Characteristics of Effective Paths in Brazilian Legal Processes

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Abstract

A Brazilian judicial process is essentially constituted by a sequence of actions that mark the history of the development of activities within the process. In this article, we create and analyse the most probable paths that characterize the classes of legal proceedings through a set of rules attributed to a complex network. We analyze the sequence of activities most probable and highlight the average times required to complete. We observed what would be the main points of delays in the possible ways of starting and ending a process in addition to the similarity between the possible paths taken. In addition, we indicate how much time would be spent, on average, in increasing the number of movements for each class of process. The characterization of these networks and the contextualization of the ideal movement path, associated with the other data generated by the proposed method, allow, through a reliable data generation process, a detailed observation of the flow of lawsuits, the identification of atypical behaviors and the planning of interventions capable of optimizing the provision of the judicial service by the judiciary.

Keywords

Complex networks„ Juridic processes, Shortest path

1. Introduction

A judicial proceeding aims to eliminate divergent conflicts of interest by making fair use of the laws applicable to the matters discussed in the course of the procedural relationship. In general, a judicial process encompasses a series of steps, called procedural movements, delimited and guided by the legal and time frames of the process, and are carried out by all the actors involved in the procedural relationship, Judge, Prosecutor, Lawyers, Parties and Servants of the Judiciary. Logically structured, but not linear, these movements guide the development of the process from its beginning to its conclusion. Steps such as the *Petição Inicial* (Initial Petition), *Citação* (Citation), *Réplica* (Replica), *Senteça* (Sentence) and *Apelação* (Appeals) are common movements

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in most processes. In essence, they lead information, in sequential form, such as identification of who brought the action, verification of the required laws, arguments of the defendant's defense, presentation of evidence and the final decision. Such movements depend and vary significantly depending on the matters involved (criminal law, family law, etc.) which makes it even more complex to obtain sequential standardization between legal processes. Despite the existence of a basic standardization taking into account the type of case, the set of transactions is not influenced exclusively of the judicial classes to which the cases are initially assigned, being often influenced by the "history" of the case and the needs that the Judge can having to realize the most diverse acts that can substantiate their final decision, which thus creates new movements and cycles of actions necessary for it to be finalized, which are different from the path initially envisaged.

Typically, the increase in the number of movements within a process makes it take more time to complete. Thus, the visualization of an optimal or sub-optimal "procedural path" becomes of great interest both for the parties involved in the case and particularly for the Judiciary, which can assess the level of efficiency of its units by identifying possible deviations and designing interventions to correct identified inconsistencies [1]. Even though these paths may be too complicated to be observed mathematically, in addition to the complexities of subjective actions taken by the parties and the judge in the course of a lawsuit, observing which movements would cause the greatest delays or greatest accelerations can serve as an important element encouraging for specific actions to maximize the services provided by the judiciary.

Thus, due to the difficulty of establishing a standard sequence of procedural movements, an alternative methodology for characterizing processes through interactions in complex networks is presented here [2, 3, 4]. In the section (2) an overview of the proposed problem will be presented. In the section (3), the mathematical rules for creating complex networks for the different chosen procedural classes will be presented. We also present the most probable paths based on data from the Court of Justice (TJ) Procedural Tables. The times spent for each stage and the connections between the most important paths are highlighted during the text. Finally, we condensed the results in the section (4) where we highlight an efficient way to obtain the influence of possible increases in time due to the need for new movements. In the section (5) we highlight the main points of our research with the main perspectives.

2. State of the art

The theory of complex networks is a highly interdisciplinary area that offers resources for the study of the most varied types of complex systems. Many dynamic nonlinear processes and stochastic simulations can be analyzed in complex networks, such as: interactions between proteins, human relationships, air transport systems, the Internet, the financial market, among other complex systems [5].

Complex network analysis is a critical tool for understanding various complex systems [6], including as an approach to obtain a quantitative understanding of the structure and evolution of law [7]. Computer science scientists and legal experts have used citation analysis methods in order to build networks of case law citations, as well as to model and quantify the complexity of the legislative [8].

It has also been used to analyze data from complex networks built from decisions of national and international courts, statutes, constitutions and international treaties. There are also works in this context that explore, for example, what characteristics of complex systems occur in statutory law, how references to judicial decisions are used to shape legal arguments, or where social dynamics exist between international judges or arbitrators. Chandler [9] examined the complex network structure of precedent-based court rulings, using data from the United States Supreme Court.

Although there are countless studies that characterize and analyze data in complex networks, no reference was found to study the movements of legal processes, in an attempt to identify and present the most probable paths of legal proceedings through a set of rules attributed to a complex network. Therefore, one of the contributions of this work is to start from the data of the classes and movements of the judicial processes of the Ceará state justice, to represent them as a complex network, modeling the existing relationships in such a way that it becomes possible to characterize the judicial processes.

3. Model

Data used were based on the classes and movements of the Unified Procedural Tables of the Judiciary created based on CNJ Resolution No. 46/2007, as well as on the record of internal movements operated within the scope of Ceará State Justice. The 1st degree lawsuits filed until 2019 and written off in 2019 in the various instances of the *Tribunal de Justiça* (TJ - Court of Justice) of the State of Ceará (Brazil) were considered, in the classes: *Procedimento Comum Cível* (Common Civil Procedure), *Execução Fiscal* (Tax Enforcement), *Procedimento do Juizado Especial Cível* (Procedure of the Special Civil Court) and *Execução de Título Extrajudicial* (Execution of Extrajudicial Title). In total, the number of 4797 cases were analyzed for the Class of Execution of Extrajudicial Title, 67499 for Common Civil Procedure, 29643 Procedure of the Special Civil Court and 23039 for Tax Enforcement with at least 300 types of different movements.

Our database from the TJ contains multiple information that characterises the processes. We emphasize that for this work, data from the judicial classes named as Enforcement of Title, Common Civil Procedure, Procedure of the Special Civil Court and Tax Enforcement were used as the most demanded classes of the assessed State Justice. The temporal information for each movement presented reveals its initializations. Thus, when a new movement starts, it indicates a new series of judicial activities. Such activities depend on the type of movement. Furthermore, the emergence of a new movement indicates the end of another, suggesting that the term 'movement' is associated with a temporal state of the legal process. In this case, we label as ΔT the lasting times of each move within a process. We identify at each step of the process which is the pair $OLD \rightarrow NOW$ as the construction of a junction between the type of movement in a previous sequence (OLD) and the sequence current (NOW). This, it is possible to set up a data table containing all flows between types of consecutive movements, in addition to obtaining data on the times spent between such movements.

To reveal the importance of transitions between different types of movements, we define a matrix $\mathbf{F}$ where its elements F_{ij} represent the number of observed strings that initially emerged from the i step and are in the j step. The matrix $\mathbf{F}$ is not symmetric since it is possible to obtain an element with $F_{ij} \neq F_{ji}$. Thus, the asymmetry of the problem suggests the spatial construction of a network of targeted actions where the nodes lead the information for each type of movement and the edges link to the sequential evolutions tuned by F_{ij}. In the Figure (1) an illustration of the formation of the creation of the complex procedural network is presented. The dots indicate each type of movement and the arrows indicate the transformation vectors between sequential movements.

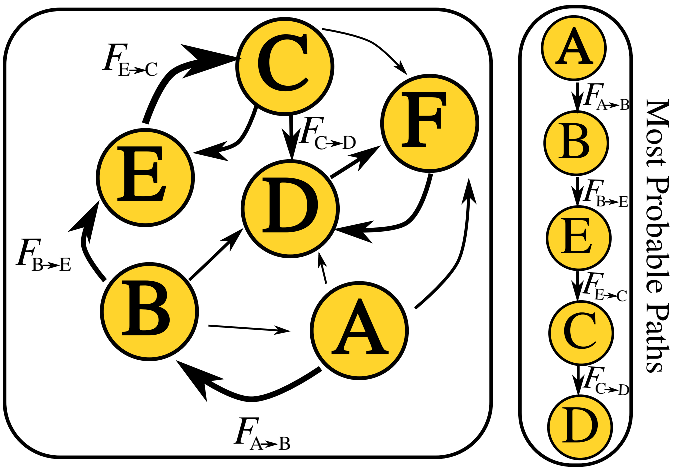

Figure 1: On the left side, an imaginary schematic model of a complex directional network for types of movement between processes is presented. Each node in the network contains a type of process (illustrated by A, B, C, D, E and F). The different widths of the arrows represent the associated weights of that network which are regulated by the F_{ij} indexes. On the right, a sequence $A \to B \to E \to C \to D$ is displayed indicating the most probable path between moves that start at A and end at D.

Thus, it is intended, for each type of judicial class, to build paths between the movements that represent it as being built, in essence, by the movements that will be visited.

An indicated way to create the most probable path is to check what would be the most frequent type of movement for the first stage of each judicial class. From there, the next points would be accessed by the incidence of F thus creating an optimal local path. This type of strategy is seen in *Greedy algorithm* techniques [10]. However, in systems with high ramifications and decision making with probabilities between similar movements, this approach can induce a large number of sequences of high degeneration or produce suboptimal temporal paths. An alternative is to check among all possible combinations of paths which would be the one with the lowest cost, or the most probable to happen. For this purpose, we created a matrix D^{ef}, called effective distance, to which its elements are regulated by:

$$D_{ij}^{ef} = exp(-\beta F_{ij}) \tag{1}$$

where $\beta = \frac{1}{\langle F_{ij} \rangle}$ regulates the influence of F_{ij}. Thus, we say that the most probable path (PP) of a process is found minimizing all routes D_{ij}^{ef}, that is:

$$PP_{ij} = Dijkstra(D_{ij}^{ef}) \tag{2}$$

where *Dijkstra* [11] is the function that returns the points of the networks with the lowest cost regulated by D_{ij}^{ef}.

Briefly, we calculate all the frequencies of pairs between consecutive movements and store them in the matrix F. Once all the elements of F are calculated, it is possible to obtain all the elements of D_{ij} through equation (1). The *Dijkstra* algorithm returns all points interspersed in the path between i and j with the least cost in the sum of all possible paths. Thus, the most influential movements for each procedural class will be discarded, thus being able to obtain analyzes of the microscopic, however relevant, components of each procedural class and observe any legal divergences, whether temporal or sequential between the highlighted movements. We emphasize that such methodology is commonly used in studies using complex networks. The highlighted equations can serve as a guide for the creation of other exploration indices of the network nodes that will quantify each type of procedural movement. Attributes such as *closeness*, *betweenness* and *pagerank* have become essential to rank the efficiency of several lawyers showing their importance in the community in which they work[12]. Thus, finding information obstacles, distinguishing points of maximum power to disseminate information, verifying possible waste and profits, are possible products arising from analyzes through complex networks [13, 14].

4. Results

Thus, for each judicial class, we obtained the movements that characterize the most probable steps (PP). In the Figure (2) we present a panel that represents the average time spent in each type of movement for the different classes studied. For this step, we highlight the most common points for constructing the paths that move F_{ij} to initiate and end a process. Thus, for the *Execução de Título Extrajudicial* (Execution of Extrajudicial Title) class (Figure (2 (a))) the most probable path indicates actions that lead to changes: *Conclusão* (Conclusion) → *Mero expediente* (Mere expedient) → *Encaminhado edital / relação para publicação* (Forwarded notice / relation for publication) → *Despacho / Decisão disponibilizado no Diário de Justiça Eletrônico* (Order / Decision made available in the Electronic Justice Journal) → *Trânsito em julgado* (Unappealable transit) → *Definitivo* (Definitive) → *Expedição de Certidão de Arquivamento* (Filing Certificate Dispatch). It is noted that during the handling of the *Mero expediente* movement there was the greatest expenditure of time. In the classes Common Civil Procedure, Special Civil Court Procedure and Tax Enforcement (Figures (2 (b) - (d))) the types of preferred movements are diverse. For the *Procedimento Comum Cível* (Common Civil Procedure) class, we observe the similar sequence, representing accentuations in delays, in the *Mere expedient* and *Trânsito em julgado* movements. Similarly, it is possible to observe in the *Procedimento do Juizado Especial Cível* (Special Civil Court Procedure) and *Execução Fiscal* (Tax Foreclosure) classes where the movements named as *Expedição de Carta* (Letter Dispatch) and *Certidão emitida* (Issued Certificate) create long delays.

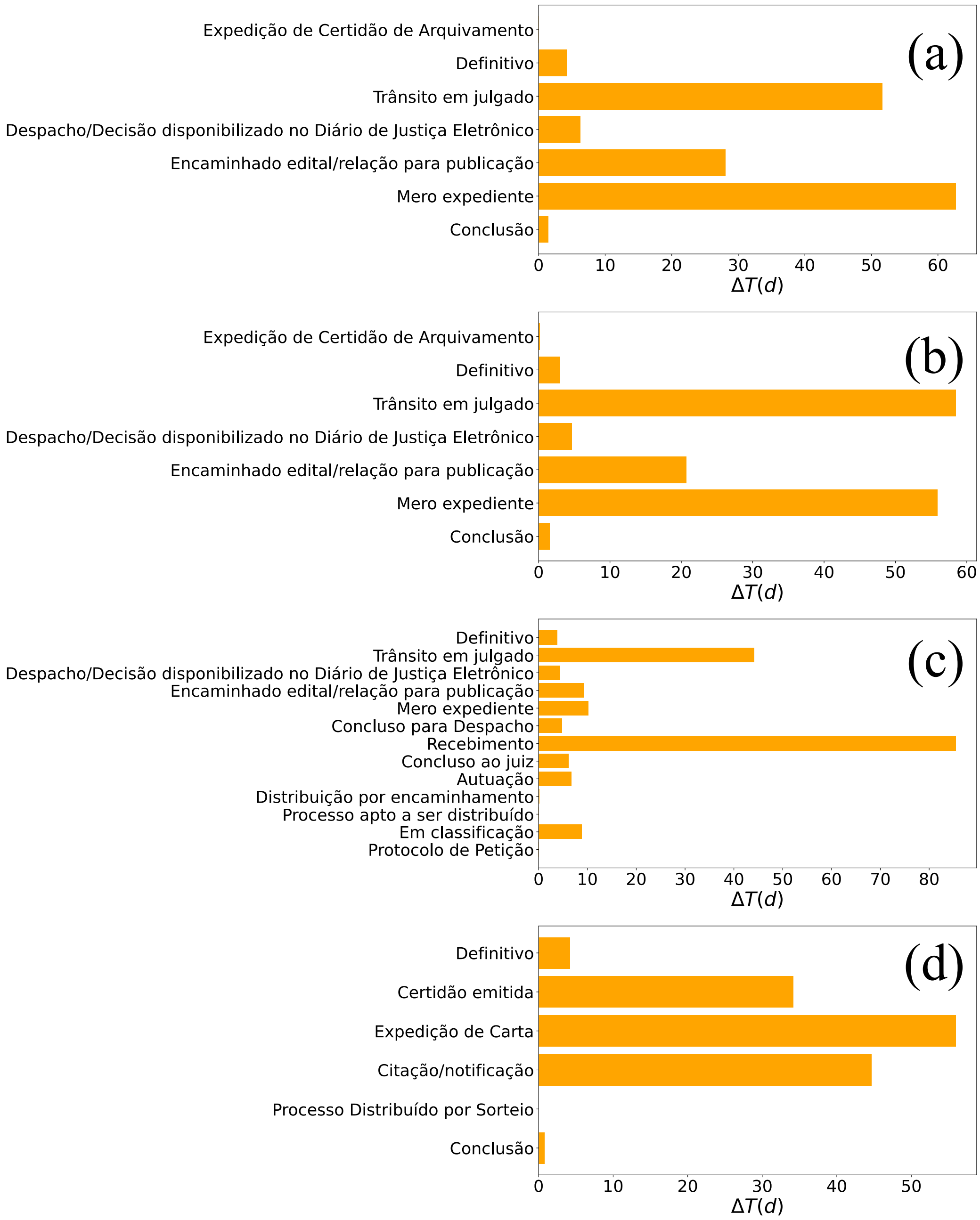

Figure 2: Average of delay time (ΔT), in days, for various movements in classes (a) *Execução de Título Extrajudicial* (Execution of Extrajudicial Title), (b) *Procedimento Comum Cível* (Common Civil Procedure), (c) *Procedimento do Juizado Especial Cível* (Special Civil Court Procedure) and (d) *Execução Fiscal* (Tax Enforcement). The start and end nodes of a process are indicated in the vertical part of each graph in its ascending form. For example, in (a), a process begins with the movement of the Petition Protocol type and ends with the Definitive movement.

The duration of a movement shown in the Figure (2) serves as a guide for the analysis of each movement. In fact, movements have unique characteristics. Internal relations between judges, lawyers, victims and defendants can influence the time of the movement depending on the class to which it is contained. For example, the class *Execução de Título extrajudicial* (Execution of Extrajudicial Title) deals with the procedure that aims to ensure the receipt of an amount represented by an extrajudicial document (check, promissory note, contract signed by two witnesses). The movements of this class contain activities that involve losses and damages from both parts of the process, lead information of fiduciary alienation, relationships between contracts, whether civil or bank, and even movements that contain contexts involved with the environment. Some movements are internal to the judicial system. Others depend on external public departments. In this case, depending on the actions involved and the history of the process, it is possible to have a long delay in movement where causal stretches that depend on police investigations or laboratory analysis can lead to an extreme time. Thus, the frequency between movements tells us information about the pre-determined character imposed on the local legal system, given by the flow chart of standard actions, how it carries cultural information in the way it is resolved. Thus, knowing the activities that lead to movements to have such different temporal patterns can be a way of verifying points that depend on greater attention from the judiciary or just a way to reclassify procedural movements in a more convincing way with the local reality. Figure (3) shows the time distribution density curves $g(\Delta T)$ for the most important procedural movements of each class presented in this work. Note that the distribution pattern is different for each class. There is no defined shape for the curves and what reinforces the idea that each movement can be studied in detail to evaluate the peaks found in $g(\Delta T)$. Note that in the classes *Execução de Título Extrajudicial* (Execution of Extrajudicial Title), *Procedimento Comum Cível* (Common Civil Procedure), *Procedimento do Juizado Especial Cível* (Special Civil Court Procedure) the moviment *Trânsito em julgado* (Unappealable transit) is presented with similar temporal characteristics (see Figure(3 (a)-(c))). This movement is used to identify the moment when a decision - sentence or agreement - becomes definitive, and can no longer be appealed. There is a modal peak at $\Delta T = 20$ days indicating a higher temporal frequency for the time spent on this movement. However, the other fluctuations may be the result of legal actions involving details of each class because, even though they are common in both, Traffic accidents (commonly seen in Common Civil Procedure) and Property Tax (observed in *Execution de Extrajudicial Title*) are, of course, distinct problems that involve different actions but are computed, in some temporal phase, by this type of movement. Thus, we reform that the diverse peaks in $g(\Delta T)$ is caused by the divergence between the diverse subjects assigned within the movements, and also within each class, which indicates that a reclassification of the nomenclature of the states involved may be necessary. within a legal process.

It is important to mention that the number of movements listed in the most probable path for each process class depends on the choice of their start and end milestones. Statistically, the most influential peers stood out from the rest. In addition, it is possible that there are paths with a high degree of similarity due to common movements, even on routes of more or less stages.

Thus, for each possible pair of starting and closing a process, within a given class, we calculate the variables N_m and $T = \sum_k \Delta T_k$ which are, respectively, the number of moves found to obtain the most probable path between network nodes and the total time spent on that path for each

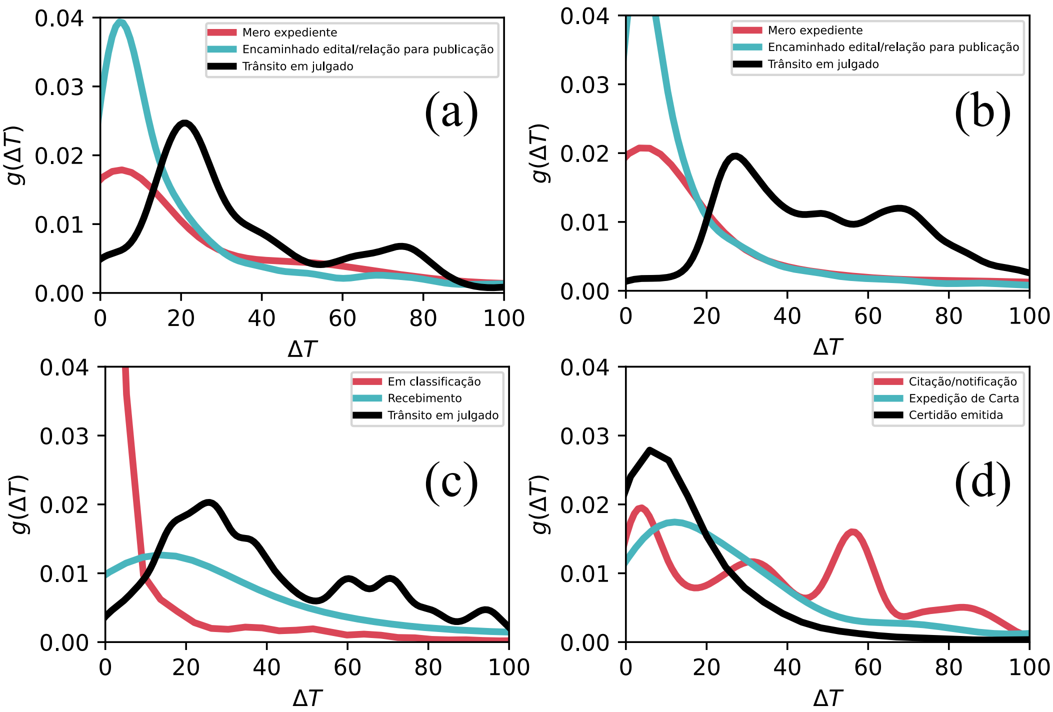

Figure 3: Time distribution density curves $g(\Delta T)$ for (a) *Execução de Título Extrajudicial* (Execution of Extrajudicial Title), (b) *Procedimento Comum Cível* (Common Civil Procedure), (c) *Procedimento do Juizado Especial Cível* (Special Civil Court Procedure) and (d) *Execução Fiscal* (Tax Enforcement) classes. Each curve represents the most important movements linked to the movements shown in Figure (2). T is express in days.

step immersed in it that took ΔT time. For example, as shown in Figure (2(a)), chosen as starting and closing points, respectively, the *Conclusão* and *Experdição de Certidão de Arquivamento* movements, we have an amount of $N_m = 7$ movements and a total of $T = 158$ days.

The Figure (4) shows the scatter plots between such variables. Note, again, that the time scale and the amount of movements required to obtain the most probable path depends on the choice of the studied class. It is important to note that the relationship between the variables suggests a linear correlation in the form $T = \lambda N_m + b$ [15] where λ indicates, on average, the increase in time allocated to a process to a unitary variation to the number of movements of that specific class. The lines highlighted in the Figure (4) indicate the linear adjustment between the variables with Pearson's coefficient [16] greater than 0.72 for any type of class cited.

The values of λ obtained by the linear adjustment for the classes Execution of Extrajudicial Title, Common Civil Procedure, Procedure of the Special Civil Court and Tax Enforcement, are, respectively, 21.3 days / movement, 11.5 days / movement, 11.9 days / movement and 26.4 days / movement. Its values reflect, graphically, the slope of the line in the graphs of the Figure (4) taking into account the dispersion of points in the graph. Thus, for each class, it is possible to estimate the effects of delays caused by the increase in the number of transactions and to rank

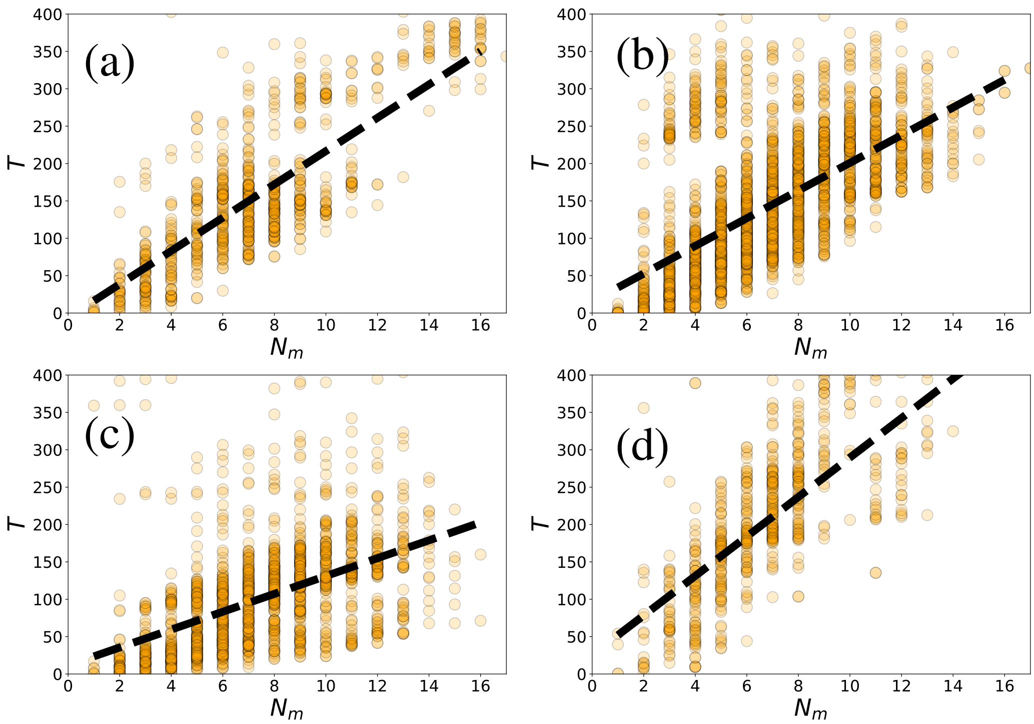

Figure 4: Average time spent T, in days, by a process obtained by the most probable path. Each point indicates a combination of a possible initialization movement and another possible closing movement, generating a sequence of N_m total movements. The results refer to the classes (a) *Execução de Título Extrajudicial* (Execution of Extrajudicial Title), (b) *Procedimento Comum Cível* (Common Civil Procedure), (c) *Procedimento do Juizado Especial Cível* (Procedure of the Special Civil Court) and (d) *Execução Fiscal* (Tax Enforcement), respectively. The highlighted lines refer to the linear adjustments in the form $T = \lambda N_m + b$.

those classes that have the highest speed in closing a legal process.

5. Conclusion

The developed article contributes to the development of research in the area of construction and evaluation of networks in the legal context, at the same time that it has the potential to allow the production of easily dated structures capable of guiding the implementation of public policy and correction actions aimed at increased productivity and better provision of justice.

The methodology used for the creation and evaluation of the data generated by the procedural movements is configured as innovative due to two important factors. The first is that it uses an approach combining data analysis and network construction with the legal context, an approach with little reference in the computer literature as in the legal or legal engineering literature. The second is because it observes and values a source of information that is normally overlooked and little valued in studies dedicated to understanding the characterization, dynamics and efficiency of legal proceedings.

Finally, the set of data generated by the characterization of the procedural movement networks, especially the inferences generated by the visualization of the time intervals between movements and also the prediction of the duration of the processes, in view of the flow of movements that they take, allows managers of the judiciary access to important data to both compare performance levels between different jurisdictional units as well as to verify the occurrence of efficiency 'bottlenecks'. A good example of this potential is the observation that in the case 159 - Execution of Extrajudicial Title "(Figure (2 (d))), the simple dispatch of a letter (*Expedição de carta* moviment) takes on average more than 50 days, the which indicates the need for the adoption of corrective measures so that the provision of jurisdiction is faster and more efficient.

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