

Cognitive coupling states based on tree cognitive fields

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Abstract. From certain point of view, the research of brain intelligence can be divided into two researching ideas :function simulation and cognitive coupling. Former is that computer is used to simulated with the brain intelligence and the two irrelative individual can be separated between the brain and computer; The latter is that the brain and computer can be united one integrated entity. Through the constructing with cognitive coupling states between the information brain,as iBrain,and machine, the Agent of the cognitive space is mapped the brain activity, the cognitive coupling states is modulated and the Agent behavior in the states is recorded, and the brain active principle is reflected by Agent activity to receive cognitive data on the coupling states. Selecting tree topological space model, cognitive information space can be divided into the three levels, such as object information, cognitive operation and arithmetic and physical quantification, like Digital Nervous Architecture called DNA feeling Agent behavior ,the all known as DNAgent; Materialized DNAgent is a software system, named Cognitive Coupling Modulator, Similar to the cyclotron. It is modulate the Agent cognitive track to verify cognitive theory or assumptions; and Agent cognitive symbol sequence data are adopted, symbol dynamics is applied to deal with the cognitive symbols, the research on the arithmetic and physical level based on the cognitive process is realized. Formation of brain information layer of the following framework:Coupled brain information process with computer and cognitive symbol sequence to achieve cognitive materialized and quantitative research; Base on new tools the Cognitive Coupling Modulator, formation the mathematical and experience level of mutual authentication.

Keywords:Cognitive Coupling States,Tree Cognitive Fields,DNAgent,Cognitive Coupling Modulator, Cognitive Symbol Sequence,iBrain

1. Information brain research background

From a philosophical, metaphysical point of view there are two kinds of brain intelligence research methods: function simulation and cognitive coupling. Former is that computer is used to simulated with the brain intelligence and the two irrelative object can be separated between the brain and computer; The latter is that the brain and computer can be united one integrated entity, in essence, is the computer's output into the input of the brain, the brain's output into the input of a computer,they is an information coupling system, known as the Human-machine coupling.

The brain is a material, energy and information dissipation structure^[1], brain research is to use instruments to stimulation,probe, scan of the brain material, energy, information process, and shooting, collecting data, use the data to understand brain. In the biological area is the main target to study the brain's physical structure; EEG field (ElectroEncephaloGram), ERP field (Event-Related Potential) aspects of the brain from the energy perspective to understand the state of brain activity energy characteristics.energy level is currently the most popular areas of brain research, MIT neuroscientists new technique can stimulate brain cells, illuminating the brain^[2]. In material, energy in-depth study, we should not forget that the core function of the brain is the symbol processor.information processing is the main driving force of evolution of the brain. Brain intelligence is the results of information dissipation of human evolution million years. It is important to research brain on information level. Some may view that cognitive psychology is the point of

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view studying the brain in the information, but, unfortunately, more like a social science of cognitive psychology, many cognitive model is difficult to verify through the rigorous approach, this situation similar to the hundred years ago the early atomic research.

Looking back a hundred years ago, when people would ask a simple question people seem to be now: the micro structure of the atom, this is junior high school teenage students in the learning knowledge. At that time, it was considered atom is like a ball, pie, solar system... What makes the human understanding of the atom was it? Are tools, including X-ray, cyclotron. Scientists bombarded with radiation to the study, with the recorder records the data after bombardment by 1) the physical and mathematical model building, 2) forecast data may be, 3) experiment, collect data, 4) according to the data correction model. At present, this model continues, the world's largest particle accelerator manufacturers are producing high energy bombardment of the event, the collection of data related to model validation. Not only the microscopic quantum world is so, the macro also astronomy radio telescope with a powerful collection of signal space, application of these research paradigm. In the area of the brain we are trying to create new tools of information, the establishment of a new research framework of natural science.

2. Cognitive coupling and cognitive information space

Based on our study the brain at the information level, we need to study the brain information processing active, and choose apparatus with the brain is coupled to the processing of information, collection of data the brain activities and online, rather than material or energy, so that recorded data will reflect the secrets of the brain information processing, and temporarily do not study the brain state of matter and energy, only to focus on brain information processing itself, is undoubtedly the computer is the best choice. The brain base on the information level known as "Information Brain "(iBrain).

When the brain operate a computer, the computer software system related operations on the brain to respond, for example, records of cognitive operation, determine the next logical step in accordance with relevant cognitive operations, that is, between the brain and the computer constitute the output of each input to achieve information coupled state. It contain that 1) the researchers on cognitive content, logic, rules, procedures, track design, 2) also includes the brain to understand the cognitive situation design of researchers , 3) and after understanding the brain's response to these situation, 4) computer decisions next node to operation based on the reaction process brain, achieve cognitive modulation, 5) If the brain acts in accordance with the preset orbit activities, means that the designer's cognitive assumptions is match to subjects cognitive, related cognitive rules is verified, 6) Otherwise, either cognitive law to be amended, or is the need to improve cognitive modulation, or other reasons. The object, content, rules of cognitive operations and procedures, track and other, sum referred to as Cognitive Information Space(CIS). Purpose of the introduction of CIS is to design software, so that the brain information space "materialized". Cognitive researchers can use software, and study with the Agent that mapping the brain behavior into CIS. It is similar to the electromagnetic field, Agent like electronics.

Researchers according to their cognitive hypothesis of the brain, specific information architecture with the software design, we call the "standard cognitive information space "(SCIS). Referred to as "standard", this space contains research content, object, assuming that such an objective materialized body, is the standard test the hypothesis. Agent instance of each behavioral processes to a track, the track can be fixed, can also be dynamically generated by cognitive decision vector. For example, SCIC as photographic "negative" produced Agent's behavior, different SCIS's design ,technology has also affected its performance, as "negative" different quality. If the SCIS is blue Agent traverse the area marked in red, the red area is the brain can be considered a subset of the its CIS. Summary, when the Agent stay on SCIS nodes and to do cognitive operations, spatial sense of recording their behavior, and constraints Agent activities in the pre-certification track, called cognitive modulation of this process, if the Agent in accordance with scheduled cognitive modulation of track activities successful, Agent is cognitive coupling states. The methods, coupled with a computer brain information activity, will be applied psychological research in advanced, such as learning, thinking.

3. Tree cognitive fields and cognitive coupling modulator

In establishing the concept of CIS, SCIS, will be thinking cognitive structure of the geometric topology. This is extremely difficult and dangerous problem, not directly solve the problem, but to look for SCIS topology. Detailed mathematical or topology point of view is not discussed, select the tree topology to represent SCIS, called the tree cognitive field, thinking based on pragmatism. If we are think that the SCIS is the results of objective things of granular computing, then select tree is normal.

The basic unit of tree cognitive fields is node, each tree node by three layers elements: basic elements of the surface is static information, referred to as primitive information, symbol, knowledge, concept, object, pattern, associated with other elements; The second layer is the cognitive operations, planning Agent on the node to how the cognitive operations, including operation of the content, methods, data recording methods, operating ultimately to cognitive meaning of the symbol sequence as cognitive symbolic sequence (CSS); arithmetic and physical description is the third layer, quantitative and dynamics description of the static information and the cognitive operations, such as coordinates, vector, processes and so on.

SCIS based on tree distribution of the three layer information field of systems as biological neural stimulation can be done on the Agent's behavior response, and also to compute control modulate the behavior of the Agent, also known as the above performance figures cognitive information space " Digital Nervous Architecture " named DNA, DNA and Agent constitute DNAgent system. Similar to the cyclotron, DNAgent coupled the state of brain dissipation information, mapping the brain information processing by modulation Agent orbital, and called the "Cognitive Coupling Modulator (CCM)". Now formation of iBrain research ideas: 1) Hypothesis materialized as DNA tree cognitive field of design and track planning of SCIS; 2) Brain information activity is mapping to Agent's Behavior of modulated in orbit; 3) The hypotheses is verified to compare the actual and forecast orbit of Agent using the collected data cognitive symbol sequence of coupling states . Figure 1 illustrates the structure of DNAgent.

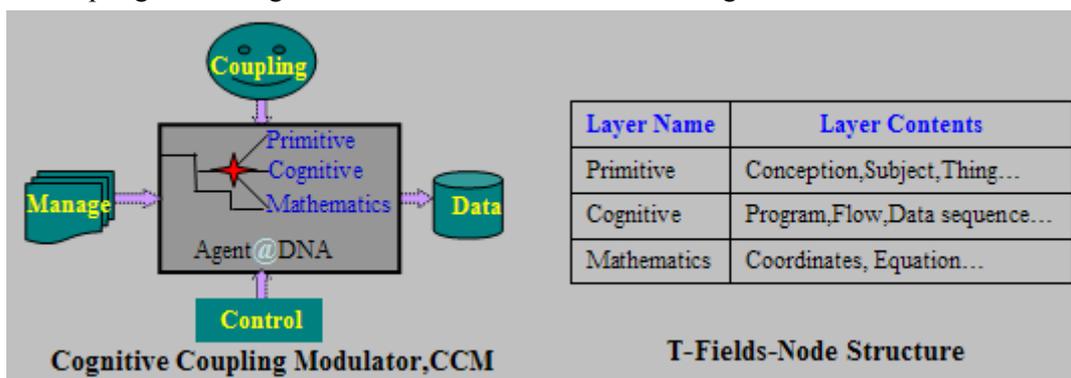


Fig1. Relevant cognitive content, operation, and quantitative relation is mapped to the tree information fields, and Brain information activities is mapped to the behavior of Agent at the T-Fields with the coupling, Computer control, modulation of human - machine process, Red Star on behalf of Agent, It is recorded that Agent active process with symbol sequence. Mathematical description mapped to the cognitive sequence of operations achieve cognitive quantitative research. Granular computing method is used to build the T-Fields.

4. Cognitive symbol sequences and Cognitive symbolic dynamics

Use of "Cognitive Coupling Modulator", iBrain can be research as: 1) Cognitive field structure: the brain information field is a tree geometric topology? 2) build cognitive information equation, 3) cognitive process modeling, 4) cognitive orbital study, 5) cognitive dynamics, 6) the material, energy and information of integration, and ultimately uncover the brain Secret, the energy level illuminating the brain, the response to the information level colored the brain, 7) DNAgent system used in digital learning to improve the efficiency of human education.

The field of symbolic dynamics^[4] is not only an important research tool for non-linear and also in the iBrain research, based on cognitive symbol sequence, it is necessary to use symbolic dynamics approach for processing data. The cognition sequence of symbols or even to make up the current cognitive psychology research methods and mathematical physics, the gap between research methods, because the cognitive symbol sequence features of both cognitive science, and then through the symbolic dynamics for the rigorous mathematical treatment and physical aspects of development. Based on the data, we can construct the

following mathematical model: 1) cognitive space: coordinates, distance, gradient, field; 2) cognitive force: value, vector, time parameters; 3) Cognitive Dynamics: functions , operator, track, attractor; 4) macro-cognitive representation: entropy, energy, spectrum; 5) cognitive control equation; 6) non-equilibrium mechanism of cognitive systems: fluctuation, bifurcation and so on. Figure 2 shows the CCM-based research paradigm.

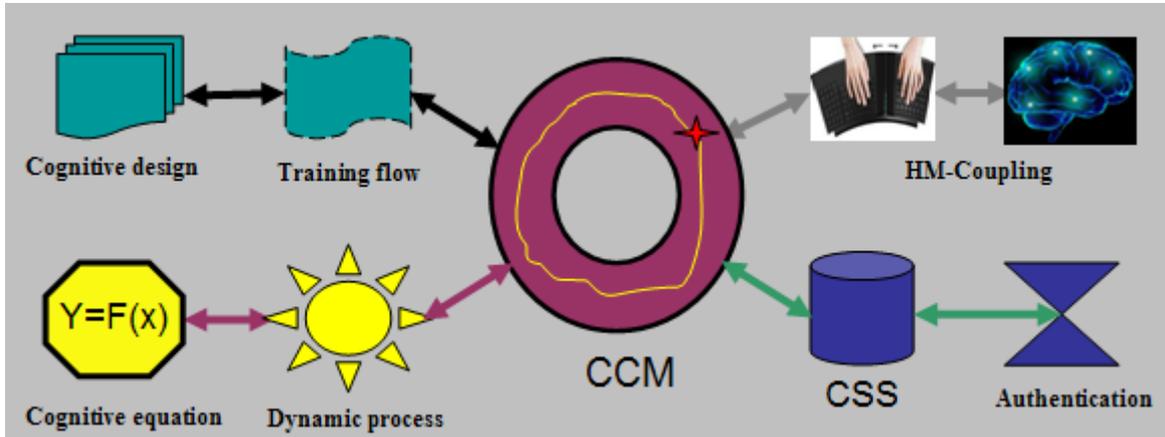


Fig2. It is two research paradigm of the CCM-based: From psychology, education and other empirical,design the cognitive DNA and Agent training flow; From the mathematical equations, dynamic perspective,design the cognitive dynamic process, track.Both flow and track is verified on CCM with CSS of HM-Coupling process.

5. A application of Cognitive symbol sequence to dictate english words

"Cognitive Coupling Modulator" is a software-based brain information coupled environment, We designed the dictation of English words of Chinese students DNAgent model, acquisition of CSS. Perform the following cognitive processes:1) starting the computer in English [BUK] voice, so that students dictation, 2) over a period of time if students are not accurate to give a book in Chinese tips, 3) In a few students have not exactly certain period of time to exit, and a new word dictation. "_" Before the representatives of the target word, then, is the sequence of cognitive operations, the computer prompts appear when the Chinese use "+" sign that some CSS: book_b-b-bl-b+bo-boo-book; book_b-bo-box-bo-bb-bo-boo-book; book_b-bo-box-bo-b-bu-bux-bu-b-bo-boo-boox-boo-bo-b+;book_b-bo-bok-bo-boc-bo-bb-bo-bog-bo-bd-do-dog-do-db-bo-boo+book;book_b-bo-boc-bocj-boc-bock-bck-buck-bck-back-bck-bock-bck-beck-bec+be-bb-be-beck-beck -bck-bick-bck-beck-beack-beck-bck-bc-boc-boce-boc-bo-b, another example sick_s -si-sit-si-ss-so-sou-soup-sou-so-ss-si-sil-silk-sil-si-s + s-si-sil-sill-sillk-sill-sil-si-sil -si-ss-si-sit-si-sil-silt-sil-si-sic-sick. Some of the first characters on the wrong word, for example, book_d-do is confuse B D, Figure 3,through 18,900 records of data are as follows, for example, A is most easily confused with O, followed by E, again, is H, the contrary, O should A most confusing as marked in red.

| C | E | E | E | C | E | E | E | C | E | E | E | C | E | E | E | C | E | E | E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | 1 | 2 | 3 | | 1 | 2 | 3 | | 1 | 2 | 3 | | 1 | 2 | 3 |
| A | O | E | H | F | T | S | H | K | N | C | P | P | H | B | F | U | A | O | Y |
| B | D | P | M | G | J | D | B | L | R | W | B | Q | C | K | A | V | W | B | M |
| C | K | S | T | H | P | T | A | M | N | B | I | R | L | W | B | W | L | R | B |
| D | B | G | T | I | A | E | B | N | M | T | L | S | C | T | A | Y | E | U | H |
| E | A | I | H | J | G | H | D | O | A | B | W | T | B | F | D | Z | J | T | E |

Fig.3 This table reflects how students A-Z of confusion between, Such as ,listen to the letters A to O,E, H(sorted according to the percentage of errors), and found the rule, the error word to mutual authentication, for example, A hearing for the O, on the contrary, O is also confusing for the A. X

is no validation of data. So, The sequence analysis of the use of cognitive symbols, reflecting the process of Chinese students the dynamic characteristics of listening. Currently only a simple analysis of these cognitive sequence data,next, the middle character error will be analysis,and build sophisticated dynamic model of Chinese students of english listening.

6. Conclusion

Base on congntive coupling states, the computer as coupling objective, instead of the tools used to simulate the brain intelligence,by cognitive coupling states, tree cognitive fields construction DNAgent and cognitive coupling modulator,on SCIS Agent cognitive symbol sequence data are adopted, and symbol dynamics is applied to deal with the cognitive symbols ,and the research on the arithmetic and physical level based on the cognitive process is realized. Innovation a paradigm of Cognitive coupling states:

1) Based on assumptions the brain is dissipative structures of material, energy and information to establish information brain research ideas.

2) Building cognitive information space to materialized human-machine coupling, mapping human-machine coupling to behavior of Agent in cognitive information space with information coupling.

3) To design can be coupled Agent's cognitive behavior tree topology the Cognitive information space," Digital Nervous Architecture ", that node construct by "information, cognitive, mathematical" three layers, formation DNAgent, the information coupling development to the cognitive coupling, cognitive modulation.

4) Establishment of empirical research framework of information brain base on cognitive orbit, modulation, cognitive symbol sequence.

5) Establishment of arithmetic and physical research framework of information brain base on Tree cognitive field, vector, fluctuation, bifurcation, cognitive equation.

6) Empirical and mathematical in the "Cognitive Coupling Modulator" to achieve integration, mutual authentication, new paradigm of brain appear.

7) Base on the iBrain to promote the material, energy and information collaboration of the three levels of study the brain.

7. Acknowledgements

Simon is especially glad that It was able to read in 1988, when 19-year-old, Ilya • Prigogine to his students, colleagues, Isabelle•Stengers Dr co-wrote "Order out of Chaos", then he was just primary school teachers graduated from secondary normal, relatively isolated rural areas in the information, took three years to read the book seven times, and "iBrain"concept formation, and try to established "Brain Information Equation ", it is clear did not succeed, however, explore the "iBrain" has become its ideals, then go on to college in higher education, a software engineer has not forgotten after all this, until 20 years later, this target is still willing to think , and thank Wuyi University research support.

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