■ ■ ■ Interval Probabilities in Juridical Practice and Its Communicative Inputs

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Abstract. The article focuses on the quantitative interpretation of trials, including its communicative inputs. Outlines some of the shortcomings of the process of identifying guilt and verdict. In the analysis of the legal solutions introduced subjective probabilities and some of the information and communication components. While the Bayesian inference is a common method for revision of beliefs, it requires precise prior probabilities and likelihoods, usually assessed in the form of intervals. Therefore this work comments upon procedures to introduce interval probabilities to statistical reasoning that support the analysis of evidence in court trials.

This work highlights the problems of judgment in legal trials and some of the communicative elements that are present here. It emphasizes the possibilities to improve the decision analysis process in trials by adopting subjective probability as a measure of uncertainty about the level of guilt of a defendant judged upon testimonies. Bayesian and other approaches can then serve to adapt beliefs. The key element of the discussion here is the introduction of interval probability estimates and the benefits they bring to legal decision making.

Keywords: legal decision making, classification system, subjective probability, interval probabilities

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Introduction

From a quantitative point of view, criminal court proceedings are a two-level classification system – the court should first decide whether a subject is “guilty” or “not guilty”, and then decide upon the penalty in accordance with active legislation. The second is usually unambiguous and does not provoke any theoretical or practical difficulties. However, the first step usually causes a lot more controversies and attracts

public debate (especially in countries with flawed and inefficient court system). Court proceedings are often quite expensive, inefficient, creating the sense of injustice mostly because of the number of people accused and released on minor or no penalty after having violated the law. The latter is typical for democratic countries in transition. Totalitarian countries experience the opposite process – almost all defendants are found guilty regardless of evidence in favor of their innocence.

I-Court trials from theoretical and practical viewpoint

A court trial has two possible types of errors: 1) the first-type error, which assumes to convict a defendant that is innocent; 2) the second-type error, which is to set free a defendant that is guilty. The presence of such errors stems from the very nature of information used in court trials. The information is often incomplete, contradictory, manipulative and always subjective in its interpretation. *In addition, the communicative process itself makes some distortions.* In the same time the legislator in the face of the parliament postulates a requirement that there should be no first-type error since no innocent man should be given a verdict. That is the basis of a contemporary court 'rule': "It's better to have a hundred guilty defendants free than one non-guilty defendant convicted". That decision making concept has been applied long time ago in ancient Roman civil law, according to which "Everyone charged with a criminal offense shall have the right to be presumed innocent until proven guilty according to the law". Such a presumption implies that any doubt is in favor of the defendant.

Those types of formulations follow the principles of humanism and democracy, but from a mathematical point of view they are absurd as they assume null first-type error. If a two-state classification system is adopted, then each decision rule or politics balances the first-type error on the account of the increase of the second-type error. The legislator's desire to have no innocent defendants convicted is only possible if all guilty defendants are liberated (i.e. maximize the type-two error). Conclusions of that sort diminish the purpose of a court since each trial should end up with an acquittal.

The other extreme is present in the court systems of totalitarian countries, where there are no defendants liberated. In those cases, null second-type error is present and all innocent defendants are convicted. Here the court system once again turns out to be useless and is replaced by the will of the subject of totalitarianism. Obviously, the requirement for lack of errors of any kind is absurd.

The operation of court systems in democratic societies is justified if most guilty defendants are convicted and most innocent defendants are liberated. In order to achieve such quality of performance, judges and the jury must break the law and allow conviction of a small fraction of innocent defendants, since in each court trial there is a slight chance of the defendant being innocent. There is no such evidence, which can rule out all doubts. Judges and the jury face public and political pressure to convict criminals. The court system and its proper operation are crucial for the society, but for this reason judges must break the law. Thus, a judge is a figure that must break the law according to his conscience and in the same time must find the balance between

the law, his conscience, the interests of the society, etc. All this prevents judges from executing the law, and gives rise to making comments or changes according to his opinion. The necessity to violate the law imputes judges' immunity (since it is impossible for a person to be responsible before the law if he is obliged to break it in order to execute his official duties). That in turn leads to lack of control over judges. *There is a great number of real-life cases in favor of how harmful from a social-communicative and economic point of view can a uncontrollable judge be.*

Bulgarian law has a "decision of conscience" assumption, which suggests that the judge is confident in his decision without any doubt. Unfortunately such a requirement is absurd, as strict certainty is an extreme state not present in real-life situations. Every human act is liable to mistakes. If the judge considers the probability of the defendant being guilty to be 99% and the probability of the defendant being innocent to be 1%, then should the defendant be convicted? And what if the probabilities are 99,999% to 0,001%? The decision of conscience requires that probabilities close to 100% to be treated as if they were 100% in order to accommodate judge's conscience, thus the information is additionally twisted through the judge's mind. The US legislation imposes the "beyond reasonable doubt" concept, which determines the verdict on the basis of the judge's character, opinion and spirit. It is necessary then to ask, "How reasonable is a reasonable doubt?"

A different view and its effects

It has been long proposed that the quantification of beliefs should be made in terms of subjective probabilities. They measure the degree of belief of an individual that a random event *A* shall occur.

An important foundation of subjective probability is the De Finetti coherence approach [De Finetti 1974; 1975]. It proves the necessity to represent beliefs in terms of probabilities in order to avoid Dutch books, i.e. schemes of sure losses. The axiomatic approach builds upon this concept and proposes a set of conditions to assure that the beliefs of an individual are rational and consistent [Pratt et al.; Tenekedjiev, Nikolova 2007]. They also allow constructing probability elicitation procedures based on the preferences of the individual. In an ideal world, people elicit unique probability measures for a given event.

Adapting and revising the beliefs of beliefs of an individual in the light of new information is possible using the Bayesian approach. It is based on the Bayes theorem that allows calculating the probability of a hypothesis given a certain fact. It uses prior knowledge about the hypotheses as well as conditional likelihoods regarding the occurrence of the event given each hypothesis. The Bayesian approach has many successful applications and its importance is undisputable. There are some major publications that discuss in much detail the use of the Bayes rule in identifying facts and evidential reasoning in trials [Goldman 1999; Goldman 2002: 237]. These works suggest that if the Bayesian approach is applied to assess evidence, the conclusions made shall be closer to the truth provided the prior probabilities and likelihoods are

accurate and exact. Goldman's statement has been investigated in much detail by Redmayne (2003), who surveys several theories of objective probability, and emphasized their abilities to constrain probabilities by the features of the world (which he claims is impossible for the subjective probability), as well as the difficulties they face in fact-finding in trials.

The main disadvantage of Goldman's statement though is that, as proven in many works since the 60th, subjective quantitative judgments are never precise, but in the form of intervals, and that fact affects probabilities as much as many other measures in decision analysis [Tenekedjiev et al. 2006; Utkin 2007]. The necessity of exact priors and likelihoods as a disadvantage of the Bayesian approach has been outlined in other papers too, as well as the fact that in most practical cases, information about probabilities is never exact [Pan, Klir]. *This is particularly true in criminal trials, where the information is incomplete, ambiguous and twisted through the perception of the witness, and communicative component does not allow to compensate for this disadvantage, and therefore does not allow the judge to be certain of his conclusions based on that data.*

The difficulty of inexact prior and likelihood has led to the development of new concepts, some of them much more complicated than the Bayesian approach. Walley (1991) proposed a complex mathematical approach, called coherent theory of imprecise probabilities, with which he approached the application of imprecise probabilities to statistical inference. Statistical decision analysis based on imprecise and interval probabilities has also been discussed in [Coolen]. Fuzzy rational decision analysis, stemming from interval estimates and bounded rationality of individuals has been discussed in [Tenekedjiev, Nikolova 2007]. The works [White; Snow] discussed methods to describe posterior probabilities when likelihoods and priors are imprecise. An important contribution in that respect is the work of Pan and Klir (1997). The authors derived formulae for exact calculation of interval-values posterior probabilities for given interval-valued priors and precise or interval likelihoods. To summarize, the notion of imprecise probabilities is a new paradigm in statistical analysis, which formalizes human judgment and yet accommodates the cases when individuals are uncertain about their beliefs. All these features make it very appropriate and applicable to the case of judgment and reasoning in trials.

Using adequate methods for revision of belief the court will be in position to work as a normal classification system and judge upon the level of guilt of a defendant in terms of probabilities based on the presented evidence. The legislator must define the prior probabilities and the limits of recognizing guilt for different kinds of offences. In this way, instead of stating that "a defendant that is found guilty of manslaughter is sentenced to imprisonment for 15 to 20 years", the court could rule out that "if the defendant is found guilty of manslaughter up to at least 99% is sentenced to imprisonment for 15 to 20 years". It is true that in this way part of the innocent defendants will also be imprisoned, but probably about 1 in every 200 cases. Such definition of the verdict will assure stochastic character of the law.

The following effects can be achieved:

– The use of interval and imprecise probabilities allows to take into consideration the imprecision of human judgment built upon evidence information in a natural way;

– Court cases will become adequate to life, because "the truth" will be evaluated quantitatively;

– Judges will not face the necessity to violate the law when they execute their official duties. Otherwise the control upon the judges is impossible and this is a serious potential for the development of corruption motives;

– Court decisions will become liable to parliament's management, and the actions of the parliament will aim at balancing the interests of the society. A similar structure for legal decision making will put legislation in the hands of legislators and they will carry the responsibility, and in the same time the court will be set free of its present political influence;

– The juridical court proceedings will become more rapid and effective.

Till the end of the 18th century a juridical practice in some countries has been applied, according to which the significance of the statements depended on the social status of the witness. As a result, the testimony of a gentleman was considered twice as important as that of a servant. Such a method, though based on reasonable preconditions, has been totally rejected. It was based on the desire to make objective statements that are intrinsically subjective, and has proven to be inadequate.

There are some obstacles before the implementation of the proposed ideas:

– The idea will face significant resistance from many public, political, juridical and economic groups;

– The essence of law is rather humanitarianly oriented and therefore specialists in that field are not (or are not willing to be) familiar with mathematics;

– Court trials will need decision analysts to assist the probability assessment process;

– The successful implementation of this idea requires that the society itself has matured enough to embrace this concept;

– The parliament is yet not prepared or not willing to take responsibility of decisions that refer to the fairness and rationality of national legislation;

– There is a conflict of interests, since one of the most powerful lobbies in a parliament is that of juridical bodies.

Conclusion

It would have been best if revealing the objective truth were possible in court. In the course of the trial only the perception of the objective truth can be quantified and not the objective truth itself. This comes to prove that the verdict is strictly subjective, while revealing the objective truth is a false pretension. The dilemma of justice dispense is also observed in medical practice. The Hippocratic oath statement "Do not harm" is well known. Each medicine is in position to harm the patients, but despite of that physicians do not stop prescribing it. This is also a potential violation of the fore-mentioned oath.

The principles that court trials obey are in most countries out-of-date. They only serve the personnel involved in this system: judges, prosecutors, lawyers, and

investigators. It causes more harm to the society than it is reasonable to accept. But all other fields of human life would have performed exactly the same way, had they have neglected the progress of science and knowledge. The improvement and adequacy of the juridical system is to be achieved with mathematical certainty. However, changes should be promoted by the respective public bodies taking the responsibility to prove their significance on a theoretical and practical basis.

Insufficient attention is paid to the quantitative interpretation of trials, including the communicative aspect. Shortcomings remain in the process of finding guilt and making a verdict. In the analysis of legal decisions subjective probabilities are introduced poorly, as well as informative and communicative inputs.

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■ ■ ■ Переменные вероятности в юридической практике и некоторые коммуникативные составляющие

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Аннотация. В статье фокусируется внимание на количественной интерпретации судебных процессов, включая коммуникативный аспект. Излагаются некоторые недостатки процесса выявления вины и вынесения вердикта. В анализ юридических решений вводятся субъективные вероятности и некоторые информационно-коммуникационные составляющие. Хотя байесовский вывод является распространенным методом пересмотра убеждений, он требует точных предварительных возможностей и правдоподобия, обычно оцениваемых в виде промежутков. Поэтому в этой работе рассматриваются процедуры введения промежуточных вероятностей в статистическую оценку, которые помогают при анализе доказательств на судебных процессах.

Работа освещает проблемы судебного разбирательства и некоторые коммуникативные элементы, присутствующие при этом. В ней подчеркиваются возможности улучшения процесса анализа решений в судебных процессах путем принятия субъективной вероятности в качестве меры неопределенности в отношении уровня вины обвиняемого. Байесовские и другие подходы могут служить для адаптации убеждений. Ключевым элементом обсуждения здесь является введение промежуточных оценок вероятности и преимуществ, которые они приносят в принятие юридических решений.

Ключевые слова: юридическое принятие решений, система классификации, субъективная возможность, переменные возможности

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