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Social Networks as the Substrate of Cultural Processes[1]

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The corpus of human knowledge is stored in books, libraries, records, computer systems, in the architectural styles of its buildings, the form of its art, music and other artifacts. But above all, human knowledge is stored in the immense neural network of human brains. Few investigators, however, have approached the concept of network at this scale. Most work in social network analysis concerns itself with the effects of different kinds of locations in networks of different types on the individuals who occupy those statuses and are socio-psychological in focus.

At this scale, however, individual brains are insignificant and replaceable, each making up about about 1.4×10^{-08} of the overall network, and, in fact, are replaced at the rate of about 8% a year worldwide, so that, every century or so, all individual brains are replaced, yet the cultural patterns stored in the network remain. In fact, the emergent properties of the network itself go far beyond the capabilities of the individual members of the net.

Neural networks can identify, store and retrieve patterns. These patterns inhere in the network itself, and not in the individual nodes. Figure 1 illustrates this in a simple way:

Figure 1: Flashcards at a stadium

A few writers have considered the global characteristics of networks not for their influence over their human occupants, but for their own intrinsic characteristics and behavior

(Woelfel, Richards et al. 1993; Woelfel 1997; Woelfel and Murero 2005; Woelfel 2009; Woelfel, Danielson et al. 2009), but overwhelmingly social scientists and computer scientists continue to focus their attentions on individual cognitive processes, and consider networks primarily as sources of influence over these individual processes. Why is this?

Neural networks, whether organic or mathematical, share an important feature: patterns detected and stored early in the life of the network serve as the basis onto which later patterns are superimposed, so that the sequence of learning is important. When a child learns about leopards, the leopard-pattern is built on the domestic cat pattern already in place. We understand the relationship between house cats and leopards not by an aristotelian deductive process, but because their patterns in our brains are largely made up of the same neurons.

Among the earliest patterns of belief to enter the written record stem from Athens. Among the most important figures in Athens were Socrates, Plato and Aristotle. Their model of knowledge was categorical, absolute, unchanging and perfect. Socrates and Plato believed that the world of experience was too volatile and evanescent to be the source of true, categorical, absolute, unchanging and perfect knowledge.

Plato believed that the world in which we lived was a false world, perhaps a place of imprisonment, which was designed to deceive us and prevent us from learning the truth, which was based in an alternative reality. Clearly, for Plato, this world can't -- and shouldn't -- be examined carefully and precisely.

Aristotle allowed that one could learn from observing this world, but only as a means of abstracting from it absolute and unchanging truths -- the underlying substantial form or "essence" of things. He thought the earth was the center of the universe, with the planets and stars surrounding the earth in concentric spheres. He also taught that all motion and change was directed toward some goal, and that all human behavior was similarly motivated by goals. He also taught that human behavior could only be understood in a limited, imprecise way.

Even earlier writings from the early Hebrews described humans as the ultimate creation of an all-knowing and all-powerful God, who were driven by good and evil impulses, but capable of freely deciding between the two, thus meriting either reward or punishment.

The Hebrew texts, along with the works of Plato, formed the basis of Augustine's Christian philosophy which continued Plato's two world model with two philosophical treatises, City of God and City of Man. Later, Aquinas incorporated Aristotle's work into the mix with his similarly bicameral work, Summa Theologica and Summa Contra Gentiles, the first of which used Hebrew scripture to construct a Christian philosophy, the second of which attempted the same using only the works of Aristotle. These two writers formed the foundation for Christian philosophy, which was has been disseminated through the network that is the Christian church for the following thousand years.

There are currently 2.3 billion Christians (33% of the world's population) and a billion and a half Muslims (22%) whose fundamental beliefs are that individuals form the foundation of society, and choose freely between good and evil alternatives based on a calculation of reward and cost. They believe that the world in which they live is only semi-real and largely evil, and must be overcome in order to achieve salvation in the next, real, world. According to the AAAS, in 2007 there were 5.8 million science and engineering researchers in the world, about 8.3-08% or 0.000000008% of the world population,and of these, the overwhelming majority either are christian or muslim, or accept the fundamental individualistic psychological model underlying those religions.

This model is not insubstantial and immaterial. It exists as synaptic connections among neurons in billions of brains, as well as in the books, libraries, computer systems and other artifactual storage systems that make up the world's collective cultural memory.

To the best of our current knowledge, synaptic connections are created and destroyed by some variant of Hebb's rule, which holds that synaptic connections between neurons that are simultaneously active grow, while inactive synapses decay. When a network is presented with a familiar pattern, the synapses which represent the memory of the pattern are reinforced. Only if the familiar pattern is not encountered for a long time will the synapses begin to decay.

This conservative characteristic of patterns learned early on is exacerbated by "thresholding." In the continuing flux that is the world in which we live, it is perhaps impossible that any pattern be confronted in exactly the same way twice. But the neural network only needs the similarity of the perceived pattern to match the old pattern to better than a threshold level; if that threshold is exceeded, the network decides that the current pattern is the old pattern, and perceives it as such. Thus if one sees a friend today, he or she may be dressed differently, wear sunglasses, be in a different context, but nonetheless be *similar enough* to activate the familiar pattern, and we see not a novel person, but an old friend. When combined with the massive reinforcement of daily prayer, weekly sermons, continuous reading of the Bible or Koran, the near complete acceptance of the model in Western literature, and more, the differences between the pattern of behaviors predicted by the individual actor pursuing goals, calculating rewards and costs predicted by the Judeo Christian Islamic Greek theory and pattern the collective network perceives on a day to day basis are insufficient to modify the old pattern, much less overthrow it.

The same might be said, however, of the classic ptolemaic model of the solar system and Aristotle's laws of motion. The differences between what we observe and what those models predict on a day to day basis are very small, and they too were embedded in a worldwide reinforcement network (strong enough to have Galileo arrested for disputing them). How did they fall?

The answer to that question may lie in another ancient Greek center of scholarship: Samos. Among the key figures who lived and studied in Samos were Pythagoras, Philolaos, Archytas, Aristarchus, and, although from Sicily rather than Samos, nonetheless a part of the Samosan network through his friend Conon of Samos, Archimedes.

The earliest patterns in the neural networks representing the Samosans were very different from those informing the Athenians. First, they did not subscribe to the “two worlds” concept, but rather believed that all that existed was what could be perceived by the senses. Secondly, their reasoning model was not categorical and perfect, as was the Athenians, but comparative and approximate. Aristarchus, for example, calculated the sizes of the earth, the moon and the sun, as well as their distances by comparative, approximate methods, such as comparison of the size of the earth’s shadow on the mood during eclipses to the size of the moon itself, or by comparing the length of the shadow cast at the bottom of a well in Egypt and Greece at the same time on the same day. Archimedes showed that the area of a circle could be calculated to any level of precision by the method of exhaustion by inscribing and circumscribing the circle with regular polygons of increasing numbers of sides. Most pythagoreans believed that the earth revolved around the sun (Antoniadi 1940). Copernicus cites Philolaos in his heliocentric model.

These early patterns in the Samosan network are the foundation of the comparative model of measurement, along with a language precise enough to communicate its findings among scientists -- the calculus. When expressed as comparisons to a standard -- particularly a worldwide standard like the meter and the second -- the differences between what the classical model predicts and what the comparative model observes are too great to be confused with the old pattern.

Social scientists are members of the Athenian network, and have an entirely different idea of measurement. (Rezaei-Moghaddam, Karami et al. 2006). The social sciences have never adopted the notion of measurement as comparison to a standard as the core of their observational methods (Pearson 1900; Popper 1935; Stevens 1946; Woelfel 2010). As a result, the differences between the old collective pattern stored in the global neural network and the pattern of observations made by social scientists is never sufficient to avoid activating the old pattern. Social scientists continue to experience the world that the Bible, Plato and Aristotle taught them to expect.

These shadows of the original Athenian pattern reveal themselves in their modern counterparts:

The “two world” model appears as Freud’s conscious/unconscious mind, as well as the statisticians’ population and sample. In the case of Freudian psychodynamics, the world we can observe (the conscious mind) is not the source of the motivations that drive behavior; these are hidden in another world (the unconscious) which cannot be observed. In Popper’s world of inferential statistics, the world we can observe (the sample) is of no real interest; what we need to know about is the population or universe, which we cannot observe. Sample statistics can be coupled with statistical assumptions to allow us to make inferences about the population, but beyond this the sample observations are of no consequence and must be disregarded. It occurs again in the distinction between the physical world and the social world. We can observe the physical world, but the more important world -- the world of human thoughts and actions -- is not strictly observable in the way the physical world can be observed, but only allows a shadowy glimpse and remains forever shrouded in obscurity.

We might make a case that Marvin Minsky and Frank Rosenblatt represent two worlds in computer science, with Minsky representing the teleological, Aristotelian world while Rosenblatt represents the observational, approximate, Samosan pattern.

The categorical model appears as categorical scales, such as 1= strongly disagree, 2= disagree, etc., or age scales such as 1= under 10, 2=10-19, 3=20-29, etc., pretest-posttest, treatment/control, and, by no means least, in the world of social network analysis, linked or not linked.

The essential nature of knowledge reappears as the concept of "validity", which refers to the extent to which a measurement corresponds to the essence of what is to be measured.

The anthrocentric notion re-arises as the psychologistic bias, in which the focus of interest is the individual actor, and society is seen as the amalgamation of the actions of all individuals, or in the focus in social network analysis on the effects of the structure of the network on its individual incumbents rather than the global action of the network.

The implication of all this is that there exist two major social networks, the Athenian and the Samosan. Science is a pattern residing in the Samosan network; the patterning of the Athenian network is incompatible with science. Social scientists are structurally members of the Athenian network, and attempts to build a science based on the Athenian pattern cannot succeed. The Samosan network makes science; the Athenian network makes philosophy and theology.

If the study of networks is to be science, it must be comparative, recognizing that all scientific measurement consists in comparisons to a standard. It must reject the notion that the human individual is the crown of creation, and stands at the center of all experience, and focus instead on the holistic character of networks.

A Comparative, Holistic Approach to Networks

In general, neural networks, of which social networks are an important class, identify, store and retrieve patterns in the ongoing flux of information that makes up the world of experience.

The main idea underlying a holistic view of networks is that it does not conceive of the cognitive processes as taking place within the nodes, but rather within the network taken as a whole:

> The fundamental hypothesis of this theory is that the structure of cognition at any point in time is given by the collective state of the network underlying that cognition, and *cognitive processes* may be considered a function of the changing state of the network over time (Woelfel 1993).

One of the most important products of networks is concepts. Plato thought that concepts originated in the World of Ideas, and what we knew of them was a result of remembering something of what we knew while we were there in a previous life. Aristotle thought that individual people could generate concepts by a process of abstraction from observations of this world. In the late 19th and early 20th century, the French sociologist Emile Durkheim suggested a third possibility -- that concepts were developed in what he called the "collective consciousness" (Woelfel, Danielsen et al. 2009). As Woelfel, Danielsen and Yum point out,

> He (Durkheim) suggests that the collective consciousness is the source of concepts: "In [Elementary Forms...] we have tried to demonstrate that concepts, the material of all logical thought, were originally collective representations" (Durkheim 1960) . A function of the collective consciousness, then, is the formation of concepts. This is at odds with those psychological approaches which consider concept formation to take place in the individual mind...(Woelfel, Danielsen et al. 2009)

There are no two snowflakes, trees, bushes or rocks that are the same. Yet over the millenia, the collective consciousness has identified continuities of patterning that it has attached to the terms "snowflake", "tree", "bush" and the like. Durkheim had no idea what kind of neurological mechanism might underlie such a process, but neural network models developed in the latter part of the 20th century provide such a mechanism.

In classic Aristotelian categorization, objects fit within a category if they share the essential attributes that define the category. If a being is *rational* and an *animal*, he is a man, according to Aristotle, since *rational* and *animal* are the essential attributes of man (Aristotle did not believe women were rational). But in a neural network, nodes become linked when they are simultaneously active, so that those nodes that are frequently co-active become strongly linked. The linkages among the nodes is the memory of the pattern. When some of the nodes become active, if the level of activation exceeds a threshold level, the remaining nodes in the pattern become active, and the entire pattern is activated.

A category in a neural network, then, is not defined by essential attributes, but by connections among nodes. If the network experiences a pattern that is similar enough to the stored pattern, the pattern becomes active. The essential element for identifying any experience, then, is similarity to previously stored experience. If an object is similar enough to previously experienced trees, then it is a tree. The pattern for "tree", however, is not simply stored in individual persons, but in the entire network of people that constitutes the social structure of society.

It is the network that learns new concepts and the relationships among them, not the individual nodes. Consider the following experiment: Individual nodes (people) sit at a computer and read a paragraph describing six people. The paragraph has been constructed by a random process, whereby people are assigned attributes (e.g., tall, short, intelligent, unintelligent, etc.) by a random process. After reading the paragraph once, the nodes are polled and score about chance in remembering the paragraph.

Raul is very conservative, intelligent, very tall.
Varsha is very conservative, unintelligent, tall.
Biff is liberal, very unintelligent, short.
Lurlene is liberal, unintelligent, very short.
Bobbie is conservative, intelligent, short.
Ray is very liberal, intelligent, very tall.

It is possible to show, however, that the set of nodes as a whole has learned the paragraph. If each node is asked to estimate the difference or dissimilarity of each fictional person and attribute from every other fictional person and attribute on a comparative scale, the averages of all the responses produce a Galileo map that is a rendition of the paragraph.

Figure 2 is a rendering of the relationships among the fictitious people and the attributes for 80 respondents as perceived by the network as a whole. Like the stadium picture of the creation in Figure 1, none of the individual nodes knows the pattern of relationships among the fictitious people and their attributes, but the network taken as a whole knows it. If the individuals talk among themselves at random, they, too, can learn the pattern, but the network learned it first.

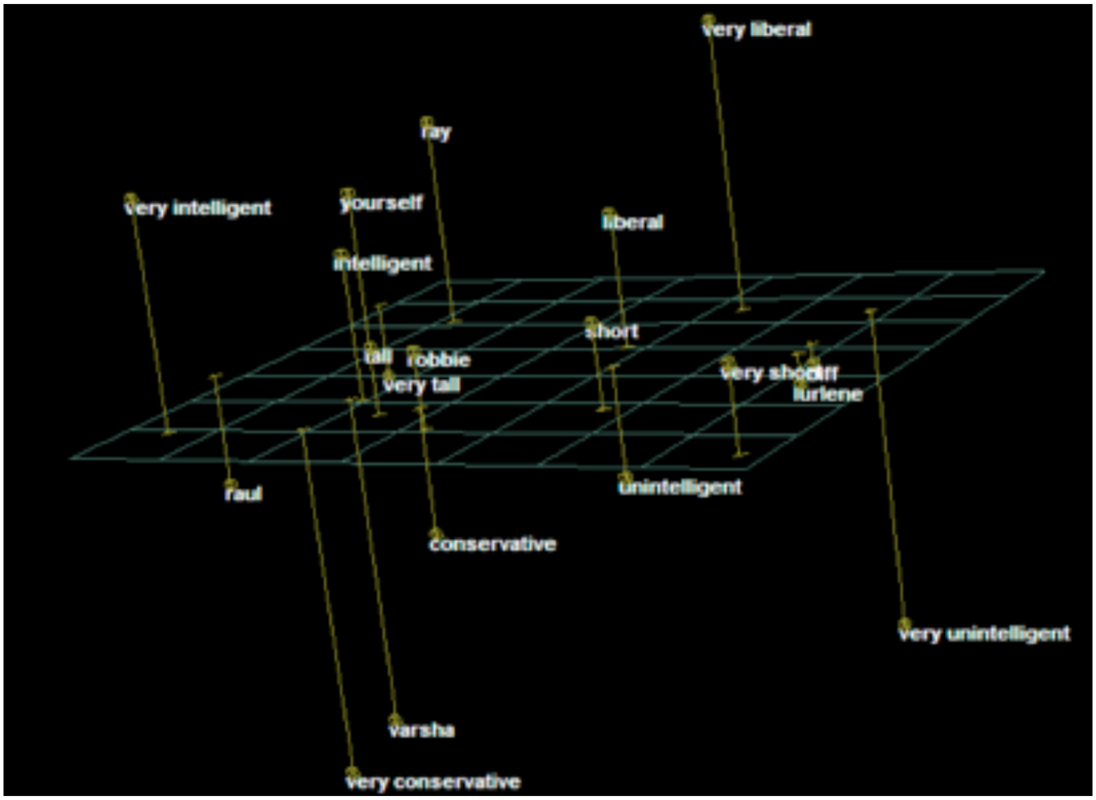

Figure 2: Distances among six persons and their attributes

Figure 2 serves a double purpose, since it shows, first, that the network as a whole is the entity that learns concepts and relationships, and, second, it shows that the Galileo procedure is an effective way to measure and display the patterns stored in the network (Woelfel and Fink 1980).

It is not the case that the network will learn the pattern without distortion. Different networks will selectively distort the patterns to which they are exposed in different ways -- in fact, the main point of this paper is to argue that the Athenian network will perceive the world in a very different way than the Samosan network. In the case of the fictitious people, the network of approximately 80 undergraduate students sometimes gets the pattern right, as it does for Biff,

Biff is liberal, very unintelligent, short.

Attribute	Distance	N
very conservative	149.81	78
conservative	184.00	77
liberal	68.46	76
very liberal	163.81	78
very intelligent	159.33	78
intelligent	194.35	77
unintelligent	112.33	76
very unintelligent	100.57	77
very tall	269.25	77
tall	125.86	77
short	60.86	77
very short	143.12	77

Table 1: Distances from Biff to attributes

but sometimes shrinks extremes, making *very liberal* into *liberal* and *very tall* into *tall*, for example, for Ray (Woelfel, Danielsen et al. 2009):

Ray is very liberal, intelligent, very tall.

Attribute	Distance	N
very conservative	142.97	77
conservative	119.56	75
liberal	86.71	77
very liberal	152.09	77
very intelligent	106.25	77
intelligent	80.63	75
unintelligent	111.36	77
very unintelligent	160.79	77
very tall	85.85	79
tall	77.16	77
short	118.54	78
very short	148.99	77

Table 2: Distances from Ray to attributes

Social and Cultural Change

Neural networks tend to be conservative. Once trained, patterns exist in the network as connections among nodes. When patterns *similar enough* to the learned pattern are presented to the network, it perceives then as if they were the old pattern. When the old pattern is activated, the connections are strengthened, and the old pattern is reinforced. Only when the network is confronted with patterns too different from any of those already learned to activate the old patterns will the old connections degrade and new ones be formed.

Networks can change only when information received by the network diverges from the patterns on which it was trained. This can happen when the network's environment changes, or by encountering other networks. In the case of individuals, these two mechanisms have been called self-reflexive activity and significant other influence (Woelfel and Haller 1971). In the case of the Athenian network of social science, the encoding system by which information from the environment is recorded is very imprecise, so change from self reflexive activity is muted. Moreover, since the network is itself highly cloistered, with virtually no communication with the network of physical science, change from significant other influence is also minimized. With the massive reinforcement of ritualized reiteration of its internal patterns, limited ability to perceive and encode precise information from the environment, and isolation from the network of physical science, the social science network has been able to persist for generations essentially without change; it's fundamental core concepts remain those of the ancient Hebrew texts and the philosophical systems of Plato and Aristotle. In the social sciences, the scientific revolution has yet to take place.

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