Joining up The Dots

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Space-time contains a complex flux of matter and energy, much like a river in flow. The entities to which we give names are patterns in this flux that we recognise as recurring. They can be physical objects, relationships, events, or circumstances. They can also be static structures, unchanging in time, or dynamic. We draw boundaries in space and time around parts of the flux that appear to be similar, and thus, create plural collections of entities, each instance of which is given the same name. To continue the river analogy, we might for example recognise vortices. The features that a collection of entities hold in common are known as characteristics or properties, and we also give these a name. However, not everything in the flux is recognizable in this way. Much of it comprises apparently random flows or static structures which do not appear to recur.

Causality is one such pattern. A causal relationship is recognised when instances of an entity of one type and those of another regularly occur in proximity. Causes are entire entities and begin before their effects. Effects can be the beginning of an entity, its end, or a change in its state. They occur after their causes have begun, and are contained by them. Causes pass outputs to their effects which receive them as inputs. These transfers can be of space/place, energy, matter, or information. Matter is organised energy, i.e., energy with a recognisable structure. Information, rather than being abstract and incorporeal, is organisation imposed on the matter and energy that convey it. So, except for space/place, causal transfers are a part of the general energy flux of the universe.

For an effect to take place it needs certain inputs. If a cause is sufficient for an effect, then it, among other possible causes, provides all the necessary inputs. If a cause is necessary for an effect, then it is the only source of some of the inputs needed by the effect. However, it is usually the case that an effect needs several causes to provide all its inputs. If the effect occurs, then these necessary causes are, together, sufficient.

Every cause, effect, or static structure is a complex of lesser entities. These lesser entities are also static structures, causes and effects. They can form patterns within the entity which give it the features we recognise. This recursion continues downwards in scale to the atomic level. Beyond that causality appears to cease. In the same way as other causal relationships, the three fundamental nuclear interactions involve transfers of matter and energy using “exchange particles”. In the strong nuclear force, the particles are gluons; in the weak nuclear force, they are bosons; and in the electromagnetic force, they are virtual photons, i.e., temporary fluctuations in energy at a point in space. The fourth fundamental force, gravity, is also believed by most physicists to involve an exchange of particles, i.e., gravitons. These transfers occur over a period of time determined by the speed of light and the transfer distance. However, gravitons are hypothetical, have never been detected, and the equipment necessary to do so is far beyond present human capability. The four fundamental interactions appear, for the present at least, to be the foundation of causality.

Entities that we recognise have patterns of static structure and causality which recur. To establish these patterns information must be transferred from a cause, although inputs of raw matter and energy may also be needed. This information must, in turn, be contained within the cause, i.e., written on the raw matter and energy that it contains, thus giving it organisation. Entropy is a measure of disorganisation in an entity or system. The more organised a system, the greater its information content and the lower its entropy. As information increases entropy decreases, and vice versa. Thus, information is the reciprocal of entropy.

Information can be regarded as a type of pattern that influences the formation or transformation of other patterns. The information transferred to an effect does not necessarily specify its structure in detail. However, it must provide the rules by which structure within the effect becomes established. Thus, for example, the strong nuclear force, the weak nuclear force, and the electromagnetic force, provide the information necessary for the assembly of atoms from more fundamental particles. In a similar way, atoms contain and transfer the information necessary for the assembly of molecules and crystals. Molecules, notably DNA, contain the information necessary for the formation of life. Life contains the information necessary for the formation of society and ecosystems. For the present at least, there are no apparent systems more complex than this.

The four fundamental interactions in physics are gravity, the strong and weak nuclear forces, and the electromagnetic force. However, the laws which give rise to these interactions are distinct from the interactions themselves. Because of recursion we tend to believe that the laws must be causes. However, this is not correct. The interactions are effects, and the laws are information passed to these effects in order to establish them. At present, we cannot identify a source of this information, and thus, a cause of the interactions. Attempts are being made to do so through string theory research, etc. However, from this work it is becoming clear that there is no cause in the conventional sense. There are no entities in the four dimensions of space-time which might be regarded as causes, and some other mechanism, yet to be identified, may be in play.

If we have several similar entities, then they all have a property or properties in common. All vortices, for example, spin. When we recognise these properties as recurring, we also give them a name. However, there are two types of property, static and dynamic. For example, a statue of a horse always occupies the same region of space irrespective of time, and so, has static properties. However, a living horse is dynamic, taking different shapes and occupying different regions of space at different times. The nature of its movement can also be recognised as a property and named. For example, a horse is something that gallops.

Causality is dynamic, i.e., entities affected by causality change with time. Static structures do not, at least not in the short term. However, they are a consequence of past causality and can, therefore, be regarded as states which persist. Some atoms, for example, persist for billions of years but were originally assembled from sub-atomic particles.

Some static structures have a geometric order in space that is recognisable, e.g., atoms, crystals, buildings, etc. Others do not and appear to us as random. Causality can also be orderly or apparently random. It can take the form of simple chains in which one or more causes lead to an effect, which in turn becomes a cause leading to another effect, and so on. Alternatively, it can take the form of more complex structures such as feedback loops, or more accurately spirals. In such loops changes in the state of one entity can be a consequence of changes in the state of another that it has previously wrought.

Simple chains of causality with no recognisable components or structure are merely a part of the general flux of the universe and, except at the atomic level, probably involve only the flow of raw energy or matter through space. However, if components in the chain are recognisable, then information is being transferred from a necessary cause to the effect.

As the entities that we recognise increase in complexity, they display emergent properties, i.e., properties of the entity in its entirety which are not held by its component parts. They also display vanishing properties, i.e., properties that the component parts have but the entity which contains them does not. However, properties do not emerge and vanish as if by magic. Rather, they are dynamic properties of the entity arising from causal relationships between its

component parts. An emergent property may, for example, be the consequence of a positive feedback loop and a vanishing property the consequence of a negative one.

Entities that are organised, i.e., that we recognise and name, are described as being low in entropy. Those that are disorganised are high in entropy. Overall, entropy is thought to be increasing, and the universe becoming ever more disorganised. Thus, we cannot expect everything to be an orderly and recognisable entity. Locally, however, entropy can decrease, and organisation increase. Life is one example, but local decreases in entropy are not its sole preserve.

Entropy is reduced by gravity. It brings particles together spatially into solar systems, for example. Thus, it reduces the number of ways in which particles can be distributed, and the number of possible states of disorganisation. Indeed, the recent entropic theory of gravity holds that gravity and entropy are reciprocal. As one increases the other decreases. Gravity is essential for life. It forms planets, life's home. It forms stars, life's source of energy. It brings elements into close proximity, providing life's material.

Entropy is also reduced by the laws of chemistry and ultimately of particle physics. These laws reduce entropy because of the highly limited number of ways in which particles can interact with one another. Thus, the laws of particle physics provide the information necessary for the assembly of life.

There is a relationship between the entropy of a system and the amount of information that it contains. Any entity or system is a complex of components and the relationships between them. The atomic item of information comprises two entities and the relationship between them. Thus, a fully organised system has a relationship between every pair of components and its information content is at a maximum. In a fully disorganised system, on the other hand, there are no relationships, the components are fully independent of one another, and the system's information content is at a minimum. Thus, organisation and disorganisation exist on a scale between two extremes: maximum and minimum information content. The information content of an entity or system is, therefore, the reciprocal of its entropy, and it may be easier to think in terms of the former rather than the latter. The measurement of information content is, however, hampered by limitations in our ability to recognise organisation.

The transfer of information provides a basis for the establishment of the relationships involved in organisation. The four fundamental interactions of physics, i.e., gravity, the strong and weak nuclear forces, and the electromagnetic force, are relationships between two entities and, thus, items of information. Gravitational interaction increases the information content of large-scale systems by bringing their components into close proximity, allowing other relationships to be formed. The latter are then information in their own right. The nuclear and electromagnetic forces are also relationships between two entities and increase the information content of small scale systems in a similar way.

Relationships can be static, i.e., unchanging with time, or dynamic. Physical objects can be treated as static, reflexive relationships. Causality, on the other hand, is dynamic because there is a time delay between a cause and its effect. Space/place, matter, energy, or information is also passed from a cause to its effect. These criteria mean that physical objects and causal relationships are each special cases of information in general.

Entities, systems, causality, and information are all recursive. Every entity comprises lesser entities. All systems comprise component systems. Every cause or effect is a complex of lesser causes and effects. Every item of information is a complex of lesser items of information. There is a lower bound to this recursion, however. For the present at least, it appears that fundamental particles cannot be broken down into lesser particles and the four fundamental interactions appear to have no cause in the conventional sense.

In essence therfore, entities, systems, causality, and information are all one and the same thing, but given different names in different contexts. We could select one name, and information seems to be the most general, but this would make explanations incomprehensible. So, this commonality must merely be borne in mind.

In summary:

- Relationships are items of information.
- Everything is a relationship, even physical objects. Thus, everything can be regarded as information.
- The entropy or degree of disorganisation of a system is the reciprocal of its information content which varies on a scale from maximum to minimum.
- The things that we recognise as entities or systems have a high information content.
- The properties of an entity are a consequence of relationships between its components.
- The things that we name are those that we recognise, and that have properties which recur.
- Physical objects and structure are a form of information and a consequence of static relationships.
- Causality is a form of information comprising dynamic relationships and the transfer of space/place, matter, energy or information.
- The four fundamental forces are effects brought about by a transfer of information, but appear to have no cause in the conventional sense.

The following characteristics apply to information in general, and can be regarded as patterns:

- It is replicable. Note that the laws of gravity, the weak nuclear force, strong nuclear force and electromagnetic force are thought to be universal, i.e., the same everywhere.
- It is translatable, i.e., a pattern in one medium can represent another pattern in another medium. Most notably, patterns in reality are encoded as patterns in the mind and in language.
- It decays with time and transmission.
- It is recursive, i.e., any item of information comprises lesser items of information, but there is a lower bound at the atomic level.

Thus far, the following patterns of causality have been recognised:

- Causes can be necessary or sufficient for their effect.
- It forms chains in which one or more causes lead to an effect, which, in turn, is a cause leading to an effect, and so on ad infinitum.
- Circular chains of causality can occur, i.e., feedback.
- Cascade can occur, i.e., components in a causal chain also act as causes of an effect outside of the chain.

Although the focus of General Systems Theory to date has been on dynamic relationships, i.e., causality, static relationships are also worthy of study.

Patterns of causality are powerful tools for understanding social trends and events. Potentially, they also provide a way of managing those trends and events by intervening in the process.

However, because they are dynamic and take place over time, we find it more difficult to recognise causal patterns than static ones. Tools are, therefore, needed to assist us.