CSC Newsletter

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COVID-19: How Biomedical Informatics Can Support Health Systems

From the scriptures, it has been reported that human lives at a certain time will experience what may look like a plague. In 1918, it was reported that there was Spanish flu and recently, varying degrees of fatalities have been reported from several diseases including Malaria, Influenza, Flu, Yellow Fever, Ebola, and currently, novel corona virus disease (COVID-19). Since its outbreak in November 2019, from Wuhan, Hubei Province, China, global concerns have heightened. Presently, more than 200,000 deaths have been recorded from over 3million cases reported by the World Health Organisation (WHO).

Out of this number, over 900,000 have recovered from the virus that has now snowballed into a pandemic. Statistics obtained from history showed that such outbreak has proved recurring in every century. Another account has it that the novel corona virus was mainly contracted through animals, so it is very crucial to avoid consumption or the use of such animals in normal life. Governments, businesses and development institutions around the world need to be apprised of COVID-19 situation; how it may unfold and by acting promptly, to protect the citizens, their employees, customers, supply chains, and financial results. So, the sensitization of the populace about the fatality of the virus should be stringent, vigorous and total while governments search for the treatment and appropriate vaccine because the highly infectious virus is capable of manifesting in various genetic formations when it transmits from one animal to the other.

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However, its adverse effect on all spheres of life worsens the social, academic, financial and other recreational activities that were cancelled all over the world as a result this pandemic, to contain the global spread, reduce transmission and the mortality rate of the infection. However, the most important sector that has taken over the stage is the health sector. The current pandemic has proven to every citizen that money and power are worthless because many developed nations with solid financial backgrounds and technology have been negatively affected. An old adage says "health is wealth", no wonder that there are professions with specialties such as Health Statistics, Biomedical Statistics, Biomedical Informatics, and Health Psychologists, among others. Biomedical Informatics emerged around two decades ago, and it involves computer applications in health care sector and biomedicine. This brings up a synergy between Computer Scientists and Healthcare/Biomedical experts in harnessing the power of automation in solving health challenges.

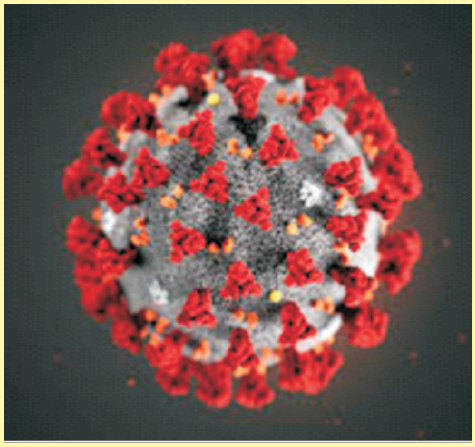
In a nutshell, Bioinformatics or Bio-Computing is the science of information as applied to or studied within the context of biomedicine. The rate of scientific discoveries and exponential growth of patients' records during COVID-19 is attracting the concept of Big Data analytics for biomedical education, research, and practice. Other areas where Biomedical Informatics are growing include website and Mobile Apps development for information dissemination and sharing, decision-making using probabilistic clinical reasoning, use of software engineering, case-based reasoning, expert systems, fuzzy logic and neutrosophic set models. Others are natural language processing, imaging and computer vision, speech recognition, embedded systems, machine learning, deep learning, chatbots, and facial recognition.

This has proven that Artificial Intelligence, a branch of Computer Science can be of tremendous support in the control and containment of COVID-19 pandemic for contact tracing and vaccine development. For instance, disease surveillance, virtual health care assistants (chatbots) due to high traffic of requests and consultations by infected patients, facial recognition and fever detection, intelligent drones and robots, curative research in the development of fast and dynamic algorithms for molecular structure and simulation, and information verification of fake news through social-media platforms, effective early warning system deployed to assist in "flattening the curve" of the pandemic.

In Nigeria, several institutions of higher learning and governments are not left out in their innovations towards fighting the pandemic. Some experts at the University of Jos, Plateau State repaired some defected ventilators; student of Federal Polytechnic fabricated a local-made ventilators; students of the Federal University of Technology, Owerri, Imo State developed a sensor-based detector that makes it impossible to touch one's face, to avoid infections. Few days ago, Lagos State launched an initiative aimed to further protecting citizens by reducing the risks of contracting the virus by having access to highly-experienced medical doctors for non-emergency primary care advice via voice or video call from their homes.

In planning for the future and based on experiences, the importance of healthcare systems and computer applications to biomedicine requires an up-to-date curriculum for biomedical informatics education for Computer Science and Information Technology students with the support of Biomedicine professionals for critical mass capacity building. The establishment of Health Information Technology policy including its ethical, legal, and societal implications must be addressed. Finally, the provision of adequate infrastructure such as fast Internet connectivity, to enable the adoption of telemedicine in Nigeria is vital. As you read along, you can see the contributions to knowledge of staff and students of the Department of Computer Science, FUNAAB, to humanity during COVID-19 pandemic.

Biomedical Informatics

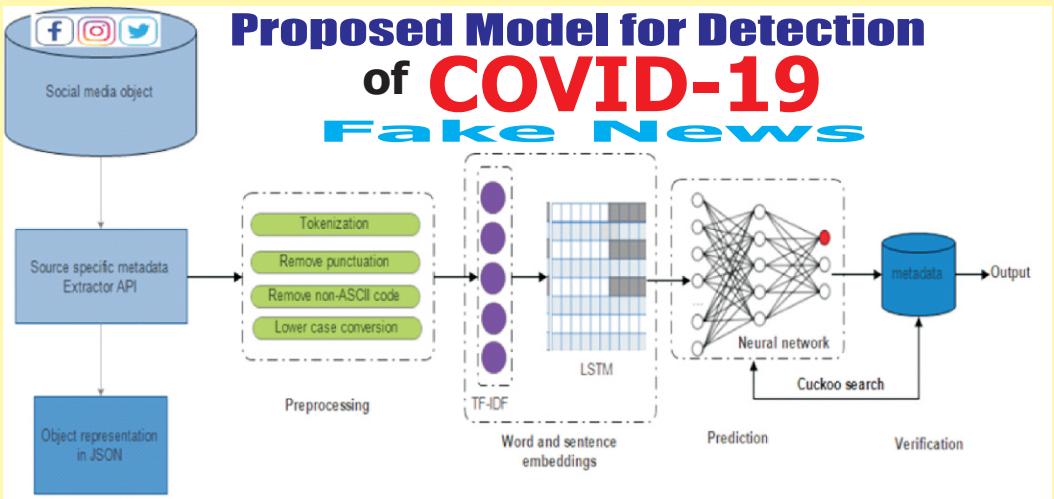


COVID-19: Detecting Fake News, Optimised ANN to the Rescue

With the ravaging corona virus disease (COVID-19), the social media have been flooded with several fake news and misinformation, which are life-threatening. Millions of people have taken to sharing rumours, half-truths, and lies connected to the public health challenge via online posts on Facebook, Twitter, Instagram, and WhatsApp, among others. Since the global crisis began, it has been discovered that over 40 percent of the corona virus-related misinformation is found on Facebook. These fake news range from unverified local remedies to conspiracy theories about the emergence of the virus. The spread of this fake news is alarming and requires adequate measures for verification and control. Artificial Neural Network ANN, a form of Artificial Intelligence can be deployed for the detection of such fake news.

ANN is designed to recognise patterns. They interpret sensory data through a kind of machine perception, labeling or the clustering of raw data. ANN is known for its capabilities, which include flexibility, competence of learning by instances, pattern classification, optimisation, function approximation, pattern matching, and associative memories. Nature-inspired meta-heuristic algorithms provide derivative-free solutions to solving complex problems. Cuckoo Search (CS) algorithm is one of the latest additions to the group of nature inspired optimisation heuristics. CS algorithm can be implemented with Recurrent Neural Network to detect fake news associated with COVID-19. The proposed model, a Cuckoo Search-based Neural Network, consists of four phases, viz: data preprocessing, feature representation, prediction, and verification phases. The data preprocessing phase involves the collection of fake news associated with COVID-19.

Data cleaning is carried out to remove non-ASCII characters and other noises from the collected data. Feature representation phase makes use of embedding techniques such as Term Frequency-Inverse Document Frequency (TF-IDF) for word-level feature extraction and Long Short Term Memory (LSTM), which is a variant of Recurrent Neural Networks' architecture for sentence-level feature extraction. Extracted features are input into the Cuckoo Search-based Neural Network for prediction. In the verification phase, the Cuckoo Search algorithm performs a search optimisation of the collected fake news by linking to related verified external news. The Cuckoo Search algorithm selects a specified number of news relating to the collected fake news as the initial population. A fitness evaluation of the initial population using levy flight (survival function) is conducted and an average worst function is used to drop less reliable news articles amongst the fake news set. The process is repeated until the iteration terminates. This process eliminates all fake news. The figure below depicts the proposed Cuckoo Search-based Neural Network.



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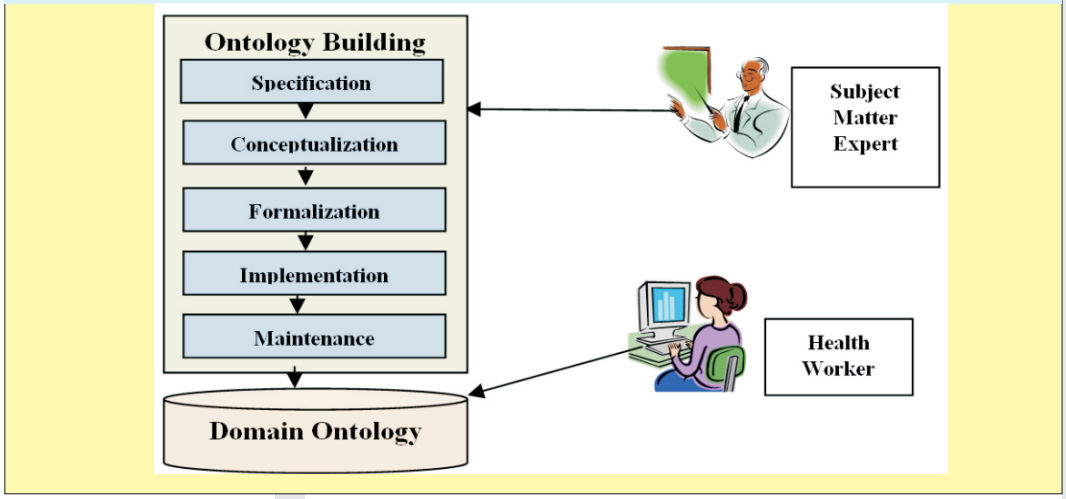
COVID-19: Drugs Ontological Categorization for Seamless Administration

Corona virus disease (COVID-19), which originated from Wuhan, China has been reported to have infected more than 2.7 million people all over the world. Several researches are ongoing to tackle the virus. Many of the studies on the discovery of effective drugs targeted at curbing the spread of COVID-19 are based on the treatment process of previous epidemic viruses such as the Severe Acute Respiratory Syndrome (SARS), Ebola Virus Disease (EVD), and Middle East Respiratory Syndrome (MERS). Drugs improved to treat COVID-19 patients are expected to inhibit viral entry into cells and viral replication inside cells or modulate host immune responses. A few antimicrobial drugs including antimalarial, antifungal, and antibiotics drugs have already been found to be effective in treating COVID-19. Genuine administration of these drugs, however, involves proper classifications to afford health workers easy access, as well as prevent/reduce wrong prescriptions, thereby reducing risk ratios.

Classification of drugs can be best achieved with Ontology. Hence, ontology is a formal and explicit specification of a shared conceptualization. Its models of entities are in a human-and machine-readable representation, and relations among entities are logically represented as axioms. Ontology enhances the capturing of domain's conceptual structure, knowledge analysis, distinction between domain knowledge and operational knowledge, knowledge sharing, knowledge reuse, and removal of ambiguities, among others. An ontological categorisation of COVID-19 drugs can be developed. The building of the ontology will facilitate classification of drugs from which systematic collection, annotation, and specific analyses can be performed. The ontology will contain terms like drug name, drug category, duration of treatment, method of administration, dosage, and treatment outcomes as its concepts.

The proposed architecture, as shown in the figure below, comprises five phases namely; Specification, conceptualisation, formalisation, implementation, and maintenance. The intended use, scope and required expressiveness of the underlying representation language of the ontology are identified in specification phase. Structuring of knowledge of the domain of interest is performed in the conceptualisation phase. During formalisation, the result from the conceptualisation phase will be transformed into a formal model where classes and subclasses with their properties are created, and the ontology is executed in the implementation phase. Regular updates to correct or enhance the ontologies are carried out at the maintenance phase. Protégé 4.3 editor can be used to create the ontology and HermiT Reasoner to assert its soundness. Consequently, results can be used to facilitate rational drug design for COVID-19.

Architecture of the Proposed Ontological Categorisation of COVID-19 Drugs



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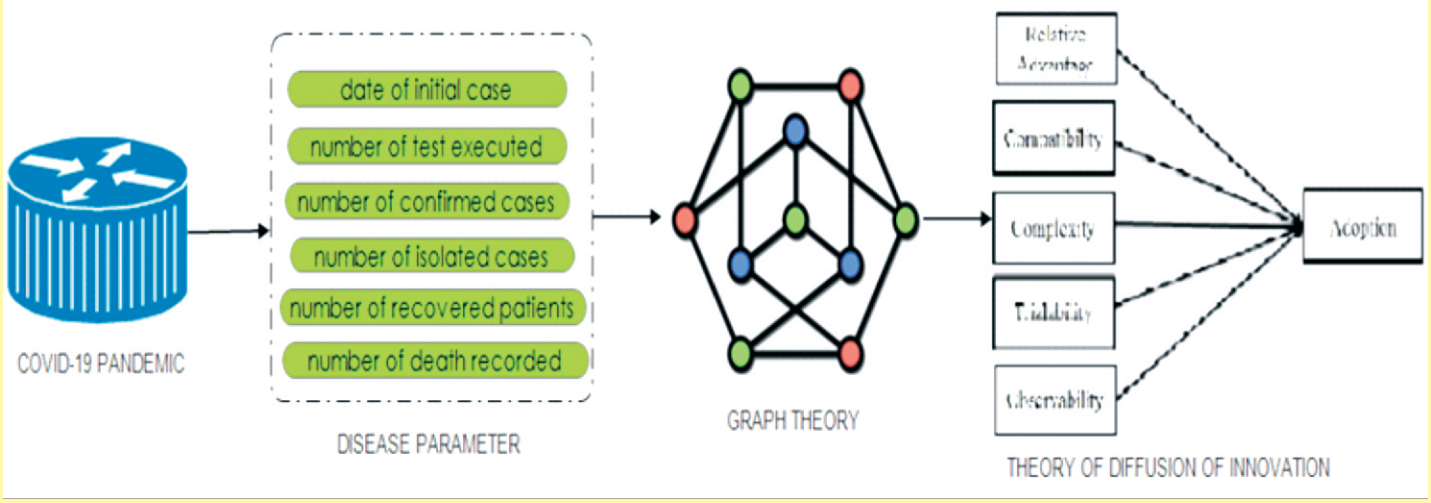
Social Network Model for Monitoring COVID-19 Transmission

According to the World Health Organisation (WHO), common symptoms of the coronavirus disease (COVID-19) include fever, cough, and shortness of breath. Some people may experience symptoms such as fatigue, aches, diarrhea, sore throat, loss of smell and abdominal pains. The disease is said to have an incubation period of between five to six days on the average. However, it can take up to 14 days but the transmission of the virus is mainly through social interactions between human beings. Social network models can be developed for controlling the transmission of COVID-19. Graph theory can be utilised in determining the growth rate of the infection in a particular area using disease-related data such as date of initial case, number of tests executed, number of confirmed cases, number of isolated cases, number of recovered patients and number of deaths. These data serve as inputs into the graph model.

In the proposed social network model, illustrated below, the initial case of infected individuals is linked to sources of infections and additionally, to a variable number of others to whom they transmitted the virus, thus providing a 'transmission network' consisting of all the links through which infection spread in a single outbreak. The theory of diffusion of innovations, which is a structural approach, will be applied as it integrates the output from the graph theory and the social network concept in understanding the channel and flow of information through mass and digital media, interpersonal, and network communication among the social system.

Proposed Social Network Model for COVID-19 Pandemic



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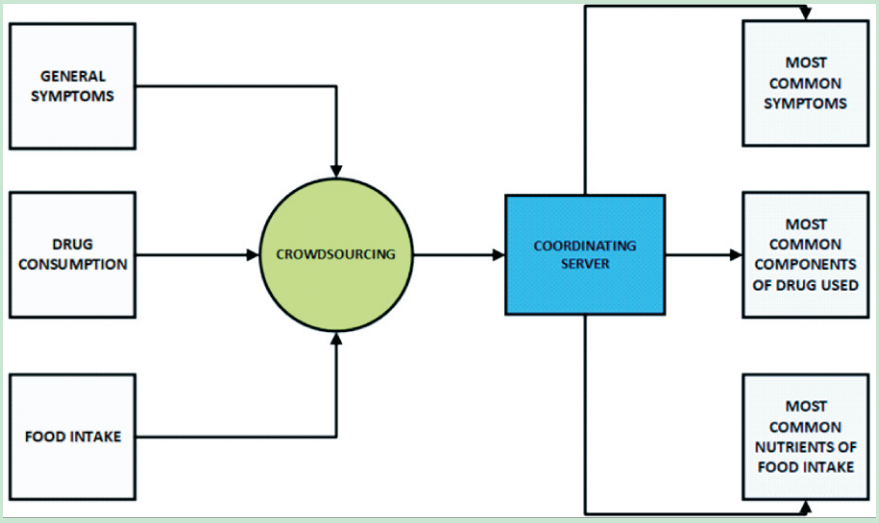
Mitigating COVID-19 Pandemic Using Crowdsourcing

As the corona virus disease (COVID-19) continues to spread globally, many countries have implemented sweeping measures such as travel bans, curfews, prohibition of mass gatherings, mandatory quarantines, closure of learning facilities, entertainment spots, and borders to curb the pandemic. However, statistics show that the rate of infection is increasing exponentially around the world. Presently, there are over 3million confirmed cases with over 200,000 deaths while over 900,000 have recovered from the infection. Consequently, intense efforts are being made by the governments, researchers, and health workers towards curbing the spread of the highly contagious virus.

Crowdsourcing is a promising approach to biomedical research and development and could produce solutions to eradicate pandemics. Crowdsourcing involves obtaining work, information, or opinions from a large group of people, who submit their data via the Internet, social media, and smartphone apps. Crowdsourcing, a concept in Information Communication Technology (ICT), can be deployed in obtaining information necessary for combating COVID-19. Crowdsourcing can be achieved by inviting the public to report in real-time via messaging apps, current symptoms and drugs used by people that have totally recovered from the diseases. For privacy sake, reports sent can be anonymised. Responses from members of the public about their health status will help experts track specific locations where COVID-19 is spreading or receding.

More importantly, data on drugs used and food taken by recovered patients can be obtained and analysed. Based on the dataset collected, data analysis tools can be employed to study, compare, and contrast the data generated about food intake, drugs and symptoms of infection. A visual map of COVID-19 hotspots can be produced, as shown below. Subsequently, various types of the composition of food nutrients and drugs, responsible for the recovery of infected patients can be formulated. As such, medical practitioners can then recommend possible nutrients and drug formulations for coronavirus patients.

Proposed Crowdsourcing Model for COVID-19



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Aligning Information Technology (IT) to Support Sustainable Development Goals (SDGs)------ (2)

In the previous edition of CSC Newsletter, we highlighted how Information technology aligned to support sustainable development goals SDGs 3 and 7. However, in this edition efforts will be made to discuss on SDGs 1, 2 and 9.

ICTs and Impact on SDG 1, SDG 2

Information and Communication Technologies (ICTs) have huge potentials to accelerate progress on the United Nations' Sustainable Development Goals (**SDGs**) and improve peoples' lives in fundamental ways. ICTs could be key catalysts, and absolutely crucial to achieving the developmental goals. SDG 1, which is **No Poverty**, is the first goal of the 2030 SDGs Agenda, which calls for ensuring social protection, enhancing access to basic services and building resilience against the impacts of natural disasters, which can cause severe damages to people's resources and livelihood. Eradicating poverty in all its forms remains one of the greatest challenges facing humanity. Africa particularly is faced with many challenges relating to poverty.

ICTs can be used to alleviate poverty, promote inclusive and sustainable economic growth. This includes improving opportunities and facilities for the poor by using ICTs to map and monitor their needs and support development initiatives. Agricultural extension and business development services can be enabled by ICTs to provide timely information and solutions as well as inclusive innovations and quality education/jobs for the poor via online education/job opportunities with ICTs. Banking the unbanked through inclusive digital financial services and effective data collection and analytics can be geared towards the eradication of poverty. ICTs can be used to promote sustainable resource management system to secure delivery of food, medicine, and disaster relief. SDG 2, which is **Zero Hunger**, seeks sustainable solutions to end hunger in all its forms by 2030, achieve food security, and improve nutrition. The aim is to ensure that everyone everywhere has enough and quality food to lead a healthy life. Achieving this goal will require better access to food and widespread promotion of sustainable agriculture.

Globally, one out of nine persons go hungry every day, according to the World Food Programme and yet, some 1.3 billion tonnes of food are wasted annually. Food wastage across the value chain is one of the problems affecting Africa. To combat this problem and make progress on SDG 2, ICTs are increasingly being deployed to influence the connection between the hunger and access to food at a scale and speed more than ever before. The power of mobile technology can be harnessed to combat hunger. Several mobile apps can be developed to create awareness to curb food wastage. Consequently, food can be redistributed from surplus centres to the needy.

Mobile technology can influence access by farmers, food transporters, and traders to market updates, value chain information and weather forecasts, which will increase rural business productivity as well as prevent food wastage. It also offers opportunities to connect people in rural/remote areas and help them improve their farming methods and productivity. Electronic agriculture (e-agriculture) can contribute to progress on SDG 2. ICTs in agriculture can influence efficiency, productivity, and sustainability. Smart farming makes tremendous contribution towards food security and sustainability. For instance, the use of wireless sensor network from independent power source distribution, monitoring irrigation valves and switches operation, and remote area control will effectively improve the production of quality farm products.

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Towards Achieving SDG 9 with ICTs

Out of the 17 Sustainable Development Goals (SDGs) developed by the United Nations General Assembly, SDG 9 focuses on **"Industry, Innovation and Infrastructure"**. This goal aims at building resilient infrastructure, promoting inclusive and sustainable industrialisation and fostering innovation. Realising SDG 9 by 2030 will require exploring innovative ways to solving some developmental challenges.Information and Communication Technologies (ICTs) are crucial in achieving an industrial revolution as innovation is key to sustaining the relevance of industries. Innovative solutions through ICTs enhance operability, flexibility of industrial processes, autonomous and intelligent manufacturing. Manufacturing processes such as product design, personnel management, logistics, and machinery automation are greatly influenced by ICTs.

Recent reports have highlighted Cyber-Physical Systems as the fourth industrial revolution following the third industrial revolution, which was based on information technology, electronics and automated production. 'Industry 4.0', a term used interchangeably with the fourth industrial revolution, is a trend towards automation and data exchange in manufacturing technologies and processes. Industry 4.0 factories are said to have machines which are augmented with wireless connectivity and sensors, connected to a system that can visualise the whole production line and make decisions on their own. Industry 4.0 will be fully realised through technologies as Internet of Things (IoTs), Cloud Computing, Cognitive Computing, Virtual and Augmented Reality, Blockchain Technology, Robotic Process Automation, and Artificial Intelligence.

Furthermore, the physical components of industrial production are being transformed into Cyber-Physical Systems by smart and digital networking by allowing for real-time management of production processes across great distances and products. An important step towards the full implementation of Industry 4.0 is digitalisation. Hence, digitalisation makes the global flow of information a lot easier. Digital technologies can also improve productivity as well as enhance resource and energy efficiency. Digitalization and electronic commerce (e-commerce) can help small and medium-sized enterprises overcome logistical and geographical challenges.

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