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Establishment of Agro-Eco Industrial Clusters: A Romanian Perspective

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ABSTRACT:
The Romanian economy feels the need to formalize links between the situational economic forecast and the forecast of technological events in industry and agriculture. The article studies a "dimension" of the organization for classifications of data, structures and economic / agro-eco-industrial events for clustering with the help of "dimensionality". Meta-prognostic relationships between economics, forecasting and forecasting agents (mathematical elements) are described and the role of metricity, sub-metricity and ultra-metricity in the observation of an automatic ontology for classifications supporting agro-eco-industrial / food clustering is highlighted. The paper proposes the algorithm of the informal classes of supervised / unsupervised data about agro-eco-industrial / food companies in Romania in order to establish classifications that would motivate the formation of clusters in the field. It is concluded that the mathematical apparatus for classification must be developed because based on symbolic mathematical models can be developed computer / computer programs for calculations of ultra-metricity of transformations for linearization's of similarities between firms, eliminating reminiscences / redundancies, aiming to reduce space / distances between data that represent, in fact, enterprises that can enter agro-eco-industrial / food clusters.

Keywords: agro-eco-industrial clusters, ultra-metricity, clustering, economic forecasting, classification

1. Introduction

Borderless telecommunications in this first quarter of the 21st century is a way to demystify economic forecasting and continue to rely on risk aversion (Bran et al., 2020; Bran et al., 2023). Forecasting intervals (future time, longer), the extensive sets of data already taken almost quasi-infinitesimally for the construction of data series, the aggregation of indicators and, especially, the entry into the new knowledge-based economy are taking place in a new field of informal statistical methods, which have become increasingly formal for *updated classifications* and *forecasts*, with the highest possible accuracy (Radulescu et al., 2020). For "forecasts" there are statistical methods, techniques, procedures, models, tools for classification, testing and validation, etc., mostly classical, but there are also requirements for "prediction" such as: "Can economic forecasts predict the future?" (Davidson & Blumberg, 2010)

Global realities: As a result of population growth and rising incomes, it is projected that by 2050, global food demand will be 70% higher. The world's population

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will increase from 7.92 billion (Statis. Mond., 2021) to 10.50 billion by 2050 (95% increase in 50 least developed countries). Food insecurity and socio-economic vulnerabilities in densely populated areas of the world will increase and persist as imperfect market infrastructures. Agri-food systems will face the negative effects of water scarcity, price volatility and climate change. Globally, there is growing demand for food and supply is relatively the same. (United Nations, 2019; European Cluster Memorandum, 2020)

Realities in Europe (EU): The European population is expected to age and stagnate. By 2050, the total population of the EU, compared to the current level of 512.4 million, will reach approx. 523.7 million people. (Iagăr, 2019) It is expected that in Romania the total population will decrease to 16.74 million people (of which in rural 6.74 million), compared to 19.53 million in 2018 (of which in rural 8.99 million). (Romanian Dev. Strategy 2020-2030) Developments have implications for the demand for agri-food products, as European markets will have limited potential for expansion. In the Romanian agri-food field, there is a *low market integration and inefficient agri-food chains*. Excessive fragmentation of the agricultural supply base has influences upstream (access to inputs) and downstream (processing, marketing and distribution of agricultural and food products), weakening the development potential of value-added activities. Long agri-food chains place farmers in captivity between suppliers and their customers, which influences their development. The practice of interposing at least two intermediaries (wholesaler + retailer) between producer and consumer is the reason that the benefits reach a small proportion to farmers. Inefficiency directly influences farmers' productivity and expressions of investment interest, especially among those with semi-subsistence farms.

In the food industry, agriculture / general economy in Romania feels the need to make connections between 1) *situational economic forecast* and 2) *prediction through deep, advanced, quasi-infinitesimal knowledge* of innovative technological events, the realization and operation of new productive economic-structures, including agri-food, through classifications in the material societal environment, so that the intangible (knowledge by forecasting) to outline the tangible future (Burlacu, Crețu et al., 2022). In the Romanian economy (2020) are accepted the concept and intention to create *agro-eco-industrial clusters* as a premise for the future *new network economy / agriculture* based on knowledge, dematerialization, circularity and self-generation in conditions of sustainability. However, there are delays in the realization of the conditions of significant formation (appearance) of agro-eco-industrial clusters, because the interest *for classifications* is reduced. In the short term, the situation is unsatisfactory, in the medium term it suffers from inadequacy, and in the long term, given globalization, it is expected that there will be an implicit, intrinsic alignment for clustered functional compatibility of the Romanian economy with the EU general and competitive economic environment.

The contribution to solving the above situation is based on theses on *measurement* and *classification,* formalizing the tangible agro-eco-industrial clustering, recognizing a lot of controllable values, through innovation (intangible clustering, knowledge), performance, competitiveness (competitive advantage), sustainability and profit. In fact, in the EU, agro-eco-industrialization is contributing to the process of transforming food chains in line with the Green Deal and the Farm to Fork Strategy, for a fair, healthy and environmentally friendly food system.

2. Review of specialized literature

We appreciate that we need to look for a "dimension" of the organization for classifications of data, structures and economic / industrial events for clustering with the help of "dimensionality", considered a signal-category for "quality", respectively stimulus quantified in series (in a series) of time of developments and productive-economic agro-food, industrial and knowledge states (Rădulescu, Gâf-Deac et al., 2022 ; Gâf-Deac et al., 2022). Porter (2007) shows that "While the existence of clusters has been long recognized, the ability to systematically measure clusters and examine their influence on regional performance is relatively recent. New tools are needed and have been developed to define cluster boundaries and measure the overlaps among clusters more rigorously." At the same time, we consider that it is not must be ignored the reality that most forensic economics work identifies hidden behavior by testing data against a null hypothesis, which is often derived from economic theory. (Zitzewitz, 2012)

Clusters are geographical concentrations of interconnected institutions and companies, including agri-food, - and they are interconnected by groups of related entities. (Porter, 2003) At present, more than 38% of the total European workforce is employed in cluster enterprises. However, the foreshadowing of the "growth poles" is the result of the spread of knowledge in each field, including agri-food. (Cortright, 2006; Dan, 2012) Enterprise / farm strategy, supply / suppliers, production, demand and competition are accompanied by horizontal integration (Porter, 1998), which contributes to the formalization of the *networked agro-eco-industrial economy*. The forecast of the formation (emergence) of agro-eco-industrial clusters in the economy and on the Romanian territory should benefit from *more precise classifications,* of *metric persuasion* in the conditions in which there are methods, techniques, procedures and tools of *ultra-metricity / under -metricity*. Variations in the data series for economic forecasting are still in operation, with relative success in the contemporary linear economy. (Coşniță, Iorgulescu, 2013; Gâf-Deac I.I., et al., 2016) Mainly, they refer to: 1) cyclicity (types of pattern repeated over time in the series tend), 2) tendency (the trend), 3) moments when the data show any moment pattern, 4) irregular variations arise to unexpected trends or events) etc. However, "clusters also gain in importance as firms migrate from vertically integrated structures." (Porter M.E., 2007; Delgado, M., Porter, M.E., Stern, S., 2010)

Yong Soo Keong, (2009) states that modern economic forecasting procedures use formal economic models to predict future economic events, good forecasters tend to use some informal judgments to form their forecasts. As such, at least 3 ways of working consolidate the forecast in modern economy, including in agriculture and food industry: a) Structural Time Series Models / STSM (with the idea to highlight the elements of interest within a time series data), b) Autoregressive Integrated Moving Average / AIMA (usual classified under the econometrics procedure) and c) Causal Macro econometric Models / CMM (it is about quantitative contribution of economic factors to major economic variables of interest).

3. Scientific research methodology
3.1 Realities in Romania

Romania entered a new era in the economy with its accession to the EU in 2007 because it had to quickly adapt its agricultural sector and rural development (the Romanian rural economy is dominated by agriculture) in order to integrate into the internal market of the Union, adopting the Common Agricultural Policy (CAP). The European model of agriculture and food industry is based on competitiveness and market orientation, respecting public tasks, such as environmental protection. (EU Strategy 2020; COM 546 / 6.10.2010) The CAP reduces the focus on direct subsidies to agriculture (Pillar I) and focuses on the integrated development of the rural economy and environmental conservation (Pillar II). The agri-food sector and agriculture play a significant role in relation to the size of the rural population (approx. 45.7% of Romania's population is in rural areas, compared to 23.6% in the EU Member States) and employment (approx. 30 % of the population is employed in agriculture, compared to 2% in EU Member States). (COM 2010-614, EC, Brussels; COM 652/2008; WIRE Conference 2011) Almost 62% of Romania's land area consists of agricultural land (66% of which is arable). In 2016, there were 10.5 million agricultural holdings in the EU, of which 65% were smaller than 5 ha, covering 173 million ha of agricultural land (39% of the total EU land area). Although the number of farms in the EU by 2020 has decreased, the area of land for production has remained constant. (Eurostat, 2018; European Cluster Observatory, 2020)

The structural characteristic of the Romanian agricultural sector compared to that of the EU Member States, refers to the size of the gap between the category of large farms and small farms. (Conference Strengthening Cluster, 2020) Subsistence / semi-subsistence agriculture in Romania has a high share and a pronounced structural division of agricultural land. As such, there is an under-utilization of agricultural potential. There are many farms that make less than 2,000 Euro standard production, and approx. 50% of the total standard production is found on farms with less than 8,000 Euro / year. In the period 2005-2020, Romanian agriculture decreased by 400,000 farms. However, more and more young farm managers are meeting (23% are under 45). The average size of the farm has remained the same for the last 20 years (approx. 3.6 ha). Average yields for agricultural products are only 30-50% of those in the EU. It is predicted that in the medium- and long-term climate change will increasingly affect Romania and its agricultural field. The food industry has a turnover of approx. 10 billion Euros (2019) with 152,760 employees. In 2019, a number of 1,474 companies in the food industry produced 8.72 million tons of food products, of which 13.8% are exported (about 7% of the country's total exports). The challenge of the Romanian agri-food sector refers to the compliance with the European standards of food safety and quality on the entire agri-food chain. Agri-food chains have developed over the past 20 years through pre-accession and foreign investor investment. Large investments belong to foreign retailers in supermarkets. Many small processing units closed because they did not meet the requirements of the standards, lacked raw materials or did not withstand the high prices of raw materials. The Romanian agricultural sector is undergoing structural changes but remains deeply polarized. Romania accounted for 30% of EU farms, but they account for only 3.3% of total standard production.

In 10 years the total number of farms has decreased by approx. 5%, but still the country with the largest number of such entities in the EU. The average size of farms has reached 3.3 to 3.6 ha, well below the EU average of 15 ha (3 million farms have less than 5 ha, and 12,310 farms have more than 100 ha, with an average of 485 ha). Almost all Romanian agricultural farms are family-owned, with a workforce of family members (99.3%). They have a weak commitment to cooperation, to meet the demands of the markets, to have access to credit and insurance. In Romania there are 17 groups of producers in temporary organizational structures, but they do not have the status of cooperative with cluster values or distinct value chain. There are 8 inter-branch organizations that contribute to vertical cooperation. There are also 24 recognized associations or producer organizations, and only one of the 68 cooperatives in Romania is recognized as a producer organization. (CAP Recommendations, 2020) The number of agricultural holdings shows decentralization with the distribution of labor resources between them. Excessive parcelling, based on the land reform of 1991, led to subsistence agriculture in Romania, ensuring its own consumption, without force on the market. The decrease in the number of agricultural holdings does not refer to their abolition, but to mergers, associations, clustering, etc. (Albu L.-L. et al., 2017)

It is certainly necessary to improve the situation of farmers and in conjunction with entities in the food processing industry within the general value chain, by resorting to: 1) associations, 2) clustering, the use of 3) short value chains, proximity and 4) feasible, sustainable food chains.

3.2 Development of short supply chains

We appreciate that at present (2022) we can move to the phase of transient development, resorting to *medium-sized agricultural holdings*, stimulating the formation of working capital, access to finance and the market. The creation of short food chains and the development of producer groups among small farmers can help farms to integrate into national and European markets (there is a concentration of agri-food supply at EU level), to respond to market demand (quantity, quality, rhythmicity and short delivery times, traceability, etc.). We find *the poor promotion of Romanian agri-food products* and the fact that the appropriate product branding is missing. The shortcomings are based on *the weak association between producers,* the difficult access of farmers and those in the food industry to the level of sophistication and entrepreneurial ambition in the field. The potential for recognition and promotion of local trademarks through Traditional Specialty Guaranteed (TSG), Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) or Certification is still untapped.

3.3 Visions and alignments for research

In Romania, it is elaborated a *Strategy for the development of the agri-food sector in the medium and long term - 2020/2030* for the intelligent and sustainable capitalization of the agri-food potential. It sets out the EU's commitment to the implementation of the CAP (Common Agricultural Policy), mainly through:

- *Priorities:* (1) consolidating land, farms and removing constraints from the land market; (2) increasing the capitalization of the country's agricultural potential and (3) reducing rural poverty.

- *Improving competitiveness:* (1) regional products, (2) improving the agri-food chain by developing associative forms and (3) increasing production.
- *Elimination of constraints in rural development:* (1) access to finance, (2) land concentration, (3) access of young people in the field and (4) skills training.
- *Combating rural poverty:* (1) employment opportunities, (2) access to credit for productive activities and (3) stabilization of the young rural population.
- *Improved institutional and policy framework:* (1) enhanced cooperation between farmers and processors of agricultural food products, (2) efficiency of agricultural / food administration and (3) efficient research-education system with rural advisory services.

Romania has access to global markets through the Black Sea and Danube ports, access to funding from European funds and domestic demand is strong. The short, medium and long proximity chains can ensure Romania a resilient, sustainable and competitive agro-eco-food sector, with the export of value-added products. It is necessary to achieve a level of coherence between agriculture, the environment and rural development. The strategic directions and objectives in the field refer to:

- Competitiveness of the agro-eco-food sector;
- Increasing the coverage of food consumption from domestic production, acquiring the status of net agri-food exporter;
- Limiting the carbon footprint of agriculture, promoting environmentally friendly and climate-resistant agriculture, water management and encouraging renewable energy production;
- Improved living standards in rural areas;
- Partnerships for education / consulting, ICT, RDI and improving the performance of agricultural administration;
- Promoting the concept of partnership for development, developing the internal capacity to achieve short, close value chains in the field.

3.4 Meta-field of forecasts based on differences and similarities between classification and agro-eco-industrial clustering

In the theory and practice of economic / agro-eco-industrial events, found in simulations with supervised databases, there is a requirement for data classifications and delimitations for the use of knowledge in decision making, including for associations and formations of clusters / proximity chains. Possession of data sets can be: a) general, b) supervised, c) unsupervised, d) in irrational spaces, e) in rational spaces, f) with normal / special distributions, etc. A classification is limited to outlining an "observation", respectively to obtaining particular, delimited signs, which may fall under the scope of quantitative and qualitative analysis. *The classes of classifications* obtained can be introduced in matrices which can be associated with properties that highlight variants and co-variants, conventional or unconventional distributions. For the time being, no specific classification spaces have been formalized that have more complete completeness than the traditional spaces (Euclidean, Boolean, Hilbertian, etc.). It is found that between *clustering* and *classification* there are differences, differences. *Clustering* takes place the grouping of data / points without taking into account their relative label / name, but the characteristics of companies / enterprises processing agricultural products, agricultural farms, if similar, justify their proximity / reunion. Such an approach, which does not outsource the information related to the data content, is qualified as *unsupervised learning*. Clustering is the result of *unsupervised learning*. If we take into account the labels / names of the data, the points, then we are dealing with *supervised learning,* a situation in which premises are created for the generation of a data system, which leads *to classification*.

Classification shows pre-determined sets of data categories, with which data classes that characterize agro-eco-industrial companies can be predefined. In the above description *classification* and *clustering* give the impression of similarity. In cluster mathematics we find: a) *supervised clustering* (clusters that have high probability density to a single class), b) *unsupervised clustering* (a function that minimizes the distances inside a cluster to keep the cluster tight), c) *semi-supervised clustering* (using side information in clustering process to enhance a clustering algorithm). (Hand, D.J., 2003)

The life and success of an agro-eco-industrial cluster depends on the distance between the points (which are processing industrial enterprises, objects of activity, profits pursued, etc.). The data found spatially and / or in time, always record positions (coordinates) that suggest: a) overlaps, b) tangents, c) distances / distances in plan or in multiplanes (n-dimensional). Searching and measuring distances between data is a procedural premise for the process of delimitations, contours, isolations, etc. of properties, resulting in the real basis of opportunity for the construction of clusters in the conditions in which the properties, functions, role, etc. data allow them to agglomerate, precipitate, coagulate, associate, quasi-autarky, etc.

Grouping or *spacing* is subject to analysis, and the discovery of techniques for stabilizing space or time intervals between data means iterative / repetitive modeling effort. A number n_i of data with parametric values p_i enter the matrix process, a situation in which even their placement in the matrix is implicit, intrinsic partitioned learning. Spatial and temporal distances can be found incidentally in pre-clustering processes, thus detecting the situations / states of configuration of specific, categorical data organization structures. It is possible, therefore, to outline a meta-field of agro-eco-industrial clustering forecasts based on the behavior of classifications. In this way, the detection and quantification of the agro-eco-industrial behavior takes place, because we find that in the Romanian agriculture and food industry there is a certain “hidden strategic and managerial behavior”.

The question is whether this "hiding" is implicit, free, or "constructed," based on lack of communication or non-communication of knowledge. In order to identify the formation potential of agro-eco-industrial clusters in Romania, clarifications are needed related to the meta-prognostic relationships between agriculture, the food industry, forecasting and forecasting agents (mathematical elements). (Figure no 1)

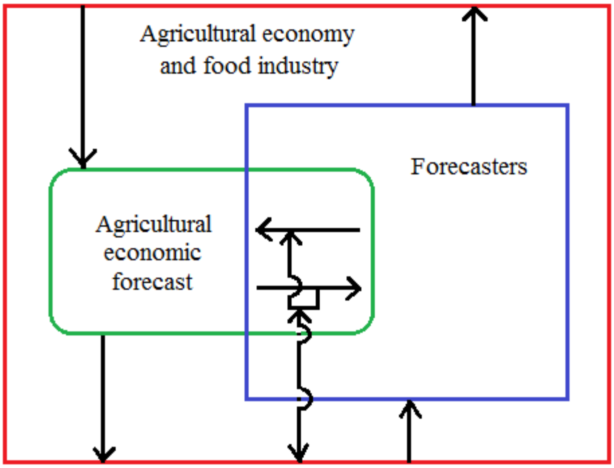


Figure no. 1. Meta-prognostic relationships between agriculture, food industry, forecasting and forecasting agents (mathematical elements)

The research of the above situation can start from the incipient example of evaluating the coordinates characteristic of the agro-eco-industrial entities in Romania related to pre-clustering. (Figure no 2)

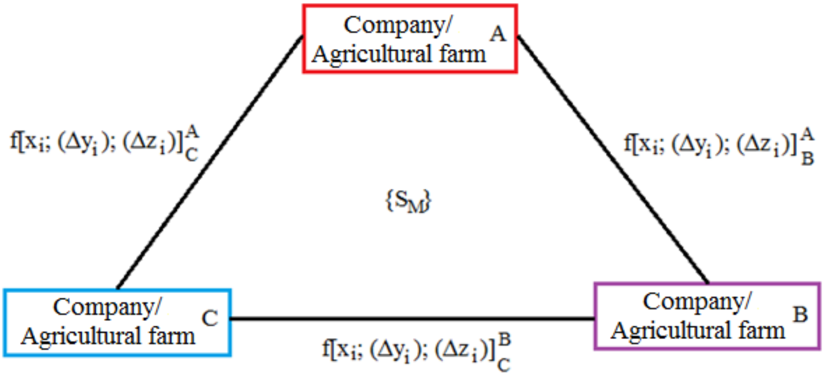


Figure no. 2. Example of assessment of the coordinates characteristic of agro-eco-industrial entities related to pre-clustering

in which:

x_i = horizontal geographical distances;
y = (Δy_i) = differentiations / differences (coincidences) between fields of activity;
z = (Δz_i) = differentiations (differences) / approximations (coincidences) between the strategic, tactical and profit objectives of the agro-eco-industrial entities.

$\{S_M\}$

This framework defines a set of characterization values in a metric space by a symbolic system with specific constraints:

$$\begin{cases} \{S_M\} = \{f(d_{AB}) * f(d_{BC}) * f(d_{Ac})\} \\ d_{AB} \leq [d_{BC} + d_{Ac}] \\ d_{BC} \leq [d_{AB} + d_{Ac}] \\ d_{AC} \leq [d_{AB} + d_{Bc}] \end{cases} \quad (1)$$

The metric space $\{S_M\}$ shows a significant triangular inequality between the 3 agro-eco-industrial entities, but offering attractiveness through properties of symmetry and *ultra-metric inequality*. On this basis, a sub-dominance of pre-quantified distances with the help of ultra-metricity is reported. The mathematical extensions of the above concept refer to the examination of the median, a (max), (min), respectively a (maxmin / minmax), all in Euclidean vision.

3.5 Ontology of classification in the meta-field of forecasts for agro-eco-industrial clustering

Modeling operations for identifying, respectively establishing the distances between data (agro-eco-industrial entities) involve: 1) measuring the dispersion, 2) the associations and 3) the combinations between the data. (Figure no 3)

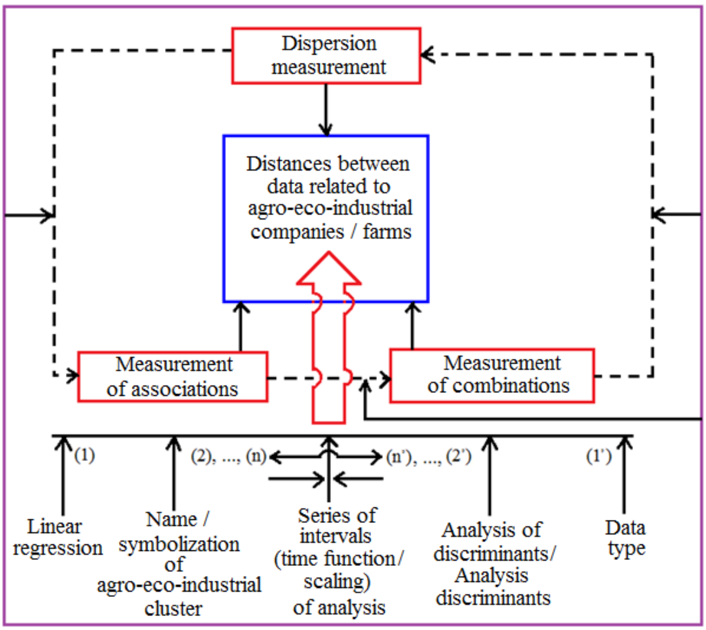


Figure no. 3. Operations for identifying / establishing distances between data in the clustering process

The rows and columns of an *n*-matrix give the primary image of the set of data gathered randomly, in variable or fixed time, (t = ct. = 0), found between agro-eco-industrial entities on the occasion of self-identification of at least one property similar, connected to similarity and at least virtual-tangential acceptance (for example, industrial enterprises in the same branch, in the same field, etc.).

Instead, $\bar{n}$ = the matrix in $(:\bar{\mathrm{R}})$ is the one in which / which can be operated simulatively with the preservation in (:R) of the real multi-simulative states of the first image entered under the incidence of researching the distances between date.

The tabular model T:(R) is purely associative with the re-image of the tabular model T: $(\bar{\mathrm{R}})$, operating, in fact, with the tabulation $(\bar{\mathrm{T}})$. In such a vision, we are dealing with an ontology of classification in a meta-field of forecasts for agro-eco-industrial clustering, through which ideas and intentions are obtained to resort to ultra-, metric or with sub-metricity. (Figure no 4)

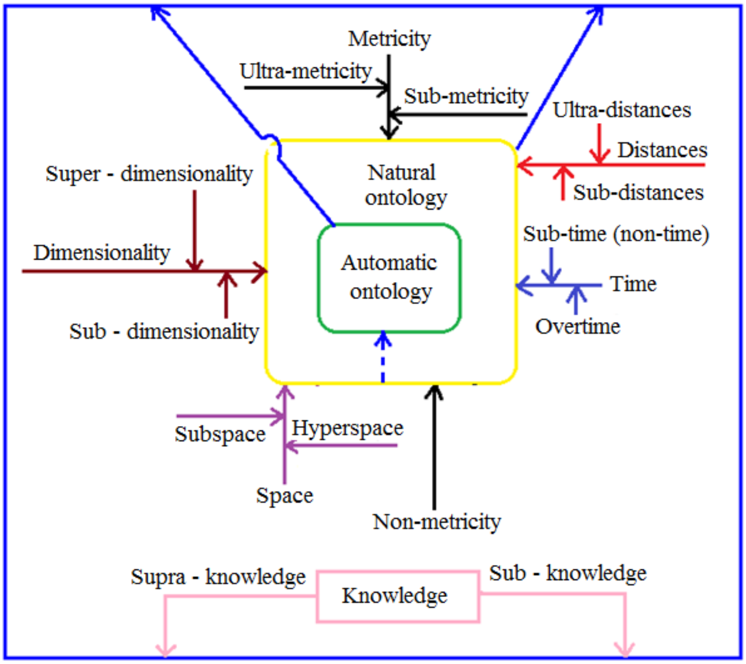


Figure no. 4. The role of sub-metricity, metricity and ultra-metricity in the observation of an automatic ontology in the classifications supporting agro-eco-industrial clustering

Ultra-metricity in a cluster field is useful in decisions to organize and manage the "joining" of agro-eco-industrial entities with each other, as a first step triggered by the inherent data systems on: 1) the shape of each entity, 2) the object activity and 3) the hierarchical power of the agro-eco-industrial entity / agro-eco-industrial cluster in the field.

3.6 Obtaining univariate classifications in agro-eco-industrial clustering

This paper proposes the algorithm of informal classes of supervised / unsupervised data on agro-eco-industrial entities in Romania in order to establish classifications that would motivate the formation of agro-eco-industrial clusters. Let be a number of informal classifications {C} to which statistical treatments can be applied (S). If these classifications are rational (:R; : $\overline{R}$), then the statistical treatments are to eliminate the reminiscences (δ_i) and redundancies (r_i) that occupy the spaces between the data. (Figure no 5)

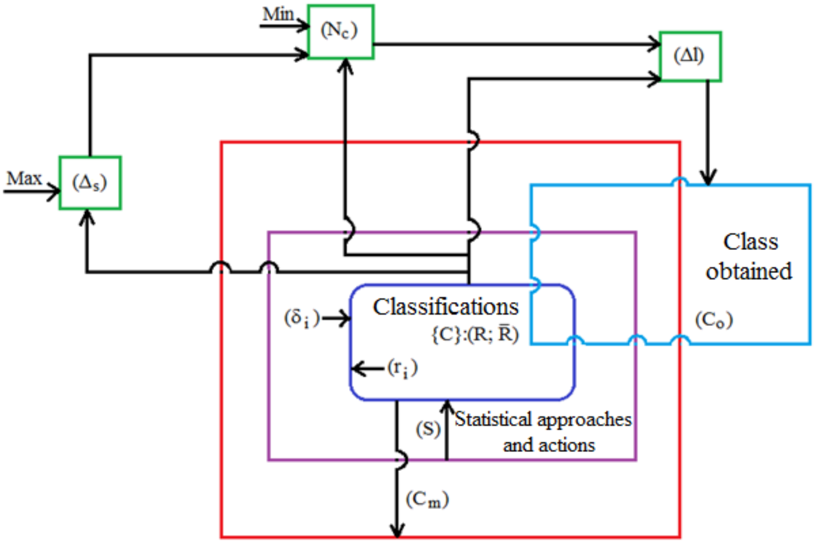


Figure no. 5. Procedural algorithm to obtain univariate classifications

in which:

(C_m) = multivariate classification;
(C_o) = univariate classification;
(Δl) = linearization transformations;
(Δ_s) = class / sub-class separation;
(N_c) = number of classes.

The simplification of calculations for ultra-metricity determinations is related to the identification and analysis of linear discriminants. Transformations for linearization's (Δl) can record relative / absolute amplitudes, highlighting the depth of refinements to eliminate reminiscences / redundancies, aiming to reduce the spaces / distances between data. In the literature in the field (Gâf-Deac I.I., et al., 2014 and 2016), concerns are highlighted for the search for global classification models, or for spatiality / spatialization, respectively the location of classifications. The most important property in the process of searching for classifications comes from *procedural adaptability,* an aspect that does not introduce the obligation to establish methods, procedures, techniques, etc. in the field, immutable for classification. (Tutz, G., 2005; Gâf-Deac I.I., 2010)

Starting from the grapho-formalization from Figure no. 5, it can be written:

$$\begin{cases} (C_m) \xrightarrow{(s)} \{C\} \\ \forall[\mathrm{Max}(\Delta_s) * \mathrm{Min}\ (N_c)] \xrightarrow{(\Delta l)} (C_o) \\ (C_o) \in [\{C\}f(s) \subset (C_m)] \approx [\{C\}f(s) \cap (C_m)] \end{cases} \quad (2)$$

At the same time:

$$\{C\}: (R; \bar{R}) - [\Phi(\bar{C}) + \Phi(\delta_i) + \Phi(\Delta_{cm})] = (C_o)f(\Delta l) \quad (3)$$

$$\{(\Delta_s)*(N_c)\} \rightarrow \mathrm{Max\ Min}\ f(\Delta l) \quad (4)$$

On the other hand:

$$\begin{cases} \sum_{i=1}^{k}(\delta_i) = \max\Phi(\delta_i) \\ \sum_{i=1}^{k}\Delta(C_m)_i = \max\Phi(\Delta C_m) \end{cases} \quad (5)$$

and

$$[\{C\}: (R; \bar{R})] - \{\pm\sum_{i=1}^{k}(\delta_i) \pm \sum_{i=1}^{k}\Delta(Cm)_i\} = (C_o)\,|_{(\Delta l)} \quad (6)$$

Making n observations of the type $(a_i, b_i, c_i, ..., z_i) \in R$ in real space, each variable provides a sub-image (SI) in the set $\{M_o\} \supset [(SI)_{ai}; (SI)_{bi}; ...; (SI)_{zi}]$ who become corresponding members of an incipient non-reminiscent and non-redundant classification. The placement of sub-images in variance-covariance matrices shows the dimensional and qualitative disproportions of the observations made on agro-eco-industrial enterprises.

Eliminating discrepancies means reducing the virtual weight of events found in simulations with supervised / unsupervised databases about the companies in question. In the context, the analogous set $\{\bar{M}_o\}$, appears, falsely appropriate and non-covariate, which is not far from the set of sub-images initially identified / delimited.

Therefore:

$$\{\bar{M}_o\} \wedge \{M_o\} \quad (7)$$

At the same time:

$$\begin{cases} [\max\Phi(\delta_i)] \wedge [\max\Phi(\bar{\delta_i})] \\ [\max\Phi(\Delta C_m)] \wedge [\max\Phi(\Delta\overline{C_m})] \end{cases} \quad (8)$$

$$[\{\sum_{i=1}^{k}(\delta_i)\}*\{\sum_{i=1}^{k}\Delta(Cm)\}] \rightarrow (C_o) - (\Phi\{M_o\})^{(Cm)} = \{M_o\}^{(Co)} \quad (9)$$

On the final configuration $\{M_o\}^{(Co)}$ one can make learning efforts, understanding the nature and realism of validated sub-images, in order to be included in a consolidated, non-reminiscent and non-redundant classification.

4. Results and discussions

In the Romanian economy, the CAEN Code provides a List of fields of activity in which companies of all sizes, state or private, can be found. (Companies-Domains, 2021) The National Institute of Statistics of Romania (NIS) has elaborated the revised version of the Classification List of activities within the national economy (NACE), in order to be compatible with the European classification list. According to NIS, the new version of the

Code has four new sections, 26 divisions, 48 groups and 101 classes, more than the old version. (ascentgroup, 2022)

Analyzing the structure of NACE Code of Romania, we used to delimit two groups of fields: (A) - Agriculture, forestry and fishing and (C) - Manufacturing industry (agro-eco-industrial / food) and we found that they comprise 43,709 (A = 26,767, respectively C = 16,942) private and state organizational entities (enterprises, firms, joint stock companies, limited liability companies, etc.).

Using the algorithmic procedure proposed in this article to obtain univariate classifications useful in achieving agro-eco-industrial clustering in the Romanian economy (Figure no. 5), the allocation of qualifiers / important coefficients was used (Table no. 1 and Table no. 2) for the categories that characterize agglomeration, proximity, tangents, similarities, coagulation, etc. agro-eco-industrial companies that will find themselves in the "silence" of different clusters:

- $\{S_M\}$= *inter-coordinate space / area for pre-clustering* = "0" (monolith / nonsense for clustering) = 0.00; min (very favorable for clustering) = 0.90; med (favorable for clustering) = 0.50; max (unfavorable for clustering) = 0.10; "1" (completely unidentified and invisible agro-eco-industrial companies / nonsense for clustering);
- (Δl) = *linearization transformations* = min (favorable for clustering) = 0.80; med (stagnation / inactivity for clustering) = 0.50; max (unfavorable for clustering) = 0.10;
- (Δ_s) = *separation of classes / subclasses* = min (unfavorable for clustering +) = 0.20; med (favorable for clustering) = 0.50; max (unfavorable for clustering "-") = 0.45;
- (N_c) = *number of classes* = "0" (monolith / nonsense for clustering); min (favorable for clustering +) = 0.30; med (favorable for clustering ++) = 0.60; max (favorable for clustering +++) = 0.90; "1" (all subject companies are fully identified and visible to each other / nonsense for clustering);
- (C_m) = *multivariate classification* = min (favorable for clustering +++) = 0.80; med (favorable for clustering ++) = 0.70; max (favorable for clustering +) = 0.60;
- (C_o) = *univariate classification* = min (favorable for clustering +) = 0.30; med (favorable for clustering ++) = 0.50; max (favorable for clustering +++) = 0.90.

The observations resulting from the assessment with ratings / coefficients of importance for the categories that characterize the clustering predispositions can be systematized on a scale of levels, with grades (L_i) of positive acceptance increasing over a range [1,…, 10]. (Figure no 6 and Figure no 7)

Table no. 1. Relevant financial data and generic ratings for the categories that characterize the clustering predispositions for the domains (A; C)

Specifications	**{CA} Bill.. Euro**	**{P} Bill. Euro**	**{NS}**	**{NC}**	**$\{S_M\}$**	**(Δl)**	**(Δs)**	**(N_c)**	**(C_m)**	**(C_o)**	**(L_i)**
A - Agriculture, forestry and fishing	9,400	0,890	125.767	26.767	x	x	x	x	x	x	x

01. Agriculture, hunting and related services	7,600	0,770	86.701	20.869	min	min	med	max +++	min +++	max +++	L8
011 – Cultivation of non-perennial plants	4,180	0,490	47.617	11.679	med	med	min +	min +	max +	med + +	L6
012 - Cultivation of plants from permanent crops	0,280	0,039	4.779	2.149	min	min	med	max +++	min +++	max +++	L9
013 – Cultivation of plants for propagation	0,029	0,003	601	210	max	max	min +	"1"	max +	min +	L4
014 – Animal husbandry	1,980	0,013	22.273	3.492	min	min	med	max +++	min +++	max +++	L9
015 - Mixed farm activities (vegetable growing combined with animal husbandry)	0,600	0,048	6.588	1.412	min	min	min +	max +++	min +++	max +++	L8
016 Activities ancillary to agriculture and post-harvest activities	0,560	0,047	4.525	1.853	max	max	max	med ++	max +	max +++	L4
017 Hunting, trapping of game and service activities ancillary to hunting	0,001	0,000(1)	510	74	"0"	max	max	"1"	max +	min +	L2
C. Manufacturing industry	x	x	x	x	x	x	x	x	x	x	x
10 Food industry	10,000	0,062	152.760	13.474	min	min	med	max +++	min +++	max +++	L9
101 Production, processing	3,120	0,018	46.861	1.169	min	min	med	max +++	min +++	max	L9

and preservation of meat and meat products										++ +	
102 Processing and preserving of fish, crustaceans and mollusks	0,012	0,000(6)	1.534	68	med	me d	min +	med ++	med ++	me d ++	L5
103 Processing and preserving of fruits and vegetables	0,052	0,000(2)	5.869	1.254	min	min	med	max ++ +	min ++ +	ma x ++ +	L9
104 Manufacture of vegetable and animal oils and fats	1,000	0,020	3.208	188	min	min	med	max ++ +	min ++ +	ma x ++ +	L8
105 Manufacture of dairy products	1,200	0,060	11.380	789	min	min	med	max ++ +	min ++ +	ma x ++ +	L9
106 Manufacture of milling products, starch and starch products	0,740	0,023	8.096	774	min	min	med	max ++ +	min ++ +	ma x ++ +	L9
107 Manufacture of bakery and flour products	1,880	0,017	64.428	7.484	min	min	med	max ++ +	min ++ +	ma x ++ +	L9
108 Manufacture of other food products	0,940	0,090	13.437	5.616	min	min	med	max ++ +	min ++ +	ma x ++ +	L7
109 Manufacture of animal feed preparations	0,380	0,018	1.947	241	med	me d	min +	min +	max +	me d +	L3

Note:
{NC} = number of organizational entities, companies, enterprises, firms, farms, SRL / SA, with specific object of activity; {NS} = number of employees; {CA} = turnover; {P} = profit.

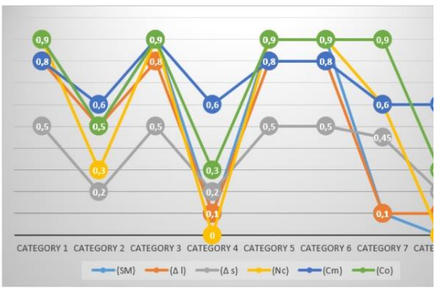
The data are according to the balance sheet submitted in 2021 for fiscal year 2020; Official data source: National Office of the Romanian Trade Register (ONRC); Updated CAEN code 2022 (coduricaen.ro/www.coduricaen.ro#A).

Table 2. Coefficients of importance* for the categories that characterize the clustering predispositions for the domains (A; C)

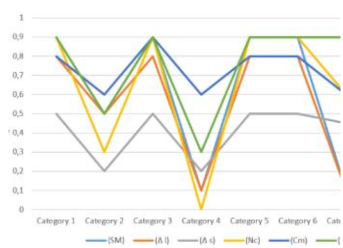
Specifications	$\{S_M\}$	(Δ l)	(Δ s)	(N_c)	(C_m)	(C_o)
(A)	x	x	x	x	x	x
(01)	0,90	0,80	0,50	0,90	0,80	0,90
(011)	0,50	0,50	0,20	0,30	0,60	0,50
(012)	0,90	0,80	0,50	0,90	0,90	0,90
(013)	0,10	0,10	0,20	0,00	0,60	0,30
(014)	0,90	0,80	0,50	0,90	0,80	0,90
(015)	0,90	0,80	0,50	0,90	0,80	0,90
(016)	0,10	0,10	0,45	0,60	0,60	0,90
(017)	0,00	0,10	0,20	0,00	0,60	0,30
(C)	x	x	x	x	x	x
(10)	0,90	0,80	0,50	0,90	0,80	0,90
(101)	0,90	0,80	0,50	0,90	0,80	0,90
(102)	0,50	0,50	0,20	0,60	0,70	0,50
(103)	0,90	0,80	0,50	0,90	0,80	0,90
(104)	0,90	0,80	0,50	0,90	0,80	0,90
(105)	0,90	0,80	0,50	0,90	0,80	0,90
(106)	0,90	0,80	0,50	0,90	0,80	0,90
(107)	0,90	0,80	0,50	0,90	0,80	0,90
(108)	0,50	0,80	0,50	0,90	0,80	0,90
(109)	0,50	0,50	0,20	0,30	0,60	0,50

Source: data processed by the authors

Note: * The importance / weighting coefficients are in the range [0, ..., 1].

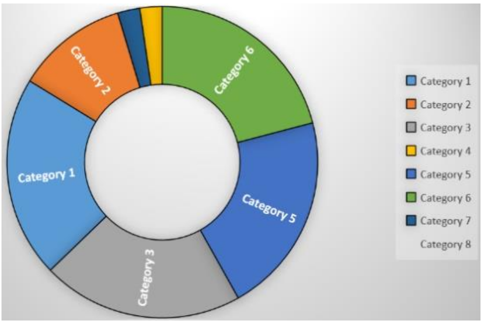


a)

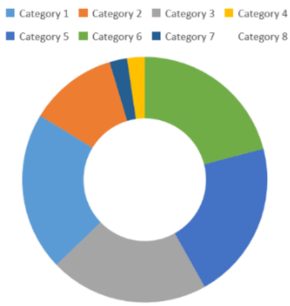


b)


c)
Category 1 Category 2 Category 3 Category 4 Category 5 Category 6 Category 7
(SM) (Co)
d)
Category 1 Category 2 Category 3 Category 4 Category 5 Category 6
(Δ l) (Co)
e)
Category 1 Category 2 Category 3 Category 4 Category 5 Category 6 Category 7
(Δ s) (Co)
f)
Category 1 Category 2 Category 3 Category 4 Category 5
(Nc) (Co)
g)
Category 1 Category 2 Category 3 Category 4 Category 5 Category 6
(Cm) (Co)
h)
Category 1 Category 2 Category 3 Category 4
Category 5 Category 6 Category 7 Category 8
i)
Category 1 Category 2 Category 3 Category 4 Category 5 Category 6 Category 7
0-0,1 0,1-0,2 0,2-0,3 0,3-0,4 0,4-0,5 0,5-0,6 0,6-0,7
j)
Category 1
Category 8
Category 7
Category 6
Category 5
(SM) (Δ l) (Δ s) (Nc)



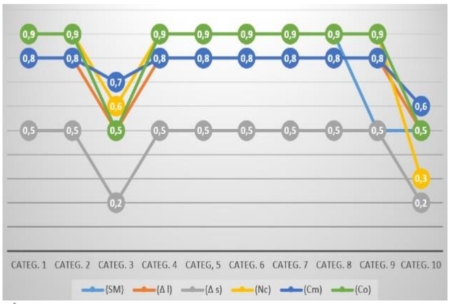
k)



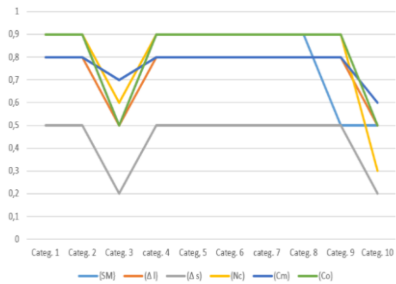
l)

Figure no. 6. Developments, trends and clustering potential for (A) - Agriculture, forestry and fishing in Romania
in which:

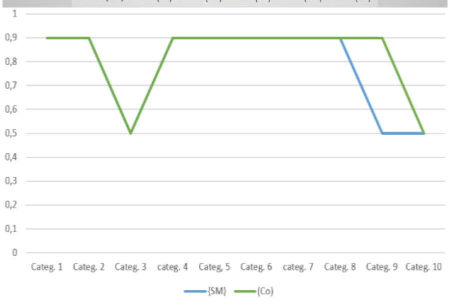
a) - b) = dominance (C_0) in the set of clustering potential characterization parameters (A);
c), d), f), e), f), g) = dominances of (C_0) in individual comparisons with the parameters of characterization of the clustering potential (A);
h), i), j), k), l) = weights for dominance (C_0) in the set of clustering potential characterization parameters (A).



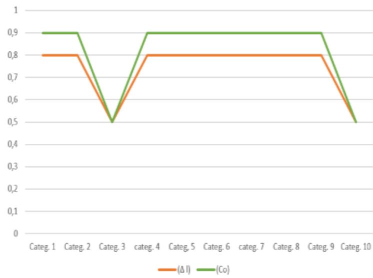
1



2



3



4

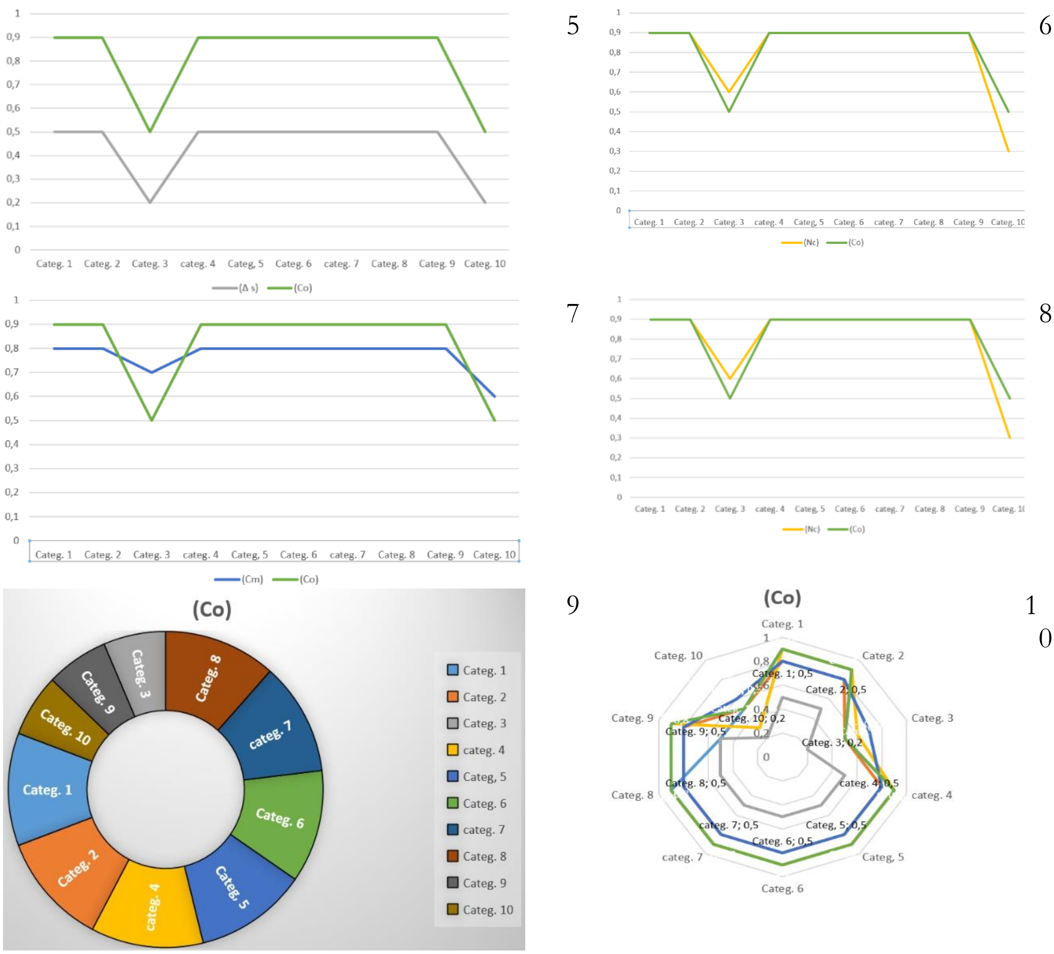


Figure no. 7. Developments, trends and clustering potential for (C) - Manufacturing industry (agri-food) in Romania

in which:

1)-2) = dominance (C_0) in the set of clustering potential characterization parameters (C);
3), 4), 5), 6), 7), 8) = dominance of (C_0) in individual comparisons with clustering potential characterization parameters (C);
9), 10) = weights for dominance (C_0) in the set of clustering potential characterization parameters (C).

Based on the above assessments, it results that for the fields researched as an example in the Romanian economy in 2019, there is a clustering potential of 83.40% in Group (A) of domains (5 positive positioning of the parameters, compared to 3 below the limits of favorability), respectively 60.00% in Group (C) of domains (8 positive positions of the parameters, compared to 2 below the limits of favorability), (Table no. 2). It is found that, in fact, (The European Cluster Conference, 2019; immoss.ro, 2020) the aggregate contribution of Romanian clusters is starting to increase in the main macro-economic indicators. At the establishment of the Romanian Cluster Association (ASR), the founding members were 20 clusters, including the Agro Food Cluster Bucharest Ilfov, the Agro Food Vest West Cluster, Arad, the Covasna Agro Food Cluster. Of the 20 founding members, 16 are directly involved in the export activity. Out of the total of 295 clusters (2020) in Romania, 63.55% are involved in the export activity, and 8.47% are large enterprises, 37.28% small and medium enterprises, 11.86% associations, 11.86% universities, 5.08% research institutes, 7.62% public authorities and 12.71% catalyst organizations. (ASR, 2020, Clusters in Romania, 2019)

The domains in which the agri-food clusters operate are mainly found in the Group composed (A; C) of domains from the CAEN Romania Code (Table no. 2), which confirms the clustering potential on these alignments.

5. Conclusions

Romania and Europe need strong, competitive and innovative agriculture and agri-food industry, based on clusters and cluster networks, through collaborative and multi-sectoral approaches, by stimulating interactions between knowledge-based companies. There are currently more than 54,900 clusters operating in Europe (according to the European Cluster Observatory, 2020), but we recognize that the EU lacks international clusters. Romania / Romania's economy, agriculture and the agro-industrial food sector can contribute to the clustering of the European economy. The mathematical apparatus of classification must be developed, because on the basis of symbolic mathematical models it is possible to develop computer programs / computerization calculations for ultra-metricity determinations of transformations for linearizations of similarities between firms, eliminating reminiscences / redundancies, aiming to reduce spaces / distances between data which represent the agro-eco-industrial enterprises that can enter the clusters. In real structures the data are still in reminiscent and redundant sub-spaces. The lack of tangents, the wide dispersion of data show repetitions of distances providing redundancies.

It follows that, in fact, the cultivation of plants in permanent crops, animal husbandry, the food industry, the production, processing and preservation of meat and meat products, the processing and preservation of fruit and vegetables, the manufacture of dairy products, the manufacture of milling, bakery and flour products are the most suitable fields in Romania for the realization of integrated value chains (with the qualification L9) and the establishment of specific clusters.

Transformations for linearizations should not be absolutized, because the construction of linearization determinants is difficult, involving inaccuracy, unpredictability and quasi-incompleteness. With such determinants with *aproperties,* errors can occur, their propagation rates are born and, in the end, the construction or delimitation of the intended classification is influenced. The basic proposal is to resort to procedural adaptability, formalizing useful sub-images, support, to eliminate discrepancies and reduce the virtual weight of events found in simulations for agro-eco-industrial clustering. Global classification patterns must be sought, respectively for the location of classifications. Thus, the practical framework for the significant formation (emergence) of agro-eco-industrial clusters in the Romanian economy and territory can be seen.

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