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A Study on Cognitive Computing in Medical Diagnosis

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Abstract: ***Cognitive Computing seeks the inspiration from the structure, functions, dynamics and behavior of the Brain. It uses Artificial intelligence and Machine learning algorithms to sense, predict, infer and think in some ways to break the conventional programming paradigm of Neumann. In this paper we analyzed these techniques in cognition, to make use in medical diagnosis. Diseases can be sensed and predicted from the textures of machine in which Human senses like sighting, smelling and hearing can be integrated into the Neurosynaptic chip(composed of neurons, axons and synapse) through programmed Corelets where Pattern recognition is carried out based on perception, action and cognition. It puts accurately disparate pieces of complex puzzle together from all the modules of test and detects the prevailing disease quickly which helps the doctor to carry out the diagnosis rapidly in dangerous disease like cancer.***

Keywords: Machine Learning Algorithm, Neurosynaptic chip, Corelets, Cognition, Medical Diagnosis

1. Introduction

1.1 Context

Cognitive computing is emerging technology which breaks traditional boundaries between neuroscience and computer science and paves the way for machines that will have a reasoning ability analogous to human brain [7]. This technology stands to bring entirely new computing architectures and programming paradigms in next generations. Cognitive systems are imbued with a new intelligence that can integrate information from a variety of sensors and sources that deals with ambiguity, responds in a context-dependent way, learn over time to solve complex problem in real world environment [1]. It is a self-configuring, self-diagnosing and self-healing system. Recently this research in cognitive has achieved many milestones: First, demonstration on multiple real time application such as navigation and music recognition; Second, compass, a simulator of true north architecture; Third, a long distance connectivity of macaque brain- that was featured on the covers of science and communication of ACM. In this paper we present a new idea in cognitive computing. This idea is about medical diagnosis using cognition technique. We introduce a machine which makes use of Neurosynaptic chip and Corelet language to identify the prevailing disease accurately and quickly which has better effects than current systems.

1.2 Motivation

Diseases are being increasing in a very expeditious rate for the past few years all over the world. Early prediction of some disease is needed for curing. All our existing technique doesn't support early prediction in a very effective manner. And separate tests are to be taken for detection of certain diseases which makes the treatment more complex to the doctor. A single symptom refers to too many ailments which lead to confusion in uncovering the correct disease [3]. But each and every syndrome has own set of symptoms. Thereby analyzing the whole set of symptoms in our body; diseases can be predicted accurately and quickly in a solitary test. The available technique in cognitive which puts the desperate pieces of complex puzzle together in real world and provides people with a good decision can be used here.

1.3 Contribution

As stated earlier, this project completely depends on the new technology available in cognitive systems. But its processing manner is as set of whole modules which leads to intricate situations while taking some key decisions on modules performed [8]. In order to combat the complexity in processing we approach a divide and conquer method whereby each test are separated into individual modules and being sorted out in a sequential manner. This process of detection will be progressing until we reach the fundamental block which is non-divisible. Due to this technique even complicated problems can be solved and good decisions can be made rapid for further treatments.

2. Important Factors

In our cognition diagnosis, every technique is in developing stage and hence many changes are to be implemented to make it use in our project .The important factors to be explained in this project are ***Neurosynaptic chip*** and ***Corelets***. Both these components has been developed and introduced successfully in many applications. The work is to modify the models and contents in it according our usage. For example, music composition recognition has already been implemented in Corelet but we have to make changes such that it recognizes disease patterns using molecular structures [8]. A detailed view of this factor is given below:

2.1 Neurosynaptic Chip

Neurosynaptic chip is composed of networks of neurons, synapse and axons, which was established by IBM-DARPA project. This resembles our brain in working process. Neurosynaptic cores is constructed by inter connecting a set of Neurosynaptic chip, where each of smaller networks, in turn, could be constructed [4]. Neurosynaptic cores is constructed by interconnecting a set of even smaller networks, and so on, until we reach a network consisting of single Neurosynaptic core, which is the fundamental block.

The structure of the Neurosynaptic chip is a Corelet which is a tree of sub-Corelets, where the leaves of the tree constitute individual Neurosynaptic chip. The entire processing of this chip depends on programmed Corelets [4]. The programming should be according to our application. It has multiple compartments known as cell. When opened, the cell builder presents a menu with five options; Topology, Subsets, Geometry, Biophysics, and Management. 'Subsets' allows the user to define functionally distinct groups of the sections created in the topology menu. Here several sections, all branching from one other can be labeled "dendrites," while another, single section that projects from the same central one can be labeled as the "axon." Management deals with naming, importing, exporting and managing details in constructed cell. Neuron model is established recently (may 13) for pattern recognition by Meyer can be implemented in 256×256 core (Fig 1). It has already been successfully executed in detecting endometrial pathology. The basic model of Neurosynaptic chip is as below

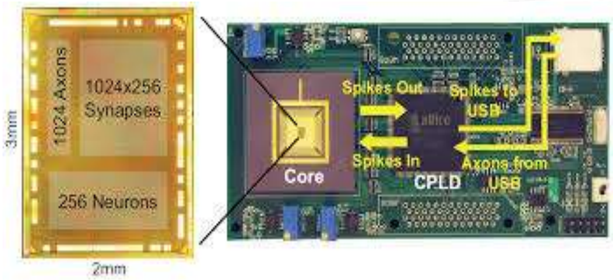

Figure 1 Left**:** neurosynaptic core. Right: test board

The Neurosynaptic core measures 2mm*3mm consisting of axons (rows), dendrites (columns), synapses (row–column junctions), and neurons that receive inputs from dendrites. The test board interfaces with the chip via a USB 2.0 link.

2.2 Corelets

Corelets are composable reusable building blocks. Each Corelet represents a complete blueprint of a network of Neurosynaptic cores that specifies a based-level function [4]. Inner workings of a Corelet are hidden, so only its external inputs and outputs are exposed to other programmers, who can concentrate on what the Corelet does, rather than how it does it. Corelets can be combined to produce new Corelets that are larger, more complex or have added functionality. Defining a Corelet as a class in an OOP framework grants us encapsulation, inheritance and polymorphism, and dramatically improves the design, structure, modularity, correctness, consistency, compactness and reusability of code.

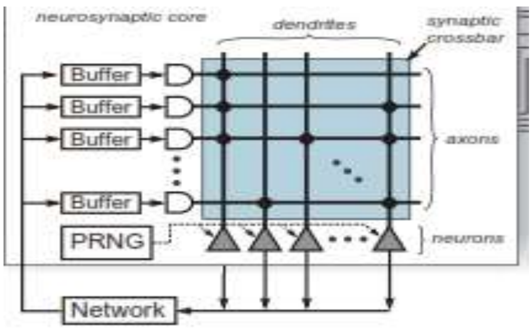

Figure 2: Interconnected networks of Neurosynaptic cores

2.3 Synapse

A Synapse is a structure that permits a neurosynaptic chip to pass electrical or chemical signals from one Corelet to another .Uses right brain concept-intuitive, thoughtful and subjective. Consumes only 1kw power and occupies less than 2 liters of volume. It uses multiple sources of information, including both structured and unstructured digital information, as well as sensory inputs (visual, gestural, auditory, or sensor-provided) [9].

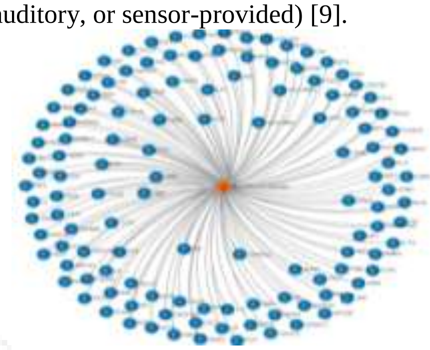

Figure 3: Depicting gene relationships

3. Programming Paradigm

In this new era of cognitive computing, we are developing True North, a non-von Neumann, modular, parallel, distributed, event-driven, scalable architecture— inspired by the function, low power, and compact volume of the organic brain. True North is a versatile sub-stratum for integrating spatiotemporal, real-time cognitive algorithms for multi-modal, sub-symbolic, sensor-actuator systems. The sequential programming paradigm of the von Neumann architecture is wholly unsuited for True North [3]. However, we set out to develop an entirely new programming paradigm that can permit construction of complex cognitive algorithms and applications which supports our medical diagnosis machine.

3.1 Programming Language

In our medical diagnostic machine, we make use of the True North architecture. The fundamental symbols of the Corelet language are the neuron, Neurosynaptic core, and Corelet [3]. Together, the symbols and the grammar are both necessary and sufficient for expressing any True North program. We implement these primitives in object-oriented methodology.

Object- oriented programming (OOP) is the ideal method for implementing Corelets for at least three reasons.

* ENCAPSULATION: Corelet encapsulates all the details of a True North program except for external inputs and outputs. By using this technique all the working is encapsulated and only test results & symptoms are given as input and disease is provided as output.
* INHERITANCE: All Corelets must use similar data structures and operations, and must be accessed by users in similar ways. Since most of the disease inherits similar symptoms but distinct in their own way. It also has an important impact in our programming methodology.
* POLYMORPHISM: We need to invoke operations such as "decompose" to clear the unwanted things in memory and "verify" to ensure that they are correct and are in consistent

with other operations in such cases the prototype may vary accordingly. Instead of writing function with different name it can be adopted.

3.2 Corelet Implementation

We have to implement the Corelet Language in our diagnostic machine using MATLAB OOP, which has the additional advantage of being a compact language for matrix and vector expressions and computations. There are four classes in this language namely neuron class, Neurosynaptic core class, connector class and Corelet class.

Corelet language is used for creating, composing and decomposing corelets [4]. This language enables the construction of complex cognitive algorithms and applications, while being efficient for True North and effective for programmer productivity.

3.3 Corelets in diagnosis

By implementing these Corelets in our medical diagnosis machine we can help doctors narrow down the options and pick the best treatments for their patients. This machine which consists of the corelets will have the various structures and patterns of the host cells in their memory. Hence they can identify the diseases by pattern recognition which helps in the prediction of the diseases as earlier as possible.

The machine uses natural language capabilities, hypothesis generation, and evidence-based learning to support medical professionals. It can incorporate treatment guidelines, electronic medical record data, doctors and nurse notes, research, clinical studies, journal articles, and patient information into the data available for analysis [5]. For example, it uses voice recognition to help diagnosis and treat dementia which is a loss of brain function that affects memory, cognitive skills, and behavior. This also helps the oncologists to treat cancer at an early stage.

4. Implementation

By making use of the corelet laboratory, medical diagnosis can be done by our “Cognitive diagnostic machine”. The **Neurosynaptic chip** (composed of neurons, synapses and axons) is imparted in this machine. It behaves as self-configuring, self-diagnosing and self-healing system. Various diseases can be sensed and predicted from the pattern or textures of the pathogenic cells and even from the smell of the victim’s breath.

Programmed Corelets are used to detect the diseases. Human senses like sighting, smelling and hearing can be integrated into the Neurosynaptic chip through programmed corelets [7] and they are used in detection of disease. For example diabetes can be identified from fruity smell, liver problem from fishery smell, Alzheimer by recognizing the pause between the speech, oncology diseases by analyzing the tumor cells pattern etc….. For recognizing these diseases several equipment are used. One such equipment is WAND-devices which predicts fever as well as throat infection or any dangerous cells in throat. The machine receives the information from all the modules of test and processes them with all other information to analyze the prevailing disease. It puts quickly and accurately disparate pieces of complex puzzle together [6] and helps the doctor to carry out the diagnosis rapidly. It avoids errors and confusions. Care should be given while programming it semantics.

4.1 Holistic Network

Rather than just considering the symptoms, disease prediction process also considers the mental and social behavior of the human. To achieve this cognitive technology analyzes and creates holistic network maps at run time, meaning that the visualization is created at the time that the user makes the request [10]. These holistic network maps can be created by annotating the domain specific terms. Annotator extracts information from millions of pages of text that can then be composed into a wide variety of runtime analytics and visualizations. It will update them each time new information is published. Extracting and processing these information by humans would likely take significantly longer time.

5. Conclusion

The diagnostic machine developed with variety of sensors and sources carries out the pattern recognition to solve difficult problems based on perception, action and cognition in complex medical field. By developing this idea, in future it can be integrated in mobiles through which alert signals or messages can be received by the people who suffer from diseases. The area which will be emerging through this technology is a home health care.

It reduces the cost in health care sector. Early prediction of some diseases like cancer is achieved by this technique. This also helps people recognize their syndrome earlier and take treatment in advance. The development of this diagnostic machine will result in the prevention of diseases. By doing so, within five years a deep insight based on DNA sequencing will be accessible to more doctors.

Cognitive computer will ship with two processors. One is a classical von Neumann processor and one is a cognitive co-processor, which will be able to deal with real world environments in the way that we can. Hence the impact of change in computing environment will not be higher. The power consumed by cognitive system is less than a light bulb therefore it prevents the system from overheating and makes them to work for long period of time without any mal-functions. Furthermore the job rates of engineers in medical sector also increases as these systems cannot be operated without any expertise in computing field.

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