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An Entropic Approach to Technology Enable Learning and Social Computing

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Abstract. Understanding one's own behavior is challenging in itself; understanding a group of different individuals and the many relationships between these individuals is even more complex. Imagine the amazing complexity of a large system made up of thousands of individuals and hundreds of groups, with countless relationships between those individuals and groups. However, despite this difficulty, organizations must be managed. Indeed, ultimately the organization's work is done by people, individually or collectively, alone or in combination with technology. Therefore, organizational behavior management is the central task of management work – it involves understanding the behavior patterns of individuals, groups, and organizations, predicting what behavioral reactions will be elicited by various managerial actions and finally applying this understanding. Undeniably, society's work is often done by organizations, and the role of management is to make organizations do that work. Without it, our entire society would quickly stop operating. Not only would the products you have come to know and love swiftly to evaporate from store shelves; food itself would suddenly become scarce, having drastic effects on huge numbers of people. To this end, the term *Technology-Enhanced Learning* is used to support workers' learning about technology; the gap between what is understood to be satisfactory and the current level of knowledge of the workforce is addressed by a *Logic-programming-based Social Computing Framework* entitled *An Entropic Approach to Knowledge Representation and Reasoning*, which relies on computational structures built on *Artificial Neural Networks* and *Cases -based Thinking*, as well as predictions and/or assessments, to empower the level of knowledge of the employees, here in technology, later in other areas.

Keywords. Entropy, Technology Enable Learning, Social Computing, Artificial Neural Networks, Case-based Reasoning, Computational Sustainability.

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1. Introduction

The success of any large organization is dependent on the success of each individual. The more successful individuals there are, the more successful the organization will be. In a large organization, there are many people and groups with different relationships to one another [1]. These relationships can be categorized into cooperative, competitive and conflictual. For example, a company may have employees who are in direct competition with one another for promotion opportunities or funding. However, in order to maintain productivity, it is important for all groups to work together cooperatively as well as competitively [2]. Every organization is unique. And yet, they all have one thing in common – the human element. The human element is what we can't get rid of and it is also the most complex aspect to a large organization. Indeed, our focus will be on the complexity of a large organization made up of thousands of individuals and hundreds of groups with myriad relationships. The focus will be on the human element to show how it defines an organization's uniqueness and its complexity. Definitely, the human element is the key to success in any situation. It is important to make sure that we are using the right people for the right job and that they have the right skillset for their position. Questions like these form the area of Organizational Behavior and are the focus of this work in the sense of Technology Enable Learning (TEL) [3]. People are the backbone of any organization, and they are what makes it stand out from others. They define an organization's uniqueness and complexity by creating a culture, values and beliefs that are specific to them. Organizations are complex systems and they rely on the input of their members to function. One of the most important inputs is human behavior. Understanding how people behave in organizations helps us understand how they will react to changes in organizational structure, culture, or processes. Hence, the question, viz.

Which are the potential benefits of adopting Technology Enable Learning?

Businesses quickly learn the benefits of using different digital learning platforms and tools. In fact, statistics indicate that the eLearning market in USA is a $197 billion business and is expected to reach $840 billion by 2030. Other studies show that today 80% of companies in the USA report using digital learning to encourage employee retention and improve learning programs. Unlike traditional learning methods that rely heavily on long lectures and thick printouts, digital learning uses a variety of formats such as text, video, animation, and gamification. Truly, not every employee processes information in the same way as the other. Some prefer to scroll through text while others do it by watching videos. For example, to decide on the qualified position of each individual in his/her organization, one may proceed having the employees answers the questionnaires [4], viz.

Importance of Each One – Five Elements (IEO – 5), that includes the statements, viz.

- *Q1 – Increasing habit of using technology by workers to organize their work affairs;*
- *Q2 – Achieving financial benefits for the organization;*
- *Q3 – Enabling workers to become self-directed learners;*
- *Q4 – Quantitative and Qualitative improvement in workers learning outcomes;* and
- *Q5 – Varying the setting in which instructive doings can be accepted to rise tractability for workers in terms of place, time and in what way to do a job.*

Scale, viz.

Extremely Critical (3), Critical (2), Not Critical at All (1), Critical (2), Extremely Critical (3)

Indeed, the benefits of adopting technology enable learning to each one in an organization may lead the workers to improve engagement and motivation; increase workers achievements; increase coaches' effectiveness; reduce costs.

The Need for Clear Organizational Aims and Goals (NCOAG – 3), that includes the statements, viz.

- *Q6 – Global reach by providing intelligence that trainees can take any place in the earth;*
- *Q7 – Taming convenience and tractability for labors to appeal to hard-to-reach groups of learners; and*
- *Q8 – Offering experiences in connection with other establishments, on a joint training relationship.*

Scale, viz.

Extremely Critical (3), Critical (2), Not Critical at All (1), Critical (2), Extremely Critical (3)

Organizations need to have clear organizational aims and goals to be successful. They need to know what they want to achieve and how they are going to do it. Undeniably, the first step is for the organization to identify its mission, vision, and values. The second step is for the organization to create a plan that will help them achieve their goals. The last step is for the organization to implement this plan by making sure that everyone knows what their role is in achieving these goals.

How Prepared for TEL is an Organization (TEL – 6), that includes the statements, viz.

- *Q9 – What percentage of training members have knowledge and expertise for teaching;*
- *Q10 – What percentage of the training members have voiced some interest in working with TEL?;*
- *Q11 – What percentage employees have access to computer equipment?;*
- *Q12 – What percentage of the employees have some familiarity of utilizing computer know-how?;*
- *Q13 – What percentage of workplaces in the organization are equipped for TEL activities? and*
- *Q14 – What percentage of executives have been involved in debates around the influence of accepting or increasing the use of TEL?*

Scale, viz.

> 75% (4), 51 – 75% (3), 25 – 50% (2), < 25% (1), 25 – 50% (2), 51 – 75% (3), > 75% (4)

The reactions to the above inquiries offer a shaky assessment of the degree to which *TEL* is currently recognized within a corporation. Much more evidence, both qualitative and quantitative, may be needed to truly define how well-organized staff and trainers are for *TEL*. However, this goal goes beyond what is intended to be achieved in this work.

One's Background, Teaching, Style and Resources Available (BTSR – 2), that includes the statements, viz.

- *Q15 – How would you rate workers access to computer technology at your organization?; and*
- *Q16 – How would you rate trainers access to computer resource personnel in your organization?*

Scale, viz.

Outstanding (6), Very Virtuous (5), Virtuous (4), Suitable (3), Poor (2), Particularly Poor (1), Poor (2), Suitable (3), Virtuous (4), Very Virtuous (5), Outstanding (6)

Background, teaching style and resources available for an organization are all important factors that can affect the success of a company, i.e., a company's background is important because it can help them underover the questionnaires statements or terms stand what they are good at and what they need to improve on. Teaching style can aid the employees understand how work with each other and how to communicate with their clients. Resources available for an organization are also important because they can help the company grow in different ways. The organization is now in the position to look at the different statements in each questionnaire and compute the respective answers, that are presented in Table 1 in a qualitative form and in Tables 2 and 3 in a quantitative form [5]. On the other hand, the main advantage of the present approach over all other existing ones is that it represents a fractal structure, which allows to penetrate the statements of the questionnaire to infinity, thereby determining its content in the right way and in the right context. Indeed, a fractal is a never-ending pattern. Fractals are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing feedback loop [6].

2. An Entropic Approach to Knowledge Representation and Reasoning

Social Media Platforms such as *Facebook*, *Twitter*, *Instagram*, and *Snapchat* are examples of *Social Computing*. These platforms allow users to share their thoughts and feelings with others in a public forum. Indeed, *Technology* has enabled *Learning* and *Social Computing* in many ways. Undeniably, the use of technology in education is not new. It has changed the way we learn, interact with others, and share information.

The entries in Table 1, for example to questionnaire *NCOAG – 3*, should be read from left to right, from *Extremely Critical (3)* to *Not Critical at All (1)* (with a fall over in intelligence), or from *Not Critical at All (1)* to *Extremely Critical (3)* (with up and coming intelligence). For example, the answer to *Q8* was *Critical (2)* → *Extremely Critical (3),* which entails that intelligence on a particular subject tends to increase, whereas no alternatives are shown for *Q7*, which indicates an imprecise state of affairs, i.e., there is no indication that the employee is unaware about his/her undertaking [5, 7].

2.1. Technology Enable Learning and Social Computing – Best-case Scenario

On the one hand, the term *Best-case Scenario* was first coined by the American economist and statistician Irving Fisher in his book *"The Theory of Interest"* [8]. Fisher's theory states that if an investor has a portfolio with two investments, one with a high risk and one with low risk, then the *Best-case Scenario* would be for both investments to perform well. On the other hand, the term can also be used in other contexts, such as when describing the best possible outcome for a person's health or life.

Table 1. The answers of an employee to questionnaires *IEO – 5*, *NCOAG – 3*, *TEL – 6*, and *BTSR – 2*.

Questionnaire	Question	Scale											
		(6)	(5)	(4)	(3)	(2)	(1)	(2)	(3)	(4)	(5)	(6)	*vagueness*
IEO – 5	Q1				×	×							
	Q2							×					
	Q3						×	×					
	Q4					×							
	Q5												×
NCOAG – 3	Q6					×							
	Q7												×
	Q8							×	×				
TEL – 6	Q9									×			
	Q10							×		×			
	Q11						×						
	Q12												×
	Q13								×				
	Q14			×		×							
BTSR – 2	Q15	×	×										
	Q16							×	×				

Heading to Figure 1 Heading to

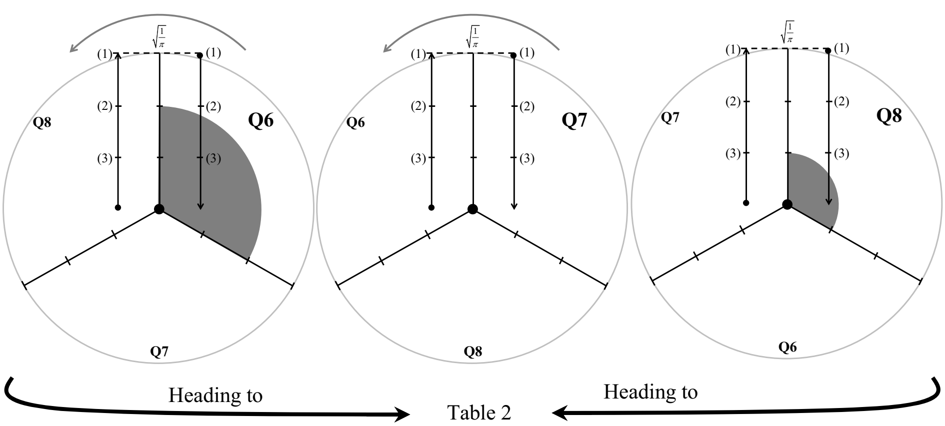

Figure 1. Pictorial interpretation of a *Worker Responses* to the *NCOAG – 3* survey in the *Best-case Scenario*.

Table 2. Evaluation of a *worker hypothetical tendency for the present universe-of-discourse to attain a state of maximum homogeneity (i.e. according* to his/her ripostes to *NCOAG – 3* survey in the *Best-case Scenario).*

	(NCOAG – 3$_{3\text{-}1}$) – Scale (3) (2) (1)	***(NCOAG – 3$_{1\text{-}3}$) – Scale (1) (2) (3)***
Q8	$exergy_{Q8} = \frac{1}{3}\pi r^2 \Big]_0^{\frac{2}{3}\sqrt{\frac{1}{\pi}}} = \frac{1}{3}\pi\left(\frac{2}{3}\sqrt{\frac{1}{\pi}}\right)^2 - 0 = 0.15$	–
	$vagueness_{Q8} = \frac{1}{3}\pi r^2 \Big]_{\frac{2}{3}\sqrt{\frac{1}{\pi}}}^{\frac{2}{3}\sqrt{\frac{1}{\pi}}} = 0$	–
	$anergy_{Q8} = \frac{1}{3}\pi r^2 \Big]_{\frac{2}{3}\sqrt{\frac{1}{\pi}}}^{\sqrt{\frac{1}{\pi}}} = 0.19$	–
Q9	$exergy_{Q_9} = \frac{1}{3}\pi r^2 \Big]_0^0 = 0$	–
	$vagueness_{Q_9} = \frac{1}{3}\pi r^2 \Big]_{\sqrt{\frac{1}{\pi}}}^{\sqrt{\frac{1}{\pi}}} = 0$	–
	$anergy_{Q_9} = \frac{1}{3}\pi r^2 \Big]_0^{\sqrt{\frac{1}{\pi}}} = 0.33$	–
Q10	–	$exergy_{Q10} = -\frac{1}{3}\pi r^2 \Big]_{\frac{1}{3}\sqrt{\frac{1}{\pi}}}^{0} = 0.04$
	–	$vagueness_{Q10} = -\frac{1}{3}\pi r^2 \Big]_{\frac{1}{3}\sqrt{\frac{1}{\pi}}}^{\frac{1}{3}\sqrt{\frac{1}{\pi}}} = 0$
	–	$anergy_{Q10} = -\frac{1}{3}\pi r^2 \Big]_{\sqrt{\frac{1}{\pi}}}^{\frac{1}{3}\sqrt{\frac{1}{\pi}}} = 0.29$

Leading to → Table 3 ← Leading to

The same procedures were applied to the remaining questionnaires leading to Table 3.

Table 3. *ieo – 5*, *ncoag – 3*, *tel – 6* and *btsr – 2* predicates' extensions according to the answers of an employee to *IEO – 5*, *NCOAG – 3*, *TEL – 6* and *BTSR – 2* questionnaires in the *Best-case Scenario* and at time *t = 0*.

	Scale (6) (5) … (2) (1)						***Scale (1) (2) … (5) (6)***				
	EX	***VA***	***AN***	***DoS***	***QoI***		***EX***	***VA***	***AN***	***DoS***	***QoI***
ioe – 5$_{3\text{-}1}$	0.11	0	0.49	0.99	0.89	*ioe – 5$_{1\text{-}3}$*	0.18	0	0.22	0.98	0.82
ncoag – 3$_{3\text{-}1}$	0.15	0	0.52	0.99	0.85	*ncoag – 3$_{1\text{-}3}$*	0.04	0	0.29	1.0	0.96
tel – 6$_{4\text{-}1}$	0.01	0	0.32	1.0	0.99	*tel – 6$_{1\text{-}4}$*	0.23	0	0.44	0.97	0.77
btsr – 2$_{6\text{-}1}$	0.01	0	0.49	1.0	0.99	*btsr – 2$_{1\text{-}6}$*	0.22	0	0.28	0.97	0.78
catch-all-clause$_{6\text{-}1}$	0.07	0	0.45	1.0	0.93	*catch-all-clause$_{1\text{-}6}$*	0.17	0	0.31	0.98	0.83

Heading to → Program 1 ← Heading to

catch-all-clause conveys a statement that exposes all prospects not concealed by individual terms (e.g., $catch - all - clause_{EX_{6-1}} = (0.11 + 0.15 + 0.01 + 0.01)/4 = = 0.07$.

{
/* *The sentences below state the extensions of predicates ioe – $5_{3\text{-}1}$ and ioe – $5_{1\text{-}3}$* */

$\neg\, ioe - 5_{3-1}\,(EX,\ VA,\ AN,\ DoS,\ QoI) \leftarrow not\ ioe - 5_{3-1}\,(EX,\ VA,\ AN,\ DoS,\ QoI),$
$not\ exception_{ioe-5_{3-1}}\,(EX,\ VA,\ AN,\ DoS,\ QoI)$

$ioe - 5_{3-1}\,(0.11,\ 0,\ 0.49,\ 0.99,\ 0.89).$

$\cdots$ (*the dots stand for the remaining predicates$_{6\text{-}1}$ in Table 3*)
}
{
$\neg\, ioe - 5_{1-3}\,(EX,\ VA,\ AN,\ DoS,\ QoI) \leftarrow not\ ioe - 5_{1-3}\,(EX,\ VA,\ AN,\ DoS,\ QoI),$
$not\ exception_{ioe-5_{1-3}}\,(EX,\ VA,\ AN,\ DoS,\ QoI)$

$ioe - 5_{1-3}\,(0.18,\ 0,\ 0.22,\ 0.98,\ 0.82).$

$\cdots$ (*the dots stand for the remaining predicates$_{1\text{-}6}$ in Table 3*)
}

Program 1. Predicate expressions for *ioe –* $5_{3\text{-}1}$, *ncoag –* $3_{3\text{-}1}$, *tel –* $6_{4\text{-}1}$, *btsr –* $2_{6\text{-}1}$, *ioe –* $5_{1\text{-}3}$, *ncoag –* $3_{1\text{-}3}$, *tel –* $6_{1\text{-}4}$, *and btsr –* $2_{1\text{-}6}$ for the *Best-case Scenario.*

2.1.1. Proof Theory vs. Logic Programming

Symbolic Logic is a formal language that has well-defined semantics and is studied using *Model Theory* [9], *Category Theory* [10, 11], *Recursion Theory* [12, 13] and *Proof Theory* [14, 15]. The computation-as-deduction approach to programming languages takes objects from logic, namely terms, formulas, and proofs, as its computational elements. This approach has the potential to allow the direct application of the rich metatheory of logic to prove the properties of specific programs and entire programming languages. The impact of *Proof Theory* on *Logic Programming*; in fact, the first thing that *Proof Theory* offers to the logical programming paradigm is a clean and straightforward means of distinguishing itself from *Functional Programming*. From the perspective of *Proof Theory*, functional programs correspond to proofs and computation corresponds to proof normalization, i.e., programs correspond to non-normal proofs and computation is viewed as a series of normalization steps. This program-as-proof correspondence is known as the *Curry-Howard Isomorphism* [16]. In contrast, proof finding is a good characterization of computation in *Logic Programming*. Here quantifying formulas are used to encode both programs and goals. The proof-theoretical concepts of inference rule, schematic variable, proof check and proof search can be implemented directly. It constructs a derivation relation ⊢ = *{{<S, s>}, where S is a Logic Programming subset, s is a Logic Programming element derivable from S using R}*, where {} is the proper notation for sets. *R* stands for the *modus ponens* inference rule, given as $\{(A\ if\ B),\ B\} \vdash A$; together, the axioms and R constitute the inference [17, 18]. A proof, derive from such a system, is given by the sequence, viz.

$$s_1,\ s_2,\ \cdots,\ s_n$$

2.1.2. Data Analysis in the Best-case Scenario – Discussion of the Results

On the other hand, it is possible to assess a management *Degree of Satisfaction* (*DoS*) score in the *Best-case Scenario* (score from employees' responses to the above questionnaires) over a 5 (five) month period (Figure 2), below. In fact, it is shown that it is possible to monitor and predict the evolution of *DoS* depending on how employees assess the situation over a 5 (five) month period; based on a mathematical proof using all possible sequences combining the terms or clauses of the predicates referred to in this work to predict a number given by the expression, viz.

$$C_1^{Predicates\ Extending} + \cdots + C_{Predicates\ Extending\ Cardinality}^{Predicates\ Extending}$$

where $C_{Predicates\ Extending\ Cardinality}^{Predicates\ Extending}$ is a predicate extension combination subset. The *Predicates Extending Cardinality* is equal to 4 (four) in this case, once only the extensions of 4 (four) predicates are present). Thus, one can have a template for the employees' answers resulting from a proof of Theorems 1 and 2 under $scale_{6-1}$ and $scale_{1-6}$. However, the scenario that will be considered is the one given by $C_{Predicates\ Extending\ Cardinality}^{Predicates\ Extending}$, where the *Predicates Extending Cardinality* is equal to 4 (four), because of lack of space. Therefore, one may have, viz.

Theorem 1. Scale$_{6-1}$.

$\forall\ (EX_1, VA_1, AN_1,\ EC_1, QoI_1,\ \cdots,\ EX_4,\ VA_4,\ AN_4,\ EC_4, QoI_4)$,
$?\ (ioe\text{-}5_{3-1}\ (EX_1, VA_1, AN_1,\ EC_1, QoI_1),\ \cdots,\ btsr\text{-}2_{6-1}\ (EX_4,\ VA_4,\ AN_4,\ EC_4, QoI_4))$.

Theorem 2. Scale$_{1-6}$.

$\forall\ (EX_1, VA_1, AN_1,\ EC_1, QoI_1,\ \cdots,\ EX_4,\ VA_4,\ AN_4,\ EC_4, QoI_4)$,
$?\ (ioe\text{-}5_{1-3}\ (EX_1, VA_1, AN_1,\ EC_1, QoI_1),\ \cdots,\ btsr\text{-}2_{1-6}\ (EX_4,\ VA_4,\ AN_4,\ EC_4, QoI_4))$.

Heading to → Figure 2 ← Heading to

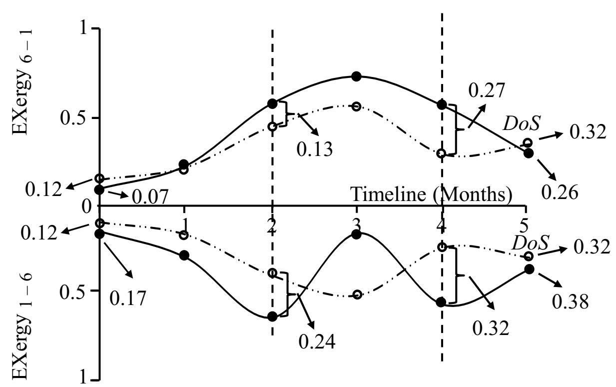

Figure 2. The evolution of a Manager's *DoS according to the employees' answers* in the *Best-case Scenario* along a period of 5 (five) months (Table 3 and Program 1).

It is now possible to quantify the evolution of the management's *DoS* along the timeline. For example, for $t = 0$ one may have, viz.

$$DoS_{t=0} = \big((EX_{6-1} + VA_{6-1}) + (EX_{1-6} + VA_{1-6})\big)/2$$

$$DoS_{t=0} = \big((0.07 + 0) + (0.17 + 0)\big)/2 = 0.12$$

On the other hand, for $t = 5$ one may have, viz.

$$DoS_{t=5} = \big((EX_{6-1} + VA_{6-1}) + (EX_{1-6} + VA_{1-6})\big)/2 =$$

$$= ((0.26 + 0) + (0.38 + 0))/2 = 0.32$$

Attending to Figure 2, if an employee entropic state is close to zero (in this case with values of $DoS_{t=0}$ = 0.12 and $DoS_{t=5}$ = 0.32 (low entropy)), the *DoS* is close to excellent

[6]. On the other hand, an analysis of Figure 2, in terms of an increase/decrease in entropy between the cut off lines at times *t=2* and *t=4,* is expressed in the form, viz.

$$I = \left((Exergy_{4-1} - \Delta DoS_{4-1}) - (Exergy_{1-4} - \Delta DoS_{1-4})\right)_{t=2} =$$
$$= (0.13 - 0.24)_{t=2} = -0.11$$

and,

$$J = \left((Exergy_{4-1} - \Delta DoS_{4-1}) - (Exergy_{1-4} - \Delta DoS_{1-4})\right)_{t=4} =$$
$$= (0.27 - 0.32)_{t=4} = -0.05$$

which tell us that at the borderlines at *t = 2* and *t = 4* the entropy values to *I* and *J* are lower, which means that the system tends to be stable.

2.2. Technology Enable Learning and Social Computing – Worst-case Scenario

The *Worst-case Scenario* is a situation that is the most unfavorable or undesirable outcome; can be a result of an event, such as a natural disaster, or it can be the result of an action, such as a business decision. In such a case, one has (Figure 3), viz.

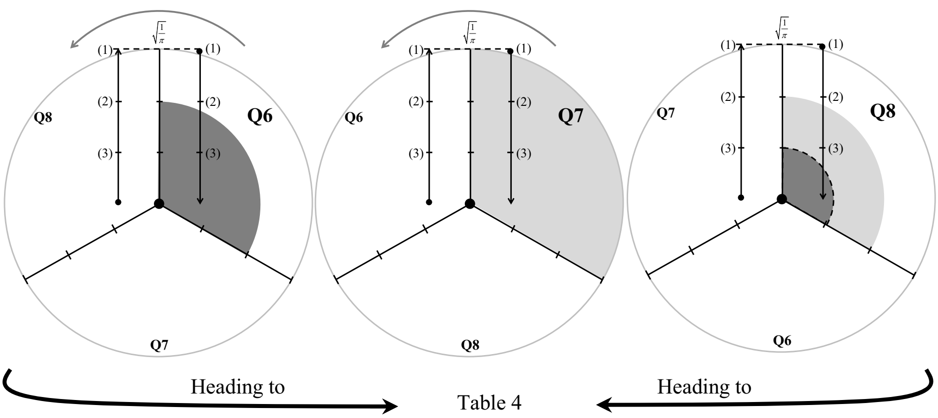

Figure 3. Pictorial interpretation of a *worker responses* to the *NCOAG – 3* survey in the *Worst-case Scenario*.

Table 4. Evaluation of a *worker hypothetical tendency for the present universe-of-discourse to attain a state of maximum homogeneity (i.e. according* to his/her ripostes to *NCOAG – 3* survey in the *Worst-case Scenario)*.

	(NCOAG – 3$_{3\text{-}1}$) – Scale (3) (2) (1)	***(NCOAG – 3$_{1\text{-}3}$) – Scale (1) (2) (3)***
Q8	$exergy_{Q8} = \frac{1}{3}\pi r^2\Big]_0^{\frac{2}{3}\sqrt{\frac{1}{\pi}}} = \frac{1}{3}\pi\left(\frac{2}{3}\sqrt{\frac{1}{\pi}}\right)^2 - 0 = 0.15$	–
	$vagueness_{Q8} = \frac{1}{3}\pi r^2\Big]_{\frac{2}{3}\sqrt{\frac{1}{\pi}}}^{\frac{2}{3}\sqrt{\frac{1}{\pi}}} = 0$	–
	$anergy_{Q8} = \frac{1}{3}\pi r^2\Big]_{\frac{2}{3}\sqrt{\frac{1}{\pi}}}^{\sqrt{\frac{1}{\pi}}} = 0.19$	–

Q9	$exergy_{Q_9} = \frac{1}{3}\pi r^2 \Big]_{0}^{0} = 0$ $vagueness_{Q_9} = \frac{1}{3}\pi r^2 \Big]_{0}^{\sqrt{\frac{1}{\pi}}} = 0.33$ $anergy_{Q_9} = \frac{1}{3}\pi r^2 \Big]_{\sqrt{\frac{1}{\pi}}}^{\sqrt{\frac{1}{\pi}}} = 0$	– – –
Q10	– – –	$exergy_{Q10} = -\frac{1}{3}\pi r^2 \Big]_{\frac{1}{3}\sqrt{\frac{1}{\pi}}}^{0} = 0.04$ $vagueness_{Q10} = -\frac{1}{3}\pi r^2 \Big]_{\frac{2}{3}\sqrt{\frac{1}{\pi}}}^{\frac{1}{3}\sqrt{\frac{1}{\pi}}} = 0.11$ $anergy_{Q10} = -\frac{1}{3}\pi r^2 \Big]_{\sqrt{\frac{1}{\pi}}}^{\frac{2}{3}\sqrt{\frac{1}{\pi}}} = 0.18$

Heading to → Table 5 ← Heading to

The same procedures were applied to the remaining questionnaires leading to Table 5.

Table 5. *ieo – 5*, *ncoag – 3*, *tel – 6* and *btsr – 2* predicates' extensions according to the answers of an employee to *IEO – 5, NCOAG – 3, TEL – 6* and *BTSR – 2 questionnaires* in the *Worst-case Scenario* and at time *t= 0*.

	Scale (6) (5) … (2) (1)						***Scale (1) (2) … (5) (6)***				
	EX	***VA***	***AN***	***DoS***	***QoI***		***EX***	***VA***	***AN***	***DoS***	***QoI***
$ioe - 5_{3\text{-}1}$	0.11	0.27	0.22	0.93	0.62	$ioe - 5_{1\text{-}3}$	0.18	0.11	0.11	0.96	0.71
$ncoag - 3_{3\text{-}1}$	0.15	0.33	0.19	0.88	0.52	$ncoag - 3_{1\text{-}3}$	0.04	0.11	0.18	0.99	0.85
$tel - 6_{4\text{-}1}$	0.01	0.25	0.07	0.97	0.74	$tel - 6_{1\text{-}4}$	0.23	0.08	0.36	0.95	0.69
$btsr - 2_{6\text{-}1}$	0.01	0.04	0.44	1.0	0.95	$btsr - 2_{1\text{-}6}$	0.22	0.13	0.15	0.94	0.65
$catch\text{-}all\text{-}clause_{6\text{-}1}$	0.07	0.22	0.23	0.94	0.70	$catch\text{-}all\text{-}clause_{1\text{-}6}$	0.17	0.11	0.31	0.96	0.72

Heading to → Program 2 ← Heading to

{
/* The extensions of predicates $ioe - 5_{3\text{-}1}$ and $ioe - 5_{1\text{-}3}$ */

$\neg\, ioe - 5_{3-1}\,(EX, VA, AN, DoS, QoI) \leftarrow not\ ioe - 5_{1-3}\,(EX, VA, AN, DoS, QoI),$
$not\ exception_{ioe-5_{3-1}}\,(EX, VA, AN, DoS, QoI)$

$ioe - 5_{3-1}\,(0.11,\ 0.27,\ 0.22,\ 0.93,\ 0.62).$

$\cdots$ (*the dots stand for the remaining predicates*$_{6\text{-}1}$ *in Table 5*)
}
{
$\neg\, ioe - 5_{1-3}\,(EX, VA, AN, DoS, QoI) \leftarrow not\ ioe - 5_{1-3}\,(EX, VA, AN, DoS, QoI),$
$not\ exception_{ioe-5_{1-3}}\,(EX, VA, AN, DoS, QoI)$

$ioe - 5_{1-3}\,(0.18,\ 0.11,\ 0.11,\ 0.96,\ 0.71).$

$\cdots$ (*the dots stand for the remaining predicates*$_{1\text{-}6}$ *in Table 5*)
}

Program 2. Logic program for $ioe - 5_{3\text{-}1}$, $ncoag - 3_{3\text{-}1}$, $tel - 6_{4\text{-}1}$, $btsr - 2_{6\text{-}1}$, $ioe - 5_{1\text{-}3}$, $ncoag - 3_{1\text{-}3}$, $tel - 6_{1\text{-}4}$, and $btsr - 2_{1\text{-}6}$ for the *Worst-case Scenario*.

2.2.1. Data Analysis in the Worst-case Scenario – Discussion of the Results

An evaluation of *DoS* in the *Worst-case Scenario* (Table 5 and Figure 4).

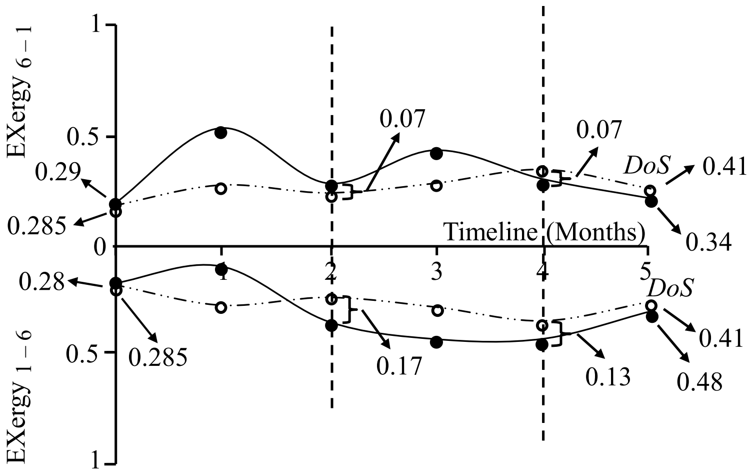

Figure 4. The evolution of a management *DoS according to the employees' answers* in the *Worst-case Scenario*

Evolution of the management's *DoS* alongside the timeline; for $t = 0$ we have, viz.

$$DoS_{t=0} = \left((EX_{4-1} + VA_{4-1}) + (EX_{1-4} + VA_{1-4})\right)/2$$

$$DoS_{t=0} = \left((0.07 + 0.22) + (0.17 + 0.11)\right)/2 = 0.285$$

On the other hand, for $t = 5$ one may have, viz.

$$DoS_{t=5} = \left((EX_{4-1} + VA_{4-1}) + (EX_{1-4} + VA_{1-4})\right)/2 =$$

$$= (0.34 + 0.48)/2 = 0.41$$

Attending to Figure 4, with values of $DoS_{t=0} = 0.285$ and $DoS_{t=5} = 0.41$ (low entropy)), *DoS* is close to excellent [6]. In terms of an increase or decrease in entropy between the cut off lines at times *t=2* and *t=4,* one has, viz.

$$I = \left((Exergy_{4-1} - \Delta DoS_{4-1}) - (Exergy_{1-4} - \Delta DoS_{1-4})\right)_{t=2} =$$

$$= (0.07 - 0.17)_{t=2} = -0.10$$

and,

$$J = \left((Exergy_{4-1} - \Delta DoS_{4-1}) - (Exergy_{1-4} - \Delta DoS_{1-4})\right)_{t=4} =$$

$$= (0.07 - 0.13)_{t=4} = -0.06$$

which tell us that at the borderlines at $t = 2$ and $t = 4$ the entropy values to I and J are lower, which means that the system tends to be stable.

2.2.2. Artificial Neural Networks vs. Case-based Reasoning

Artificial Neural Networks [19, 20] are a type of machine learning algorithm that is inspired by the human brain. They are used for pattern recognition and classification. *Case-based Reasoning* [21, 22] is a type of *Artificial Intelligence* (*AI*) that uses past experiences to solve new problems (Figure 5). It is used in different arenas, such as *Medicine*, *Law*, and *Engineering*.

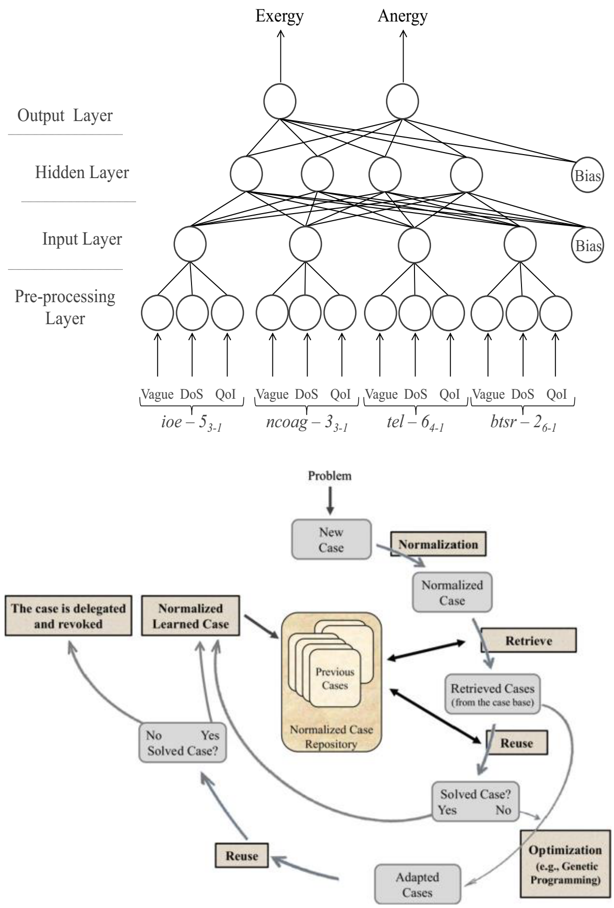

Figure 5. *Artificial Neural Networks* vs. *Case-based Reasoning*.

The main difference between *Artificial Neural Networks* and *Case-based Reasoning* is that the former uses *Supervise Learning* while the latter uses *Unsupervised Learning*. *Supervised Learning* is a type of machine learning that uses labeled data to train the model. *Unsupervised Learning* does not use labeled data to train the model. It can be used for clustering or dimensionality reduction, and both use information gathered from Figure 6, underneath. The comparison between these two approaches will be the subject of future work.

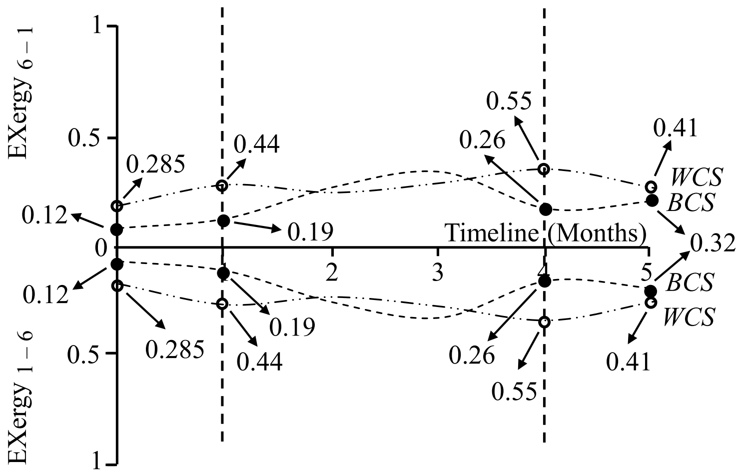

Figure 6. *Mean Value* of the *Employees' Entropy States* over a five-month period.

3. Conclusions

On the one hand, a *Mathematical-logical* approach to *Technology Enable Learning* and *Social Computing* was presented and fixed in terms of *Programming Logic Theories*, that later will be complemented by a *computational framework* based on *Artificial Neural Networks* and *Case-based Reasoning*. A say on *Computational Sustainability* that addresses problems arising from interactions between the natural and the human-developed sphere on a temporal and spatial base. These problem-solving techniques and methodologies are applied to computational sustainable challenges including *Health*, *Poverty Alleviation*, *Renewable Energy*, just to name a few. In terms of planning and search technologies, the ability of computational sustainability to consider many possible outcomes is undeniably a cognitive ability that would greatly benefit human problem solving and decision making. In particular, the motivation and ability to explore the space of impact of technology and policy intervention is poorly studied, but unforeseen impacts are not necessarily predictable outcomes. On the other hand, the fractal nature of questionnaires helps us to study and understand important scientific concepts, such as the way bacteria grows, patterns in freezing water and brain waves, for example. In our case, the fractal structure of the questionnaires allows one to replace a statement in one questionnaire with another questionnaire at any time, in a drill that can go to infinity, revealing the deep reasons behind a given statement or justification of a decision making.

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