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Genetic Epistemology of Intelligent Natural Systems

GEORGE S. MACCIA

School of Education, Indiana University, Bloomington, IN 47405, U.S.A.

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Abstract—General systems theory requires that system properties be distributed. In the cognitive domain, intelligence is a concept that characterizes cognitive behavior. Through philosophical analysis, the systemic distribution of artificial and natural intelligence are evaluated with respect to logical primitives in pattern recognition (qualitative intelligence). In order to determine the extent of that distribution, relevant cognitive conditions in machine programs, infrahumans and humans are examined. Qualitative intelligence is shown to be distributed in infrahuman and human systems but not in machine systems.

INTRODUCTION

In *Theaetetus*, Plato distinguished two kinds of natural intelligence: 'right opinion' and 'true opinion'. Right opinion was described as the direct apprehension of things. True opinion was described as conception which was justified by definition or classification.

In leading Theaetetus to see that right opinion was not equivalent to true opinion, Socrates had him conclude that it was impossible to distinguish Socrates or Theodorus from any other snub-nosed person by means of definition or classification. He brought Theaetetus to agree that he and Theaetetus would recognize each other when they next met at the Agora.

Now they faced a disjunct. Description and recognition could not be reconciled. Socrates expressed his view of that separation as follows [11]:

> We are supposed to acquire a right opinion of differences which distinguish one thing from another when we have already a right opinion of them and so we go round and round: . . . and we may be truly described as the blind directing the blind; for to add to those things which we have already in order that we may learn what we already think is like a soul utterly benighted.

In standard accounts of mental processes, the separation of basic, 'instinctual', from derived 'abstractive', cognition continues the Socratic disjunct in knowing. From a general systems vantage, such disjunct is not acceptable. Consideration of intelligence, in that view, must be holistic. Intelligence must be distributive.

In this paper I shall consider conditions of natural intelligence associated with right opinion and explicate such opinion as conditions of qualitative intelligence. Through reference to findings in cognitive research and in pattern analysis through artificial intelligence, I shall attempt to establish that these conditions are pervasive in the behavior of human and infrahuman systems, but not in machine programs.

I shall argue that sentient systems not only perceive and respond to things, they disclose them to one another. Such disclosures are made by bodily movement and vocal sounds. In humans this expressive signing is enhanced or replaced by ostensive or directive use of verbal or non-verbal language.

The theoretical basis for characterizing natural intelligence will be developed as cognitive states of three kinds: recognition, acquaintance and appreciation. Recognition will be described as a selection through marking the non-comparable features of a thing. Exemplification of recognition will be drawn from studies in perception and pattern recognition. Acquaintance will be described as mapping unique relations connecting components of an entity. In exemplifying acquaintance, I shall draw from studies in forensic art and topography. Appreciation will be described as a discernment of

the fittingness of unique relations connecting constituents of an entity. In exemplifying appreciation, I shall employ modes of judgement for determining authenticity of objects or events.

In order to test the significance of my explication, I shall consider its resolutive strength to account for findings in animal behavior, perception, cognition and artificial intelligence in pattern recognition.

DISCUSSION

Whenever one attempts to set forth the conditions of artificial intelligence or of natural intelligence, dualistic representations of mind–body surface; such representations raise more questions than they settle.

The theory of psychical experience in which mind was separated from body was set forth by Plato. Over the centuries, through one disquisition after another, the dualism that Plato laid down between soul (of which mind was agent) and body has been argued. Attempts to vindicate Plato's separation continue to produce explanations of intelligent behavior as mindful. Attempts to provide monistic explanations of intelligence continue to characterize it as mindless. A recent effort toward such a monistic characterization of intelligence is the cybernetic one offered by Turing [23] and others. This effort was an analogical rather than logical attempt toward a resoultion of mind–body dualism. Artificial intelligence was invented. It is an attempt to model mind such that natural intelligence can be mapped into a computer. If such could be done, it was claimed, mentalistic terms would be moot and have fictional rather than factual significance. Their use would serve science fiction rather than science, for no one could claim computer mentality, nor would there be a point in talking of a distinct human mentality.

The possibility of such isomorphic representation of human cognition was placed in serious doubt by 'Bremermann's limit'. Through mathematical calculations of the maximum rate of data processing in both biological and mechanical systems, he found that limit to be 2×10^{47} bits per second per gram mass. He wrote [3]:

> A mosaic of 100×100 cells, each of which may either be black or white, has $2^{10,000} \approx 10^{3000}$ possible patterns . . . Theorem proving and problem solving also leads to exponentially growing 'problem trees'. If our conjecture is true, then it seems that the difficulties that are currently encountered in the field of pattern recognition and theorem proving will not be resolved by sheer speed of data processing of some future super computers.

The significance of Bremermann's limit is that it is held by some that light driven computers will enable success in pattern recognition despite program inefficiencies. Bremermann's limit, however, is a physical limitation not a temporal one. Pattern recognition is a configural not an iterative affair.

Before one can specify mind as a purposive goal-seeking system in terms of a theory of any system, a general systems theory such as Steiner and I presented in SIGGS [16], a comprehensive theory of natural intelligence must be developed. Then too, a comprehensive theory of natural intelligence is a requirement for determining to what extent natural intelligence can be represented artifactually. One cannot decide questions of natural intelligence in terms of artificial intelligence. One must know what natural intelligence is before one decides whether it can be mapped into fuzzy sets and parallel processes. Moreover, a comprehensive theory of natural intelligence should further the resolution of the body–mind problem. Indeed, a systems theory of mind would mend the schism.

Plato identified qualitative intelligence. Such identification unwittingly offered a way to further a resolution of the body–mind problem. This recognition is embedded in the dialog between Socrates and Theaetetus in which an effort was made to characterize knowledge, but which came to grief during the discussion on knowing uniques.

If, on meeting Theaetetus in the Agora or any other place Socrates did recognize Theaetetus or Theodorus, Socrates exhibited both memory and correct judgment. That judgment could not have been solely recalled perceptual discrimination, for it was not a difference, but an impression of features shared by others. In Theaetetus, however, they were constitutively unique, i.e. peculiar to him. That judgment, as Socrates held, was not a classification of common attributes that Theaetetus shared with other persons. Theaetetus as *Theaetetus* was not an instance of humankind, for one does not argue one's recognition of a unique. One discloses that recognition and acknowledges it. As Socrates pointed out, an argument would be superfluous. Right opinion does not follow as a consequence of deductive or inductive inference, it precedes such quantifications. Right opinion ostensively selects the unique from all others, i.e. points out, directs to, and thereby, acknowledges.

It readily is apparent that such ostensive communication is not restricted to human cognition. Birds and bees do it. A theory of mind that includes right opinion cannot be exclusive. A more full account of intelligence is required, for persons and other sentient beings do recognize, become acquainted and appreciate.

Judgment within qualitative cognition involves neither partitioning (definition) nor discrimination. Discernment of differences includes comparisons that employ, however implicitly, the logical oper-

Quant. Intelligence uses "other"

ator 'other', whereas recognition, acquaintance, and appreciation employ the ostensive operator 'none-other'. 'None-other' is an operator which is indexical not instantial. It does not negate the 'other' as 'non-other'. It separates one from all others.

Such configural perception has been explicated psychologically by Gestalt psychologists. Ralph Norman Haber studied eidetic images of children. A photographic image he claimed is, 'a real phenomenon' [7].

Polyani [19] and Fodor and Pylyshyn [5] offered philosophical arguments which made tacit (bodily) knowing plausible. Since it is not my intent to explore or offer psychological explanations, I shall say little about quantitative intelligence except to note that it is the intelligence to which most psychologists attend and which is usually associated with mental acts that employ abstractive inference, i.e. modes of generalization or instantiation.

Qualitative intelligence has not received much attention except in studies of eidetic imagery. What has been noted in such studies is that imagery is selective. It singles out pervasive attributes that mark off one thing, personal or universal, irrespective of shared attributes with others of that kind.

In his introduction to Luria's book, *The Mind of a Mnemonist* [14], Jerome Brunner made it clear that the Mnemonist was 'quite inept at logical organization'. He wrote, '. . . it is a memory that is peculiarly lacking in one important feature: the capacity to convert encounters with the particular into instances of the general . . .' [14].

The Mnemonist once said [14]:

> [I] frequently have trouble recognizing someone's voice over the phone, and it isn't merely because of a bad connection. It's because the person happens to be someone whose voice changes twenty to thirty times in a course of a day. Other people don't notice this, but I do.

This person's astounding memory resulted from his ability to recall his experience of events in complete detail. The interest here, however, is not with his feats of remembering, but how he used the images he saw.

In order to recall lists of numbers, words or symbols, he used a device of bringing to memory a familiar street in his hometown, and then taking an imaginary walk along it. He would place in proper sequence (on trees, gates or fences, or any convenient projection or cranny) the items to be remembered. Occasionally when he was in error, he would repeat his walk and find [14]:

> Sometimes I put a word in a dark place and have trouble seeing it as I go by. Take the *box*, for example. I'd put it in a niche in the gate. Since it was dark there I couldn't see it . . . some times if there is a noise, or another person's voice suddenly intrudes, I see blurs which block off my images.

Recognition was pivotal for the Mnemonist. Without the ability to index, he would have been in a state of booming, buzzing, inhibiting images. When his memory is viewed in the light of 'real time' perception, his accomplishment is no great thing. Who cannot read off a list of numbers or symbols before one's eyes while strolling along a well-lighted street? That fact, however, raises an important point. Qualitative intelligence, unlike quantitative intelligence, requires that an object be present. To paraphrase Macbeth, 'The dagger I see must be before me'.

In a monograph that asked the question: 'How direct is visual perception?' Fodor and Pylyshyn answer that visual perception is *direct*. They demonstrate their claim by means of a critical examination of Gibson's ecological theory of perception [5].

From studies in animal behavior, it is evident that indexical procedures (marking things off) are required both on the part of the observed and the observer. Whether animals are scaled, feathered, or furred, they employ indices. Both observers (researchers) and observed (animals) employ two kinds of indices, primary or secondary. A primary index is one which is constituent and continuous. A secondary index is attached and continuous.

Of the studies that I read, primary indices used by observers were 'mug shots', 'nose prints', 'neck prints', vocal sounds and conspicuous malformations, such as: 'crooked tail' and 'broken tusk'. Primary indices employed by the observer mostly appeared to be those of distinctive odor or taste; for example, mothers of newly born offspring licked them and smelled them before allowing them to suckle. Even in lion prides where a young member of a pride may suckle any female in lactation, their membership had to be confirmed by smell and taste. If found not a member, the cub was not allowed to suckle. Salmon on the way home to spawn in the Fraser River avoided cul-de-sacs by smelling their way home from the coastline. They tracked '. . . a familiar scent like a foxhound' [10].

Secondary indices employed by the observers were tags such as radio transmitters, ear notches, plastic inserts, balloons or identification numbers. Secondary indices employed by the observed were spraying of shrubs and trees by means of scent glands, renal organs, or rectal ones. Even the skunk is able to recognize its own terrible stench from that of another skunk's when patrolling its marked territory. However, no observer seems to have such keen perspicacity.

I was struck by an invariable form of indexing used by observers of furred animals. Each animal was given a name. With the name, the animal acquired a personality. Description of behavior now included intention and temperament. Even in a

case where the observers solely used ear notching as indices, when they became acquainted with an animal it received a name and exhibited personality. 'It was a tiny week-old cub, still pitch black, whimpering and unable to walk. We named him Solomon, and he soon became the delight and bane, of both our lives' [12].

Recognition in human cognition seems as native as instantiation. In a study of pictorial recognition [13].

> Subject were shown ten thousand photographs and soon after, given a recognition test that included photographs that they had not seen. Remarkably, they identified 66 per cent of the pictures they had seen—a fact that according to one estimate, requires the storage of well over a billion bits of information and is just barely within the range of the most powerful supercomputers.
>
> The rat's olfactory system provides a very simple cortical circuit in which we can correlate the behavioral evidence and the physiological measures of memory. But we are still a long way from tracing the chain of events in a human being that starts with, say, a handshake and culminates with a new name and a new face being programmed into a memory system whose circuits number in the trillions.

AI limitations

With such physical complexity speed of data processing or parallel processing of data cannot emulate cognitive processes in recognition, even a rat uses more than its sense of smell for recognition. Tracing a number of neural processes becomes increasingly complex when different processes are in focus to the same referent.

It is patent that recognition is a cognition of configurations. Cognition in acquaintance is of unique relations connecting attributes of a recognized object. For example, a witness may identify a recognized suspect by expressing that that person is, '. . . third from the left'. Carriage horses and sledge dogs teamed together both know and preserve their place in line. A driver acquainted with a city can take 'a short cut'.

The field studies of animal behavior reveal acquaintance both by the observer and observed. They get to know each other to the extent that behavioral transformations occur. In the example that follows notice the behavioral change in the relation between Iain and Virgo, man and elephant, who were acquaintances [9].

> A little further on Iain opened the door of the Land-Rover and slipped out, moving cautiously toward an elephant with one tusk. When he was about two paces from her, she turned on him, lifting her head, ears outstretched, only needing to fling her trunk to hammer his chest. He spread out his arms in a similar human gesture and stood his ground. They looked at each other and slowly they lowered ears and arms. Iain stretched out a hand. Hesitatingly, she touched it with her trunk. It was a fleeting moment of contact between man and beast in which ancient enmities between alien intelligences were forgotten.

Friendship is a well-known relation between persons who are acquainted. Such seems to be the case with infrahumans also. Witness Koko and her kittens, and relations between baboons who are acquainted [22].

> Friendship as applied to animals is an anthropomorphic concept, but I think it has meaning among baboons. Ties across family lines often long-lasting and these "friends" liked simply to be together, sitting, resting, sleeping, grooming, and often moving near one another when the troop foraged.

Familiarity seems to be one condition of acquaintance. A period of association is a close one and constitutive connections are unique. Of course, acquaintance need not result in friendship. It could lead to avoidance or hostility. Jan Goodall's murdering apes had such adversive effect on the victimised siblings whose young had been killed by a sister ape and her offspring [6].

Two descriptive applications of acquaintance have been developed, forensic art and topography. In a study on the recognition of faces, it was found that when simple verbal corrections were provided to the artist working from witnesses' descriptions, the likeness was much closer than when the artist employed a description alone. In that same study, it was asserted that humans have 'the ability to detect and describe conspicuous features, a process beyond the capability of machines' [8].

Topographical maps provide the traveler with related conspicuous features of a landscape, sea bottom, or cloud formation, so that one can locate position and, in some contexts, avoid unseen obstacles.

The capacity to apprise fittingness of features and their relations is appreciation. The well-known and little understood keen discrimination and perspicacity of the connoisseur exemplifies appreciation at its finest. The perspicacity of some vinmasters is astonishing. The finished product is apprised from newly vatted wine, and proper mixes are added so that the vintage becomes authentically what it is supposed to be some years hence. Even non-connoisseurs apprise the authenticity of something 'special', whether or not they display the vinmaster's perspicacity. 'Every cook' adds a dash of this or that until the mix tastes 'just right'.

The perspicacity of nonhumans has been seen in the behavior of dogs and other domestic animals. Bloodhounds, for example, following a scent are not mislead by crisscrossing over older scents, or encountering the target scent mixed with other ones. With acquaintance, house pets are not deceived by the sounds and sights of other animals imaged on a T.V. screen. Our macaw, Hu-Knab-Ku, ignores voices coming from a recording, a radio or a television set, but screeches her warning or welcome when the voices she hears are live. Amazingly, she recognizes our arrival at home solely by the sound of our cars. To us she cries a welcome; when other vehicles stop at our door she is silent.

"Isn't that special?"

Authenticity appears to be the goal of appreciation. Field studies of animal behavior invariably show that when an animal encounters a dead animal, even when that animal is an acquaintance, efforts to rouse or protect the dead animal dissipate after a whiff or a prod or two.

CONCLUSION

Four conditions are necessary for qualitative intelligence: (1) the state of affairs which is the object of cognition must be epistemically present; (2) the presence may be perceptual or imagined, but the image must be accurate and complete; (3) the association between the knower and known must be intimate or heightened; and (4) the object of cognition must be a unified whole with its own identity having characteristics that are discrete.

The significance of qualitative intelligence for a theory of natural intelligence is an extension of the range of cognition to include recognition, acquaintance and appreciation.

Qualitative intelligence is constitutive of cognition in infrahumans as well as humans. In a world within which sentient beings move about, bodiliness of mind is manifested. Such bodiliness in part employs indexical signs which are either ostensive utterances or disclosive actions—actions that mark off unique attributes of a present state of affairs.

Extant theories of mind that are characterized solely in terms of bodiliness (theories that seek explanation solely in terms of physical mechanisms or sensation) are too narrow. As Fodor and others have noted, representations of the world are intentional. Such is also the case with theories of mind that are characterized solely in terms of mentalness (those that seek explanation solely in terms of linguistic ordering or use).

Philosophers have noted that self is inexplicable in behavioristic characterizations of mind. Self-recognition is held to be the primary condition for mindedness, and such is what distinguishes humans from all other animals [15, 17, 24]. Yet it is evident that, at least one animal, Koko, can recognise herself: 'Scanning the first issue of *Gorilla* . . . Koko point to pictures of Michael and herself' [25]. Koko extends herself as humans do; she takes possession of other animals as pets [25]:

> Abandoned at birth, the kittens had been wet-nursed by a cairn terrier for four and a half weeks. 'Love that', signed Koko to the kittens. Gingerly examining them, she chose the tailless male and named him ALI. BALL.

It is clear that Koko is fond of ALL BALL, for she 'Like a child with a pet . . . dresses Ball in linen napkins and hats. And she signs for Ball that they should tickle each other—one of her favourite games' [25].

Koko and ourselves have 'right opinions' through which she and we are joined with other minds. Such joining signifies that a general systems theory of mind is not limited to human beings. Qualitative intelligence is an interspecies link.

EPILOGUE

Are any other extensions necessary to a theory of natural intelligence? Are there other interspecies links? I think that there are. In order to make such a case, I would have to argue that knowing how to do something is a cognitive enterprise which is not reducible to psychomotor reflex or routine skills. That case has been made in part by Ryle who showed that knowing how to do something is critical employment of skills [20]. It was made in part by Israel Scheffler who showed that knowing how could not be reduced to knowing that, or vice versa [21] and by Bartlett who showed that a condition of skill acquisition entailed timing of action that reduced oscilitory movements [1]. The three conditions—cognitive decision, non-reducibility, and smoothness of action—provide the start. The rest requires another treatise.

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