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Expert System for Corona Diagnosis (ESCD)

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Abstract:
Background*: Nowadays researchers are working tirelessly to find ways to better understand, treat and eventually eliminate COVID-19. This paper presents an Expert System for Corona Diagnosis (ESCD) to predict Covid-19 based on cognitive automation and production-rules.*
Materials and Methods*: This paper gives an overview of artificial intelligence in the medical and healthcare sector and presents a system that uses artificial-intelligence methods to solve problems within a specialized domain that ordinarily requires human expertise. Cognitive Automation extracts the symptoms from the unstructured text which can be found on various online resources like blogs, forums, social media websites, etc. The knowledge base is built using facts and rules which are extracted from the expert domains. Also, this paper presents the implementation of the ESCD inference engine using python packages for the initial diagnosis of the disease. An inference engine is built using efficient procedures and a prediction process to deduct a correct diagnosis, it provides a methodology for reasoning about information in the knowledge base and for formulating conclusions.*
Results*: ESCD is designed to predict who may be infected with Corona by using social media tools. The success of ESCD majorly depends on the quality, completeness, and accuracy of the information stored in the knowledge base.*
Conclusion: *This system can be one of the tools to incredible progress in diagnosing Covid-19 and protect people. Characteristics of ESCD are high performance, understandable, reliable, and highly responsive. The combination of cognitive systems and cognitive theory led to make a highly intelligent application.*
Key Word*: Expert Systems; Artificial Intelligence; Python, Interference Engine; Knowledge Base, Covid-19; Cognitive Automation*

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I. Introduction

AI is one of medical industry technology to monitor and controls the spread of COVID-19 (Coronavirus) pandemic which can easily track the spread of this virus, identifies the high-risk patients, and is useful in controlling this infection in real-time. Several AI applications for COVID-19 pandemic are used to detect the cluster of cases and to predict where this virus will affect in future by collecting and analyzing all previous data [1]. Cardiovascular disease is the main cause of death worldwide and has long since become an area of development for artificial intelligence tools. The diagnosis of acute myocardial infarction and the prognosis of heart failure, the former being the main cause of death and the latter the entity with the highest morbidity and the highest cost burden for the healthcare system, are two areas of development in which artificial intelligence-based modeling can be attempted. Examples of application for each of the components of both processes are presented, explaining the results and comparing them with conventional tools habitually used in the medical setting [2]. An expert system is a software system that attempts to reproduce the performance of one or more human experts, most commonly in a specific problem domain, and is a traditional application and/or subfield of artificial intelligence, the first expert system was developed in 1965 by Edward Feigenbaum and Joshua Lederberg of Stanford University in California, U.S. Dendral, as their expert system was later known, was designed to analyze chemical compounds, expert systems now have commercial applications in fields as diverse as medical diagnosis [3]. The use of the fuzzy expert system would help to diagnose COVID –19 virus at a much early stage. It will give more accurate results compared to the doctor's diagnosis. The benefits will be gained by both doctors and patients as the doctors will be able to save their time in diagnosing patients and focus more on treating COVID–19 patients and patients will be able to diagnose themselves and get the appropriate treatment as soon as possible [4]. Decision support systems applied within the 'remote medicine' framework may be of help, not only to the process of monitoring the evolution of chronic wounds under treatment, but also to facilitate the prevention and early detection of potential risk conditions in the affected patients. In this paper, the design and definition of a new decision-support methodology to be applied to the monitoring and assessment stages of the medical treatment process for pressure ulcers is proposed [5]. The diagnosis of heart failure can be difficult, even for heart failure specialists. Artificial Intelligence-Clinical Decision Support System (AI-CDSS) has the potential to assist physicians in heart failure diagnosis. The aim of this work was to evaluate the diagnostic accuracy of an AI-CDSS for heart failure. AI-CDSS for cardiology was developed with a hybrid (expert-driven and machine-learning-driven) approach of knowledge acquisition to evolve the knowledge base with heart failure diagnosis [6]. Diagnostic expert-based systems are computer systems that seek to emulate the diagnostic decision-making ability of human experts. Some notable systems include Mycin for infectious diseases, and Internist-1, QMR and DXplain for general internal medicine. Medical expert systems generally include two components: (1) a knowledge base (KB), which encapsulates the evidence-based medical knowledge that is curated by experts, and (2) a rule-based inference engine devised by the expert, which operates on the knowledge base to generate a differential diagnosis [7] [8].

AI- based approaches were highlighted in healthcare during the course of the Covid- 19 pandemic where AI- based technologies and methods have been deployed in modelling the virus spread and optimal utilization of resources. Availability of huge amount of high- quality data enriched with information may help the AI- based approaches effectively study the complicated real- life health related issues leading to a better management. Promising initial results have been obtained by the researchers using AI- based technology but the regulation around data exchange is the major hurdle in its implementation in real life [9].

There are many expert system examples in the medical and healthcare sector: MYCIN: It was based on backward chaining and could identify various bacteria that could cause acute infections. It could also recommend drugs based on the patient's weight. DENDRAL: expert system used for chemical analysis to predict molecular structure. PXDES: an example of expert system used to predict the degree and type of lung cancer. CaDet: one of the best expert system examples that can identify cancer at early stages. DXplain: this is a clinical support system that is capable of suggesting a variety of diseases based on just the findings of the doctor [10].

The challenges in the healthcare industry in 2021 were examined, as well as how we can expect new and emerging technologies to be used to manage those challenges associated with the virus and continue to invest in the technology needed to ameliorate them [11]. Densen states that by 2020, information about the body, health, and healthcare is predicted to double every 73 days, it has been suggested that integrating technology such as Clinical Decision Support Systems (CDSS) are the only way medical professionals can hope to keep up with the increase in information [12].

Researchers all over the world are building intelligent cognitive machines that can imitate many behaviors of humans [13]. Cognitive automation is based on software bringing intelligence to information-intensive processes, it leverages different algorithms and technology approaches such as natural language processing, text analytics and data mining, semantic technology and machine learning [14]. Online data can be found on various sources like blogs, forums, social media websites etc. covering a vast range of topics, there are health related blogs and forums where people discuss their health issues, symptoms, diseases, medication etc. [15].

II. ESCD Architecture

People share their issues online using various sources like blogs, forums, social media websites, etc. ESCD is built based on Expert System's Cognitive Automation, it uses natural language processing, text analytics to extract the symptoms from the online recourses.

The architecture of ESCD contains special heuristics or rules to diagnosis the Coronavirus which are built using the fact and knowledge taken from the expert persons and represented in the Knowledge Base as a fact and rules using python library. Inference Engine manages the entire structure of ESCD, and it delivers different methodology for reasoning. The user uses ESCD through the interface to write the symptoms and get the diagnose. Figure 1 shows the main components of ESCD: Knowledge Base, Inference Engine, Cognitive Automation, and social media recourses.

III. ESCD Implementation

Knowledge-Based (KB) of ESCD

COVID-19 is a highly infectious disease that will usually produce symptoms [16] [17]. The symptoms are represented as Facts in the ESCD. The knowledge base of an ESCD is a store of both, factual and heuristic knowledge. Factual Knowledge − It is the information widely accepted by the Knowledge Engineers and scholars in the task domain. Heuristic Knowledge − It is about practice, accurate judgment, one's ability to evaluate, and guessing. Signs and symptoms of coronavirus disease 2019 (COVID-19) may appear two to 14 days after exposure. Common signs and symptoms can include:

- Fever
- Cough
- Tiredness

Early symptoms of COVID-19 may include a loss of taste or smell. Other symptoms can include:

- Shortness of breath or difficulty breathing
- Muscle aches
- Chills
- Sore throat
- Runny nose
- Headache
- Chest pain
- Pink eye (conjunctivitis)

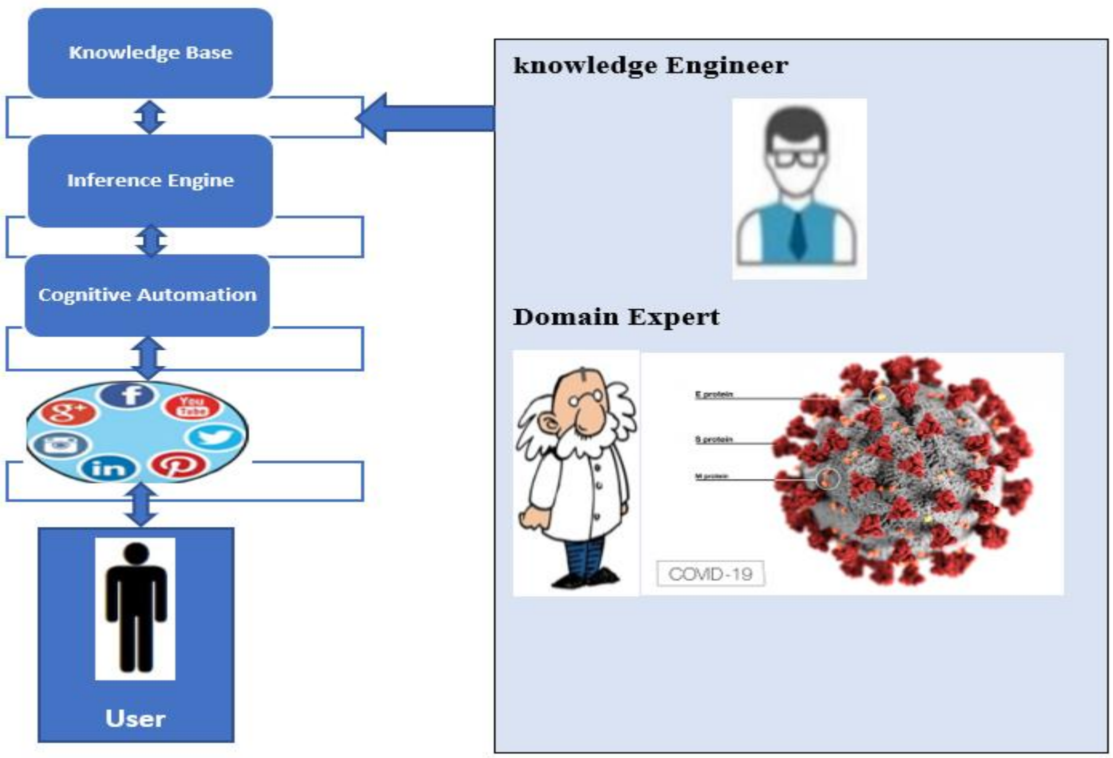

Figure no1 shows ESCD Architecture

Using python:
<f-1>: Symptoms('Fever')
<f-2>: Symptoms('Cough')
<f-3>: Symptoms('Tiredness')
<f-4>: Symptoms('Shortness of breath or difficulty breathing')
<f-5>: Symptoms('Muscle aches')
<f-6>: Symptoms('Chills')
<f-7>: Symptoms('Sore throat')
<f-8>: Symptoms('Runny nose')

<f-9>: Symptoms('Headache')
<f-10>: Symptoms('Chest pain')
<f-11>: Symptoms('conjunctivitis')
<f-12>: Symptoms(' loss of taste or smell')

Inference Engine

ESCD uses two different algorithms of inferencing: Forward Chaining and Backward Chaining. A Backward Chaining algorithm is a form of reasoning, which starts with the goal and works backward, chaining through rules to find known facts that support the goal. The goal is broken into sub-goal or sub-goals to prove the facts true, it is called a goal-driven approach, as a list of goals decides which rules are selected and used. The backward-chaining method mostly used a depth-first search strategy for proof [18]. A Forward Chaining algorithm is a down-up approach, as it moves from bottom to top. It is a process of making a conclusion based on known facts or data, by starting from the initial state and reaches the goal state. The Forward-chaining approach is also called as data-driven as we reach to the goal using available data [19].

The ESCD Inference Engine acquires and manipulates the knowledge from the knowledge base to deduct a correct diagnosis. The first step is to build a subclass of Facts and use Rule to decorate its methods as mention below.

```
class Symptoms(Fact):
  """Info about the patient"""
 pass
```

In Experta a rule is a callable, decorated with Rule. Rules have two components, LHS (left-hand-side) and RHS (right-hand-side).

- The LHS describes the conditions on which the rule should be fired.
- The RHS is the set of actions to perform when the rule is fired.

```
@Rule(Facts()) # This is the LHS
def _(self):
"""This rule will match with every instance of facts."""
 # This is the RHS
```

Figure 2 shows flow chart of ESCD Inference Engine

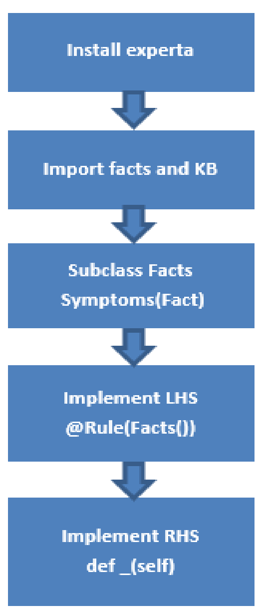

Figure no2 shows ESCD Inference Engine flow chart

The following sample of the inference engine for reasoning:

```
 class InreferenceEngine(KnowledgeEngine):
   @Rule(NOT(Symptoms('Fever')),Symptoms('Cough'),)
   def guess_Diagnoses0(self):
      print("Hypersensitivity")
@Rule(NOT(Symptoms('Fever')),Symptoms('Cough'),Symptoms('Runny nose'))
   def guess_Diagnoses0(self):
      print("Cold")
@Rule(AND(Symptoms('Fever'),Symptoms('Cough'),Symptoms('Runny nose'),Symptoms('Headache')),NOT
(Symptoms('loss of taste or smell')))
   def guess_Diagnoses1(self):
      print("diagnosis is flu, you have to do test")
      print(self.facts)
@Rule(AND(Symptoms('Fever'),Symptoms('Cough'),Symptoms('Runny
nose'),Symptoms('Headache'),Symptoms('loss of taste or smell')))
   def guess_Diagnoses2(self):
      self.declare(Symptoms('Shortness of breath or difficulty breathing'))
   @Rule(Symptoms('Shortness of breath or difficulty breathing'))
   def guess_Diagnoses3(self):
      print("If you have Muscle aches and Chills")
      self.declare(Symptoms('Muscle aches'),Symptoms('Chills'))
         @Rule(Symptoms('Muscle aches'),Symptoms('Chills'))
   def guess_Diagnoses4(self):
      print("If you have Sore throat and Chest pain and Tiredness")
      self.declare(Symptoms('Chest pain'),Symptoms('Sore throat'),Symptoms('Tiredness'))
```

Cognitive Automation

ESCD uses text analytics capabilities to perform Linguistic Rules. Cognitive Automation employs a sophisticated mix of linguistic and metric-based guidelines to determine if the unstructured data in the on-line resource contains Corona symptoms. Figure 3 shows ESCD Cognitive Automation stages.

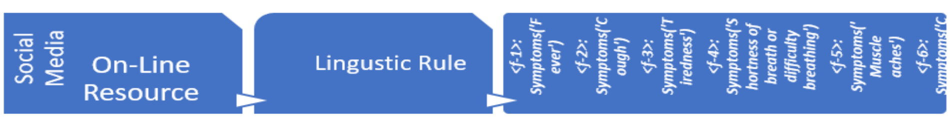

Figure no3. ESCD Cognitive Automation

IV. Conclusion

The Expert System for Corona Diagnosis (ESCD) is a type of artificial intelligence application that works with social media data. ESCD will help the user to initial diagnose COVID–19 virus, it is built based on the Expert System's Cognitive Automation using natural language processing, it extracts the information from unstructured data and explores the user's symptoms. The System strength results from that ESCD can provide a consistent conclusion for repetitive decisions and the knowledge base of ESCD can be updated and extended.

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