NARODOWE CENTRUM NAUKI

OPUS-21

Wniosek o finansowanie projektu badawczego

Rekonceptualizacja probabilizmu w kontekstach prawnych

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WNIOSEK NOWY/POWTÓRZONY

Czy wniosek był składany w poprzedniej edycji konkursu OPUS?	TAK [ ] / [X] NIE

INFORMACJE PODSTAWOWE

Tytuł w języku polskim	Rekonceptualizacja probabilizmu w kontekstach prawnych
Tytuł w języku angielskim	Rethinking legal probabilism
Słowa kluczowe w języku polskim	epistemologia formalna, probabilizm, zastosowanie probabilizmu w prawie, sieci bayesiańskie, niepewność, ocena dowodów, filozofia dowodów
Słowa kluczowe w języku angielskim	formal epistemology, probabilism, legal probabilism, bayesian networks, uncertainty, evidence evaluation, philosophy of evidence
Czas realizacji [w miesiącach]	36
Obszar badawczy	HS - Nauki Humanistyczne, Społeczne i o Sztuce
Panel dyscyplin	HS1 - Fundamentalne pytania o naturę człowieka i otaczającej go rzeczywistości
Pomocnicze określenia identyfikujące	HS1_004 - Logika, metodologia nauk, filozofia nauki

STRESZCZENIE

The goal of this project is to develop a probabilistic modeling method of handling the multiplicity of items of evidence, hypotheses and theories of what happened, and the resulting decisions in the court of law. In light of the current criticism of the probabilistic approach to such issues, such a method should (1) be sensitive to the argumentative structure involved, and (2) capture the idea that in a legal context we are dealing with a class of competing narrations.

The point of departure is to represent narrations as bayesian networks enriched with an additional layer of information as to which nodes correspond to evidence, and which are binary narration nodes. The key idea is that with such bayesian networks as building material, various features requested by the critics (such as coherence, resiliency, missing evidence, explaining evidence, or ways to handle a multiplicity of proposed narrations) can be explicated in terms of corresponding properties of, operations on, and relations between bayesian networks.

The output will be a unifying extended probabilistic model embracing key aspects of the narrative and argumentative approaches, with implementation in the programming language R. What the project will uniquely bring to the table is joining the familiarity with epistemological debates, familiarity with the details of evidence assessment in legal cases and technical skill to programmatically implement, simulate and test various theoretical moves.

WNIOSKODAWCA

Status wnioskodawcy	1. Uczelnia

PODMIOTY REALIZUJĄCE

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Czy podmiot stanowi jednostkę zaliczaną do sektora finansów publicznych?	TAK [X] / [ ] NIE
Klasyfikacja podmiotu zgodnie z ustawą o finansach publicznych	Uczelnie publiczne
Czy podmiot pozostaje pod zarządem komisarycznym lub znajduje się w toku likwidacji bądź postępowania upadłościowego?	TAK [ ] / [X] NIE
Kierownik podmiotu / Osoba uprawniona do reprezentacji	prof. dr hab. Wiesław Laskowski, Prorektor ds Badań Naukowych
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KRS	-
Czy podmiot otrzymuje subwencję na prowadzenie działalności naukowej?	TAK [X] / [ ] NIE

Podmiot poziomu II	
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OPIS SKRÓCONY

Rekonceptualizacja probabilizmu w kontekstach prawnych

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RETHINKING LEGAL PROBABILISM

Rafał Urbaniak

1. Scientific goal

The **goal of this project** is to **develop a probabilistic modelling method of handling the multiplicity of items of evidence, hypotheses and theories of what happened, and the resulting decisions in the court of law**. In light of the current criticism of the probabilistic approach to such issues, such a method should (1) be **sensitive to the argumentative structure** involved, and (2) capture the idea that in a legal context we are dealing with a **class of competing narrations**.

The point of departure is to represent narrations as bayesian networks enriched with additional layer of information as to which nodes correspond to evidence, and which are binary narration nodes. **The key idea is that with such bayesian networks as building material, various features requested by the critics (such as coherence, resiliency, missing evidence, explaining evidence, or ways to handle a multiplicity of proposed narrations) can be explicated in terms of corresponding properties of, operations on, and relations between bayesian networks.**

The output will be a **unifying extended probabilistic model embracing key aspects of the narrative and argumentative approaches, with implementation in the programming language R.** What the project will uniquely bring to the table is joining the familiarity with epistemological debates, familiarity with the details of evidence assessment in legal cases and technical skill to programmatically implement, simulate and test various theoretical moves.

2. Significance

2.1. State of the art. Legal probabilism (LP) comprises two core tenets: (1) the evidence presented at trial can be assessed, weighed and combined by means of probability theory; and (2) legal decision rules, such as proof beyond a reasonable doubt in criminal cases, can be explicated in probabilistic terms [21,35,45]. Skepticism about wider mathematical and quantitative models of legal evidence is still widespread among prominent legal scholars and practitioners, partially in light of conceptual difficulties with probabilitistic decision criteria and arising puzzles of naked statistical evidence [1,7,33,34,40,50]. Relatedly, various informal notions have been claimed to be essential for a proper explication of judiciary decision standards [17,27,30,48,58]. Recently, the No Plausible Alternative Story theory (NPAS) [2–4,4,6,42–44], and argumentation theory [5,29,57] suggest that LP cannot capture the multiple-scenario based and argumentatively structured nature of legal evidence evaluation. However, LP has been defended against this objection by developing appropriate Bayesian Networks methods.

A Bayesian network comprises a directed acyclic graph of relations of dependence between variables and conditional probability tables corresponding to these relations. Simple graphical patterns (called *idioms*) often appear while modeling the relationships between evidence and hypotheses. Complex graphical models can be constructed by combining these in a modular way [15,20,31,38,49]. BNs have been used to reconstruct legal cases [18,32], and to develop a general approach [55]. Once all the pieces of evidence and claims are represented as nodes, one should use the **scenario idiom**. A BN that uses the scenario idiom would consist of the nodes for the states and events in the scenario (with each node linked to the supporting evidence), a separate scenario node that has all states and events as its children, and a node corresponding to the ultimate hypothesis as a child of the scenario node. The scenario node in a sense unifies the different events and states: changing the probability of one part of the scenario will also usually change the probability of the other parts. This strategy is supposed to make sense of the notion of the **coherence of a scenario** as different from its probability given the evidence. On this approach [53–56], coherence is identified with the prior probability of the scenario node. The approach is also supposed to model reasoning with multiple scenarios. Given a class of narrations, all the nodes used in some of the separate BNs that correspond to them are to be used to build one large BN, and all separate scenario nodes are to be included in the final large BN. An alternative approach to using BNs in legal context [39] starts with a criticizm a higher-order probabilistic approach to narrations I have developed in [51]. My approach so far has no connection to BNs and so it "fails to offer a convincing and operational means to structure and compare competing narratives." The authors of [39] represent separate narrations in terms of separate BNs, and deploy **bayesian model comparison and averaging** as a tool for reasoning with multiple scenarios.

2.2. Pioneering nature of the project. Here are the key reasons why I am convinced **the scenario node approach is not satisfactory**. (A) Adding a parent node by *fiat* without any good reasons to think the nodes are connected other than being a part of a single story, introduces probabilistic dependencies between the elements of

a narration. (B) Another problem is the identification of prior probability with coherence. This does not add up intuitively: there are coherent but unlikely stories. (C) In general, the legal probabilistic approach to coherence is very simple and fails to engage with rich philosophical literature exactly on this topic [14,22,23,28,37,41,47]. (D) The merging procedure with scenario nodes assumes that for the nodes that are common to the networks to be merged, both the directions of the arrows in the DAGs and the conditional probability tables are the same across different narrations. This is unrealistic.

Here are the key **limitations of the model selection and averaging approach**. (E) The use equal priors is highly debatable. This approach would render prior probabilities quite sensitive to the choice of hypotheses and thus potentially arbitrary. Also, this approach seems particularly unsuitable for criminal cases. If the only two hypotheses/models on the table ultimately say "the defendant is guilty" and "the defendant is innocent", the prior probability of each would be 50%. But defendants in criminal cases, however, should be presumed innocent until proven guilty. A 50% prior probability of guilt seems excessive. Some take the presumption to mean that the prior probability of guilt should be set to a small value [24,25], but it is not clear whether this interpretation can be justified on epistemological or decision-theoretic grounds. (F) More recent models rely on relevant background information about people's opportunities to commit crimes [19]. But even if these models are successful in giving well-informed assessments of prior probabilities any evidence-based assessment of prior probabilities, they are likely to violate existing normative requirements of the trial system [8,16,46]. People who belong to certain demographic groups will be regarded as having a higher prior probability of committing a wrong than others, and this outcome can be seen as unfair [9]. (G) Model selection based on likelihood (given equal priors) or posterior model probabilities in general (if priors are not assumed to be equal) boils down to a variant of the threshold view, and so all the difficulties with the threshold view apply. (H) There is a rich literature on the difficulties that linear pooling runs into [11–13]. One problem is that the method satisfies the unanimity assumption: whenever all models share a degree of belief in a claim, this is exactly the output degree for that belief. Another problem is that linear pooling does not preserve probabilistic independence [36]: even if all models agree that certain nodes are independent, they might end up being dependent in the output. There is also a variety of impossibility theorems in the neighborhood [26].

The key elements in my planned work are as follows. (1) Representation. Use BNs taken separately without scenario nodes to represent various narrations. without assuming the conditional probability tables or directions of edges are the same across the BNs, adding another layer of information, dividing nodes into evidence and narration nodes. **(2) Dynamic BNs.** Averaging does not seem to be the right way to model cross-examination. To take the argumentative approach seriously and to be able to model relations such as "undercutting" and "rebutting" I will consider another dimension: BNs changing through time in light of other BNs. **(3) BN-based coherence.** with Alicja Kowalewska I have formulated a BN-based coherence measure that is not a function of a probabilistic measure and a set of propositions alone, because it is also sensitive to the selection and direction of arrows in a Bayesian Network representing an agent's credal state. Now, it needs to be deployed (implemented in **R** for BNs) and properly tested on real-life cases discussed in the LP literature. **(4) Divide and conquer.** I propose that ensemble methods should be deployed for multiple narration variants available from one side (as in when, say, the prosecution story comes with uncertainty about the direction of an arrow or about a particular probability table), but selection methods should be used when final decision is to be made between narrations proposed by the opposing sides. **(5) Ensemble methods.** One question that arises is whether the general concerns about linear pooling arise for such limited applications. If not, the remaining concern is what priors should be used. In light of the controversial nature of equal priors, I plan to study the consequences of rescaling coherence scores (already mentioned) to constitute model priors. The idea is that given that narrations are to be developed by the sides themselves, taking coherence of their narration as determining the prior might be more fair than using equal priors or relying on geographical or population statistics. If yes, perhaps some other methods boiling down to a variant of sensitivity analysis can be deployed: look at all BNs corresponding to some variant of the narration of one of the sides, find the ones that give strongest (and the weakest) support to the final conclusion, and these give you a range of possible outcomes. **(6) Selection criteria.** The so-called New Legal Probabilism (NLP) is an attempt to improve on the underspecificity of NPAS [10]. While still being at most semi-formal, the approach is more specific about the conditions that a successful accusing narration is to satisfy for the conviction beyond reasonable doubt to be justified. Di Bello works out the philosophical details of requirements such as evidential support and completeness, resiliency, and narrativity. It is far from obvious that such conditions are susceptible to a Bayesian networks explication. I plan to rely on a more expressive probabilistic framework [51,52], that is capable of expressing such features within a formalized higher-order

language. The key hypothesis is that they can be recast in terms of properties of BNs and that the existing BN programming tools can be extended to implement testing for these criteria. This will make them susceptible to programmatic implementation and further study by means of computational methods. The hope is that on one hand, they will do better than the existing proposals, and where they fail, further insights can be gained by studying the reasons behind such failures.

3. Work plan

Throughout the whole project I plan to cooperate with Marcello Di Bello (Arizona State University). Over the last year we co-authored the Stanford Encyclopedia of Philosophy entry on Legal Probabilism. We decided to continue our fruitful cooperation. For over two months we have been working on a book proposal to be submitted to Oxford University Press exactly on the issues to be studied in this research project. Marcello Di Bello is an excellent philsopher with extensive research experience in the philosophy of legal evidence, and he would bring his expertise to the table when working both on the book and on the papers, whereas I would be focused on the technical aspects and the underlying formal philosophy. During the last year of the research **I plan a six months' stay at Arizona State University**, to work in person with Di Bello on finalizing the book that presents the results of the project.

Apart from publications, the results will be presented at various conferences devoted to legal reasoning. These include the yearly conferences of the *International Association for Artificial Intelligence and Law* and of the *Foundation for Legal Knowledge Based Systems (JURIX)*, and more general conferences gathering formal philosophers, so that the research is inspired by interaction not only with legal evidence scholars, computer scientists, but also philosophers. I am also already an invited speaker at the upcoming "Probability and Proof" conference that will be part of an international conference on the philosophy of legal evidence ("The Michele Taruffo Girona Evidence Week") in Girona (Spain) May 23-27 2022. See the table at the end for the planned stages and output of research.

4. Methodology

I will be using four methods: (a) informal conceptual analysis; (b) formal conceptual analysis; (c) computational metods (R simulations, etc.); and (d) case studies. I will rethink and model the existing impliementations of whole-case-scale-BNs in legal evidence from the perspective of the new framework and reconstruct cases which extensively use probabilistic reasoning, but for which BNs have not been yet proposed. Both the literature already listed and many textbooks on quantitative evidence in forensics are great sources of such cases.

What the project will uniquely bring to the table is joining the familiarity with epistemological debates on the nature of coherence (which legal probabilists ignore or are unaware of), familiarity with the details of evidence assessment in legal cases (which formal epistemologists seem to be unaware of) and technical skill to programmatically implement, simulate and test various theoretical moves.

A larger initiative involving reconstructing various cases using different representation methods and comparing the representations, called *Probability and statistics in forensic science*, took place at the Isaac Newton Institute for Mathematical Sciences. My approach will be in the same vein.

I have extensive experience in analytic philosophy, conceptual analysis, philosophical logic and probabilistic and decision-theoretic methods as deployed in philosophical contexts. I also have teaching and publishing record that involves statistical programming in the **R** language (my sample programming projects can be visited at https://rfl-urbaniak.github.io/menu/projects.html), and so am also competent to develop AI implementations and tests of the ideas to be developed.

One research risk is that it will turn out that some of the informal requirements cannot be spelled out in probabilistic terms, or expressed in terms of properties of Bayesian networks. In such an event, I will study the reasons for this negative result. It might happen that there are independent reasons to abandon a given condition, or it might be the case that probabilistic inexplicability of a given condition is an argument against the probabilistic approach. Either way, finding out which option holds and why would also lead to a deeper understanding of the framework and lead to a publication in academic journals. Another research risk is that the case studies will show that other methods are more efficient or transparent. This would itself constitute a result that could be used to further modify the framework so that its best aspects could be preserved, while the disadvantages discovered during case studies avoided.

Stage 1 Philosophical & formal unification	Obtain a unifying extended probabilistic framework by incorporating further insights from philosophical and psychological accounts of legal narrations, and from the argumentation approach. Defend its philosophical plausibility. (6 months) A philosophical paper published in an academic journal such as *Synthese*, *Mind* or *Ratio Juris*. Working title: *Why care about narration selection principles?*
Stage 2 AI implementation	Develop Bayesian Network Methods for the obtained formal framework, so that the insights from the argumentation approach and informal epistemology, mediated through it, can be incorporated in AI tools. (12 months) A technical paper published in a journal such as *IfCoLog Journal of Logics and their Applications*, *Law, Probability and Risk* or *Artificial Intelligence and Law*. Working title: *Implementation of narration assessment criteria in Bayesian Networks with* ***R***.
Stage 3 Case studies	Evaluate the developed framework and AI tools by conducting case studies from its perspective. (6 months) One paper on how the formal framework handles case studies and one paper on how the developed AI tools handle real-life situations in journals such as *Artificial Intelligence* or *Argument & Computation*. Working titles: *Rethinking the famous BN-modeled cases within the narration framework* and *BNarr, an* ***R*** *package to model narrations with Bayesian Networks*.
Stage 4 Back to challenges	Investigate the extent to which the new framework helps to handle the issues raised in points A-H. (12 months) Completion of the planned book.

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OPIS SZCZEGÓŁOWY

Rekonceptualizacja probabilizmu w kontekstach prawnych

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Rethinking legal probabilism

Rafał Urbaniak

1 Scientific goal

As many miscarriages of justice indicate, scientific evidence is easily misinterpreted in court. This happens partially due to miscommunication between the parties involved, partially due to the usual probabilistic fallacies, but also because incorporating scientific evidence in the context of a whole case is hard. Probabilistic tools for piecemeal evaluation of scientific evidence and spotting probabilistic fallacies in legal contexts are quite well developed. Yet, the construction of a more general probabilistic model of incorporating such evidence in a wider context of a whole case, useful for theorizing about evidence evaluation and legal decision standards, remains a challenge. Legal probabilism (LP), for our purpose, is the view that this challenge can and should be met. This project intends to contribute to further development of this enterprise relying on motivations that come from different sources: formal epistemology, the development of bayesian networks, the practice of probabilistic evidence evaluation and the points raised by the critics of LP.

The assessment of evidence in the court of law can be viewed from at least three perspectives: as an interplay of arguments, as an assessment of probabilities involved, or as an interaction of competing narrations. Each perspective presents an account of legal reasoning (Di Bello & Verheij, 2018; van Eemeren & Verheij, 2017). Individually, each of these strains has been investigated. The probabilistic approach, while being fairly mature, is still underdeveloped in light of various lines of criticism developed by the representatives of the other strains.

The **goal of this project** is to **develop a probabilistic and yet narration-based modelling method of the interaction of various items of evidence and hypotheses and the resulting decisions in the court of law**. This will be achieved by accomodating important **insights provided by the critics of legal probabilism**. One crucial point is that the fact-finding process should be conceptualized as **a competition of narrations**, and standard probabilistic approaches do not capture this dimension. Another point comes from the argumentation theory framework: an adequate model should capture the structure of the arguments involved and the interplay between them, and it is not clear how this is to be achieved within the probabilistic approach. The point of departure is to represent narrations as bayesian networks enriched with additional layer of information as to which nodes correspond to evidence, and which are binary narration nodes. **The key idea is that with such bayesian networks as building material, various features requested by the critics (such as coherence, resiliency, missing evidence, explaining evidence, or ways to handle a multiplicity of proposed narrations) can be explicated in terms of corresponding properties of, operations on, and relations between bayesian networks.** Thus, the goals are three-fold:

1. Philosophical and conceptual improvement of legal probabilism by elaborating ways of representing probabilistically the narration-based perspective and the adversarial character of evidence assessment, which are typically absent from probabilistic approaches.
2. Formulation of a formal and computational probabilistic framework that incorporates features resulting from achieving goal 1. This will be done using Bayesian networks, hierarchical Bayesian models and imprecise probabilities. (**R** code capturing the technical features developed will be made openly available.)
3. Addressing the question of how evidence of different types can be aggregated and how adjudication should proceed in the presence of multiple competing narrations of what happened. The research in 1. and 2. will help to address this very practical and pressing question.

The output will be a **unifying extended probabilistic model embracing key aspects of the narrative and argumentative approaches, , with implementation in the programming language R.**
What the project will uniquely bring to the table is joining the familiarity with epistemological debates, familiarity with the details of evidence assessment in legal cases and technical skill to programmatically implement, simulate and test various theoretical moves.

2 Significance

2.1 State of the art

2.1.1 Legal probabilism

From among the three perspectives already mentioned, the probablistic approach will be my point of departure, for the following key reasons:

- The project is to be informed by and reflect on the actual practice of legal evidence evaluation, and much of scientific evidence in such contexts has probabilistic form.
- Probabilistic tools are fairly well-developed both for applications and within formal epistemology, reaching a state of fruition which should inspire deeper reflection.
- Statistical computing tools for such methods are available, which allows for programming development and preliminary computational and data-driven evaluation of the ideas to be defended.

Accordingly, the view in focus of this research is legal probabilism (LP)—an ongoing research program that comprises a variety of claims about evidence assessment and decision-making at trial. At its simplest, it comprises two core tenets: first, that the evidence presented at trial can be assessed, weighed and combined by means of probability theory; and second, that legal decision rules, such as proof beyond a reasonable doubt in criminal cases, can be explicated in probabilistic terms.

The early theorists of probability in the 17th and 18th century were as much interested in games of chance as they were interested in the uncertainty of trial decisions (Bernoulli, 1713; Daston, 1988; Franklin, 2001; Hacking, 1975). Bernoulli's prescient insights attained greater popularity in the 20th century amidst the law and economics movement (Becker, 1968; Calabresi, 1961; Posner, 1973). Finkelstein & Fairley (1970) gave one of the first systematic analyses of how probability theory, and Bayes' theorem in particular, can help to weigh evidence at trial. Lempert (1977) was one of the first to propose to use likelihood ratios for assessing the relevance of evidence. Such contributions fueled what has been called the New Evidence Scholarship, a rigorous way of studying the process of legal proof at trial (Lempert, 1986).

2.1.2 Challenges to New Evidence Scholarship

Tribe (1971) attacked what he called 'trial by mathematics', by listing well-known cases of misuse or probabilities in legal contexts and practical difficulties in assessing the probability of someone's criminal or civil liability, and pointing out the dehumanization of trial decisions that legal probabilism seems to propose. After Tribe, many argued that probabilistic models are either inadequate or unhelpful (Allen, 1986; Brilmayer, 1986; Cohen, 1986; Dant, 1988; Underwood, 1977). This negative trend has been somewhat mitigated by the discovery of DNA fingerprinting in the eighties and progress in forensic science in general, with the increasing role of quantitative evidence in the court of law (Kaye, 1986, 2010; Koehler, 1996; National Research Council, 1992; Robertson & Vignaux, 1995).

Skepticism about wider mathematical and quantitative models of legal evidence is still widespread among prominent legal scholars and practitioners (see, for example, Allen & Pardo, 2007). This is partially in light of conceptual difficulties extensively discussed in the literature, which arise when one wants to formulate a probabilistic decision criterion for the court of law. Imagine you are a trier of fact in a legal proceeding in which the defendant's guilt is identified as equivalent to a certain factual statement G and that somehow you succeeded in properly evaluating $\mathsf{P}(G|E)$—-the probability of G given the total evidence presented to you, E. One question that arises in such a situation is: when should you decide against the defendant? When is the evidence good enough? What we are after here is a condition Ψ, formulated in (primarily) probabilistic (and perhaps decision-theoretic) terms, such that the trier of fact, at least ideally, should accept any relevant claim A (including G) just in case $\Psi(A,E)$. One straightforward attempt might be to say: convict if $\mathsf{P}(G|E)$ is above a certain threshold, otherwise acquit (Dekay, 1996; Kaye, 1979; see, for example Laplace, 1814; Laudan, 2006).

This move, however, seems to be blocked by the so-called paradoxes of legal proof or puzzles of naked statistical evidence. Nesson (1979), Cohen (1981), and Thomson (1986) formulated scenarios in which, even if the probability of guilt or civil liability, based on the available evidence, is particularly high, a verdict against the defendant seems unwarranted. A variant of such a scenario—the gatecrasher paradox—goes as follows. Suppose our guilt threshold is high, say at 0.99. Consider the situation in which 1000 fans enter a football stadium, and 991 of them avoid paying for their tickets. A random spectator is tried for not paying. The probability that the

spectator under trial did not pay exceeds 0.99. Yet, intuitively, a spectator cannot be considered liable on the sole basis of the number of people who did and did not pay. While recently some doubt the relevance of abstract philosophical examples for the actual practice (Hedden, 2019; Ross, 2020), at least conceptual challenges remain.

Another conceptual problem is the so-called difficulty about conjunction. It arises, because intuitively there should be no difference between the trier's acceptance of A and B separately, and her acceptance of their conjunction, $A \wedge B$, that is, that $\Psi(A,E)$ and $\Psi(B,E)$ just in case $\Psi(A \wedge B,E)$. If $\Psi(H,E)$ is just the threshold criterion requiring that $\mathsf{P}(H|E)$ be sufficiently high, Ψ in general fails to satisfy this equivalence, as the probability of a conjunction generally can be lower than the probability of any of the conjuncts.

Arguably, these problems underscore a theoretical difficulty with probabilistic accounts of legal standards of proof. How to define them, or whether they should be even defined in the first place, remains contentious (Diamond, 1990; Horowitz & Kirkpatrick, 1996; Laudan, 2006; Newman, 1993; Walen, 2015). Judicial opinions offer different paraphrases, sometimes conflicting, of what these standards mean. In the last decade, philosophers have also joined the debate (Gardiner, 2018; for critical surveys see Redmayne, 2008).

At least *prima facie*, then, it seems that some conditions other than high posterior probability of liability have to be satisfied for the decision to penalize (or to find liable) to be justified. Accordingly, various informal notions have been claimed to be essential for a proper explication of judiciary decision standards (Haack, 2014; Wells, 1992). For instance, evidence is claimed to be insufficient for conviction if it is not *sensitive* to the issue at hand: if it remained the same even if the accused was innocent (Enoch & Fisher, 2015). Or, to look at another approach, evidence is claimed to be insufficient for conviction if it doesn't *normically support* it: if—given the same evidence—no explanation would be needed even if the accused was innocent (Smith, 2017). A legal probabilist needs either to show that these notions are unnecessary or inadequate for the purpose at hand, or to indicate how they can be explicated in probabilistic terms.

2.1.3 The alternative perspectives

More recently, alternative frameworks for modeling evidential reasoning and decision-making at trial have been proposed. They are based on inference to the best explanation (Allen, 2010; Hastie, 2019; Ho, 2019; Nance, 2019; Pardo & Allen, 2008; Schwartz & Sober, 2019), narratives and stories (Allen, 1986, 2010; Allen & Leiter, 2001; Clermont, 2015; Pardo, 2018; Pennington & Hastie, 1991a), and argumentation theory (Bex, 2011; Gordon, Prakken, & Walton, 2007; Walton, 2002). Those who favor a conciliatory stance have combined legal probabilism with other frameworks, offering preliminary sketches of hybrid theories (Urbaniak, 2018a; Verheij, 2014).

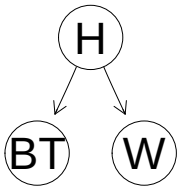
The main point of criticism of LP is that legal proceedings are back-and-forth between opposing parties in which cross-examination is of crucial importance, reasoning goes not only evidence-to-hypothesis, but also hypotheses-to-evidence (Allen & Pardo, 2007; Wells, 1992) in a way that seems analogous to inference to the best explanation (Dant, 1988), which notoriously is claimed to not be susceptible to probabilistic analysis (Lipton, 2004), and the process is an interaction of multiple arguments that remain in fairly complicated relations. An informal philosophical account inspired by such considerations—The **No Plausible Alternative Story (NPAS)** theory (Allen, 2010)—is that the courtroom is a confrontation of competing narrations (Ho, 2008; Wagenaar, Van Koppen, & Crombag, 1993) offered by the sides, and the narrative to be selected should be the most plausible one. The view is conceptually plausible (Di Bello, 2013), and finds support in psychological evidence (Pennington & Hastie, 1991b, 1992) (while the psychological support does not prove that this approach is rational, it suggests that a narration-related approach, if rational, might be more realistic).

It would be a great advantage of LP if it could model phenomena captured by the narrative approach. But how is the legal probabilist to make sense of them? From her perspective, the key disadvantage of NPAS is that it abandons the rich toolbox of probabilistic methods and takes the key notion of plausibility to be a primitive notion which should be understood only intuitively. It would be even better for LP if the incorporation of such insights could lead to the resolution of the already mentioned conceptual difficulties.

2.1.4 Bayesian networks as a tool for legal probabilism

The idea that Bayesian networks can be used for probabilistic reasoning in legal fact-finding started gaining traction in late eighties and early nineties (Edwards, 1991), and it found its way to nowadays standard textbooks on the topic (Fenton & Neil, 2018a; Taroni, Biedermann, Bozza, Garbolino, & Aitken, 2014).

A Bayesian network comprises two components: first, a directed acyclic graph of relations of dependence (represented by arrows) between variables (represented by nodes); second, conditional probability tables. Consider the graphical component first. The graph is acyclic: the arrows connecting the nodes do not form loops. As an illustration, let H be the claim that the suspect committed the murder, BT the presence of a blood type B match with a crime scene stain, and W the fact that an eyewitness observed the suspect near the scene around the time of the crime. The graphical component of the Bayesian network would look like this.



The *ancestors* of a node are all those nodes from which we can reach it by following the arrows going forwards. The *parents* of a node are those for which we can do this in one step. The *descendants* of a node are all which can be reached from it by following the arrows going forward. The *children* are those for which we can do this in one step. In the example, H is the parent (and ancestor) of both W and BT, which are its children (and descendants). There are no non-parent ancestors or non-children descendants.

The variables, which are represented by nodes and are connected by arrows, stand in relation of probabilistic dependence. To describe these relations, the graphical model is accompanied by conditional probability tables. For instance, they can look as follows (the blood type frequency estimate is realistic (Lucy, 2013), and so are the conditional probabilities for the eyewitness identification, although for complications about assessing eyewitness testimony see Wixted & Wells (2017) and Urbaniak, Kowalewska, Janda, & Dziurosz-Serafinowicz (2020)).

	H = murder	H=no.murder
W = seen	.7	.4
W = not.seen	.3	.6

	H = murder	H=no.murder
BT = match	1	.063
BT = no.match	0	.937

(A prior for the root node(s) is also required; here, say, $\mathsf{P}(H = murder) = .01$ and $\mathsf{P}(H = no.murder) = 0.99$.)

While the Bayesian network above—comprising a directed acyclic graph along with probability tables—is simple, a correct intuitive assessment of the probability of the hypothesis given the evidence is already challenging. The reader is invited to try to estimate intuitively the probability that the defendant committed the murder (H=murder) given the following states of the evidence:

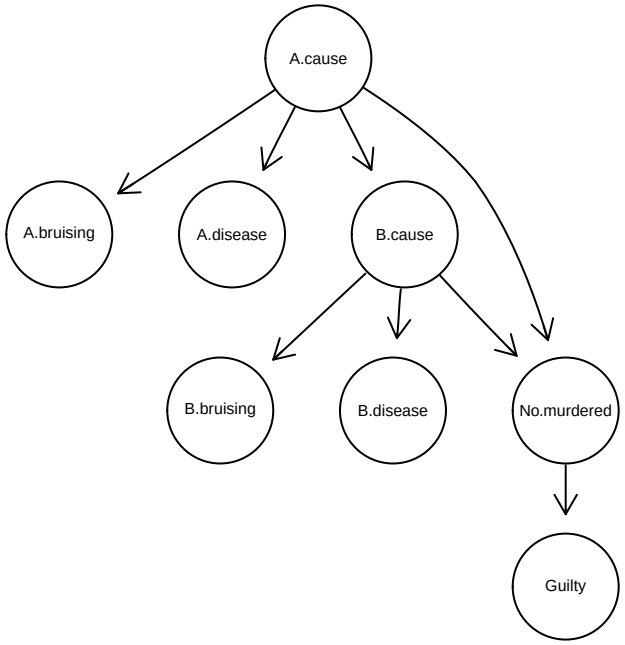
- The suspect's blood type matches the crime stain but information about the witness is unavailable.
- The suspect's blood type matches the crime stain but the witness says they did not see the suspect near the crime scene.
- The suspect's blood type matches the crime stain and the witness says they saw the suspect near the crime scene.

	H=murder
BT = match,W=?	.138
BT = match,W=not.seen	.074
BT = match, W=seen	.219

Already at this level of complexity, calculations by hand become cumbersome. In contrast, software for Bayesian networks will easily give the results visible on the left. Perhaps surprisingly, the posterior probability of H is about .22 even when both pieces of evidence are incriminating (BT=match, W=seen).

In a similar vein, fairly simple graphical patterns (called *idioms*) often appear while modeling the relationships between evidence and hypotheses. Complex graphical models can be constructed by combining these basic patters in a modular way. Discussion of general methods for Bayesian network constructions can be found in (Bovens & Hartmann, 2004; Friedman, 1974; Hepler, Dawid, & Leucari, 2007; Neil, Fenton, & Nielson, 2000) and general idioms are discussed in (Fenton, Neil, & Lagnado, 2013).

Some attempts have been made to use Bayesian networks to weigh and assess complex bodies of evidence consisting of multiple components. On one hand, we have serious reconstructions of real complex cases. Kadane & Schum (2011) made one of the first attempts to model an entire criminal case, Sacco & Vanzetti from 1920, using probabilistic graphs. Here is another, more recent, example by Fenton & Neil (2018b), who constructed a Bayesian network for the famous Sally Clark case.



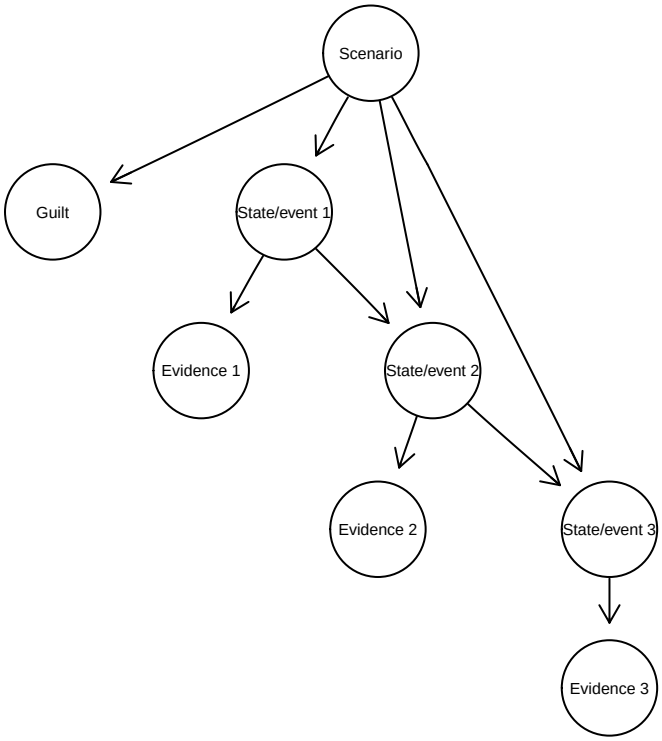
The arrows depict relationships of influence between variables. Whether Sally Clark's sons, call them *A* and *B*, died by SIDS or murder (A.cause and B.cause) influences whether signs of disease (A.disease and B.disease) and bruising (A.bruising and B.bruising) were present. Since son A died first, whether A was murdered or died by SIDS (A.cause) influences how son B died (B.cause). How the sons died determines how many sons were murdered (No.murdered), and how many sons were murdered decides whether Sally Clark is guilty (guilty).

Evidence (cumulative)	P(Clark guilty)
A bruising	.2887
A no signs of disease	.3093
B bruising	.6913
B no signs of disease	.7019

In Fenton's calculation, the prior probability of Guilty = Yes should be .0789. After taking into account the incriminating evidence presented at trial, such as that there were signs of bruising but no signs of a preexisting disease affecting the children, the posterior probabilities are as in the table on the left.

The literature contains examples of more general methodological reflection on the use of BNs for modeling whole cases. The main idea is that once all the pieces of evidence and claims are represented as nodes, one should use the *scenario idiom* to model complex hypotheses, consisting of a sequence of events organized in space and time: a scenario (Vlek, Prakken, Renooij, & Verheij, 2014). A discussion of modelling crime scenarios by means of graphical devices mixed with probabilities can be also found in the work of Shen, Keppens, Aitken, Schafer, & Lee (2007), Bex (2011), Bex (2015) and Verheij (2017). See also the survey by Di Bello & Verheij (2018). Dawid & Mortera (2018) give a treatment of scenarios in terms of BNs.

A graphical model that uses the scenario idiom would consist of the following components: first, nodes for the states and events in the scenario, with each node linked to the supporting evidence; second, a separate scenario node that has all the other as its children; finally, a node corresponding to the ultimate hypothesis as a child of the scenario node. Such a model could look like this:



Note that the scenario node unifies the different events and states. Because of this unifying role, changing the probability of one part of the scenario (say State/event 2) will also change the probability of the other parts (State/event 1 and State/event 3). This is intended to capture the idea that the different components of a scenario form a whole.

One challenge that this strategy is supposed to help with is the question of how to make sense of the notion of the coherence of a scenario as different from its probability given the evidence. On this approach (Vlek, 2016; Vlek, Prakken, Renooij, & Bart Verheij, 2015; Vlek, Prakken, Renooij, & Verheij, 2013; Vlek et al., 2014), coherence is identified with the prior probability of the scenario node.

Another challenge that the framework is supossed to meet is the question of how to formally represent reasoning with multiple scenarios on the table. On this approach (called scenario merging), given a class of narrations, all the nodes used in some of the separate BNs are to be used to build one large BN, and separate scenario nodes are to be added to it, so that one BN supposedly represents multiple scenarios at once.

A somewhat alternative approach to representation of and reasoning with multiple scenarios has been developed by Neil, Fenton, Lagnado, & Gill (2019). They correctly criticize (Urbaniak, 2018a) where I only sketch some theoretical moves in a second-order language towards the probabilistic modelling of the narrative approach. The critics point out the paper makes no connection to BNs and so it "fails to offer a convincing and operational means to structure and compare competing narratives." This is a fair assessment of the limits of what I have achieved so far. They propose to represent separate narrations in terms of separate BNs, and to deploy bayesian model comparison and averaging as a tool for reasoning with multiple scenarios. That is, Bayes Theorem with hypotheses as models (BNs), yields:

$$\mathsf{P}(M = m_i|E) = \frac{\mathsf{P}(E|M = m_i)\mathsf{P}(M = m_i)}{\sum_{i=1}^{n} \mathsf{P}(E|M = m_i)\mathsf{P}(M = m_i)} \tag{1}$$

Then, assuming equal priors, models with higher likelihoods will have higher posterior probabilities, and the most plausible model will be the one with the highest posterior (that is, with equal priors, with highest likelihood). Alternatively, they propose averaging the predictions for a given variable φ by taking the ensemble model:

$$\mathsf{P}(\varphi|E) = \sum_{i=1}^{n} \mathsf{P}(\varphi|M = m_i, E)\mathsf{P}(M = m_i|E) \tag{2}$$

where the weights are identified with the posteriors of the models given the evidence, which are calculated using (1). The priors of the form $\mathsf{P}(M = m_i)$ used in (1) are either taken to be equal for all i, or postulated to be different. Fenton in an example uses 0.8 for the prosecution model and 0.2 for the defense model, but no clear guidance as to how model priors are to be chosen is provided.

2.2 Pioneering nature of the project

2.2.1 Points of disagreement

Here are the key reasons why I am convinced the scenario node approach is not satisfactory:

A. The use of a scenario idiom is problematic. Adding a parent node by *fiat* without any good reasons to think the nodes are connected other than being a part of a single story, introduces probabilistic dependencies between the elements of a narration. Merely saying that, say, the defenendant made jointly some claims is not a good reason to assume they are probabilistically dependent.

B. Another problem results from the identification of prior probability with coherence. This does not add up intuitively. After all, it is quite coherent with my views that if I win a lottery, I'll buy a large house in Auckland and move there, while both the prior and the posterior given the total available evidence of this scenario are rather low.

C. In general, the legal probabilistic approach to coherence is very simple and fails to engage with rich philosophical literature exactly on this topic (Douven & Meijs, 2007; Fitelson, 2003a, 2003b; Glass, 2002; Meijs & Douven, 2007; Olsson, 2001; Shogenji, 1999), including a long list of counterexamples to the existing proposals and desiderata that a probabilistic coherence measure should satisfy (Akiba, 2000; Bovens & Hartmann, 2004; Crupi, Tentori, & Gonzalez, 2007; Koscholke, 2016; Merricks, 1995; Schippers & Koscholke, 2019; Shogenji, 1999, 2001, 2006; Siebel, 2004, 2006).

D. The merging procedure with scenario nodes assumes that for the nodes that are common to the networks to be merged, both the directions of the arrows in the DAGs and the conditional probability tables are the same across different narrations. This is suboptimal. Different sides in court might construe causal dependencies differently, and even if they agree about the direction of an arrow, they might disagree about the probability table associated with it. Even a single side might consider different scenarios with different probabilities, say, when there is some uncertaintly inolved in the probability assignment itself.

Here are the key limitations of the approach proposed by Neil et al. (2019):

E. The idea that model priors should be equal is highly debatable. For one thing, this approach would render prior probabilities quite sensitive to the choice of hypotheses and thus potentially arbitrary. In addition, this approach seems particularly unsuitable for criminal cases. If the only two hypotheses/models on the table ultimately say "the defendant is guilty" and "the defendant is innocent", the prior probability of each would be 50%. But defendants in criminal cases, however, should be presumed innocent until proven guilty. A 50% prior probability of guilt seems excessive. Some (Williamson, 2010) try to defend a variant of the principle of indifference by reference to informational entropy, and a proposal along this line has been used in practical recommendation by expert committees (ENFSI Expert Working Group Marks Conclusion Scale Committee, 2006). However, this attempt has been sensibly criticized by Biedermann, Taroni, & Garbolino (2007). The question remains, what should the proper application of informational entropy in the context of BN selection and averaging look like, given that information entropy considerations independently are in epistemologically decent standing? Importantly, whatever conclusions in such contexts are epistemologically justified, how do they square with the presumption of innocence? Some take the presumption to mean that the prior probability of guilt should be set to a small value (Friedman, 2000; Friedman, Allen, Balding, Donnelly, & Kaye, 1995), but it is not clear whether this interpretation can be justified on epistemological or decision-theoretic grounds.

F. More recent models rely on relevant background information, for example, geographical information about people's opportunities to commit crimes [Fenton, Lagnado, Dahlman, & Neil (2019). But even if these models are successful in giving well-informed assessments of prior probabilities any evidence-based assessment of prior probabilities, they are likely to violate existing normative requirements of the trial system (Dahlman, 2017; Engel, 2012; Schweizer, 2013). For instance, if the assessment of prior probabilities relies on demographic information, people who belong to certain demographic groups will be regarded as having a higher prior probability of committing a wrong than others. This is what a well-informed assessment should amount to. Yet, if some people's priors are higher than other people's priors, it will be easier to convict or find liable those who are assigned higher priors, even if the evidence against them is the same as the evidence against those assigned lower priors. This outcome can be seen as unfair (Di Bello & O'Neil, 2020). The question remains: what procedure of choosing the priors both is justified by epistemological considerations and does not generate tension with fairness considerations?

G. Model selection based on likelihood (given equal priors) or posterior model probabilities in general (if priors are not assumed to be equal) boils down to a variant of the threshold view, and so all the difficulties with the threshold view apply.

H. Model averaging in the proposed form boils down to taking a weighted average of the probabilities provided by the models (weighted linear pooling). However, there is a rich literature on the difficulties that linear pooling runs into (see the surveys in Dietrich & List, 2016; Franz Dietrich & List, 2017a, 2017b). One problem is that the method satisfies the unanimity assumption: whenever all models share a degree of belief in a claim, this is exactly the output degree for that belief. But clearly, a claim can receive additional boost from multiple agents with different pieces of evidence agreeing on something (for instance, in witness corroboration). Another problem is that linear pooling does not preserve probabilistic independence (List & Pettit, 2011): even if all models agree that certain nodes are independent, they might end up being dependent in the output. There is also a variety of impossibility theorems in the neighborhood (Gallow, 2018).

2.2.2 Strategy and novelty

First, we need to represent narrations with their argumentative and dynamic structure in probabilistic terms. Once this is done, the resulting resulting representation tools can be used to work out an explication of the notion of coherence that does a better job than merely probabilistic explications that are available. Once this is done, various methods of dealing with multiple BNs, be it ensemble methods or some model selection methods, should be put into place, by explaining in a principled way which of these methods should be used in what context and why. One key novelty is in the formulation and BN implementation of selection criteria that so far have only been discussed informally in philosophical literature. Once this explication is obtained, further investigation of the role these criteria should play and their principled justification will proceed. I cover these steps in more detail now.

Representation. I will use BNs taken separately without scenario nodes to represent various narrations. Crucially, I will not assume the conditional probability tables or directions of edges are the same across the BNs, thus allowing for more realistic flexibility. To be able to accommodate insights provided by NPAS and other critics of LP, I will add another layer of information: for each BN one needs to specify a set of binary nodes such that a certain combination of their states counts as a narration, and a set of evidence nodes, which are supposed to support this narration.

Dynamic BNs If what we are modeling is cross-examination, averaging does not seem to be the right way to go. To model cross-examination, we need to take the argumentative approach seriously and to be able to model relations such as "undercutting" and "rebutting". And these relations can be modelled by adding or removing nodes or arrows in the network in a suitable manner. But this means we might have to consider another dimension: BNs changing through time in light of other BNs. How to make sense of this formally so that the result makes sense philosophically remains an open question.

BN-based coherence. With Alicja Kowalewska I have developed a coherence measure that diverges from the known candidates in three important respects: (1) It is not a function of a probabilistic measure and a set of propositions alone, because it is also sensitive to the selection and direction of arrows in a Bayesian Network representing an agent's credal state. (2) Unlike in the case of quite a few coherence measures, it is not obtained simply by taking a mean of some list of all possible intermediate values (such as confirmation levels between all subsets of a narration). It is also sensitive to the minimal values of the intermediate values. (3) The intermediate values used are not simply confirmation levels, but rather confirmation levels weighted by the probabilities of their antecedents. Preliminary tests on existing philosophical counterexamples suggests the performance of the measure is much better than the existing coherence measures. Now, it needs to be deployed (implemented in **R** for BNs) and properly tested on real-life cases discussed in the LP literature.

Divide and conquer. In fact, dealing with multiple models is difficult in this context. On one hand, many machine learning methods are not available. For instance, one cannot evaluate models in terms of their performance with respect to the data. Whenever you want to use resampling methods (such as cross-validation), or some information criterion scoring (suchs as Akaike Information Criterion), you need to have a dataset with multiple datapoints to start with, and such datasets are usually not available (and often conceptually unimaginable) for the problems typically faced in the court of law. On the other hand, averaging often doesn't

make sense either. After all, often no epistemological or decision-related progress might be gained based on averaging the prosecutor's and the defendant's stories, if they disagree about crucial elements of the case. I propose that ensemble methods should be deployed for multiple narration variants available from one side (as in when, say, the prosecution story comes with uncertainty about the direction of an arrow or about a particular probability table, and averaging helps to gauge the uncertainty involved), but selection methods should be used when final decision is to be made between narrations proposed by the opposing sides.

Ensemble methods. One question that arises is whether the general concerns about linear pooling arise for such limited applications. If not, the remaining concern is what priors should be used. In light of the controversial nature of equal priors, I plan to study the consequences of rescaling coherence scores (already mentioned) to constitute model priors. The idea is that given that narrations are to be developed by the sides themselves, taking coherence of their narration as determining the prior might be more fair than using equal priors or relying on geographical or population statistics. If yes, perhaps some other methods boiling down to a variant of sensitivity analysis can be deployed: look at all BNs corresponding to some variant of the narration of one of the sides, find the one that supports the ultimate conclusion the most, and the one that supports it the least, and these give you a range of possible outcomes.

Selection criteria. The so-called New Legal Probabilism (NLP) is an attempt to improve on the underspecificity of NPAS (Di Bello, 2013). While still being at most semi-formal, the approach is more specific about the conditions that a successful accusing narration is to satisfy for the conviction beyond reasonable doubt to be justified. Di Bello identifies four key requirements that a successful convicting narration should satisfy:

(Evidential support)	The defendant's guilt probability on the evidence should be sufficiently supported by the evidence, and a successful accusing narration should explain the relevant evidence.
(Evidential completeness)	The evidence available at trial should be complete as far as a reasonable fact-finders' expectations are concerned.
(Resiliency)	The prosecutor's narrative, based on the available evidence, should not be susceptible to revision given reasonably possible future arguments and evidence.
(Narrativity)	The narrative offered by the prosecutor should answer all the natural or reasonable questions one may have about what happened, given the content of the prosecutor's narration and the available evidence.

Prima facie, it is far from obvious that such conditions are susceptible to a Bayesian networks explication. However, I have already developed a more expressive probabilistic framework (call it Narration-Friendly Probabilism (NFP)) capable of expressing such features within a formalized higher-order language (Urbaniak, 2018b). On NFP, the notion of narration is quite wide: narrations not only contain factual statements about what happened, but also claims about evidence, about narrations, about relations between evidence and various parts of various narrations etc. I extend the basic propositional language with propositional operators N_i and E corresponding to "*. . . is part of narration i*" and "*. . . is part of the evidence*," and model narrations as finite sets of sentences from this language. Due to this intuitive move, many important aspects of narrations normally discussed only informally, similar to those discussed by Di Bello, become expressible in terms of probabilistic measures for such a formal language. Let's very briefly gesture towards a few examples:

- A defending narration explains a piece of evidence e just in case if there is an attacking narration whose posterior is raised conditional on e, the probability of e conditional on this defending narration is above the negligibility threshold.
- An attacking narration misses some evidence just in case there are some statements not in the evidence set such that the probability of the claim that at least one of them is part of evidence conditional on the existing evidence ($\{\varphi|\varphi \in$ Evidence$\}$), its description ($\{E\varphi|\varphi \in$ Evidence$\}$), and on this attacking narration is above the strong plausibility threshold.
- A narration contains gaps just in case there are some claims which are not part of it, but conditional on the content and the description of this narration and the evidence available, their disjunction is strongly plausible, and it is strongly plausible conditional on the content (but not on the description) of this narration and on evidence that at least one of these claims is part of the narration.
- A narration is dominant just in case it doesn't miss any evidence, it doesn't contain any gap, and in light of all available information and evidence it is at least as likely as any other narration, and is strongly

plausible.

While threshold- or likelihood-ratio-based selection criteria for models are unlikely to succeed, as already discussed, I am convinced the criteria formulated in philosophical terms in (Di Bello, 2013) and in higher-order terms in (Urbaniak, 2018a) are in better standing. The key hypothesis is that they can be recast in terms of properties of BNs and that the existing BN programming tools can be extended to implement testing for these criteria, intended as seprately necessary and jointly sufficient requirements for the winning narration. This will make them susceptible to programmatic implementation and further study by means of computational methods. The hope is that on one hand, they will do better than the existing proposals, and where they fail, further insights can be gained by studying the reasons behind such failures.

3 Work plan

Stage 1 Philosophical & formal unification	Obtain a unifying extended probabilistic framework by incorporating further insights from philosophical and psychological accounts of legal narrations, and from the argumentation approach. Defend its philosophical plausibility. (6 months)
Stage 2 AI implementation	Develop Bayesian Network Methods for the obtained formal framework, so that the insights from the argumentation approach and informal epistemology, mediated through it, can be incorporated in AI tools. (12 months)
Stage 3 Case studies	Evaluate the developed framework and AI tools by conducting case studies from its perspective. (6 months)
Stage 4 Back to challenges & output	Investigate the extent to which the new framework helps to handle the issues raised in points A.-H., finalize the book. (12 months)

The planned publication output is as follows:

- Stage 1 will result in one philosophical paper published in an academic journal such as *Synthese*, *Mind* or *Ratio Juris*. Working title: *Why care about narration selection principles?*
- Stage 2 will lead to one technical paper published in a journal such as *IfCoLog Journal of Logics and their Applications*, *Law, Probability and Risk* or *Artificial Intelligence and Law*. Working title: *Implementation of narration assessment criteria in Bayesian Networks with* ***R***.
- Stage 3 will lead to a publication of one paper on how the formal framework handles case studies and a further paper on how the developed AI tools handle real-life situations in journals such as *Artificial Intelligence* or *Argument & Computation*. Working titles: *Rethinking the famous BN-modeled cases within the narration framework* and *BNarr, an* ***R*** *package to model narrations with Bayesian Networks*.
- Throughout the whole project I plan to cooperate with Marcello Di Bello. Over the last year we co-authored the Stanford Encyclopedia of Philosophy entry on Legal Probabilism. We decided to continue our fruitful cooperation. For over two months we have been working on a book proposal to be submitted to Oxford University Press exactly on the issues to be studied in this research project. Marcello Di Bello is an excellent philsopher with extensive research experience in the philosophy of legal evidence, and he would bring his expertise to the table when working both on the book and on the papers, whereas I would be focused on the technical aspects and the underlying formal philosophy. During the last year of the research **I plan a six months' stay at Arizona State University**, to work in person with Di Bello on finalizing the book that presents the results with special focus on issues investigated in Stage 4 (especially chapters 6 and 8-14 cover the relevant issues).

The tentative list of planned chapters is as follows (two of them already exist as sample chapters for the book proposal submission):

I Legal probabilism and its foes
- 1 The emergence of legal probabilism
  - 1.1 Famous cases
  - 1.2 Probabilistic evidence
  - 1.3 Trial by mathematics
  - 1.4 Some history
- 2 A skeptical perspective
  - 2.1 The difficulty about conjunction
  - 2.2 The complexity objection
  - 2.3 The problem of corroboration
  - 2.4 The problem of artificial precision
  - 2.5 Naked statistical evidence
  - 2.6 The problem of priors
  - 2.7 The reference class problem
  - 2.8 Non-probabilistic perspectives

II Evidence assessment
- 3 Bayes' Theorem and the usual fallacies
  - 3.1 Assuming independence
  - 3.2 The prosecutor's fallacy
  - 3.3 Base rate fallacy
  - 3.4 Defense attorney's fallacy
  - 3.5 Uniqueness fallacy
  - 3.6 Case studies
- 4 Complications and caveats
  - 4.1 Complex hypotheses and complex bodies of evidence
  - 4.2 Source, activity and offense level hypotheses
  - 4.3 Where do the numbers come from?
  - 4.4 Modeling corroboration
  - 4.5 Stories, explanations and coherence
- 5 Likelihood Ratios and Relevance
  - 5.1 Likelihood ratio as a measure of evidence strength
  - 5.2 The risk of false positive and its impact
  - 5.3 Hypothesis choice
  - 5.4 Levels of hypotheses and the two-stain problem
  - 5.5 Relevance and the small-town murder scenario
  - 5.6 The cold-hit confusion
  - 5.7 Likelihood ratio and cold-hit DNA matches
- 6 Bayesian Networks
  - 6.1 Bayesian networks to the rescue
  - 6.2 Legal evidence idioms
  - 6.3 Scenario idioms
  - 6.4 Modeling relevance
  - 6.5 Case study: Sally Clark
  - 6.6 DNA evidence
- 7 Corroboration
  - 7.1 Boole's formula and Cohen's challenge
  - 7.2 Modeling substantial rise in case of agreement
  - 7.3 Ekelöf's corroboration measure and evidentiary mechanisms
  - 7.4 General approach with multiple false stories and multiple witnesses
- 8 Coherence
  - 8.1 Existing probabilistic coherence measures
  - 8.2 An array of counterexamples
  - 8.3 Coherence of structured narrations with Bayesian networks
  - 8.4 Application to legal cases
- 9 New legal probabilism
  - 9.1 Desiderata
  - 9.2 A probabilistic framework for narrations
  - 9.3 Probabilistic explications of the desiderata
  - 9.4 Bayesian network implementation

III Trial Decisions
- 10 The functions of the proof standards
  - 10.1 Conceptual desiderata
  - 10.2 Protecting defendants
  - 10.3 Error reduction and error distribution/allocation
  - 10.4 Dispute resolution and public deference
  - 10.5 Justification and answerability
- 11 Standards of proof
  - 11.1 Legal background
  - 11.2 Probabilistic thresholds
  - 11.3 Theoretical challenges
  - 11.4 Specific narratives
  - 11.5 The comparative strategy
  - 11.6 The likelihood strategy
  - 11.7 Challenges (again)
  - 11.8 Probabilistic thresholds revised
  - 11.9 Bayesian networks and probabilistic standard of proof
- 12 Accuracy and the risk of error
  - 12.1 Minimizing expected costs
  - 12.2 Minimizing expected errors
  - 12.3 Expected v. actual errors
  - 12.4 Competing accounts of the risk of error
  - 12.5 Bayesian networks and the risk of error
- 13 Fairness in trial decisions
  - 13.1 Procedural v. substantive fairness
  - 13.2 Competing measures of substantive fairness
  - 13.3 Bayesian networks and fairnesss
- 14 Alternative accounts and legal probabilism
  - 14.1 Baconian probability
  - 14.2 Relative Plausibility
  - 14.3 Arguments
  - 14.4 Sensitivity
  - 14.5 Normic Support
  - 14.6 Justification/foundherentism
  - 14.7 Completeness
  - 14.8 Relevant alternatives
  - 14.9 Knowledge
- 15 Conclusions

Apart from publications, the results will be presented at various conferences devoted to legal reasoning. These include the yearly conferences of the *International Association for Artificial Intelligence and Law* and of the *Foundation for Legal Knowledge Based Systems (JURIX)*, and more general conferences gathering formal philosophers, so that the research is inspired by interaction not only with legal evidence scholars, computer scientists, but also philosophers. I am also already an invited speaker at the upcoming "Probability and Proof"

conference that will be part of an international conference on the philosophy of legal evidence ("The Michele Taruffo Girona Evidence Week") in Girona (Spain) May 23-27 2022.

4 Methodology

Standard arguments for the legitimacy of Bayesianism[1] deploy usually rather abstract pieces of reasoning to the effect that if one's degrees of beliefs satisfy certain conditions, they also have to satisfy the probabilistic requirements. My approach to thinking about the plausibility of Bayesian epistemology is rather unlike such approaches. Instead, I prefer the *proof-of-the-pudding* methodology. I am convinced that an important part of the philosophical assessment of the Bayesian research program has to do with its achievements or failures in contributing to debates in philosophy which are not themselves debates about the status of Bayesianism itself. In particular, it would be great news if insights from Bayesian epistemology could be used to further develop forensic AI and deepening our understanding of judiciary decision making.

What the project will uniquely bring to the table is joining the familiarity with epistemological debates on the nature of coherence (which legal probabilists ignore or are unaware of), familiarity with the details of evidence assessment in legal cases (which formal epistemologists ignore or unaware of) and technical skill to programmatically implement, simulate and test various theoretical moves.

I will be using four methods: (a) informal conceptual analysis; (b) formal conceptual analysis; (c) computational metods (R simulations, etc.); and (d) case studies. I will rethink and model the existing impliementations of whole-case-scale-BNs in legal evidence from the perspective of the new framework and reconstruct cases which extensively use probabilistic reasoning, but for which BNs have not been yet proposed. Both the literature already listed and many textbooks on quantitative evidence in forensics are great sources of such cases.

A larger initiative involving reconstructing various cases using different representation methods and comparing the representations, called *Probability and statistics in forensic science*, took place at the Isaac Newton Institute for Mathematical Sciences. My approach will be in the same vein.

I have extensive experience in analytic philosophy, conceptual analysis, philosophical logic and probabilistic and decision-theoretic methods as deployed in philosophical contexts. I also have teaching and publishing record that involves statistical programming in the **R** language (my sample programming projects can be visited at https://rfl-urbaniak.github.io/menu/projects.html), and so am also competent to develop AI implementations and tests of the ideas to be developed.

One research risk is that it will turn out that some of the informal requirements cannot be spelled out in probabilistic terms, or expressed in terms of properties of Bayesian networks. In such an event, I will study the reasons for this negative result. It might happen that there are independent reasons to abandon a given condition, or it might be the case that probabilistic inexplicability of a given condition is an argument against the probabilistic approach. Either way, finding out which option holds and why would also lead to a deeper understanding of the framework and lead to a publication in academic journals. Another research risk is that the case studies will show that other methods are more efficient or transparent. This would itself constitute a result that could be used to further modify the framework so that its best aspects could be preserved, while the disadvantages discovered during case studies avoided.

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[1] See for example (Earman, 1992; Urbach & Howson, 1993) for an early yet fairly comprehensive survey, or (Pettigrew, 2011) for a discussion of more recent contributions. See also (Bovens & Hartmann, 2004; Bradley, 2015; Swinburne, 2001).

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STRESZCZENIE POPULARNONAUKOWE

Rekonceptualizacja probabilizmu w kontekstach prawnych

dr hab. Rafał Urbaniak

Uniwersytet Gdański

Wydział Nauk Społecznych

REKONCEPTUALIZACJA PROBABILIZMU W KONTEKSTACH PRAWNYCH

Rafał Urbaniak

Probabilism prawny to projekt badawczy, który posługuje się teorią prawdopodobieństwa do analizy, modelowania i poprawy oceny dowodów i procesów decyzyjnych w sprawach sądowych. Probabilizm prawny jest podejściem reprezentowanym przez mniejszość, ale zyskał na popularności w drugiej połowie wieku dwudziestego w powiązaniu z ruchem "prawo i ekonomia."

W sprawach prawnych, różne linie dowodowe mogą się zbiegać, jak na przykłady gdy dwoje świadków zeznaje, że widziano oskarżonego na miejscu przestępstwa, albo mogą iść w przeciwne strony, jak gdy świadkowie zeznają, iż widzieli oskarżonego na miejscu przestępstwa, ale test DNA pokazuje że nie ma zgodności między oskarżonym a materiałem z miejsca przestępstwa. Innym źródłem złożoności jest to, że hipotezy wysuwane przez różne strony mają nieraz dość złożoną strukturę. W jaki sposób rozmaite stwierdzenia i dowody je wspierające powinny być składane w jedność i oceniane?

Probabilistyczne narzędzia fragmentarycznej oceny dowodów naukowych i narzędzia pomagające dostrzegać błędy probabilistyczne są całkiem dobrze rozwinięte. Jednakże, konstrukcja bardziej ogólnego modelu umieszczającego takie dowody w szerszym kontekście całej sprawy, przydatnego dla teoretyzowania o ocenie dowodów i stadnardach dowodowych, pozostaje wyzwaniem. Projekt zamierza przyczynić się do dalszego rozwoju tego przedsięwzięcia polegając na motywacjach pochodzących z różnych źródeł: epistemologii formalnej, rozwoju sieci bayeisańskich, praktyki oceny dowodów probabilistycznych i zastrzeżeń sformułowanych przez krytyków probabilizmu prawnego.

Punktem wyjścia będzie reprezentacja narracji za pomocą sieci bayesiańskich z dodatkowymi informacjami na temat tego, które elementy odpowiadają dowodom, a które narracjom. Kluczowy pomysł polega na tym, że budując na takich sieciach można wyeksplikować różne własności narracji wymagane prez krytyków (takie jak koherencja, odporność, brakujące dowody, wyjaśnianie dowodów, czy sposoby radzenia sobie z mnogością proponowanych narracji).

RETHINKING LEGAL PROBABILISM

Rafał Urbaniak

Legal probabilism is a research program that relies on probability theory to analyze, model and improve the evaluation of evidence and the process of decision-making in trial proceedings. Legal probabilism remains a minority view among legal scholars, but attained greater popularity in the second half of the 20th century in conjunction with the law and economics movement.

In legal cases, different lines of evidence may converge, such as two witnesses who testify that the defendant was seen at the crime scene, or they may diverge, such as a witness who asserts the defendant was seen at the crime scene while DNA testing shows no genetic match between the defendant and the scene. Another source of complexity is that the hypotheses put forward by the parties in a trial are often complex structures of statements. How can different statements, and their supporting evidence, be combined and the overall prosecutor's case (or the defense's case) be put together and evaluated?

Probabilistic tools for piecemeal evaluation of scientific evidence and spotting probabilistic fallacies in legal contexts are quite well developed. Yet, the construction of a more general probabilistic model of incorporating such evidence in a wider context of a whole case, useful for theorizing about evidence evaluation and legal decision standards, remains a challenge. This project intends to contribute to further development of this enterprise relying on motivations that come from different sources: formal epistemology, the development of bayesian networks, the practice of probabilistic evidence evaluation and the points raised by the critics of legal probabilism.

The point of departure is to represent narrations as bayesian networks enriched with additional layer of information as to which nodes correspond to evidence, and which are binary narration nodes. The key idea is that with such bayesian networks as building material, various features requested by the critics (such as coherence, resiliency, missing evidence, explaining evidence, or ways to handle a multiplicity of proposed narrations) can be explicated in terms of corresponding properties of, operations on, and relations between bayesian networks.

KWESTIE ETYCZNE

1. Badania na ludzkich zarodkach oraz materiale pozyskanym z ludzkich zarodków i płodów	
Czy w planowanych badaniach będą wykorzystywane ludzkie zarodki?	TAK [ ] / [X] NIE
Czy w planowanych badaniach wykorzystane będą tkanki lub komórki pochodzące z ludzkich zarodków lub płodów?	TAK [ ] / [X] NIE
Czy w planowanych badaniach będą wykorzystywane ludzkie embrionalne komórki macierzyste (hESCs)?	TAK [ ] / [X] NIE
2. Badania z udziałem ludzi	
Czy planowane badania odbywają się z udziałem ludzi?	TAK [ ] / [X] NIE
Czy planowane badania polegają na aktywnej interwencji fizycznej lub psychologicznej dotyczącej uczestników badania?	TAK [ ] / [X] NIE
Czy w planowanych badaniach wykorzystywany będzie ludzki materiał genetyczny?	TAK [ ] / [X] NIE
Czy planowane badania są eksperymentem medycznym zgodnie z ustawą z dnia 5 grudnia 1996 r. o zawodzie lekarza i lekarza dentysty (Dz. U. z 2018 r. poz. 617 ze zm.)?	TAK [ ] / [X] NIE
Czy planowane badania stanowią niekomercyjne badanie kliniczne, które wymaga rejestracji w Centralnej Ewidencji Badań Klinicznych (https://www.clinicaltrialsregister.eu/) zgodnie z ustawą z dnia 6 września 2001 r. Prawo Farmaceutyczne (Dz. U. z 2017 r. poz. 2211 ze zm.) oraz ustawą z dnia 20 maja 2010 r. o wyrobach medycznych (Dz. U. z 2017 r. poz. 211 ze zm.)?	TAK [ ] / [X] NIE
3. Ludzkie komórki/tkanki	
Czy w planowanych badaniach wykorzystywane będą ludzkie komórki lub tkanki dostępne komercyjnie, inne niż wskazane w punkcie 1?	TAK [ ] / [X] NIE
Czy w planowanych badaniach wykorzystywane będą ludzkie próbki biologiczne pozyskane w projekcie lub pochodzące ze źródeł niekomercyjnych?	TAK [ ] / [X] NIE
4. Dane osobowe	
Czy planowane badania wiążą się z przetwarzaniem danych osobowych?	TAK [ ] / [X] NIE
Czy w planowanych badaniach wykorzystywane będą dane osobowe pochodzące z innych źródeł, spoza podmiotu realizującego badania?	TAK [ ] / [X] NIE
5. Zwierzęta	
Czy w planowanych badaniach wykorzystywane będą zwierzęta kręgowe lub głowonogi?	TAK [ ] / [X] NIE
Czy w planowanych badaniach wykorzystywany będzie materiał biologiczny pochodzący od zwierząt (np. krew, mocz lub inne)?	TAK [ ] / [X] NIE
Czy w planowanych badaniach wykorzystywane będą zwierzęce tkanki, komórki lub linie komórkowe dostępne komercyjnie?	TAK [ ] / [X] NIE
6. Współpraca naukowa z krajami spoza Unii Europejskiej	

Czy działania związane z badaniami podejmowanymi w krajach spoza UE stanowić mogą ryzyko pojawienia się wątpliwości natury etycznej?	TAK [ ] / [X] NIE
Czy w badaniach planowane jest użycie lokalnych zasobów ludzkich, kulturowych lub naturalnych, np. udziału ludzi, zwierząt, roślin, materiału genetycznego ludzi lub zwierząt, szczątków ludzkich, materiału o wartości historycznej, roślin lub zwierząt chronionych itp.?	TAK [ ] / [X] NIE
Czy w ramach badań planowany jest import lub eksport materiału badawczego z krajów spoza UE?	TAK [ ] / [X] NIE
Jeśli zaplanowane badania obejmują kraje o niskim lub średnim dochodzie, czy przewiduje się podział korzyści wynikających z realizacji projektu?	TAK [ ] / [X] NIE
Czy sytuacja w tym kraju mogłaby narazić osoby biorące udział w badaniach na ryzyko?	TAK [ ] / [X] NIE
7. Środowisko, zdrowie i bezpieczeństwo (w tym badania na materiale genetycznie zmodyfikowanym)	
Czy planowane badania obejmują wykorzystanie mikroorganizmów, organizmów, tkanek lub komórek genetycznie modyfikowanych (GMO, GMM)?	TAK [ ] / [X] NIE
Czy planowane badania dotyczą gatunków zwierząt lub roślin chronionych lub obszarów chronionych?	TAK [ ] / [X] NIE
Czy planowane badania wymagają użycia czynników lub warunków, które mogą być szkodliwe dla ludzi, w tym personelu badawczego?	TAK [ ] / [X] NIE
8. Dziedzictwo kulturowe	
Czy w badaniach planowane jest użycie zasobów dziedzictwa kulturowego, w tym ludzi, flory i fauny, ich materialnych pozostałości, materialnych i niematerialnych wytworów kultury oraz obszarów chronionych ze względu na ich wartość kulturową?	TAK [ ] / [X] NIE
9. Nadużycia i podwójne zastosowanie	
Czy w badaniach planowane jest wykorzystanie lub wytworzenie produktu podwójnego zastosowania (np. patogeny, oprogramowanie, technologie), które wymagają autoryzacji eksportowej zgodnie z Rozporządzeniem UE 428/2009?	TAK [ ] / [X] NIE
Czy planowane badania mogą potencjalnie być źródłem nadużyć, przestępstw, ataków terrorystycznych?	TAK [ ] / [X] NIE

Opis działań podjętych w celu zapewnienia wykonywania badań zgodnie z zasadami dobrej praktyki w danej dziedzinie/dyscyplinie naukowej oraz informacja, czy jakieś zgody zostały już wydane, bądź informacje, jak te warunki zostaną spełnione [w języku angielskim]

Oświadczenie

Oświadczam, że - w przypadku planowania badań wymagających pozyskania zgód, opinii, zezwoleń lub pozwoleń właściwych organów/komisji zobowiązuje się do ich uzyskania przed rozpoczęciem realizacji badań, których dotyczą; - jestem świadoma/y wymogu przekazania do NCN w raportach rocznych i końcowym wszystkich uzyskanych zgód, opinii, zezwoleń lub pozwoleń niezbędnych do realizacji projektu; - jestem również świadoma/y, że prowadzenie badań bez wymaganych zgód, opinii, zezwoleń lub pozwoleń stanowić może podstawę do nierozliczenia projektu z koniecznością zwrotu części lub całości środków.	TAK [X] / [ ] NIE

PLAN BADAŃ

Lp.	Nazwa zadania	Podmioty
1	Wypracowanie listy warunków nakładanych na narrację Establishing a list of requirements on narration	• Uniwersytet Gdański, Wydział Nauk Społecznych
2	Wypracowanie elementów podejścia argumentatywnego do eksplikacji formalnej Working out the elements of the argumentative framework which will be explicated formally	• Uniwersytet Gdański, Wydział Nauk Społecznych
3	Ocena filozoficzna wypracowanych warunków Philosophical evaluation of the conditions developed so far	• Uniwersytet Gdański, Wydział Nauk Społecznych
4	Probabilistyczna eksplikacja warunków zachowanych w ocenie Probabilistic explication of the conditions evaluated positively in the previous stage	• Uniwersytet Gdański, Wydział Nauk Społecznych
5	Sformułowanie warunków w kategoriach sieci bayesiańskich Formulation of the requirements in terms of bayesian networks	• Uniwersytet Gdański, Wydział Nauk Społecznych

6	Przygotowanie pakietu R nadbudowanego nad bnlearn do stosowania tych warunków na sieciach bayesiańskich Preparation of an R package built over bnlearn to apply the conditions to bayesian networks	• Uniwersytet Gdański, Wydział Nauk Społecznych
7	Ewaluacja obliczeniowa elementów uzyskanej teorii Computational evaluation of various elements of the narrative approach	• Uniwersytet Gdański, Wydział Nauk Społecznych
8	Stosowanie pakietu do sieci bayesiańskich otrzymanych dla studium przypadków Applying the package to bayesian networks obtained in case studies	• Uniwersytet Gdański, Wydział Nauk Społecznych
9	Rozwiązanie problemów ze stosowaniem "scenario nodes" Resolution of problems with the scenario nodes approach	• Uniwersytet Gdański, Wydział Nauk Społecznych
10	Rozwiązanie problemów z bayesowskim wyborem modelu i uśrednianiem dla tych zastosowań Resolution of the problems with Bayesian model selection and averaging for these applications	• Uniwersytet Gdański, Wydział Nauk Społecznych

ZBLIŻONE ZADANIA BADAWCZE

Czy kierownik (PI) ubiega się o finansowanie wskazanych we wniosku zadań badawczych również z innych źródeł?	TAK [ ] / [X] NIE
Czy kierownik (PI) realizuje/realizował zadania badawcze zbliżone do zadań objętych tym wnioskiem?	TAK [X] / [ ] NIE
Kierownik (PI) jest	AUTOREM OPISÓW PROJEKTU [X] / [ ] WSPÓŁAUTOREM OPISÓW PROJEKTU

Opis zbliżonych zadań i uzasadnienie konieczności ich finansowania [w języku angielskim] Należy wskazać realizowane i zrealizowane zadania badawcze, co do których mogłoby zajść podejrzenie podwójnego finansowania w przypadku uzyskania finansowania na zadania badawcze objęte niniejszym wnioskiem. Wyjaśnienie powinno w sposób jednoznaczny wskazywać różnice pomiędzy zadaniami badawczymi i zawierać uzasadnienie konieczności finansowania zadań badawczych w niniejszym wniosku.
My ongoing project funded by NCN (to be completed in 2021) focuses on practical and philosophical issues with the use of probability for legal evidence evaluation. The main outcomes focus on particular problems and how they should or should not be handled, and having completed it provides me with the right background to the proposed project. The planned research, on the other hand, proposes to develop a uniform and novel approach to all of them bringing new tools (such as bayesian networks and R programming language) and resolutions (such as the narrative perspective) to the table.

Podmioty

Uniwersytet Gdański	
Czy podmiot ubiega się o finansowanie wskazanych we wniosku zadań badawczych również z innych źródeł?	TAK [ ] / [X] NIE

WSPÓŁPRACA MIĘDZYNARODOWA

Czy projekt realizowany we współpracy międzynarodowej?	TAK [X] / [ ] NIE
Rodzaj współpracy	• Współpraca międzynarodowa z partnerami z zagranicznych instytucji naukowych, którzy nie ubiegają się o środki finansowe na ten cel w ramach ogłaszanych przez instytucje partnerskie programów, organizowanych we współpracy z NCN w oparciu o procedurę agencji wiodącej
Kraje	• Stany Zjednoczone Ameryki

Podmioty - Stany Zjednoczone Ameryki

Lp.	Podmiot
1	Arizona State University

Opis korzyści wynikających ze współpracy międzynarodowej [w języku angielskim]
In this project I plan to cooperate with Prof. Marcello Di Bello (Arizona State University). Our cooperation so far has been immensely fruitful. Some of our papers published in very good journals include criticisms and responses to each other's views, and we ended up co-authoring the Stanford Encyclopedia of Philosophy entry on Legal Probabilism (accepted, final version to be published in a few weeks). At this stage, we started working on a book proposal devoted to improving on the state of the art in legal probabilism and the goal is to work on the book and a few resulting papers with the project I am applying for. The key aspect of the cooperation is that our interests and competences complement each other. Prof. Di Bello is much more versed in legal philosophy, while I am more focused on the technicalities. In result, our work - we hope - will find a balance between philosophical relevance and formal progress. Part of my research plan is to spend six months near the end of the duration of the project at Arizona State University, intensely working with Prof. Di Bello on polishing the final version of the book.

ZESPÓŁ BADAWCZY

1. Rafał Urbaniak, Kierownik (PI)	
Podmiot	Uniwersytet Gdański
Zakres prac [w języku angielskim]	- Performing research as specified in the four stages of the work plan in the proposal. - Coordinating the supporting role of the other group member, preparing computational tasks, writing general scripts for testing and development etc. - Cooperation with Marcello Di Bello on the book development.

2. Stypendysta/Student/Doktorant_1, Stypendysta/Student/Doktorant	
Podmiot	Uniwersytet Gdański
Zakres prac [w języku angielskim]	Mostly programming and mathematical work to check our coding and calculations and to develop pieces of code and models for various hypotheses we formulate in the process. Some editorial and coordination work as well.
Wymagane kwalifikacje [w języku angielskim]	A student with background in computer science (BA). Having run the Chair of Logic, Philosophy of Science and Epistemology at the University of Gdansk for nine years now, and having attempted many hires at various positions, I came to the conviction that given the salaries the academic institutions can offer it is next to impossible to find a good and willing candidate with a PhD degree to conduct research in formal philosophy. Multiple attempts I have made have been futile, and usually ended with good and interested candidates withdrawing their candidatures upon learning what the remuneration is, or leaving for a better-paid job outside of academia soon after being hired. Given how exhausting, bureaucratically time-consuming and disappointing the process is, I give up on trying to hire a post-graduate level cooperator.

KIEROWNIK (PI)

dr hab. Rafał Urbaniak	
Podmiot	Uniwersytet Gdański
Zakres prac [w języku angielskim]	- Performing research as specified in the four stages of the work plan in the proposal. - Coordinating the supporting role of the other group member, preparing computational tasks, writing general scripts for testing and development etc. - Cooperation with Marcello Di Bello on the book development.

Stopień doktora	
Czy kierownik (PI) posiada stopień doktora?	TAK [X] / [ ] NIE
Rok nadania stopnia	2008
Dziedzina w języku polskim	nauki humanistyczne
Dziedzina w języku angielskim	humanities
Dyscyplina w języku polskim	filozofia
Dyscyplina w języku angielskim	philosophy
Nadany przez	
Nazwa podmiotu w języku oryginalnym [transkrypcja na alfabet łaciński]	University of Calgary
Nazwa podmiotu w języku angielskim	University of Calgary

Informacje o przerwach - ankieta dorobku	
Długoterminowe (powyżej 90 dni) udokumentowane zasiłki chorobowe lub świadczenia rehabilitacyjne w związku z niezdolnością do pracy w okresie ostatnich 10 lat przed rokiem wystąpienia z wnioskiem - liczba dni	b.d.
Urlopy związane z opieką i wychowaniem dzieci udzielone na zasadach określonych w Kodeksie pracy - liczba dni	b.d.

Młody naukowiec	
Dzienna data nadania stopnia	2008-06-09

Dyscypliny naukowe (zgodnie z klasyfikacją MNiSW)		
Lp.	Kod i nazwa	Główna dyscyplina naukowa

1	1.2 - filozofia	Główna dyscyplina naukowa

Dane osobowe	
Imię	Rafał
Drugie imię	
Nazwisko	Urbaniak
Nazwisko poprzednie	
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Adres zamieszkania	
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Województwo	pomorskie
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Miejscowość	Sopot
Ulica, numer domu, numer lokalu	ul. Sienkiewicza 23 m. 91

Adres korespondencyjny	
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Województwo	pomorskie
Kod pocztowy	81-811
Miejscowość	Sopot
Ulica, numer domu, numer lokalu	ul. Sienkiewicza 23 m. 91

Elektroniczny identyfikator naukowca	
Elektroniczny identyfikator naukowca	0000-0002-6321-2866
Rodzaj identyfikatora	ORCID

Zatrudnienie

Lp.	Nazwa podmiotu w języku polskim	Nazwa podmiotu w języku angielskim	Stanowisko w języku polskim	Stanowisko w języku angielskim
1	Uniwersytet Gdański; Wydział Nauk Społecznych; Instytut Filozofii	University of Gdańsk; Faculty of Social Sciences; Institute of Philosophy	profesor uczelni	associate professor

ANKIETY CZŁONKÓW ZESPOŁU

dr hab. Rafał Urbaniak, Kierownik (PI)

PRZEBIEG KARIERY NAUKOWEJ

Informacje o przebiegu kariery naukowej [w języku angielskim]

EDUCATION

2013
Habilitation in Philosophy, University of Warsaw, Poland
Applications of selected paradoxes in analytical philosophy

2008
Ph.D. in Philosophy, University of Calgary, Canada
Leśniewski's systems of logic and mereology - history and re-evaluation

POSITIONS HELD

2014- Associate Professor, Department of Philosophy, Sociology and Journalism, University of Gdańsk, Poland
2012-2019 Postdoctoral Fellow of the Research Foundation Flanders, Centre for Logic and Philosophy of Science, Ghent University, Belgium
2008-2014 Assistant Professor, Department of Philosophy, Sociology and Journalism, University of Gdańsk, Poland
2008-2012 Postdoctoral Researcher, Centre for Logic and Philosophy of Science, Ghent University, Belgium
2007 Instructor of Record, Department of Philosophy, University of Calgary, Canada
2005-2008 Teaching Assistant, Department of Philosophy, University of Calgary, Canada

NOTE ON PUBLICATIONS
Since I do not support the publishing houses making money on open access, all my publications are listed as open access are made openly available on my academia.edu profile.

PUBLIKACJE NAUKOWE

1. Michał Bilewicz, Patrycja Tempska, Gniewosz Leliwa, Maria Dowgiałło, Michalina Tańska, Rafał Urbaniak, and Michał Wroczyński , *Artificial intelligence against hate: Intervention reducing verbal aggression in the social network environment.*	
Autorzy	Michał Bilewicz, Patrycja Tempska, Gniewosz Leliwa, Maria Dowgiałło, Michalina Tańska, Rafał Urbaniak, and Michał Wroczyński
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Artificial intelligence against hate: Intervention reducing verbal aggression in the social network environment.
Artykuł/książka/rozdział	artykuł
Czasopismo	Aggressive Behavior
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 47 issue 3
Rok publikacji	2021
Otwarty dostęp	Nie
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	10.1002/ab.21948
PDF publikacji	

2. Rafal Urbaniak, Marcello Di Bello , *Legal Probabilism*	
Autorzy	Rafal Urbaniak, Marcello Di Bello
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Legal Probabilism
Artykuł/książka/rozdział	artykuł
Czasopismo	Stanford Encyclopedia of Philosophy entry
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	Available online

Rok publikacji	2021
Otwarty dostęp	Tak
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	nie posiada
PDF publikacji	Legal Probabilism (Stanford Encyclopedia of Philosophy).pdf

3. Rafal Urbaniak and Michal Tomasz Godziszewski , *Modal quantifiers, potential infinity, and Yablo sequences*	
Autorzy	Rafal Urbaniak and Michal Tomasz Godziszewski
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Modal quantifiers, potential infinity, and Yablo sequences
Artykuł/książka/rozdział	artykuł
Czasopismo	Review of Symbolic Logic
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	Confirmation email attached.
Rok publikacji	2021
Otwarty dostęp	Nie
Liczba cytowań (bez autocytowań)	0
Status publikacji	Przyjęta do publikacji
DOI	nie posiada
PDF publikacji	
Potwierdzenie przyjęcia publikacji do druku	RSLconfirmation.pdf

4. Rafal Urbaniak, Alicja Kowalewska, Pavel Janda, and Patryk Dziurosz-Serafinowicz , *Decision-theoretic and risk-based approaches to naked statistical evidence: some consequences and challenges*	
Autorzy	Rafal Urbaniak, Alicja Kowalewska, Pavel Janda, and Patryk Dziurosz-Serafinowicz
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Decision-theoretic and risk-based approaches to naked statistical evidence: some consequences and challenges

Artykuł/książka/rozdział	artykuł
Czasopismo	Law, Probability and Risk
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 19 issue 1
Rok publikacji	2020
Otwarty dostęp	Nie
Liczba cytowań (bez autocytowań)	1
Status publikacji	Opublikowane
DOI	10.1093/lpr/mgaa001
PDF publikacji	

5. Rafal Urbaniak and Pavel Janda , *Probabilistic models of legal corroboration*	
Autorzy	Rafal Urbaniak and Pavel Janda
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Probabilistic models of legal corroboration
Artykuł/książka/rozdział	artykuł
Czasopismo	International Journal of Evidence and Proof
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	Online first 2019
Rok publikacji	2019
Otwarty dostęp	Tak
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	10.1177/1365712719864608
PDF publikacji	Urbaniak and Janda - 2019 - Probabilistic models of legal corroboration.pdf

6. Rafal Urbaniak , *Probabilistic legal decision standards still fail*

Autorzy	Rafal Urbaniak
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Probabilistic legal decision standards still fail
Artykuł/książka/rozdział	artykuł
Czasopismo	Journal of Applied Logics
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 6 issue 5
Rok publikacji	2019
Otwarty dostęp	Tak
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	nie posiada
PDF publikacji	Urbaniak_Probabilistic_legal_decision_standards.pdf

7. Rafal Urbaniak , *Narration in judiciary fact-finding: a probabilistic explication*	
Autorzy	Rafal Urbaniak
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Narration in judiciary fact-finding: a probabilistic explication
Artykuł/książka/rozdział	artykuł
Czasopismo	Artificial Intelligence and Law
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 26 issue 4
Rok publikacji	2018
Otwarty dostęp	Tak
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	10.1007/s10506-018-9219-z

PDF publikacji	

8. Rafal Urbaniak and Pawel Pawlowski , *Many-valued logic of informal provability: a non-deterministic strategy*	
Autorzy	Rafal Urbaniak and Pawel Pawlowski
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Many-valued logic of informal provability: a non-deterministic strategy
Artykuł/książka/rozdział	artykuł
Czasopismo	Review of Symbolic Logic
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 11 issue 2
Rok publikacji	2018
Otwarty dostęp	Tak
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	10.1017/S1755020317000363
PDF publikacji	

9. Rafal Urbaniak and Bert Leuridan , *Challenging Lewis's challenge to the best system account of lawhood*	
Autorzy	Rafal Urbaniak and Bert Leuridan
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Challenging Lewis's challenge to the best system account of lawhood
Artykuł/książka/rozdział	artykuł
Czasopismo	Synthese
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 195 issue 4
Rok publikacji	2018
Otwarty dostęp	Tak

Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	10.1007/s11229-016-1287-6
PDF publikacji	

10. Rafal Urbaniak , *Numbers and propositions versus nominalists: yellow cards for Salmon & Soames*	
Autorzy	Rafal Urbaniak
Tytuł w języku oryginalnym [oraz tłumaczenie tytułu na język angielski]	Numbers and propositions versus nominalists: yellow cards for Salmon & Soames
Artykuł/książka/rozdział	artykuł
Czasopismo	Erkenntnis. An International Journal of Analytic Philosophy
Informacje dodatkowe, np.: tytuł monografii w języku oryginalnym, wydawca, miejsce wydania, numer tomu/zeszytu, strony, ISBN/ISSN, redaktorzy i inne.	vol 77 issue 3
Rok publikacji	2012
Otwarty dostęp	Tak
Liczba cytowań (bez autocytowań)	0
Status publikacji	Opublikowane
DOI	10.1007/s10670-012-9402-7
PDF publikacji	

DOKONANIA ARTYSTYCZNE

b.d.

BADANIA NAUKOWE FINANSOWANE PRZEZ NCN

DANE POBRANE AUTOMATYCZNIE

Tytuł w języku polskim	Pojęciowe, formalne i praktyczne aspekty kryminologicznych i prawniczych zastosowań narzędzi probabilistycznych.
Nr rejestracyjny	2016/22/E/HS1/00304
Źródło(a) finansowania	NCN
Nazwa konkursu	SONATA BIS-6
Kwota	830 050 PLN
Podmiot realizujący w języku polskim	Uniwersytet Gdański; Wydział Nauk Społecznych
Data rozpoczęcia realizacji	2017-10-02
Data zakończenia realizacji	2021-10-01 W trakcie realizacji
Wynik oceny raportu końcowego	brak wyniku oceny - projekt w trakcie realizacji/raport w przygotowaniu/raport w trakcie oceny
Lista najważniejszych publikacji będących rezultatem projektu (skopiowana automatycznie z ostatniego raportu zaakceptowanego przez NCN)	Publikacje w czasopismach: - Rafal Urbaniak Pavel Janda, Probabilistic models of legal corroboration, The International Journal of Evidence & Proof, 24, 1-23, Sage Publishing, 2019, IF: 3, - Opublikowane - Rafał Urbaniak, Narration in judiciary fact-finding: a probabilistic explication, Artificial Intelligence and Law, 26, 345-376, Springer Netherlands, 2018, IF: 0, - Opublikowane - Małgorzata Stefaniak, Rafał Urbaniak, Varieties of legal probabilism: a survey, Decyzje, 30, 33-52, Wydawnictwo CeDeWu, 2018, IF: 0, - Opublikowane Publikacje książkowe/ rozdziały w publikacjach książkowych: - Rafał Urbaniak, Diderik Batens, Induction, Introduction to Formal Philosophy, 1, 105-130, Springer International Publishing, 2018, 10.1007/978-3-319-77434-3, - Opublikowane Teksty w publikacjach pokonferencyjnych - Michal Tomasz Godziszewski, Rafal Urbaniak, Infinite liar in a (modal) finitistic setting, 8th Indian Conference, ICLA 2019, 18-29, Springer, Berlin, Heidelberg, 2019, https://doi.org/10.1007/978-3-662-58771-3_3, - Opublikowane - Rafał Urbaniak, Beating the Gatecrasher Paradox with Judiciary Narratives, LORI 2017: Logic, Rationality, and Interaction, 637-642, Springer, 2017, Berlin, https://doi.org/10.1007/978-3-662-55665-8_44, - Opublikowane - Rafał Urbaniak, Reconciling Bayesian Epistemology and Narration-based Approaches to Judiciary Fact-finding, TARK 2017: Sixteenth Conference on Theoretical Aspects of Rationality and Knowledge, 482-492, EPTCS, 2017, 10.4204/EPTCS.251.37, - Opublikowane

Publikacje dodane przez redaktora	
W przypadku braku publikacji naukowych, zwięzły opis innych efektów badań	

PROJEKTY EUROPEJSKIE

b.d.

INNE PROJEKTY BADAWCZE SPOZA NCN

b.d.

NAJWAŻNIEJSZE OSIĄGNIĘCIA NAUKOWE

Informacje o najważniejszym osiągnięciu naukowym [w języku angielskim]
While this achievement gives zero points in the Polish academic scoring system, I am most satisfied with becoming a co-author of a Stanford Encyclopedia of Philosophy entry on legal probabilism. I am honored that the editors considered me competent to provide an extensive elaboration on the topic of my research. Working on the entry with Marcello Di Bello took us around a year, and brought us immense joy. Having written such an entry contributes to academic visibility much more than many papers published in journals.

DOŚWIADCZENIE NAUKOWE

Doświadczenie naukowe zdobyte w kraju i za granicą [w języku angielskim]

2022
(awarded)
Explicating normic support
Bednarowski Trust Fellow, host: Martin Smith, University of Edinburgh, Scotland

2021
(awarded)
Epistemological challenges to imprecise probabilism
The Kosciuszko Foundation Fellowship, host: Branden Fitelson, Northeastern Unversity, USA

2015-2019
Forensic and judicial probability vs. probability theory. Formal tools for real-life justifications
Postdoctoral Fellowship of the Research Foundation Flanders, Belgium

2012
Mathematical existence, abstraction principles and real number theory
Trinity College Long Room Hub Visiting Fellow, Trinity College Dublin, Ireland

2012-2015
Mathematical theories with parsimonious ontologies: their strengths and limitations
Postdoctoral Fellowship of the Research Foundation Flanders, Belgium

2011-2012
Knowability paradox and Nyaya logic
Visiting Fellow, Benares Hindu University, Varanasi, India

2009
Modal reconstructions of mathematical theories
British Academy Visiting Fellow, Bristol University, United Kingdom

2009
Development of adaptive logics for the study of central topics in contemporary philosophy of science
Postdoctoral Researcher, Centre for Logic and Philosophy of Science, Ghent University, Belgium

2008
Contextual and formal-logical approach to scientific problem-solving processes
Postdoctoral Researcher, Centre for Logic and Philosophy of Science, Ghent University, Belgium

2005-2006
The History of Logical Metatheory
Research Assistant to Prof. Richard Zach, University of Calgary, Canada

2005-2008
PhD Student & PhD candidate, Izaak Walton Killam Memorial Scholarship, University of Calgary, Canada

WYRÓŻNIENIA I NAGRODY

Najważniejsze krajowe lub miedzynarodowe wyróżnienia wynikające z prowadzenia badań naukowych oraz innej aktywności naukowej i artystycznej [w języku angielskim]

HONORS AND AWARDS

2014
"Start" scholarship of the Foundation for Polish Science

2014
Selected in Ghent auditions for presentation in TEDx Ghent

2012
Selected for the Academy of Young Scientists of the Polish Academy of Science

2011
The Polish Minister of Science award for young researchers

2005
Dean's Entrance Scholarship, University of Calgary

2005
Best M.Sc. thesis in logic, Polish Association for Logic and Philosophy of Science

SELECTED INVITED LECTURES

2021
Story coherence with Bayesian Networks with Alicja Kowalewska, invited webinar at Center for Logic, Language, and Cognition University of Turin, Italy

Story coherence with Bayesian Networks, invited graduate class taught with Alicja Kowalewska at Arizona State University, USA

2018
Potential Infinity, Leśniewskian Definitions, Arithmetic & Yablo sequences, Logic, Language, and Ontology – WaragaiFest 2018, Tokyo, Japan

Modal Quantifiers, Potential Infinity, and Yablo sequences, Proof Society Summer School 2018, Ghent University, Belgium

2017
Narrations in judiciary fact-finding and the difficulty about conjunction, Faculty of Philosophy, University of Groningen, Netherlands

Paradoxes of informal provability and many-valued indeterministic provability logic, Kyoto Philosophical Logic Workshop III, Kyoto University, Japan

Narration in Judiciary Fact-Finding: A Probabilistic Explication, Tokyo Forum for Analytic Philosophy, The University of Tokyo, Japan

2015
Non-deterministic logic(s) of (informal) provability, University of Oxford (United Kingdom), University of Oslo (Norway)

A non-classical logic of informal provability (with Pawel Pawlowski), Munich Center for Mathematical Philosophy, Germany

Non-deterministic logics of provability, ntia et Nomin 2015, Cracov, Poland

Workshop on probabilistic logic, Metafizz Student Club, Trinity College Dublin, Ireland

2013

Mereology and mathematics. The case of Leśniewski and his continuators, Parts in Logic and Metaphysics, Université de Rennes I, France

Stanisław Leśniewski: Re-thinking the philosophy of mathematics, Academia Europaea 25th anniversary congress, Wrocław, Poland

2012

Gödelizing the Yablo sequence, Trinity College Dublin, Ireland

Neologicism: for real(s), Numbers and Truth, University of Gothenburg, Sweden
Abstraction without abstracta, Polish Philosophical Congress, Wisła, Poland

The philosophical usefulness of paradoxes, Banaras Hindu University, Varanasi, India

Busting a myth about Leśniewski and definitions, Warsaw University, Poland

2010
Frames, similarity, many-valuedness, Workshop on Types and Frames, Heinrich-Heine Universität, Düsseldorf, Germany

Yellow Card for Salmon, Oxford University, United Kingdom

Swinburne's modal argument for the existence of the soul (with Agnieszka Rostalska), Canterbury University, Christchurch, New Zealand

2009
Modalities+Identities-Entities, Structure and Identity and Abstraction Workshop, Bristol University, United Kingdom

Galileo on falling bodies, Platonism, Dynamic Reasoning, Université Paris I Panthéon-Sorbonne, France
Nominalist Neologicism, University of St. Andrews, Scotland

Abstraction without Abstracta, Trinity College Dublin, Ireland

Modality and Existence, keynote address, Polish Society for Logic and Philosophy of Science annual meeting, Warsaw University, Poland

Logic and Religion: a case study, Bristol University, United Kingdom

Nameability and Mathematical Existence, Logic & Language Seminar, University of Edinburgh, Scotland

WYKŁADY I REFERATY

Informacje o wygłoszonych prezentacjach na uznanych konferencjach międzynarodowych [w języku angielskim]

SELECTED CONFERENCE TALKS

2020
(1) Story coherence with Bayesian Networks with Alicja Kowalewska, and (2) Imprecise Credences Can Increase Accuracy wrt. Claims about Expected Frequencies, Bayesian Epistemology: Perspectives and Challenges, LMU, Munich, Germany

2019
(1) Modal Quantifiers, Potential Infinity, and Yablo sequences with Michał Tomasz Godziszewski, and (2) Combining truth values with provability values: a non-deterministic logic of informal provability with Paweł Pawlowski, International Congress of Logic, Methodology and Philosophy of Science and Technology, Prague, Czech Republic

Infinite liar in a (Modal) Finitistic Setting, 8th Indian Conference on Logic and its Applications, ICLA 2019, Delhi, India

2018
(1) Abstraction Principles via Leśniewskian definitions. Potential infinity and arithmetic and (2) Narrations in judiciary fact-finding and the difficulty about conjunction, Unilog 2018, Vichy, France

2017
Reconciling Bayesian epistemology and narration-based approaches to judiciary fact-finding, Sixteenth conference on Theoretical Aspects of Rationality and Knowledge 2017, University of Liverpool, United Kingdom

Beating the Gatecrasher Paradox with Judiciary Narratives, Logic, Rationality, and Interaction 2017: 6th International Workshop, Sapporo University, Japan

Probabilistic Explication of the Notion of Narration as Used in Judiciary Contexts, Progic 2017: The 8th workshop on Combining Probability and Logic, Munich, Germany

Probabilistic explication of the notion of narration as used in judiciary contexts, ntia et Nomin 2017, Palolem, India

2016
Understanding conditionals, Hokudai-Ghent Joint Symposium Connecting Japan and Belgium, Ghent, Belgium

Failxplication of truth (untyped), Language and metalanguage, logic and meta-logic. Revisiting Tarski's hierarchy, Louvain-la-Neuve, Belgium

Probabilistic explication of the notion of narration as used in judiciary contexts, Justification of court decisions: law-theoretic and interdisciplinary perspectives, Jabłonna, Poland

Not too abstract abstraction principles for real numbers, Polish Ontology Nowadays, Warsaw, Poland

2015
The non-applicability of selected paraconsistent logics, 15th Congress of Logic, Methodology and Philosophy of

Science, Helsinki, Finland

First steps towards non-classical logic of informal provability (with Pawel Pawlowski), 15th Congress of Logic, Methodology and Philosophy of Science, Helsinki, Finland

2014
Verbality and Disagreement in the Nyaya-Samkhya debate about causality, Udaharanas, Drstantas and Nyayas in Texts and Contexts, Gujarat University, Ahmendabad, India

Irrational bookies, Third Reasoning Club Conference, University of Kent, United Kingdom

A comparative study of selected filtered paraconsistent logics, 5th World Congress on Paraconsistency, Kolkata, India

2012
Gödelizing the Yablo sequence, Trends in Logic XI – Advances in Philosophical Logic, Ruhr-Universität Bochum, Germany

INNE ISTOTNE OSIĄGNIĘCIA W NAUCE

Informacje o innych istotnych osiągnięciach w nauce oraz aktywności naukowej [w języku angielskim]

WYNAGRODZENIA I STYPENDIA

Lp.					
1			Rok 2022	Rok 2023	Rok 2024
	Nazwa	dr hab. Rafał Urbaniak	36 000	36 000	36 000
	Rodzaj udziału	Kierownik (PI)			
	Podmiot	Uniwersytet Gdański			
	Rodzaj zatrudnienia	wynagrodzenie dodatkowe			
	Okres pobierania wynagrodzenia [w miesiącach]	36			
	Wynagrodzenie całkowite [PLN]		108 000		
2			Rok 2022	Rok 2023	Rok 2024
	Nazwa	Stypendysta/Student/Doktorant_1	0	30 000	30 000
	Rodzaj udziału	Stypendysta/Student/Doktorant			
	Podmiot	Uniwersytet Gdański			
	Rodzaj zatrudnienia	stypendium/wynagrodzenie studenta lub doktoranta			
	Okres pobierania wynagrodzenia [w miesiącach]	24			
	Wynagrodzenie całkowite [PLN]		60 000		

APARATURA

INNE KOSZTY

Lp.	Inne koszty bezpośrednie				
1.			Rok 2022	Rok 2023	Rok 2024
	Nazwa / opis [w języku angielskim]	Office supplies	2 000	2 000	2 000
	Kategoria	Materiały i drobny sprzęt			
	Podmiot	Uniwersytet Gdański, Wydział Nauk Społecznych			
	Kwota łącznie [PLN]		6 000		
	Uzasadnienie i kalkulacja [w języku angielskim]		Minor office supplies needed for printing, copying etc.		
2.			Rok 2022	Rok 2023	Rok 2024
	Nazwa / opis [w języku angielskim]	Books	4 500	4 500	4 500
	Kategoria	Inne koszty			
	Podmiot	Uniwersytet Gdański, Wydział Nauk Społecznych			
	Kwota łącznie [PLN]		13 500		
	Uzasadnienie i kalkulacja [w języku angielskim]		Books to be purchased during the project. Experience with the previous project suggests that these needs are satisfied with the budget of around 1000 EUR a year, so the plan is to accordingly budget 4500 PLN a year.		

3.			Rok 2022	Rok 2023	Rok 2024
	Nazwa / opis [w języku angielskim]	Conference attendance	0	12 000	12 000
	Kategoria	Wyjazdy służbowe			
	Podmiot	Uniwersytet Gdański, Wydział Nauk Społecznych			
	Kwota łącznie [PLN]		24 000		
	Uzasadnienie i kalkulacja [w języku angielskim]		I plan to attend four conferences, two a year over the last two years of the duration of the project. A flight back and forth with attendance fees and a fairly cheap hotel pre-covid, would make it around 3500 PLN per conference. I'm budgeting 4000 per conference to adjust for the post-covid price shift. The other researcher will attend two conferences total over the last two years.		

4.			Rok 2022	Rok 2023	Rok 2024
	Nazwa / opis [w języku angielskim]	Research stay at Arizona State University	0	0	90 000
	Kategoria	Wyjazdy służbowe			
	Podmiot	Uniwersytet Gdański, Wydział Nauk Społecznych			
	Kwota łącznie [PLN]		90 000		
	Uzasadnienie i kalkulacja [w języku angielskim]		Six months stay at the Arizona State University, during the last year of the program. I am calculating 4000 USD per month, but the amount will include visa processing costs, the flight costs, minor related travels, accommodation (I will need to find a furnished short-term apartment), and whatever fees will be required by the hosting institution.		

OPEN ACCESS

Nazwa podmiotu	Koszty pośrednie na Open Access [PLN]			Razem [PLN]
	2022	2023	2024	
1. Uniwersytet Gdański	2 000	2 000	2 000	6 000

POMOC PUBLICZNA

1. Uniwersytet Gdański	
Czy finansowanie będzie stanowiło pomoc publiczną?	Tak [ ] / [X] Nie
Kierownik (PI) i osoby reprezentujące podmiot zapoznały się z zasadami występowania pomocy publicznej	Tak [X] / [ ] Nie

ZESTAWIENIE KOSZTÓW PODMIOTÓW

Uniwersytet Gdański				
Koszty pośrednie OA (%)	1,99			
Pozostałe koszty pośrednie (%)	20			
	Rok 2022	Rok 2023	Rok 2024	Razem [PLN]
Koszty bezpośrednie, w tym:	42 500	84 500	174 500	301 500
- koszty wynagrodzeń i stypendiów, w tym:	36 000	66 000	66 000	168 000
-- wynagrodzenia etatowe	0	0	0	0
-- wynagrodzenia dodatkowe	36 000	36 000	36 000	108 000
-- stypendia i wynagrodzenia studentów i doktorantów	0	30 000	30 000	60 000
- koszty aparatury naukowo-badawczej, urządzeń i oprogramowania	0	0	0	0
- inne koszty bezpośrednie	6 500	18 500	108 500	133 500
Koszty pośrednie, w tym:	10 500	18 900	36 900	66 300
- koszty pośrednie OA	2 000	2 000	2 000	6 000
- pozostałe koszty pośrednie	8 500	16 900	34 900	60 300
Koszty ogółem	53 000	103 400	211 400	367 800

ZESTAWIENIE CAŁKOWITYCH KOSZTÓW NA POSZCZEGÓLNE LATA REALIZACJI

	Rok 2022	Rok 2023	Rok 2024	Razem [PLN]
Koszty bezpośrednie, w tym:	42 500	84 500	174 500	301 500
- koszty wynagrodzeń i stypendiów, w tym:	36 000	66 000	66 000	168 000
-- wynagrodzenia etatowe	0	0	0	0
-- wynagrodzenia dodatkowe	36 000	36 000	36 000	108 000
-- stypendia i wynagrodzenia studentów i doktorantów	0	30 000	30 000	60 000

- koszty aparatury naukowo-badawczej, urządzeń i oprogramowania	0	0	0	0
- inne koszty bezpośrednie	6 500	18 500	108 500	133 500
Koszty pośrednie, w tym:	10 500	18 900	36 900	66 300
- koszty pośrednie OA	2 000	2 000	2 000	6 000
- pozostałe koszty pośrednie	8 500	16 900	34 900	60 300
Koszty ogółem	53 000	103 400	211 400	367 800

PLAN ZARZĄDZANIA DANYMI

1. Opis danych oraz pozyskiwanie lub ponowne wykorzystanie dostępnych danych
Sposób pozyskiwania i opracowywania nowych danych i/lub ponownego wykorzystania dostępnych danych
Data collected: - publicly available information about legal cases used as examples. No other personal data will be collected or processed. - electronic versions of relevant publications. Data produced - Code for the R package - Code for Bayesian Networks used in the case studies - Calculations of the results of implementation of the package with relevant visualisations - Publications
Pozyskiwane lub opracowywane dane (np. rodzaj, format, ilość)
Publications in PDF format, source files in Rmd, and code scripts in R. Size below 10 GB.
2. Dokumentacja i jakość danych
Metadane i dokumenty (np. metodologia lub pozyskiwanie danych oraz sposób porządkowania danych) towarzyszące danym
Data collected on legal cases are publicly available through various legal institutions' websites.
Stosowane środki kontroli jakości danych
Published texts of court decisions do not require further quality control.
3. Przechowywanie i tworzenie kopii zapasowych podczas badań
Przechowywanie i tworzenie kopii zapasowych danych i metadanych podczas badań
All data and will be stored on the researcher's computers - one laptop and one desktop unit, both protected with Linux Mint passwords. As a backup, password-protected Google Drive account will be used.
Sposób zapewnienia bezpieczeństwa danych oraz ochrony danych wrażliwych podczas badań
Both computers and the google drive are password-protected, and no sensitive data will be stored.
4. Wymogi prawne, kodeks postępowania
Sposób zapewnienia zgodności z przepisami dotyczącymi danych osobowych i bezpieczeństwa danych w przypadku przetwarzania danych osobowych
No personal data will be processed.
Sposób zarządzania innymi kwestiami prawnymi, np. prawami własności intelektualnej lub własnością. Obowiązujące przepisy
No issues.

5. Udostępnianie i długotrwałe przechowywanie danych
Sposób i termin udostępnienia danych. Ewentualne ograniczenia w udostępnianiu danych lub przyczyny embarga
Data related to programming will be provided with a user guide and made publicly available on github for as long as physically possible.
Sposób wyboru danych przeznaczonych do przechowania oraz miejsce długotrwałego przechowywania danych (np. repozytorium lub archiwum danych)
Github is one of the main tools to make one's code public.
Metody lub narzędzia programowe umożliwiające dostęp do danych i korzystanie z danych
Rstudio, Atom, Sublime text.
Sposób zapewniający stosowanie unikalnego i trwałego identyfikatora (np. cyfrowego identyfikatora obiektu (DOI)) dla każdego zestawu danych
No need to add identifiers to R packages other than the ones automatically provided by github, publications will be assigned DOIs by the publishers.
6. Zadania związane z zarządzaniem danymi oraz zasoby
Osoba (np. funkcja, stanowisko i instytucja) odpowiedzialna za zarządzanie danymi (np. data steward)
PI
Środki (np. finansowe i czasowe) przeznaczone do zarządzania danymi i zapewnienia możliwości odnalezienia, dostępu, interoperacyjności i ponownego wykorzystania danych
Not needed.

OŚWIADCZENIA ADMINISTRACYJNE

OŚWIADCZENIA KIEROWNIKA (PI)

Oświadczam, że:

1. zadania badawcze objęte niniejszym wnioskiem nie są i nie były finansowane z NCN ani z innego źródła;
2. w przypadku ubiegania się lub uzyskania finansowania zadań badawczych objętych tym wnioskiem z innego źródła niż NCN:
   a) w razie uzyskania finansowania z NCN
      - zrezygnuję z ubiegania się o finansowanie z innego źródła

      albo
      - powiadomię osobę upoważnioną do reprezentowania podmiotu będącego wnioskodawcą o rezygnacji ze środków przyznanych na realizację zadań badawczych przez Dyrektora NCN;

   b) w razie uzyskania finansowania z innego źródła
      - powiadomię osobę upoważnioną do reprezentowania podmiotu będącego wnioskodawcą o rezygnacji z ubiegania się o finansowanie w tym konkursie NCN

      albo
      - zrezygnuję z przyjęcia finansowania z innego źródła;
3. w przypadku zakwalifikowania wniosku do finansowania wyniki badań uzyskane w wyniku realizacji projektu badawczego będą poddane ewaluacji i opublikowane w wydawnictwie/wydawnictwach o zasięgu międzynarodowym;
4. w przypadku zakwalifikowania wniosku do finansowania, wyrażam zgodę na zamieszczenie, wraz z informacją o wynikach konkursu, na stronie podmiotowej NCN oraz Ośrodka Przetwarzania Informacji (OPI), popularnonaukowego streszczenia projektu;
5. zapoznałem się z zasadami doręczania decyzji Dyrektora NCN;
6. wyrażam zgodę na dokonanie weryfikacji wniosku przy pomocy oprogramowania antyplagiatowego oraz umieszczenie treści wniosku w bazie danych oprogramowania;
7. zapoznałem się z treścią Kodeksu Narodowego Centrum Nauki dotyczącego rzetelności badań naukowych i starania o fundusze na badania i zobowiązuję się do jego stosowania;
8. w przypadku uzyskania finansowania zobowiązuję się do przebywania przez co najmniej 50% czasu trwania projektu na terytorium Rzeczpospolitej Polskiej i pozostawania w dyspozycji podmiotu realizującego projekt na zasadach określonych w Regulaminie przyznawania środków na realizację zadań finansowanych przez Narodowe Centrum Nauki w zakresie projektów badawczych.

Akceptacja oświadczenia	TAK [X] / [ ] NIE

OŚWIADCZENIA KIEROWNIKA PODMIOTU / OSOBY UPRAWNIONEJ DO REPREZENTACJI

Oświadczam, że:

1. zadania badawcze objęte niniejszym wnioskiem nie są i nie były finansowane z NCN ani z innego źródła;
2. w przypadku ubiegania się lub uzyskania finansowania zadań badawczych objętych tym wnioskiem z innego źródła niż NCN:
   a) w razie uzyskania finansowania z NCN
      - zrezygnuję z ubiegania się o finansowanie z innego źródła
      albo
      - zrezygnuję ze środków przyznanych na realizację zadań badawczych przez Dyrektora NCN
   b) w razie uzyskania finansowania z innego źródła
      - zrezygnuję z ubiegania się o finansowanie w tym konkursie NCN
      albo
      - zrezygnuję z przyjęcia finansowania z innego źródła;
3. działając w imieniu podmiotu, który reprezentuję, w przypadku uzyskania finansowania projektu badawczego zobowiązuję się do:
   a) włączenia projektu badawczego do planu zadaniowo-finansowego podmiotu;
   b) zatrudnienia kierownika projektu badawczego oraz wykonawców niezbędnych do realizacji projektu badawczego na zasadach zgodnych z wnioskiem i warunkami konkursu;
   c) zatrudnienia kierownika projektu na cały okres realizacji projektu na podstawie umowy o pracę na co najmniej połowę pełnego wymiaru czasu pracy;*
   d) zapewnienia warunków do realizacji prowadzonych badań, w tym udostępnienia przestrzeni biurowej/laboratoryjnej oraz aparatury naukowo-badawczej niezbędnej do realizacji tych badań;
   e) zapewnienie obsługi administracyjno-finansowej realizacji projektu badawczego;
   f) sprawowania nadzoru nad realizacją projektu badawczego i prawidłowością wydatkowanych na ten cel środków finansowych;
4. w przypadku zakwalifikowania wniosku do finansowania, wyrażam zgodę na zamieszczenie, wraz z informacją o wynikach konkursu, na stronie podmiotowej NCN oraz Ośrodka Przetwarzania Informacji (OPI), popularnonaukowego streszczenia projektu;
5. zapoznałem się z zasadami doręczania decyzji Dyrektora NCN;
6. wyrażam zgodę na dokonanie weryfikacji wniosku przy pomocy oprogramowania antyplagiatowego oraz umieszczenie treści wniosku w bazie danych oprogramowania;
7. zapoznałem się z treścią Kodeksu Narodowego Centrum Nauki dotyczącego rzetelności badań naukowych i starania o fundusze na badania i zobowiązuję się do jego stosowania;
8. jestem świadomy/a, że w przypadku przedłużenia czasu realizacji projektu, jestem zobowiązany/a do kontynuacji zatrudnienia kierownika projektu na podstawie umowy o pracę na co najmniej połowę pełnego wymiaru czasu pracy przez cały okres przedłużenia okresu realizacji projektu, przewidzianego we wniosku.*

*nie dotyczy osób pobierających świadczenia emerytalne z systemu ubezpieczeń społecznych

Akceptacja oświadczenia	TAK [X] / [ ] NIE

OCHRONA DANYCH OSOBOWYCH

INFORMACJA O ZASADACH PRZETWARZANIA DANYCH OSOBOWYCH

Na podstawie art. 13 ust. 1 i 2 rozporządzenia Parlamentu Europejskiego i Rady (UE) 2016/679 z dnia 27 kwietnia 2016 r. w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych oraz uchylenia dyrektywy 95/46/WE (ogólne rozporządzenie o ochronie danych) (Dz. Urz. UE L 2016, Nr 119, s. 1) informujemy osoby wnioskujące o finansowanie projektu badawczego, działania naukowego, stażu, stypendium doktorskiego lub komponentu badawczego, że:

a) Narodowe Centrum Nauki z siedzibą w Krakowie przy ul. Twardowskiego 16, 30-312 Kraków jest administratorem Pani/Pana danych osobowych,
b) kontakt z wyznaczonym Inspektorem Ochrony Danych w Centrum jest możliwy za pomocą poczty elektronicznej pod adresem iod@ncn.gov.pl, telefonicznie pod numerem +48 12 341 9113 lub bezpośrednio w siedzibie administratora danych osobowych,
c) podstawę prawną przetwarzania Pani/Pana danych osobowych przez Centrum stanowi art. 6 ust. 1 lit. c ogólnego rozporządzenia o ochronie danych w związku z art. 20 ustawy z dnia 30 kwietnia 2010 r. o Narodowym Centrum Nauki (Dz. U. 2018 poz. 947 z późn. zm.),
d) Pani/Pana dane osobowe będą przetwarzane w celu:
   - rozpatrywania wniosku o finansowanie projektu badawczego, działania naukowego, stażu, stypendium doktorskiego lub komponentu badawczego,
   - nadzoru, obsługi finansowo-księgowej, kontroli w trakcie jak i po zakończeniu projektu badawczego, działania naukowego, stażu, stypendium doktorskiego lub komponentu badawczego, oceny ich realizacji i rozliczenia umów o finansowanie – w przypadku przyznania środków finansowych na realizację projektu badawczego, działania naukowego, stażu, stypendium doktorskiego lub komponentu badawczego,
   - przeprowadzania ewaluacji realizacji zadań Centrum, sprawozdawczości, upowszechniania w środowisku naukowym informacji o przyznanym przez Centrum finansowaniu badań, realizacji innych czynności regulowanych przepisami prawa powszechnie obowiązującego oraz w celach archiwalnych,
e) od momentu pozyskania, Pani/Pana dane osobowe będą przetwarzane przez okres niezbędny do realizacji celów wskazanych w lit d), dochodzenia związanych z nimi roszczeń, okres wymagany przez przepisy prawa powszechnie obowiązującego oraz przez okres przechowywania zgodny z instrukcją kancelaryjną Centrum i Jednolitym Rzeczowym Wykazem Akt,
f) podanie przez Panią/Pana danych osobowych stanowi wymóg ustawowy i bez ich podania nie można zrealizować celów wskazanych w lit d),
g) odbiorcami Pani/Pana danych osobowych mogą być wyłącznie podmioty uprawnione do uzyskiwania danych osobowych na podstawie przepisów prawa, oraz w zakresie określonym w art. 31 ustawy z dnia 30 kwietnia 2010 r. o Narodowym Centrum Nauki (Dz. U. 2018 poz. 947 z późn. zm.) osoby korzystające ze strony podmiotowej Centrum,
h) Pani/Pana dane osobowe mogą być powierzone do przetwarzania podmiotom zewnętrznym takim jak m.in. Ośrodek Przetwarzania Informacji - Państwowy Instytut Badawczy z siedzibą przy al. Niepodległości 188b, 00-608 w Warszawie w ramach realizowanych przez nie usług na podstawie umów o powierzenie danych osobowych, a podmioty te są również zobowiązane do zachowania poufności przetwarzanych danych,
i) przysługuje Pani/Panu prawo dostępu do treści swoich danych, sprostowania swoich danych osobowych oraz ograniczenia przetwarzania swoich danych osobowych,
j) przysługuje Pani/Panu prawo wniesienia skargi do Prezesa Urzędu Ochrony Danych Osobowych w przypadku naruszenia przepisów ogólnego rozporządzenia o ochronie danych.