

INVESTIGATING MESOPOTAMIAN CYLINDER SEALS
ICONOGRAPHY BY USING ARTIFICIAL NEURAL NETWORKS.
THE ISIN-LARSA PERIOD

1. MODELS FOR ANALYSIS OF FIGURATIVE MESOPOTAMIAN GLYPHTIC

Modelling has always been an integral part of the development of archaeology, at least over the past forty years. In the broadest sense, archaeology is the study of the human activity from the past and a model is a simplified representation of reality. As a model does not represent reality, but gives us useful information and allows us to see aspects of the world that we have selected in advance, in a computational model reality is summed up in a few key features, omitting unnecessary details. Human societies in their natural environment can be considered as complex systems.

Such systems consist of many parts that interact with each other and are present in every hierarchy in the universe, from the molecular level to the big planetary systems up to the large-scale structure of the universe. Modelling can help to identify the relationships between items within a complex socio-environmental system in a particular hierarchy. Simulations related to large populations and their non-linear interactions are operations that require a substantial commitment in terms of resources, both human and technological. In recent years, however, the introduction of new mathematical techniques, rapid advances in computing, and tools for modelling have greatly improved the potential of complex systems analysis in archaeology (RAMAZZOTTI 2010, 2013).

Fieldwork and research have always produced large amounts of qualitative and quantitative data. Without some hope to handle their complexity, data derived from non-archaeological research may never be interpreted or published. Therefore archaeologists are able to apply usual statistical methods such as averages and medians, to name just a few, in order to facilitate the reading of the results and produce graphs as histograms and pie charts. In order to adopt a Bayesian method it is necessary to go beyond the classical statistical methods and to use a model-based approach. In each project, researchers need to get an idea of the problem concerned by investigating, examining data and observing how they are distributed. Graphs and histograms are of particular importance in the construction of a model that is very useful and widely used by archaeologists because it allows to simplify the problem and to interpret the results in a clearer and more precise way. Thanks to the modelling of the problem and to the choice of prior evaluations, one can, through the Bayesian theorem, get the information retrospectively. In other

words, through the Bayesian approach, *a priori* knowledge and assumptions can be included explicitly in the equations and, thereafter, the interaction between old and new information can be formalised.

Archaeological data are not only a simple record that can be represented, compared, collected, coded, and from which information can be extracted; the record is an integral part of an information process in which the object is only a mean and not the goal of the information flow, influenced by a number of factors in which the context is determined by the dynamics of a cognitive system that auto-organise, so often difficult to decode with “simple” probabilistic and statistical systems that help an interpretation that is more like a snapshot than a tale that unfolds in the plot of time.

Like other fabrics the seals were the subject of both these different lines of research: on one hand, the simple analysis of the different variables linked to the figurative components identified within a scene; on the other hand, the search of connections that overcome this step bringing us to a level of understanding that is as close as possible to the cognitive processes of who made these objects (RAMAZZOTTI 2005). Of fundamental importance are the studies that Camiz and Rova have developed since 1994 through the analysis of a *corpus* of 1247 seals of Jamdat Nasr period (CAMIZ, ROVA 1996, 2001, 2003; CAMIZ *et al.* 1998, 2003, 2007). The purpose of their research was to obtain an overview of the relationships between different groups of seals studied and classified according to their iconographic features and other factors such as geographical origin, dating and context of discovery.

The methodological basis of this study is based primarily on Multiple Correspondence Analysis up to the elaboration that considers not only the presence or absence of certain iconographic elements, but also the order (as well as their remoteness or proximity) and the way in which they are associated. Their composition can then be examined according to two levels of increasing complexity. The first level is represented by fixed sequences of elements that form small substructures; the second is represented by the composition of the whole image. The third level of analysis is carried out by turning the image into a sequence of symbols or strings. Suitable algorithms are then developed to examine the distance between different sequences. Once a matrix is produced, an analysis of the main coordinates is conducted on the sequences and followed by a Cluster analysis.

Another approach to the problem of the analysis of the seals is represented by Artificial Neural Networks. In short, Artificial Neural Networks (ANNs) are information processing systems that try to simulate in a computer system the operation of biological nervous systems, which are formed by a large number of nerve cells and connections (synapses) between them. Neural networks are based on connective methods consisting of many small units connected together by links weighed and working synchronously and

asynchronously. While in traditional computers the data are processed individually and sequentially, in a neural network data work in parallel and are able to handle a considerable volume of information. Artificial Neural Networks come from the need to reproduce typical activities of the human brain, as the so-called associative memory processes, the perception of images, the comprehension of language and the sense-motor coordination.

An artificial neural network attempts to emulate the behaviour of the biological neural network which we usually call the brain, or more accurately to capture the essential features of the processes that allow, thanks to partial knowledge of certain words (patterns), to remember whole sentences or phrases connected to circumstances and places. There are various types of neural networks: the classical classification distinguishes between supervised and non-supervised networks. The first type is characterised by an input and a known output and the weights are updated, during the procedure, according to the wanted output. This procedure is called “training” of the network. The “supervision” consists precisely in knowing the answer you would expect from a given input. A neural network is then able to give consistent answers to inputs that had not been presented in the training phase. The most common network of this type, which is also the most popular, is the multilayer network (i.e. where the nodes are placed in parallel layers, usually 2 or 3, maximum 4); another one is the back propagation network, called after the training algorithm name.

A classic example of a similar network is used for character recognition. A series of characters (usually contained in a square grid) are presented to the network and the network is trained to recognise which characters they are. Then it will be able, given any symbol, to determine which character it “looks like”. Non-supervised networks are generally used to perform input classifications, such as the famous Kohonen networks (SOMs – Self-Organizing Maps), which have a wide range of applications (KOHONEN 1997). These networks group the inputs into categories consisting of similar inputs (according to certain criteria). A SOM also creates a map of the inputs putting close together similar inputs. A particularly effective application of the use of SOM to the figurative analysis is the study carried out on seals of the Akkadian and Ur III period by Di Ludovico and Ramazzotti (DI LUDOVICO, RAMAZZOTTI 2008).

Another study that uses a special type of neural networks called Auto-Contractive Maps was published by DI LUDOVICO and PIERI (2011) and covers in particular cylinder seals of the Ur III period. Auto-Contractive Maps (Auto-CM) are a particular type of non-supervised neural network, developed by P.M. Buscema at the Semeion Research Centre. Those networks are able to trace the natural relationships between variables, highlighting soft and weak links that would escape from a traditional statistical analysis. One can thus highlight the semantic map of the variables identified studying the figura-

tive representation of the seals developing a graph which points out some important connections hardly detectable with other standard probabilistic methods. This method is the one used in the research presented in this paper.

2. THE DATASET

The first part of this experiment is represented by the creation of a database containing data as homogenous and standardised as possible. The idea of creating a dataset, consisting of a collection of seals and their stamps belonging to period of Isin and Larsa (2000-1750 a.C.), presents not few difficulties that are related to the inherent problems, both the choice of seals themselves and the computer support necessary for the collection of information. Computer tools represent a fundamental instrument to enable researchers to always keep on top of the data, to easily check all the objects collected and to interchange and compare information (RIZZA 2006). The structure of the database includes two types of variables: those that can be defined as concrete variables and the abstract ones. The latter are a reflection of our way of understanding the data inside of a quest that has a breath of scientific type. You begin to collect stamps having in mind a theory which is, at that time, only at an initial state, with the awareness of having to make choices that may not be easy and painless, but which are nevertheless inevitable. It is therefore a step forward from the level of ideas to the level of the objective reality which does not always shines for clarity and completeness of the information it contains.

The *corpus* of data must therefore necessarily take into account the following two realities. On the one hand, the seal is a physical object and a vehicle of direct information; on the other hand, the seal can become a *semeion* between two systems of thought that are very distant in time. In this perspective the seal is an object that allows us to move from a reconstructive level to an interpretation level, and a sign that transforms the act of sealing or of possessing the seal itself into a communicative moment for the various socio-cultural aspects that are involved in the study of these objects. Returning to the problem of the selection of seals, the first criterion of inclusion that I chose was determined by the “certainty” of dating.

Regarding the glyptic production and other elements, the period of Isin and Larsa is indeed a moment that raises numerous difficulties in dating (COLLON 1986). There are stylistic criteria used for dating, as the presence of intercession scene in place of the presentation scene, or technical criteria as the prevailing use of hematite, a material for the manufacture of the seal, or the development of a new technique of realisation, that can help us, but they cannot give us the certainty of dating which can then fluctuate from the time of the Third Dynasty of Ur to Old Babylonian period. Everything that

concerns all aspects of human artistic production may be subject to dating criteria that are not necessarily stylistic, but may involve other levels and mental experience that are not always so mechanically interpretable. This has led to a drastic reduction of the number of items considered, since in most cataloguing works, the Isin and Larsa period is included in the discussion of Early Babylonian period or is considered as the final moment of the Third Dynasty of Ur. Another criterion of selection was the geographical origin, that it was possible to determine being almost entirely the Mesopotamian land.

The seals included in this research are also selected from catalogues able to offer complete information about the materials of their manufacture and their state of wornness, since these information convey crucial observations, which are not exclusive of the seal as an object but may also involve its use and function. The homogeneity of figurative representations led to another important guideline for the selection of the material, as a guarantee of a more timely recognition of formal and aesthetic variables. At the end of this first step of the research, the selected seals were 130. This number permits to reach an acceptable compromise between quality and quantity of inserted objects and, above all, given the number of variables considered for classification, represents an important measure of data. The selected seals and their stamps are from Babylon (51% of the total), from Diyala (43%), and only for three seals the origin is outside Mesopotamia. These three seals were included in the database to offer an example of production outside Mesopotamia. Most of the records examined originate from places that were the subject of excavations especially by H. FRANKFORT (1955) for the Diyala region and by A. PARROT (1954) for the area of Girsu and Larsa (excavations 1931-1933). Geographical origin, when not explicitly stated, is not determined. Only for 46 seals out of 130 it was possible to establish the exact place of discovery. Other seals come from private collections that have been edited separately, as the Chiha collection (DOUMET 1922), or are part of other museum collections as the seals from the British Museum or the seals of the Egyptian Museum of Turin (BERGAMINI 1987).

The seals have always represented a strong economic attraction for the antiquarian market, for the material which can be invaluable as well as for the ease of transport and also for their possible transformation into a variety of pendants; this explains the significant presence of these objects within private collections. One of the richest collections was bought by the British Museum in 1825 from the heirs of Claudius James Rich (1786-1821), a member of the East India Company resident in Baghdad.

The archaeological excavations can give us only the certainty of the place of discovery, but cannot prove if the seal was actually manufactured in that same place. Even *dating* presents considerable challenges because the seal is a type of object often subject to reuse (re-carving). The reuse of

a seal results in a prolongation of its life and in a consequent falsification of the date of its manufacture but it also offers extra details of stylistic and technical nature.

3. ANALYSIS OF THE ICONOLOGICAL REPRESENTATIONS IN THE *CORPUS*

Among interpretative disciplines of history of art, iconology deals with the subject or meaning of the artwork, as opposed to its shape. At a first reading level some primary keys were identified to give us the basic information for the study of figurative representation of the seals of the period examined. Five types of scenes were so identified. The first and prevalent, with a percentage of 45% of the total, is the intercession scene recognised by virtually all scholars as the innovative scene typical of the Isin and Larsa glyptic. The second type of scene is the presentation scene with a percentage equal to 39%, typical of the production period of the third dynasty of Ur, and still considerably used in this period. The third type involves a character in front of the deified King with a percentage of 10%. The fourth kind presents a character in front of deity with a percentage of 5%. The fifth and final type is present on one seal and represents a deity in front of another deity (1%).

We proceed by locating, within every single group, significant elements operating a kind of syntactic deconstruction to discover, for every scene, constituent base elements that present a meaning not changing in contact with other variables (Figs. 1-2). The intercession scene is based on three elements:

- 1) The interceding deity;
- 2) The worshipper or another character that is introduced in front of the deity;
- 3) The object of devotion, which can be either a deified King, or another male or female deity.

These characters interact with each other into a quite standardised compositional scheme: the interceding divinity is represented behind its worshipper with both hands raised; the worshipper follows, with his hands gathered below in front of a deity, which can be standing or sitting and represented with iconographic features that identify it as a deified King or as a deity with no particular signs that could identify it or, on the contrary, as a specific deity of the pantheon. These are the main characters of this type of scene that we can certainly interpret as a cult scene, offering all sorts of variations on the theme. These variations do not change the syntactic level structure of the scene, but are just different interpretations of it, due to reasons that are related to another sphere of investigation leading back to regional type variations, re-carved or engraver's errors unable to interpret it correctly. The increasing number of the actors appearing in the figurative field does not cover the principal level characteristic of this iconology.



Fig. 1 – Intercession scene.



Fig. 2 – Presentation scene.

Some variations in the pattern do not seem to affect the deep meaning of the scenes, as for example in the intercession scene on the seal classified as BM 108777, where three deities intercede; some other variations, like the one on the seal classified as BM 89479, where a woman is represented instead of a worshipper (although the interpretation is uncertain), somehow modify the meaning but not the syntactic structure. On another seal classified as BM 89552 the worshipper is upside down which has been interpreted as linked to a funerary context (COLLON 1986).

It is as if in a sentence like: “I eat an apple”, simple in its structure with a subject, a verb and a complement, we would add other words as “I eat two apples” or “I eat an apple with gusto”: the structure does not change, but the fact of eating two apples provides an extra information that needs decoding however, using other information which often are not available: why two apples? One is too small or the subject is hungrier? Often lacking this depth of information for the seals, our task is to annotate these features in an attempt to shed some light on their meaning that surely exist, because nothing is added to the case especially on an object as the seal so important at a social level.

The second type is the presentation scene. The syntactic structure is similar to that of intercession, but it changes in the spatial arrangement and posture of the protagonists who are always the worshipper, the interceding deity and the divinity or the deified King. The order, however, is different: the goddess interceding before the worshipper that introduces him in the sight of the deity taking him by hand. This type of depiction may have variations on the theme as the previous type with the introduction here of other characters as the dwarf with arched legs and severed head depicted in profile, well attested and in a larger number in the intercession scene. The third type of scene stars a character in front of the deified King. In this case the figure of the interceding goddess is missing. Here, too, the characters in front of the deified King may be more than one and attend other secondary characters.

We are again in front of a cult scene, but the lack of the character who intercedes in front of the deity would have in this case a much deeper meaning that could be related to a different interpretation of the relationship between the character that stands in front of the deity and the deity itself. The absence of interceding deity from the figurative field might lead to think that the worshipper now enjoys a “closeness”, a physical relation to the King. This could indicate a direct access of this character to the King, maybe as the holder of a high office within the palace bureaucracy, and its multiplication within the scene may be explained with a father and son (or sons) relationships.

The other two types of scenes examined represent only a variation in the typology of the two main characters involved in the unfolding of the scene, but I nevertheless decided to classify them because the fact that there is a deity in front of another deity, meaning that the character is faced with a deity and not in front of the deified King, perhaps could narrow the field of use of the seal to the templar and not palatial bureaucracy (WINTER 1991).

4. THE ICONOGRAPHIC ANALYSIS. THE VARIABLE ELEMENTS OF THE SCENES

The analysis shifts, at this point, to the iconographic study of the peculiarities of the variables that do not characterise each typology, either because these are basically constant in all scenes or because they are only occasionally detectable and as such can be considered as elements that enrich the figurative field, but are not decisive enough to modify the interpretation at the semantic level.

Three main classes of variables can be distinguished:

- 1) Human or divine characters;
- 2) Animals and hybrid beings;
- 3) Objects that are not bound to the characters, but are free in the figurative field.

For each of these classes, variables will be examined within the typological characteristics of the scene. The divine figures that can be found within the scene, when they are not replica of the interceding goddess, can offer us considerable enrichment about the iconography of the deities. On the seal BM122834 we can find one deity that presents all the iconographic features of the goddess Ishtar, although in the catalogue I preferred to interpret it more cautiously as a warrior goddess. Some interpretations recognise her as the goddess Shala, the *paredra* of the storm god Adad. The goddess is represented interceding with an advanced foot on the back of a little lion. Torso and face are in frontal position. Two quivers are crossed on her back. Her outstretched hand holds a rod and a ring. Usually she holds, in one hand, a

mace with a double headed lion and clutches a curved weapon (harpé) in the other one (MATTHIAE 2000).

Other deities appear only in two seals: the BM 129500 and BM 102048. The first is in a scene with a character in front of a deity, the second is the so-called nude goddess in an intercession scene. Her identification as a deity is questioned because her attitude with the hands clasped on her belly, in frontal position on a small pedestal or lion cub, would simply identify her as a devout woman connected to fertility cult practices. This type of figure does not seem to appear before 1825 and disappears around 1750. Its presence is linked to a manufacturing type limited to provincial environments and characterised by a linear shape which makes think of a Northern origin (MATTHIAE 2000).

We shall now proceed to the examination of non-divine figures. One of them is the one defined “the King with the mace”, who appears on three seals: BM 102058 (the character in front of the deity); BM 116280 (presentation scene) and BM 89552 (intercession scene). He is represented on the first seal while holding the harpé with one hand and a stick with the other, on the second seal again while holding the stick, and on the third seal naked with a double belt around the waist and a small stick in the hand. Another character has been classified as a “hero” since he is engaged in mythical battles. On the first seal (BM 101972), the “hero” is in frontal position and he is holding a cup from which water gushes; on seal BM 132858 he is represented with a short skirt, standing, while the right hand grasps the rear paw of the lion, his right leg over the animal’s head, and finally on the BM 89198 (Fig. 3) in the same position, but naked.

The so-called dwarf from bowed legs is one of the filling characters that distinguish the glyptic production of Isin and Larsa and Early Babylonian period. He occurs in all types of scenes and is represented with both hands raised or with hands folded on the belly, front facing or turned right or left handed, upside down, naked wearing a cap or bald. On two other seals are present the so-called “detached heads”, bizarre fill patterns with obscure meaning except perhaps their pictorial value as the representation of the sign *sag*.

Our analysis now focuses on the types of animals and fantastic creatures often represented as human-animal hybrids. The first is the so-called “bull man” recalling mythical fight scenes that characterised the glyptic of the Akkadian period. He is represented standing, grabbing the forelegs of a lion on BM 89303, in heraldic position with another bull man with the arms raised on BM 129500, standing and front facing holding a spear as on BM 89456, or grasping with the right the rear paw of the lion and holding the left paw on the feline’s neck as on BM 89026.

Interesting are the representations of all kinds of hybrids between fish and man with all their variations: fish with human head and arms, fish with



Fig. 3 – BM 89198.

human head and cap with crest, fish with human head and fish animal hybrids, the so-called goat fish. All appear individually in the intercession scene except for the goat fish that is present on the BM 129495 seal that represents a presentation scene.

The figure of the hybrids is connected with Enki and has a long iconographic history, from the representation of the seven sages, *apkallu*, civilising heroes sent by Ea to bring culture to the ancient inhabitants of Mesopotamia, until Roman times, especially at the time of Augustus when the Capricorn zodiac sign becomes the symbol of the emperor. Another animal that recurs with some frequency is the lion that appears as a victim of the assault of the “bull man” or as associated to the deity or as standing in the figurative field without a particular relationship with the other characters in the scene. The dog is quite frequent and is often represented as sitting. The inscriptions of the *kudurru* identify him as the symbol of the goddess Gula, who provides for the health of his worshipper and could also recall a symbology which sees the seal as an amulet with apotropaic functions and a lucky charm for the health of its possessor. The monkey is another animal that had excellent luck in this period’s glyptic. Always sitting, often found next to the inscription he is also connected somehow with the sun god and associated with the astral symbolism.

The focus now moves on the analysis of the unconstrained variables. These can be further subdivided into symbols that do not have a specific astral meaning and real astral symbols. Astral symbols have an almost ubiquitous presence within the *corpus* of data examined. We can distinguish various types:

- 1) The crescent moon often represented in top centre of the figurative scene;
- 2) The star disk with crescent moon;
- 3) The star;
- 4) The disk with crescent moon.

The crescent moon is universally referred to as the symbol of the goddess Inanna, and it is often interpreted as linked to a magical and protective sphere. The addition of the sun disk in figurative composition was also seen

as a symbol of Eclipse, while for the starry disk, very interesting is the theory advanced by Mehmet-Ali ATAÇ (2008) that comparing astral symbols connected with the sun in the stele of Naram-Sin with those present in the seals, highlighted the triangular elements inside the iconography of the star disk with crescent moon and distinguishes the ones with straight sides as matching a symbolisation of the light of the sun from those with wavy lines representing the heat of the sun. Mehmet-Ali Ataç interprets this as the symbol of a syncretism between the representation of the Akkadian god Shamash and the worship of the Sumerian goddess Shamash.

5. THE TRAINING

At this point, after the identification of the variables, we can start the experimental data processing previously identified and selected within the *corpus* of the seals. The data collected in an Access file are exported to an Excel file. The file consists of 160 variables and 130 records and the defined variables are classified in 4 main areas previously identified: iconology, characters (divine and human), animals and symbols. Each main area includes additional subdivisions that add variables of iconographic nature such as the type of clothing worn by a particular character or the posture of animals and characters up to the definition of their location within the figurative field including symbols. The file has been encoded to a text file with the extension .txt. The data so processed have been loaded in the experimental software developed by dr. Massimiliano Capriotti and used by the Laboratory of Analytical Archaeology and Artificial Adaptive System (LAA&AAS), ready for the algorithm processing and weight definition. The parameters chosen for this step were:

- 1) Input Type: variables.
- 2) Weight metrics: Auto-Contractive Maps, Linear Correlation, Prior Probability.
- 3) Auto-CM parameters. Epochs: 100,000, Energy: 0.0001, Learning Rate: 15.

The result is the generation of graphs according to all three types of metrics. To display the corresponding graph we used the open source software GEPHI v. 0.8.1.

6. THE MST TREE

The next step was the graph visualisation and layout to make it “readable” and the study of the Minimum Spanning Tree resulting from statistical measures already examined in previous chapters. The order in which variables appear is determined by the value set by the Auto-CM matrix. The greater their value, the higher is their representation in this scale that analyses the multiplicity of their connections within the graph. The variables in position number

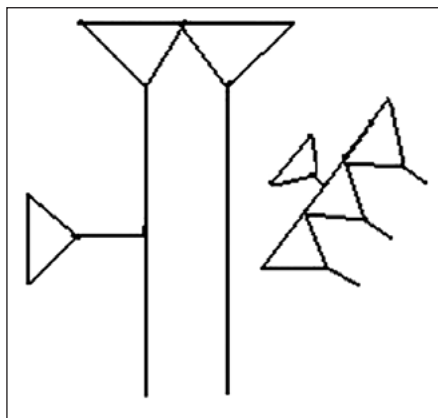


Fig. 4 – Zibanitu.

Fig. 5 – BM 11669.

two and three immediately gain our attention and stimulate our curiosity. If we made a simple analysis of occurrences, i.e. how often these variables appear in the figurative field, their position would have been far more modest. Also the graph is susceptible to this sort of trichotomy and expands by following these three branches. The one with hybrid with fish is more peripheral, but the first two are very centrally located. The role represented by a worshipper is certainly a semantically significant character, but the position of the “ball and staff” is definitely a surprise.

Not interpreted univocally, still remains a “mysterious object”. Associated with the pot that often accompanies it in the figurative field of the seal, the “ball and staff” is interpreted by some scholars as an object in some way linked to the world of shepherds or connected to the naked goddess and, in this sense, the pot would have performed as a comb and the “ball and staff” as a toiletry item (COLLON 1986). For the allocation to the pastoral world the “ball and staff” is indicated as a not better identified subject connected to the carding of wool. The naked goddess does not appear so close in the ramifications of the graph while the pot turns out to be included in the same group. Interesting that the “ball and staff” appears instead associated with many elements linked somehow to the sphere of gifts and divine attributes: harpé and stick, scepter, harpé just to name a few.

The network may suggest something that the only examination related to its mere pictographic representation might not leap immediately to the eyes. More enlightening at this point could be the interpretation of this object as a symbol of the zodiac sign of Libra (COLLON 1986). The Libra symbol tied to justice could now justify a central location of this element within an object as the seal, in which justice is seen as the seal of “legality”. Certainly striking is the similarity between the iconographic yield of this sign and the cuneiform sign

that indicates the scales: the Akkadian *zibanitu* and the later zodiac abbreviation of Libra (DURING CASPER 1997). In this case we could be in the presence of a particular historical moment in which the *zibanitu* has not been “canonised” yet and still suffers from his pastoral tradition tied to a farming calendar and a rendition of the pictographic nature sign (ROGER 1998) (Figs. 4-5).

7. THE RANKING

In the table below, the variables are ranked according to the multiplicity of their connections.

Id	Label	Degree
60	[CHAR]:worsh.1	11
132	[SYMBOLS]: ball and staff1	8
11	[ANIMAL]:hyb. fish1	7
80	[CHAR][POST]:int.H up supp.	4
49	[ANIMAL][POST]: stand	4
44	[ANIMAL][POST]: lie	4
26	[ANIMAL]: bird1	4
140	[SYMBOLS]: drill hole1	4
141	[SYMBOLS]: drill hole2	4
21	[ANIMAL]: monkey1	4
55	[CHAR]:god	4
87	[CHAR][POST]:stand	4
48	[ANIMAL][POST]: sit	4
83	[CHAR][POST]:H right up greet	4
84	[CHAR][POST]:H. left up greet	3
109	[CHAR][ATTR]: animal	3
8	[ANIMAL]: goat	3
37	[ANIMAL][POS]:hight c.	3
33	[ANIMAL][POS]:front	3
28	[ANIMAL]: bull man1	3
9	[ANIMAL]: oyster	3
40	[ANIMAL][POS]:low l.	3
56	[CHAR]: Sun god	3
15	[ANIMAL]: fly	3
79	[CHAR][POST]:Asc.	3
95	[CHAR][CLOTHES] short skirt	3
66	[CHAR] interc.	3
158	[SYMBOLS][POS]: low r.	3
38	[ANIMAL][POS]:low	3
61	[CHAR]:worsh.2	3
98	[CHAR][CLOTHES] naked	3
90	[CHAR][POST]:stand+object	3
76	[CHAR][POS]:front	3
67	[CHAR]: male1	3

58	[CHAR]: w. deity	3
85	[CHAR][POST]:sit	3
150	[SYMBOLS][POS]:right	3
94	[CHAR][CLOTHES]skirt+ lines	3
29	[ANIMAL]: bull man2	2
96	[CHAR][CLOTHES]flound. Skirt+wrap	2
64	[CHAR]: char.1	2
126	[SYMBOLS]: tree	2
45	[ANIMAL][POST]: advan.	2
25	[ANIMAL]: turtle	2
91	[CHAR][POST]:stand offer.	2
47	[ANIMAL][POST]: stood hinds legs	2
31	[ANIMAL][POS]:left	2
70	[CHAR]: king	2
74	[CHAR]: head	2
10	[ANIMAL]:griffin lion h.	2
17	[ANIMAL]: goat fish	2
138	[SYMBOLS]: dates	2
63	[CHAR]:dwarf	2
152	[SYMBOLS][POS]:center	2
118	[CHAR][ATTR]: wedge+ring	2
143	[SYMBOLS]: globes	2
160	[SYMBOLS][POS]: low c.	2
50	[ANIMAL][POST]: upright	2
30	[ANIMAL][POS]:right	2
68	[CHAR]: male2	2
108	[CHAR][HAT]: turban	2
123	[CHAR][ATTR]: sceptor	2
71	[CHAR]: K_mace	2
134	[SYMBOLS]: crook	2
159	[SYMBOLS][POS]: low l.	2
24	[ANIMAL]: snake	2
3	[ICO]: Char. In fr. of deif. K.	2
59	[CHAR]: hero	2
131	[SYMBOLS]: staff	2

36	[ANIMAL][POS]:hight l.	2
155	[SYMBOLS][POS]: hight l.	2
157	[SYMBOLS][POS]: low	2
154	[SYMBOLS][POS]: hight r.	2
2	[ICO]: Char. in fr. of D.	2
43	[ANIMAL][POST]: grab	2
13	[ANIMAL]: lion1	2
7	[ANIMAL]: dog	2
153	[SYMBOLS][POS]: hight	2
149	[SYMBOLS]: pot	2
4	[ICO]: Pres. Sc.	2
100	[CHAR][CLOTHES]flound dress	2
57	[CHAR]:Deity	2
52	[CHAR]:goddess2	2
35	[ANIMAL][POS]:hight r.	2
101	[CHAR][CLOTHES] dress+lin.	2
151	[SYMBOLS][POS]:left	2
72	[CHAR]: deif. K.	2
135	[SYMBOLS]: moon cres.	2
105	[CHAR][HAT]:crested cap	2
102	[CHAR][CLOTHES] dress+verti.strip.	2
51	[CHAR]:goddess1	2
62	[CHAR]:worsh.3	2
1	[ICO]: D. in fr.D.	1
130	[SYMBOLS]: post+horn	1
78	[CHAR][POST]:H. up suppl.	1
54	[CHAR]:nak. goddess	1
42	[ANIMAL][POS]:upright	1
137	[SYMBOLS]: star disc+moon cres.	1
5	[ICO]: Interc. Sc.	1
127	[SYMBOLS]: bush	1
20	[ANIMAL]: hedg.	1
46	[ANIMAL][POST]: float	1
65	[CHAR]: char.2	1
6	[ANIMAL]: eagle lion h.	1
136	[SYMBOLS]: disc with moon crescent	1
122	[CHAR][ATTR]: mount m. sh.	1
34	[ANIMAL][POS]: hight	1
16	[ANIMAL]: fish	1
27	[ANIMAL]: bird2	1
113	[CHAR][ATTR]: jag. knife	1
39	[ANIMAL][POS]:low r.	1
93	[CHAR][CLOTHES] flound. skirt	1
22	[ANIMAL]: monkey2	1
14	[ANIMAL]: lion2	1
12	[ANIMAL]:hyb. fish2	1
18	[ANIMAL]: fish+hum. h.	1
110	[CHAR][ATTR]:axe	1
99	[CHAR][CLOTHES]tight dress	1
75	[CHAR][POS]:]up. down	1
23	[ANIMAL]: scorpion	1
112	[CHAR][ATTR]: crook	1
92	[CHAR][POST]:stand roy. post.	1
89	[CHAR][POST]:stand H. up	1
142	[SYMBOLS]: drill hole3	1
103	[CHAR][HAT]: point.	1
119	[CHAR][ATTR]: rod+ring	1
147	[SYMBOLS]: harpÅ©	1
139	[SYMBOLS]: fork	1
120	[CHAR][ATTR]: mace	1
146	[SYMBOLS]: lion scim.	1
116	[CHAR][ATTR]: HarpÅ©+stick	1
125	[CHAR][ATTR]: flow. vase	1
19	[ANIMAL]: frog	1
41	[ANIMAL][POS]:low c.	1
32	[ANIMAL][POS]:center	1
148	[SYMBOLS]: star	1
69	[CHAR]: small figure	1
73	[CHAR]: priest	1
128	[SYMBOLS]: altar	1
117	[CHAR][ATTR]: wedge	1
88	[CHAR][POST]: int.+obj.	1
53	[CHAR]:goddess3	1
144	[SYMBOLS]: spear	1
133	[SYMBOLS]: ball and staff2	1
97	[CHAR][CLOTHES]long dress	1
81	[CHAR][POST]:int. A. left up right back	1
114	[CHAR][ATTR]: cup	1
129	[SYMBOLS]: post	1
77	[CHAR][POST]:H. Belly	1
156	[SYMBOLS][POS]: hight c.	1
107	[CHAR][HAT]: tiara	1
104	[CHAR][HAT]: cap	1
86	[CHAR][POST]:sit+obj.	1
145	[SYMBOLS]: mace+doub. lion h.	1
82	[CHAR][POST]:int.A. r. back l. H_belly	1
111	[CHAR][ATTR]: stick	1
115	[CHAR][ATTR]: sh. Stick+axe	1
106	[CHAR][HAT]:squared	1
121	[CHAR][ATTR]: sm. vess.	1
124	[CHAR][ATTR]: cur. sword	1

Tab. 1 – The ranking.

8. BETWEENNESS CENTRALITY

With a few tweaks, Between Centrality measure also confirms the same provision of the variables of the graph (Tab. 2).

Id	Label	Betweenness Centrality			
132	[SYMBOLS]: ball and staff1	0.665074437	56	[CHAR]: Sun god	0.037417403
60	[CHAR]:worsh.1	0.651142425	38	[ANIMAL][POS]:low	0.037417403
49	[ANIMAL][POST]: stand	0.454661253	61	[CHAR]:worsh.2	0.037417403
80	[CHAR][POST]:int.H up supp.	0.450123398	47	[ANIMAL][POST]: stood hinds legs	0.03725818
51	[CHAR]:goddess1	0.442958363	68	[CHAR]: male2	0.03725818
48	[ANIMAL][POST]: sit	0.355624552	13	[ANIMAL]: lion1	0.03725818
28	[ANIMAL]: bull man1	0.349892524	149	[SYMBOLS]: pot	0.03725818
21	[ANIMAL]: monkey1	0.314704243	101	[CHAR][CLOTHES] dress+lin.	0.03725818
33	[ANIMAL][POS]:front	0.307300374	151	[SYMBOLS][POS]:left	0.03725818
87	[CHAR][POST]:stand	0.291218852	8	[ANIMAL]: goat	0.025077621
109	[CHAR][ATTR]: animal	0.175941406	9	[ANIMAL]: oyster	0.025077621
152	[SYMBOLS][POS]:center	0.171960831	40	[ANIMAL][POS]:low l.	0.025077621
140	[SYMBOLS]: drill hole1	0.16606958	79	[CHAR][POST]:Asc.	0.025077621
67	[CHAR]: male1	0.153490964	66	[CHAR] interc.	0.025077621
37	[ANIMAL][POS]:hight c.	0.131518191	90	[CHAR][POST]:stand+object	0.025077621
83	[CHAR][POST]:H right up greet	0.120452193	58	[CHAR]: w. deity	0.025077621
95	[CHAR][CLOTHES] short skirt	0.109067749	150	[SYMBOLS][POS]:right	0.025077621
91	[CHAR][POST]:stand offer.	0.107475519	94	[CHAR][CLOTHES]skirt+ lines	0.025077621
26	[ANIMAL]: bird1	0.097683305	126	[SYMBOLS]: tree	0.02499801
44	[ANIMAL][POST]: lie	0.097205636	74	[CHAR]: head	0.02499801
11	[ANIMAL]:hyb. fish1	0.086298862	160	[SYMBOLS][POS]: low c.	0.02499801
55	[CHAR]:god	0.085900804	123	[CHAR][ATTR]: sceptor	0.02499801
98	[CHAR][CLOTHES] naked	0.085502747	159	[SYMBOLS][POS]: low l.	0.02499801
30	[ANIMAL][POS]:right	0.073083353	157	[SYMBOLS][POS]: low	0.02499801
154	[SYMBOLS][POS]: hight r.	0.073083353	2	[ICO]: Char. in fr. of D.	0.02499801
100	[CHAR][CLOTHES]flound dress	0.073083353	43	[ANIMAL][POST]: grab	0.02499801
158	[SYMBOLS][POS]: low r.	0.061778521	7	[ANIMAL]: dog	0.02499801
85	[CHAR][POST]:sit	0.061778521	52	[CHAR]:goddess2	0.02499801
17	[ANIMAL]: goat fish	0.061300852	29	[ANIMAL]: bull man2	0.012578616
50	[ANIMAL][POST]: upright	0.061300852	96	[CHAR][CLOTHES]flound. Skirt+wrap	0.012578616
135	[SYMBOLS]: moon cres.	0.061300852	64	[CHAR]: char.1	0.012578616
15	[ANIMAL]: fly	0.049597962	45	[ANIMAL][POST]: advan.	0.012578616
76	[CHAR][POS]:front	0.049597962	25	[ANIMAL]: turtle	0.012578616
31	[ANIMAL][POS]:left	0.049359127	10	[ANIMAL]:griffin lion h.	0.012578616
70	[CHAR]: king	0.049359127	138	[SYMBOLS]: dates	0.012578616
24	[ANIMAL]: snake	0.049359127	63	[CHAR]:dwarf	0.012578616
3	[ICO]: Char. In fr. of deif. K.	0.049359127	118	[CHAR][ATTR]: wedge+ring	0.012578616
105	[CHAR][HAT]:crested cap	0.049359127	143	[SYMBOLS]: globes	0.012578616
141	[SYMBOLS]: drill hole2	0.037497015	108	[CHAR][HAT]: turban	0.012578616
84	[CHAR][POST]:H. left up greet	0.037417403	71	[CHAR]: K_mace	0.012578616

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134	[SYMBOLS]: crook	0.012578616	112	[CHAR][ATTR]: crook	0
59	[CHAR]: hero	0.012578616	92	[CHAR][POST]:stand roy. post.	0
131	[SYMBOLS]: staff	0.012578616	89	[CHAR][POST]:stand H. up	0
36	[ANIMAL][POS]:hight l.	0.012578616	142	[SYMBOLS]: drill hole3	0
155	[SYMBOLS][POS]: hight l.	0.012578616	103	[CHAR][HAT]: point.	0
153	[SYMBOLS][POS]: hight	0.012578616	119	[CHAR][ATTR]: rod+ring	0
4	[ICO]: Pres. Sc.	0.012578616	147	[SYMBOLS]: Harpé	0
57	[CHAR]:Deity	0.012578616	139	[SYMBOLS]: fork	0
35	[ANIMAL][POS]:hight r.	0.012578616	120	[CHAR][ATTR]: mace	0
72	[CHAR]: deif. K.	0.012578616	146	[SYMBOLS]: lion scim.	0
102	[CHAR][CLOTHES] dress+verti. strip.	0.012578616	116	[CHAR][ATTR]: Harpé+stick	0
62	[CHAR]:worsh.3	0.012578616	125	[CHAR][ATTR]: flow. vase	0
1	[ICO]: D. in fr.D.	0	19	[ANIMAL]: frog	0
130	[SYMBOLS]: post+horn	0	41	[ANIMAL][POS]:low c.	0
78	[CHAR][POST]:H. up suppl.	0	32	[ANIMAL][POS]:center	0
54	[CHAR]:nak. goddess	0	148	[SYMBOLS]: star	0
42	[ANIMAL][POS]:upright	0	69	[CHAR]: small figure	0
137	[SYMBOLS]: star disc+moon cres.	0	73	[CHAR]: priest	0
5	[ICO]: Interc. Sc.	0	128	[SYMBOLS]: altar	0
127	[SYMBOLS]: bush	0	117	[CHAR][ATTR]: wedge	0
20	[ANIMAL]: hedg.	0	88	[CHAR][POST]: int.+obj.	0
46	[ANIMAL][POST]: float	0	53	[CHAR]:goddess3	0
65	[CHAR]: char.2	0	144	[SYMBOLS]: spear	0
6	[ANIMAL]: eagle lion h.	0	133	[SYMBOLS]: ball and staff2	0
136	[SYMBOLS]: disc with moon crescent	0	97	[CHAR][CLOTHES]long dress	0
122	[CHAR][ATTR]: mount m. sh.	0	81	[CHAR][POST]:int. A. left up right back	0
34	[ANIMAL][POS]: hight	0	114	[CHAR][ATTR]: cup	0
16	[ANIMAL]: fish	0	129	[SYMBOLS]: post	0
27	[ANIMAL]: bird2	0	77	[CHAR][POST]:H. _Belly	0
113	[CHAR][ATTR]: jag. knife	0	156	[SYMBOLS][POS]: hight c.	0
39	[ANIMAL][POS]:low r.	0	107	[CHAR][HAT]: tiara	0
93	[CHAR][CLOTHES] flound. skirt	0	104	[CHAR][HAT]: cap	0
22	[ANIMAL]: monkey2	0	86	[CHAR][POST]:sit+obj.	0
14	[ANIMAL]: lion2	0	145	[SYMBOLS]: mace+doub. lion h.	0
12	[ANIMAL]:hyb. fish2	0	82	[CHAR][POST]:int.A. r. back l. H_belly	0
18	[ANIMAL]: fish+hum. h.	0	111	[CHAR][ATTR]: stick	0
110	[CHAR][ATTR]: axe	0	115	[CHAR][ATTR]: sh. Stick+axe	0
99	[CHAR][CLOTHES]tight dress	0	106	[CHAR][HAT]:squared	0
75	[CHAR][POS]:]up. down	0	121	[CHAR][ATTR]: sm. vess.	0
23	[ANIMAL]: scorpion	0	124	[CHAR][ATTR]: cur. sword	0

Tab. 2 – Betweeness Centrality.

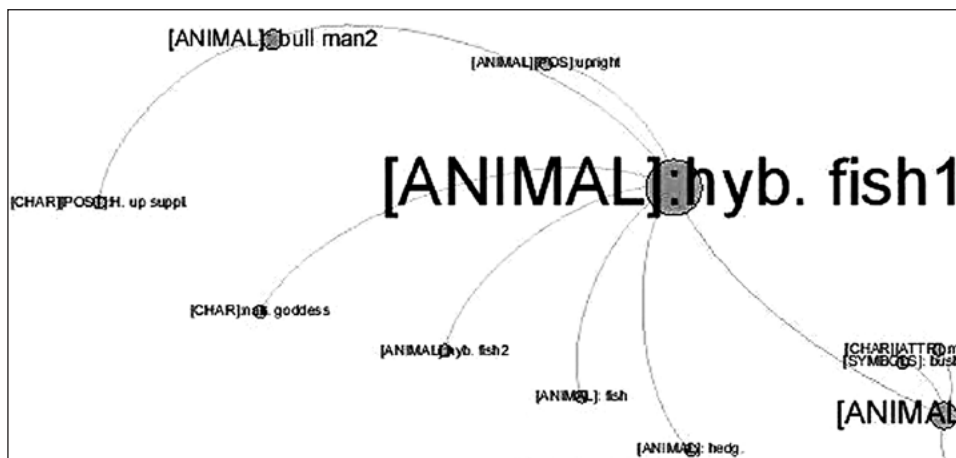


Fig. 7 – BM 129500 in the graph.

Summarising, for the definition of the graph in its more peripheral components the network has detected in these classes “singularities” around which it reconstructed the entire field of a figurative seal, which assumed in this case a prototypical function and meaning, using parameters that go beyond a simple comparative and purely statistical analysis.

10. CONCLUSION

Althought Neural Networks alone are not the only method of analysis, nevertheless together with a classical approach they can introduce a new way of thinking. They can find logical connections, not affected by the so called western thought, and they are able to find similarities between different cultures without analyzing every single component. Another fundamental element emerging from this analysis is the “wealth” of information that is found in the class of seals of Isin and Larsa, although examined within a limited group of 130 items. The extreme richness of the figurative field and the number of combinations it offers, give us the opportunity to reflect on the presence/absence of any single variable and its persistence in connection with other variables. Small yet great objects which do not “close” as was once their task, but open a thousand doors.

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ABSTRACT

The analysis of a *corpus* of seals belonging to the period of Isin and Larsa, carried out through the use of the Artificial Neural Network Auto-Contractive Maps, allows us to understand the complexity of the relationship of the different elements of the visual domain and its variety. The point of view adopted here is that of reading the iconology and iconography of the so-called “presentation scene” by offering an interpretation that goes beyond the concept of standardised and homogeneous production without any special innovative connotations.