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THE ROLE OF ANNOTATED LOGICS IN AI: A REVIEW

JAIR M. ABE[1,*], KAZUMI NAKAMATSU[2], ARI AHARARI[3], JOÃO I. DA SILVA FILHO[4]

[1] *Graduate Program in Production Engineering, Paulista University, São Paulo, Brazil*
[2] *University of Hyogo, Kobe, Japan*
[3] *Sojo University, Kumamoto, Japan*
[4] *Santa Cecília University, Santos, Brazil*

Abstract. Annotated Logics are a category of non-classical logics that have recently appeared from a historical point of view. They are a type of paraconsistent, paracomplete and non-alethic logic. With the rapid development of AI and Automation and Robotics, more and more theory and techniques were coined to support the various issues that the themes were presenting. This expository work explores how to deal directly with conflicts (contradictions) and paracompleteness directly, without extra-logical devices. Support is given by the paraconsistent annotated evidential logic Eτ. Some applications are discussed.

Keywords. Paraconsistent logic; Annotated logic; Expert systems; Computer networks, AI.

1. INTRODUCTION

With the fantastic advance experienced by Informatics, especially at the end of the last century and this one, we can say that it has transformed the day-to-day lives radically as never before. For such techniques and theories, new theoretical foundations were being created for the research's theoretical foundation. Thus, more formal and comprehensive theories were needed to support the advances, and the common denominator is logic. In this work of expository character, the objective is to expose a new logic that has been cultivated for three decades, namely, the paraconsistent annotated evidential logic Eτ, which may be the logic underlying inconsistent theories, but not trivial [1, 2]. This means that theories based on it can make a direct treatment of concepts such as imprecision, inconsistency and paracompleteness, themes that have gained relevance in AI and Automation and Robotics. It is known that the direct treatment of inconsistencies brings substantial gains in the issues analyzed, as there is no need to resort to extra-logical devices. Even in hardware, implementations are more straightforward, e.g. in electronic prototyping platform Arduino, even in multi-agent systems, where the issue of inconsistency plays an interesting role, as the presence of conflict between agents can mean that they can indicate an interaction among them

Dedicated to Professor Phan Dinh Dieu on the occasion of his 85th birth anniversary.

*Corresponding author.
E-mail addresses: jairabe@uol.com.br (J.M. Abe); nakamatu@pf7.so-net.ne.jp (K. Nakamatsu); aharari@cis.sojo-u.ac.jp (A. Aharari); inacio@unisanta.br (J.I.D.S. Filho).

in the sense of an 'evolution' in the task a be solved. It should be noted that the appearance of inconsistencies can be the key to improvements, replacements, etc. In this article we illustrate how anomalous behavior in computer networks can be identified by paraconsistent logic.

1.1. The concepts of paraconsistent annotated evidential logic E$\boldsymbol{\tau}$

Here we will present the basic concepts of the Paraconsistent Annotated Evidential Logic Eτ [2]. The atomic formulas of the Logic Eτ are of the type $p(\mu, \lambda)$, where $(\mu, \lambda) \in [0,1]^2$ and $[0,1]$ which is the real closed unit interval (p denotes a propositional variable in the usual sense). Therefore, $p(\mu, \lambda)$ can be intuitively read "It is assumed that the favorable evidence p is μ and λ is contrary evidence". Thus, we have interesting reading:

$p(1.0, 0.0)$ can be intuitively read as a true proposition,
$p(0.0, 1.0)$ can be intuitively read as a false,
$p(1.0, 1.0)$ can be intuitively read as an inconsistent,
$p(0.0, 0.0)$ can be intuitively read as a paracomplete, and
$p(0.5, 0.5)$ can be intuitively read as an indefinite proposition.

To determine uncertainty and certainty degrees, we introduce the formulas as follows:

Uncertainty Degree: $G_{un}(\mu, \lambda) = \mu + \lambda - 1 (0 \le \mu, \lambda \le 1)$;
Certainty Degree: $G_{ce}(\mu, \lambda) = \mu - \lambda (0 \le \mu, \lambda \le 1)$.

An order relation $\le$ is defined on $[0,1]^2$: $(\mu_1, \lambda_1) \le (\mu_2, \lambda_2) \iff \mu_1 \le \mu_2$ and $\lambda_2 \le \lambda_1$ forming a lattice which is symbolised by τ. With the uncertainty and certainty degrees, we can determine the following 12 output states, shown in Table 1. Extreme and Non-extreme states are shown in Figure 1. Figure 2 shows the states together with certainty and uncertainty degrees and the control values.

Table 1: Extream and non-extream states

Extreme states	Symbols	Non-extreme states	Symbol
True	V	Quasi-true tending to Inconsistent	QV $\to \top$
False	F	Quasi-true tending to Paracomplete	QV $\to \bot$
Inconsistent	$\top$	Quasi-false tending to Inconsistent	QF $\to \top$
Paracomplete	$\bot$	Quasi-false tending to Paracomplete	QF $\to \bot$
		Quasi-inconsistent tending to True	Q$\top \to$ V
		Quasi-inconsistent tending to False	Q$\top \to$ F
		Quasi-paracomplete tending to True	Q$\bot \to$ V
		Quasi-paracomplete tending to False	Q$\bot \to$ F

1.2. The algorithm Para-analyzer

In what follows, we present the algorithm para-analyzer [9]. The primary concern in any analysis is knowing how to measure or determine the certainty degree regarding a proposition if it is False or True. Therefore, for this, we take into account only the certainty degree G_{ce}. The uncertainty degree G_{un} indicates the measure of the inconsistency or paracompleteness. If the certainty degree is low or the uncertainty degree is high, it generates an indefinite. The resulting certainty degree G_{ce} is obtained as follows.

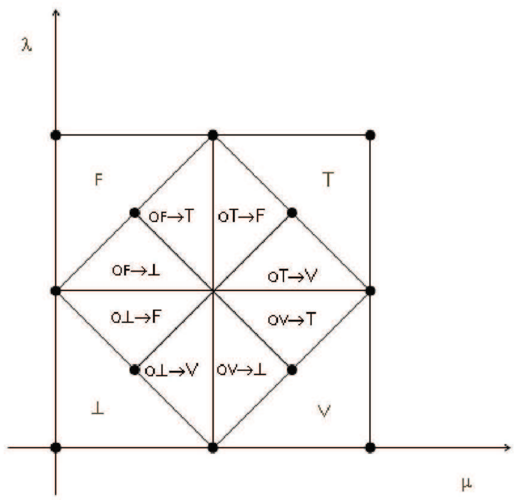

Figure 1: Extreme and Non-extreme states of the lattice τ

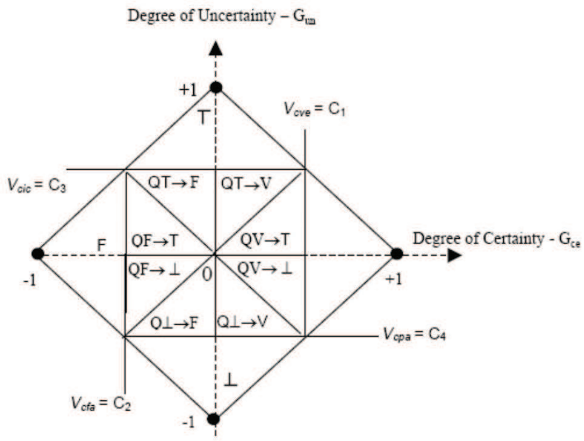

Figure 2: Certainty and Uncertainty degrees with decision states of the lattice τ

If $V_{cfa} \leq G_{un} \leq V_{cve}$ or $V_{cic} \leq G_{un} \leq V_{cpa}$, then $G_{ce} =$ Indefinite.

For $V_{cpa} \leq G_{un} \leq V_{cic}$,
if $G_{un} \leq V_{cfa}$, then $G_{ce} =$ False with degree G_{un} and
if $V_{cic} \leq G_{un}$, then $G_{ce} =$ True with degree G_{un}.

The algorithm Para-analyzer is as follows.

```
/* Definitions of the values */
      Max_vcc = C_1              /* maximum value of certainty Control */
      Max_vctc = C_3           /* maximum value of uncertainty control */
      Min_vcc = C_2              /* minimum value of certainty Control */
      Min_vctc = C_4           /* minimum value of uncertainty control */

/* Input Variables */
      μ,  λ
```

```
/* Output variables */
      digital output = S1
      Analogical output = S2a
      Analogical output = S2b

/* Mathematical expressions * /
being:
      0 ≤ μ ≤ 1 and 0 ≤ λ ≤ 1
      Gun(μ; λ) = μ + λ − 1
      Gce(μ; λ) = μ − λ

/* Determination of the extreme states */
      if Gce(μ; λ) ≥ C1   then S1 = V
      if Gce(μ; λ) ≥ C2   then S1 = ⊤
      if Gun(μ; λ) ≥ C3   then S1 = F
      if Gun(μ; λ) ≤ C4   then S1 = ⊥

/* Determination of the non-extreme states */
      for 0 ≤ Gce < C1 and 0 ≤ Gun < C2
           if Gce ≥ Gun   then S1 = QV → ⊤
           else S1 = Q⊤ → V
      for 0 ≤ Gce < C1 and C4 < Gun ≤ 0
           if Gce ≥ Gun   then S1 = QV → ⊥
else S1 = Q⊥ → V
      for C3 < Gce ≤ 0 and C4 < Gun ≤ 0
           if |Gce| ≥ |Gun|   then S1 = QF → ⊥
           else S1 = Q⊥ → F
      for C3 < Gce ≤ 0 and 0 ≤ Gun < C2
           if |Gce| ≥ Gun   then S1 = QF → ⊤
           else S1 = Q⊤ → F
     Gct = S2a
     Gce = S2
/* END */
```

2. ANALYZING COMPUTER NETWORK PERFORMANCE

One of the essential items for determining the end-user's satisfaction is responsive service. To parameterize the network's operation, a day of operation shall be monitored, for 15 hours, divided into 30-minute intervals [16, 17]. Some of the most significant attributes shall be used, such as.

- Total network packets (bytes).
- Total response time (ms).
- Average speed (bytes/ms).
- The number of requests.
- The number of zero bytes responses.

From the network logs, it is possible to extract the values of the attributes, shown in Figure 3.

Hour interval	Total network packets (bytes)	Total response time (ms)	Average speed (bytes/ms)	Number of requests	Number of zero bytes responses
8:00 a 8:29	101550313	186703410	0,5439124706	3311	779
8:30 a 8:59	101317599	384871739	0,2632502954	4515	32
9:00 a 9:29	144107833	296218480	0,4864917037	5020	201
9:30 a 9:59	149058945	558951986	0,2666757588	10348	84
10:00 a 10:29	153643549	603540143	0,2545705547	13126	2705
10:30 a 10-59	129625661	535538428	0,2420473569	18442	8644
11:00 a 11:29	113215036	181009325	0,6254652129	6829	296
11:30 a 11:59	98916878	429472435	0,2303218319	2671	40
12:00 a 12:29	89950808	281068865	0,3200312066	5051	894
12:30 a 12:59	93957712	348408989	0,2696764864	6844	3304
13:00 a 13:29	40352244	60526974	0,6666819987	1489	568
13:30 a 13:59	34759397	25246230	1,3768153503	1786	7
14:00 a 14:29	82984378	82816003	1,0020331215	8493	5147
14:30 a 14:59	103544699	156568116	0,6613396242	5180	1180
15:00 a 15:29	97323535	77590646	1,2543204628	4090	19
15:30 a 15:59	111349090	88934444	1,2520356005	9973	4345
16:00 a 16:29	116516110	148779326	0,7831471827	8299	59
16:30 a 16:59	134981701	177338304	0,7611536704	9268	43
17:00 a 17:29	101774848	98992388	1,0281078177	6730	36
17:30 a 17:59	84745862	67398212	1,2573903593	3868	28
18:00 a 18:29	63605693	81593640	0,7795422903	5449	38
18:30 a 18:59	92411148	113160272	0,8166395005	5153	109
19:00 a 19:29	91532492	124104104	0,7375460525	2359	55
19:30 a 19:59	200608215	111540378	1,798525508	4727	37
20:00 a 20:29	255225540	199250269	1,2809294626	5517	49
20:30 a 20:59	184581912	194732439	0,9478744936	4061	44
21:00 a 21:29	159659251	150403821	1,0615371999	3676	146
21:30 a 21:59	119997798	98105026	1,2231564772	12739	8554
22:00 a 22:29	126283972	180791028	0,6985079591	10007	5917
22:30 a 22:59	170579432	69887729	2,4407636997	4500	398

Figure 3: Attributes values obtained from the daily operation of a computer network

The first attribute is used to analyze the response time (in milliseconds) related to the conducted requests. The second attribute is related to the volume of data (in bytes) requested in a given interval. At first, one might think that higher values, more efficient network operation. However, this attribute is loaded with uncertainty, considering that it can also denote network congestion. The third attribute range is calculated based on the first two, by simple arithmetic average, to calculate network bandwidth use. The fourth attribute is the number of requests that occurred in a given interval. This attribute itself is not enough to determine the level of the network quality. A network with many requests may indicate either good performance or a high rate of retransmissions, which is considered undesirable. The fifth attribute is fundamental when considered in conjunction with the fourth attribute, as it allows differentiating situations where there is a large number of retransmissions. The obtained values of the attributes are then tabulated and normalized in the range from 0 to 1. For a contextualized view, the image of Figure 4 can give a good idea of network operation from two significant parameters: average speed and the number of zero bytes responses.

Based on the values of the attributes obtained from the one-day operation of the computer network, two different scenarios from two-time intervals on another day of operation will be analyzed to verify the network's operation.

In the selected intervals, the following values were obtained, as shown in Table 2.

A computer network operating at a high speed within its parameters is taken as favorable evidence. Therefore the average speed attribute can be considered directly proportional to greatness. This argument can also be applied to the number of requests attribute since it

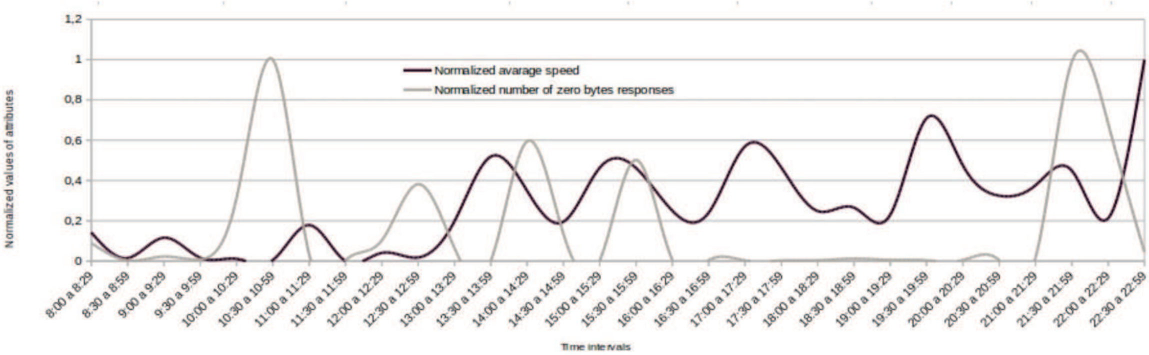

Figure 4: Comparison between average speed and the number of zero bytes responses

Table 2: Network attributes from two assessed scenarios

Scenarios	Total network packets (bytes)	Total response time (ms)	Average speed (bytes/ms)
Scenario1	99646060	228119138	0.4368158712
Scenario2	126428976	76538921	1.6518259514
	Number of requests	Number of 0 byte responses	
Scenario1	4086	40	
Scenario2	11238	5532	

indicates that the network has been operated in total working capacity to meet the user demands. In what concerns the zero byte response attribute, the opposite occurs, as a network with high non-response indicates that the searched resources could not be found; thus, it can be considered inversely proportional greatness. The normalized values shall be used as degrees of favorable evidence for the average speed and number of requests attributes, as directly proportional greatnesses. The opposite shall be applied to the number of zero byte response attribute. In this case, the favorable evidence shall be defined as its denial. The favorable(μ) and unfavorable(λ) evidence degrees are taken from the normalized values of the attributes and are presented in Figure 5.

After the network attributes' parameterization, the proposition "The computer network is functioning within its normal operating values?" shall be analyzed. For this purpose, the Para-analyzer will be applied, representing scenarios 1 and 2, in Figure 6 and Figure 7, respectively.

The global analysis is calculated considering the favorable evidence(μ) multiplied by their respective weights (all equal, in both scenarios) and finally added. The same is done to the unfavorable evidence (λ) [2].

2.1. Analysis of the results

In scenario 1, the global analysis presents a quasi-false result tending to paracomplete and inconsistent with the standard network performance. Although the number of zero byte response attribute has substantial favorable evidence, this was not enough to represent a standard operation since the other two attributes have not been sufficient to support the results. Diagnosis: the analysed network in scenario 1 is not congested due to the low

Scenarios	Normalized average speed (attribute 1)	Normalized number of requests (attribute 2)	Normalized number of zero byte responses (attribute 3)	Attribute 1 evidences		Attribute 2 evidences		Attribute 3 evidences	
				μ	λ	μ	λ	μ	λ
Scenario1	0,093417539	0,1565117821	0,0038207711	0,9	0.91	0,15	0,85	100	0
Scenario2	0,643085955	0,5875369132	0,3696885493	0,64	0,36	0,58	0,42	0,36	0,64

Figure 5: Normalised values and favorable (μ) and unfavorable (λ) evidence of the attributes

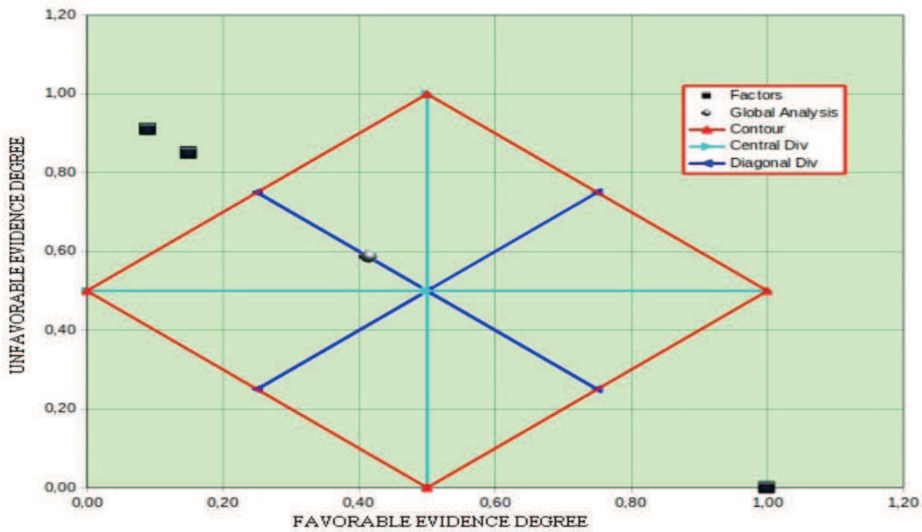

Figure 6: Analysis of scenario 1 result by the Para-analyzer algorithm

number of requests and can locate the searched resources. Abnormally, it still functions at low speed, which concludes that the network is underutilised.

In scenario 2, the global analysis presents a quasi-true result, tending to paracomplete and inconsistent with the standard network performance. The high average speed and many requests present a situation of full use of the network capacity. However, it is observed that it begins to show clear signs of degradation due to the high number of zeros bytes responses. Diagnosis: the analysed network in scenario 2 operates in a high degree of utilization, with early congestion signals and performance degradation.

As seen in both presented scenarios, the parameters' determination in a computer network is a complex task. By their uncertainty and contradictory characteristics, and their dynamic operation, the Paraconsistent Annotated Evidential Logic Eτ emerges as an essential tool for analyzing this type of environment.

However, the correct choice of the attributes to be studied is a crucial element in interpreting the obtained data. In the studied scenarios, three of the main attributes were chosen. As noted, the values lead to stochastic and unpredictable behavior. Therefore, it still demands some degree of interpretation and experience from experts.

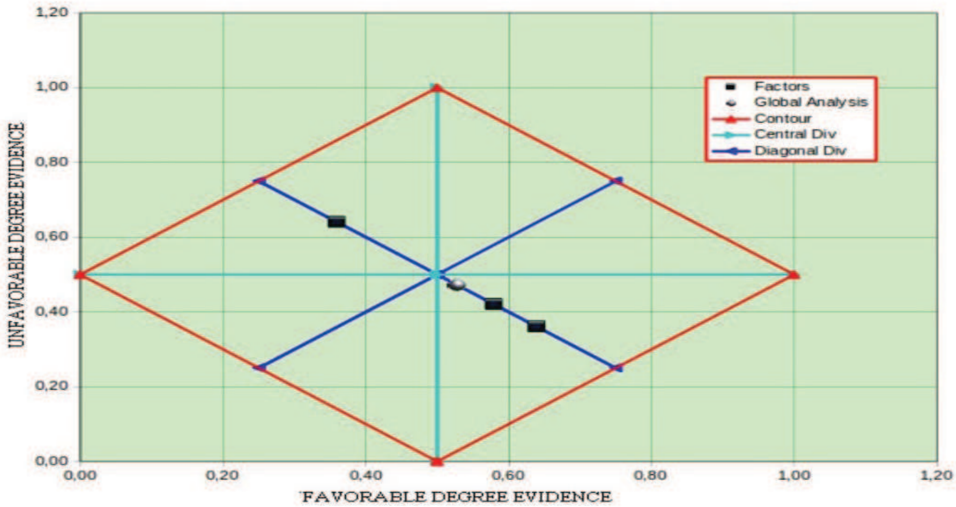

Figure 7: Analysis of scenario 2 result by the Para-analyser algorithm

3. ANALYZING SCENARIOS

We are going to present an expert system based on Logic Eτ for analyzing scenarios. We will do a simulation based on factors adapted from Porter [18] and expert opinions extracted through questionnaires applied to the leading companies in the sector in the country and professionals from related areas.

As an example of application and as a resource for presenting the idea, let us assume that we want to analyze the scenario for the next five years.

According to Porter [18], the five competitive forces are translated by the following factors for internal environmental analysis.

Direct competitiveness factors.

1 - Potential;
2 - Substitution of products;
3 - Relationship with customers;
4 - Relationship with suppliers;
5 - Relationship with competitors;

Indirect competitiveness factors and supporting factors.

6 - Governmental;
7 - Technological and ecological;
8 - Economic and market;
9 - Cultural and demographic;
10 - Regional titles;
11 - Infrastructure.

In each of these factors, experts will be asked to assign evidence regarding the future scenario. The results obtained there will form the basis of the data.

Regarding the factors, one must think that they are independent of each other. Thus, according to the experts, we seek to attribute the degrees of favorable evidence(μ) and unfavorable evidence(λ). The values of the notes attributed by the experts (Exp) result

FACTOR	GROUP A				GROUP B				GROUP C			
	Spec 1		**Spec 2**		**Spec 3**		**Spec 4**		**Spec 5**		**Spec 6**	
	μ1	λ1	μ2	λ2	μ3	λ3	μ4	λ4	μ5	λ5	μ6	λ6
1	1,0	0,2	0,8	0,1	0,7	0,4	0,9	0,2	0,7	0,4	0,9	0,2
2	0,8	0,2	0,8	0,3	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2
3	1,0	0,2	0,8	0,1	0,7	0,4	0,9	0,2	0,7	0,4	0,9	0,2
4	1,0	0,2	0,8	0,1	0,7	0,4	0,9	0,2	0,7	0,4	0,9	0,2
5	0,7	0,5	0,8	0,3	0,8	0,2	0,8	0,2	0,8	0,9	1,0	0,9
6	1,0	0,2	0,8	0,1	0,7	0,4	0,9	0,2	0,7	0,4	0,9	0,2
7	0,8	0,2	0,8	0,3	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2
8	1,0	0,2	0,8	0,1	0,7	0,4	0,9	0,2	0,7	0,4	0,9	0,2
9	0,8	0,2	0,8	0,3	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2
10	1,0	0,2	0,8	0,1	0,7	0,4	0,9	0,2	0,7	0,4	0,9	0,2
11	0,8	0,2	0,8	0,3	0,8	0,2	0,8	0,2	0,8	0,2	0,8	0,2

Figure 8: Data basis formed by the favorable and unfavorable evidence attributed by experts to each one of the strips established for the factors.

from a series of factors, such as, for example, their experiences, their backgrounds, their achievements, their degrees of optimism and even their states of mind, at the time of assignments [20]. Objective data can also be taken into account.

To avoid a single line of thought, the choice of experts with different backgrounds for the attribution of values becomes more important. For example, an exciting board of directors, formed by experts for analyzing scenarios with backgrounds and experience in engineering and management, assume leadership positions in the company under study.

It is possible to argue that the area of the approach of the process concerning the areas of training. Nothing prevents this more than a specialist in the same field of training. It is up to the knowledge architect to talk about the need or not for more experts. However, we will understand that the process allows; it is not advisable to use less than four experts not to be contaminated by subjectivity.

We consider three groups' opinions: two company managers, two specialist engineers, and two specialist economists have been brought together and are translated on board 1.

3.1. The systematic method of the individualized analysis of factors

Built based on data, the first step for applying the method is to establish the time horizon to appraise the scenario. As an example of applying the method and as a resource for the idea's exhibition, let us analyse the next five years. With the results obtained in the research (Figure 5), we can extract the experts' opinions on the scenario for the next five years. They are shown in Figure 8.

Factor	S1 OR S2 = G1		S3 OR S4 = G2		S5 OR S6 = G3		G1 AND G2 AND G3		Indicators 11 / Demand Level 0,500 / Decisions		
	μ_{1A}	λ_{2A}	μ_{1B}	λ_{2B}	μ_{1C}	λ_{2C}	μ_{1R}	λ_{2R}	Dc	Dco	Decisions
1	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
2	0,80	0,20	0,80	0,80	0,80	0,20	0,80	0,20	0,60	0,00	FEASIBLE
3	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
4	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
5	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
6	0,80	0,50	0,80	0,80	0,80	0,90	0,80	0,50	0,30	0,30	NON-CONCLUSIVE
7	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
8	0,80	0,20	0,80	0,80	0,80	0,20	0,80	0,20	0,60	0,00	FEASIBLE
9	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
10	0,80	0,20	0,80	0,80	0,80	0,20	0,80	0,20	0,60	0,00	FEASIBLE
11	1,00	0,20	0,90	0,90	0,70	0,40	0,70	0,20	0,50	-0,10	FEASIBLE
GLOBAL ANALYSIS							0,74	0,20	0,54	-0,06	FEASIBLE

Figure 9: Analysis of the study of the scenario by MFI method

3.2. The enforcement of maximisation rule OR and minimisation rule AND

The next step is to enforce the maximization rule OR and minimization rule AND Annotated Evidenced Paraconsistent Logic Eτ to the opinions for each of the chosen factors in the strip obtained in the research.

The maximisation rule OR and the minimisation rules AND for the experts' opinions are enforced, grouped according to board 2, in other words: [(Expert1) OR (Expert 2)] AND [(Expert 3) OR (Expert 4)] AND [(Expert 5) OR (Expert 6)].

3.3. Analysis of the results

These final results are analyzed, after the applications of the maximization and minimization operations, by the para-analyzer algorithm adopted as control values for the true and false states, the degree of certainty $G_{ce} = 1/2$ and as the degree of uncertainty $G_{un} =$ - 1/2. In this way, we will only have a favorable or unfavorable scenario for the company if we have a degree of certainty, a module equal to or greater than 1/2.

In short, the criterion of division is the following:

$G_{ce} \geq 50\%$ (or 1/2) $\rightarrow$ feasible

$G_{un} \leq -50\%$ (or -1/2) $\rightarrow$ unfeasible

$-50\% < \text{Dc} < 50\% \rightarrow$ non-conclusive

In observing the favorable and unfavorable evidence degrees resulting from the application of the maximisation and minimisation rules to the experts' opinions in the study as to the future scenario, by the MFI method, it allows us to precisely what is each factor's influence in the presentation of the future scenario. Let us notice that the degree of certainty is above 0.50% as established as a criterion for a feasible scenario (0.51%); in other words, it is

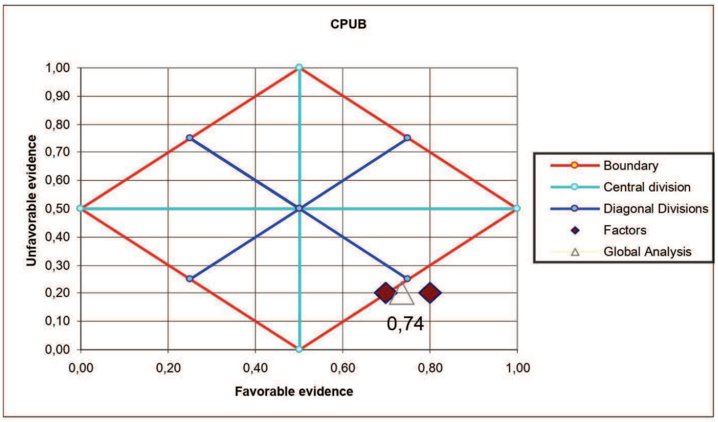

Figure 10: Enforcement of the para-analyzer device on CPUB, for analysis of the future scenario, by MFI method.

favorable, even with a factor presenting an unfeasibility governmental issue. Therefore one must analyze this factor, but the whole scenario is optimistic.

We supposedly admit that the factors have the same weight (the same degree of influence) in the future scenario analysis to decide what to plan strategically. One can observe the joint influence of all the factors, catching on the Cartesian Plan Unitary Board and (R) point, which can be called global analysis, whose degrees of favorable evidence and unfavorable evidence is obtained by the arithmetic measures of the favorable and unfavorable degrees as a result, after the enforcement of the maximization and minimization rules to the experts' opinions.

The global analysis W is the weighted average of the factors that represent factors of influence on the CPUB and translates, in some way, the influence resulting from all the factors considered in the analysis of the future scenario. As W belongs to the true state, it is said that the result is conclusive. In other words, the analysis shows that the scenario is optimistic, for all the analyzed factors converge to a belief that, to the company in question, one may outline strategies that might be fitting for the company in agreement with this scenario.

It is possible to refine the process, check different weights to the factors, and calculate a regarded average for W's determination. Experts might as well do this build-up with weights.

4. MORE APPLICATIONS

The work [22] analyzes IT management services quality, focusing on its critical incidents as a strategic business factor and understanding difficulties professionals face in improving IT services. To assist managers in their decision-making process to improve IT services, a new method was proposed based on Logic Eτ. Validation of the proposed method was compared to a Brazilian foreign trade company's case study. Logic Eτ was an essential instrument in this study. It is a tool to analyze multiple takes of contradictory decisions, to converge on a single type of central decision-making and is suitable mainly for beginner's managers (first level) who need decision support quickly and accurately. After the results entered into the algorithm spreadsheet to the analyser and compared with surveys of a real case, we concluded that the tool based on Logic Eτ presents a unified and efficient front of the comparison with the facts. The use of the expert's experience and the transformation of this qualitative information on quantitative data by the algorithm to-analyzer were essential for validating this study instrument. Organisations rely on various IT (Information Technology) services for the maintenance of their operations. Proper management of these services is of paramount importance because, in many cases, the services are subject to incidents, which may be defined as unplanned events that can potentially lead to an accident. Categorization and correct classification of incidents is of paramount importance, as they may cause a stoppage of essential services and result in financial losses and even cause an impact on the organisation's image. Classification of incidents identifies the exact kind of incident and what components are involved and determines the incident priority, which is, for example, classifying it as critical or not. Depending on the size of the operation, the Service Desk can have many technicians of level 1 (first contact with the user), and differences in classification of incidents occur frequently, i.e. the same type of incident can be classified as critical by a technician and as not critical by the other. Therefore, the classification may have inconsistent or contradictory results. The research problem on which this study is based is: there are differences between the classifications of incidents in the IT Service Desk teams. For this situation, the classical Aristotelian logic does not treat those inconsistencies and contradictions correctly. Thus, the use of non-classical logic, Paraconsistent Logic, for example, would be the most appropriate in this situation. In [22], an expert system based on Logic Eτ was used to address inconsistencies in the classification of IT Incidents, helping managers maintain the quality of services utilised by the organisation to increase the Service Desk's efficiency area. ITIL (Information Technology Infrastructure Library) was considered a management tool, a framework of better practices that deal with Incident Management in IT and the ISO/IEC 20000, which addresses this concept depicting Systems Certification of Services Management in IT. In [20], the expert system was applied to present future scenarios, proposing a new way of constructing technical and operational criteria. Future studies can consider contradictions and be reliable, also operationally efficient. Such method presents numerical output generated by the model so that they are easily understood by the decision-makers (we have considered 02 (two) economists 02 (two) executives and 02 (two) professors). It shows the results of strategic topics between truth and falsehood, answering the following question: is it possible to develop future prospective scenarios with contradictory and paracomplete data? The main advantages of using the Logic Eτ are that the input parameters are set by the structure of experts' thinking, consolidating a common logic translated into mathematical terms. Compared with other classical studies, paraconsistent decision-making was compared with statistical methods [7] and the Fuzzy decision method [6]. The result presented by MFI is based upon the position of the global analysis W on the CPUB, pointing out still, the degree of uncertainty of the data in use. One of the significant advantages that MFI presents is its incredible versatility. We may make it more precise and reliable in various manners. For example, using a more significant number of factors of influence; fixing more than three strips for each factor; increasing the module of the degree of certainty and/or of the degree of contradiction in the enforcement of the para-analyzer device; taking the opinions from the most significant number of experts for the construction of the data basis etc. In the example above, we take the first strip of the factor as a basis, but he may establish the company's more essential strips in agreement with the decision-maker. Besides, for its structure, MFI allows easy computerization in its enforcement. Without much hardship, we might make software capable of running the functions of the para-analyzer device. It can be observed in the enforcement of MFI to all the analyzed cases is that, in all of them, the final result did not present a high inconsistency. That shows that the constructed data basis (Figure 6) does not show significant inconsistencies; in other words, the four experts' opinions were coherent. In the end, virtually all the problems in which the uncertainty, the ambiguity or the natural language of the human being is relevant to present situations favorable to the analysis of the scenarios the enforcement of the Logic Eτ in the analysis of scenarios for the strategic planning has many advantages, among which we summarily repeat? Versatility, precision, and trust, in addition to allowing to deal with contradictory data. More use of annotated logics is to be found in [8, 11, 14, 15]

5. CONCLUSIONS

Paraconsistent logic, despite having been born of philosophical questions, has in recent years found fertile ground for applications. This is explained by its theoretical characteristics. In effect, such logic extends classical logic, that is, paraconsistent logic contains classical logic. Furthermore, one of the best known non-classical logics, Fuzzy logic, is also contained in annotated paraconsistent logic. Paraconsistent logic goes beyond these and related systems in that it treats impreciseness, contradictions, and paracompleteness in a non-trivial way.

From the text, it can be seen that the concept of inconsistency is presented in several applications in AI. Thus, to make a logical treatment of the concept, we need to use new logic, in this case, the paraconsistent logic. A particular class, namely the noted logics, proved to be helpful for the task.

In this article, we show, albeit a tiny part, how we can apply Logic Eτ in Expert Systems and how it can also be applied in different contexts. We hope to present more applications in our future works.

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