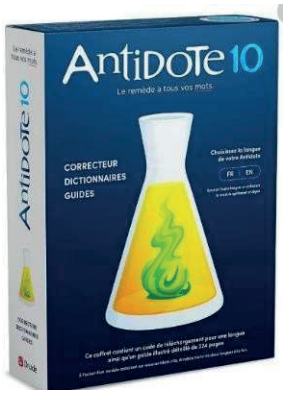
During the current pandemic, the intervention of innovative technologies can assist research in the study phase, making this activity more reliable. Artificial intelligence can increase data collection capacity and gather data, allowing faster and more thorough reworking. Research centers often confront various obstacles in identifying drugs and vaccines. The main difficulty arising in this phase of research is the presence of many variables to consider. The selection of appropriate variables is the first way that new technologies can limit the field of alternatives and facilitate the discovery of best solutions.

Processing skills become crucial, as the study of the characteristics to be examined depends on many sources. Beginning from the historical databases of medical and pharmaceutical research that aggregate evidence from the field during an emergency, technological solutions outline the spectrum of research activity. In addition, they enable the prompt implementation of the procedures and techniques for comparing identified compounds and solutions to be tested.

ARTIFICAL INTELLIGENCE

Antidote Match

Integrated platform with artificial intelligence for cutting-edge clinical research. This platform can carry out clinical studies to discover interventions for infected people and, at the same time, identify a vaccine. The information obtained through the platform is based on a reliable mass of data and on the use of algorithms to accelerate the search process.



Company Antidote | Technology ALGORITHM | Progress IN DEVELOPMENT

ARTIFICAL INTELLIGENCE

Iktos

Research process accelerated by artificial intelligence using algorithms for learning. Studies based on the process of synthesizing molecules for obtaining new drugs are often guided by artificial intelligence. Artificial intelligence identifies the most suitable molecules to counteract the virus, thanks to the support of algorithms that compare the characteristics of molecules and viruses and uncover the solutions with the greatest probability of success. The technique in use is based on models acquired with reference to drugs already in use and allows researchers to reduce the study time of a solution.

IKTOS

Artificial Intelligence for new drug design

Company IKTOS | Technology AI | Progress IN DEVELOPMENT

ARTIFICAL INTELLIGENCE

IBM Summit

Computing processor enhanced with artificial intelligence. This mega-processor has a computational capacity that can perform up to 200 million billion calculations per second. In the exploratory phases of medical and pharmaceutical research, it is particularly useful to select compounds to interact with the virus. The study phase is accelerated by the reduction of variables and the increase of first analyses conducted to show how fast the execution is, given the identification of 77 potential solutions in a much wider range in a few days.

ARTIFICAL INTELLIGENCE

Frontera Supercomputer

Supercomputer powered by computational skills and artificial intelligence. The supercomputer can perform simulations at breakneck speed to analyze the molecular structure of the coronavirus and evaluate its infection capabilities. This study phase is preparatory to the development of pharmaceutical solutions. The study is also extended to the symptomatic characteristics of the disease to identify all-round solutions.

BLOCKCHAIN

Innoplexus

Combination of blockchain and artificial intelligence. Innoplexus is a data analysis system that provides certified health information thanks to the blockchain. The study of pharmaceutical solutions begins with structured and unstructured health data, collected mainly from online sources and aggregated with company data to ensure a knowledge process updated in real time. In addition, searching within databases is made faster by artificial intelligence, which reduces study time and costs.

CLOUD COMPUTING

Benevolent-AI

Information archive supported by machine learning. The medical information acquired through analyses carried out during the pandemic is combined with information derived from the vast scientific literature in the medical field. Here, machine learning favors the identification of potentially effective solutions. This archive has already produced six compounds that block the cellular development of the coronavirus. Studies can now be accelerated and have a greater chance of success.

RESEARCHING: DEVELOP

TECHNOLOGIES

ARTIFICIAL INTELLIGENCE (AI)

- Centaur Chemist
- ChemRxiv

DEEP LEARNING
- Deargen
- Insilico Medicine

The research phase continues with the development of solutions that can be used to treat patients with COVID-19 and to develop a vaccine. The goal is to identify new molecules and compounds that can be sent for experimentation and then used in hospitals in the fight against the virus.

In this phase, the time aspect is of pivotal importance, as research takes years to complete. Thus, the implementation of innovative technologies can favor a drastic reduction in waiting. At the same time, the intervention of smart technologies can be useful to reduce costs of the development of a solution, as most experiments fail; an a priori selection can reduce both time and costs.

Artificial intelligence and deep learning are useful for achieving high levels of efficacy, giving priority to the solutions that have a better chance of success, as the interaction between the drugs and the virus's responses can be evaluated more efficiently.

CASE STUDIES

ARTIFICAL INTELLIGENCE

Centaur Chemist

Intelligent platform for the definition of new drugs. This platform helps improve productivity in the drug development phase because, through artificial intelligence, it analyzes hypotheses and assigns them an order of priority based on their probability of success. Research centers pay more attention to solutions with a high potential for success, improving the time and reducing the costs of development.

ARTIFICAL INTELLIGENCE

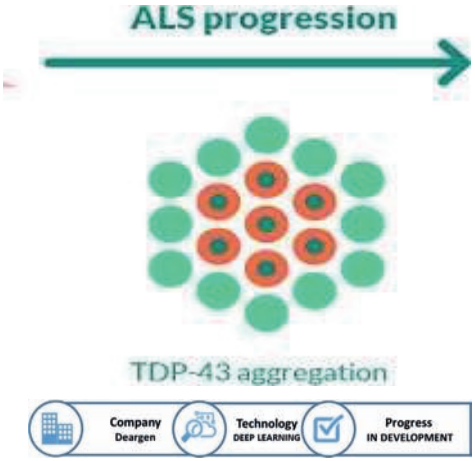
ChemRxiv

Algorithms equipped with artificial intelligence for detailed data analysis. With this system, drugs can be evaluated in terms of their similarity in molecular structure. The algorithms automate and accelerate the process, allowing only drugs with a valid structure to move toward the testing phase. The drugs already in circulation and those in the approval phase are taken as a model for molecular comparison.

DEEP LEARNING

Deargen

Prediction model for antiviral drugs supported by deep learning. This model's main function is to analyze the interaction between drugs and the coronavirus. Deep learning assesses how existing drugs interact with COVID-19. The prediction is based on the determination of an affinity score between a drug and a protein, returning useful information also for the preparation of new drugs. In this way, selection and development occur in a more targeted way.



DEEP LEARNING

Insilico Medicine

Drug evaluation model based on machine learning. This model favors the analysis of the effectiveness of a drug on the target because the deep learning automatisms allow selecting the characteristics of the drugs from the biochemical characteristics of the virus molecules. A more effective, faster, and cheaper solution development process is possible through this model.

CONCLUSION

The innovations described in this report outline a framework of knowledge and offer general reflections. Technologies not only open up new horizons and scenarios that are not always imaginable but also make more evident the need to radically rethink the practices and methods of organizing human, social, and economic relations. Challenged by this hyper-complexity, all actors must face the indeterminacy and ambivalence of the ongoing metamorphosis of political, social, and cultural processes and the inadequacy of the interpretative frameworks offered by traditional cognitive schemes. At the same time, the technologies described uncover issues with regard to ethics and privacy; some of these technologies offer firm guarantees in terms of cybersecurity, while others are unexplored, leaving room for doubt on their use. The challenge is in the communication between different languages, between people, between machines, and between people and machines.

The new digital speed, in the complex interaction with the human factor and the system of social relations, preserves the original ambivalence of any factor of change and any social and cultural process. Ambivalence, therefore, which not only provides an extraordinary opportunity but also highlights the limits and inefficiencies of a traditional approach, involves considering the phenomena from a single angle of observation. An awareness of the inadequacy and irreversibility of a process denotes the concrete risk of focusing exclusively on the technological dimension and, more generally, on the application of the same, again underestimating the people involved, the system of relationships, and the socio-cultural context.

Technology is neither a magic wand guaranteeing a bright future nor a science fiction movie. Unconditional trust is not being put in the intelligent systems being built. Such systems depend on the quality of the data, but if they are imperfect or not properly integrated by people in their different daily practices, they will not enable the creation of value. Technology itself is neither positive nor negative; it is simply a possibility. Smart technologies are a tool whose value always depends on human implementation in a specific context of use. It is thus necessary to overcome the gap between humans and technology and rethink the complex relationship between the natural and artificial, while recognizing the connections in place. We need to facilitate the transition from industry 4.0.

Innovative technologies can help contain the spread of the coronavirus by supporting humans in facing certain challenges, including through prevention, diagnosis, treatment, and, finally, research. Several platforms and support applications, through the integration and analysis of heterogeneous

data, help map and monitor new outbreaks, allowing policy makers to try to manage the crisis; healthcare institutions to intervene promptly, despite the conditions of “operational suffering” in which they find themselves given the overload of work; and citizens to protect themselves adequately. Prevention, however, means not only monitoring the spread of the virus but also intervening operationally to drastically slow the spread. In view of this need, it is of pivotal importance to analyze the innovative technologies used to meet these challenges, including the technologies still under development (e.g., social robots). It is about the possibility of creating a medium between patient and doctor, to reduce direct contact while maintaining a high level of monitoring, or even of effectively replacing humans in essential activities to reduce the risk of infection, such as sanitizing public areas, delivering medicines, or transporting essential goods in contactless mode.

The support of smart technologies also materializes in diagnostic activities mainly through the use of AI-based chatbots, which help relieve the pressure of too many patients on healthcare structures, for a first diagnosis, offering an effective triage and self-assessment system through simple and intuitive interfaces. Furthermore, the added value afforded by smart technologies to the diagnosis phase of COVID-19 lies in the ability to accelerate, through the instrument of artificial intelligence and deep learning, the process that leads to suitable outcomes with all the obvious advantages in operational and epidemiological terms.

At this time, there is still no vaccine for COVID-19, but the technologies provided in this report offer improved ways to administer treatment, increase management skills of the people involved, avoid the dangers arising from the lack of medical equipment, and strengthen the supply network of pharmaceutical and medical material. We are confident that through the ability of artificial intelligence to analyze therapeutically relevant characteristics and through additional learning in the vast scientific literature, treatments to end the pandemic will be found.

App: abbreviated form of "application". By itself, the term means any program, regardless of the medium on which it is used. In everyday use, we refer to mobile apps, or those for mobile phones and tablets, typically designed and built in a lighter way than hardware resources used for classic desktop computer applications.

Artificial intelligence: a set of techniques that make machines, especially electronic ones, capable of solving problems and reproducing human intelligence activities.

Big data: extensive information data collection in terms of volume, speed, and variety that requires specific analytical technologies and methods for the extraction of value or knowledge.

Blockchain: a shared and unchangeable data structure; often defined as a digital register whose entries are grouped in blocks and concatenated in chronological order and whose integrity is guaranteed using cryptography.

Cloud computing: the technology to process and store data on a network. It can make hardware (IaaS - infrastructure as a service), software platforms (PaaS - platform as a service), or software (SaaS - software as a service) available remotely.

3D printer: machine capable of creating plastic objects from digital files. Most open source printers use FDM technology, which, to create objects, lays layers of molten plastic on top of each other.

Deep learning: a sub-category of machine learning that refers to the branch of artificial intelligence made up of automatic learning algorithms inspired by the structure of artificial neural networks.

Digital health: convergence of digital and genomic technologies with the fields of health, healthcare, lifestyle, and society, to improve the efficiency of healthcare delivery and make drugs more personalized and precise.

Drones: aircrafts characterized by the absence of a human pilot on board. Its flight is controlled by the computer on board the aircraft, under the remote control of a navigator or pilot, on the ground or in another vehicle.

GPS technology: GPS, which stands for Global Positioning System, is a system for global positioning. With GPS, it is always possible to locate the longitude and latitude of objects and people.

Internet of Things: a system that allows maximizing the collection and use of data from a multitude of sources (e.g., industrial products, factory systems, transport vehicles) to the benefit of greater digitization and automation of processes. It also takes advantage of machine learning and artificial intelligence to create new business and value services for consumers.

Qr-Code: the contraction of Quick Response Code, which is a fast response barcode. It is a symbol that returns, whenever it is framed by the camera of a smartphone, data and information to the user.

Robot: an automaton, automatic mechanical operator controlled by an electronic brain, with reference to the programmable devices used in some sectors of industry and scientific research for serial and automatic operations.

Smart technologies: a combination of digital and cognitive technologies capable of carrying out activities or making decisions autonomously for human beings.

Thermal chambers: an instrument that can detect, without contact, the thermal energy radiated by anyone with a temperature above absolute zero (–273.15° C). It makes visible the temperature distribution of the framed areas by generating a photo.

Virtual assistants: software agents that can perform activities or services for an individual through commands or questions. Some virtual assistants are able to interpret human language and respond through synthesized voices. Through virtual assistance, users can ask questions, control home automation devices and voice playback, and manage other basic tasks (e.g., email, to-do lists, calendars) with verbal commands.

Wearables: a type of electronic device that is usually worn on the wrist and has functions such as notifiers connected to the smartphone with wireless, medium waves FM or more often with Bluetooth. The most common wearable devices are smartwatches. Another wearable device is a smart bracelet, called a “fitness band”, that interacts with the user either through screens or LEDs and has sensors for monitoring physical, cardiac, and sleep activity.

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This report is part of the Digital4Human program, which deals with studying cognitive technologies such as what actors can do in terms of new resources and how they contribute to value co-creation processes. The new socio-material practices are being investigated.
In the Digital4Human program, projects are under development on artificial intelligence, cognitive computing, & value co-creation; artificial Intelligence & social robots; blockchain & market shaping; blockchain & agri-food; and the customer experience & phygital customer journey.

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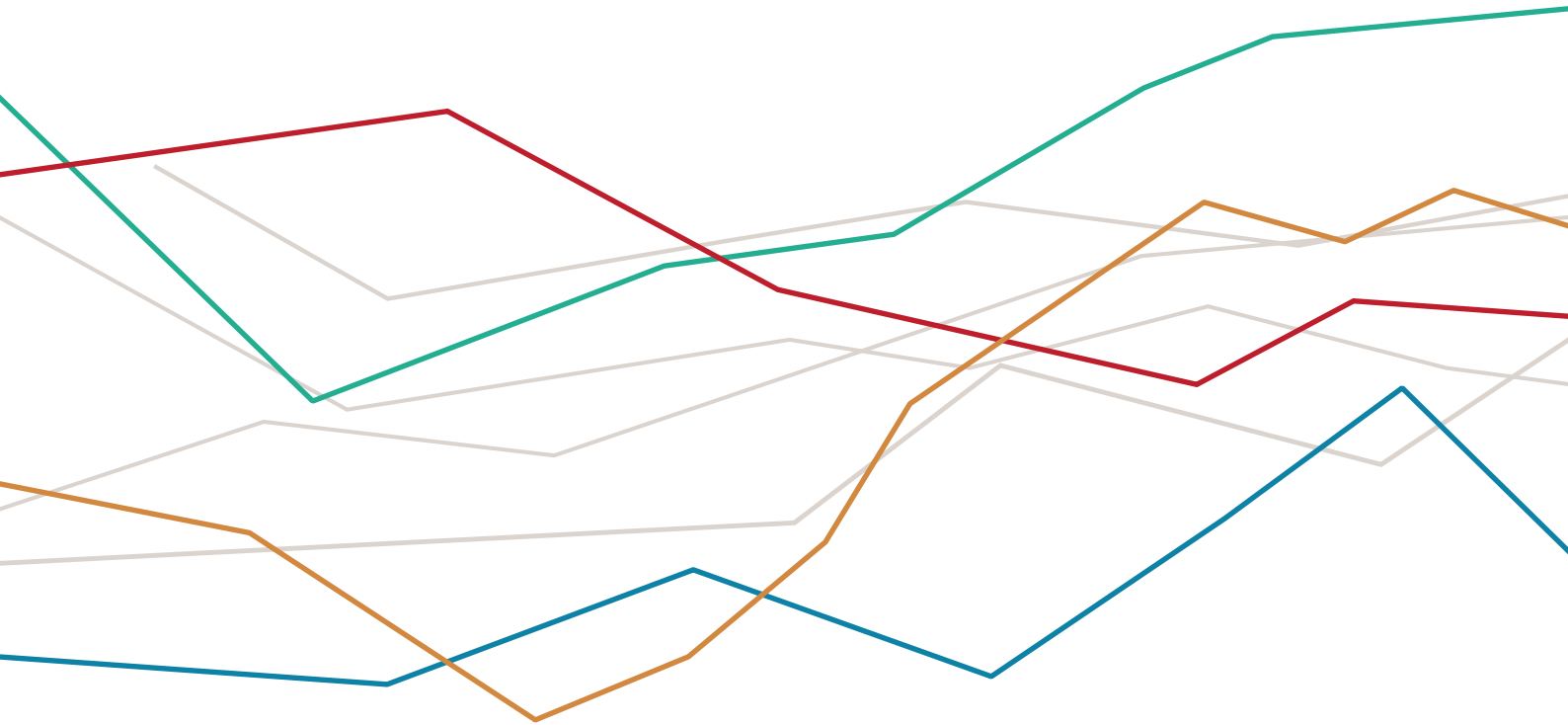

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