ANALYTICAL SUPPORT OF THE PROCEDURAL DECISION-MAKING PROCESS

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Анотація. У процесі юридичних досліджень розробляються і застосовуються приватні наукові методи для вивчення правової реальності, такі як метод порівняльного правознавства, метод тлумачення та формально-правовий метод. Однак на сучасному етапі юридичних досліджень неможливо обмежитися лише цими методами. Навіть вчені-правознавці, які послідовно захищають статус догматичної юриспруденції, визнають, що застосування цих методів з усіма їх достоїнствами встановлює обмежувальні рамки для розуміння практичної дії позитивного права та оригінальності його теоретичного бачення. Проте застосування цих методів у дослідженні правової реальності дозволяє зробити висновок про загальні тенденції розвитку оціночних концепцій, які є основними в цивільному процесуальному праві. Запропоновано підхід до формування системи інформаційного забезпечення процедурного прийняття рішень, заснованого на застосуванні механізму нечітких умовиводів, реалізованому в логічній основі багатошарової нейромережі прямого зв'язку. Згідно з цим підходом, метод подолання семантичної невизначеності в оціночних поняттях процесуального права розробляється за допомогою відповідних термінів (нечітких множин) відповідних лінгвістичних змінних. Як приклад обрано статтю про "Порушення авторського права або суміжних прав" Кримінального кодексу Азербайджанської Республіки, на основі яких запропоновано формалізм для оціночної концепції "значної шкоди" стосовно застосованої санкції. Для вироблення адекватного поняття пропонується шкала оцінки можливих санкцій, отримана на основі опису відповідних правових норм із точки зору нечітких імплікативних норм.

Ключові слова: оціночне поняття, правова норма, нечіткий набір, багатошарова нейронна мережа, нечіткий висновок.

Аннотация. В процессе юридических исследований разрабатываются и применяются частные научные методы для изучения правовой реальности, такие как метод сравнительного правоведения, метод объяснения и формально-правовой метод. Однако на современном этапе юридических исследований невозможно ограничиться только этими методами. Даже ученые-правоведы, которые последовательно защищают статус догматической юриспруденции, признают, что применение этих методов со всеми их достоинствами устанавливает ограничительные рамки для понимания практического действия положительного права и оригинальности его теоретического видения. Тем не менее, применение этих методов в исследовании правовой реальности позволяет сделать вывод об общих тенденциях развития оценочных концепций, которые являются основными в гражданском процессуальном праве. Предложен подход к формированию системы информационного обеспечения процедурного принятия решений, основанного на применении механизма нечетких умозаключений, реализованном в логической основе многослойной нейросети прямой связи. Согласно этому подходу, метод преодоления семантической неопределенности в оценочных понятиях процессуального права разрабатывается с помощью соответствующих терминов (нечетких множеств) соответствующих лингвистических переменных. В качестве примера выбраны статьи о "Нарушении авторского права или смежных прав" Уголовного кодекса Азербайджанской Республики, на основе которых предложен формализм для оценочной концепции "значительного ущерба" относительно примененной санкции. Для выработки адекватного понятия предлагается шкала оценки возможных санкций, полученная на основе описания соответствующих правовых норм с точки зрения нечетких импликативных норм.

Ключевые слова: оценочное понятие, правовая норма, нечеткий набор, многослойная нейронная сеть, нечеткий вывод.

Abstract. In the process of legal research, private scientific methods are developed and used to study legal reality, such as the method of comparative jurisprudence, the method of interpretation (explanation) and the formal legal method. However, at the present stage of legal research, it is impossible to be limited only by these methods. Even legal scholars who consistently defend the status of dogmatic jurisprudence rec-

ognize that the application of these methods, with all their merits, sets a limiting framework in understanding the practical action of positive law and the originality of its theoretical vision. Nevertheless, the application of these methods in the study of legal reality allows us to draw a conclusion about the general trends in the development of evaluative concepts that are fundamental in civil procedural law. It is offered an approach to the formation of a system of information support of procedural decision-making based on the application of fuzzy inference mechanism implemented in the logical basis of the feedforward multilayer neural network. Under this approach, a method to overcome the semantic uncertainty in the evaluation terms of procedural law is developed by using appropriate terms (fuzzy sets) of corresponding linguistic variables. As an example it is selected the Articles on "Violation of copyright or neighboring rights" of the Criminal Code of the Azerbaijan Republic based on which has been proposed formalism for the evaluation concept of "significant harm" in relation to the sanction applied. For making an adequate to evaluation concept notion it is proposed grading scale of possible sanctions, obtained on the basis of the description of the relevant legal norms in terms of fuzzy implicative rules.

Keywords: evaluation concept, legal norm, fuzzy set, multilayer neural network, fuzzy conclusion

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1. Introduction

Lack of accuracy in the formulations of procedural law is one of the most actual and unavoidable problems of practical jurisprudence. According to [1] the phenomenon of semantic uncertainty of legal norms is known ab origin of the legal doctrine. Most clearly, this uncertainty manifests itself in criterion concepts, which are used in law though relatively not long ago, but they have deep enough roots, because have to do with the forms of human thought and means of expression. Most of the phraseology used in the legal theory and legal practice are not artificially created, and are based on natural (literary) language. Moreover, the legal terminology inherently much more incorporates the laws and regularities of natural language, rather than, for example, the system of chemical or physical terms. Language of legal norms has completely inherent properties of natural language systems including such as synonymy and polysemy, which are actually the main sources of uncertainty.

Sometimes (if not often) it is impossible under each common word in the legal statement to imply a strictly defined legal concept with its own specific content. Such it would seem clear ex facto the terms as "dispute", "interest", "possibility" and even "justice" still have not found a unique understanding in the legal science, as in natural language depending on the context these terms have different values. In addition, the many-validness of word and fuzziness of expressed its concept are completely different things. Multivalued word can have simultaneously several well-defined (crisp) concepts. In this case, the uncertainty associated with the response on question: what of the values of word do mean in a given context of the legal wording. Uncertainty immediately disappears as soon as you select an adequate value of alternative synonyms of word. However, when operating with fuzzy concepts of law it is appeared a completely different factor of uncertainty, which manifests itself in the framework of a single value (term) of the word as linguistic variable. Thus, the most topical problem is deliverance of the propositions of law and criterion concepts, in particular, from the fuzziness as one of the factors of uncertainties inherent in natural language system. Such uncertainty can be eliminated by contextual environment of "fuzzy word". However, it is not always possible because descriptive technique of droit is not and cannot a priori be perfect. Let us choose, for example, the frequently occurring in legislation criterion concepts, such as "reliable", "with difficulty", "immediately", "basic", "special", "obviously", etc. In droit, they have the same meaning as the corresponding words of natural language. Even in normal (for example, everyday) word usage their content is often vague and allows multi-valued interpretation. Nevertheless, the use of the above propositions of law in legislation does not mean that there has been negligence of legislator, especially in some cases substantial vague-

ness (fuzziness) of legal terms is justified because it gives the required flexibility of legal phraseology.

It is well known that the existing propositions of law, in which the reality of language is inextricably combined with the realities of thought, in its essence and form are logical propositions (rules), which affirm or abnegate anything about the considered objects and relations of reality. Also known and it is shared by many scientists that in the application of legal rules it is impossible to expect absolute accuracy. However, the sources of inaccuracies in the law enforcement are investigated, as a rule, enough perfunctorily, are not disclosed and are not analyzed their causes in terms of modern scientific concepts, one of which is legally fuzzy logic. Therefore, the main purpose of this article is disclosure and estimation the methodological significance of fuzzy logic in respect to law-making and law enforcement from the position of the existence of the criterion concepts and their logical nature.

2. Fuzzy Modeling of Legal Norm Subject to Semantic Uncertainty of Criterion Concepts

As an example, let us consider Article 165 – “Infringement of author's or adjacent rights” of CC of AR, which formulates as follows [2]:

Illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship and as a result of these acts damage caused was in significant size – is punished by the penalty at a rate from hundred up to five hundred of nominal financial unit or public works for the term from hundred sixty up to two hundred forty hours.

The same acts committed: repeatedly; on preliminary arrangement by group of persons and by organized group – is punished by the penalty at a rate from five hundred up to one thousand of nominal financial unit or imprisonment for the term up to three years.

In this case, the composition of the offense A is “illegal use of author's or adjacent rights” characterized by features B_1 – “edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship”. Sanction S_1 is “punished by the penalty at a rate from hundred up to five hundred of nominal financial unit or public works for the term from hundred sixty up to two hundred forty hours”. In the case of the additional features of offence B_2 – “the same acts committed repeatedly or on preliminary arrangement by group of persons and by organized group”, then sanction S_2 – “punished by the penalty at a rate from five hundred up to one thousands of nominal financial unit or imprisonment for the term up to three years” is applied. Subject to adopted notation this rule (norm) can be written as:

$$\begin{cases} (A \approx B_1) \Rightarrow S_1, \\ (A \approx (B_1 \wedge B_2)) \Rightarrow S_2. \end{cases} \quad (1)$$

Ex facto it seems that the wording of given legal norm and its logical formalism (4) are quite definite. However, it is only at first glance. The stumbling block here is the criterion concept “extensive damage”, or rather its semantic uncertainty. Along with the other terms of the linguistic variable “damage” such as “minor damage”, “large damage”, “extra-large damage”, “substantial damage”, etc. its interpretation is of great importance in law enforcement and law-making. The enquiry is unadvised estimate of the damage size can lead, on the one hand, to insufficient enforcement of author's or adjacent rights protection, and on the other – to the unreasonable extension of applied sanctions. Moreover, in various situations the terms of the linguistic variable “damage” can be interpreted differently. Therefore, for each concrete case it is desirable to form the corresponding scale of graduation.

3. Classification of the Offense (on example of Art. № 165 of the CC of AR)

Obviously, the law enforcement process (judicial proceedings) is multi criterion procedure, which implicates the use of a compositional rule of estimation aggregation for each concrete case. To estimate the offense and formulate of appropriate sanctions let us choose five criterion concepts: u_1 – “minor damage”; u_2 – “significant damage”; u_3 – “large damage”; u_4 – “substantial damage”; u_5 – “extra-large damage”. In other words, $C = (u_1, u_2, u_3, u_4, u_5)$ is a set of attributes, which classify sanctions. Then, assuming that used in the legal norm criteria are fuzzy sets, one can estimate the offense with sufficient set of fuzzy implicative rules in the form “If <...>, then <...>” and on this basis one can establish the appropriate scale of possible sanctions gradations.

So, let us paraphrase the main provisions of Art. No 165 of the CC of AR as follows [3, 4]:

- e_1 : “If there are illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, as well as compulsion to co-authorship, then it is prescribed a minimum punishment (the penalty at a rate from hundred up to five hundred of nominal financial unit)”;
- e_2 : “If in addition to the above there are illegal reprinting or distribution of another's scientific, literary, art or other product, then it is prescribed a punishment above the minimum (public works for the term from hundred sixty up to two hundred forty hours)”;
- e_3 : “If, in addition to the conditions specified in e_2 , the same acts committed repeatedly on preliminary arrangement by group of persons and by organized group, then it is prescribed a maximum punishment (imprisonment for the term up to three years)”;
- e_4 : “If in the present case, there are attributes mentioned in e_3 , but instead a group of persons it is impaired by one person repeatedly infringed copyrights, then it is prescribed a moderate punishment (the penalty at a rate from five hundred up to one thousands of nominal financial unit)”;
- e_5 : “If there is compulsion to co-authorship, but it is not confirmed illegal reprinting or distribution of another's scientific, literary, art or other product by group of persons and by organized group, then it is prescribed a moderate punishment (the penalty at a rate from five hundred up to one thousands of nominal financial unit)”;
- e_6 : “If it is not confirmed edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, as well as compulsion to co-authorship, then components of crime is absent”.

In the above statements (cause-effect relations), we assume the following features as input characteristics: X_1 – edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product; X_2 – compulsion to co-authorship; X_3 – reprinting or distribution of another's scientific, literary, art or other product; X_4 – illegal use of author's or adjacent rights repeatedly by group of persons or by organized group; X_5 – illegal use of author's or adjacent rights repeatedly by one person, and Y – punishment (level of applied sanction) as output characteristic. Then, defining corresponding values (terms) of linguistic variables X_i ($i=1\div5$) and Y , based on the above statements let us construct fuzzy implicative rules in the form:

- e_1 : “If $X_1=BE$ and $X_2=BE$, then $Y=MINIMAL$ ”;
- e_2 : “If $X_1=BE$ and $X_2=BE$ and $X_3=BE$, then $Y=ABOVE\ THE\ MINIMAL$ ”;
- e_3 : “If $X_1=BE$ and $X_2=BE$ and $X_3=BE$ and $X_4=BE$, then $Y=MAXIMAL$ ”;
- e_4 : “If $X_1=BE$ and $X_2=BE$ and $X_3=BE$ and $X_5=BE$, then $Y=MODERATE$ ”;
- e_5 : “If $X_2=BE$ and $X_3=BE\ NOT$ and $X_4=BE$, then $Y=MODERATE$ ”;
- e_6 : “If $X_1=BE\ NOT$ и $X_2=BE\ NOT$, then $Y=ABSENT$ ”.

Suppose that linguistic variable Y is defined on discrete set $J = \{0; 0,1; 0,2; \dots; 1\}$. Then used in implicative rules its terms one can describe for all $x \in J$ by fuzzy sets with corresponding membership functions [5]: $Y_1=MINIMAL$ as $\mu_{Y_1}(x)=x$; $Y_2=ABOVE\ THE\ MINIMAL$ as $\mu_{Y_2}(x)=x^{(1/2)}$; $Y_3=MODERATE$ as $\mu_{Y_3}(x)=x^2$; $Y_4=MAXIMAL$ as: $\mu_{Y_4}(x)=1$, if $x=1$, and $\mu_{Y_4}(x)=0$, if $x<1$; $Y_5=ABSENT$

as $\mu_{Y5}(x)=1-x$. To fuzzify the terms from left parts of accepted rules the Gaussian membership functions $\mu_{Yk}(x) = \exp\{-(u-1)^2/\sigma_k^2\}$ ($k=1\div 5$) are used, which restore the fuzzy subsets of the universe (u_1, u_2, u_3, u_4, u_5), where $u_i = (d_{i-1}+d_i)/2$ ($i=1\div 5$) (see Fig. 1). In this case, values for σ_k are chosen in agreement with priority of offence attributes within legal norm.

Figure 1 – Gradation of damage caused because of offence

Fig. 1 shows the gradation of damage estimation levels presented in general form. However, obviously that any interval $[d_0, d_5]$ one can convert to unit segment $[0, 1]$ by simple transformation $x=d_0+t(d_5-d_0)$, where $t\in[0, 1]$. Therefore, evaluating illegal use of author's or adjacent rights in aspect of caused damage is graduated on a scale of unit segment (see Fig. 2), where $d_i=0,2i$ ($i=0\div 5$), one can fuzzify the terms from left parts of implicative rules as:

- BE (edition under a name or different way in assignment ...): $A=\{0,0391/u_1; 0,1409/u_2; 0,3679/u_3; 0,6977/u_4; 0,9608/u_5\}$;
- BE (compulsion to co-authorship): $B=\{0,0183/u_1; 0,0889/u_2; 0,2910/u_3; 0,6412/u_4; 0,9518/u_5\}$;
- BE (reprinting or distribution of another's ...): $C=\{0,0063/u_1; 0,0468/u_2; 0,2096/u_3; 0,5698/u_4; 0,9394/u_5\}$;
- BE (illegal use of author's or adjacent rights repeatedly ...): $D=\{0,0130/u_1; 0,0183/u_2; 0,1299/u_3; 0,4797/u_4; 0,9216/u_5\}$;
- BE (illegal use of author's or adjacent rights repeatedly...): $E=\{0,0001/u_1; 0,0040/u_2; 0,0620/u_3; 0,3679/u_4; 0,8948/u_5\}$.

Figure 2 – Levels of damage for offence estimation on a scale of unit segment

Then according to these formalisms the fuzzy rules can be formulated as follows:

- e_1 : "If $X_1=A$ and $X_2=B$, then $Y=Y_1$ ";
- e_2 : "If $X_1=A$ and $X_2=B$ and $X_3=C$, then $Y=Y_2$ ";
- e_3 : «If $X_1=A$ and $X_2=B$ and $X_3=C$ and $X_4=D$, then $Y=Y_4$ ";
- e_4 : "If $X_1=A$ and $X_2=B$ and $X_3=C$ and $X_5=E$, then $Y=Y_3$ ";
- e_5 : "If $X_2=B$ and $X_3=\neg C$ and $X_4=D$, then $Y=Y_3$ ";
- e_6 : "If $X_1=\neg A$ and $X_2=\neg B$, then $Y=Y_0$ ".

Further, for left parts of these rules it is necessary to calculate the values of membership functions $\mu_{Mi}(u)$ ($i=1\div 6$). In particular:

- e_1 : $\mu_{M1}(u)=\min\{\mu_A(u), \mu_B(u)\}$, $M_1=\{0,0183/u_1; 0,0889/u_2; 0,2910/u_3; 0,6412/u_4; 0,9518/u_5\}$;
- e_2 : $\mu_{M2}(u)=\min\{\mu_A(u), \mu_B(u), \mu_C(u)\}$, $M_2=\{0,0063/u_1; 0,0468/u_2; 0,2096/u_3; 0,5698/u_4; 0,9394/u_5\}$;
- e_3 : $\mu_{M3}(u)=\min\{\mu_A(u), \mu_B(u), \mu_C(u), \mu_D(u)\}$ $M_3=\{0,0010/u_1; 0,02/u_2; 0,1299/u_3; 0,4797/u_4; 0,92/u_5\}$;

$e_4: \mu_{M4}(u)=\min\{\mu_A(u), \mu_B(u), \mu_C(u), \mu_E(u)\}$ $M_4=\{0,0010/u_1; 0,0040/u_2; 0,06/u_3; 0,368/u_4; 0,895/u_5\}$;

$e_5: \mu_{M5}(u)=\min\{\mu_B(u), 1-\mu_C(u), \mu_D(u)\}$ $M_5=\{0,0013/u_1; 0,018/u_2; 0,1299/u_3; 0,430/u_4; 0,0606/u_5\}$;

$e_6: \mu_{M6}(u)=\min\{1-\mu_A(u), 1-\mu_B(u)\}$, $M_6=\{0,9608/u_1; 0,8591/u_2; 0,6321/u_3; 0,3023/u_4; 0,0392/u_5\}$.

As result, one can rewrite the rules in more compact form:

e_1 : “If $X=M_1$, then $Y=Y_1$ ”; e_2 : “If $X=M_2$, then $Y=Y_2$ ”; e_3 : “If $X=M_3$, then $Y=Y_4$ ”;

e_4 : “If $X=M_4$, then $Y=Y_3$ ”; e_5 : “If $X=M_5$, then $Y=Y_3$ ”; e_6 : “If $X=M_6$, then $Y=Y_0$ ”.

To transform this rules the Lukasiewicz’s implication $\mu_H(w, j)=\min\{1; 1-\mu_W(w)+\mu_J(j)\}$ is used, where H is fuzzy subset on $W \times J$. Then for each pair $(u, j) \in W \times J$ on $W \times J$ one can obtain corresponding fuzzy relations in the following matrixes:

$$R_1 = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 0,9817 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_2 & 0,9111 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_3 & 0,7090 & 0,8090 & 0,9090 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_4 & 0,3588 & 0,4588 & 0,5588 & 0,6588 & 0,7588 & 0,8588 & 0,9588 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_5 & 0,0482 & 0,1482 & 0,2482 & 0,3482 & 0,4482 & 0,5482 & 0,6482 & 0,7482 & 0,8482 & 0,9482 & 1,0000 \end{bmatrix},$$

$$R_2 = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 0,9937 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_2 & 0,9532 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_3 & 0,7904 & 0,8090 & 0,9090 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_4 & 0,4302 & 0,7464 & 0,8774 & 0,9779 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_5 & 0,0606 & 0,3768 & 0,5078 & 0,6083 & 0,6930 & 0,7677 & 0,8352 & 0,8972 & 0,9550 & 1,0000 & 1,0000 \end{bmatrix},$$

$$R_3 = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 0,9987 & 1,0000 \\ u_2 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 0,9817 & 1,0000 \\ u_3 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 1,0000 \\ u_4 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 1,0000 \\ u_5 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 1,0000 \end{bmatrix},$$

$$R_4 = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 0,9999 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_2 & 0,9957 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_3 & 0,9378 & 0,9478 & 0,9778 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_4 & 0,6321 & 0,6421 & 0,6721 & 0,7221 & 0,7921 & 0,8821 & 0,9921 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_5 & 0,1052 & 0,1152 & 0,1452 & 0,1952 & 0,2652 & 0,3552 & 0,4652 & 0,5952 & 0,7452 & 0,9152 & 1,0000 \end{bmatrix},$$

$$R_5 = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 0,9987 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_2 & 0,9817 & 0,9917 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_3 & 0,8701 & 0,8801 & 0,9101 & 0,9601 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_4 & 0,5698 & 0,5798 & 0,6098 & 0,6598 & 0,7298 & 0,8198 & 0,9298 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \\ u_5 & 0,9394 & 0,9494 & 0,9794 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 \end{bmatrix},$$

$$R_6 = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 1,0000 & 1,0000 & 0,9992 & 0,9492 & 0,8792 & 0,7892 & 0,6792 & 0,5492 & 0,3992 & 0,2292 & 0,0392 \\ u_2 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 0,9809 & 0,8909 & 0,7809 & 0,6509 & 0,5009 & 0,3309 & 0,1409 \\ u_3 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 0,8779 & 0,7279 & 0,5579 & 0,3679 \\ u_4 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 0,8877 & 0,6977 \\ u_5 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 1,0000 & 0,9608 \end{bmatrix}.$$

The general functional solution R is obtained by intersection of the matrixes $R_1, R_2, \dots, R_6$:

$$R = \begin{bmatrix} & 0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 & 0,6 & 0,7 & 0,8 & 0,9 & 1 \\ u_1 & 0,9817 & 0,9987 & 0,9987 & 0,9492 & 0,8792 & 0,7892 & 0,6792 & 0,5492 & 0,3992 & 0,2292 & 0,0392 \\ u_2 & 0,9111 & 0,9817 & 0,9817 & 0,9817 & 0,9809 & 0,8909 & 0,7809 & 0,6509 & 0,5009 & 0,3309 & 0,1409 \\ u_3 & 0,7009 & 0,8009 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,8701 & 0,7279 & 0,5579 & 0,3679 \\ u_4 & 0,3588 & 0,4588 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,5203 & 0,6977 \\ u_5 & 0,0482 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,0784 & 0,9608 \end{bmatrix}.$$

To define sanction according to level of caused damage because of offence it is necessary to apply the rule of composition reference in the fuzzy domain: $E_k = G_k \circ R$, where E_k is the sanction by causing of damage of k -th level; G_k is describing of k -th level of damage by appropriate fuzzy subset. Then, according to equations: $\mu_{E_k}(j) = \max\{\min[\mu_{G_k}(u), \mu_R(u)]\}$; $\mu_{G_k}(u) = 0$, if $u \neq u_k$ and $\mu_{G_k}(u) = 1$, if $u = u_k$, E_k is k -th row of matrix R .

Now, to classify sanctions let us use defuzzification procedure for fuzzy outputs of applied model. Therefore, the 1st level of damage is described by fuzzy set: $E_1 = \{0,9817/0; 0,9987/0,1; 0,9987/0,2; 0,9492/0,3; 0,8792/0,4; 0,7892/0,5; 0,6792/0,6; 0,5492/0,7; 0,3992/0,8; 0,2292/0,9; 0,0392/1\}$. Further, establishing level sets $E_{1\alpha}$ and calculating appropriate their cardinal numbers $M(E_{1\alpha})$ by formula $M(E_{1\alpha}) = \sum_{k=1}^n [x_k / n]$, we have:

- for $0 < \alpha < 0,039$: $\Delta\alpha = 0,039$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 0,8; 0,9; 1\}$, $M(E_{1\alpha}) = 0,5$;
- for $0,039 < \alpha < 0,229$: $\Delta\alpha = 0,19$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 0,8; 0,9\}$, $M(E_{1\alpha}) = 0,45$;
- for $0,229 < \alpha < 0,399$: $\Delta\alpha = 0,17$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 0,8\}$, $M(E_{1\alpha}) = 0,4$;
- for $0,399 < \alpha < 0,549$: $\Delta\alpha = 0,15$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7\}$, $M(E_{1\alpha}) = 0,35$;
- for $0,549 < \alpha < 0,679$: $\Delta\alpha = 0,13$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4; 0,5; 0,6\}$, $M(E_{1\alpha}) = 0,3$;
- for $0,679 < \alpha < 0,789$: $\Delta\alpha = 0,11$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4; 0,5\}$, $M(E_{1\alpha}) = 0,25$;
- for $0,789 < \alpha < 0,879$: $\Delta\alpha = 0,09$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3; 0,4\}$, $M(E_{1\alpha}) = 0,20$;
- for $0,879 < \alpha < 0,949$: $\Delta\alpha = 0,07$, $E_{1\alpha} = \{0; 0,1; 0,2; 0,3\}$, $M(E_{1\alpha}) = 0,15$;
- for $0,949 < \alpha < 0,9817$: $\Delta\alpha = 0,0325$, $E_{1\alpha} = \{0; 0,1; 0,2\}$, $M(E_{1\alpha}) = 0,10$;
- for $0,9817 < \alpha < 0,9987$: $\Delta\alpha = 0,017$, $E_{1\alpha} = \{0,1; 0,2\}$, $M(E_{1\alpha}) = 0,15$.

Finally, the point estimation of fuzzy set E_1 is obtained in following form:

$$F(E_1) = (1/\alpha_{\max}) \int_0^{\alpha_{\max}} M(E_{1\alpha}) d\alpha = (1/0,9987) \int_0^{0,9987} M(E_{1\alpha}) d\alpha = (1/0,9987)[0,5 \cdot 0,039 + 0,45 \cdot 0,19 + 0,4 \cdot 0,17 + 0,35 \cdot 0,15 + \dots + 0,15 \cdot 0,07 + 0,1 \cdot 0,0325 + 0,15 \cdot 0,017] = 0,3268.$$

By similar actions, one can calculate estimations of other outputs: for level of damage u_2 – $F(E_2) = 0,3714$; for u_3 – $F(E_3) = 0,4578$; for u_4 – $F(E_4) = 0,6431$; for u_5 – $F(E_5) = 0,9608$. Thus, in accepted assumption finale scale for estimation and choosing sanctions on discussed affair about illegal use of author's or adjacent rights can present as showed in the Fig. 3.

Figure 3 – The scale for choosing sanctions on the base of damage levels

Inherently, the value 0,3268 being defuzzified output of fuzzy model of legal norm “Illegal use of author's or adjacent rights” as upper level corresponds to sanction E_1 according to minor damage. Similarly, we mean that defuzzified output 0,3714 is upper level of sanction E_2 according to significant damage; 0,4578 is upper level of sanction E_3 according to large damage; 0,6431 is upper level of sanction E_4 according to substantial damage; 0,9608 is upper level of sanction E_5 according to extra-large damage. The obtained gradation of the evaluative concepts “The level of damage caused” used in the process of law enforcement relative to violations of copyright or related rights, we use to classify sanctions in accordance with the composition of the offense (Table 1).

Table 1 – Classification of sanctions in the framework of law enforcement

Sanction	Comment	Evaluative concept	Interval
Not guilty	There is no corpus delicti	Minor damage	[0; 0,3268]
Minimum	Fine in the amount of 100 to 500 AZN	Significant damage	(0,3268; 0,3714]
Above minimum	Appointment of community service for a period from 160 to 240 hours	Large damage	(0,3714; 0,4578]
Medium severity	Fine in the amount of 500 to 1000 AZN	Substantial damage	(0,4578; 0,6431]
Maximum	Imprisonment for a term of 3 years with confiscation of property	Extra-large damage	(0,6431; 0,9608]

4. Estimation of Offence (on example of Art. № 165 of the CC of AR)

After establishment of reasonable scale for classification of sanctions in respect to illegal use of author's or adjacent rights let us realize estimation of offence. To this effect accepting basis logic structure (4) corresponding legal norm, the following quite trivial implicative rules are selected [3, 4]:

e_1 : “if for the first time as a result of illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship and as a result of these acts damage caused was in minor size, then components of crime are absent”;

e_2 : if for the first time as a result of illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship and as a result of these acts damage caused was in significant size, then it is prescribed a minimum punishment in the form of the penalty at a rate from hundred up to five hundred of nominal financial unit;

e_3 : “if for the first time as a result of illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship and as a result of these acts damage caused was in large size, then it is prescribed an

above minimum sanction, i.e. punishment in the form of public works for the term from hundred sixty up to two hundred forty hours”;

e_4 : “if repeatedly as a result of illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship and as a result of these acts damage caused was in substantial size, then it is prescribed a moderate punishment in the form of the penalty damage at a rate from five hundreds up to one thousand of nominal financial unit”;

e_5 : “if repeatedly as a result of illegal use of author's or adjacent rights objects, that is edition under a name or different way in assignment of authorship of another's scientific, literary, art or other product, its illegal reprinting or distribution, as well as compulsion to co-authorship and as a result of these acts damage caused was in extra-large size, then it is prescribed a maximal punishment in the form of the imprisonment for the term up to three years with deprivation of property”;

e_6 : “if mentioned acts committed on preliminary arrangement by group of persons and by organized group and damage caused was in extra-large size, then it is prescribed a maximal punishment in the form of the imprisonment for the term up to three years with deprivation of property”.

Here are used two criterion concepts of legal norm as input characteristics: 1) the linguistic variable A_1 – size of caused damage by illegal use of author's or adjacent rights, which has 5 values (terms) formalized by Gaussian membership functions with nodes in the correspondent points $u_i = [0, 2(i-1) + 0, 2i] / 2$ ($i=1 \div 5$) (see Fig. 2); 2) the linguistic variable A_2 – availability of similar precedent in the past or availability of other persons of criminal offence, which has 3 values (terms) formalized by Gaussian membership functions with nodes in the points 0, 0,5 and 1 accordingly.

Output characteristic is linguistic variable Y – the level of subsequent punishment, which has 5 fuzzy values (terms) described by Gaussian membership functions with nodes in the points 0.3268, 0.3714, 0.4578, 0.6431 and 0.9608 accordingly (see Fig. 4).

In the context of the above reasoning, it is not difficult to form a basic set of linguistic rules for building the appropriate fuzzy inference system. For convenience, all variables of this system are summarized in the form of Table 2.

Table 2 – Fuzzy inference system variables for offense assessment

		Variable name	Amount of damage caused
		Abcissas of vertices of membership functions	0,1; 0,3; 0,5; 0,7; 0,9
Inputs	x_1	Universe	[0,1; 0,9]
		Variable name	The presence of a precedent in the past and/or other participants in the offense
		Abcissas of vertices of membership functions	0; 0,5; 1
	x_2	Universe	[0, 1]
		Variable name	Punishment level
		Abcissas of vertices of membership functions	0,3268; 0,3714; 0,4578; 0,6431; 0,9608
Output	y	Universe	[0,3268; 0,9608]

Thus, realizing above rules in notation of MATLAB/Fuzzy Inferences System (see Fig. 4) let us construct the sample of training pairs in the form of Table 3.

Figure 4 – Realization of rules ($e_1 - e_6$) in notation of MATLAB/Fuzzy Inferences System

Table 3 – The sample of 30 training pairs in the form of input-output data set

№	Inputs		Output	№	Inputs		Output
	x_1	x_2	y		x_1	x_2	y
1	0,100	0,000	0,383	16	0,265	0,868	0,538
2	0,300	0,000	0,407	17	0,507	0,241	0,492
3	0,500	0,000	0,479	18	0,779	0,150	0,723
4	0,700	0,000	0,644	19	0,823	0,232	0,738
5	0,900	0,000	0,711	20	0,852	0,068	0,718
6	0,100	0,500	0,440	21	0,874	0,732	0,802
7	0,300	0,500	0,483	22	0,206	0,859	0,535
8	0,500	0,500	0,644	23	0,214	0,377	0,426
9	0,700	0,500	0,643	24	0,177	0,786	0,514
10	0,900	0,500	0,855	25	0,845	0,195	0,745
11	0,100	1,000	0,556	26	0,625	0,105	0,532
12	0,300	1,000	0,644	27	0,808	0,914	0,779
13	0,500	1,000	0,711	28	0,148	0,059	0,393
14	0,700	1,000	0,855	29	0,133	0,768	0,483
15	0,900	1,000	0,711	30	0,852	0,323	0,788

After loading the generated training set into the ANFIS editor the neural network based fuzzy inference system is generated as shown in Fig. 5.

Figure 5 – Generated neural network based fuzzy inference system in notation of MATLAB/ANFIS

In our case, the neural network based fuzzy inference system contains 2 input variables with five terms for the first and three – for the second, 15 implicative rules, one output variable with 15 terms. As the supervisory training method, the hybrid method was chosen, which is the combination of the least squares method and the method of decreasing the inverse gradient. As a result of training, the membership functions of terms of input linguistic variables are identified as shown in Fig. 6.

Figure 6 – The membership functions of terms of input linguistic variables

The following Fig. 7 shows the graphical interface for viewing the rules of the generated fuzzy inference system and the fragment of the optimal set of basic implicative rules.

Figure 7 – Graphical interface for viewing the rules of the generated system

Following Table 4 lists the “trained” fuzzy implicative rules in a somewhat simplified form. For example, the noted rule 4 (see Fig. 7) is interpreted as: “if x_1 is X_{12} =ESSENTIAL (i.e. a fuzzy set described by the Gaussian function $\mu_{X_{12}}(u)=\exp\{-(-u-0.3075)^2/0.0703^2\}$) and x_2 is X_{21} =FIRST HAS PLACE (i.e. the set described by the Gaussian function $\mu_{X_{21}}(u)=\exp\{-(-u-0.6090)^2/0.1983^2\}$), then y is Y_2 =PAYMENT OF FINE (from 100 to 500 AZN)”.

Table 4 – Hybrid-tuned logical rules

№	Inputs		Output	
	x_1	x_2	Defuzzified value	Assessment of offense (sanction)
1	X_{11}	X_{21}	0,3859	Y_1 – corpus delicti is absent
2	X_{11}	X_{22}	0,4334	Y_2 – payment of fine from 100 to 500 AZN
3	X_{11}	X_{23}	0,5678	Y_3 – community service for a period from 160 to 240 hours
4	X_{12}	X_{21}	0,4005	Y_2 – payment of fine from 100 to 500 AZN
5	X_{12}	X_{22}	0,4453	Y_2 – payment of fine from 100 to 500 AZN

6	X_{12}	X_{23}	0,6503	Y_3 – community service for a period from 160 to 240 hours
7	X_{13}	X_{21}	0,4704	Y_2 – payment of fine from 100 to 500 AZN
8	X_{13}	X_{22}	0,6572	Y_3 – community service for a period from 160 to 240 hours
9	X_{13}	X_{23}	0,7226	Y_4 – payment of fine from 100 to 500 AZN
10	X_{14}	X_{21}	0,7302	Y_4 – payment of fine from 100 to 500 AZN
11	X_{14}	X_{22}	0,5859	Y_3 – community service for a period from 160 to 240 hours
12	X_{14}	X_{23}	0,9796	Y_5 – imprisonment for up to three years with confiscation of property
13	X_{15}	X_{21}	0,7242	Y_4 – payment of fine from 100 to 500 AZN
14	X_{15}	X_{22}	0,8815	Y_5 – imprisonment for up to three years with confiscation of property
15	X_{15}	X_{23}	0,6810	Y_3 – community service for a period from 160 to 240 hours

Figure 8 – Aggregated parameters of the outputs of the adapted fuzzy inference system

Fig. 8 shows the distribution of output parameters of the adapted fuzzy inference system, in fact, on the basis of which 5 clusters were established in the form of intervals for defuzzified values of fuzzy outputs y : $[0; 0,4]$, $(0,4; 0,55]$, $(0,55; 0,7]$, $(0,7; 0,85]$ and $(0,85; 1]$.

5. Conclusion

In the process of simulation, for assessing the corpus delicti three criteria were used. On the basis of these criteria it was possible to

build and study the cause-effect relations between the characteristics of the offense and the result of law enforcement by using of the adapted neural network based fuzzy inference system (Fig. 9).

Figure 9 – Dependence of the sanction on the corpus delicti

The numerical interpretation of the offense degree and, accordingly, the level of the imposed sanction does not exceed 0,85 with a maximum of 1, increases relatively moderately with an increase in x_2 and sharply increases with an increase in x_1 . The proposed method allows quickly and relatively easily diversify itself functions for other types of offenses. To do this, it is necessary to formalize the relevant legal norms and generate sufficient statistics of assessments for various scenarios of the composition of offenses. In the future, such system is capable of functioning in an autonomous mode, since to develop and adapt of system it is enough to involve existing heuristic knowledge in the field of law enforcement.

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