

INTRODUCTION

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I am starting this notebook to gather into one place my developing theory of cognitive automata. This project is a basic research project which has the goal of firmly establishing a science of intelligent systems. A cognitive automaton is defined to be a machine which thinks and reasons in the same sense that living beings (dogs, cats, etc. up to Homo sapiens) do so.

This is obviously an ambitious undertaking. The topic has been studied by a number of people of various backgrounds for half a century without success. The current attitude which largely prevails in the field is that the goal can not be accomplished and, therefore, the proper direction for this work is the simulation of "intelligent behavior" rather than the achievement of intelligent behavior.

This lesser goal I reject. It is my belief that 50 years of effort has not been crowned with success because the fundamentals necessary as the grounds for the possibility of intelligence in machines has been neglected. My research program is aimed at correcting this situation.

The early entries in this notebook are, for the most part, compiled from my other notes [WELL1], [WELL2], [WELL3]. It seems best to begin at the beginning and describe the propaedeutics of my approach.

There are four fundamental fields of knowledge upon which this work is founded. These fields are as follows.

Theoria

- ~~OR~~ Pure Reason (The Theory of Kant)

Praxia

- Affective Intelligence (behavioral and cognitive psychology)
- Empirical Reason & the development of intellect { behavioral and cognitive psychology of J. Piaget }
- Neural Science

In addition, we will draw also, as poesis, from the science of neuro-fuzzy soft-computing.

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The Contribution of Philosophy

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All sciences, either explicitly or implicitly, are founded on philosophy. This is a truth which is usually neglected by the modern practitioners of science. In the case of the science of cognitive automata, no philosophical basis has been put forward. Instead, very fundamental issues such as "what is intelligence?" have received no critical and well-considered answers. What we see instead is a vague hodge-podge put forth by amateurs playing at philosophy.

Philosophical thought is never superficial and metaphysical systems are very difficult to construct. Most people today, including most scientists and even some "philosophers" do not possess a philosophy; rather, they possess a plurality of opinions of dubious interconnectability.

Fortunately, mankind is in possession of one of the greatest philosophical systems ever developed to address knowledge and reason. This is Kant's philosophy of critical idealism as described in Critique of Pure Reason [KANT1]. The foundation of my work begins with the development of a mathematical system which describes the architectonics of pure reason foreshadowed by Kant. [It should be noted that certain aspects of Kant's theory, especially those dealing with intuition, I have had to revise in the light of historical developments in both mathematics and psychology; however, this revision has taken the shape of mere clarification of and re-definition of certain particular terms and details. This revision does not alter the foundation of Kant's theory]

It is inappropriate in this notebook to give a detailed treatment of critical idealism. Such an undertaking would, by itself, be a major philosophical treatise. This record is the record of a science; the science of cognitive automata automata departs from the philosophy of critical idealism at the issue of "free will." By its very nature, an automaton is a state-driven system possessing no more free will than a chair or a cloud. As is amply pointed out by Joad [JOAD], every science must, by its very nature, bifurcate its view of the universe. No science

can ~~possibly~~ take place without this. However, such a bifurcation is not permitted in the philosophy of critical idealism as that philosophy came to mature development in the hands of Hegel. Thus, this research is the activity of a science and not of a philosophy.

Yet, as a science, we must have our foundations constructed on philosophical grounds. The science of cognitive automata must strictly adhere to certain fundamental principles which I will now summarize.

Knowledge

Our common-sense notion of knowledge is "that which is known to be factually true." Unfortunately, such a description is not at all adequate and, further, the word knowledge represents a complex hierarchy of notions including such notions as understanding and comprehension.

Even an individual factum exhibits ⁱⁿ itself two aspects. There is the material basis for the factum ("empirical knowledge") and there is a form or structure by which the factum is represented and placed in association with other facts ("a priori knowledge"). The separation of the matter of knowledge from its form is not possible.

An individual factum can not be said to have meaning unless it is connected to and associated with other facts to form a "body of knowledge." We call such an interconnected structure a manifold. ~~The necessity~~ Understanding and comprehension refer to the existence of a fundamental unity in this manifold in which no factum is held in conscious contradiction with other facts. We call this ~~unity~~ manifold the Manifold of Consciousness.

* Knowledge, therefore, refers to the existence of this entire and unified manifold. Our fundamental mental structure, by its nature as a manifold, must therefore ~~be~~ have a connectionist theory as one aspect of its scientific basis.

This is where traditional artificial intelligence theory, as well as many aspects of the theory of neuro-fuzzy logic, make the first serious mistake. It has been said by many that

"Knowledge is rules." This is a false premise inasmuch as it tries to identify knowledge with form and omits matter. This division is destructive to the existence of knowledge.

Rational, Affective, and Active Intelligence

The fundamental objective of a cognitive automaton is the spontaneous construction of a manifold of knowledge and the employment of that knowledge in reciprocity with the real world. The process by which this ~~see~~ occurs is called intelligence.

While intelligence must be considered as a unity, it is useful and permissible to discuss three specific aspects of it. The first aspect involves the rational and logical process by which cognitions are constructed and through which understanding and comprehension are achieved. We may call this rational intelligence. The object of rational intelligence is a subset of the Manifold of Consciousness which we may term the Manifold of the Understanding (M.U.).

An automaton cannot be called "cognitive" unless it possesses the capability of determining its own actions (whether these actions are intellectual or physical). Expressed another way, a cognitive automaton must be self-motivated. The process by which motivation and self-direction take place we may call affective intelligence. It is through motivational intelligence that a reasoning agent determines ^{to} what the process of rational intelligence will be applied.

This affective intelligence has within it two aspects. First, there is a causal aspect by which is gained the attention of the agent. This aspect may be viewed as an emotional intellect containing both a process (emotional intelligence) and an object. This object is a subset of the Manifold of Consciousness which we may term the Manifold of Emotion (M.E.).

The second aspect of Affective Intelligence is the process by which competing stimuli are prioritized

to determine a specific motivational state of being which determines the actions of the ~~reason~~ cognitive automaton. We may term this process the Motivational Determinant and assign to its activities a subset of the Manifold of Consciousness we will call the Manifold of Motivation (M.M.).

Finally, the cognitive automaton must be able to act, ~~both~~ intellectually, intentionally, and physically. The process by which this takes place we call Active intelligence. Its direct object is a subset of the Manifold of Consciousness we may term the Manifold of Activity (M.A.).

Intuition and Sensibility: The Faculty of Imagination

All that can be known of the external world by direct experience are communicated to the mind by way of the senses. Sensation provides the matter of experience. However, before sensational matter can ~~be~~ enter in consciousness, it must be united with a form; no representation of the data of sensation is possible except that sensation be given a form of representation.

As Kant proves, the form of a sensation is independent of the particular sensation since this form must be applicable to any and all sensation. He terms this a priori form a pure intuition of the faculty of sensibility. Sensation united with pure intuition provides the representation in consciousness which Kant named the Appearance.

There are two principal aspects of pure intuition. The first of these aspects is an "internal" intuition of the mind which gives order to the sequence of appearances in consciousness. This pure intuition is called subjective time.

Subjective time must not be confused with the objective time measured by clocks. Kant proved that the intuition of time (subjective time) is necessary for the possibility of experience. Without an intuition of subjective time, there is no basis within the mind by which the proper sequence in which appearances are presented can be known.

This pure intuition of time is not based on any sort of "internal clockwork" within consciousness. Rather, it

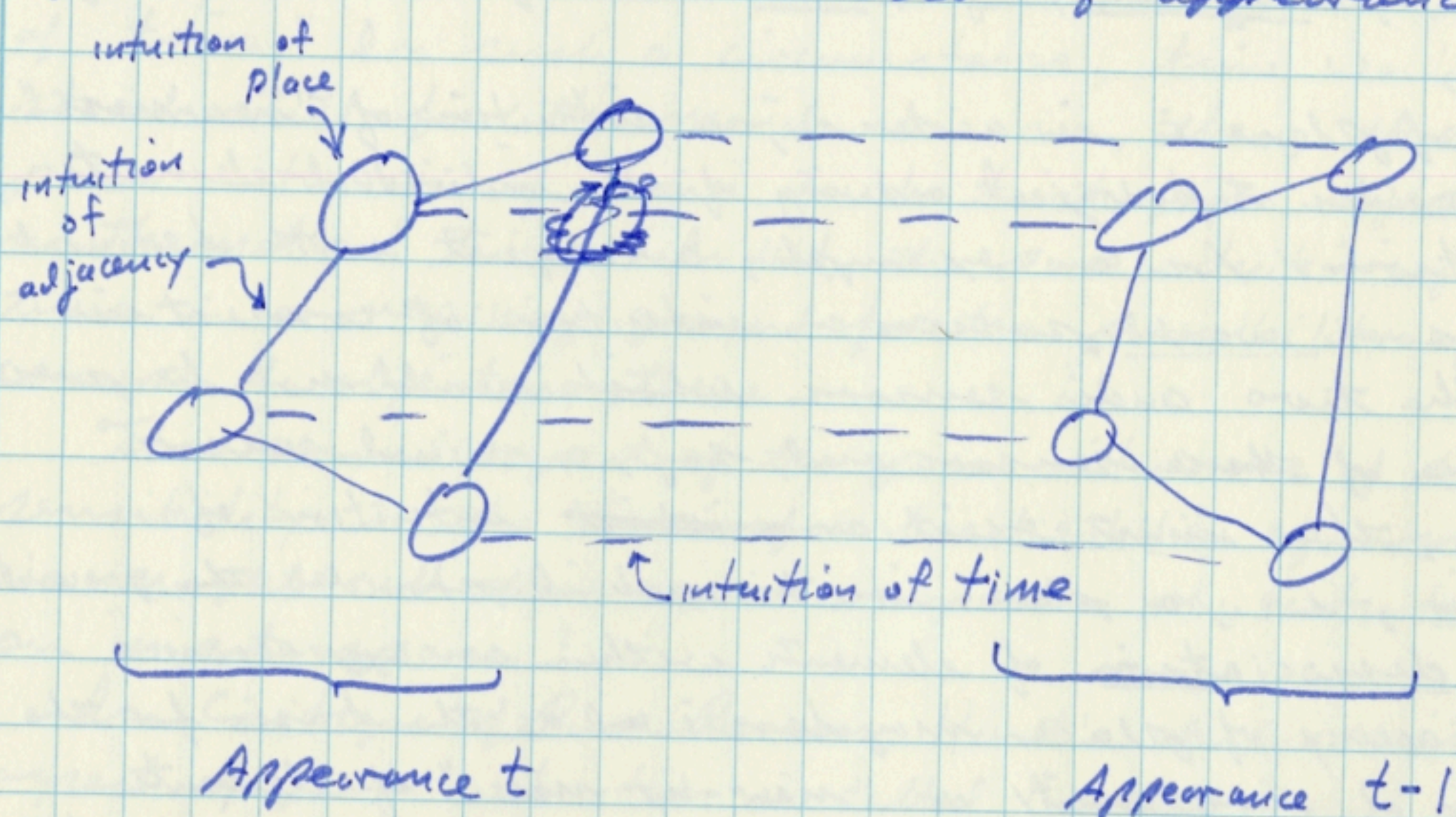
is nothing other than the intuition ^{that} of changes in the appearances how taken place and a partial ordering of the ~~sequence~~ order in which appearances were presented. The pure intuition of time contains within it no representation of duration; should all appearances ^{cease} (including those arising from autonomous sensations of the autonomic physiological functions), the mind would have no sensation of the "passage of time." In such a circumstance, time would literally stand still for the mind. We see, then, that the pure intuition of time is distinct from objective or mathematical time. Indeed, the pure intuition of subjective time is a necessary ground for the possibility of the concept of objective time.

The second aspect of the pure intuitions of the sensibility is the basis for localizability of appearances. We might call this ~~aspect~~ aspect the intuition of an "input space."

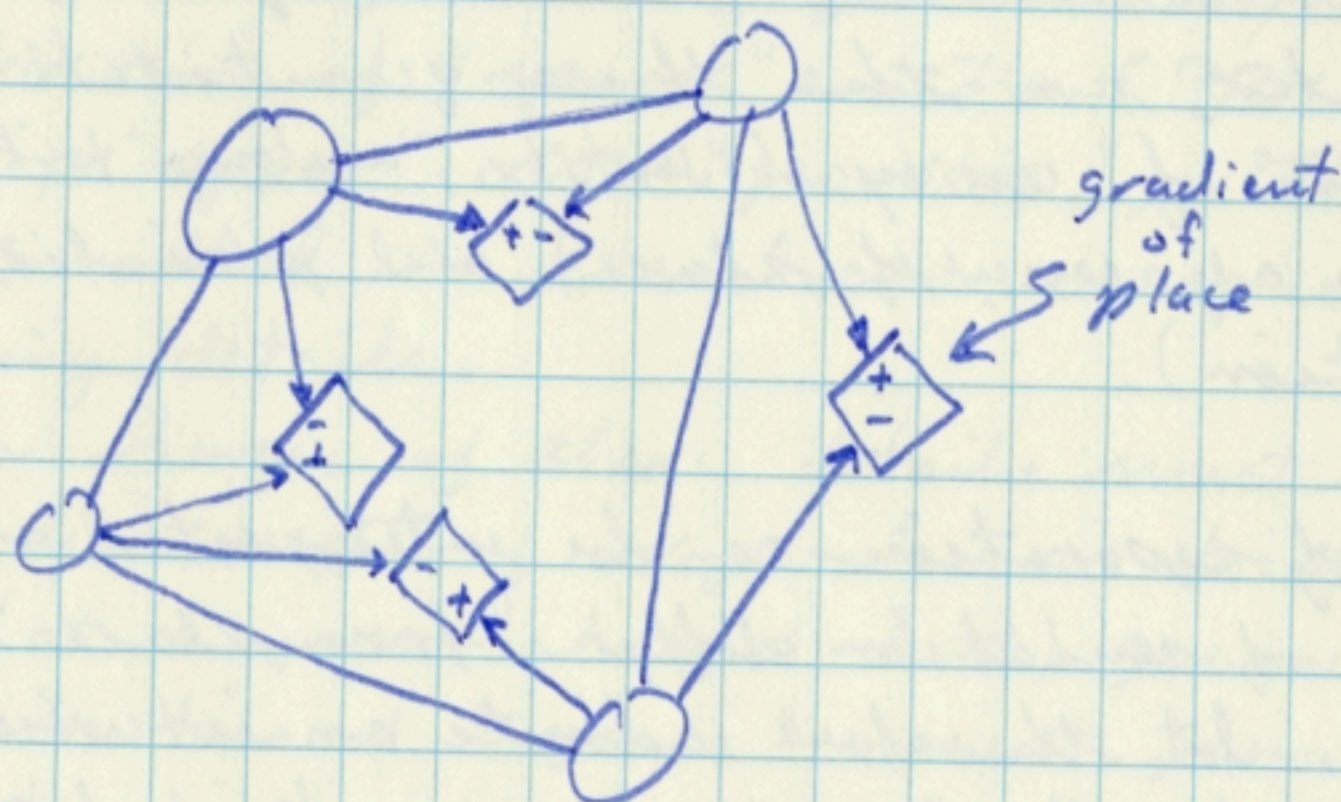
In Critique of Pure Reason, Kant's description of this aspect of pure intuition is called "space" and it is difficult to conclude that he meant anything other than the space of Euclidean geometry. Such an interpretation, however, is both inadequate for a complete representation of all sensations (not merely vision) and, furthermore, would assign to Euclidean geometry an apodictic status which Euclidean geometry does not, in fact, possess. Kant, however, did not provide any detailed description or definition of "space" in the CPR (nor did he explicitly identify "space" with "geometry"). This omission can not be permitted to stand and we must fill in the missing details.

The basis of these details must be the possibility of such concepts of experience or localizability, motion, and (at a more abstract level) geometry. Furthermore, the intuition of "space" must provide form to all sensations, not merely the visual. It has been suggested by Poincaré ^{Poincaré} [POIN] ~~is~~ that the a priori intuition of "space" is the intuition of the structure known in mathematics as a "group." Without going into Poincaré's theory (which suffers from a few physiological misconceptions), we can summarize a set of pure intuitions

A pictorial example of the pure intuitions of place and adjacency is illustrated below. In addition, since the pure intuition of time may be viewed as a subjectively temporal relation of adjacency, the intuitions of place, adjacency, and gradient extend between successive appearances and permit provide the basis for associations to be made between different appearances in the succession of appearances.



As for the intuition of gradient, we may illustrate gradient of place in an appearance or in the following diagram.



That part of the faculty of sensibility which provides the form of an appearance is called the Faculty of Imagination; that part of the faculty of the sensibility which provides the matter of an appearance is called the Faculty of Sensation.

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