Mind Modeling using Transparent Intensional Logic

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Abstract. In this paper the possibility of human mind modeling is discussed. According the recent knowledge from cognitive and neurology sciences we inspect the human brain principles. Position of natural language (NL) is outlined alongside its connection with human senses. As a result the Theory of three layers (TTL) is introduced. Arguments from the Incompleteness theory are used to support its own truthfulness and legitimacy of TTL. Moreover the boundary between processes that can be modeled using AI and those that are purely characteristic for living beings is sketched. Finally we briefly describe the GuessME! system that uses Transparent Intensional Logic (TIL) to extract the natural language meaning.

Key words: Theory of mind, Theory of three layers, Universal grammar, TIL, GuessME!

1 Introduction

Artificial intelligence field has recently been amazed by the IBM's Watson system [1]. Watson participation in Jeopardy! quiz showed how a set of binary digits can defeat human contestants with a great advance in final points. Has the AI reached the point of the artificial brain? Truly, Watson is a kind of nerd as he uses powerful search algorithms to compete human players. Some categories from the quiz revealed Watson actually does not understand NL [2]. Other projects like True Knowledge [3] and Aura [4] also tries to simulate processes taking place in human brain. As none of the systems focuses on the overall architecture of the brain they are all limited to the simulated area. Search through memorized knowledge is the case of Watson, strict domains of information are found in Aura and True Knowledge is limited to simple factual questions [2]. We focus on data available through observations, neurology studies and cognitive science experiments, to inspect the brain and propose the theory of three layers that describes the principles of human intellect. At first, importance of natural language followed by the nature of objects denoted by its sentences is figured out. Then the countability of the artificial mind is discussed. As a result we describe a GuessME! system based on Transparent Intensional Logic. This system acquires knowledge through simple game that simulates the evolution of human brain during life.

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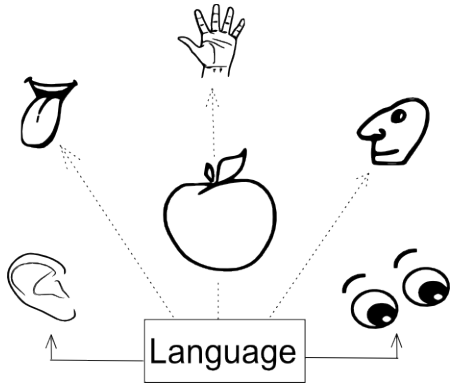

Fig. 1. Observing an apple by five senses accompanied by NL module providing communication channel through sensual and audible senses

2 Position of natural language

Natural language is a powerful tool to communicate not only our internal states but also anything else. Some people think NL is a cultural artifact that has to be learned like any other ability. But as Steven Pinker explains in his remarkable book [5] NL is rather an instinct and is developed spontaneously in childhood. One passage form the book describes a deaf boy born to deaf parents who learned the sing language in their late ages. According this fact they were unable to memorize all grammatical rules and they avoided complex signs. These parents had taught the boy their sign language and he spontaneously invented missing grammatical parts. Such phenomenon, reported as a movement from a pidgin language to creole one, outlines that NL is more likely to develop on DNA base rather than by cultural imprinting. Moreover we presume that it is Language itself that is innate and its actual nature depends on a culture and personal abilities. Story of the deaf boy shows how the imprinted rules of Language affect communications skills even if typical sources of information are limited. Observation of an apple by an average human delivers five codes (see Figure 1). Data from visual and audible senses seems to have an advantage. They are heavily used by NL as they provide rapid communication channel without visible effort. However NL does not use original information. Instead it is a set of generalized codes (words, sentences) that are easy to understand for a communication partner - saying the word "apple" is more efficient than painting its shape into sand. Natural selection identified vision and audition as the best candidates for this sort of reduction of actual information. This puts constraints on NL not Language itself as can be thought. Language is independent from the code used. One example is art. To find the nature of pictures by Pablo Picasso means to understand his Language developed over visual codes. Blind people miss essential sense for NL processing nevertheless they are able to acquire NL

by introduction of new code provided by tactile sense. Consideration of the vision and audition as cornerstones of Language would put deaf-blind people into very sad life. Individuals with such handicap miss information from eyes and ears so their ability to interact with environment looks impossible. There is no way to teach those people NL but with special types of Language (usually based on touch) even mathematic can be learned by them [6]. We think every human, independently of available senses, disposes with a language based on the rules of Language (also called Universal grammar by Noam Chomsky [7]). Communication of such language depends on communicators. Deaf-blind baby born into environment that exclusively uses NL is comparable to misunderstood artist trying to sell own pictures. Independence of NL and Universal grammar can also be proved by Aphasia disorder caused by damage to certain parts in brain. When Wernicke's area undergoes damage patients are unable to understand words of NL [8]. They can formulate sentences but usually use random or invented words. Such behavior denotes existence of centralized system for mapping words of a language into corresponding codes provided by senses. People using sing language supports the theory by reporting similar troubles after the damage of the area [9]. Knowing the words one want to use in communication, the process proceeds to Broca's area responsible for grammatical structure of a sentence. Malformation in this area causes non-fluent sentences with disjointed words [10]. Complicated language elements including passive are misinterpreted [11] revealing the inability to process the syntax. Again sign language can be similarly limited by damage in the area. Consequently two subparts of language are distinguished - one for dictionary and one for actual grammar of the language. Whether one uses NL, sign language or any other form of language it seems all are processed by these parts. Aphasia studies showed another surprising fact. When people with damage to Broca's area had recovered they reported that they were aware what they wanted to say but could not express themselves [8].

3 Subject of Natural language and the theory of incompleteness

The aphasia disorder introduced in the previous section, reported not only the autonomous position of Language but also the independence of its subject. One deaf Mexican Indian lived for more than 20 years in total isolation as his parents were unable to sign. He had developed no language but was found obviously intelligent [12]. Language-less people are intelligent due to thoughts. However, this kind of thinking should not be confused with a sort of a Language. Artists use their language to express thoughts not vice versa. When Albert Einstein was cogitating on the theory of relativity could he depend only on NL or some formal logic system (FLS)? A FLS try to describe the nature of world and discover new facts about it. But the necessity of axioms and inference rules position it on the same level with NL (see Figure 2). Albert Einstein discovered his theory, according P.J. Laird and the book "The Computer and the mind" [13],

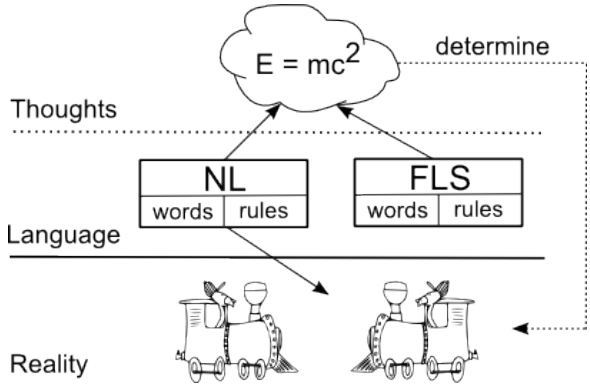

Fig. 2. Thoughts at the topmost level

thanks Calculation, Creation, Induction or Deduction. Abstractedly from the principle used he had had to realize the nature of the things. This could not happen at the level of language as no writer was able to synthesize such text. His observations, purely based on thoughts, were described by a language (recall famous examples of the Relativity theory with trains traveling at the speed of light) only after he had realized them. Thoughts seem to be generally available and the real art of science is the ability to realize them and create appropriate terms in a language for them. Darwinian Theory massively uses natural selection principle. Was this principle available only after people had named it? We consider thoughts as a foundation of all objects in reality. Esoteric nature of claims is supported by Kurt Gödel and the Theory of incompleteness. Proofs used by this theory are on edge for many people. Sentence *"This sentence is not provable"* is difficult to understand. Taking figure 2 into account, we position this sentence both into Language and Thoughts layer. Simply said it tries to associate non existing reality with thought. Science usually observes reality and describes it with a language (bottom-up processing). Einstein used top-down processing while he cogitated in thoughts, than described them by NL and confronted with reality. Gödel tried different processing. He created a structure combining all three layers and postulated equality between them. The structure proved the impossibility of its own existence and introduced unusual paradox. Anyone can think about such structure, describe it by language but fails to confront it with reality. Human senses detect material objects and consequently codes available to a language are mainly connected with Reality. Reasoning is dependent from the theory of truthfulness and humans tend to confront everything with outside world. This is the key of Gödel's theory. It shows the independence of Reality, Language and Thoughts. While Language can describe both Reality and Thoughts all three layers postulate a hierarchy as in figure 2. Theory of three layers (TTL) put Reality at the bottom. Position of Language in the middle is hard to prove. Basically, principles of Language have roots in Thoughts and no language can exists without those ideas. It is

possible to describe these principles by NL (language is a set of words over an alphabet accompanied by rules to simplify codes and allow the communication) but their application is actually used. One can put the principles to account of natural selection but will always end up with a set of ideas (accidence, natural selection) that seems to be major. TTL presuppose Thoughts are the fundamental concept and consider Gödel's theory as a fact limiting what can be computed. Any language (NL, FLS, C++, etc.) is limited by Universal grammar set within Thoughts. Even neural networks are regulated by principles from Thoughts. Neuroplasticity is the ability of neural network to accommodate various tasks. Area usually processing touch can learn to treat visual information [14] or blind people can use tongue to see [15]. Although Thoughts at the top level of the hierarchy can be hardly proved by science (operating over Reality) several graduated scientists have confirmed the benefits resulting from positive tuning of human mind [16] [17]. Brain as a product of reality can inspect the surrounding world through senses, use a language to describe and communicate it. However, the character of the mind settled within the brain is not possible to specify. TTL puts the mind into the first layer and therefore excludes it from computational set of problems. Indubitable a sort of language in the brain of Einstein was incorporated while discovering the Theory of relativity but what coded the ability to realize key concepts for the theory (initial axioms)? How the universal program for the following story would look like?

There is a well in the sandy desert. The settlement of aborigines is two kilometers far away. Every morning a man has to take bottles to the well for refilling. One morning when the man is walking towards a well a horse is galloping next to him. How should he realize that by riding the horse the refilling is much more efficient?

TTL excludes the existence of such program. Any reasoning measurable by science takes place in the brain and therefore is a sort of language (inference mechanism of FLS is an application of Language's principles). Realization of axioms and initial rules must be done by mind set in uncountable Thoughts layer. Artificial intelligence can take advantages of efficiency, faultlessness but will always be left to the smartness of living beings.

4 Using TIL as a language

Although the previous section claimed the nature of the mind it also proved the possibility of NL understanding by a computer. The key task is a FLS that implicitly codes the sentence's information - subject, objects, time tense, relations, etc. With a natural language sentence Broca's and Wernicke's areas probably process the associations between different codes and ensure appropriate formulation of relations between them. The Transparent Intensional Logic [18] is capable of simulating these areas. A NL parser (e.g. SYNT [19]) transcribes a sentence into TIL construction that implicitly codes all information from the sentence (relations, attitudes, time tense, etc.). Such construction is computa-

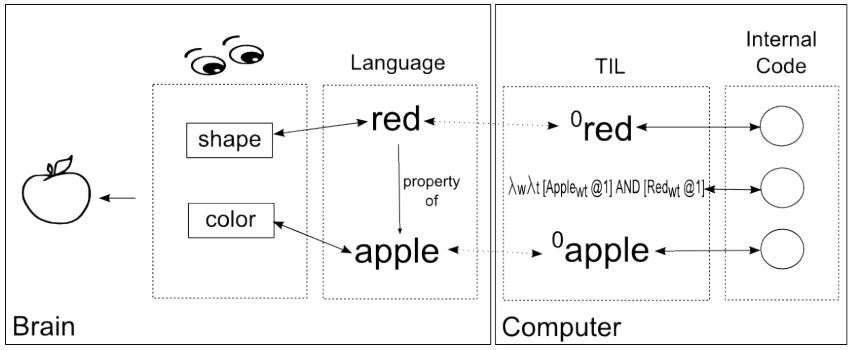

Fig. 3. Using TIL as a language for a computer

tionally feasible and can be processed by the Dolphin Nick system [20] - the TIL interpreter. Understanding of NL depends from senses therefore it is necessary to introduce a virtual code that maps on the TIL constructions. Figure 3 plots the situation. While words in human brain are associated to codes from senses, in a computer system virtual code is used for this purpose. Notice the possibility of visual information (in the form of camera output) incorporation. Generally any sense can replace the internal code but as artificial perception is under intensive research, virtual code is chosen. Using TIL one can teach the computer to understand facts and check consistency of theories. Thanks the TIL property of possible worlds, one can postulate axioms and rules for the theory of chemical reactions independently from the theory of physics. It is even possible to combine them in a new theory.

Taking TTL facts into account we designed a GuessME! system. It is inspired by Watson and Aura projects which try to create an artificial agent capable of communicating in NL. Neither project does it properly [2]. Either it ignores the meaning (Watson) or suppresses the NL itself (Aura). GuessME! is based on a simple game for two players. One player chooses an object or event which should be then guessed by a competitor. Beside Yes/No questions, players are allowed to use time (was it before...?) and structures having a set of simple words as the answer (what is the color of...?). By playing such game computer can obtain new facts. Actually the main purpose of the GuessME! is a simulation of the human brain evolution during life. No one is born intelligent and has to examine the surrounding world. In system like Watson huge libraries are developed to operate over. Usually the system is not aware of the facts meaning. It uses search algorithms or kind of inference mechanism to obtain answers. In GuessME! software we grant the independence of asking. Universal grammar sets the existence of properties, relations and events. By generating questions about objects' properties or relations, system can obtain new information. Books from first classes of elementary school are used to teach GuessME! initial knowledge. We hope such system will achieve higher levels of NL understanding than any other AI system developed till these days.

5 Conclusions

This paper sets the boundary between computers and living beings by consulting results from recent scientific experiments. Theory of three layers excludes the existence of a formal calculus for mind and therefore prohibits existence of software as intelligent as human. It positions the science in the Reality layer and enforces the incompleteness of any artificial project. Hereby it reveals the possibility of processing NL by a computer. As a result Transparent Intensional Logic is chosen to enable the extraction of NL meaning by a computer. Progressive method used in GuessME! system allows acquiring of knowledge in natural manner and introduces new method of AI system education.

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