Redefinición del “aprendizaje en red” en la cuarta revolución industrial

Redefinition of "Network learning" in the fourth industrial revolution

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Alexandro Escudero Nahón*

RESUMEN

La “cuarta revolución industrial” provocará una transformación en los escenarios educativos porque incorporará redes ciberfísicas en la producción, logística y consumo de bienes y servicios. La teoría educativa ha abordado tradicionalmente los escenarios educativos tecnologizados con categorías de análisis propias de la tercera revolución industrial y es necesario superar esos lastres conceptuales. Este texto propone el concepto de “aprendizaje en red” y toma como punto de partida la ontología poshumanista y la epistemología de la teoría del actor-red. Así, el aprendizaje sería un proceso que asocia agencias humanas y no humanas por igual, que opera sin centro ni periferia, y cuyo objetivo es garantizar su autorregulación y persistencia porque en cuanto las agencias dejan de operar, la red de aprendizaje desaparece. El aprendizaje es, en sí mismo, una red heterogénea en funcionamiento. Asimismo, en este texto se identifican algunas agencias humanas y no humanas básicas que permiten constituir redes de aprendizaje, fortalecerlas o destruirlas. Además, se justifica por qué la investigación educativa debería crear datos de manera inductiva y construir categorías de análisis en forma abductiva para identificar nuevos objetos de estudio en los escenarios de aprendizaje de la cuarta revolución industrial, que se caracterizan por ser híbridos, ambiguos y contingentes.

Palabras clave
Teoría educativa, poshumanismo, teoría del actor-red, cuarta revolución industrial, aprendizaje en red, filosofía de la educación

ABSTRACT

The "fourth industrial revolution" will provoke a transformation in educational scenarios because it will incorporate cyber-physical networks in the production, logistics and consumption of goods and services. Educational theory has traditionally approached technological educational scenarios with categories of analysis typical of the third industrial revolution and it is necessary to overcome these conceptual weights. This paper proposes the concept of "network learning" taking as a starting point the posthumanist ontology and the epistemology of the actor-network theory. Thus, learning would be a process that associates human and non-human agencies alike, which operates without center nor periphery, and whose objective is to guarantee self-regulation and persistence because as soon as the agencies stop operating, the learning network disappears. Learning is, in itself, a heterogeneous network in operation. Likewise, this paper identifies some basic human and non-human agencies that allow learning networks to be established, strengthened or destroyed. In addition, it is justified why educational research should create data through an inductive manner and construct categories of analysis abductively to identify new objects of study in

Keywords
Educational theory, posthumanism, actor-network theory, fourth industrial revolution, network learning, philosophy of education

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* PhD in Education. Fulltime professor-researcher. Universidad Autónoma de Querétaro [Queretaro Autonomous University]. Mexico.

the learning scenarios of the fourth industrial revolution, which are characterized by being hybrid, ambiguous and contingent.

INTRODUCTION

According to the specialized literature, we are at the dawn of the fourth industrial revolution and, after what has happened in the three previous ones, radical changes are expected in our way of living, working, studying, consuming and relating with each other (Schwab , 2015, 2016, World Economic Forum, 2016).

The First Industrial Revolution took place in the late eighteenth century in the United Kingdom, with the emergence of steam power, the mechanization of agriculture, manufacturing and transportation (Daemmrich, 2017). The Second Industrial Revolution was consolidated in the United States of America at the beginning of the 20th century.

In this case, electrification was the disruptive technology that allowed mass production (Hintz, 2011; MacLeod, 2016). The Third Industrial Revolution started in the middle of the last century with the invention of semiconductors, digital platforms and the rise of personal computers (Hermann, Pentek & Otto, 2016).

Unlike the previous three revolutions, the fourth is not defined by the emergence of a specific disruptive technology, but rather by the convergence of several digital, physical and biological technologies, such as artificial intelligence, increased intelligence, robotics, 3D printing, *cloud computing*, the *big data*, the "Internet of things" or nanotechnology (Rose, 2016). This confluence generates cyber-physical networks. Far from being a science fiction scenario, these networks already operate in working, financial or leisure settings, with self-regulatory capabilities, making their own decisions and with minimal or no human intermediation (Roland Berger, 2016).

The association between several cyber-physical networks is generating stimulating projects such as "smart cities", "factories 4.0", "green economies", etc. (Tecnalia, 2017); but it is also posing challenges for people to acquire the professional skills necessary to compete on the current labor market (Devezas, Leitao & Sarygulov, 2017; Lorenz *et al*., 2016; Lorenz et al., 2015).

The Third Industrial Revolution approach was product-oriented which required focusing professional skills on automating processes and individual machines to introduce improvements in the product (Hermann et al., 2016, Kagermann, Wahlster & Helbig, 2013). Now, the Fourth Industrial Revolution approach focuses on digital ecosystems, i.e., it is generating innovative business models based on the interconnection of millions of consumers, machines, products and services. Therefore, new professional competences are required to allow making

improvements throughout the entire value chain (Slama et al., 2015); for example, critical thinking, creativity, emotional intelligence, etc. (Morita-Alexander, García-Ramírez & Escudero-Nahón, 2016). At the same time, new technical professional competences are required such as knowledge of cyber-physical networks and digital ecosystems (Adams et al., 2017, OECD, 2017, UNESCO, 2015, World Economic Forum, 2016).

According to the study "50 educational innovations in Latin America, Graduate XXI, a map of the future" (Rivas & Delgado, 2016), several highly technological educational innovations are being consolidated on our continent. They emphasize, for example, adaptive learning, which uses artificial intelligence and *big data*; comprehensive network education services, that use *cloud computing* and the el Internet of things, *gamification* of education, based on the originality of the notion of “online persistence”, similar to videogames on the Internet or virtual reality platform; hybrid and mobile learning, where several on line and traditional tools are made available to the apprentice.

Educational research has addressed these educational innovations through several categories of analysis, for example, *e-learning*, self-learning settings, virtual teaching-learning settings, education mediated through technology, network learning, among others (Gros, 2012; Hsu *et al*., 2012; Hung, 2012). The concept of “network learning” is particularly interesting since it refers to technical and human connections used by students to obtain good academic results in highly *technologized* study settings. This expression is not original, since, regardless of the historical epoch, people have always created a network of connections to learn; however, we started reflecting on this topic only when digital technology made certain unusual connections that go beyond temporal and social limitations in order to access new sources of information and new learning references (Jiménez, Bustamante & Albornoz, 2015; Pedersen, 2010).

However, network learning reveals certain conceptual limitations in addressing these educational innovations since it inherited ontological and epistemological principles of modern humanism which is characterized by its anthropocentrism and dichotomy (Pedersen, 2010). Hence, it supposes that technology and education are two well differentiated and autonomous spheres (Jiménez *et al*., 2015; Thomas & Buch, 2013), and eagerly places the apprentice at the center of the educational process and above all the other non-human elements that participate in the learning process (Carlson, 2015).

Given the foregoing, this term is not very useful in studying educational innovation in highly *technologized* scenarios where non-human elements play a leading role and operate without any center or periphery, i.e., as a network (Knox, 2016; Minerva, Biru & Rotondi, 2015; Rivas & Delgado, 2016).

For the first time in history it has been possible to identify the emergence of an industrial revolution. However, educational research has the challenge and the opportunity to go beyond the modern humanistic vision that currently involves online learning and to redefine this category of analysis in order to explain the relation between educational technology and the learning processes (Baygin *et al.*, 2016; Escudero, 2016a).

This text claims it is necessary to make a posthumanist ontological proposal and an epistemological proposal based on the actor-network theory to redefine the concept of network learning. Subsequently, it proposes two research methods to study this type of learning: the inductive data collection and the construction of an adbuctive analysis of categories. Here the objective is to outline a research procedure to trace which human and non-human elements associate to create agencies and how learning networks emerge, how they strengthen and how they associate with other networks and how they disappear.

ANTHROPOCENTRISM AND DICHOTOMY IN MODERN HUMANISM

The first records of the word “humanism” date from the Latin *humanitas*. At that period, the term referred to a distinction between the culture and the education a free man would receive and that was not, in any way, typical of the "barbarian man" (Arbea, 2002). Throughout history, it transformed into different types of humanism, such as the classic, the medieval, the enlightened, the existentialist, etc. (Echeverría, 2006, Kakkori & Huttunen, 2010), but all of them endowed "the human" with four characteristics (Espinosa, 2016; Knox, 2016): essentialism, universalism, autonomy and transcendence. In fact, humanism is a distinction, explicit or veiled, that the human being makes of himself based on a supposedly essential condition that separates him and makes him different, better and more important than "the non-human".

The truly modern humanism emerged in Europe in the 17th century. Unlike prior concepts of humanism, this modern humanism was infused by enlightened thinking and by a peculiar optimism about the rational faculty of the human being (Chernilo, 2017). Hence, the modern project was based on the promise that the science and technology would free human kind from its pre-modern customs/atavismos (Dolphijn & Van der Tuin, 2011). However, modern humanism based its ontology on a crafty synecdoche (Weaver, 2010).

By postulating that "man is the measure of all things", i.e., by using a part to refer to the entirety, it produced an anthropocentric world that, by definition: a) is hierarchical, since it overestimates the "the human" agency and despises the "the non-human" agency; b) it separates ontology from epistemology, hence, separates the learner from what he learns, and with what he learns; c) it divides and classifies disciplines of

knowledge according to an object of anthropocentric study, i.e., it assumes that "the human" is a subject of study with well-defined attributes and substantially different from "the non-human".

To sustain anthropocentrism, modern humanism had to resort to another sophistry: dichotomy. First, it argued that, given its rational essence, “the human” maintained a disruptive relationship with “the non-human”. Second, it simplified the complexity of the interconnections that “the human” maintains with the world into two categories (human/non-human); and third, this symbolic dichotomic rule always implied an unfair devaluation of the “non-human” (St. Pierre, 2013).

The modern educational theory has inherited modern humanism and, for that reason, it starting point is always a limiting provincial paradigm that places “the human” at the center as sole cognizant subject, with well-defined essential attributes separated from what he learns and from the things he uses to learn (Snaza & Weaver, 2015). This legacy also imprinted another limitation: the educational theory is based on dichotomic assumptions and, in spite of the complexity of the interconnections between the elements in educational settings, they are endowed with well-defined limitations, essential attributes and an unfair devaluation of, for example, “the object” before “the subject”, “the body” before “the mind”, “the setting” before “the person”, “technology” before “education”, in short, it devaluates “the non-human” before “the human” (González, 2015). Precisely because modern humanism still dominates the discourse of educational technology because this field of study is addressed incorrectly as two different worlds in ontological terms, as dichotomic and autonomous spheres (Thomas & Buch, 2013).

Since the first half of the 20th century, the undesirable effects of modern humanism were threatened, ironically, the survival of our species. Pollution, inequality and discrimination have lead to disenchantment of the promise of the modern project and have catalized an impulse to make ontological and epistemological reformulations that lead to new conceptualizations of the human. The main protagonist of this theoretical convulsion is posthumanism.

Posthumanism is a thought made up of several theoretical conceptual tendencies, such as critical posthumanism, anti-anthropocentric posthumanism, transhumanism and analytical posthumanism, which common objective is to reformulate a new ontology that generates a different definition of human (Braidotti, 2013; Skageby *et al.*, 2016; Weaver, 2010; Wolfe, 2010). Hence, the application of posthumanism to education advocates a rupture of the anthropocentric and dichotomic vision and introduces a complex thought that a) off-centers the human and places it at the same level of importance as the non-human at the moment of learning (Wolfe, 2010); b) admits that the human and the non-human constitute the world, they are constituted interdependently

and, thus, their agencies are equally important for learning (Braidotti, 2013); c) no longer entails that the one learning is invariably human (Snaza & Weaver, 2015); and d) admits that the non-human has always been a condition of the possibility to learn and not only an accessory of this process.

Therefore, the artifactual and simplified sense of the educational technology, referring only to the tools used to teach and learn, is overcome, and a more complex version is constructed that includes all the human and non-human elements in dynamic processes (DeLanda, 2006; Usher & Edwards, 2005). This requires the construction of a new epistemological narrative to study the *technologized* educational settings characterized by being full of heterogeneous elements that maintain different connections among them such as software, social networks, hardware, Internet signal, artificial intelligence, increased intelligence, Internet of things, learning management platforms and, of course, humans.

As of the second half of the 20th century, the debacle of the modern and positivist vision of social sciences led to several theoretical and conceptual reformulations. One of the most relevant was the bifurcation that traditional sociology experienced with the emergence of the "sociology of associations" (Devenin & Henríquez, 2011). This proposal claimed that traditional sociology had been undermined in its capacity to address, describe and explain its objects of study because it assumed that society exists, in itself, in an essential manner (Latour, 2008).

According to this critic, traditional sociology has caused, at least, two undesirable effects (Pignuoli-Ocampo, 2014): a) it took the term "society" as an explanation of what had to be explained and thus, confusing the cause with the effect: the result was a deficit of its explicative capacity; b) as it assumed that society existed essentially, then it tried to describe the properties of that social "substance" and lost the capacity to react before the dynamism of the object of study.

In contrast, the "sociology of associations" proposed a conceptual theoretical framework that revitalized social studies: the actor-network theory (ANT) (Latour, 2007, 2008, 2009). The ANT was consolidated in the 20th century, more specifically in the '80s, and since then, it is a referent for studies that seriously address the role of science and technology in relation to the notion of society (Jackson, 2015).

One of ANT most audacious epistemological principles is that society, in itself, does not exist, at least not as an essential substance in which social things occur (this is meant to be ironic). Neither is it a homogeneous context; even less a prerogative of humans over non-human. For ANT, "social" is everything that is associated with a network (Harman, 2009). Hence, the associations make up society and not the other way around.

This Copernican twist in the object of study allows defining society as a movement, an assembly process, a circulating fluid

That put multiple elements and agencies in contact. These elements and agencies, in general, are humans and non-humans.

Hence, ANT epistemological principle is useful to redefine the term network learning. However, it is worth clarifying first that, unlike other definitions of network, ANT postulates a performative and not an ostentatious character of network; a hybrid character of the elements that constitute it; a broad conception of the term agency, and symmetry between human and non-human elements (Latour, 2008). Therefore, for ANT:

- The network is performative and not ostentatious. A network is such as long as the elements that make it up exercise their agencies; as soon as those agencies stop operating, the network disappears. Hence, no element of the network has, essentially, in itself, any agency; associations are needed so agencies can create a network.
- The network is hybrid. If human and non-human elements achieve associating, they make up hybrid units susceptible of being analyzed as "almost human" elements or "almost not human" elements.
- There are multiple types of agencies in a network and not all of them are performed by the human being. An agency is not only the capacity that the elements of the network have to generate transformations but also its capacity to receive these influences as if it were a mobile target.
- In order for a network to be powerful, it needs to ensure the persistence of its agencies. Non-human elements are essential in fulfilling this purpose. Hence, the importance of human and non-human elements is symmetrical in the network since its value does not reside in its human condition but rather in the capacity they have to ensure that nothing threatens the proper operation of the agencies.

Therefore, a learning network can be defined as follows: learning is, in itself, a network in operation. This network requires associating several human and non-human elements and agencies to be able to operate correctly. This network does not have and essentialist character, but it exists rather as long as its human and non-human elements exercise their agencies adequately. A learning network is performative and as soon as the multiple agencies stop operating adequately, the network disappears. When a learning network is powerful and has innovative results, it is capable of associating with other networks; it can sustain itself for a long time; it can strengthen itself and give the impression that it attracts, influences and transforms almost everything.

If educational research would admit that associations are the basis of the "social" and not the other way around, then it would be able to address the learning process as a network. It would be capable of tracing the agencies that human and non-human elements draw forth when associated to a learning network. It explicatory capacity and speed reaction before the current educational settings would improve (Echeverría & González, 2009). A horizon of conceptualizations would open that could account for emerging actors that are now constituting the educational technology. Given the above, the objective of an educational research, from this perspective, would be to trace what human and non-human elements associate to create agencies, which agencies are most important, what are the main problems learning networks face to emerge, establish themselves, persist, strengthen themselves or, why do they disappear (Escudero, 2016b).

OBJETIVE OF THE EDUCATIONAL RESEARCH FROM THE ANT PERSPECTIVE

Trace Multiple Agencies Inductively

The positivist research that predominates in the studies on education until the second half of the 20th century had as main objective verifying hypotheses. Hence, most studies were conducted by using the deductive-hypothetical method characterized by defining accurately a case study, construct a dense theoretical framework with pre-defined categories of analysis and, design data collection instruments before tackling the field of study.

Here, we propose a diametrically contrary research method. The objective in accessing the network is to trace meticulously the agencies that emerge when the human and non-human elements are active. This is an inductive access process to the network since it suspends the analytical categories previously learned; it has no research design prior accessing the network and neither is it accompanied by a predesigned data collection instrument, but all of this is consolidated throughout the study (Bryant, 2017; Gibson & Hartman, 2014; Holton & Walsh, 2016).

If we accept the premise that there are no predefined objects of study with inherent attributes or defined limits in a learning network process, but that the elements and their agencies are assembled in situation, and only the proper operation of this assembly installs the network, then, we can admit that the objects of study in the network are hybrid, contingent, contradictory, ambiguous, paradoxical. However, it is possible to trace the network activity or at least the sediments of said activity (Fenwick & Edwards, 2010, 2011; Fenwick, Edwards & Sawchuk, 2011; Law, 2004).

The inductive method does not emphasize verifying the existence or absence of predesigned analytical categories but rather in being sensitive

to the data generated by the activity of the elements and their agencies in the network. This sensitivity could be stimulated when trying to respond to two simple questions:

What main problem do agencies face in trying to form in the learning network? and, How do the network elements try to solve this problem?

Traditional techniques and data collection instruments are still useful, but their current objective is to identify the ambiguities, contingencies, paradoxes, controversies, etc. with which network elements and agencies usually interact. In-depth interviews, informal conversations, focus groups, etc. are very adequate techniques to obtain information from human network agencies; observation, immersion, multimedia records, etc. are usually useful to register agencies of non-human actors (Fenwick & Edwards, 2010). The information obtained with these instruments does not suffice to create categories of analysis. It is necessary to apply another method to outweigh the mere description of the problem and to propose a conceptual explanation.

Construct Analytical Categories in an Abductive Manner

Abduction is a cognitive process that can stimulate the creation of analytical categories since it integrates, assesses and, at times, disintegrates constantly in several and different hypotheses throughout the research in order to give a sense to the facts that are apparently disconcerting. Locke *et al.* (2008) schematized it as follows: deduction is capable of saying that "something must be as such"; induction demonstrates that "something is such", but abduction suggests that "something could be as such". Unlike the deductive research method, that designs a hypothesis before tackling the field of study, abduction integrates and disintegrates constantly several hypotheses by using categories of analysis constructed in the network to explain the issue at hand (Dunne & Dougherty, 2015). The result of the abduction is the explanation of an issue based on the reiterated creation of hypotheses that are being verified on the network or that disintegrate by creating new hypotheses (Pape, 1999; Reichertz, 2007).

One of the methodological implications of redefining the learning network concept based on ANT is that the study network cannot be conceived from an essential standpoint that exists by itself. No: the learning network will exist as long as human and non-human elements will associate and create agencies. When this stops, the learning network disappears. Therefore, the access to the study network requires identifying, before anything else, if some agencies are operating and which one operates more intensively.

Next, we present a proposal of general agencies that would constitute the learning network and which have been adapted from the general

procedure of cyber-physical networks of the fourth industrial revolution (Hermann *et al*., 2016) (See Figure).

It is necessary to identify, in the descriptive level, what human and non-human elements associate to create each one of these agencies. As explained in the figure, some of these agencies are better performed by non-human elements while others are better performed in collaboration of both. Agencies operate in the network without any pre-established order, in an ongoing manner, and will be effective provided they are performative, i.e., provided they keep several network elements well associated.

The most routine agencies, such as capturing data with sensors and exchanging them, have been substituted by robots that, based on certain sensorial materials and algorithms, perform tasks more efficiently than humans. However, there are other agencies in which the collaboration between humans and non-human has been very useful, for example, the production of relevant information, their interpretation based on criteria appropriate to the situation and the registry of this type of knowledge. Lastly, intuition reflection and innovation agencies are, until now, predominantly human.

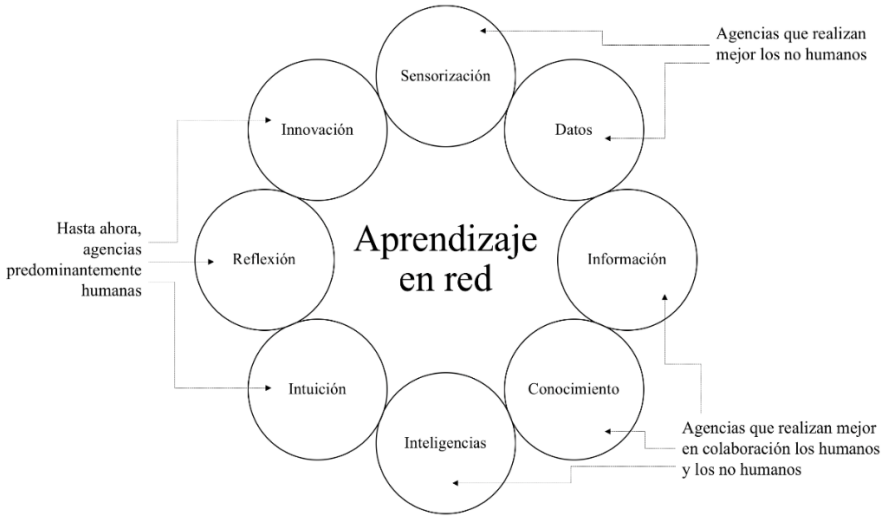

Figure. General Agencies Performing Learning Network

It is necessary at the conceptual level to explain by means of a category of analysis the issues that impede human and non-human elements to associate to create and sustain each one of these agencies at the time it registers how the network elements achieve overcoming the issue. Hence,

it is convenient to give a general description of the agencies that constitute the cyber-physical network in the fourth industrial revolution (See Table).

Table. Description of the phases of the learning network

Activity	**Description**
Sensorization	Capture as accurately as possible the stimuli and environment variations such as movement, speed, temperature, humidity, sounds, image, etc. These stimuli must be translated into data that can be useful to make decisions
Data exchange	The timely exchange of data and their interpretation within a context and with certain criteria convert them in valuable information
Production of information	Information dealt with proper skills converts into categories of analysis. The rigorous application of these categories to specific problematic situations converts into knowledge.
Knowledge	Knowledge with a purpose promote intelligence
Intelligences	The reiterative and creative application of intelligences to explain or solve a specific problem leads to several actions, but inverted resources in this application are optimized with intuition
Intuition	Intuition groups experience, intelligences, imagination, creativity, etc. in a dynamic manner, but it is regulated through reflection
Reflection	Reflection is capable of assessing from different standpoints the process through which all the previous agencies were created. Likewise, it assesses the pertinence, utility and originality of the results to recognize the degree of innovation
Innovation	Innovation is the controlled introduction of a useful and original process. One of its effects is the attraction of other networks.

This proposal of general agencies of learning network would be useful to identify within highly technologized educational settings which agencies perform better the non-human elements and which do perform better the human ones, and which agencies perform better in collaboration.

CONCLUSIONS

The imminent consolidation of the fourth industrial revolution poses the challenge of assessing to what extent theoretical, conceptual and methodological referents have been used in the last fifty years to study the educational technology and if they are still appropriate for their analysis and development or if it is necessary to strip them from some of their handicaps to comply with said purpose.

Learning network is a term which objective is to define a field of study for settings highly mediated by technology. However, since it has inherited from modern humanism certain ontological and epistemological principles, it possesses at least two conceptual handicaps: an anthropocentric character and a reductionist dichotomy.

Posthumanism ontological reformulations dispel these conceptual handicaps and show that the human and the non-human should be equally important for the educational research since both are essential at the moment of learning. Furthermore, it is not possible to separate the learner from he learns or from the things with which he learns; i.e., the non-human is the condition of the possibility to learn and not only a learning accessory. On the other hand, epistemological reformulations of the actor-network theory show that society, in itself, does not exist, but rather the associations of human and non-human elements make up societies. One of the most relevant alliances for educational research is the blend of human and non-human elements to learn.

Therefore, a redefinition of learning network would postulate that learning, as such, is a network of elements and heterogeneous agencies in correct operation. Learning is a performative process, i.e., when agencies stop operating, the learning network disappears. Hence, the challenge and the objective of the educational research is, from this standpoint, to recognize that new research procedures are required before the imminent consolidation of the fourth industrial revolution. Hence, it is possible to trace inductively and abductively the human and non-human elements that associate to create agencies that allow generating learning networks, how they strengthen, how they associate to other networks and why they disappear.

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