Hristo Konstantinov Blidov

ABSTRACT OF PhD THESIS

INTELLIGENT METHODS FOR PROCESSES ANALYSIS IN JUSTICE ADMINISTRATION

Supervisor:

Corr.-Member Lyubka Atanasova Doukovska

Sofia, 2022

CONTENTS

INTRODUCTION

In recent years, intelligent methods for analysis and modeling of complex processes, in which useful information is extracted, by applying mathematical approaches, as well as methods from the field of "artificial intelligence", have been increasingly used. Every real process actually represents a set of separate sub-processes that run parallel in time. This greatly complicates the discovery of regularities in the functioning of a given system. The use of mathematical tools for modeling, including the apparatus of Generalized Nets (GN), is proven in practice as an adequate and correct method for solving complex and important tasks. The present dissertation analyzes and evaluates the results of the application of these methods and, on this basis, draws conclusions of theoretical and practical significance.

Another approach, the subject of research in the dissertation, exploits two mathematical formalisms defined by Krasimir Atanasov: the algebraic apparatus of indexed matrices (IM), when applying algebraic operations over matrices of different dimensions, and intuitionistic fuzzy sets (IFS) as mathematical a tool for dealing with uncertainty. IFS are used for the pairwise comparisons and evaluations of the behavior of the objects according to criteria, as well as for determining the values of the correlation thresholds between the criteria and the tolerance thresholds, which are necessary in the decision-making process.

In the present dissertation work, original results related to the research of modern paradigms in the field of intelligent systems have been achieved, using analytical and experimental models.

A major focus of the dissertation work is the analysis of the significant variety of research and existing methods that were to determine the approaches, methods and algorithms applicable to certain classes of objects. The main efforts to achieve the desired results were directed to Intelligent methods for processes analysis in justice administration.

The current dissertation aims to analyze the processes in justice administration with the means of modern paradigms from the field of intelligent systems. To achieve this goal, the following tasks have been formulated:

1. to choose appropriate intelligent techniques for the processes analysis in justice administration;
2. to apply the apparatus of the Generalized Nets (GN) for the processes analysis in justice administration;
3. to apply the apparatus of Intuitionistic fuzzy sets (IFS) for the pairwise comparisons and evaluations of the behavior of the objects involved in the processes analysis in justice administration;
4. to develop a model of the first phase of the first court instance of the judicial process;
5. to develop a model of the second phase of the first court instance of the judicial process;
6. to develop a model of court proceedings before an appeal court;
7. to develop a model of cassation proceedings before the Supreme Court of Cassation;
8. to develop a model of the judicial proceedings for annulment of effective court decisions before the Supreme Court of Cassation.

The results of the analysis of the conducted research are presented in two refereed scientific publications with SCImago Journal Rank (SJR) - *Lecture Notes in Networks and Systems,* на *Springer International Publishing* и в две международни конференции - *the 10-th International Conference on Intelligent Systems - IS'20* и в *the 11-th International Conference on Intelligent Systems - IS'22.*

All publications are referenced and indexed in world-renowned databases with scientific information, thus complying with the requirements of the law on the development of the academic staff in the Republic of Bulgaria.

The dissertation is structured in an introduction, three chapters and a conclusion, and is accompanied by a declaration of originality of the obtained results and a bibliography.

Original results have been achieved related to the research of modern paradigms in the field of intelligent systems, using analytical and experimental models.

CHAPTER 1

1.1. Introduction and description of the legal process

1.1.1. Historical review

There are three main legal systems worldwide [16, 17], namely: - continental or European (Romano-Germanic) legal family based on the continental legal system; - family of common law based on common (Anglo-Saxon) law and precedent; - religious-traditional legal family.

1.1.2. Civil procedure law

Civil procedure law is a branch of operative law. It regulates the relations regulated by it through the method of state power and subordination, similar to constitutional, administrative, criminal law and criminal process, which use the same method [16].

1.1.3. Sources of civil procedure law

At the head of the sources is the Constitution of the Republic of Bulgaria. After the Constitution, in the hierarchy of sources of civil procedural law, there are international treaties to which the Republic of Bulgaria is a party. The secondary EU law follows - EU Regulation No. 44. In the next place are the internal normative acts - codes, laws and the by-laws issued based on them - ordinances, regulations, etc. [16, 17].

1.1.4. Claim and right to claim

The subject of the present work is the civil process, and in particular one part of it - the general claim process or the so-called "claim process" [10, 12, 13, 14, 15]. The claim process begins on the occasion of a legal dispute. The claim and the right to claim are fundamental procedural categories.

The right to claim, as a right to justice, belongs to both the claimant and the defendant. The claimant, filing the claim, figuratively speaking, "brings the defendant into the game". The latter cannot file a claim before the durg surd for the same dispute. However, he can, if the claimant requests that the case be dismissed, the defendant may not agree

and the case will continue. This is a manifestation of the defendant's right of action as a right to justice.

1.1.4.1. Types of claims

There are several types of claims [5, 6, 10, 12, 13, 14, 15]:

- A declaratory action is one whose claim is limited to the request to resolve a civil dispute with the force of a res judicata. The protection sought by him is exhausted by the res judicata, with which the disputed right (legal relationship) is denied or confirmed. Therefore, the declaratory action expresses in its purest form the essence of the claim process.

- A condemnation claim is one with which the claimant requests from the court:

- to establish with the res judicata that there is an unsatisfied civil claim in favor of the claimant against the defendant;

- to allow forced satisfaction of the claim against the defendant. The admission of forced gratification against the defendant finds expression in his conviction. Therefore, a condemnation claim always includes a request to condemn the defendant.

- A constitutive claim:

In a number of cases, substantive law empowers one of the subjects of the civil legal relationship to unilaterally cause a change in the legal sphere of the other subject of the legal relationship, which is independent of his will.

It is characteristic of a process that it is a process. It is a pre-arranged procedure. The parties cannot agree on something different, as is the case in civil legal relations. Procedural law regulating civil relations between persons is regulated by means of a normative act - most often a Code. The Bulgarian model of a continental legal system was introduced by the current Civil Procedure Code of the Republic of Bulgaria (CPC).

1.1.5. Development of civil legal relations

Civil process comes when there is some illegality. The means, the procedural method of protection against this illegal development of the legal relationship is the claim process. The claim process is the procedure that is for consideration and decision by force of res

judicata of a civil dispute. It is a process, not a static legal relationship. The process begins with the presentation of the claim, but it is quite possible that years will pass until the civil process goes through the individual court instances (first instance, appeal and cassation) until the dispute is resolved.

1.1.6. Court

The protection-sanction is given by a third party. It is an independent third party independent of both parties. Especially this independence is evident from the claim process, which according to our law is judicial and according to the new constitution, judicial bodies under our system can only be courts.

1.1.7. Parties in the general claim process

The parties in the general claim process are the persons on whose behalf and against whom the case is being brought - i.e. the claimant and the defendant. In certain cases, the participation of a third party, called an "interested party in the process", who assists the claimant or the defendant in the case, is also possible. The court is not a party to the process, but is the body that exercises the function of management and resolution of the arising legal dispute [19].

1.1.8. Subordination

Subordination represents 1) the competence of the relevant body to issue the official act, the decision on the dispute and 2) expresses the affiliation, subordination of the specific legal dispute to the judicial power of the specific body. This is the same, viewed from two aspects – 1) from the competence and 2) from the subordination of the relevant case to this competence. Jurisdiction of the courts falls precisely on the administration of justice, the decision by force of a res judicata of a given case, of a given dispute. That is, jurisdiction in civil cases is the right and obligation of the relevant court to examine and decide with the res judicata a civil case [5].

Jurisdiction determines the order in which the case will be heard. This procedure for civil cases is usually regulated by the Civil Procedure Code.

1.1.9. Jurisdiction

Jurisdiction presupposes jurisdiction and represents the competence of a specific court in the system of courts to exercise authority over the examination and decision of a civil case.

There are different types of jurisdiction - generic, local and functional jurisdiction Depending on the delineation of these jurisdictions, the competent court is determined for the specific case. As a rule, generic, local and functional jurisdiction subordinate the case to a specific court [5].

CHAPTER 2

INTELLIGENT METHODS FOR AN ANALYSIS OF COMPLEX PROCESSES

2.1.   Computational intelligence.

2.2.   Basic approaches in the copmputational intelligence

In the last two decades there appeared gradually a new scientific field, which was termed "Computational intelligence", one of the most popular definitions of computational intelligence in the respective academia is of the following type:

"Computational intelligence is a methodology, including calculations, showing possibilities for training and/or for coping with a new situation, so that the system is comprehended as having one or more attributes of judgements, such as summary, opening, association and abstraction.".

Finally, it can be concluded that **the applied methods of the classical artificial intelligence use human knowledge, whereas these of computational intelligence try to create the conditions for efficient interaction between man and computer, which leads to increasing human intelligence**.

2.3. Intelligent systems

"**Intelligent systems**" is a term, having a wide scope and not accepted in a straightforward fashion. The magazine "Intelligent Systems" of the biggest professional organisation globally - Institute of Electrical and Electronics Engineers - IEEE is focused mainly on informatics, while in the numerous international scientific forums devoted to the intelligent systems, there is much wider understanding in the direction of interdisciplinary and multidisciplinary approach. There is special emphasis on the term "intelligent", whose content corresponds to a great extent, in terms of sense and scope, to the terms and techniques, considered above. However, the term "systems" has a

domineering importance. "System" means not only structural characteristics (elements, relationships, interactions), but also specific realization (including simulation). The examples of intelligent systems are exceptionally varied: intelligent systems for management, intelligent systems for decision taking, intelligent robotized systems, intelligent systems for training, intelligent bioinspired systems, intelligent virtual companies, etc., [46, 49, 50, 51, 52, 79].

2.4. Introduction to the theory of the Generalized Nets

During the years the definition of GN changed several times with the aim of improvement. The present definition dates back to 2007. The GN is made up of transitions. Graphically each transition is represented by two elements - $\bigcirc$ and $\top$.

Each transition to GN should have at least one entry and one exit position (see Fig. 2.4.) [1, 2]. The graphical symbol of the position is ($\bigcirc$).
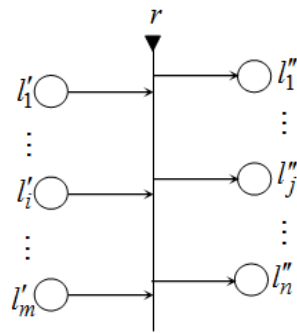
Figure. 2.4. Presentation of a transition in GN

In order to present the indexed matrix it is necessary first to define the sets I and R, whereas I is a fixed set of indices, and R is the set of the real numbers. Then, for indexed matrix with indexed sets K and L ($K, L \subset I$ and $K = \{ k_1, k_2, \ldots, k_m \}$, $L = \{ l_1, l_2, \ldots, l_n \}$), the following is obtained:

$$[K, L, \{a_{k_i, l_j}\}] = \begin{array}{c|cccc} & l_1 & l_2 & \ldots & l_n \\ \hline k_1 & a_{k_1, l_1} & a_{k_1, l_2} & \ldots & a_{k_1, l_n} \\ k_2 & a_{k_2, l_1} & a_{k_2, l_2} & \ldots & a_{k_2, l_n} \\ \vdots & \ldots & \ldots & \ldots & \ldots \\ k_m & a_{k_m, k_1} & a_{k_m, l_2} & \ldots & a_{k_m, l_n} \end{array}, \qquad (1)$$

where $a_{k_i,l_j} \in R$ for $i \in [1, m]$ and $j \in [1, n]$.

The transition of GN is defined via ordered set of seven of the type:

$$Z = <L', L'', t_1, t_2, r, M, \square>,$$

where:

- $L' = \{l'_1, ..., l'_i, ..., l'_m\}$ – final not empty set of entry positions of the transition;

- $L'' = \{l''_1, ..., l''_j, ..., l''_n\}$ – final not empty set of exit positions of the transition;

- t_1 – moment of activating the transition;

- t_2 – duration of the active state of the transition;

- r – a condition of the transition, which determines which token may pass from its entry positions to its exit positions.

It is formed via an indexed matrix of the type:

$$r = \begin{array}{c|ccccc} & l''_1 & \dots & l''_j & \dots & l''_n \\ \hline l'_1 & r_{1,1} & \dots & r_{1,j} & \dots & r_{1,n} \\ \vdots & \dots & \dots & \dots & \dots & \dots \\ l'_i & r_{i,1} & \dots & r_{i,j} & \dots & r_{i,n} \\ \vdots & \dots & \dots & \dots & \dots & \dots \\ l'_m & r_{m,1} & \dots & r_{m,j} & \dots & r_{m,n} \end{array}, \qquad \text{for } i \in \{1,2,...,m\}, j \in \{1,2,..,n\} \qquad (2)$$

$r_{i,j}$ is a predicate, which corresponds to i^{th} entry position of the transition and j^{th} exit position of the transition. If the predicate is true (has value "*true*") it is possible that the nucleus passes from i^{th} entry position to t^{th} exit position. The predicates may not depend on future events.

2.5. Intuitionistic Fuzzy Sets (IFS).

2.5.1. Definition of Intuitionistic Fuzzy Sets (IFS)

The theory of the Fuzzy Sets (FS) was defined by Lotfi Aliasker Zadeh in 1965 as a mathematical apparatus for an adequate description of the inaccuracy and uncertainty in nature [126].A proof of the increasing interest in these were the developments, defined subsequently: L-FS (L-Fuzzy Sets) of Goguen [48], FS with interval values (Interval

Valued Fuzzy Sets) of Gorzalczany [49], "coarse" (rough) sets of Pawlak and intuitionistic fuzzy sets (IBS) of Krassimir [29 - 32, 38, 40, 46, 49, 80].

A represents intuitionistic fuzzy sets (IFS), the description of which is of the following type:

$$A = \left\{ \langle x, \mu_A(x), v_A(x) \rangle / x \in E \right\},$$ (8)

where E is a fixed set, the function $\mu_A : E \to [0,1]$ specifies the respective degree of belonging, and the function $v_A : E \to [0,1]$ specifies the respective degree of not belonging of the element $x \in E$ to the set $A \subseteq E$ and for each $x \in E$ the following is complied with:

$$0 \le \mu_A(x) + v_A(x) \le 1.$$ (9)

The function π_A is described by the mathematical expression:

$$\pi_A(x) = 1 - \mu_A(x) - v_A(x),$$ (10)

Which specifies the degree of uncertainty of the element's belonging $x \in E$ to the set *A*. Evidently, FS is a special case of IFS, where $\pi_A(x) = 0$ for each $x \in E$.

2.6. Indexed matrices

The term Indexed Matrix (IM) was introduced in 1984 by Corresponding Member Krassimir Atanassov, doctor of technical sciences, doctor of mathematical sciences. During the last 25 years some of their properties were studied, but were mainly used as an additional instrument for the description of the transitions of the Generalized Nets (GN), intuitionistic fuzzy relations and graphs with edges and as a whole in some algorithms for taking decisions [18, 25].

During the last 30 years some of their properties were investigated and summarized in the book of Krassimir Atanassov "Towards an Augmented Matrix Calculus". Let *I* be the determined set of indexes and *R* be the set of real numbers. Via an indexed matrix with sets of indices *K* and *L* (*K*, *L* ⊂ *I*) we will note:

$$
\left[K,\ L,\ \left\{a_{k_i,l_j}\right\}\right] \equiv
\begin{array}{c|cccc}
 & l_1 & l_2 & ... & l_n \\
\hline
k_1 & a_{k_1,l_1} & a_{k_1,l_2} & ... & a_{k_1,l_n} \\
k_2 & a_{k_2,l_1} & a_{k_2,l_2} & ... & a_{k_2,l_n} \\
\vdots & ... & ... & ... & ... \\
k_m & a_{k_m,l_1} & a_{k_m,l_2} & ... & a_{k_m,l_n}
\end{array}
\tag{11}
$$

where $K=\{k_1,\ k_2,\ ...,\ k_m\}$, $L=\{l_1,\ l_2,\ ...,\ l_n\}$, for $1 \le i \le m$, and $1 \le j \le n : a_{ki,lj} \in R$.

CHAPTER 3

RESULTS OF THE APPLICATION OF INTELLIGENT METHODS FOR PROCESSES ANALYSIS IN JUSTICE ADMINISTRATION

3.1. Description of the first phase of the first court instance of the General Claim Process

3.1.1. Filing a claim. Review of the claim by the court

The general claim process as a proceeding represents a chain of gradually occurring procedural actions of the parties and the human rights body. We have the term pending process. It is a process that has begun and is not finished. It begins with the filing of the claim - this is the first procedural action [5, 15]. The claim is considered officially filed when the claim is submitted to the court. (Art. 125 of the Civil Procedure Code) Once the claim has reached the competent court, the role of the judge begins in the management and administration of the judicial process.

The first action that the judge should perform upon receipt of the claim is to check its regularity.

After the regularity check, the court checks whether the claim is admissible.

After the judge found that the claim is regular and admissible, he sent the claim to the defendant for a response - a response to a claim.

3.1.2. Procedural actions of the defendant. Exchange of court papers

The defendant has the following several options for action [9], respectively for defense:

- the defendant can admit the claim;

- the defendant may not file an answer to a claim, i.e. to become disinterested in the process at this stage;

- the defendant may, within the given one-month period, submit an answer to the claim, with which he disputes the claim in whole or in part;

- the defendant, in addition to submitting an answer to a claim, may in turn file a counterclaim against the original claimant.

3.1.3. Preparation of the case in closed session

After verifying the regularity and admissibility of the claims, as well as the other requests and objections of the parties, the court issues a ruling on all preliminary questions and on the admission of evidence. The court schedules the case in an open session, for which it calls the parties, to whom it delivers a copy of the ruling.

3.1.4. Types of court hearings

The consideration of the case covers the totality of the procedural actions of the court and the parties, consisting of preparation of the case, collection of evidence and oral arguments. These actions are done in public in open court sessions, unless the law provides for this to be done in closed session. A protocol is drawn up during the consideration of the case.

3.1.5. Case report

The judge in the case prepares a draft report on the case, which is brought to the knowledge of each of the parties.

The court indicates to the parties which of the facts claimed by them lack evidence.

The court provides an opportunity for the parties to present their opinion in relation to the given instructions and the report on the case, as well as to take the relevant procedural actions.

Claim proceedings at first instance generally go through two phases. The first phase of the trial ends with an oral report. It aims to prepare the consideration of the case on its merits. The second phase aims at gathering evidence (forensic search).

3.2. Generalized net model of the General Claim Process - first phase of the first court instance

The results obtained from the application of intelligent techniques for the processes analysis in justice administration, and in particular the first phase of the first court instance proceedings, by using the apparatus of generalized nets, are presented in [2*].

The GN-model of of the General Claim Process - first phase of the first court instance (see Fig. 3.2.) contains 6 transitions, 22 places and 4 types of tokens that have the following sence:

Token "E" – "*Court of first instance*"

Token "C" – "*Claimant*"

Token "D" – "*Defendant*"

Token "F" – "*Documents*"
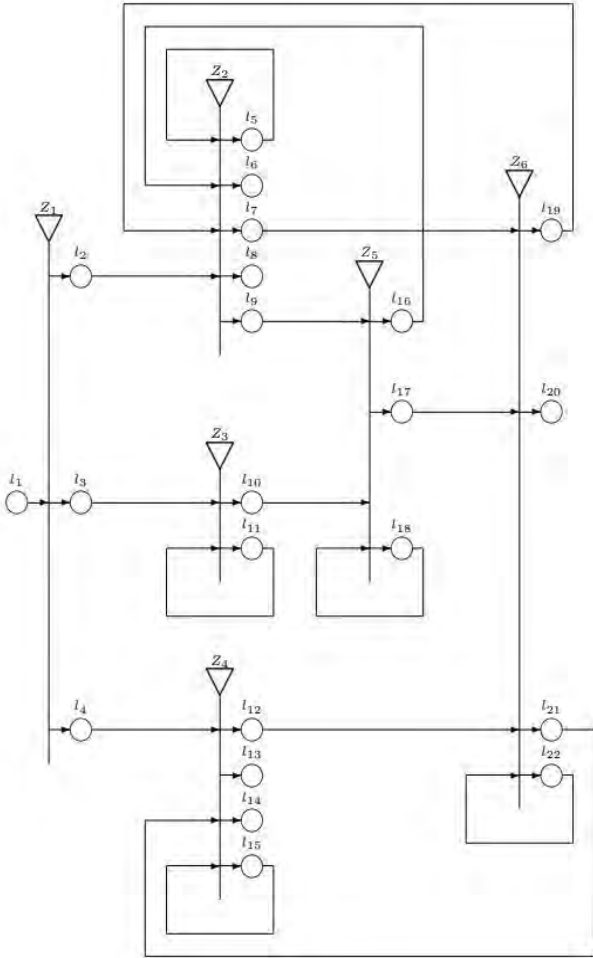
Fig. 3.2. GN-model of of the General Claim Process - first phase of the first court instance

3.3. Description of the second phase of the first court instance of the General Claim Process

3.3.1. Court appearance

The court proceeds to clarify the factual side of the dispute. The subjective statements of the parties that certain facts have taken place have been presented to the court. The claimant can clarify and supplement the claim, as well as indicate and present evidence in connection with the objections made by the defendant, and the defendant - to indicate and present new evidence that he could not indicate and present with the answer to the claim. Also, the parties are obliged to make and justify all their requests and objections and take an opinion on the circumstances claimed by the opposite party.

The court asks questions about the facts claimed by the parties, and these questions aim to separate the disputed from the undisputed. The defendant may request an additional term to take an opinion on the evidentiary requests made by the plaintiff at this meeting and to indicate additional evidence in connection with the objections made. When this request is granted, the court rules on the challenges and requests made in a closed session with a decision that is communicated to the parties [5, 15. 20].

3.3.2. Evidence. Gathering evidence

The court collects all admitted evidence with the participation of the parties. If necessary, he schedules a new hearing to collect evidence that was not collected for reasons beyond the control of the parties.

As a set of procedural actions, proof covers: the indication, presentation, collection and discussion of evidence. All these actions are carried out by the court or before the court, and with a guaranteed opportunity for both parties to take part in these actions if they wish [5, 6, 9, 10, 20].

The importance of proof in the claim process is extremely great.

3.3.3. Burden of proof

The question of the burden of proof is a question of the consequences of the failure to prove, the burden of proof consists in the right and the duty of the court to accept that

this legal consequence, the legal fact of which has not been proven, has not occurred. (if the fact has not taken place, its legal consequences cannot arise).

To the parties, the burden of proof indicates what each of them must prove, and to the court, the burden of proof indicates what legal conclusion it must make if one or other facts are not proven. The burden of proof is an institute that stands on the border between substantive and procedural law, so it is subject to norms that are authoritative for both branches of law.

3.3.4. Evidence

The means of evidence are provided and regulated by law sources of information about the facts subject to proof (legally and evidentially relevant facts). Such sources of information are the explanations of the parties; witness statements; the documents; the physical evidence and the conclusions of the experts.

3.3.4.1. Explanations of the parties

The court may order the party to appear in person to explain the circumstances of the case. The admission of fact made by the party or its representative is assessed by the court in view of all the circumstances of the case.

3.3.4.2. Written evidence

The terms "written evidence" and "document" are identical for civil procedural law.

Written evidence - a written or electronic document, is a thing on which a statement is materialized in writing.

3.3.4.3. Witness testimony

Testimony is collected through the examination of witnesses by the court. There are two groups of witnesses - in the mode of bringing and in the mode of summoning.

3.3.4.4. Experts

An expert is appointed at the request of the party or ex officio when special knowledge in the field of science, art, crafts and others is needed to clarify some issues arising in the case.

The expert should prepare an expert opinion on the tasks assigned to him by the parties and by the court.

The conclusion is evaluated in view of all the data in the case, its regime is the same as the other means of evidence.

3.3.4.5. Material evidence

At the request of the parties or at its discretion, the court may order an inspection of movable or immovable property or the examination of persons with or without the participation of witnesses and   experts.

3.3.5. Indication of means of evidence. Admission of evidence

The indication of evidential means is a statement that there is a certain evidential means which should be collected.

The evidence shall be specified by the parties. They are specified in the claim, respectively – in the response to the claim. These terms are exclusive - after their expiration, it is not allowed to point to and present other means of evidence, except in the cases listed below.

3.3.6. Collection of evidence. Court search

The collection of evidence consists in extracting, perceiving and certifying the facts contained in them in the case.

Evidence is collected by the court with the participation of the parties. Depriving the party of the opportunity to participate in the collection of evidence is a serious procedural violation within the meaning of Art. 281, item 3 of the Code of Criminal Procedure and was subsequently canceled as incorrect by the Supreme Court pursuant to Art. 293, para. 2 of the Civil Procedure Code.

The collection of evidence is carried out in an open court session after its admission. The court is obliged to collect all admissible evidence. Oral evidence is recorded in the protocol, and written evidence is attached to the case.

The collection of evidence is at the heart of the legal process. The truth for the court is the proven facts and circumstances of the case. The decision of the court should correspond to the allegations proved by the party. The better the claimant or the defendant defended his claims and was able to substantiate and support them with evidentiary material, the greater his chance of winning the court case. The principle of

establishing the truth is deeply rooted in the Bulgarian Civil Procedure Code (CPC) - Art. 10 and states that the court provides the parties with an opportunity and assists them in establishing the facts that are relevant to the decision of the case. However, the Bulgarian legislator and standard-setter is not an innovator. The general principles of the civil process in Bulgaria are leading, both in the law of the European Union and in every legal system in the world.

Another leading principle in the civil process is the one proclaimed in Art. 9 CPC principle for the equality of the parties in the process, which stipulates that the court provides the parties with an equal opportunity to exercise the rights granted to them. It applies the law equally to everyone, which means that both the plaintiff and the defendant have equal rights and opportunities to defend their claims and positions before the court, through the engagement of evidence.

Once collected, evidence is subject to discussion through oral contests between the parties and to judgment by the court in rendering judgment.

3.3.7. Oral competitions

After the conclusion of the judicial search, it is the turn of the oral contests (Article 149 of the Code of Civil Procedure). They consist of the final oral presentation of factual and legal arguments by the parties.

When the case is explained, the court declares the oral contests closed and indicates the day on which it will announce the decision.

3.3.8. Protocols of the sessions

When the case is examined in an open court session, a protocol is drawn up. The protocol of the session is evidence of the judicial proceedings performed in the court session. Actions not certified in the protocol are considered not performed.

3.3.9. Court decision. Essence of the court decision

The court announces its decision with reasons at the latest within one month after the hearing in which the consideration of the case is completed [14].

From the moment it was announced by the court, there is already a decision. If it has not been announced, we have an incomplete factual situation - the decision does not give rise to legal consequences, and the terms for its appeal do not begin to run.

3.3.10. Types of court decisions

In essence, a court decision is a unilateral authoritative pronouncement by a court that resolves a legal dispute by establishing what the actual legal position is between the disputants and obliging them to comply with it.
In the event that the court upholds the claim in full, and depending on what is being sought and the type of claim, the judgments may be declaratory decision, decision of conviction or constitutive decision.

Declaratory decisions – their content is exhausted by the finding that the disputed right exists/does not exist. They enjoy res judicata, but not executive or constitutive power.

Convicting court decisions - in addition to confirming the disputed right, they also allow for its enforcement, i.e. they have, in addition to the res judicata, executive power.

Constitutive court decisions - in addition to confirming the controversial potestative right, they also rule on the change sought on the basis of this right in civil jurisprudence.
In the event that the court completely rejects the plaintiff's claim, the rendered decision denies the existence of the disputed right. This type of decision can only be conclusive and is used only with res judicata.

Depending on the judge who issued the judgment, acts are divided into first-instance, appeal and cassation.

3.3.11. Types of defective decisions - void, inadmissible and incorrect

The term "vicious decisions" refers to vices of the will expressed by the court in its formation. The law regulates the types of vices in the formation of the will, the method of attack and the consequences.

3.3.11.1. Void decisions

A decision that does not meet the requirements for a valid decision is null and void – it is not in writing, in a foreign language, lacks a signature, the court enters a foreign country's exclusive competence, etc. A void judgment is not capable of giving rise to consequences.

It is important that the court always verifies ex officio the validity of the contested act.

3.3.11.2. Inadminissible decisions

A decision that does not meet the requirements under which the case can be decided on its merits is inadmissible. It is a matter of a decision that was rendered in the absence or improperly exercised right of defense, as well as if the court was seised.

The result of the appeal is a constitutive decision (not a declaration as in nullity). The decision is invalidated, removed as a legal act. Annulment cancels the court decision and everything disputed in the case.

3.3.11.3. Incorrect decisions

This valid and permissible decision, which contradicts the actual legal situation, is incorrect. With them, the court's conclusion regarding the subject of the dispute is not correct, i.e. it does not reflect the actual state of the material legal relationship.

3.4. Generalized net model of the General Claim Process - second phase of the first court instance

The results obtained from the application of intelligent techniques for the processes analysis in justice administration, and in particular the second phase of the first court instance proceedings, by using the apparatus of generalized nets, are presented in [3*]. The GN-model of the General Claim Process - second phase of the first court instance (see Fig. 3.4.) contains 12 transitions, 32 places and 3 types of tokens that have the following sence:

Token "C" – "*Claimant*"

Token "D" – "*Defendant*"

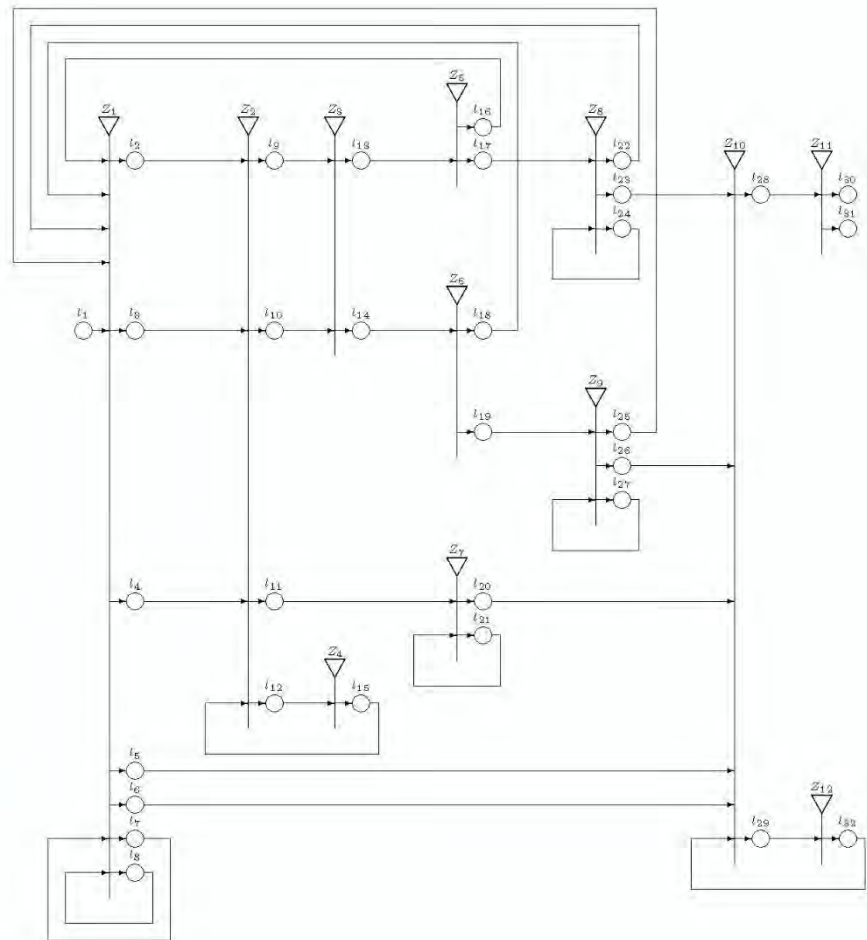**Token "A"** – "*Documents of the claimant*"

Fig. 3.4. GN-model of the General Claim Process - second phase of the first court instance

3.5. Description of the appeal proceedings of the General Claim Process

3.5.1. Essence of the appeal proceedings. Competent court

Appeal proceedings is a way of challenging a bad decision, allowing the legal dispute to be re-examined on its merits. The subject of the appeal is the substantive dispute, therefore it is said that the appeal is a continuation of the activity of the court of first instance. It is also referred to as second first instance [5, 11].

The appeal may be filed against the entire decision or against individual parts of it (dispositive beginning).

The person on whose behalf the appeal is filed is called the appellant, and the opposing party (the defendant in the appeal) is called the party being appealed.

The right of appeal arises with the announcement of the first-instance judicial act and its delivery to the relevant party in the case.

3.5.2. Comparison with the right of claim

The right to appeal [10, 12, 13,20] belongs to certain authorized persons: - The parties constituted in the case at first instance (typical and atypical main parties); - Persons who were not constituted as parties before the court of first instance also have this right.

3.5.3 Apeal

The appeal is in writing, as its content and form are precisely provided for in the Civil Procedure Code.

The appeal must be filed through the court of first instance, which is required to serve the review of the regularity of the appeal [11].

The Civil Procedure Code clearly states when a complaint is irregular. If there is a discrepancy with the intended content and form of the complaint, the party is notified to remedy the irregularities within one week.

The complaint is returned in 2 hypotheses:

- when it is submitted after the expiration of the appeal period and

- when the irregularities committed are not remedied in time.

If the appeal is regular or the irregularities are removed within the deadline, the court of first instance is obliged to send a transcript to the opposite party.

Within a two-week period, the opposing party may submit a response.

3.5.4. Cross-appeal

As before the court of first instance, as well as at the second instance, the party being appealed (the defendant to the appeal) may, in addition to filing a response to the appeal, also file a counter-appeal. In this case, the parties in the proceedings acquire 2 qualities in the proceedings before the appellate court - of the appellant and of the party under appeal.

In the event of a cross-appeal being filed, it must meet the requirements for an appeal. The court checks the regularity of the cross-appeal.

In the proceedings before the appeal court, in practice, the actions resemble the activity of the court of first instance.

3.5.5.   Proceedings before the Appeal court

3.5.5.1. Preparatory session

In a closed session, the appeal court examines the admissibility of the appeals, rules on the admission of the new evidence indicated by the parties and schedules the case for consideration in an open session.

3.5.5.2. Open court session. Gathering evidence

The Appeal court, composed of three judges, examines the appeals in open session with the summons of the parties, at which it reports the appeals and the responses of the parties

The collection of evidence is done according to the general rules applicable to the proceedings before the court of first instance. The evidence gathered in the first instance is not initially gathered before the appeals instance.

Of extreme importance is the fact that in the appellate proceedings the parties cannot claim new circumstances, point out and present evidence that they could have pointed out and presented in time in the first-instance proceedings.

3.5.5.3. Oral competitions

After the conclusion of the trial before the appeal instance, the court starts the oral contests, to which the rules of the first-instance court proceedings apply accordingly.

3.5.6. Competence of the Appeal court. Decision of the Appeal court

The jurisdiction of the appeal court depends on the vice of the decision.

1. When the decision is void, the appeal court declares the nullity and, if the case is not subject to termination, returns it to the court of first instance for a new decision.

2. When the decision is inadmissible, the appeal court invalidates it by terminating the case.

The court must first check whether the decision is valid, then whether it is admissible and only finally whether it is correct.

3. When the appeal court considers that the appealed decision is valid and admissible, it proceeds with the construction of its own opinion on the essence of the case - the resolution of the substantive legal dispute, by confirming or canceling in whole or in part the first-instance decision. If the decision is not appealed by the other party, the position of the appellant cannot be worsened by the new decision.

1. If it reaches the same opinion as that of the court of first instance, the appeal court confirms the appealed decision.

2. If the appeal court's opinion on the resolution of the dispute is essentially different from that of the court of first instance, it cancels the appealed decision (in whole or in parts).

3.6. Generalized Net Model of the General Claim Process - Proceedings before an Appeal court

The results obtained from the application of intelligent techniques for the processes analysis in justice administration, and in particular the appeal court instance proceedings, by using the apparatus of generalized nets, are presented in [4*].

The GN-model of the General Claim Process - Proceedings before an Appeal court (see Fig. 3.6.) contains 6 transitions, 23 places and 5 types of tokens that have the following sence:

Token "E" – "*Court of first instance*"

Token "F"– "*Court of first instance, performing a function other than that of token "E""*

Token "G"– "*Appeal court*"

Token "C"– "*Appelant*"

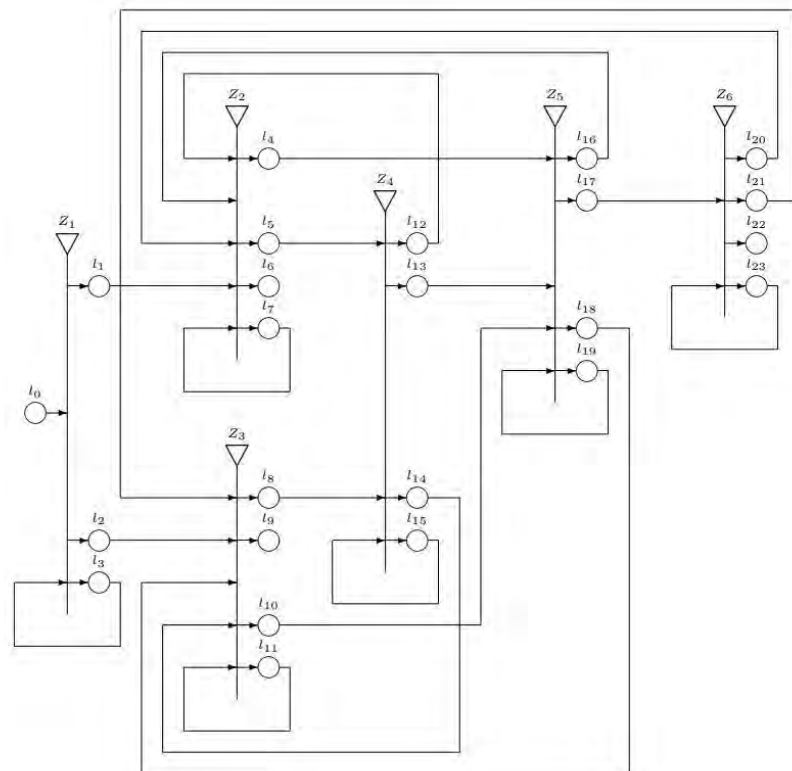**Token "D"**– "*Defendant to the appeal*"

Fig. 3.6. GN-model of the General Claim Process - Proceedings before an Appeal court

3.7. Description of the cassation procedings of the General Claim Process

3.7.1. Essence of the cassational appeal. Competent court

The cassation appeal in Bulgarian procedural law [5, 6, 10, 11, 12, 15] is that it is regulated as regular, but not always possible due to the assessment of admissibility according to Art. 280 of the Code of Civil Procedure, the third instance for review of the decisions of the appellate courts.

Another feature of the cassation proceedings consists in the expressly listed in Art. 280, para. 1 of the Civil Procedure Code strict grounds for allowing the cassation appeal. For the parties to the case, the cassation instance has the character of exclusivity, in the sense of limited accessibility. Only the Supreme Court of Cassation of the Republic of Bulgaria is competent

3.7.2. Decisions, subject to cassational appeal. Grounds for allowing cassational appeal

The cassation proceeding is a specific court proceeding, since in order to develop the case it goes through 2 different phases. The first phase is related to the admission to consideration of the case on its merits. Only after the case has been admitted for consideration, the Supreme Court of Cassation owes a ruling on the legal dispute on the merits. The Supreme Court of Cassation is competent to consider the case.

3.7.3. Grounds of cassation

These grounds for admission are different from the grounds for a cassation appeal within the meaning of Art. 281 of the Civil Procedure Code, which are related to vices of the appellate decision. This is related to the verification of the merits of the complaint. Void, inadmissible or incorrect decision (as in appeal).

Grounds:

1. All cases where the decision is void;

2. Inadmissible decisions;

3. Incorrect decision

3.7.4. Cassation appeal. Answer of a cassation appeal

The party that appeals to the Supreme Court of Cassation with a cassation appeal is called the "appellant" and the other party - the defendant in the cassation appeal. The cassation appeal is filed within a one-month preclusion period from the delivery of the decision to the party. The submission is made through the court that issued the appeal decision.

The appeal court, and not the Supreme Court of Cassation, has the duty to conduct an ex officio examination regarding the possible presence of deficiencies in the appeal.

The appeal court checks the regularity of the complaint and if it does not meet the established legal requirements, it informs the party to remove the admitted irregularities within one week.

If the appeal is regular, the appeal court sends it together with the exchanged documents and the case to the Supreme Court of Cassation. After accepting the appeal, the appeal court sends a copy of it to the defendant and gives him a one-month deadline to respond. The defendant may also file a counter-appeal in cassation within the response period.

3.7.5. Check on admissibility of the cassation appeal

After the appeal and the response are sent to the Supreme Court of Cassation, it checks the admissibility of the appeal in a closed session and rules on it with a ruling - in the event that the Supreme Court of Cassation finds the cassation appeal inadmissible, it is barring, because it deprives the party of its right to cassation proceedings. The Supreme Court of Cassation rules on the admission of the cassation appeal with a ruling in a closed session of three judges.

3.7.6. Examination of the cassation appeal on the merits

If the Supreme Court of Cassation accepts the appeal as admissible and admits it for examination on the merits, the Supreme Court of Cassation proceeds to summon the parties - this is done by publication in the State Gazette.

Cassation appeals (if there is a counter appeal) are considered by a three-member panel of the Supreme Court of Cassation in an open session.

3.7.7. Cassation decision. Return of the case to the Appeal court and powers of the Supreme court of cassation in case of re-appeal

1. With its decision, the Supreme Court of Cassation may uphold the decision of the appellate court or annul it in whole or in part:

2. If it finds that the decision is void or inadmissible - the Supreme Court of Cassation will do the same as the appellate court in this case - if it is void or terminates the case or if it is not subject to termination, returns it for a new consideration. If he finds that the decision is inadmissible - he invalidates it and terminates the case or sends it to the competent court if it is inadmissible due to wrong jurisdiction.

3. The decision is annulled as incorrect when the substantive law is violated or significant violations of the judicial procedure rules are committed or the decision is unfounded. The court returns the case for a new consideration by another panel of the appellate court only if it is necessary to repeat or carry out new judicial actions.

3.8. Generalized Net Model of the General Claim Process - Cassation proceedings before the Supreme Court of Cassation

The results obtained from the application of intelligent techniques for the processes analysis in justice administration, and in particular of the cassation proceedings, by using the apparatus of generalized nets, are presented in [5*].

The GN-model of the General Claim Process – Cassation proceedings before the Supreme Court of Cassation (see Fig. 3.8.) contains 5 transitions, 20 places and 4 types of tokens that have the following sence:

Token "G"– "*Appeal court*"

Token "C"– "*Appelant*"

Token "D"– "*Defendant of the cassation appeal*"

Token "H"– "*Supreme Court of Cassation*"
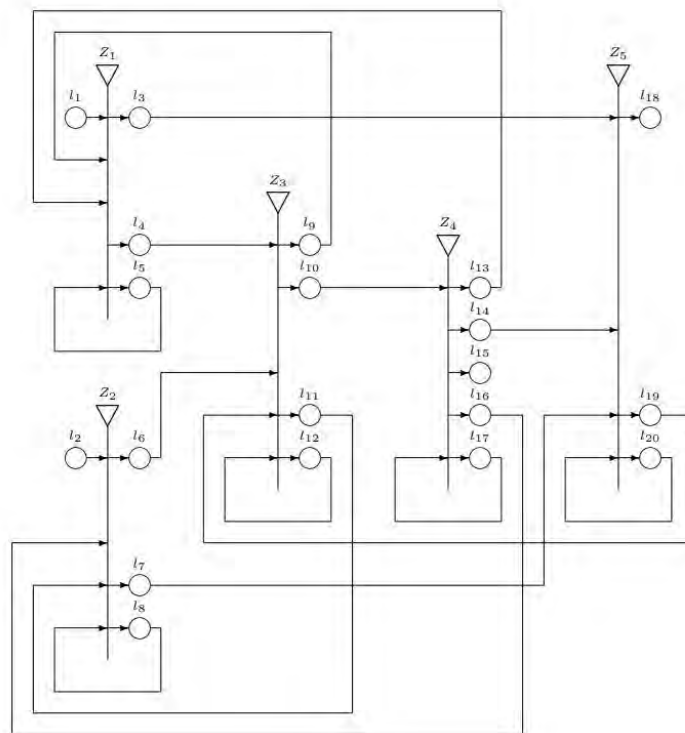
Fig. 3.8. GN-model of the General Claim Process – Cassation proceedings before the Supreme Court of Cassation

3.9. Description of the annulment procedings of an effective court decision of the General Claim Process

3.9.1. Essence and scope of annulment

The annulment under Art. 303 of the Civil Procedure Code constitutes a remedy against defective judgments entered into force. And here, as in the cassation appeal, the Supreme Court of Cassation is competent to consider and rule on the dispute raised. [5, 6, 11, 14, 15].

Only non-appealable and res judicata decisions are subject to annulment.

3.9.2. Petitioner/ Claimant

Legitimate to initiate proceedings for annulment is above all the "interested party". Such is the person bound by a decision unfavorable to him, which is incorrect due to the

presence of a vice, expressly mentioned in Art. 303 affecting this person (for example, he was irregularly summoned).

3.9.3. Grounds for annulment

The grounds for annulment are seven in total and they are explicitly listed in Art. 303, para. 1 of the Civil Procedure Code.

3.9.4. Procedure for annulment

Competent to consider the application for annulment is always and only the Supreme Court of Cassation. Regardless of whether the annulment of a decision of a regional, district, appellate and supreme court of cassation is requested, a three-member trial of the Supreme Court is competent. In the latter case (in the case of a request to annul a decision of the Supreme Court of Cassation), another trial of the Supreme Court of Cassation is competent to consider the request.

Referral to the Supreme Court of Cassation is made at the request of the interested party. The petition is filed through the court of first instance and must meet the requirements that apply to the appeal and contain a precise and motivated statement of the grounds for annulment. If the application does not meet these requirements, the party is sent a notice to remove them within a week. If the irregularities of the application for cancellation are not removed within the deadline, the same will be returned to the applicant.

A transcript shall be attached to the application, which shall be served on the opposing party. She can give an answer within a week of receiving the transcript. The right to request cancellation is limited by a three-month preclusion period, which runs from a different time depending on the reason.

3.9.5. Check of the admissibility of the annulment request

The Supreme Court of Cassation rules on the admissibility of the application in a closed session by checking whether the contested act is subject to annulment under Art. 303, whether it originates from a legitimate person, as well as whether the application was submitted within the deadline.

3.9.6. Pronouncing essentially. Competence of the Supreme court of cassation

Essentially, that is on the merits of the request, the Supreme Court of Cassation decides in an open session. The Supreme Court of Cassation either rejects the request or respects it. The annulment restores the pendency of the case within the annulled part and in relation to the persons in respect of whom the decision was annulled. In the annulment decision, the Supreme Court of Cassation indicates where to start the consideration of the case. In the event that, between the same parties, for the same request and on the same basis, another effective decision that contradicts it has been passed before it, the court cancels the incorrect decision.

3.10. Generalized Net Model of the General Claim Process – Annulment proceedings before the Supreme Court of Cassation

The results obtained from the application of intelligent techniques for the processes analysis in justice administration, and in particular of the annulment proceedings of an effective court decision, by using the apparatus of generalized nets, are presented in [6*] The GN-model of the General Claim Process – Annulment proceedings before the Supreme Court of Cassation (see Fig. 3.10.) contains 6 transitions, 23 places and 5 types of tokens that have the following sence:

Token "A"– „*Archive*"
Token "E"– " *Court of first instance* "
Token "C"– "*Claiman*"
Token "D"– "*Defendant*"
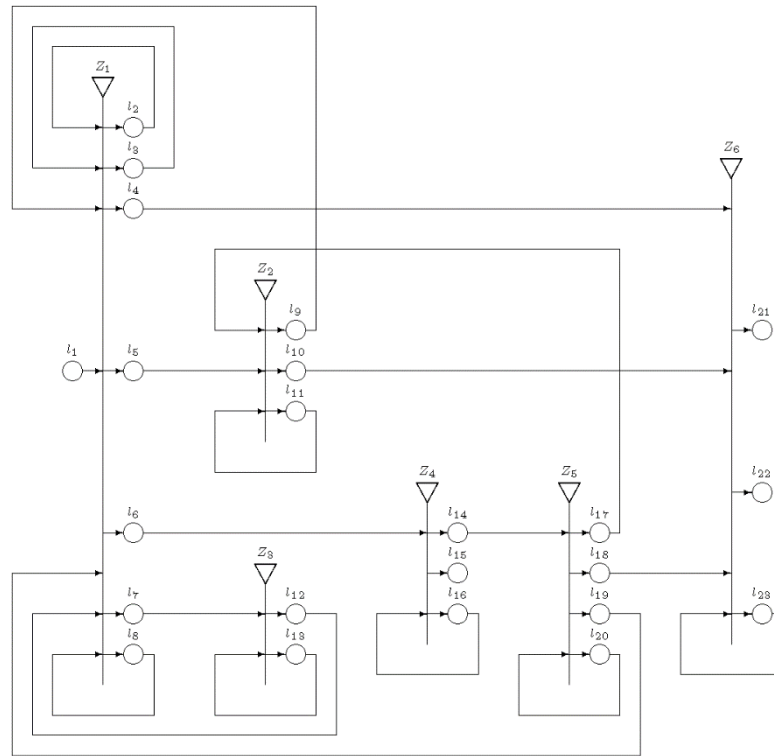**Token "B"**– "*Supreme Court of Cassation*"

Fig. 3.10. GN-model of the General Claim Process – Annulment proceedings before the Supreme Court of Cassation

3.11. Results of the study of judicial process by the means of the application of the apparatus of temporal intuitionistic fuzzy pairs

The results obtained from the application of intelligent techniques for the processes analysis in justice administration, and in particular of the apparatus of temporal intuitionistic fuzzy pairs, are presented in [1*].

A certain period of time "X" was considered, in which the court "Y" was referred to "N" number of claims. The court is obliged to check the regularity of the claim.

There are different hypotheses:

- the claim is initially regular and the court did not find any irregularities in it;
- the claim is irregular. In this case, the court is obliged to instruct the claimant to rectify the irregularity within a period specified by law, and the options for development are the following:
- if the claimant follows the instructions of the court - then the court officially initiates the court case and gives it a number - for example, "gr.d. № 5/2020." /before that there is no court case number, but only an incoming number and date of the claim - for example "Entr. № 13 / 10.01.2020"/;
- if the claimant does not follow the instructions of the court - the court returns the claim and no court case is initiated at all.

It should be borne in mind that the more common hypothesis is that the court's instructions should be followed and the court should formally initiate a court case (about 80-90% of the filed claims continue to the next phase of the court's investigation).

The temporal intuitionistic fuzzy evaluation is:

$$\left(\frac{b(t)}{a(t)}, \frac{c(t)}{a(t)}\right),$$

where a(t), is the total number of claims submitted so far, b(t) – the number of the regular claims submitted so far, a(t), c(t) – the number of the number of the claims rejected so far. Therefore, the evaluation is a TIFP because:

$$\frac{b(t)}{a(t)} + \frac{c(t)}{a(t)} \leq 1,$$

and $a(t) – b(t) – c(t)$ is the number of claims, returned for correction that have not yet been filed in a corrected form. It is possible that some of them will be re-submitted, as the irregularities on them will be corrected, and another part - will remain irregular.

Once it has been established that the claim is regular, the court should examine whether the claim is admissible. The reason for inadmissibility could be the fact that in the same court or in different courts there are two pending cases between the same parties, on the same grounds and for the same request. In such a case, the filed case is later terminated and the claim is returned to the claimant.

The options are as follows:

- if the claim is inadmissible - the court terminates the case;
- if the claim is admissible - the court sends the claim to the defendant for a response.

At this stage of the proceedings, on average, about 5-10% of the claims are dropped. Only after the judge found that the claim was regular and admissible, he sent the claim to the defendant, giving the latter the opportunity to take a position on the claim by filing a response or counterclaim.

Once there is already pending court proceedings, it is logical for it to develop and, respectively, to end with a court act. There are different options for terminating (prematurely or not) court proceedings as follows:

- waiver of the claim by the claimant;
- withdrawal of the claim by the claimant;

- suspension of the court proceedings at the request of the parties, which has not been resumed by them after the expiration of 6 months;
- court agreement;
- the claim of the claimant is fully respected;
- the applicant's claim is dismissed in its entirety;
- the applicant's claim is upheld in part.

It is important to keep in mind that period "*X*" due to delay (due to procedural conduct of the parties or the court), the case may not be closed. This means that for the period under review, perhaps about 60% of the initiated cases are expected to be completed at first instance.

The temporal intuitionistic fuzzy evaluation is:

$$\left(\frac{e(t)}{d(t)}, \frac{f(t)}{d(t)} \right),$$

where $d(t)$ is the total number of cases, $e(t)$ – is the number of cases in which a final decision has been reached (positive or negative for the claimant or has ended with a termination agreement, $f(t)$ – the number of cases in which the process was terminated prematurely.

Therefore, the evaluation is a TIFP because:

$$\frac{e(t)}{d(t)} + \frac{f(t)}{d(t)} \leq 1,$$

and $d(t) - e(t) - f(t)$ is the number of cases, the number of cases that have not been closed so far. Some of them may be completed in some of the possible ways, and some may not be completed.

The temporal intuitionistic fuzzy evaluation for the claimant's request is:

$$\left(\frac{h(t)}{g(t)}, \frac{i(t)}{g(t)}\right),$$

where $g(t)$ is the total number of claims, $h(t)$ – is the number of claims in which the claim of the claimant is fully or partially upheld, $i(t)$ – the number of rejected claims.

Therefore, the evaluation is a TIFP because:

$$\frac{h(t)}{g(t)} + \frac{i(t)}{g(t)} \le 1,$$

and $g(t) - h(t) - i(t)$ is the number of cases not completed in period "X". Some of them may be completed in some of the possible ways, and some may not be completed. The temporal intuitionistic fuzzy evaluation from the point of view of the claimant is:

$$\left(\frac{k(t)}{j(t)}, \frac{l(t)}{j(t)}\right),$$

where $j(t)$ is the total number of claims, i.e., $j(t) = g(t)$, $k(t)$ – is the number of claims in which the claim of the claimant is fully respected, $l(t)$ – the number of rejected claims, i.e., $l(t) = i(t)$. Therefore, the evaluation is a TIFP because:

$$\frac{k(t)}{j(t)} + \frac{l(t)}{j(t)} \le 1,$$

and $j(t) - k(t) - l(t)$ is the number of cases in which the claim of the claimant is only partially upheld.

CONCLUSION

The dissertation work is devoted to the application of innovative, intelligent methods for the processes analysis in justice administration. The latest advances in the design of highly efficient data processing algorithms are applied. The intelligent technologies used require the processing of large data flows, using all available information about the monitored processes.

In the dissertation, for the purposes of the analysis, mathematical modeling tools were used, and the Generalized Nets (GN) apparatus was chosen as the most appropriate. Another approach, the subject of research from the dissertation work, is the algebraic apparatus of indexed matrices (IM), when it is necessary to apply algebraic operations over matrices of different dimensions, and intuitionistic fuzzy sets (IFS) as a mathematical tool for treating uncertainty.

The research methodology in the dissertation includes the use of a numerical and experimental approach. The numerical approach was used in the implementation of the algorithms by means of computer calculation of the intelligent methods for the processes analysis in justice administration. The experimental approach was used in the collection of data from observations of indicators characterizing the processes in justice administration.

The results of the analysis of the conducted research are presented in two refereed scientific publications with SCImago Journal Rank (SJR) - *Lecture Notes in Networks and Systems,* на *Springer International Publishing* and in two international conferences - *the 10-th International Conference on Intelligent Systems - IS'20* and *the 11-th International Conference on Intelligent Systems - IS'22.*

All publications are referenced and indexed in world-renowned databases with scientific information, thus complying with the requirements of the law on the development of the academic staff in the Republic of Bulgaria.

The dissertation is structured in an introduction, three chapters and a conclusion and is accompanied by a declaration of originality of the obtained results and a bibliography.

Summary of the obtained results

As a result of the conducted research, presented in this dissertation, the following scientific, scientific-applied and applied results were achieved:

1. Appropriate intelligent techniques have been selected for the processes analysis in justice administration.

2. The apparatus of the Generalized Nets (GN) was applied for the processes analysis in justice administration.

3. The Intuitionistic Fuzzy Sets (Fuzzy Sets) apparatus is applied for the pairwise comparisons and evaluations of the behavior of the objects involved in the processes analysis in justice administration.

4. A model of the first phase of the first court instance of the judicial process has been developed.

5. A model of the second phase of the first court instance of the judicial process has been developed.

6. A model of the court proceedings before an appeal court has been developed.

7. A model of cassation proceedings before the Supreme Court of Cassation has been developed.

8. A model of the judicial proceedings for annulment of effective court decisions before the Supreme Court of Cassation has been developed.

Directions for future research

The results obtained in the dissertation are applicable to the solution of a wider range of tasks related to the analysis of the processes in the administration of justice. This could be a direction for future research that will lead to the enrichment of the researched scientific field. More specifically, if the developed models of generalized nets of different phases and instances of the general claim process are implemented programmatically and are implemented in a specific court and even in the court system of the Republic of Bulgaria, they could be used for the following activities:

1. Accounting at any moment of a pending case at which stage it is and for how long each of its individual steps has been carried out;

2. What is the workload of the judges at each moment of time - this will make it possible to select judges for each subsequent procedure from those with less workload, which, in turn, could contribute to the development and improvement of the Centralized system for the distribution of cases in all courts in the Republic of Bulgaria, introduced by the Supreme Judicial Council of the Republic of Bulgaria (the so-called "System for random distribution of cases in the court").

Publications on the subject of the dissertation

1*. Blidov, H., Doukovska, L., Evaluating the General Claim Process through Temporal Intuitionistic Fuzzy Pairs. Chapter of Book: Uncertainty and Imprecision in Decision Making and Decision Support: New Advances, Challenges, and Perspectives, Series: Lecture Notes in Networks and Systems, 338, Springer International Publishing, Switzerland, 2022, ISSN:2367-3370, DOI:10.1007/978-3-030-95929-6_14, 1-7. SJR (Scopus):0.151.

2*. Blidov, H., Doukovska, L., Atanassov, K.. Generalized Net Model of the First Phase of the General Claim Process. Proceedings of the 10-th International Conference on Intelligent Systems - IS'20, Varna, Bulgaria, IEEE Xplore, 2020, ISBN:978-1-7281-5456-5, ISSN:1541-1672, DOI:10.1109/IS48319.2020.9200126, 626-629.

3*. Blidov, H., Doukovska, L., Generalized Net Model of the Second Phase of the General Claim Process – First Court Instance, Proceedings of the 11-th International Conference on Intelligent Systems - IS'22, 12-14 October, Warsaw, Poland, IEEE Xplore, (in print).

4*. Blidov, H., Doukovska, L., Generalized Net Model of the General Claim Process – Proceedings before an Appeal Court, Chapter of Book Series: Lecture Notes in Networks and Systems, Springer International Publishing, Switzerland, (in print).

5*. Blidov, H., Doukovska, L., Generalized Net Model of the General Claim Process - Cassation proceedings before the Supreme Court of Cassation, Proceedings of the 11-th International Conference on Intelligent Systems - IS'22, 12-14 October, Warsaw, Poland, IEEE Xplore, (in print).

6*. Blidov, H., Doukovska, L., Generalized Net Model of the General Claim Process - Annulment Proceedings before the Supreme Court of Cassation, Chapter of Book Series: Lecture Notes in Networks and Systems, Springer International Publishing, Switzerland, (in print).

Declaration of the originality of the results

I declare that this dissertation contains original research results obtained by me {with the support and assistance of my supervisor}. Results that have been obtained, described and/or published by other scientists are duly and extensively cited in the bibliography.

This dissertation has not been applied for a degree at any other graduate school, university or scientific institute.

Signature: ....

/Hristo Konstantinov Blidov/