# EMERGENCE IS AN ISOMORPHY

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**January 2017**

Isomorphies play roles in the origins, existence, organization, and changes within the situations or systems in which they occur.

An isomorphy is a pattern-of-material-organization that occurs in two to many different situations or systems.

An isomorphic pattern-of-material-organization can occur in space, in material structure, and/or in process.

As an isomorphy, emergence[1] occurs in physics and chemistry, geology, planetology, and cosmology, from molecular biology and physiology to neurology, from sociology and ecology to biological evolution. Emergence is universal in its occurrence.

Just as emergence is universal in its occurrence, the definition of emergence has to be valid and understandable universally—in every discipline of the sciences and humanities.

How can a definition for emergence and emergent property that works at the level of physics, with the emergence of atoms, ions, isotopes, and molecules also work at the level of ecology and biological evolution with the emergence of a new species of bird or flower?

This problem vanishes when it is taken into account that emergence is an isomorphy. As a universal isomorphy, emergence occurs in all the disciplines. In the context of the great differences in the subject matters of the various disciplines, what is the common feature of emergence that occurs in each and every one of them?

As the name implies, an isomorphy has the same shape or pattern-of-organization in every situation in which it occurs, whether it is at the molecular level, the geologic level, or the ecological level. At each of these levels, the isomorphy is composed of different things. At the molecular level, it would be composed of molecules. At the geologic level it might be composed of landforms, and at the ecological level, it could be composed of plant and animal communities as they vary across the landscape.

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[1] The discussion in this paper is not about concepts. It is about the reality-referents of concepts. It is not about the concept of emergence. It is about emergence itself. In this paper concepts are recognized to be mental tools that are used by the mind to achieve understanding of the world outside the mind, outside the brain.

What is happening here is that as the isomorphy occurs in progressively more complex situations, the isomorphy tends to occur in different, usually more complex forms. The key point to understand is that the basic pattern-of-organization of the isomorphy (in space, in structure, and/or in process) occurs at each level, even though at each level it is composed of different types of components and is generally progressively more complex.

It is that basic pattern-of-organization (in space, in structure, and/or in process) that provides the core of the universal definition of the isomorphy, the part which is understandable in every discipline.

Isomorphies develop. They occur in simpler forms in situations that are relatively simple with few other factors playing roles, and they occur in more complex forms in more complex situations where there are greater numbers of other factors playing roles. The higher the level where an isomorphy occurs and plays its role, the more other factors will be there playing their roles. Those additional factors and their roles influence the nature of the isomorphy and its roles. Nevertheless, the basic form of the isomorphy will always be there determining its basic role in the situation.

Isomorphies, such as emergence, occur in altered forms and play altered roles in various situations depending on what other factors are there. The fewer other factors that are in the situation in which the isomorphy occurs, the simpler will be the form of the isomorphy—the closer to its basic form it will be. The basic form of an isomorphy occurs in the simplest situation in which the isomorphy occurs. That will be the universal form of the isomorphy, the form that gives it its identity as that particular kind of isomorphy—wherever that isomorphy occurs.

That simplest basic form, a recognizable pattern-of-organization (in space, in structure, and/or in process), provides the information required to create the basic definition of the isomorphy. Because isomorphies occur in altered forms with altered roles depending on the situations in which they occur, that basic definition must be developed, enhanced, to provide appropriate specific definitions for the developed forms of the isomorphy.

## How To Define Emergence

As an isomorphy, emergence occurs in diverse situations in the subject matters of all the disciplines.

As an isomorphy, emergence has a basic form that occurs in the simplest situation in which emergence exists and plays its role.

As an isomorphy, emergence develops, occurring in simpler forms in simple situations where few other factors are playing roles, and occurring in more developed, more complex forms in more complex situations where greater numbers of other factors are playing roles.

As an isomorphy, the simplest basic form of emergence occurs within the developed forms, giving them their identity as instances of emergence.

Emergence is defined by the qualities it has in its basic form. Emergence is further defined, developed stage by developed stage, by the additional factors that play roles that alter the nature of emergence and that alter the nature of the roles emergence plays. The content of a definition of a case of emergence reveals what stage of the development of emergence that case is.

***What Emergence Is***

At its simplest stage, emergence is the coming into existence, as a consequence of the motion of matter, of a pattern-of-material-organization that was not there just previously. The pattern-of-material-organization is newly existent—emergent.

Any group of material objects has a group-pattern-of-organization composed of the objects and the distance and direction relations between them. The motion of even one of the objects will initiate new distance and direction relations between the object that moves and all the other objects in the group—resulting in a newly existent group-pattern-of-organization, a newly emergent pattern-of-material-organization.

Emergence is a process-pattern-of-material-organization. It is the process whereby a newly existent pattern-of-material-organization comes into existence. The newly existent pattern-of-organization is an emergent property or emergent product, depending whether it is a part or quality of a larger pattern, or whether it is a whole new pattern, such as an emergent object.

## Foundational Stages of Emergence Due to Six Different Factors

***Emergence Due to Sequential-Enhancement***

As one of the objects of a group of objects moves among the other objects, there is a continuous change of the distance and direction relations of that moving object with the other objects. There is continuous creation of emergent pattern-of-material-organization due to the continuous change of distance and direction relations.

The motion of an object through space is a sequentially occurring process. Consequently, the change of distance and direction relations due to that motion occurs sequentially. There is a continuous sequential emergence of newly occurring pattern-of-material-organization.

The occurrence of something new in a situation constitutes an enhancement of that situation. The occurrence of new part of the ongoing motion, the occurrence of the new distance and direction relations between the moving object and the other objects, the occurrence of the continuous sequence of new group-patterns-of-organization, are all sequentially occurring enhancements of the situation—sequential-enhancement.

The simplest, basic, form of emergence, that based on the motion of an object in relation to other objects in its group, with the consequent emergence of new group-pattern-of-organization, is emergence due to sequential-enhancement.

***Emergence Due to Combinatorial-Enhancement***

When well separated objects move into close association with one another, they together form a group. A group comes into existence—it emerges as a consequence of the converging motion of the objects. The coming into existence of the group, as a consequence of the converging objects, is an enhancement of the situation—combinatorial-enhancement.

With the emergence of the group there is also the emergence of hierarchic organization. The group, as a whole, constitutes the top level of the hierarchic organization, and the individual objects that are the components of the group constitute the lower level.

An emergent hierarchic level generally has qualities that do not occur at lower levels. As a simple example, a group is always larger than any individual component of the group. A more complex example occurs in multilevel hierarchic organization where each level exists as a combination of the components of the lower levels such that the components of each level are different in what they are from the components of lower levels. An atom is different from the elementary particles of which is composed, and a molecule is different from the atoms of which it is composed. A multicellular organism is different from the individual cells that all together constitute the multicellular organism. An ecosystem composed of both abiotic and biotic components is different from the abiotic components, such as rock and air, and different also from the biotic components, such as amoebas, zebras, and acacia trees.

It can also happen that an emergent quality, property, level, object, or system can have one or more qualities that also occurred as qualities of the lower level components. Isomorphies are examples of this. A particular isomorphy can occur at multiple levels of a highly complex hierarchy. This often happens with the development of an isomorphy where the isomorphy occurs in simpler forms at the lower levels of the hierarchy, and in more complex forms at higher levels.

The hierarchical organization of material reality—from protons, atoms, and molecules, to planets, stars, and galaxies—from organelles, cells, and organisms, to social systems and ecosystems—is the result of emergence due to combinatorial-enhancement.

***Emergence Due to Adjacent-Relation***

When one object is moving on a direct path towards another object, the motion will bring the two objects closer and closer together, until there is no space between them. A new organizational pattern emerges—adjacent-relation. With adjacent-relation there are the two objects existing there together as a group. There is the direction-relation between them, but because there is no space between the objects, there is no distance-relation—an emergent group-pattern-of-material-organization with a direction-relation but no distance-relation.

When there is no space between the objects, the substantiality of the one object will be in direct contact with the substantiality of the other object.

The contact-relation comes into existence—the contact relation emerges.

The basic definition of emergence states that emergence occurs when the motion of matter results in the coming into existence of a pattern-of-material-organization (in space, in structure, and/or in process) that was not there just prior. This descriptive-definition is centered on pattern-of-organization, and in this case adjacent-pattern-of-organization emerges. But with the emergence of the adjacent-relation, something additional happens, the emergence of a supraorganizational-factor—contact.

The situation where contact emerges has organizational aspects, such as the direction- and the adjacent-relations between the objects, but there is more involved in the emergence of contact. This event is based on the nature of matter, its materiality, its substantiality.

In prior cases of emergence, the matter played three distinct roles. It occupied space, it moved, and it was a component of a pattern-of-organization. Now the matter plays another role due to its substantiality—one part touches another part, one part contacts another part.

The emergence of the supraorganizational-factor, contact, is the result of the roles of the adjacent-relation between objects and the inherent substantiality of those objects.

***Emergence Due to Blocked Motion***

When one object is moving on a direct path towards another object, the motion will eventually result in a collision between the objects. The motion of the one object will result in a push against the other object. This push is the emergent factor.

Motion and sequential-enhancement play their roles here, continuously changing the distance relation between the objects, shrinking the pattern-of-organization between them until combinatorial-enhancement occurs and they become a group. Eventually the two objects constitute a group with no space between them, and emergence due to adjacent relation occurs in conjunction with the substantiality of the objects, with the consequent emergence of the supraorganizational-factor, the contact relation. The one object plays a blocking role, and the momentum of the other object plays a role that results in the emergent push.

Multiple factors play roles here that result in the emergence of push.

Push, like contact, is a supraorganizational-factor. There are organizational factors involved, such as the direction relation between the objects, and the directional orientation of the push, but there is more involved in the emergence of push. This event is

based on the nature of matter, its materiality, its substantiality, now interrelating with motion and the consequent momentum the moving object has when blocked.

***Emergence Due to Push***

In a group of objects that are not moving relative to one another, when one of the objects moves, comes into contact with, and pushes against one of the other objects, that second object will begin to move relative to the other objects in the group. The motion resulting from the push will change the distance and direction relations of that newly moving object with all the other objects in the group. New group-pattern-of-organization will emerge.

This is a two-stage emergence event—the emergence of the motion due to the push, and the emergence of the new pattern-of-organization due to the motion of the pushed object. With the emergence of motion there is the concurrent emergence of new pattern-of-organization.

Motion is a supraorganizational-factor. There are organizational factors involved with motion, such as the direction of the motion, but for motion to occur there must be a role for substantiality—it is matter that moves.

With emergence due to push, there are two concurrent emergent products, the motion of the pushed object, and the emergent group-pattern-of-organization. The emergence of the supraorganizational-factor, motion, results in the concurrent emergence of new pattern-of-organization.

The emergence of the two prior supraorganizational-factors, contact and push, did not result in the emergence of new pattern. Neither contact nor push itself results in change of direction or distance relations between objects. Change of direction and distance relations requires the supraorganizational-factor motion.

***Emergence Due to Coherence***

Units of matter stick together, they bond, they cohere. This is a stage in the development of combinatorial-enhancement. Units of matter not only come together to form a group, they join together, in a variety of ways, to form structure. For example, when atoms join together to create molecules, each type of molecule has a specific pattern-of-structural-organization of the component atoms.

Coherence is a supraorganizational-factor based on the nature of matter, its materiality, its substantiality. Like the previous supraorganizational-factors, coherence has organizational aspects, such as the directional relation between the coherent objects, and their positional-orientation to one another—what side of the one object is coherent to what side of the other object. And, as with the other supraorganizational-factors, there is more to coherence than the organizational factors. Matter bonds to matter in a variety of ways, from covalent bonding of atoms to Velcro strips sticking together, with all these different ways of bonding the result of what matter is, the result of the intrinsic nature of what it is that is substantial.

When coherence occurs—when coherence emerges—structure emerges.

When the *supraorganizational-factor* coherence emerges, the *organizational-factor* structure emerges.

Structure is an emergent form of pattern-of-material-organization.

When coherence occurs, a new pattern-of-organization emerges, and it does so in an emergent form of pattern-of-material-organization.

Thus, as when motion is emergent there is concurrent emergence of group-pattern-of–material-organization—when coherence is emergent there is concurrent emergence of structural-pattern-of-material-organization.

## Emergence at Higher Levels

Foundationally, emergence in its simplest form, is based on (a) material components, (b) relations between those components, (c) pattern-of-material-organization, (d) motion, and (e) sequential-enhancement.

These foundational components are present in all developed forms of emergence, together giving each case, form, stage, or level of emergence its intrinsic identity as an instance of emergence.

At each hierarchic level there are emergent factors, emergent patterns-of-material-organization, that did not occur at, nor play roles at, prior lower levels, but that can play their roles at the level at which they are emergent, and also at levels that are higher yet. These emergent factors can play roles in the nature of emergence at the higher hierarchic levels of the organization of material reality—resulting in the developed forms of emergence.

At high levels, hundreds or thousands of factors can be involved in the process of emergence, as for example in the process of biological evolution. Nonetheless, the foundational components of the process of emergence, the foundational form of emergence, will be there within these highly complex forms of emergence, making it possible to identify the highly complex forms as cases of emergence.

To understand the complex forms of emergence, it is necessary to identify the foundational components and their roles as they occur within the highly developed forms. Because the basic components themselves will likely be in developed form, it might take some effort to recognize them.

In the extrinsic context, the environment, of any developed form of emergence, there will be an abundance of other factors playing diverse roles in the situation. To understand the forms of emergence that occur in these complex contexts, it is necessary to identify, out

of that abundance of other factors, those specific additional factors that are interrelating with the basic form of emergence and giving it its developed form.

Another factor to take into consideration when identifying highly developed forms of emergence is the complexity of hierarchic organization. Hierarchic complexity can be one of the interrelating factors giving a case of emergence its developed form. With hierarchic organization the higher levels are composed of factors, components, that were emergent at lower levels. The higher levels are emergent from the lower levels by way of combinatorial-enhancement.

The factor to take into consideration is that in systems, especially complex systems, the levels are not isolated from one another, specifically they are not operationally isolated. Components of lower levels can interact with higher levels, not as components of the higher level, but as something extrinsic to the higher level coming into the higher level and interacting there. For example, a lower level component can come in and interact with a quality or component that is emergent at the higher level.

Thus, a developed form of emergence can have an organization that is multilevel, with components and relations, such as sequential-enhancement, combinatorial-enhancement, adjacent-relation, blocked-motion, push, coherence, and various emergent additional factors, spread out and interrelating over two to several hierarchic levels.

When creating a definition for one of these developed higher level forms of emergence, the content of the definition should be descriptive of what makes that form distinct. This descriptive-definition might include the stage of development, the hierarchic level, and most importantly those specific additional factors that interrelate with the basic pattern of the process of emergence to make this form what it is.

A descriptive-definition focuses on that which is being defined. This form of definition focuses on the intrinsic qualities of what is being defined, factors of its intrinsic structure and processes. A descriptive-definition does not include the relations of what is being defined with other things that exist. Those relations are extrinsic to the target of the definition.

This discussion of how to define emergence contains an abbreviated description of the basic nature of emergence. Here are links to papers providing further understanding of emergence:

Vesterby, Vincent. 2019. “Emergence Is Why It Is Not Possible to Explain Life Solely with Physics and Chemistry.” OSF Preprints. July 9. osf.io/cwnt7.

Vesterby, Vincent. 2019. “The Intrinsic Nature of Emergence—with Illustrations.” OSF Preprints. July 9. osf.io/n2skj.

Date of original version of “Emergence Is an Isomorphy”—January 2017