

CLASSIFICATION BY A PROXIMITY MATRIX

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ABSTRACT

Elaboration of concepts of Matter, Being and Becoming marks the first Age of Greek Philosophy. The school of Pitagoras is the first break between reality and thought, but splitting of spirit from matter is completed by Descartes. However specificity of modern science is encounter of technique and theory: experimental method defines the amount of dialogues with nature. A general order is supported from atoms up to stars (Le système du monde by Laplace).

At the present day, Physics seeks a general law, from which all particles in nature may be mathematically derived. However at the same time, one can observe the end of general views (theory of the Relativity). Indeed scientific vision is coherent with technical apparatus available for an observer in this time and this world (Heisenberg).

Such an evolution is also important for the survey and mapping disciplines, as they are also part of human thought. Therefore they should keep into account the huge changes due to the revolution of Information Sciences; furthermore they should be able to join with even quite different disciplines.

However some starting points, in this sense, might also consist in trying all possible relationship among the ISPRS and other International Associations, whose general aims may look similar to ours. With a certain degree of originality, a Proximity matrix could study this relationship.

1 THE AGE OF GREEKS

The western philosophy was born with the development of concepts of Matter, Being and Becoming, which marked the first epoch of Greek philosophy.

In connection with this elaboration, also was born the idea of very small, indivisible particles, as building “bricks” of matter.

The philosophical and scientific devices were closely connected. “Water is the prime cause of everything”: this assertion by Thales altogether performs three philosophical concepts: the research of a material cause for everything, the necessity of answering by use of reason, the idea that it is possible to relate everything to a unique principle.

From the concept of the prime cause, the Greek philosophy passed to the concept of “basic substance” of the world. As Anaximandros said, this substance is infinite and eternal, and it is a ground of the whole visible reality.

This same question stays, to the present day, before physicists, which try to find out a fundamental law for the motion, from which all the particles, and their properties too, can be derived mathematically. For example, many scientists say that all particles could be related to a universal substance, called energy or matter.

Anaximenes said that the air was the basic substance, and that its changing, into the other substances of the world, was caused by a process of condensing and rarefaction.

Eraclitus thought that fire was the basic substance, but it is at the same time the source of all changes. Consequentially the basic concept of becoming enters the human view of world. Eraclitus states that the unity of the world is the dialectics of the opposites, which represents a type of harmony.

The modern physics is very close to the Eraclitus’s philosophical concepts: indeed the energy is the substance from which all the elementary particles come out, all the atoms and the whole world.

The next step was admitting that in each object there are the same substances, although in different quantities. Anaxagoras believed that different types of grain are present in every substance: the variety of the world is due to the ratios between these grains. There is only one step to the concept of atom; Democritus made this step

There is no unique element, but the basic substance is the atom: the eternal, indestructible, indivisible unit of matter, which may be endlessly repeated. As such a way, it is finite and motion is possible in the empty space between the atoms.

According to Democritus, the atoms are made with the same substance, with different sizes and shapes: "colour is pure appearance, pure appearances are sweet and bitter. Only the atoms and the empty space have a real existence".

The ideas of atomic theory have been adopted from other Greek philosophers in successive ages. Plato was not a disciple of Democritus, on the contrary he would have burnt his books, but Plato promoted concepts very close to the doctrines of atomism.

The School of Pitagoras stated a linkage between Religion and Mathematics: this concept proved in the following centuries very attractive for human thought. According to Russell: "no man has ever had a larger influence on human thought"

For this School (and, later, for Plato's one, too) the smallest particles are not the old physical elements (fire, water, air, earth), but merely mathematical forms: all things are numbers, as Pitagoras says. However in modern quantum mechanics, the basic elements are complex mathematical forms.

Plato has full knowledge of regular Pitagoric solids: he states some forms of relationship between earth and cube, air and octahedre, fire and tetrahedre, and water and icosahedre.

For Democritus, atoms are the ever-lasting and indestructible units of matter, which cannot transform into each other. Modern physics thinks different from Democritus, but surprisingly like Pitagoras.

However things are not quite so simple and a substantial difference exists between the background of the Greeks and of the modern scholars. Actually, since Galileo and Newton at least, the basic assertion of science is that only what is validated by experience can be taken as acceptable (Heisenberg, 1958).

2 THE MODERN SCIENCE AND THE DISJUNCTION BETWEEN PHYSICS AND PHILOSOPHY

In a common view of early Greek civilization, the main impulse was taken from crude reality of actual world: it was a lively reality, with no separateness between matter and spirit.

In the famous tale of cavern, the true philosopher is a man that holds truth. However this immediate holding of truth cuts the linkage with outer world: this is the first break between reality and thought.

The prisoner, who escapes from cave to sunlight, sees that he had been deceived: for the first time, he perceives the truth. This immediate approach, to the truth reality, tends to become even stronger than the reality as felt by human senses. Contact with truth takes place in the spirit of man, not in the world.

After nearly 2000 years of inadequate interest for natural sciences, the new trend, in this field, was leaded and escorted by new philosophical ideas, which have their source in the distinction between self and the world.

Descartes's philosophy is intrinsically different from the Greek one: the starting point is not a basic substance, but a basic knowledge. This means that (in Descartes's view), what we know by our intellect, is more true than what we may perceive from the outer world.

Splitting of soul from body, spirit from matter, already started by Plato, is now completed. Philosophy and Natural Sciences developed on the ground of polarity between "res cogitans" and "res extensa", as the Natural Science obviously focused upon the latter (Descartes).

Claim of Reform on the personal religion divided ego and its relationship to god from world. Merger of empirical knowledge and mathematics (Galilei) was, at first, due to the need of keeping out of dangerous theological disputes. However in the long time, the main result was separation of ego from God and from the World.

This dualism succeeded for a couple of centuries: Newton's mechanics and classical Physics came out of the basic hypothesis that the world can be described, without speaking both of us and of God.

Uniqueness of modern science is based upon melting of techniques and theories, upon systematic concurrence between the will to shape the world and the wish to understand it.

Experimental method defines the aggregate of all possible dialogues with nature. In fact, nature may be simplified, even hurt, but it can, in any case, contradict our hypotheses, although this may happen in the frame of the specific language,

we are using. However the language is constantly in progress, to the need of facing nature according to the cultural confines of time.

Galileo states something further: nature comes to us with a mathematical language, this language is unique and may be decoded by the experiment.

The general view, according to which the complexity of the nature is just apparent, not substantial, lasted for centuries. Newton's laws of motion put together the physics of by Kepler and Galilei and Leibniz's calculus.

Therefore it is a merger of the science of ideal machines (acting without friction, for instance) and the science of astral motion (with their remote interaction). This is exactly opposite to atomism and to the theory of collisions.

3 THE END OF GENERAL VIEWS

In order to understand natural processes, it is better to observe celestial bodies (and ideal reality), or the living? Progress, in modern science, was marked by the abandon of vitalistic inspiration.

Two main and extreme concepts of nature took vigor: the one of the atomists (stressing random collision) and the other of the mechanists, which relies upon eternal, out-of-time laws.

At the present time, a variety of physical and chemical, as well as sociological, phenomena shows the role of both case and necessity. Some sort of linkage, in fact, is evident between dynamics (the science of forces and trajectories) and the science of complexity and of becoming (i.e., the substance of living process).

The earlier synthesis, due to Newton, could hardly be exhaustive: the universal force of interaction is not able to take into account the complex and irreversible behavior of matter.

At the present day, physics seeks a general law, from which all particles in nature may be mathematically derived. Such a law can refer to protons or meson waves: Democritus may be quoted in this case.

Different types of waves may be considered: in this case all particles may be derived from a universal source (energy or matter): Anaximandrus said something, like this, very long ago.

For the modern Quantum Theory, elementary particles are complex mathematical forms: Pitagoras would agree. Energy of elementary particles may be thought off as the basic substance: Eraclitus comes straight to this.

The second principle of Thermodynamics revives the conflict among theories of collision and of basic laws, introducing a new, possible statistical description (collisions can be counted, being discrete events).

Maxwell describes the state of equilibrium, at which distribution of velocities fits the Gaussian curve. Boltzmann means, on his side, to describe the evolution toward this state of equilibrium. He takes into account physical evolution at the level of molecular population, rather than at the level of single trajectories.

However other factors have come into the game, to limit the relevance of classical physics. Firstly the Newtonian viewpoint keeps out the observer, assuming the existence of a basic view, apart of time.

The time is taken into account not only by biology, geodesy, sociology, etc., but also by physics: the world has a story to tell.

A fundamental idea, of the present time, is that any scientific description of world should be coherent with capabilities of an observer, of this world (even in theory), and not with possible access of somebody, quite free of physical confinements.

As linked to propagation of signal, we perceive a precise limit: the speed of light. This speed ("c") confines the volume of space that may someway to affect the observer.

In Newton's physics, no universal constant plays the same role. Planck's constant ("h") states a natural mass scale of objects: the atom cannot anymore be taken as a miniature solar system.

Relativity has deeply changed the classical idea of physical objectiveness; furthermore quantum mechanics did even worse, canceling the human ambition of achieving a complete description of reality.

Bohr's complementary principle is an extension of the indetermination principle of Heisenberg: position or momentum of electrons can be caught, but never both at the same time. No unique theoretical language exists, which may express the completeness of a physical system, with all its variables (Prigogine, 1979).

4 THE SIGNIFICANCE OF COMMUNICATION

A parcel of information should add something to the already available amount of knowledge of community, if it is supposed to increase that. This is true also for arts, for literature, etc.: students generally don't like the classic authors, just because their quotations are quite familiar to them.

Common people believe that the specific role of a Mecenates be to gather and defend a number of already existant masterpieces, rather than foster creativity of contemporary artists. The same common people thinks that the general scientific knowledge of its age is to be stored at the institutes or libraries supported by the state, which – in common, totally honest, view – is the ultimate, real proprietor of the knowledge.

However stored information is substantially lessened: in fact, information is a process, not a tank! In the western world, the idea prevails that only we hold advanced technological equipment: however the mere strategy of storing knowledge might make unfertile the very core of western science, which works only by a huge financial power.

Nowadays science must come out of laboratories and universities, to accept and promote the inter-disciplinarily character as the focus of progress. Whitehead says that collision of theories is an opportunity, not a calamity.

The true lesson, from indetermination principle, is that reality is unbelievably rich, much more than any possible language can express. A language, however complex, is able to express only a part of rela: according to Bohr, the language is always a choice.

All languages and all viewpoints, about the system, are complementary: indeed it is useless to expect the discovery of a unique viewpoint, which should describe the completeness of reality. The real world is too rich to be enlightened by one single reflector.

Such an evolution is also important for the survey and mapping disciplines, as they are also part of human thought. Therefore they should keep into account the huge changes due to the revolution of Information Sciences; however they should be able to join with even quite different disciplines (Psychology, Linguistics, etc.) (Wiener, 1950).

5 MATRICES AND STRUCTURES OF MULTIDIMENSIONAL DATA ANALYSIS

Matrices are powerful tools to represent different structures in the different branches of the multidimensional data analysis, like Data Sampling, Factorial Analysis, Correspondence Analysis, Multiple Regression and Variance Analysis.

Data Sampling can be performed by:

- Inventory tables
- Qualitative matrices
- Quantitative matrices

Concerning factorial analysis, one can use contingency and/or correlation matrices.

- Contingency matrices contain:
 - Absolutes frequencies
 - Relative frequencies
 - Absolute contingencies
 - Relative contingencies
 - Absolute conditional frequencies
 - Relative conditional frequencies
- Correlation matrices in turn contain:
 - Variances and co-variances
 - Correlation coefficients
 - Eigen-values and eigen-vectors

Concerning correspondence analysis, one can use:

- Rank matrices
- Similarity matrices

- Proximity matrices
- Distance matrices
- Logical description matrices
- Weight matrices

Notice that Rank matrices can be subdivided in:

- Preference matrices
- Score matrices

and Logical description matrices are based upon:

- Binary logic
- Fuzzy logic

Multiple Regression and Variance Analysis need:

- Design matrices
- Normal matrices
- Variance-covariance matrices
- Correlation matrices
- Local redundancy matrices
- Reliability matrices

Notice that design matrices are based upon:

- Interpolation / approximation processes
- Network adjustment of geodetic type

and that non-linear models involve Jacobian and Hessian matrices.

6 FOSTER INTERNATIONAL RELATIONSHIP: AN EXAMPLE

An initial step aimed to examine what is in common among our organization and other agencies or groups presently active. Firstly we tried with OEEPE: with a certain degree of originality, this relationship could be studied by a Proximity Matrix, whose general validity, in order to ascertain similarity and intercourse, is well known.

As everybody knows, matrix theory gives a powerful support to study possible similarities of different data series. Therefore a proximity matrix (a four-folder table, as shown in figure 1, which is put below together with the other remaining figures) was performed, showing an existent linkage between the two families or groups.

Seven technical commissions perform the scientific and technical work of ISPRS. Each commission is actually trusted to some working groups. Moreover a number of links to some commission, which each other, are provided. A certain number of special projects is also to be mentioned.

The OEEPE is also subdivided different projects The four-folder table contains 42 rows and 18 columns. The values of the elements are 1, 2 and 3, in the scale of growing proximity.

On figure 2, a proximity matrix is proposed, having only two different type of values (namely 2 and 3): so a higher degree of proximity is taken into consideration. On figure 3, the unique type of value is the number 3: this means that just the closest similarity is taken into account.

Matrix 1 and 2 were later re-ordered (see figures 4 and 5), as to stress some clusters, which are common fields for research. Unfortunately the last matrix appeared too empty to be significantly processed.

On matrix 1 (see figure 6), three big clusters are marked, for the following topics:

- Digital Photogrammetry and Image Processing
- Applications
- GIS and Workstations

On matrix 2 (see figure 7), six clusters are marked, for the following topics:

- Data-base and Data-management
- GIS and Workstations
- GPS and Laser
- GIS and DEM
- Digital Photogrammetry and Image Processing
- Remote Sensing and SAR

On figure 7, it is worth remarking the appearance of two areas: “GIS and DEM” and (absolutely new!) “GPS and Laser scanning”, which are very close to each other. The usage of GPS and laser scanning for automatic digital ortho-images production is, in fact, quickly developing worldwide. A lot of tutorials and meetings have taken place, in recent times, concerning this very important subject.

The working principle of Laser Scanning is scanning of landscape by an aircraft mounted laser device. So distance from surface may be evaluated as function of time delay for laser ray.

Knowledge of position and asset for the aircraft is given by an integrated GPS-INS system: space coordinates of ground points, which have reflected laser rays may thus be calculated. The knowledge of the geoid undulation is also strictly requested.

This system has also an epistemological value: Photogrammetry is a “classical” discipline, based upon order and precision, on the contrary, these new methods go more into details and, for this fact, they enter in a wider field where disorder is to be taken into account.

Basic is also the time factor in the above-said methods. Indeed a proper management of data acquired lets different objectives to be pursued.

For instance, the height of trees in a wood-land may be evaluated; the scanner also “pierces” vegetation and gives a DTM independent of plant coverage of soil. The same process is true for town blocks, which different degrees of sophistication. However a greater detail may be achieved, if compared with classical photogrammetric methods.

Scanning on ground is due to composition of aircraft motion and deflection of laser ray in the orthogonal direction of movement: the scanning system is both methodical and randomized.

Measurements from different devices (GPS, INS, video, laser scanner, etc.) are recorded independently from each other, but they are all labeled with a GPS time: this makes synchronous all recordings.

Moreover Laser Scanning is only possible, when contemporary to INS and GPS, as Photogrammetry may be quite autonomous, as a process. This goes in the sense of overlapping of different technologies.

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REFERENCES

- Heisenberg, W., 1958. *Physics and Philosophy*. New York
- Prigogine, I., Stengers, I., 1979. *La nouvelle alliance*. Paris
- Wiener, N., 1950. *The human Use of Human Beings*. Boston

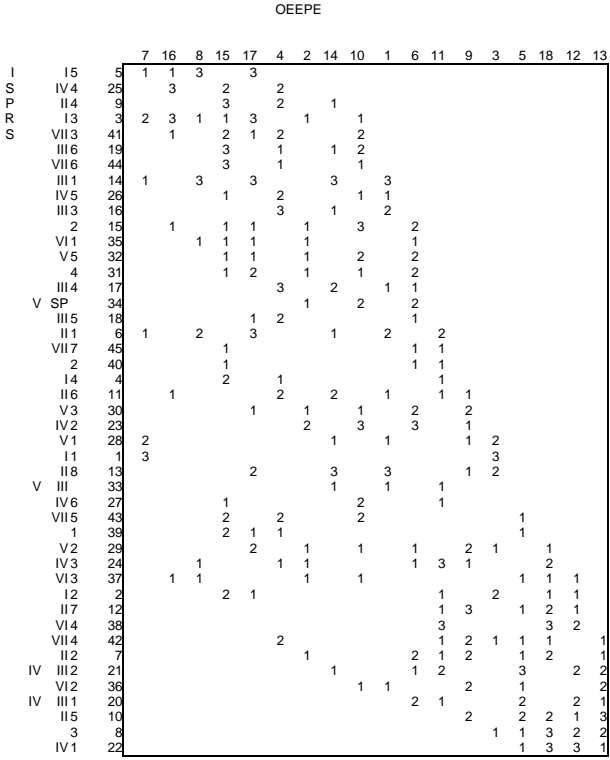


Figure 4.

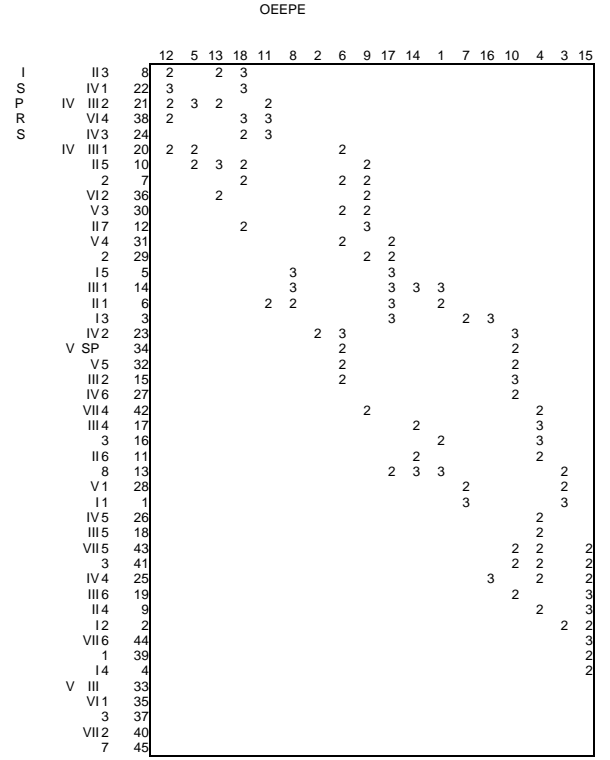


Figure 5.

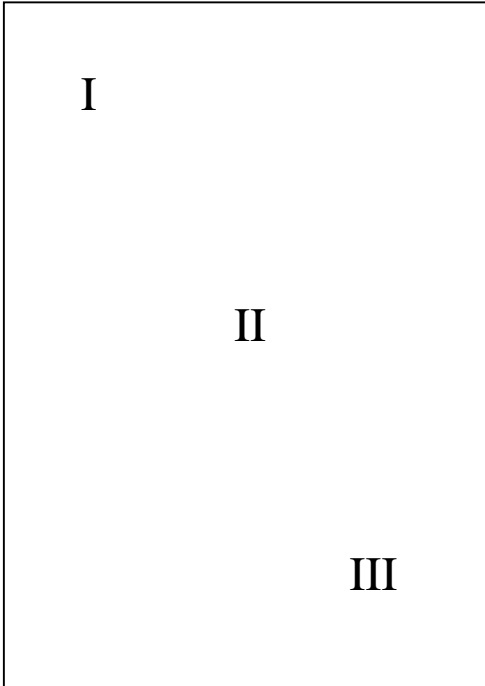


Figure 6.

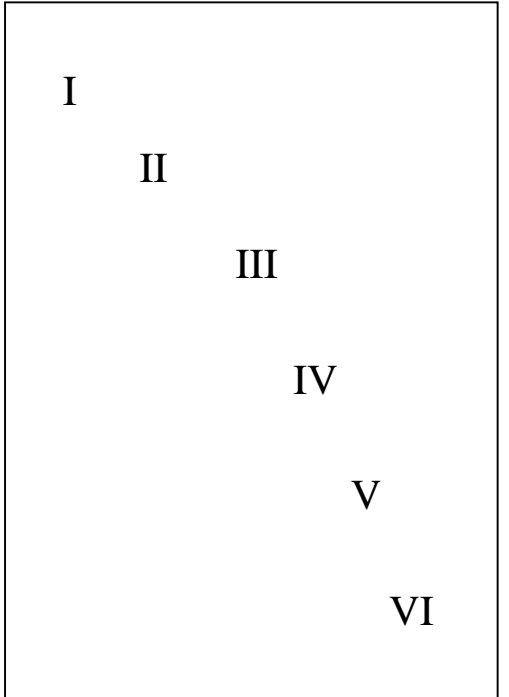


Figure 7.