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There are no translations available.

Differences and similarities between a matrix and a network

What is a matrix –reloaded [2009]

A few years ago I could effectively describe what a matrix was only by giving examples of it showing the three things necessary for its formation. Here at the dawn of 2009 I can take a deep breath and say “A matrix is a context essential for and catalytic to one phase of emergence” and then sit back and consider what that implies and what questions it raises.

A matrix is essential for, supportive of and directive in the development of emergent systems.

The three requirements for a matrix are: A safe space in which to interact, energy to enable interaction, and stuff to interact with (input). Only when all three factors are present can emergent development take place.

The one requirement for emergence is: the existence of a matrix or series of matrices in which it will take place. Whatever develops; the emergent entity within the matrix, is separate from it but intimately connected with it and constantly interacting with it, because ongoing interaction with

the matrix is necessary for each phase of emergence to complete.

Does emergence cause a matrix to be formed?

The first question that came to me when I reached the above conclusion was: Is a matrix a set of conditions that develops as part of the emergence process itself? And the second question was: How do I explain what is “one phase of emergence”? From there, more questions start branching off so in the sound tradition of science everywhere, as one answer becomes clearer we have created more questions and shall have to take them one at a time.

Emergence cannot take place without a matrix, but can either be said to be the “cause” of the other?

Well, the emergence of the body and brain form a matrix that allows the emergence of intelligence and the emergence of further entities via reproduction. But matrices also get formed entirely by chance –a handful of soil in still water under sunlight is a matrix. It won’t be long before life exploits it and emerges quite quickly as slimy green algae. You could argue that the earth as an emergent system created the little matrix puddle on purpose, or that the puddle is just part of the solar system matrix, but I’m not going to argue with you. There is evidence that matrices can arise in many ways and that the process of emergence exploits them wherever they exist, but whether one is a part of the process of or causative of the other remains an open question. It’s a big question –because if emergence has to take place wherever there is a matrix, there is almost certainly going to be emergent life on any planet with the right conditions; in fact it would be impossible for such a planet not to develop life.

The biggest matrix you are ever likely to see is the universe. It has planets (safe spaces) plenty of available energy, and a hell of a lot of stuff to explore for input. It is autonomous (it provides all its own planets, energy and stuff). Our solar system is also a matrix, but without the sun, planet earth would have been a matrix of a very limited kind. The earth's 'own' energy is thermal, and the only safe space for the emergence of life to occur is around thermal vents in the deep bed of the ocean. Life has gone ahead and developed there anyway which adds weight to the idea that wherever a matrix is present, emergence automatically attempts whatever it can.

You can make a temporary matrix by leaving an old tin of pineapple lying around near a radiator, but the emergence of life is a rather long process to sit and watch. You can get a much better demonstration of what occurs in a matrix by making yourself a coffee. If you use a mug for the safe space, and coffee grounds and water for input, you'll have a cold disorganized mess, especially if you put milk and sugar in as well, but as soon as you add energy by heating the mixture in a microwave you create a matrix. The ingredients merge and become more than the sum of their parts, beginning to change their form and nature, to one that seems somehow more ordered and yet more complex. You have a nice frothy coffee. If you continue to add energy, what's called a phase transition will take place and you'll have coffee-flavored steam all over your microwave. (And if you're a physicist and have access to the equipment you could continue adding energy and attempt to create the world's first cappuccino plasma.)

What is one phase of emergence?

Emergent systems develop in phases, with four stages to a phase. The period between one phase transition and another is one phase of emergence.

Throughout the process of emergence, a linear increase of energy in the system will cause non-linear changes in the properties of the system. Those changes are phase transitions, and they correspond with matrix shifts. A phase is part of a process; a matrix is the context in which that part of the process takes place.

Notice how when the phase transition occurred in the example above, the coffee jumped matrix. As steam, it was no longer able to remain in the mug; it had taken on a shape and form the mug could not contain. To contain it and pursue another phase transition, a different ‘safe space’ would be necessary such as our physicist’s gas containment field.

Notice also that the coffee could not have made a phase transition without all three aspects of the matrix. Thinking about this kind of thing can get you familiar with the physical aspects of a matrix, and that may be all there is to get to know. Perhaps interaction with the matrix is a feature of emergent development itself; not of the matrix it takes place in. I am inclined to believe the matrix context is important, however, because the process of emergent development is able to take place in clear phases and stages that can only be triggered or enabled by interaction with the matrix. This is what I see as intelligence in action when it takes place in the context of learning. It is what I see as emergence in action when I consider physics, and here we have to consider the tricky Zen-like question “So could emergence itself be thought of as a kind of intelligence?” Don’t ask me for any help with that one.

Without the matrix involved in the equation, emergence would appear to be getting something from nothing. Emergence produces unique combined effects, but many of these effects are co-determined by the matrix context and the interactions between the emerging system and its matrix. At each phase transition into a new matrix and level of complexity, entirely new properties appear in the system. The synergies and processes associated with emergence are real and measurable, as is aptly demonstrated in many publications (the ones I would most recommend is “Emergence: the connected lives of ants, brains, cities and software” by Steven

Johnson and “Sync” by Steven Strogatz if anyone would like further reading in this direction.)

Emergent intelligence

My own specific study of matrices and emergence is in the development of intelligence. Because it is not just material substance such as bodies and brain networks that can have emergent properties, in fact it’s not even always living substance that emerges from a matrix either. Things like villages and cultures can be emergent (and not just the kind of cultures you find in the bottom of an old pineapple tin). And of course intelligence, psychology, learning and animal behavior, none of which can be pointed out in your average autopsy, are also emergent systems.

In the emergence of intelligence, matrices are the contexts that both house and induce the maturation of both brain and mind, and each matrix prompts the development of the next brain network and its associated abilities of mind at the same time as exploring the current one.

If emergence is taking place in the physical brain, and also taking place in intelligence, psychology and mind, at the same time as the physical development of the body, we might expect to look to DNA for a synchronized unfolding of these events controlled by gene transcription, and if human emergence is successful that is precisely what we can observe. Physical brain growth spurts coincide neatly with phase transitions right at the time new skills need to be learned, and brain growth slows down to let the body catch up and develop its own skills and tools just as the mind starts being inspired to use them. It can all unfold like a beautiful symphony with perfect timing and synchronization.

But it may not. The thing about emergence is, it is never a definite given unless it progresses in the right order and without interference. Like baking a cake or running a program, it is a series of steps that can only run to its full conclusion in continuing appropriate conditions. If at any point in development any aspect of a matrix is lost or incomplete, or if interaction with the matrix ceases, emergence will flounder, and development may slow down or stop.

There are two ways this can happen and you can see this very easily with plants. There are two ways to kill plants –don't give them the input they need, and/or give them inappropriate input.

These two issues affect all emergent systems whatever their nature. In intelligence they are referred to as 'non use' (lack of input) and 'wrong use' (inappropriate input). Both lead a system to atrophy. This seems very straightforward and obvious with plants and physical bodies but becomes confusing when we don't know what appropriate input should be for a system or what is inappropriate for that system. If you grew up in a society where everyone believes that plants need water, vodka and vindaloo, your ideas of appropriate input could be confused, and this is exactly the sort of problem currently facing the development of intelligence. 'Any' sort of input at any stage will not do. We can see that when we put a plant under green light, although such light is not poisonous to the plant, it is missing the appropriate input to photosynthesize and growth will slow down and stop, yet we cannot see that when we put a child's mind in front of a TV set, a very similar problem occurs. The content of the programmes does not matter, because the problem with wrong input –regardless of what it is- is that it takes up all the time and attention that should be spent on the right input, without which emergence flounders. While we are entertaining ourselves with images and sounds of animals in a forest, we are missing real time in the real forest with real animals. The brain simply can't use input that stimulates only one or two senses, and –most importantly- the very young brain cannot develop without the body physically moving about.

Physical movement is so closely tied to awareness in early matrices that a three year old child

cannot say the words “sit down” without sitting down, or the word “hand” without moving a hand. Physical movement is crucial for those early nets to grow. TV is no problem for someone who has all the frontal networks fully developed, but these are never going to develop efficiently if we block the development of the earlier nets they depend on.

A complication of the emergence of intelligence slowing down is that it falls out of sync with physical development, which goes ahead regardless. The physical tools are being built for tasks that the mind cannot yet fathom, but tries to copy anyway. We end up with mature adult bodies and children’s –in some cases infants’- immature minds.

The stages in one phase

A matrix provides appropriate input to interact with. It is interaction with this input in particular ways that appears to enable emergence to successfully take place. The sequence of events within each phase of emergence is the same although the complexity of interactions (and the system itself) increases in each new phase. This ‘sequence of events’ is the ‘learning cycle’ I have referred to as COMP, and the same sequence can be looked on as a cycle of growth, a cycle of development or a phase of emergence. An emergent system passes through the cycle once in each phase, and each phase prepares us for the next (at a certain part of each development phase the agent that is developing will start to interact with the next matrix, in a few random areas at first, then more and more, so that as one development cycle comes to a close and there is a phase transition, the agent is well equipped to begin progression in the next one.)

A good way to imagine this process is to think of a computer game with several levels. The aim of the game is to get the treasure at the highest level. You start at level one and you wander

round exploring and picking up anything that may be useful. After playing for a while you become adept, and at the same time you start to find gateways into level two. If you go through permanently before you have found all the tools you're likely to be either lost or ill-equipped, but you are allowed in for short periods to grasp the basics. When you know enough and have enough experience and skills to proceed, you find yourself pushed into the next level.

Each level has four stages. The first stage is exploring until you know all the basics of the territory, collecting clues or skills or magical items or bits of information, learning what is useful and what isn't. The second stage is finding out what all these things are for and how they are to be used, and the third stage is starting to use them. The fourth stage is becoming adept and trying variations, and after that a phase transition happens and we find ourselves in level two, where we repeat the process.

Shift the 'computer game' analogy now into real life: This is how we learn any skill. Consider learning to walk. We explore whatever resources the matrix has provided (our muscles, bones and body and a place to move around, and we interact with them. We figure out what the available tools are, how to use them, and by continued practice we become adept, we try variations –running, skipping, jumping, climbing-until our experience of 'walking' is complete. We no longer need to concentrate on it; it has become automatic, and we move on to explore other possibilities. We walk out of our current matrix ('in arms') and start to explore what will be our next one –the living planet. We don't want to go there permanently before we have found all the tools, because we'd be likely to be lost or ill-equipped, but we are allowed in for short periods to grasp the basics.

This portrays the four stages in a physical context. The same stages occur in any kind of successful interaction in comparative ways. In a functional intelligence context I have used the mnemonic COMP to describe what the mind is doing when the body is, for example, learning to walk. In optimal conditions, psychological development works in synchrony with the phases of physical and neural development.

There are dual aspects of development here –the physical and the psychological; the physical being the development of networks and the psychological being the development of intelligence. Correct interaction with the matrix keeps the development of brain and mind in sync (and also in sync with the development of the body) throughout the cycle.

The cycle begins with concentration –in the case of walking, this means tuning into ones own state of balance and orientation, noticing what moves are successful and what moves are not, how many different moves there are in each sequence, and so on. Observation is that special sort of attention to feedback that tells us what needs to be achieved and helps us to imagine what the right moves are like. Modeling successful moves from memory enables us to copy what we did yesterday that worked, and try adding a bit more, and the practice & variation stage speaks for itself.

In any given matrix except the final one for a system, the system learns in this way: it explores the current matrix, taking in information and assimilating it into the known, and at some stage begins to explore the next matrix.

Learning itself is an emergent thing, constantly opening doors onto the next level, but here I do not intend to dwell on the learning process; having written plenty about that elsewhere. Here I want to make clear the difference between matrices and brain networks.

What is a network –digitally remastered

I’m hoping I’ve already got some of the way to clarifying this by explaining that a network is part of an emergent system and therefore will be in a matrix, but can a network be considered a matrix itself? It’s certainly possible to have one matrix inside another; after all a womb (one matrix) can be inside a parent (another matrix) who is living in a solar system (another matrix) so do series of matrices all come in matrioshka form like this?

The answer to both of these is ‘no’. There are many similarities between networks and matrices, but also some differences. And matrices don’t all come ‘nested’, although the earlier ones may.

A matrix brings together the factors that catalyze particular behaviors in matter and energy which trigger further development, always in the direction of increased complexity. A network does this too.

But a matrix is autonomous; it provides energy and input as well as a safe space for its agent. Networks can provide a safe space for the emergence of thought, but they cannot fire without sufficient input, and I here hypothesize that they cannot provide input to themselves of sufficient quality to continue to cause ongoing emergence without external input, because if networks could do this they would never atrophy, always keeping themselves occupied by producing their own input whenever we weren’t using them.

If the source of the three essentials is not the same place, it's not a matrix. A network is part of an emergent system; not the whole system, just like a planet is part of the solar system; not the whole system. Whole systems can become their own matrix or contain other matrices when matured, but individual networks cannot. The mind will become its own matrix, but its individual processors won't.

Because one of the key components is energy, a matrix is only created by interaction. It may be between chemical factors, material ones like planets bearing water being close enough to the sun, or psychological ones, like the mutual attraction of friends.

Even a womb, the classic example of matrices, cannot become a matrix on its own –even with an egg in it. The egg has a safe space in which to develop where there could be enough energy to sustain it, it already has some data 'hardwired' into it –it's own DNA -but it awaits interaction with input –the information carried to it by a sperm- and must then interact by assimilating that data (the unknown) into its own DNA (the known) in order to kickstart emergence –in the first instance, releasing the chemicals that cause it to bond itself to the matrix (literally, via the umbilicus) and start using the energy and nutrients to replicate itself because in emergence, more is different. This is what we do in the first stage –we collect things together of similar type. A critical mass of cells triggers another stage of development apparently all by itself, but remember that energy is now being transferred to the system constantly and the next phase can go right ahead. And this new stage is of a totally different and much more complex order –cells are differentiating into tissues- a phase transition has taken place. The rule of 'pay attention to your neighbors' is employed by cells at this stage. Later, another phase transition will trigger the ordering of tissues into organs and another increase of complexity. The body will make all these matrix shifts of its own before the brain is even built; all within the brain's "Matrix 1" of the womb.

You may have noticed that I have just implied that having sex initiates the forming of a matrix, but should remember (a) that only reproductive sex counts and (b) that it won't be forming a matrix for you.

In intelligence, each matrix serves the development of one network, but each network serves the development of the whole brain and the whole intelligence. Because there is one matrix appropriate for the growth of each network, it is important to distinguish between network labeling and matrix labeling (e.g., N1; M1). Remember the network is in the matrix (and it may not be the only thing in the matrix).