ON PROBABLE GROUNDS

Probabilistic Thought and the Principle of Reason in Law and Data Science

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PREFACE

Probably this thesis could have turned out differently. There are simply too many butterflies in this world to believe that there is an immutable and foreseeable determinist chain of causal necessities leading from the big bang to this bundle of paper. For instance, I can easily imagine myself handing in a thesis entitled '*The* Lockean Proviso *in Nozick's* Anarchy, State and Utopia' or '*The* rule of recognition *in Hart's* The Concept of Law: *merely a* matter of fact *or a metaphysical foundation in disguise?*". Such topics would have tied in nicely with some of the interests I pursued during the past years and would have been a perfectly befitting pinnacle for a degree in philosophy of law. This raises the question: why this thesis and not another? The current text appears to be neither a random outcome (which would have been the case if I had flipped a coin to decide on which topic to write or rented a monkey to bang its fists on my keyboard) nor an iron necessity written in stone. If one is to compare my typing fingers striking the keys to a pair of dice rolling on a casino table, the dice in this metaphor are of the loaded type: tendencies, preferences, allowances and allurements skewed the probabilities of their course but the actual outcome stayed accidental. As Popper (1990) writes: "Looking at my own long life, I find that the main allurements which led me on and on […] were *preferences*. The solutions were *accidents*." (p. 26) So which are the hidden weights, the altered edges, the bumps in the table?

hidden weights: the world folded within my fingers

What 'loads' my body in its actions is not, as is the case with loaded dice, a little lump of metal, but my environment as it is folded into me. This 'environment' or 'world' appears through the encounters it has with my body and becomes mine through the traces it leaves in it. For instance, in the case of my fingers, the folded environment consists out of the books whose pages they turned, the people they touched, the conversations which made them gesticulate, the objects which scarred them, the first disciplining pencils which made them write, the sunrays which stroke them, and innumerable other elements. Clearly, this thesis could not have been written without any of these elements. However, as it is uncommon to thank inanimate things in a preface (Thank you sun, air, laptop, and desk!), I will stick to some names that cannot be left unmentioned: in Leiden prof. Oudemans, in Brussels prof. Gutwirth, dr. Hildebrandt and Niels van Dijk, and, always and everywhere, Sebastian Abrahamsson.

a posteri *established tendencies*

A second observation is that the tendencies or biases, whether towards a certain number in a crooked die or towards a certain style of reasoning in a piece of writing, emerge from a specific constellation of 'hidden weights' and can only be inferred *a posteriori*. Thus, in retrospective (for the reader the preface is the first part of the thesis, to

me it is the last) it appears that there are at least three important biases that might have had a significant impact on the paths followed in this thesis:

1. a philosophical hunch: thinking certainty and uncertainty at once

1. A philosophical hunch: to think certainty and uncertainty *at once* within the notion of 'probable grounds'

In 1897 Mallarmé wrote and published the poem *Un Coup de Dés Jamais N'Abolira Le Hasard* ('A Throw of the Dice will Never Abolish Chance'). Hacking (2004) calls this poem the "most subtle and many-layered expression" of the "self-conscious conception of pure irregularity, of something wilder than the kinds of chance that had been excluded by the Age of Reason" (p. 10). It arose in the nineteenth century, "[p]arallel to the taming of chance" (p. 10), as an "ultimate backlash, a sort of statistical nihilism" (p. 147). Hacking argues that the first poignant articulations of this philosophical experience of an absolute and blind chance, which is always *primordial* to the "approximate Law" (Hacking, 2004, p. 215) into which it stabilizes, can be traced back to two philosophers: Peirce (who coined tychism as the name of the doctrine that absolute chance is the primordial factor of the universe1892) and Nietzsche (e.g.: "I gave it [chance] back to all things, I redeemed them from their servitude under purpose", 2006, p. 132). In the second half of the twentieth century Deleuze and Badiou (e.g. Badiou, 2000, pp. 72 ff.; Brassier, 2000; Deleuze, 1983, pp. 25-7) both claimed to be the true heir of this primordial experience of chance. Leaving aside the differences which divide these authors, I will focus on the question how to gain philosophical *access* to this 'absolute chance' and articulate it without ending up in a romantic, anti-calculative discourse. Thus the hunch – or: the philosophical itch – that has been guiding me in this thesis is whether the concept of 'probable grounds' might offer the possibility to think *at once* both this pure chance *and* the relative certainty following from statistical methods – which in itself seems as difficult a feat as perceiving Wittgenstein's duck-rabbit (1997, p. 194) as both a duck *and* a rabbit.

2. a double bind

2. A double bind towards philosophy of law and philosophy of science

When I enrolled for the degree *Philosophy of a specific discipline* at Leiden University I did not know what this "specific discipline" would be in my case. Having a background in both civil law and cognitive psychology (specializing in research methodology) allowed me to explore philosophy of law as well as philosophy of science. At first this double bind towards two disciplines – each with its own distinct style of reasoning – appeared as a complicating factor that I had to get rid of, but at second thought (inspired by the idea of an 'ecology of practices': Stengers, 2005) it also seemed that such a non-place as the in-

between of two practices might actually turn out to be a fertile ground for doing philosophy.

3. a tendency towards semantics

3. A tendency towards semantics

I have often tried to do 'practical' or 'applied' philosophy in the hope to advance another discipline. But whenever I try to formulate a constructive ethical opinion or a thought-provoking cultural critique I always get stuck in 'fundamental' or 'semantic' questions (what *is* a 'critique', 'culture', 'use', 'practical', 'fundament', 'logic', 'philosophy', etc.?) that are mere philosophy for philosophy's sake. Both for me and for the reader this can be a frustrating experience – the endless dabbling in semantics feels as if one never leaves square one. However, while such an approach is of little help in *answering* questions ("*Shall we go right or left? Based on a logical analysis and ethical assessment I say: to the right*"), it might transform them in to more interesting questions ("*Why do we think in the dichotomy right and left, and is it possible to think differently?*").

The tendencies described above correspond to the matters discussed in the three first chapters. The *first chapter*, informed by the philosophical hunch that there might be a possibility to think probability and the principle of ground together (1), explores the historical and philosophical grounds of the notion 'probable ground'. In the *second chapter* – here the disciplinary double bind (2) enters the stage – a research question is formulated by placing the notion of 'probable ground' against the background of law and data science. Last but not least, the tendency towards semantics (3) is elaborated in more detail in the *third chapter*, which presents the philosophical methodology of this thesis. Now that these important cards are on the table, it is time to roll the dice: in the second half of this thesis the relatively distinct themes of the first three chapters begin to overlap, blend together and interact. In *chapter four* the way wherein the principle of ground moves the course of my thoughts comes to the fore as I give a historical account of the world which preceded the seventeenth century emergence of probability. In *chapter five* I present law as a practice of probable *grounds* and attempt to retrace their functioning within this discipline. Following Spinner's (1977) analysis of some of Parmenides' fragments, I reformulate the role of probable grounds as a legal settlement following from an assumed correspondence between the subjective belief of the judge and the legal proof indicating reality. Retracing the functioning of probable grounds within the practice of law shows the efforts that have to be made in order to establish the seemingly so effortless paths of correspondence between 'subjective' and 'objective' probabilities. *Chapter six* shows how probable *ratios* function within the practice of data science, i.e. as ratios that do *not* claim

the status of grounds. I argue that one of the implications hereof is not only that the opposition between the subjective and objective interpretation of probability looses much of its edge, but also that probability can no longer be conceived as 'a gradation of possibility' (Leibniz, 1999, p. 94) and, consequently, does no longer fall under the venerated Aristotelian metaphysics of potentialities striving towards actualisation. After all, the rationality of probable ratios only reigns in the *present future* and can be considered independent of the question whether they actualise in the *future present*. Finally, in *chapter seven* the concepts which emerged during the process of writing this thesis, i.e. not only 'probable ground' but also 'affection', 'before' and a 'parallax between practices', are recapitulated and evaluated. This concluding chapter also returns to the pivotal question whether it is possible to reformulate the deadlock dichotomy certainty-uncertainty in such a way that it becomes possible to think them at once.

TABLE OF CONTENTS

	Preface	1
chapter 1	Introduction: the rationality of probable grounds	6
chapter 2	Research question: how do probable grounds move reasoning in law and data science?	19
chapter 3	Method: a parallax view on the affections of probable grounds in law and data science	22
chapter 4	A prelude to the parallax: before probable grounds	28
chapter 5	The probable grounds of law – solid/uncertain encounters of being and thought	32
chapter 6	Probable ratios in data science – the eternal sunshine of the present future	41
chapter 7	Conclusion – new affections	52
	Bibliography	57

This is a thesis on *probable grounds*. Because knowledge exempt of any doubt is scarce – or maybe even impossible[1] – most decisions which are taken are based on probable grounds. To take a decision on probable grounds means to act rationally under uncertainty. Such rational decision-taking on probable grounds is omnipresent: the judge convicts the suspect because the evidence makes it highly probable that he or she is guilty as charged; the researcher writes that it is likely that the studied drug is effective because it is highly improbable that the measured effects are due to chance; the broker invests money in a stock whose value is most likely to grow; the military airplane drops a bomb from a spot where it is probable to hit the target; and the rational consumer – an intuitive statistician (Brunswik, 1943; Gigerenzer, 2000) – chooses the car which is probably the best buy because it received the highest average rating from other consumers. In none of the aforementioned cases there is certainty that the right decision is made: against all odds the suspect can turn out to be innocent, the drug ineffective, the stocks worthless, the bomb a miss, and the car a lemon. Thus, probable grounds always have to come with a disclaimer: *improbable does not mean impossible* (cf. Esposito, 2007). In case of uncertainty relying on probable grounds seems the most rational thing to do but it also implies a risk since improbable events *do* happen sometimes[2]. Or, to put it differently: it is not probability but possibility which lures the gambler in to irrational behaviour.

rationality independent of actuality in the future present

However, as Esposito (2007) convincingly argues, the fact that an improbable event occurs does not affect the rationality of taking decisions on probable grounds[3]: even if things will turn out differently than expected the probable grounds guarantee a justification. She builds this argument on the distinction (2007, pp. 50-67) between the

[1] Following the 'Popperian' method of trial and error, science does not produce certain knowledge but merely working hypotheses. As the amount of attempts to falsify these hypotheses grows they become more powerful (*corroborated*). Yet, notwithstanding the extent of corroboration, a future falsification of a hypothesis can never be excluded. (Popper, 2002b)

[2] The fallacy that improbable events are impossible played an important role in a recent criminal case in the Netherlands. In 2003 Lucia de B., a nurse, was sentenced to life imprisonment for multiple murders. The most important proof of her guilt was statistical 'evidence of attendance' (*dienstroosterbewijs*) : during several of her shifts a statistically remarkable high amount of patients had died. The court relied on statistical expertise and concluded that the repeated coincidence of these deaths with Lucia de B.'s presence as the nurse on duty could not be attributed to chance. The judgement was highly criticised (Derksen, 2006) and received wide media coverage. In March 2010 the case was reopened and in April 2010 Lucia de B. was acquitted. Hoge Raad (Netherlands Supreme Court), LJN: BD4153 (*Lucia de B.*), 11 March 2010; Hof Arnhem, (Court of Arnhem), LJN: BM0876, (*Lucia de B.*), 14 April 2010. Van Asperen de Boer (2007) gives a good account of the statistical and legal details of the case.

[3] Many financial models contain probabilistic elements. Even though these models, which were one of the important causes of the current economic crisis, have been heavily criticised as being too complicated, opaque and risky, the rationality of taking decisions on probable grounds is not disputed as such. Esposito draws a parallel between the

present future ('gegenwärtige Zukunft'), i.e. the future as it presents itself in the now, and the *future present* ('zukünftige Gegenwart'), i.e. a now that will take place in the future. According to Esposito the rationality of a decision which is made on probable grounds is based upon the *present future*[4] and thus can never be refuted by a *future present*. The future actualisation of an improbable event does not make the probable ground less rational. On the contrary, when one calculates and plans the future on probable grounds one has to reckon with the possibility – although hopefully very small and improbable! – that things will turn out differently than expected or hoped for.[5] Even though Hume already pointed out that induction, and its underlying supposition "*that the future will be conformable to the past*" (Hume, 2000, p. 31), is mere "*custom and habit*" (Hume, 2000, p. 37) and not rationality[6], the world would probably be less rational if the probabilities of the *present future* would be structurally ignored because the *future present* is fundamentally open and undecided. As we all know: success in the past does not guarantee success in the future and from the fact that the sun has risen every morning for millions of years it does not follow that we can count on it that it will continue to do so. Still it would be irrational not to take probable grounds into account. It simply seems undeniable that probable grounds are indispensable in order to take rational decisions – not only because they often work out quite well in the *future present*, but even more because they are the rational thing to do in the *present future*.

probable grounds: a contradiction in terms?

Yet the notion of *probable grounds* seems not only opaque, but even paradoxical to a certain extent. Since Hume's formulation of the problem of induction there has been an endless amount of attempts to show that a *probable ground* is as much a contradiction in terms as a round square. Most of these arguments rest on two assumptions: firstly that a ground is a rational, certain and solid step in deductive thought, and secondly that

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modern probabilistic models and oracles in Antiquity: both are irrefutable by future events. When a prophecy did not occur it was not the oracle that was to blame but its interpreter (Esposito, 2007, p. 65).

[4] The notion of a *present future* also can help to overcome the distinction between a probability which refers to what something already *is* (e.g., the woman *is* pregnant or non-pregnant – but given the test results of the pregnancy test in the *present future* it is improbable that she is pregnant) or to what something *will* become (e.g. the bomb will be a hit or a miss – but in the *present future* it is improbable that it is a miss). However, this does not imply that the *present future* should be understood as some kind of pseudo-Aristotelian potentiality (cf. Hermes is already present *qua dunamis* in the block of wood before the artist has begun to cut the sculpture out of it: Aristotle, 1947, book IX, section 6) which becomes actualised in the *future present*, because according to Esposito the rationality of a probable ground is the likelihood of an event in the present future and is independent of its actualisation in the future present.

[5] "Diese können dazu führen, dass man eine in der Vergangenheit eingenommene Position, so rational und wohlüberlegt sie auch immer gewesen sein mag, bereut – auch mit dieser Möglichkeit rechnet man bereits in der Gegenwart. […] Obwohl man die Zukunft nicht kennen kann, verspricht die Berechnung ihre Planbarkeit. Diese sollte, wie wir sahen, garantieren, daß man in der Zukunft nichts würde bereuen müssen, und in der Gegenwart den Konsens mit andere Akteuren ermöglichen". (Esposito, 2007, pp. 53-4)

[6] "…that all our experimental conclusions proceed upon the supposition that the future will be conformable to the past. To endeavour, therefore, the proof of this last supposition by probable arguments, or arguments regarding existence, must be evidently going in a circle, and taking that for granted, which is the very point in question". (Hume, 2000, p. 31)

probability is a mere inductive habit of thought without any rational justification, and thus uncertain and shaky[7]. With these assumptions in mind it is unsurprising that Leibniz, the intellectual father of the 'principle of ground', never spoke of *probable* grounds. In those instances where Leibniz specifies the *ratio* which according to his principle has to be given, it is always with the adjective *sufficient* ('sufficiens'):

sufficient grounds

> "…, the principle of Sufficient Reason, in virtue of which we believe that no fact can be real or existing and no statement true unless it has a sufficient reason why it should be thus and not otherwise". (Leibniz, 1992, p. 74)

Thus, the *principium rationis suffientis*, the *Principle of Sufficient Reason*[8], states that every contingent fact must have an underlying reason which explains it (see, e.g., Pruss, 2006), or as Schopenhauer reformulated it: "that everything must have a sufficient reason for being as it is, and not otherwise" (1889, p. 20). Like Descartes, the other famous rationalist, Leibniz was looking for something solid to ground one's reasoning. Clearly stern deductive reasoning, which led Descartes to the absolute certainty of his *fundamentum inconcussum*, is very different from a probabilistic way of thinking which revolves around the notions of uncertainty and induction. Still, when a determinist (whose doctrine says that every event has a cause) fails to find sufficient grounds, probable grounds might be the next best thing to ease epistemological uncertainty. In fact, one could argue that probability and statistics reconcile "Scientia to her arch-rival Fortuna" (Gigerenzer et al., 1990, p. xiii). Probability turns Fortuna – who only shows her true colours, according to the sobering warnings of Boethius' *Lady Philosophy*, "when she shows herself to be inconsistent and changing" (1973, p. 225) – from fickle and pure uncertainty into (even though often uncertain) certainty. *Uncertain certainty*: again we end up in a contradiction in terms.

uncertain certainty

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[7] For example, in the *Theaetetus*, 162e, Socrates says: "ἀπόδειξιν δὲ καὶ ἀνάγκην οὐδ᾽ ἡντινοῦν λέγετε ἀλλὰ τῷ εἰκότι χρῆσθε, ᾧ εἰ ἐθέλοι Θεόδωρος ἢ ἄλλος τις τῶν γεωμετρῶν χρώμενος γεωμετρεῖν, ἄξιος οὐδ᾽ ἑνὸς μόνου ἂν εἴη. σκοπεῖτε οὖν σύ τε καὶ Θεόδωρος εἰ ἀποδέξεσθε πιθανολογίᾳ τε καὶ εἰκόσι". In translation (Plato, 2002, 162e, p. 81): "…; but you do not advance (*legetê*) any cogent proof (*apodeixin de kai anagken*) whatsoever, you base your statements (*chresthe*) on probability (*eikoti*). If Theodorus, or any geometrician, should base his geometry on probability, he would be worth nothing. So you and Theodorus had better consider whether you will accept arguments founded on plausibility and probabilities (*pithanologia te kai eikosi*) in such important matters". In general this translation is rather anachronistic: not only because of the use of 'probability', but also expressions like 'base statements', 'found on arguments', etc. Quoted in: Franklin, 2001, p. 195, who translates *eikoti* (derived from ἔοικα) as 'likelihood', which seems to me a less anachronistic translation than 'probability'. Franklin also refers to similar passages in Plato, e.g. *Phaedo* 92d and *Pheadrus* 229e.

[8] Paradoxically, Leibniz deemed his principle to be so obvious, that it was not in need of any further explanation or grounding : "On a pretendu d'abord que je commets une petition de principe. […] Ce principe est celuy du besoin d'une Raison suffisante, pour qu'une chose existe, qu'un événement arrive, qu'une vérité ait lieu. Est ce un principe qui a besoin de preuve? […] J'ose dire que sans ce grand Principe, on ne sauroit venire à la prevue de l'existence de Dieu, ny rendre raison de plusieurs autres verités importantes. Tout le monde ne s'en est il point servi en mille occasions?". (Leibniz, 1890, p. 419)

How did those seemingly opposite concepts of ground and probability end up in their unlikely alliance? A first observation which could help to explain this entanglement is the almost simultaneous emergence of probability and the so called *principium rationis* ("principle of ground") in the second half of the seventeenth century. According to Heidegger (1997, p. 49), who argues that this latter principle has paved the road for the calculating thought which defines the science and technology of our modern age[9], the first published record of the *principium rationis* is contained in a treatise written by Leibniz in 1671. In this treatise (*Theoria motus abstracti*) the principle, which Leibniz characterizes as "*most noble*" (*nobilissimo illo*), is only mentioned as an aside: *Nihil est sine ratione* – Nothing is without ground (Leibniz, 1880, p. 232; 1969, p. 142).

principle of ground (Leibniz, 1671)

probability (Pascal-Fermat, 1654 Bernoulli, 1692)

By the time that the *principle of ground* was formulated for the first time, the modern notion of probability was already seventeen years old. Its official moment of birth took place in the summer of 1654 when Pascal and Fermat sent each other five letters concerning the so called 'problem of points'[10]. Inspired by this correspondence (Stigler, 1999, p. 239) Christian Huygens wrote the booklet *Rekeningh in Spelen van Geluck* (written in 1656, published in 1660), which was immediately translated into Latin as *De ratiociniis in ludo aleae* (1657). This text was the point of departure for Jacob Bernoulli's famous *Ars conjectandi* (The art of conjecturing) which "presents the most decisive conceptual innovations in the early history of probability" (Hacking, 1975, p. 143) and completes the emergence of probability. The law of large numbers[11], which is the chief theorem of the *Ars conjectandi*, was proved in 1692 (Hacking, 1975, p. 143) but the book was only posthumously published in 1713.

In *Ars conjectandi* Bernoulli underlines that probability does not contradict the idea that every event has a cause: all uncertainty is epistemological. For if all causes could be

[9] "…we, who live in this age, stand under the reign of the claim of the mighty *principium reddendae rationis*. We who live today are who we are only insofar as the mighty claim of rendering reasons bepowers us" (Heidegger, 1957, pp. 59-60; 1991, p. 30). With regard to science Heidegger writes: "The authority of the powerful fundamental principle of reason is the element in which the sciences move just as fish do in water and birds do in air" (1991, p. 123), and, "Science responds to the demand of *ratio reddenda* and does so unconditionally. Otherwise, it couldn't be what it is". (1991, p. 30)

[10] The 'problem of points' questions how the stakes in a dice game should be divided when it is prematurely cut off, i.e., whether there is a fair division of the stakes based on the probability of each player to win the total game (given the results of the previous rounds). The Pascal-Fermat correspondence concerning the problem of points has been translated to English (David, 1962) and practically every book on probability mentions them as the origin of mathematical probability (e.g. Daston, 1988; Gillies, 2003; Hacking, 1975; Maistrov, 1974; Oosterhuis, 1991; Schuh, 1964; Vlis & Heemstra, 1988).

[11] The *Law of Large Numbers* states that the average of the results obtained from a large number of trials should be close to the expected value, and will tend to become closer as more trials are performed. Bernoulli's version of the law is called the weak law of large numbers. In a letter to Leibniz (3 October 1703) Bernoulli writes: "…it must be inquired whether the probability of an accurate ratio increases steadily as the number of observations grows, so that finally the probability that I have found the true ratio rather than a false ratio exceeds any given probability; or whether each problem, so to speak, has an asymptote — that is, whether I shall finally reach some level of probability beyond which I cannot be more certain that I have detected the true ratio" (Bernoulli, 1966, p. 24).

determined the future could be determined with certainty: "*All things which exist or are acted upon under the sun – past, present, or future things – always have the greatest certainty in themselves and objectively*". (1966, p. 3) Bernoulli, just like all the other classical probabilists of his era (Daston, 1988), considers probability to be a degree of certainty: "*For probability is a degree of certainty and differs from absolute certainty as a part differs from the whole*". (1966, p. 3) Moreover, when something is so very probable that its "probability nearly equals the whole certainty" it should be considered *morally certain*: "*Thus, if one thing is considered morally certain which has 999/1000 certainty, another thing will be morally impossible which has only 1/1000 certainty*". (1966, p. 3) Bernoulli continues that, "*[b]ecause it is still rarely possible to obtain total certainty, necessity and use desire that what is merely morally certain be regarded as absolutely certain*". (1966, p. 7) Thus the *Ars conjectandi* exemplifies why Daston calls the classical probabilist a 'rationalist *manqué*' (1988, p. 241): although Bernoulli embraces rationalism he also acknowledges that given epistemic uncertainty you have to cut your coat according to your cloth. However, before we endorse the concept of the classical probabilist as a 'rationalist *manqué*' we should not merely focus on his 'defect' but also on the 'rationalism' itself: what is the *ratio* that a rationalist *manqué* like Bernoulli was looking for? In order to answer that question we will first have to take a closer look at the *ratio* of the *principium rationis* which, according to Leibniz, underlies every event.

probability as a degree of certainty

ratio – both cause and reason

How to translate the *principium rationis* (or, in its more fully fledged formulation, *the principium reddendae rationis sufficientis*) from Latin into English? The sufficient *ratio* which should[12] be rendered is both an epistemological (relating to how we think and know) and an ontological (relating to what is) ground: it is both a reason of thought for the subject and a cause of being for the object[13]. However, in the standard translation in English of the *principium rationis sufficientis* as the *principle of sufficient reason* – in fact this translation is so much standardized that it is often used in the abbreviated form PSR (see, e.g., Pruss, 2006) – this Janus-faced character of the ratio (as a ground that is both cause and reason) is erased. This is why I have spoken, in accordance with the German translation as *der Satz vom Grund*, of the 'principle of *ground*'. Lilly, in his translation of Heidegger's *Der Satz vom Grund* ('The Principle of Reason'), uses 'reason', 'foundation', 'ground', 'grounds', or even 'ground/reason' to translate the equivocal *Grund* (1991, p. xiii). In the present, 'atomic' (Heidegger, 1991, p. 121 ff.) age, the principle of *Grund* or *ratio* has not only

[12] *Reddendae* is the gerundivium, which has to be translated as '*should be* rendered'.

[13] When read together with the Leibnizian understanding of truth, namely as a proposition in which the predicate is contained in the subject, the *principio rationis* can be reformulated as "*all predication has a foundation in the nature of things*" (Smith, 2005b, p. 130): "*The principle of sufficient reason says not only that the notion of a subject contains everything that happens to the subject, all its difference – that is, everything that is truly predicated of the subject – but also that we should be able to* demonstrate *that this is the case*" (Smith, 2005b, p. 131), "*just as we can demonstrate that the predicate "three sides" is contained in the concept of the triangle*"(Smith, 2005a, p. 6). Discussing the Leibnizian notion of truth in more detail is beyond the scope of this introductory chapter, but I refer the interested reader to: De Bakker, 2008.

become an imperative to give an 'account' which justifies a judgement (Heidegger, 1991, p. 119 ff.), but also to secure the establishment of objects through calculation and reckoning.

probability – both degree of belief and stochastic frequency

It is worth noticing that the seventeenth and eighteenth concept *probability* has the same kind of duality as the *ratio* in Leibniz's principle: "*On the one side it is statistical, concerning itself with stochastic laws of chance processes. On the other side it is epistemological, dedicated to assessing reasonable degrees of belief in propositions quite devoid of statistical background*" (Hacking, 1975, p. 12). During the first two centuries of its existence nobody really seemed to be concerned by this equivocal nature of probability, but in the last 150 years it has divided probabilists and statisticians in two irreconcilable camps: *Bayesians* who say that probabilities are subjective degrees of belief and, on the other hand, *Frequentists* who hold that probabilities are objective frequencies[14]. Bayesian statisticians attribute probabilities to hypotheses ('this hypothesis has a probability of 0.85'), whereas their objectivist counterparts hold that – given a certain hypothesis that in itself is either completely false or true – only data can have a probability ('given this hypothesis these results are highly unlikely: they have a probability of 0.001'). A nice illustration of the depth of this divide is the reaction of Popper, who belonged to the camp of the objectivists, on his discovery that his former ally Carnap also had begun to defend a subjectivist position:

> "Carnap was then [in 1934], and for some years afterwards, entirely on my side, especially concerning induction […]. Carnap and I had come, in those days, to something like an agreement on a common research programme on probability, based on my *Logik der Forschung*. […]
>
> This was the state of the discussion reached in 1934 and 1935. But 15 years later Carnap sent me his new big book, *Logical Foundations of Probability*, and, opening it, I found that his explicit starting point in this book was the precise opposite – the bare, unargued assumption that the degree of confirmation is a probability in the sense of probability calculus. I felt as a father must feel whose son has joined the Moonies; though, of course, they did not yet exist in those days". (Popper, 1990, pp. 4-5)

probability – an approximation of the underlying true ratio

Not only was the classical concept of probability Janus-faced, but so were the true ratios, or 'reasons', that these probabilities were supposed to approximate: ratios between black and white pebbles in an urn[15], between boys and girls in a population, between different

[14] In 2010 the prestigious Von Dantzig price for Statistics in the Netherlands was awarded to prof. Grünwald and prof. Van Zanten for their attempts to bridge the gap between Bayesian and frequentist statistics. See: http://www.vvs-or.nl/

[15] "…if, for example, we replace the urn by the atmosphere or the human body (both of which contain

diseases in a human body, between guilty and innocent people etc. In the two centuries following its discovery *degrees of belief* and *observed frequencies* coincide within the concept of probability because they are supposed to be natural indexes of the underlying true *ratios*. Because the true ratios are hidden in the urn of nature we can merely know them indirectly from the observed frequencies of similar cases. In this way the *a priori* ratio can be deduced from *a posteriori* observed frequencies (which correspond to the degree of belief):

> "But indeed, another way is open to us here by which we may obtain what is sought; and what you cannot deduce *a priori*, you can at least deduce *a posteriori* – i.e., you will be able to make a deduction from many observed outcomes of similar events. For it must be presumed that every single thing is able to happen and not to happen in as many cases as it was previously observed to have happened and not to have happened in like circumstances. For if, for example, an experiment was once conducted on 300 men of the age and constitution of which Titius is now, and you observed that 200 of them had died before passing the next ten years and that the others had further prolonged their lives, you could safely enough conclude that the number of cases in which Titius must pay his debt to nature within the next ten years is twice the number of cases in which he can pay his debt after ten years. And so, if anyone has observed the weather for the past several years and has noted how many times it was calm or rainy; or if anyone has judiciously watched two players and has seen how many times this one or that one has emerged victorious: in this way he has detected what the ratio probably is between the number of cases in which the same events, with similar circumstances prevailing, are able to happen and not to happen later on." (Bernoulli, 1966, p. 12)

Bernoulli does not merely posit that the *a priori* ratio can be deduced from *a posteriori* observations, but with his 'law of large numbers' he also gives a practical guideline to find these true ratios. The basic idea of this law is that the approximation of the hidden true *ratios* becomes more precise as the number of observations grows (Basel, 3 October 1703, letter to Leibniz):

> "…it must be inquired whether the probability of an accurate ratio increases steadily as the number of observations grows, so that finally the probability that I have found the true ratio rather than a false ratio exceeds any given probability;

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fuel for various mutations and diseases as the urn contains pebbles), we will in the same way be able to determine by observations how much more easily this or that event can take place in the regions of the atmosphere or the human body". (Bernoulli, 1966, p. 13)

> or whether each problem, so to speak, has an asymptote – that is, whether I shall finally reach some level of probability beyond which I cannot be more certain that I have detected the true ratio. […] if the former is true, we will investigate the ratio between the numbers of possible outcomes *a posteriori* with as much certainty as if it were known to us *a priori*. And I have found the former condition is indeed the case; whence I can now determine how many trials must be set up so that it will be a hundred, a thousand, ten thousand, etc., times more probable (and finally, so that it will be morally certain) that the ratio between the numbers of possible outcomes which I obtain in this way is legitimate and genuine."
> (Bernoulli, 1966, p. 24).

Though the law of large numbers seems to be intuitively sound it took Bernoulli great pains to come up with the mathematical proof:

> "Moreover, although – and this is amazing – even the stupidest man knows, by some instinct of nature per se and by no previous instruction, that the more observations there are, the less danger there is in straying from the mark, it requires not at all ordinary research to demonstrate this fact accurately and geometrically.".[16] (Bernoulli, 1966, pp. 23-4)

Leibniz's ratio = Bernoulli's ratio?

Summarizing we could make two observations about the *ratio* in *classical probability* and Leibniz's *principium rationis*. Firstly, we notice a difference: the *ratios* of the probabilists are not simply grounds in general, but they are grounds that are *proportions* between different cases[17]. However, the second observation is that this difference is relatively small compared to what Bernoulli's and Leibniz's *ratio*[18] have in common: in both *ratios* the subject and object coincide.

Leibniz and probability

Leibniz cannot be credited for the invention of the modern notion of probability, but as an important "witness to the transformation" (Hacking, 2004, p. 9) and "the first philosopher of probability" (Hacking, 1971b, p. 597) he nevertheless is the main protagonist in Hacking's (1975) seminal book on the seventeenth century emergence of

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[16] "Quanquam autem, quod mirabile est, etiam stupidissimus quisque […] quo naturae instinctu per se & nulla praevia institutione norit, quod quo plures observations fiunt, hoc minus a scopo aberrandi periculum sit; hoc ipsum tamen accurate & geometrice demonstrare minime vulgaris indaginis est" (Bernoulli, 1993, p. 117). Part of this fragment is also discussed by Daston (1988, p. 229). See also: Bernoulli, 2006, p. 35 ff.

[17] In 1933 Kolmogorov came up with the axiomatic formalization of probability which states that the probability of an event is a non-negative real number:

$$0 \leq P(E) \leq 1 \qquad \forall E \in F$$

where *F* is the event space and *E* is any event in *F*. Kolmogorov's axiom does not elucidate probability in a philosophical way (Hacking, 1976, p.), but it merely provides a mathematical tautology: probability is what fits the axioms of probability.

[18] In this regard it is worthwhile to notice that in the index of the most recent volume of the *Akademie*-edition of Leibniz's philosophical writings (1999) there are three main entries for the word *ratio*: 'ratio (*Grund*)', 'ratio (*Vernunft*)', and 'ratio (*Verhältnis*, proportio)'.

probability. Contrary to Descartes (who had "no truck with the nascent concept of probability", Hacking, 1975, p. 45), Leibniz showed a lively interest in the ideas springing forth from the probabilistic revolution. Not only did he write quite extensively on probability in matters concerning aleatory contracts and testimony in court (see e.g. Leibniz, 1996, book 4, chapter xiv, 'Judgment', chapter xv, 'Probability', and chapter xvi, 'The degrees of assent'), but he also entertained a lively correspondence (consisting of 21 letters[19]) with Jacob Bernoulli during the period from 1687 until the latter's death in 1705 (Sylla, 1998).

no probability without the ratio *of the* principium rationis*?*

In this thesis I will try to take Hacking's argument even further. The argument I will develop is that Leibniz – by formulating (firstly in 1671) the principle of reason with its Janus-faced *ratio* – was not only a witness but also a crucial facilitator in the emergence of probability (approximately from 1654 to 1692). This might be what Heidegger hints at when he remarks:

> "Parenthetically, Leibniz, the discoverer of the fundamental principle of sufficient reason, was also the inventor of 'life insurance'" (Heidegger, 1991, p. 124)

Although this statement is historically incorrect – not Leibniz but Johan de Witt can be considered to be the inventor of life insurance – it might be true in a philosophical sense. Heidegger's parenthetical remark suddenly would make sense if it could be proved that the two pivotal elements of life insurances, i.e. probabilistic grounds and the desire for certainty and security, follow from the Leibnizian reason that is requested by his principle of reason.

being and thought: the same

Leibniz's *ratio* belongs both to the realm of thought and being[20]. The hypothesis which I propose is that this theme of 'co-originality' (Cristin, 1998, p. 88 ff.), that posits a co-belonging ("*aeque originaria*": of the same origin) between "thinking self" ("*cogito*") and "things thought" ("*varia a me cogitantur*")[21], as it is also to be found in the principle of reason, facilitated the emergence of probability. As Cristin (1998) notices, the Leibnizian co-originality of being and thought announces "an ontological rediscovery of Pre-Socratic themes (especially those of Parmenides) which was later to reach its full development in Heidegger". (p. 89)

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[19] These letters can be found in Bernoulli, 1993; Leibniz, 1855. Some letters have been translated into English: Bernoulli, 1966.

[20] Cristin differentiates Leibniz's co-originality from Heideggers: the former posits a co-belonging of "thinking self" and "things thought", whereas the latter transfers it fully to the ontological plane by speaking of the "thought" and "being" (1998, p. 88-89). However, I will not develop this distinction as it would lead us on too many side-ways..

[21] "prima Experienta nostra constat esse ipsas internas perceptions, nempe non tantum me esse qui cogitem, sed et varietatem esse in meis cogitationibus (quae due a se invicem independentia et aeque originaria judico") ab ipsis Scepticis est inculcatum, […]" (Leibniz, 1880, p. 327). (For an interpretation of this fragment see: Cristin, 1998, p. 89 ff.)

probable ratio as a calculative proportion

To assume a relation between the ratios expressed in probabilities and those that have to be rendered according to Leibniz's principle, is far from self evident. Yet, maybe probable ratios are an instance of ratio as such? Probabilistic ratios are quantitative or calculative proportions[22] that transform uncertainty in less uncertainty, whereas Leibniz ratio is an almost infinite regress[23] (in the end everything leads back to the final ratio) of solid, 'made-in-one-piece' reasons that lead to absolute certainty. According to Heidegger quantitative calculation is merely one of the instances ("…reckoning in the sense of an operation with numbers is a special kind of reckoning distinguished by the essence of quantity", p. 100) of this Leibnizian ratio which is both "reckoning" as "a deed" and as "what is reckoned, the presented calculation, the account" (1991, p. 100).

sufficient or probable reason?

When the focus is shifted from the seeming opposition[24] between probability and ground (inductive and uncertain v. deductive and certain) to the Janus-faced *ratio* that underlies both, the notion of *probable grounds* is not so paradoxical any longer. From the very first formulations of the *principium rationis* it is clear that in practice the imperative *reddendae* (should be rendered) cannot always be satisfied by *sufficient* grounds: "Most frequently, however, these reasons [i.e, *sufficient reasons why it should be thus and not otherwise*] cannot be known by us" (Leibniz, 1992, p. 74). The imperative to bring the ratio of 'thinking itself' in accordance with the ratio of 'things thought' will not always be completely satisfied. When the sufficient reason cannot be known, insufficient (i.e. probable) reason is the next best thing. Although one can argue whether it was Leibniz or Bernoulli who formulated the probabilistic *Principle of Insufficient Reason*[25] (which is likely to

[22] Even though in, for instance, post-eighteenth century law these calculative proportions have become very implicit. Thus most modern Western lawyers would consider it an impossibility to express 'proof beyond reasonable doubt' and the intimate conviction of a judge in precise quantitative terms (i.e., as a number between 0 and 1). Franklin (2001, p. 362-72) even argues that in procedural law a *totally* unquantified, archaic kind of probability has survived. The manifold attempts that were made in the seventeenth and eighteenth century to quantify legal proof and conviction in probabilistic terms have been largely superseded by more hermeneutic approaches in the nineteenth century.

[23] Because of this regress of reasons (an "infinitely infinite seriality", p. 25) Deleuze calls Leibniz a very Baroque thinker (Deleuze, 1993, p. 49): "The individual notion, the monad, is exactly the inverse of God to the degree that reciprocals are numbers that exchange their numerator and their denominator: 2, or $^2/_1$, has as a reciprocal $^1/_2$. And God, whose formula is $^\infty/_1$, has as its reciprocal the monad $^1/_\infty$". Deleuze thus opposes the classicism of Descartes to Leibniz's Baroque Mannerism: "Essentialism makes a classic of Descartes, while Leibniz's thought appears to be a profound Mannerism" (p. 56).

[24] The assumption that there is an opposition between Leibniz's probabilistic ideas and his *principium rationis* has been challenged in recent research (see e.g. Dascal, 2001; Dascal, 2005; Roinila, 2007).

[25] It is not completely clear who gave the principle this name, but as far as known it is first mentioned as such in a probability textbook by Von Kries (1886). Bernoulli does not name the principle as such but describes it, for instance, in the fourth chapter of *Ars conjectandi* (Bernoulli, 1966, p. 9): "… all cases are equally possible, or that they all can happen with equal ease" ("…*omnes casus aequè possibiles esse, seu pari facilitate eveniri posse*"). Though the principle of insufficient reason is commonly attributed to Bernoulli, Hacking argues that the latter got the idea from Leibniz (1975, p. 125): "Before the 1713 publication of *Ars conjectandi* no well-circulated work makes use of equipossibility. Bernoulli himself did not employ it much. He got it from Leibniz, who had long associated it with probability".

be a play on Leibniz's principle and that was later renamed the *Principle of Indifference*), it is clear that insufficient reason seems to be a necessary supplement of sufficient reason.

insufficient reason: a supplement to sufficient reason

The *Principle of Insufficient Reason* says that *not* knowing can also be a ground for reasoning: when the mind is '*tabula rasa*' about the occurrence of certain events, then the *rational* thing to do is to assign *equal* probabilities to each of several alternatives if there is no known reason for preferring one to another (see, e.g. Hald, 1998, p. 159). Thus, for instance, if one has no knowledge[26] whatsoever to base one's beliefs on the *a priori* probability of a rainy day is equiprobable[27] with a sunny day (50% : 50%). Even though the original *Principle of Insufficient Reason* has been critiqued intensely (Hacking, 1971a; Howson, 2002; Sober, 2002), the idea which still stands is that uncertainty can be transformed into something which at least has a certain semblance of rational certainty. By departing from an assumption of equi-probability, uncertainty can be transformed in to something more or less rational and reliable:

> "Let us take a set of events configured in such a way that there is *a priori no reason* why any one of them should occur *rather than* any other. […] When, armed with this hypothesis, we attempt to calculate the likelihood of one event occurring (understood as this or that outcome of throwing the dice), we implicitly assume the following *a priori* principle: *whatever is equally thinkable is equally possible.* It is precisely this *quantitative* equality between the thinkable and the possible that allows us to work out the probability or frequency of an event when we play a game of chance". (Meillassoux, 2008, p. 96)

the downfall of sufficient reason

Over time probable grounds have outgrown their status of supplements. In fact one could even argue that, whereas sufficient grounds are past their prime, probable grounds continue to make the *principio rationis* important for our current age. After all, from the second half of the twentieth century the principle of *sufficient* reason has been under heavy attack – both scientifically[28] (e.g. Popper, 1979, 'Of Clocks and Clouds', p. 214) and philosophically[29] (e.g. Meillassoux, 2008) – as too determinist and onto-theological (there has to be an ultimate reason or final cause which cannot be anything else but God: "*This*

[26] In Leibniz the principle of insufficient reason is only epistemological *because* there is an underlying causality that is 'indifferent': 'It is not we who are indifferent, but the objective tendencies […]'. (Hacking, 1971b, p. 602) Thus, the state of 'no knowledge', i.e. epistemological insufficient reason, coincides with the objectively equipossible grounds.
[27] Leibniz speaks of "aequalibus aequalia" (Leibniz, 1882, p. 448), i.e. "giving equal weight to equal suppositions (Hacking, 1971b, p. 601).
[28] "Indeterminism, which up to 1927 had been equated with obscurantism, became the ruling fashion; and some great scientists, such as Max Planck, Erwin Schrödinger, and Albert Einstein, who hesitated to abandon determinism, were considered old fogies, […]". (Popper, 1979, p. 214)
[29] See for instance: "Quentin Meillassoux […] saves necessity, including logical necessity. But like Hume, he grants that there is no acceptable ground for the necessity of the laws of nature. Meillassoux' proof - for it is indeed a proof - demonstrates that there is only one thing that is absolutely necessary: that the laws of nature are contingent" .(Preface by Badiou in: Meillassoux, 2008, p. vii)

reason must be in some sort of real being, or in its cause […] and is usually named with one word: GOD"[30], (Leibniz, 1890, p. 289, translation in Heidegger 1991, p. 26). For instance, Meillassoux, in reformulating Hume's induction problem, argues that the necessitating principle of sufficient reason did only emerge *because* the universe appeared as a probabilistic 'dice-universe':

the primacy of probable (insufficient) reason

> "Every time it [the dice] is thrown, this dice-universe invariably results in the same physical universe – mine, the one I have always been able to observe on a daily basis. […] The latter has never infringed the principle of uniformity; it has always presented me with the same result given the same initial conditions. The improbability of this stability in the outcome seems so aberrant that I do not even pause to consider the possibility that it might be solely the result of chance. Consequently, I infer from it – via an inference which is generally executed too quickly even to be noticed – the existence of a *necessary* reason, but a necessity that is *extra-logical* as well as *extra-mathematical*. […] if physical laws *could actually change for no reason,* it would be extraordinarily improbable if they did not change *frequently,* not to say frenetically". (Meillassoux, 2008, pp. 97-8)

Pruss, belonging to the minority of defenders of the principle, wails that "a significant amount of work in the twentieth century was put into discussions of attempts to disprove the PSR, whether by counterexample or by reduction to absurdity" (Pruss, 2006, p. 13). Thus it might seem surprising that Heidegger says of this 'outdated' principle that it is what makes our current age tick. However, in this respect it is telling that Heidegger did *not* call his famous course "On the principle of *sufficient* reason", but merely "On the principle of reason". The *kind* of reason is left open[31].

what is left of the PSR in science and technology: probabilistic ratios

In fact in contemporary science and technology it is not only the *sufficiency* of reasons and causes which appears anachronistic, but also 'reason' and 'cause' as a *ground* sounds a bit rusty. Of course, science and technology still look for causes and reasons, but these have long lost their metaphysical aura of foundational *Grounds* with capital 'G'. Causes and reasons are more and more often only probabilistic ratios in algorithmically

[30] "Ea ratio debet esse in aliquot Ente Reali seu causa. […], et uno vocabulo solet appellari DEUS" (Leibniz, 1890, p. 289). Similar conclusions can be found in contemporary accounts of the principle as well: "This means that this PSR, if true, is strong enough to ground the Cosmological Argument for the existence of a necessarily existing First Cause. Of course, it is a separate question what the nature of this First Cause is, though, as I have noted in Chapter 5, there are considerations in favor of a theistic answer." (Pruss, 2006, p. 321) Unsurprisingly, the recommendation algorithm of the website *Amazon* suggests that customers who look for books on the principle of sufficient reason might also be interested in theological books which argue for the existence of God. However Heidegger notes that while in our atomic age, as Nietzsche says, God is dead, "the calculated world still remains and everywhere includes humans in its reckoning inasmuch as it reckons up everything to the *principium rationis*" (Heidegger, 1991, p. 101). When there is no God that can function as the *summa ratio*, the rendering of reasons becomes truly infinite or, as Deleuze would say, even more 'Baroque'. (1993)

adjusted working hypotheses – probabilistic temporary models that have to be eternally adjusted and whose accordance with the data can never be proved conclusively. A new discipline that seems to be exemplary of this shift away from the foundational reading of the principle of sufficient reason to the *principium rationis* as the mere reign of probabilistic ratios is *data science* (Hand, 2007), whose practitioners combine "the skills of a software programmer, statistician and storyteller/artist to extract the nuggets of gold hidden under mountains of data". (The Economist, 2010, February 27th, p. 2)

data science: a pragmatic view on probability

One of the striking novelties of this new discipline is the fact that it has an extremely pragmatic approach that makes the distinction of subjective and objective probability of no importance. Most[32] data scientists shrug their shoulders in indifference towards the Popperian ban on Bayesian (i.e. subjectivist) probability and either fully embrace Bayesianism[33] or use both branches of statistics as they please. Let us recall the irreconcilable quarrels between those who adhere to the position that probability is objective and those who hold that it is subjective: adherents to the former argue that one can never attribute a probability to a hypothesis itself and that probabilities only relate to the likelihood of observed data given a certain hypothesis, whereas the latter maintain that the higher the probability of a hypothesis, the more reason there is to believe that it is true. However in the many applications of data science, e.g., automated speech recognition systems and spam filters, *both* the probability of the data and the probability of the hypotheses are calculated! The multiplicity of probabilistic hypothesis (e.g. ' the sound **** has a probability of 0.65 to mean *head* and a probability of 0.23 to mean *hat*', or, 'an email with VIAGRA in the subject line has a probability of 0.999 to be spam') is subjected to an algorithmically infinite process of negative feedback, probabilistic adjustment of the hypotheses and falsifying scrutiny. It is an endless shuttling hence and forth between data and probabilistic hypotheses to fine tune thought (the categorization in folders, as words, etc) towards being (the sounds, the emails, etc). The question what the probabilities express (e.g. is there an objective propensity of VIAGRA-emails to have a probability of 0.999 to be spam or is this probability the rational belief we have to attach to the hypothesis that it is spam?) recedes into the realm of irrelevant metaphysical wonder – what counts is how well the spam filter or speech recognition system *works*.

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[31] Meillassoux takes this to its extreme and argues that the principle of *sufficient* reason has to be replaced by the principle of *un*reason (2008).

[32] The status of this new discipline, its methods and its implications is still highly debated. See, for instance, the *Wired* (2008) article by Anderson and the abundance of replies that it has provoked.

[33] One of the most important data scientists at Microsoft proudly shows pictures of his pilgrimage to the tomb of Reverend Bayes: http://research.microsoft.com/en-us/um/people/horvitz/revbayes.htm

chapter 2

RESEARCH QUESTION: HOW DO PROBABLE GROUNDS MOVE REASONING IN LAW AND DATA SCIENCE?

summarizing

Before proceeding to the research question I will first recapitulate some of main ideas formulated in chapter one. Where have the introductory remarks on probable grounds/ratios brought us so far? Following Hume's problem of induction the notion of probable ground seemed to lack rationality or even to be a contradiction in terms: a probable ground is like an uncertain certainty. The assumptions on which this conclusion rests is that a ground is a rational, certain and solid step in deductive thought, whereas probability is a mere inductive habit of thought without any rational justification, and thus uncertain and shaky. However, on closer inspection both the notion of probability and ground seemed to be too equivocal to allow for such a simple juxtaposition. Following Esposito I argued that the rationality of probability does not depend on the actualization of a probable event: an event that is probable in the present future but never occurs in the future present does not disproof the rationality of relying on probable grounds. Moreover the notion of ratio can be translated in many different ways such as 'ground', 'reason', 'foundation' or 'cause'. Also the notion of probability is far from unequivocal. How can we say that a 'probable ratio' (or: 'probable ground') is an incoherent imbroglio in which the constituent parts annul each other in contradiction (e.g. a probable ground is neither rational nor probable), if these constituents themselves are opaque to us? Thus the point of view is reversed: by tracing the emergence of probable grounds from a historical and philosophical perspective[34] this might also allow us to shed some light on rationality and probability. The historical perspective brought me to the second half of the seventeenth century, wherein both the classical concept of probability (Bernoulli) and the principle of reason (Leibniz) emerged. What both have in common is a Janus-faced *ratio* – even though in probabilistic thinking this *ratio* is a proportion and in the *principium rationis sufficientes* it is not, both create a coinciding identity between the ratios of thought and those of being. Another thing that is common to both probabilistic and sufficient ratios is their *reckoning* nature – even though in the former it is more explicit – that produces certainty.

probability and rationality are such equivocal notions that simple juxtaposition is impossible

"probable grounds" as the point of departure

Not only do the principle of reason and the classical concept of probability share a similar ratio, but also their histories are intertwined. From the days of its conception and onwards probabilistic ratio has been the supplement to sufficient ratio. The probabilistic principle of *insufficient* reason would offer a way out if the *sufficient* reasons

[34] See the following chapter for more details on the methodology of this thesis.

could not be unearthed. Thus the lack of reason could be turned into, even though insufficient, reason after all. From the 1920s and onwards the principle of sufficient reason has been increasingly criticized – logically, scientifically and philosophically. Inversely proportional to this downfall, probable ratio has emancipated itself from its supplementary role. Probable ratio is no longer the humble *ancilla* of sufficient ratio.

law as the first and the last great bastions of foundational grounds and reasons

Yet there is a field wherein things have not progressed in the same way. That field is law. In law, at least in all its modern Western varieties, the whole legal process always revolves around finding the right grounds (justifications) and the establishment of sufficiently convincing causal connections. In law the principle of sufficient ground still rules in a way that has been long lost in most contemporary scientific and technological practices. Moreover, law is not only one of the *last* bastions of sufficient reason but it was also its *first*: both the emergence of the most archaic[35] form of the principle of sufficient reason in the writings of Parmenides (Spinner, 1977) and the fully-fledged Leibnizian variety came about in a context of legal thinking. As I argued before, Leibniz's principle of sufficient reason has been supplemented from its inception with probable reason. Thus, unsurprisingly, law – with its eternal epistemological uncertainty of the judge, the inescapable need to give a decision, the indirectness of legal evidence, the possibility to assign numerical weight to different kinds of proof (e.g. half or full proof), etc. – was not only the cradle of sufficient reason but also of its supplementary twin: probable reason (Daston, 1988; Franklin, 2001; Hacking, 1975). Consequently we could say that law is the 'practice of origin' of the *principium rationis*: both its sufficient and probable variety. However in law, contrary to e.g. data science, the ratio of the *principium rationis* still continues to be more than mere ratio as a proportion. In law ratio is *both* proportion and ground.

ratio as ground – a meaning preserved in law

Ratio, a simple word, shapes how we think. However, *how* it makes us think, i.e. relate to the world around us, is subject to change. This evolvement – over time, between languages, disciplines, practices, etc.[36] – questions whether we can speak of an 'us' at all. Even though Janus-faced *ratio* tends to appear as universal and timeless, this is a position that is both historically and philosophically untenable. In order to be able to think how

[35] Although the first archaic version of the principle of sufficient reason can be found in Anaximander it is Parmenides (*On Nature*, fragment 8) who gives the principle its logical grounding (Pruss, 2006, pp. 20-26). This famous *ex nihilo nihil fit* reads: "I shall not permit you to say or to think that it grew from what-is-not, for it is not to be said or thought that *it is not*. What necessity could have impelled it to grow later rather than sooner, if it began from nothing? Thus it must either fully be, or be not at all. Nor will the force of conviction ever allow anything, from what-is, to come-to-be something apart from itself; […]". (Parmenides of Elea, 1996, fragment 8a)

[36] To trace the evolvement of words that are important for how we think has been is a way of doing philosophy that has become very important in twentieth century continental philosophy. Heidegger and Derrida have become the exemplary philosophers of the 'etymological' way of thinking; Stengers has coined the notion 'ecology of practices' and focused on thinking in between different practices and disciplines (see e.g. http://www.imbroglio.be/site/spip.php?article43 or (Stengers, 2005).

probable ratio – whose reign is quickly spreading itself over a vast amount of domains – moves thought, I will trace it through two practices. Firstly there is *law*: the practice that is supposed to be the cradle of both the principle of reason (Spinner, 1977) and probable ratio (Daston, 1988; Franklin, 2001; Hacking, 1975). Secondly there is *data science*: the practice in which being and thought fully coincide in algorithms with probabilistic ratios.

thinking ratio through law and data science

After this concise recapitulation of the pivotal questions raised by the notion 'probable ground', it is time to present my research question: How does the reckoning and Janus-faced ratio of probable grounds move reasoning in law and data science?[37] I hypothesize that in answering this question it will be impossible to avoid an issue that was raised at the beginning of this chapter: the relationship (or lack of it) between probability and the actualization of possibilities in time (cf. the questions raised by Esposito, 2007).

research question

Yet, before I can proceed with tracing answers to the central question of this thesis – how does the calculative and Janus-faced ratio of probable grounds move reasoning in law and data science? – I will have to present the methods which will help me to pursue this question. After all, probable grounds do not only shape thought in law and data science, but also my own reasoning[38] in this thesis. Method and object of study overlap and coincide. To ask how probable grounds shape reasoning (e.g., can one think philosophically if one reasons on probable grounds?) while my own thoughts on this matter are also shaped by these probable grounds: it seems a task worthy of Von Münchausen who escaped from a swamp by pulling himself up by his own whig. Thus, unsurprisingly, the matters raised in the following chapter on method will not be unrelated to the questions raised in this chapter.

[37] I do not assume any causal direction, as it would be misguided to assume that there is a law or data science *independently* of reckoning and Janus-faced ratio, or the other way around, that this ratio exists outside the embodiment in a practice. In fact my research question could thus be posed in two ways. Not only "How does the reckoning and Janus-faced ratio of probable grounds move reasoning in law and data science?", but also "How does the reasoning in law and data science move the reckoning and Janus-faced ratio of probable grounds?"

[38] Meillassoux calls this correlationalism: "Correlationism consists in disqualifying the claim that it is possible to consider the realms of subjectivity and objectivity independently of one another. Not only does it become necessary to insist that we never grasp an object 'in itself', in isolation from its relation to the subject, but it also becomes

chapter 3

METHOD: A PARALLAX VIEW[39] ON THE AFFECTIONS OF PROBABLE GROUNDS IN LAW AND DATA SCIENCE

"*…Spinoza will affirm strongly, in book two, that we can only know [connaître] ourselves and we can only know external bodies by the affections that the external bodies produce on our own. […], this is the basic anti-Cartesian proposition since it excludes every apprehension of the thinking thing by itself, that is it excludes all possibility of the cogito. […] a body must be defined by the ensemble of relations which compose it, or, what amounts to exactly the same thing, by its power of being affected. […] A body has something fundamentally hidden: we could speak of the human species, the human genera, but this won't tell us what is capable of affecting our body, what is capable of destroying it. The only question is the power of being affected. What distinguishes a frog from an ape? It's not the specific or generic characteristics, Spinoza says, rather it's the fact that they are not capable of the same affections*". (Deleuze, 1978, 24th January, p. 6)

the before *that allows an affect to emerge*

To live is to be affected[40]: the flower is affected by the sun, the lover is affected by his beloved, the ear is affected by the scream, the scientist is affected by the microbe below his microscope, and as Jakob von Uexküll famously showed: the tick has only three ways of being affected[41]. Before an affection can arise there always has to be something which

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necessary to maintain that we can never grasp a subject that would not always-already be related to an object". (2008, p. 5)

[39] 'Parallax view' is a reference to Žižek's (2006) book by the same name. Though my theoretical and methodological stance differs in many respects from Žižek's (e.g. there is no Lacan, Hegel or Marx to be found in this thesis, nor do I endorse the dialectical understanding of the 'parallax') I adopted the term – as I explain later in this chapter - to express a philosophical way of thought that is ignited by the "confrontation of two closely linked perspectives between which no neutral common ground is possible". (Žižek, 2006, p. 4)

[40] The word *affection* is used here in a Deleuzian sense. Following book 2 and 3 of Spinoza's *Ethics*, Deleuze distinguishes between *affect* ('affectus') and *affection* ('affectio'). Contrary to the former an *affection* has to be understood as a specific form of an *idea*: "the trace of another body on my body" (Deleuze, 1978, 24th January, p. 5). According to Spinoza there are three kinds of ideas: affections, notions and essences. Affections are the lowest form of this trio "…because these ideas of affection know [connaissent] things only by their effects: I feel the affection of the sun on me, the trace of the sun on me. It's the effect of the sun on my body. But the causes, that is, that which is my body, that which is the body of the sun, and the relation between these two bodies such that the one produces a particular effect on the other rather than something else, of these things I know [sais] absolutely nothing" (Deleuze, 1978, 24th January, p. 5). A similar difficulty to give a proper English word for *affection* can also be seen in the translation of section 13 of Leibniz's *Monadology*: "…; et par consequent il faut que dans la substance simple il y ait une pluralité d'affections et de rapports quoyqu'il n'y en ait de parties"(Leibniz, 1885, p. 608). In translation by Bennett: "So although there are no parts in a simple substance, there must be a plurality of states and of relationships" (Leibniz, 2004). Deleuze reformulates: "And even when the monad will be the subject without parts, predicates will continue to be "affections and relations", at least in the lexicon of the *Monadology*" (Deleuze, 1993).

[41] "In this particular case, the *Umwelt* is reduced to only three carriers of significance or *Merkmalträger* : (1) the odor of the butyric acid contained in the sweat of all mammals; (2) the temperature of thirty-seven degrees corresponding to that of the blood of mammals; (3) the typology of skin characteristic of mammals, generally having hair and being supplied with blood vessels". (Agamben, 2004, p. 46)

comes *before*, that is to say an a priori which is a relational *constellation* or a *landscape* which attunes the *affector* and the *affectee* in such a way that there is a space where they can meet and become what they are (e.g., only within a complex network of organs, words, laboratory instruments, etc., the microbe and the microbes researcher can arise *as such*: as a microbe and a researcher).

That there is such a *before* that allows the affect to emerge is both a very obvious and a very counterintuitive idea. In twentieth century philosophy it has been pointed out over and again that feeling, speaking, writing or doing research is never immediate – every sensation, utterance, letter or research paper has to traverse a 'before' (an 'a priori') before it comes into being. Yet, because this *before* of every affection is so close to our skin (or, sometimes because it simply *is* our skin) it is easy to overlook it. Moreover, the argument of the *before* has often been misconstrued as a relativist assertion (Latour, 2002) which corrupts the pureness of the observation, the truthfulness of the feeling, the reality of the fact, etc. But how can one corrupt something – direct sensations, an original or *mentalese* language of thought, etc. – that would not have existed without this 'corruption'? There is no pure input which precedes the before. Only *in* a so called *before* something can emerge. It is important to underline that the *before* does not mediate an immediate, but that it is a mediation *without* original input. Retracing the paths traversed by such mediations without an immediate origin has been the endeavour of many thinkers in different fields. Just to give a flavour of the vast range of fields which have been covered one could think of the utterance of speech (in *On Grammatology*, 1997, Derrida famously debunked the fallacy that so-called *direct* speech is more immediate, pure, natural and original than written language), the experience of one's self (Ricoeur, 2008, p. 143, argued that self-understanding is never an "immediate intuition of the I" as it always involves mediation by a "long detour through objectification, making reflection an interminable Odyssey") and the production of scientific knowledge (Latour, 1999, became famous for his ethnological studies wherein he opened the black box of scientific mediators and showed that scientific knowledge, however real and effective it might be, is never *pure* scientific observation: *no microbe without microscope*).

the affection of probable ratio

Since the seventeenth century affections have emerged that traverse a *before* of probable ratio. For example, however different they may be in many respects, both the judge who has to decide whether the suspect is guilty or innocent and the spam filter that has to categorize an incoming mail into either the spam or the inbox folder, traverse this before of probable ratio. Probable ratio is the element that both the judge and the spam filter

traverse before they are affected by what something *is* – for the *is* (e.g. 'the suspect *is* guilty'), which is opened up by this affection, is an affection of probable ratio.

what is the 'what is' of probable ratio?

What is this probable ratio they traverse? In asking this question the difficulty is *how* to ask it. If it is indeed true that in law and data science the question of 'what is?' traverses the before of probable ratio, we have to ask ourselves if this is the case in philosophy as well. When we ask philosophically after the 'what is' of probable ratio in law and data science, we cannot simply assume that we ourselves do *not* traverse this probable ratio when thinking philosophically. Or, to reformulate the question: is the 'what is' of philosophy different from the 'what is' of law and data science? Does it also share in the affection of reckoning and Janus-faced ratio? Because if this would be the case the question would coincide with what is questioned. To be affected by philosophical thought is to ask for the 'what is?' of *thinking*. If one, as I did in the beginning of this chapter, posits that thought is a way of being affected, one is inclined to answer this question affirmatively. After all, one could in fact hold that the whole notion of the word 'affection' is exemplary of a reckoning and Janus-faced ratio. Meillassoux (see above, footnote 32) calls this correlationism:

> "Correlationism consists in disqualifying the claim that it is possible to consider the realms of subjectivity and objectivity independently of one another. Not only does it become necessary to insist that we never grasp an object 'in itself', in isolation from its relation to the subject, but it also becomes necessary to maintain that we can never grasp a subject that would not always-already be related to an object" (Meillassoux, 2008, p. 5)

Even though philosophical thinking might not be affected by probable ratio, it most likely is affected by ratio as such: "Thinking appears as rationality".[42] Heidegger writes: "The *principium rationis* as thought by Leibniz not only determines, by the sort of demand it makes, modern cognition in general, but it permeates in a decisive manner that thinking known as the thinking of thinkers – philosophy"[43] (Heidegger, 1991, p. 43).

a manifesto of method

How to proceed? The method proposed in this thesis is one of utmost indirectness. The problem of circularity should not be belittled – but it is possible to pay attention to the mediators (such as words) that guide us when we think about thinking. Let me (clearly not everybody will agree with this manifesto of method, so it is time to abandon the all

[42] "Das Denken erscheint als das Rationale". (GA8, Heidegger, 2002, p. 213)
[43] "Das von Leibniz gedachte principium rationis bestimmt in der Art seines Anspruches das neuzeitliche Vorstellen nicht nur im allgemeinen, sondern es durchstimmt in entscheidender Weise jenes Denken, das wir als Denken der Denker kennen, die Philosophie". (Heidegger, 1957, pp. 80-1)

encompassing *we*, the colloquial *you* and the impersonal *one* by which I have tried to lure the reader into this text) declare the way in which I will try to proceed.

the before

(1) To think the *before* – but how?

Where to look for the probable grounds as the before? At the beginning of this paragraph I wrote: "…*to pay attention to the mediators (such as words) that guide us when we think about thinking*". Yet, it is clear that mediators are not only words but the whole of the relational constellation that precedes thought – which consists out of a heterogeneous assemblage of actants (cf. Latour, 2005) such as my body, its technological prostheses (e.g. a pencil, a typewriter and an external hard drive: Kittler, 1999), the words (which are technological prostheses as well: Stiegler, 1998) in which I speak and the landscapes and architectures in which I move. Should one follow the Heidegger-Derrida 'method' of retracing the words through which one thinks? Or maybe the ethnographic-semiotic 'method' of Actor-Network theoreticians like Latour (for instance, retracing the very particular network of scientists, microscopes, pipettes and coffee machines which allow a microbe to emerge)? Before I can attempt to answer this question I will first need to have a look at the other methodological imperatives.

breaks and interruptions

(2) Looking for breaks and interruptions in the *before* of thought.

The relational constellation that precedes thought, i.e. the *before*, evolves over time, both within and between languages, within and between practices. The fact that the before of thought is neither static nor eternal allows me to create a certain distance to my thought. Although similarities and differences which emerge in evolutions and translations do not offer a way out of the circularity of thinking about thinking, they nevertheless create a stance wherein the thinker does not necessarily have to coincide completely with what is thought. In the in-between of a difference there can be a reason to start to think differently. The 'before' or 'always-already' cannot be avoided, but the way in which it moves us can become more noticeable.

a parallax between two practices

(3) Practices: going hence-and-forth between the parallax of law and data science.

Though I can never be outside the before of the questioning of what is, in going hence-and-forth between different ways of thinking I could become affected by the difference and similarities between them. As Jacques Rancière said in an interview: "Philosopy is always a discourse *between* something and something"[44]. Such a philosophical way of thought which proceeds by "putting two incompatible phenomena on the same level", is what Žižek baptized the "parallax view":

[44]"D'une manière générale je ne pense pas que la philosophie soit une philosophie de quelque chose. La philosophie est toujours un discours *entre* quelque chose et quelque chose […] La philosophie est pour moi un travail sur l'homonymie." (Blouin, During, & Zabunyan, 2005, p. 142)

> "…the illusion of being able to use the same language for phenomena which are mutually untranslatable and can be grasped only in a kind of parallax view, constantly shifting perspective between two points between which no synthesis or mediation is possible. Thus there is no rapport between the two levels, no shared space—although they are closely connected, even identical in a way, they are, as it were, on the opposed sides of a Moebius strip. […] although they are linked, they are *two sides* of the same phenomenon which, precisely as two sides can never meet". (Žižek, 2006, p. 4)

A parallax view is something of a paradox: it allows one to become affected by the unaffected, the unmediated. The question which follows is of course: a parallax between what and what? Which practices, which modes of thought? In the first chapter I argued that probable grounds have become ubiquitous – not only the judge or the statistician rely on probable grounds, but everyone of us while being 'intuitive statisticians' (Brunswik, 1943; Gigerenzer, 2000). Is this true? Are you an intuitive statistician when you look into the eyes of your beloved or mourn for the loss of a relative? Is the 'we' of thinking on probable grounds restricted in some way, for example, does is only concern Western thought or technological-scientific actions? Or, to pose a question that might be even more difficult, are the probable grounds which direct thought the same in different practices? For instance, Jonathan Cohen (1977) famously argued, that probable grounds in legal reasoning ("Baconian probability") are fundamentally different from those in calculative (or as Cohen calls it: "Pascalian") probability. To put it in more abstract terms: which 'unit' or 'system' should one study? In this thesis I will try to think between law and data science: both practices are affected by probable ratio in a way that is at the same time both very similar and yet abysmally different. I do not claim that this is the only or best way to question what probable ratio is, there are many roads that lead to Rome, but given my own background thinking through these two practices suits me.

looking for a before that affects my thought

(4) <u>To think is to *reshape* the before of thought – the Deleuzian imperative of creation of new philosophical concepts.</u>

After three methodological imperatives I still do not have a clear answer how and where to begin. The first methodological imperative was to look for the *before* – but which *before* is relevant? The second demanded to look for the breaks and interruptions of the *before* – but how to know where to encounter them? And while I declared in the third imperative that I would look at law and data science, the choice for these two particular practices might seem rather arbitrary. So, how to begin? I answer this question in a pragmatic way:

a beginning without grounds

I do not look for the *before* 'in itself'[45], but for a *before* that affects the way I think and which opens up possibilities for new affections. I cannot define this 'before' beforehand, neither predict where the breaks will be, nor say beforehand which modes of thought are encompassed in the 'we' of probable grounds: if I would know that this whole exercise would be superfluous. Without any grounds, not even probable grounds, to guarantee its outcome this is an uncertain journey. Thus my beginning is not very well grounded: I simply start by thinking the words 'before' and 'probable grounds' and I can only *hope* that by closely following the mediations which make me think, in particular the interruptions and breaks which I might encounter, the trajectory which I traverse could affect the way I think and open up possibilities for new affections. Yet, as became clear in chapter 1, the words surrounding both ratio *in general* and *probable* ratio in particular (cause, reason, ground, possibility, correspondence of subject-object, reckoning, etc.) are philosophical slippery slopes. This is a promising sign for me who has set myself the task to have a parallax view (2006) at probable reason in order to find new words or concepts (Deleuze & Guattari, 2003) that will allow for new philosophical affections and relations.

[45] Of course there is no 'before in itself': the 'before' is never 'just' out there. In the same way as the 'microbe' emerges as an 'artefact' or 'invention' from microscopes, scientists, words and pipettes, the attempt to retrace the 'before' of probable ratio will also necessarily traverse its own 'before'. Still this does not imply that it is my subjective creation (and neither is the microbe a mere figment of imagination), because this 'before' is not the subjective me who thinks, but the whole which is traversed and which steers my thoughts. The before is neither objective nor subjective, but an affection.

In the first chapter I followed Hacking's thesis (1975) that probability in the modern understanding of the word, that is Janus-faced (aleatory-epistemological) and reckoning, only emerged in the second half of the seventeenth century. However, the word as such emerged at least[46] a century earlier when Jesuits[47] developed the so-called method of 'probabilism' or 'probabilistic casuistry' (Byrne, 1968) to decide in morally equivocal matters: it is "a form of moral reasoning aimed at interpreting and solving the practical issues of every-day life posed by the unprecedented changes of the early modern era" (Maryks, 2008, p. 3).

probabilism

> "What is to be done when authorities, especially the Fathers of the Church, are found to disagree? The problem became pressing in the Renaissance as more and more texts were discovered and more and more interpretations of existing texts were invented. […] Probabilism says that one may follow some probable opinion or other, even a less probable opinion. The word 'probable' here does not mean well supported by evidence. It means supported by testimony and the writ of authority. When a doctrine is disputed, and you are in doubt how to act, you may, according to the probabilists, follow a course of action that is recommended by some authority, even when weightier authorities counsel the opposite course of action. […], from the point of view of the Jansenists, the probabilists would first of all decide on a course of action for its social and moral expediency. Then they would find some old text that could be interpreted as approval of that course of action". (Hacking, 1975, p. 24)

As Hacking (1975, pp. 18-30) shows, the relationship between this kind of moral probabilism and modern probability is far from evident. The fact that Pascal, a Jansenist

[46] Garber & Zabell (1979) argue that the word 'probability' has been around much longer and point, e.g., to the use of 'probabilis' in Cicero. In a similar vein Franklin (2001, p. 103-4) argues that the seventeenth century emergence of mathematical probability is an offshoot of a much older uninterrupted tradition of unquantified probability which reaches from antiquity till our present day, and he stresses that even in ancient Greek two words were in use that we today often (anachronistically) translate as 'probability': πιθανόν (*pithanon*) and εἰκός (*eikos*). *Pithanon* is a word that was particularly common in rhetorics, meaning something like 'persuasive', 'plausible' or 'convincing'. *Eikos* (from ἔοικα = 'to resemble') was normally used in the sense of 'like' or 'likely', but Plato (see also above, footnote 7) used it in the specific sense of 'like truth, but not truth'. Aristotle's *Poetics* (1995, 1460a, chapter 25, p. 134-5, lines 11-2) contains a line of advise to poets that nicely illustrates the use of both words: "What is convincing though impossible (ἀδύνατα εἰκότα, *adunata eikota*) should always be preferred to what is possible but unconvincing (δυνατὰ ἀπίθανα, *dunata apithana*)."
Though such accounts (Franklin, 2001; Garber & Zabell, 1979) are very enlightening with respect to the prehistory of probability, and even show that in some particular cases such proto-probability was associated with a rudimentary frequentist understanding ('when things happen often they are more probable'), they do not challenge the fact that *Janus-faced and reckoning* probability only arose in the second half of the seventeenth century.

and one of the main founders of modern probability, was an extremely fierce opponent of Jesuit probabilism, exemplifies this troubled relation. Probabilism never recovered from Pascal's devastating attack in his *Provincial Letters* (1962) and it became forever "associated with hypocritical minds and the alleged backwardness of the Counter-Reformation" (Maryks, 2008, p. 3). Nevertheless the word 'probable' in the sense of 'approvable', 'worthy of approval' or 'trustworthy'[48] still lingered on for a few centuries:

> "A couple of centuries ago one readily spoke of a 'probable doctor', apparently meaning a medical man who could be trusted. We no longer speak that way". (Hacking, 1975, p. 18)

The reason why probabilist casuistry seems so backwards from a contemporary perspective is precisely because it lacks the two major characteristics of modern probability: it does not base itself on clear-cut calculations, which makes it appear as lax, permissive or even opportunist, and instead of being equivocally objective-subjective it relies fully on the approval by an authoritative opinion, which surrounds it with a very medieval aura. And yet probabilism and modern probability are not unrelated.

the book of Nature: from Jesuit probabilism to modern probability

As Hacking (1975) convincingly argues, it was the late Renaissance understanding of Nature as a book[49] which allowed for the large leap from probabilism into modern probability.

> "Nature is the written word, the writ of the Author of Nature. Signs have probability because they come from this ultimate authority". (Hacking, 1975, p. 30)

This new understanding of Nature led to the slow dissolution[50] of the medieval distinction between the demonstrative high sciences, "such as optics, astronomy, and mechanics" (Hacking, 1975, p. 35), where effects could be demonstrated from first causes, and low sciences such as medicine, astrology or alchemy, where one has to rely on the indirect evidence from signs (effects) to diagnose an underlying state (hypothetical first causes). The understanding of the world as a text written by God and the need to find the right way of reading it, made the notion of the sign ubiquitous and respectable. For modern probabilists the signs which are to be found in the 'text' of nature provide evidence and testimony that overrules every other authoritative opinion: probability is no

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[47] Though originally developed by a Dominican theologian, Bartolomé de Medina (1527–1580), probabilist casuistry became particularly popular among Jesuits.

[48] *Probabilis* in *classical* Latin meant, among other things, 'having the appearance of truth' or 'seeming likely' and was thus closer to the modern colloquial, non-mathematical sense of 'probable' (Garber & Zabell, 1979, p. 45).

[49] Galileo (2008, p. 183) famously writes in *The Assayer* (1623): "Philosophy is written in this all-encompassing book that is constantly open before our eyes, that is the universe; but it cannot be understood unless one first learns to understand the language and knows the characters in which it is written. It is written in mathematical language, […]".

longer an attribute of persons and their opinions but of signs which can be found in Nature, that is the written opinion of the Creator. In 1686 Leibniz underlines in *Recommandation pour instituer la science générale* that he does not speak of probability as understood by the Casuists, which relies on the reputation of scholars, but of a probability that can also be called verisimilitude (*vraisemblance*) because it draws upon the nature of things to the extent (*proportion*) that they are known:

> "Je ne parle pas ici de cette probabilité des Casuistes, qui est fondée sur le nombre et sur la réputation des Docteurs, mais de celle qui se tire de la nature des choses à proportion de ce qu'on en connaît, et qu'on peut appeller la vraisemblance". (1890, p. 167; 1999, p. 707)

Sullerot (2006), who gives a nice overview of the ideas concerning probability in the *New Essays* (Leibniz, 1882, 1996), proposes to call this approach the *naturalisation* or *realisation* of the probability: it is nature and the things (*res*) themselves that give testimony of their nature through signs which can be understood in terms of probability. Nevertheless, probability in Leibniz is – as it is in the writings of other seventeenth century probabilists – not *fully* naturalised but always Janus-faced. Even though the foundation of probability "is always grounded in likelihood or in conformity to truth", this "resemblance between the probable and the true comes either from the thing itself or from 'something extraneous' ['conformity with something we know or on the testimony of those who know it', *KdV*]". (Leibniz, 1996, book IV, chapter 15, p. 457)

So far I looked at two phenomena in this chapter that preceded the emergence of Janus-faced and reckoning probable grounds: old-school Jesuit probabilism and a shift towards a calculative textualization of nature. However, at least one crucial 'ingredient' still seems to be missing: proof. Hacking (1986) opens his British Academy lecture of 1973 by stating:

proof

> "Leibniz knew what proof is. Descartes did not. […] Leibniz's concept of proof is almost the same as ours. It did not exist about his time. […] Leibniz was sure that mathematical truth is constituted by proof while Descartes thought that truth conditions have nothing to do with demonstration. […] The modern reader tends to equate intuition and deduction with axiom and theorem proved, but this is to see matters in a Leibnizian mould. The Cartesian distinction is chiefly psychological. One man might require deduction where another would intuit. In either case the end product is perception of truth". (p. 47 and 51)

[50] Hacking (1975, p. 35 ff.) underlines that he merely describes this dissolution in order to clarify the origin of the concept of 'inductive evidence', and not the origin of the highly complex and equivocal concept of the 'experimental method'.

For Descartes there can be direct access of truth and certainty by intuition, whereas for Leibniz truth and certainty can only be reached indirectly – through proof (which often will turn out to be a 'Baroque', Deleuze, 1993, chain of proof-upon-proof). From proof to probability it is only a little step[51]: "finite proofs and probability" are "coarse and inadequate" reflections of "the very nature of truth, the infinite proof" (Hacking, 1986, p. 59). As I will argue in the following chapter the emergence of this concept of proof might have emerged in the context of legal thought.

grounds after all

However, before going to the next chapter, it is time to pause for a moment and look at my own style of reasoning: in this chapter I explored the state of affairs *before* there was anything as 'probable grounds'. And in the next chapter, on law and probable grounds, the *before* involves the role of law in the shaping of modern probability as well as the Parmenidian 'principle of reason' *avant la lettre*. While I declared the death of the principle of sufficient reason in chapter one, and argued in the previous chapter that my own approach is not very well grounded – at least not in the classical sense – but only traverses 'mediation' without immediate origin, here I am: unearthing origins, pointing to proto-forms of probability, contaminated by the bewilderment of so many other scholars (e.g. Franklin, 2001; Garber & Zabell, 1979) about the fact that probability seemingly appeared 'out of nothing' ("But that is impossible – nothing comes out of nothing!", say the little Parmenides and Leibniz within me). In fact, there is a curious contrast between the style of this chapter, presenting grounds (probabilism, a textualization of nature, etc.) of the principle of probable ground, and the fact that this chapter describes a time *before* the principle of ground (both the sufficient and its supplementary, probabilistic, variety). Maybe it is therefore better to say that probabilism, the calculative textualization and the legal setting (*see infra*, chapter 5) *allowed* for the emergence of an affection that makes them *now* appear to me *as grounds*.

[51] The words "proof" and "probability" are etymologically closely related through the Latin verb "probare" (to test, prove worthy).

THE PROBABLE GROUNDS OF LAW – SOLID/UNCERTAIN ENCOUNTERS OF BEING AND THOUGHT

grounds

Law is the discipline of grounds. For instance, most German case law begins by a heading called "grounds" (*Gründe* or *Entscheidungsgründe*), in Dutch judgments the legal arguments (*middelen*) are enumerated and followed by whether they are grounded or should be rejected, a format which is also common in France (where they speak of *moyen*[52]), and also the verdicts in other Western societies[53] abound with 'reasons' and 'grounds'. A legal verdict *without* any factual and legal grounding to justify it does not deserve its name. Even during Stalinist show trials allegations were invented to create the illusion of grounded judgments, i.e. of law. A judge who does not even pretend to ground his or her decisions, openly declaring the verdict to be fully ungrounded, belongs to the realm of the absurd. The chains of factual and legal grounds that form the foundation of a legal decision create the expectancy, or at least the hope, that it is correct. Thus it will not come as a surprise that Leibniz's *principium rationis* and the law are not unrelated. The only question is: how are they related? Was law already a discipline of grounds *before* the formulation of the principle of reason? Or is it as Berkowitz (2005) argues only *after* Leibniz's *principium* that law developed its obsession with reasons and grounds?

> "[…] Leibniz's metaphysics, and specifically his embrace of the principle of sufficient reason (*nihil est sine ratione*), shifted the inquiry into law from a knowing of law itself to a knowing of the reasons, grounds, and justifications for law. Law comes to be subordinate to its justification or rationalizations; in other words, law is emptied of any independent meaning and authority". (p. 7)

uncertainty

Notwithstanding the question *when* law became the discipline of grounds, it is clear that this is not the only aspect that characterizes it: law is also the discipline of uncertainty. While the same might go for other areas of life, in law it is *particularly* evident that a judge never has direct access to the matters under dispute but always has to rely on testimonies and other kinds of proof. Judgments that turn out to be incorrect, especially in criminal cases such as *Lucia de B.* (2010), where an innocent person is presumably wrongly convicted, cause public outrage[54]. Yet, in law there is *always* a certain amount of

[52] As Latour (2010) shows the word *moyen* (which can be translated as 'legal mean', 'ground', 'argument' or 'reason') is crucial in the creation of legal arguments.
[53] I have limited myself to Western legal systems. For some seminal descriptions of non-Western legal systems, see e.g.: Gluckman, 1965; Malinowski, 1926; Moore, 2005.
[54] See above, footnote 2, on the case of *Lucia de B.* Hoge Raad (Netherlands Supreme Court), LJN: BD4153 (*Lucia de B.*), 11 March 2010; Hof Arnhem, (Court of Arnhem), LJN: BM0876, (*Lucia de B.*), 14 April 2010

uncertainty. No legal system requires the judge to be fully certain, but 'merely' to establish, e.g., a 'conviction beyond reasonable doubt'. Hence, Van Asperen de Boer writes about the use of statistical evidence:

> "How did one dare to use a [statistical] number to convict somebody? Is it not possible that something very improbable could take place nevertheless? However, one has to realize that decision-making under uncertainty is inherent to criminal procedure. You never know for sure. It has to be 'beyond reasonable doubt' that the criminal offence is committed by the suspect. But when this uncertainty is expressed in a number, many people become very alarmed". (Van Asperen de Boer, 2007, p. 66, *transl. mine*)

What is exemplified by a case like *Lucia de B.* is that in law, contrary to e.g., data science, probable ratio can never be *merely* a probabilistic proportion, but always also has to be a probable *ground*.

proof

In law the way to overcome uncertainty and generate solid grounds is by means of *proof*. This might sound counterintuitive as proof itself is often inconclusive or even fully lacking. However, this is not an insurmountable barrier as long as one can rely on presumptions and add up several pieces of partial proof (such as 'half proof') to create sufficient legal grounds. Such methods were already conceived by the Romans (Daston, 1988; Franklin, 1991, 2001; Hacking, 1975) and became particularly advanced after the twelfth century (Daston, 1988, p. 42 ff). Leibniz, a lawyer himself, was also very well aware of this:

> "When jurists discuss proofs, presumptions, conjectures, and evidence, they have a great many good things to say on the subject and go into considerable detail. They begin with *common knowledge*, where there is no need for proof. They deal next with *complete proofs*, or what pass for them: judgments are delivered on the strength of these, at least in civil actions. In some places they are more cautious in criminal actions; in these there is nothing wrong with insisting on *more-than-full* proofs, and above all for the so-called *corpus delicti* if it is that sort of case. […] Then there are *presumptions*, which are accepted provisionally as complete proofs – that is, for as long as the contrary is not proved. There are proofs which are, strictly speaking, *more than half full*; a person who founds his case on such a proof is allowed to take an oath to make up its deficiency (*juramentum suppletorium*). And there are others that are *less than half full*; with these, on the contrary, the oath is administered to the one who denies the charge, to clear him (*juramentum purgationis*). Apart from these, there are many degrees of conjecture and of evidence. And in criminal proceedings, in particular, there is evidence (*ad*

torturam) for applying torture […]. The entire form of judicial procedures is, in fact, nothing but a kind of logic, applied to legal questions. (Leibniz, 1996, pp 464-5; also quoted and discussed in: Franklin, 1991, p. 133; Roinila, 2007, p. 155; Sylla, 1998, p. 49)

the role of law in the emergence of probability: a well-documented fact

Thus the argument that I present in this chapter is that law, with its inherent uncertainty, its need for grounds and its rudimentary methods of quantifying inconclusive evidence, allowed for the unlikely marriage between probabilistic casuistry and the calculative textualization of nature. This is in itself not a very novel or original idea: the role of law[55] in the emergence of seventeenth century probability is almost impossible to overlook (Daston, 1988; Franklin, 1991, 2001; Hacking, 1975). Even when writing about probability in seemingly a-legal contexts, such as chance games, probability's role is always to guarantee a *just* or *fair* game setup or division of the stakes. For instance, Huygens speaks in his *Rekeningh in Spelen van Geluck*[56] (1660) of 'fair play' ('rechtmatigh spel', Daston, 1988) and Leibniz (1999, p. 92-101) opens *De incerti aestimatione* (September 1678) by writing that a game is fair (*justus*) when hope and fear have the same *ratio*[57].

a new dimension: not just the emergence of probability *or of the* principium rationis, *but of* probable grounds

As I do *neither* want to simply repeat or refine this well-established picture of law (in particular its way of coping with uncertainty through proof) as the facilitator of the emergence of probability, *nor* merely elaborate on the role of legal reasoning (the role of factual and legal grounds) in the constitution of Leibniz's *principium rationis*, I try to bring these two lines of research together. What I add to the existing research on *either* probability *or* the *principium rationis*, is an attempt to retrace the relation between law and *probable grounds*, i.e. the probabilistic or insufficient *ratios* which supplement Leibniz's *principium rationis sufficientis*. I hope to show that law did not just contribute, on the one hand, to the emergence of probability because it had developed ways to quantify uncertainty and cope with situations where only inconclusive proof was available, and on the other hand to the principle of ground because it is a discipline of grounding, but that law gave raise to the Janus-faced nature which characterizes both insufficient and sufficient ratios.

First I will try to substantiate this claim by taking a closer look at the legal and Janus-faced (a coincidence of being and thought) nature of Parmenides' 'principle of reason'-*avant la lettre*. Secondly I will try to retrace a similar trajectory in the constitution

[55] Not only the legal way of copying with evidence helped the shaping of probabilistic calculus, but also the modular logic which plays a role in the fair execution of conditional rights. Leibniz described the latter in his early works *De conditionibus* (Leibniz, 1930, pp. 99-15, originally published 1665) and *Specimina Juris*, (1930, pp. 367-430, originally published 1667-69). See also: Thiercelin, 2008.

[56] First appeared in translation as *De ratiociniis in ludo aleae,* 1657. See further above, chapter 1.

[57] "Justus ludus est si spes et metus utrinque eadem ratio sit", Leibniz, 1999, p. 92.

of Leibniz's *principium rationis sufficientis* and its supplementary principle of insufficient reason.

Parmenides

Twenty five centuries separate us from Parmenides – the man who is considered to be one of the earliest and most important fathers of Western thought, and in particular of philosophy, logic and science. Henceforth the little of his writings that has survived – a collection of fragments, in total approximately 160 lines, of a didactic poem (Burnet, 1920, pp. 126-45; Diels & Kranz, 1959, pp. 227-45) – belongs probably to the most analyzed texts of the world. There are at least two famous parts which cannot be left unmentioned when writing about the prehistory of the *principium rationis*.. Firstly (see also above, footnote 35) there is fragment 8, in which the *ex nihilo nihil fit*, which is often understood as a rudimentary version of the principle of reason[58], can be found:

Parmenides' principle of ground?

> "I shall not permit you to say or to think that it grew from what-is-not, for it is not to be said or thought that *it is not*. What necessity could have impelled it to grow later rather than sooner, if it began from nothing?"[59] (Parmenides of Elea, 1996, fragment 8, line 7-10)

and

> "[…]: either *it is* or *it is not*."[60] (Parmenides of Elea, 1996, fragment 8, line 16)

Parmenides' adequation of thought and being

Secondly, there is fragment 3, which contains the adequation of thought and being:

> "for it is the same thing that can be thought and that can be"[61] (Burnet, 1920, p. 129, fragment 3)

From the contemporary perspective both themes, the 'something-cannot-come-out-of-nothing' and the *adaequatio rei et intellectus*, are of course easily understood as precursors of modern rationality[62]. While the aforementioned fragments might sound very familiar and modern to the contemporary reader, the poem of which they are part has nothing in common with the style of modern scholarship. Not only because of the curious form of a

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[58] It is important to underline that it is only in *retrospect* that Parmenides' writings are understood as containing a rudimentary version of the principle of reason. Parmenides does not speak of anything even vaguely related to words like 'ratio', 'ground', or 'reason', nor does he formulate any 'principles'.

[59] "οὔτ᾽ ἐκ μὴ ἐόντος ἐάσσω
φάσθαι σ᾽ οὐδὲ νοεῖν· οὐ γὰρ φατὸν οὐδὲ νοητόν
ἔστιν ὅπως οὐκ ἔστι. Τί δ᾽ ἄν μιν καὶ χρέος ὤρσεν
[10] ὕστερον ἢ πρόσθεν, τοῦ μηδενὸς ἀρξάμενον, φῦν;", Diels & Kranz, 1959, p. 235-6, fragment 8, lines 7-10.

[60] "ἔστιν ἢ οὐκ ἔστιν", Diels & Kranz, 1959, p. 236, fragment 8, line 16.

[61] ". . . τό γάρ αυτό νοεῖν εστίν τε και είναι.", Diels & Kranz, 1959, p. 231, fragment 3.

[62] See e.g Popper (2002a, p. 549), who turns Parmenides in a critical-rationalist *avant la lettre*: "He [Parmenides] is a revolutionary thinker, […] his revolution consisted, partly, in trying to prove a doctrine of immobility or invariance of reality, the non-existence of change. Some of his other revolutionary innovations were: his discovery of the distinction between *appearance* and the *reality* behind the appearances; and his onslaught upon common sense, empiricism, and traditional belief which he thought was based upon mere convention (name-giving) rather than truth: upon *doxa*, the mere opinion of the mortals. In all of this he had, of course, predecessors, but he went far beyond them".

'didactic poem' – neither fully poetic, nor truly abstract (Heidegger, 1992, p. 2-3) – but also because the quoted lines are part of a revelation given to Parmenides by a goddess to whom he has travelled in a chariot after he has entered through "aetherial gates" (fragment 1, line 14) the "roads of day and night" (fragment 1, line 11). This 'mythological' side to Parmenides' writings is a bit of an embarrassment to the modern reader and many interpreters prefer to ignore or understand it as a simple allegory (Spinner, 1977, p. 96 ff). Who is this goddess and what is her role within the text? Heidegger calls her the goddess of truth (1992, p. 5), but it is more likely[63] that she is *Dikē*, the goddess of law and truth, who is named twice in Parmenides' fragments: first as the *Dikē polupoinos*[64] ("avenging *Dikē*", fragment 1, line 14) who keeps the keys to the gates of day and night, and secondly it says that *Dikē* is the one who "*does not loosen her shackles so as to allow it to come-to-be or to perish, but holds it fast*" (Parmenides of Elea, 1996, fragment 8, lines 14-5) and thus guarantees the *ex nihilo nihil fit*. Moreover, the goddess also says that it was not ill chance (*moira*), but *themis* and *dikē*[65] (fragment 1, line 28) that brought Parmenides on this path.

a goddess

Dikē

a perplexity: why are there so many legal terms in Parmenides?

Here we might be struck by a perplexity: why do the founding fragments of all Western philosophy, logic and science abound with what seem to be (at least from the modern perspective) *legal* terminology? What are the roles of the goddess *Dikē*,, and the words *themis*[66] and *dikē* [67] a in this text? Let's begin by the question whether *Dikē* is a *legal* goddess. Translating *Dikē* simply with *Justice* does not seem to be very helpful[68] – not paying any attention to the particularities of the Greek notion *Dikē* might lead one astray into a swamp of anachronisms – *completely* ignoring[69] the fact that this goddess stands in a legal context seems to be too radical as well. A rare exception to this tendency to fully ignore the legal connotations of *Dikē* is presented, with the proverbial *deutsche Gründlichkeit* ('Teutonic thoroughness'), by Spinner (1977) who argues that in its

[63] See also Popper, 2002a, pp. 545-7.
[64] "Δίκη πολύποινος"
[65] "θέμις τε δίκη"
[66] *Themis* a very particular word, meaning something like 'approved behaviour' or "law", and often anachronistically translated as 'justice' or 'order'; see e.g. Gagarin, 1989.
[67] *Dikē* is another word that has no clear equivalent in English, originally meaning "ruling" or "settlement", i.e. "what one gets as the result of a judgment", later more broadly "plea, case, trial, court" or even "legal process", and finally becoming in Heraclitus and Parmenides "a cosmic force" of unity which is implied in the legal process and its outcome; Gagarin, 1974, p. 187-8.
[68] "Just as impossible[…] is an interpretation of δίκη on the basis of the modern concept of justice and the Roman *iustitia*", Heidegger, 1992, p. 96.
[69] For instance, Popper (2002a, p. 12) describes *Dikē* as the "divine guarantor of truth". Heidegger (1992, p. 92 and 96) is slightly more subtle, but also prefers to disconnect *Dikē* from the legal context and understand it through the words *deiknumi* ('demonstrate') and *aletheia* ('truth', 'unconcealedness'):
" […] δίκη (which for the Greeks immediately resonates with δεικνυμι, to demonstrate, to indicate, and δίκειν, to thrust)" and "Δίκη, understood as the order which ordains, i.e., assigns, to humanity its relations and comportment, takes its essence from a relation to ἀλήθεια, […]".

Spinner: *a legal reading of Parmenides*

Parmenidean articulation the 'principle of sufficient reason' is in the first place a legal, and not a logical, principle:

> "The principle of sufficient ground is according to its nature not a logical principle of epistemology, but a cosmic principle of law with a translogical character"[70] (p. 109)

In order to explain how Spinner reaches this surprising conclusion, I have to clarify the often heard position which he criticizes: that Parmenides is a precursor of Leibniz who *almost* says that everything has a ground but who simply fails to make the final step of articulating the notion of 'ground' because he formulates his 'principle' in a negative way (*ex nihilo nihil fit*). What makes Spinner's reading of Parmenides thought provoking is that instead of considering the negative formulation as arbitrary ("Saying that *nothing is without ground* is basically the same as saying that *everything has a ground*") or as a failure, he argues that the negative formulation of the 'principle of ground' is of essential importance and that this can be understood from a legal procedural perspective. In a nutshell Spinner's hypothesis is that Parmenides' *ex nihilo nihil fit* follows from a legal way of shifting the burden of proof during a procedure: when both parties cannot produce sufficient proof, one of them will have the advantage of a presumption while the other will have the disadvantage of the *burden* of the proof, or to put it more precisely – the burden of an otherwise irresolvable uncertainty which implies losing the case.

'ex nihilo nihil fit'*understood as a legal-procedural principle: the* 'grounding-avoidance principle'

> "In *Parmenides* the principle of sufficient grounding comes into force, when the logical possibility for grounding has ended"[71] (p. 129)

One could call this a *Begründungs-Vermeidungsprinzip* ('grounding-avoidance principle', p. 129): a deadlock (*Patt-Situation*, p. 129) is avoided or circumvented by assuming that the contrary of what cannot be proved must be true. After all, independent of the amount of uncertainty, in law a case *has* to be decided. Crucial in Spinner's argument[72] are the aforementioned lines 9-15 of fragment 8:

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[70] "Das Prinzip der zureichenden Begründung ist seiner Natur nach kein logisches Erkenntnisprinzip, sondern ein kosmisches Rechtsprinzip translogischen Charakters".

[71] "Das Prinzip der zureichenden Begründung tritt bei *Parmenides* in Aktion, wenn die logische Begründungsmöglichkeit *endet*".

[72] "This is indeed an astonishing line of argumentation: From the lacking necessity of the contrary, the inevitable correctness of [Parmenides'] own doctrine is concluded. Because there is no knowable ground that says that it is otherwise, it necessarily follows that the state of affairs with regard to Being has to be as stated. Lack of necessity of the contrary is a sufficient ground for the correctness of the opposite position of the alternative grounds. It is like this, because there is no compelling reason that it is not like this. What Parmenides staged here, with extremely skillful direction of the discussion, and by making use of the principle of sufficient ground, is not an argument of justification (in the sense of a positive proof of truth) in favor of the proper point of view, but rather a shift in the burden of proof to the detriment of the opposite position, combined with the rigorous exploitation of this effective shift of the problem". (Spinner, 1977, p. 128-9, *tranl. mine*, original below)

"Dies ist nun in der Tat eine erstaunliche Argumentation: Aus der fehlende Notwendigkeit des Gegenteils wird auf die zwangsläufige Richtigkeit der eigenen Lehre zurückgeschlossen. Weil kein erkennbarer Grund vorliegt, daß es anders sei, muß es sich mit dem Sein notwendigerweise so verhalten, wie behauptet wird. Mangelende Notwendigkeit

> "What necessity could have impelled it to grow later rather than sooner, if it began from nothing?" (Parmenides of Elea, 1996, lines 9-10)

Spinner reads: as it can *not* be proved that something comes out of nothing, the burden of proof can *not* be fulfilled and hence Parmenides has to conclude that the contrary is true.

> "Thus it must either fully be, or be not at all" (line 11)

Henceforth it is not the stalemate which has disappeared, but *Dikē* requires there to be a settlement, i.e. a *krisis* ('judgment' or 'decision', line 15) according to *dikē*, whether something is or is not:

> "Nor will the force of conviction ever allow anything, from what-is, to come-to-be something apart from itself; wherefore *Dikē* does not loosen her shackles so as to allow it to come-to-be or to perish, but holds it fast. The decision on these matters depends on this: either *it is* or *it is not*. (lines 12-5)

So where has Spinner's legal reading of Parmenides brought me? Although Spinner's reading is problematic in many respects, mostly because of his abundant use of words such as 'Grund' or 'Patt-Stellung" that are completely alien to Parmenides' text and era in general, it is thought-provoking in at least three respects. Firstly because the legal outlook gives a way, though not followed by Spinner himself, to read the *ex nihilo nihil fit* without the need to take recourse to a language of reasons, grounds, rationality and logic. Instead it allows one to think the *ex nihilo* in its *negative* formulation, that is, in terms of legal uncertainty, the burden of proof, *dikē*, and *krisis*. Read in this way the line "Thus it must either fully be, or be not at all" does not *deny* the existence of non-being or of a twilight zone between being and non-being, but only says that *dikē* cannot allow it because there is a *lack* of proof in its favour. The *lack* of proof constitutes the necessity of being:

the lack *of proof constitutes the necessity of being*

> "It is like this, because there is no compelling reason that it is not like this". (Spinner, 1977, p. 128)

a legal thought which does not coincide with 'justitia' and 'rectitudo'

Secondly, Spinner also allows one to think about the *legal* dimension of Parmenides without reading it as contemporary legal 'metaphors' or expressions (justification, critical judgement, correctness, etc. – almost every word related to rationality is in some way related from 'justice' and 'right'[73]) to describe rational thought. Finally, Spinner helps to

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zugunsten der Gegenseite ist ein zureichender Grund für die Richtigkeit der anderen Seite der Grundalternative. Es ist so, weil kein zwingender Anlaß besteht, daß es nicht so ist. Was hier von *Parmenides* in äußerst geschickter Diskussionsregie mit Hilfe des Prinzips der zureichende Begründung in Wirklichkeit inszeniert worden is, ist keine Begründungsargumentation (im Sinne eines positiven Wahrheitbeweises) zugunsten des eigenen Standpunktes, sondern eine *Verschiebung der Beweislast* zulasten der Gegenposition, verbunden mit der rigorosen Ausbeutung dieser folgenreichen Problemverschiebung". (Spinner, 1977, p. 128-9)

[73] While being a tendency beginning in Roman, and maybe even ancient Greek thought (Spinner, 1977, p. 102), it is only in the modern period (with its acme in Nietzsche's notion of '*Gerechtigkeit*' or *justice*) that *juridici* and *veridici* have fully converged. Heidegger (1992, p. 53) notes: "In the age in which the modern period finds its completion in a historical total state of the globe, the Roman essence of truth, *veritas*, appears as *rectitudo* and *iustitia*, as 'justice'." Heidegger also poses that this adequation is not present as such in Parmenides notion 'aletheia' ('truth'): "It seems as

An adequation of thought and being which has not solidified yet

see that the adequation of thought and being in Parmenides, especially when thought of as an encounter between being and the thought of a judge under the denominator of *dikē* (legal settlement), does not yet have the self-evidency or the solidity of Janus-faced ratio.

It will take another twenty centuries until Leibniz formulates his principle that will bring the encounter between thought and being under its modern and decisive Janus-faced denominator of 'ratio' or 'ground'. While it is unnecessary to repeat what I have already discussed in chapter one – how Leibniz articulated the *principium rationis* and how he became the first philosopher of probability – it is interesting to restate what I noted in the beginning of this chapter: that Leibniz's ratio is strongly related to the practice of law. In a way Leibniz's articulations of sufficient and probable ratio traverse a similar but much more explicit path through law than Parmenides writings: there is a similar movement of creating an encounter between being and thought in order to create a settlement of the uncertainty that is in accordance with *dikē* (Parmenides) or fairness (Leibniz, e.g. '*justus ludus*'). Of course it must also be noted that such a comparison cannot be straightforward because seventeenth century legal reason consists out of completely different terms than those that made up the legal universe of ancient Greece: instead of *themis*, *krisis* and the goddess *Dikē*, there are justice, jurisprudence, proof, evidence, law, reasons, grounds, and lots of calculation. Thus I certainly do not argue that Leibniz' articulations of sufficient and probable grounds simply *repeat* Parmenides, but what I try to show is that there is a forgotten Eleatic and legal "inheritance" (Spinner, 1977, 130) or 'before' that offers words such as *Dikē* or "natural Jurisprudence"[74] to think 'probable grounds' in a way that is not self-evident, or even paradoxical, to the modern mind: as solid-uncertain encounters (whether as *aletheia* under the denominator *Dikē*, as Janus-faced ground construed from

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if ἀλήθεια has withdrawn itself from the history of Occidental humanity. It seems as if the Roman *veritas*, and the truth which evolves out of it as *rectitudo* and *iustitia*, correctness and justice, have commandeered the field of the essence of ἀλήθεια". (p. 53)

[74]In a letter to Burnett, from February 1697 (Original in French in: 1887, p. 194), Leibniz call probabilistic calculus a "natural Jurisprudence" and underlines the immense importance of it – not only for law but also for other field of life: "But practical Philosophy is founded on the true Topics or Dialectics – that is to say, on the art of estimating the degrees of proofs, which is not yet found among the authors who are Logicians, but of which only the Jurists have given samples that are not to be despised and that can serve as a beginning for forming the science of proofs proper for verifying historical facts and for giving the meaning of texts. For it is the Jurists who are occupied ordinarily with the one and the other in [legal] processes. Thus […] a natural Jurisprudence [is needed], by which the way to estimate the degrees of proofs may be learned demonstratively. For several probable arguments joined together sometimes make a moral certainty, and sometimes don't. There is therefore need of a sure method to be able to determine it. It is often said, with justice, that reasons should not be counted, but weighed; however no one has yet given us that balance that should serve to weigh the force of reasons. This is one of the greatest defects of our Logic; we feel the effects of it even in the most important and most serious matters of life, which concern justice, the peace and well-being of the State, human health, and even religion. It is almost thirty years since I made these remarks publicly, and since that time I have done a quantity of research, to lay the foundations of such works; but a thousand distractions have prevented me from giving final form to those Philosophical, Juridical, and Theological Elements that I had

inconclusive proofs and presumptions, or as self-adjusting probabilistic ratios) of being and thought. This brings me to the following chapter on data science: whereas in law ratio is still *both* ground and proportion, in data science ratio seems to be merely the latter[75].

projected. If God still gives me life and health, I will make it my principal business". (transl. from: Sylla, 1998, pp. 66-7, which is a slightly adjusted adaptation of Adams, 1994, pp. 198-9).

[75] This shift towards ratio as merely probabilistic proportion, instead of ground *and* proportion, also explains why the *Bayesian-frequentist* debate (as described in chapter one) between those who hold probability to express objective frequencies ('frequentists') and those who argue that probabilities represent justificatory subjective degrees of belief ('Bayesians') is losing its edge within data science: instead of looking for a *ground* in *either* falsification through the improbability of the data *or* through justificatory induction which makes a belief more probable, this division is of little importance for the workings of the probabilistic proportions tumbling through the negative feedback loops created by data scientists. See for the Popper-Carnap controversy on probability: Michalos, 1971. For the discussion of the question whether corroboration (a hypothesis that resists many attempts of falsification becomes increasingly 'corroborated') is in fact the pseudo-inductive justificatory grounding of a belief: Watkins, 1984.

PROBABLE RATIOS IN DATA SCIENCE – THE ETERNAL SUNSHINE OF THE PRESENT FUTURE

In data science, as I wrote in chapter one, probabilistic ratios are not so much 'grounds', but 'algorithmically adjusted probabilistic temporary models'. In order to substantiate this claim I will take a closer look at the way in which probable ratio appears within data science. In the second half of this chapter my explorations in this regard will lead me to the question how *probability* (i.e., probabilistic ratios) within data science is related to the concept of *possibility*.

However, before I can develop any thoughts on the working and appearance of probable ratios within data science, I will first have to clarify some of the notions involved. I will do this in three consecutive steps: firstly, I will explain the relation between probability and statistics, secondly what data science and data mining is, and thirdly how statistics compares to the analytical part of data science and data mining (the data analysis algorithm).

step 1: what has probability to do with statistics?

Step 1: What has probability to do with statistics?

The word 'Statistik' was first used by the German 'statist' Gottfried Achenwall in his book *Staatsverfassung der heutigen vornehmsten europäischen Reiche und Völker im Grundrisse* (1749). This 'Statistik', 'Staatswissenschaft' or 'Kameralwissenschaft' was the practice of gathering demographical data, such as the amount of fertile women or conscriptable men, which expressed the power, wealth or strength of a state and contributed to the eighteenth century emergence of the nation state (Desrosières, 1999; Porter, 2003). Mostly such 'Statistik' would be what we call today *descriptive* statistics: straightforward counting that does not involve the drawing of any conclusions beyond what is expressed by the actual data, but only the reformulation in a concise or visually attractive manner (tables, percentages, charts, etc). However, if one wants to extend one's conclusions beyond the immediate data[76], one has to weigh the gathered data with probabilistic assumptions (e.g. 'if we assume that this is a fair die, these data are extremely unlikely to occur by chance'). This extension from *descriptive* to *inferential* statistics is one of the important reasons why statistics have "already overrun every branch of science with a rapidity of conquest rivalled only by Atilla, Mohammed, and the Colorado beetle"

from descriptive to inferential statistics

[76] When the Royal Statistical Society was founded in 1834 its emblem was a wheatsheaf adorned with the motto *Aliis Exterendum* – "to be threshed out by others" or "for others to interpret" – but already in 1857 this caption was removed because it was considered to limitative. (Hilts, 1978; Kendall, 1942, p. 79; Poovey, 1998, p. 310-11) This nicely exemplifies the shift from mere descriptive statistics to inferential statistics.

(Kendall, 1942, p. 69). Enzensberger calls probability and inferential statistics two sisters: the first one being very pretty, the other ugly but practical (2009, p. 26). Just like geometry or algebra (2009, p. 44) pure probability is a beautiful but self-enclosed logic, whereas in inferential statistics its axioms are used to draw inferences from actual data. Although most scientists do not question the statistical methods they use, recently some doubts have been raised about the value of statistical inferences (Biau, Jolles, & Porcher, 2010; Ioannidis, 2005; McCloskey & Ziliak, 2008). These doubts are connected to a problem which was already noted by Popper in the first edition (1934) of his *magnum opus* (Popper, 2002b), namely *that probabilistic statements are in principle not falsifiable*!

the 'ugly sister': what is the value of statistical inferences?

probabilistic statements are unfalsifiable

> "For although probability statements play such a vitally important role in empirical science, they turn out to be impervious to strict falsification". (Popper, 2002b, 133)

For instance, the non-probabilistic –famous and infamous (Popper, 2002b; Taleb, 2007)– statement that all swans are white can be easily falsified by one single black swan; however, there is no analogous method to falsify the hypothesis that a coin is unbiased, i.e., has a probability of ½ to turn up tails. Only if we would be able to produce an *infinite* sequence of tosses with this coin – which is of course impossible! – and the relative frequency of tails would turn out to be for instance ⅓, we could falsify a probabilistic hypothesis: only "an infinite sequence of events […] could contradict a probability estimate" (Popper, 2002a, p. 182). One could think that this would be a major problem for scientific research because the majority of hypotheses formulated in science are *statistical*, i.e., probabilistic: for instance, when a scientist wants to know if a certain medical treatment has a statistically significant effect, his or her situation can be compared with a person tossing a coin and hoping to find out whether the coin is biased, viz. that there is a difference between the treatment group and the control group. However, the only way to *falsify* the null hypothesis that the treatment has no effect would require an *infinite sequence* of trials. Nevertheless, the empirical sciences are very successful in deciding when to accept and when to reject a hypothesis. Assume for instance that a scientist, whose hypothesis is that a coin is unbiased, has made 10.000 tosses and only 5 times tails turn up. Given the hypothesis this result, i.e. these *data*, are highly improbable (although not impossible!) and therefore the scientist may decide to consider his or her hypothesis as "practically falsified" (Popper, 2002b, p. 182):

practical falsification

> "It is fairly clear that this 'practical falsification' can be obtained only through a methodological decision to regard highly improbable events as ruled out – as prohibited. But with what right can they be so regarded? Where are we to draw the line? Where does this 'high improbability' begin?" (Popper, 2002b, p. 182)

the trouble with statistical significance

Most sciences have answered Popper's question by establishing the famous p-values of 0.01 or 0.05: if, given a certain hypothesis, observed data have a probability that is lower than 0.01 or 0.05 the result is considered to be statistically significant and the hypothesis is rejected because it is "practically falsified". However, this approach of course gives raise to a certain arbitrariness (McCloskey & Ziliak, 2008) – for instance, why use $p \leq 0.05$ as a cut-off point and not $p \leq 0.07843$? Moreover, a 'statistically significant' falsification always brings along the uncertainty that it was wrong – after all unlikely things *do* happen. The ground or reason on which to decide whether to reject a hypothesis is always uncertain because improbable does *not* mean impossible. Yet, a highly statistically significant result is not meaningless either. It is, to use an expression which I introduced in chapter one, an *uncertain certainty*.

step 2: what are data science and data mining?

Step 2: What are data science and data mining?

The present age is often characterized as the information age (Castells, 2000a, 2000b, 2009): as "a new kind of capitalism" (Himanen, 2001, p. 12). Whereas most pit-coal mines have been closed down during the last decades, transforming raw data into valuable information has become the new booming industry (e.g. Hand, 2007; Tanaka, 2010, 1st April; The Economist, 2010, February 27th). The software industry "specialising in data management and analytics" has an estimated value of "more than $100 billion and [is] growing at almost 10% a year, roughly twice as fast as the software business as a whole" (The Economist, 2010, February 27th, p. 2). Increasing computing power, and processing and storage capacity have created a need to manage and analyse the avalanche of data in modern society. Especially when data are available in bulk it can become close to impossible to see the wood for the trees. A nice example hereof can be seen in the current debates around the SWIFT agreement, which allowed US intelligence service to sift through all international bank transfers in order to detect suspicious transactions which could be possibly related to terrorism (Barrett, 2010, 8th April; Traynor, 2010, 11th February). Whatever stance one takes in these debates, which are focused on whether the transfer of SWIFT data is an infringement on the sovereignty of the EU and civil liberties such as privacy, they also made clear that it is far from self evident to find golden nuggets of useful information in the records of the approximately 11 million financial transactions which are made every day. This explains that new disciplines that help to extract "useful information from large data sets or databases" such as *data mining*, (also known as "Knowlegde Discovery in Databases" or *KDD*) which lies "at the intersection of statistics, machine learning, data management and databases, pattern recognition, artificial intelligence, and other areas" (Hand, Mannila, & Smyth, 2001, p. xxvii) and the even

managing the avalanche of data

data mining & KDD

data science

broader discipline of *data science* (Hand, 2007), whose practitioners combine "the skills of software programmer, statistician and storyteller/artist to extract the nuggets of gold hidden under mountains of data" (The Economist, 2010, February 27th p. 2), have become new and upcoming fields. Apart from the fact that the overlapping fields of data mining and data science both deal with very large volumes of data, they also share a very practical outlook – maybe 'data engineering' would in fact be a more appropriate name than 'data science'. For example, a topic such as experimental or survey design is clearly outside the scope of data mining (Glymour, Madigan, Pregibon, Smyth, & Fayyad, 1997, p. 11; Hand, 1999, p.17). Shalizi (2010, June 17) describes data mining as:

a practical approach

> "[…] the art of finding and extracting useful patterns in very large collections of data. […] the aim is to directly guide action (*praxis*!), rather than to develop a technology and theory of induction. In some ways, in fact, it's closer to what statistics calls 'exploratory data analysis', though with certain advantages and limitations that come from having really big data to explore".

step 3: what has statistics to do with data science?

<u>Step 3: What has statistics to do with the analytical part of data science (i.e., the data analysis algorithm)?</u>

Large parts of data science do not concern the actual analysis of data but the preparation of the analysis and the visualisation of the results:

> "What differentiates data science from statistics is that data science is a holistic approach. We're increasingly finding data in the wild, and data scientists are involved with gathering data, massaging it into a tractable form, making it tell its story, and presenting that story to others" (Loukides, 2010, June 2)

However, for the sake of the argument I will not discuss these parts of data science but rather focus on the *analytical* part wherein useful patterns are extracted from the data. In this respect statistics and data mining clearly have much in common: both "are concerned with discovering structure in data" (Hand, 1999, p. 16) and deal with uncertainty by quantifying it (Glymour et al., 1997).

One difference between statistics and data mining is that the datasets in the latter are sometimes so big that they cover the whole population and not just a sample: thus data science tends to be more about "model fit rather than its generalisation" (Hand, 1999, p. 17) from sample to population. Nevertheless, probable ratios are as much an important feature in data science as in statistics, particularly when patterns are used to generalize towards the future (forecasting and anticipatory predictions). Another important difference between statistics and data science is that the latter is not primarily about

models in statistics, algorithms in data mining

models[77] but about algorithms (Hand, 1999). This difference needs more clarification as it is a source of endless misunderstandings. For instance, in a much criticized but widely read article Anderson (2008) declared that the new data science means the end of models and theory as patterns would be self-emergent from correlations found in large data sets:

> "'Correlation is enough.' We can stop looking for models. We can analyze the data without hypotheses about what it might show. We can throw the numbers into the biggest computing clusters the world has ever seen and let statistical algorithms find patterns where science cannot". (Anderson, 2008)

As was correctly noted it is wrong to say that *merely* looking for correlations in data sets will do the trick:

> "[…] anyone who thinks the power of data mining will let them write a spam filter without understanding linguistic structure deserves the in-box they'll get." (Shalizi, 2008, 25 June)

algorithmic automation of discovery

However, contrary to the classical statistical approach in data mining the data are subjected to an "on-going process (even if the data set is fixed)" (Hand, 1999, p. 18) in which large parts consist out of algorithmically automated[78] discovery (Glymour, 2004) in "an attempt to discover the unexpected" (Hand, 1999, p. 18). Thus the issue is not that there is a *lack* of hypotheses, models, or theories in data mining but, quite the opposite, that there is an *abundance*: there is an endless algorithmic hence and forth between data and malleable, probabilistic hypotheses. Whereas models in statistics tend to be static, mathematical descriptions, data science draws on computer science and artificial intelligence[79], giving "pseudocode descriptions (simplified versions of computer programs) of algorithms, telling you how to process data to reach a conclusion". (Hand, 2007, pp. 113-4) Hence, data mining techniques can also be described as belonging to the domain of "machine learning":

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[77] "In statistics, a model is a description of the data as it occurs, summarizing its distribution, relationships between observed characteristics, and so on, […]". (Hand, 2007, p. 113) Thus a model could look, e.g., something like "test score= (0,2)*(age) + (0,6)*(years of education)" or "$Y_i = b_0 + b_1 Income_i$".

[78] The fact that part of the on-going process in data mining is automated, does of course not imply that being a data scientist is a simple job that only involves pushing a 'start'-button – on the contrary! Developing algorithms and following up on the on-going process of data mining ("One examines the data one way, interprets the results, looks more closely at the data from a related perspective, looks at them another way, and so on", Hand, 1999, p. 18) is a complicated job that requires many skills. (Loukides, 2010, June 2)

[79] "For the typical computer scientist, the statistics literature is relatively impenetrable: a litany of jargon, implicit assumptions, asymptotic arguments, and lack of details on how the theoretical and mathematical concepts are actually realized in the form of a data analysis algorithm. The situation is effectively reversed for statisticians: the computer science literature on machine learning and data mining is replete with discussions of algorithms, pseudocode, computational efficiency, and so forth, often with little reference to an underlying model or inference procedure. An important point is that both approaches are nonetheless essential when dealing with large data sets. An understanding of both the "mathematical modeling" view, and the "computational algorithm" view are essential to properly grasp the complexities of data mining". (Hand et al., 2001, p. xxviii)

How to make machines find the regularities in a data set?

> "There's a place where AI, statistics and epistemology-methodology converge, or want to anyhow. 'Machine learning' is the AI label: how do we make a machine that can find and learn the regularities in a data set? (If the data set is really, really big, and we care mostly about making practically valuable predictions, this becomes data mining, or 'knowledge discovery in databases,' KDD.) The statisticians ask very similar questions about model-fitting and hypothesis-testing. The epistemologists are mired in the problem of induction, and 'inference to the best explanation' […]. The fields over-lap in the most crazy-quilt and arbitrary way." (Shalizi, 2010, June 3)

statistics as the grammar of data science

Keeping all of this in mind, "one should not overlook that the model and algorithm approaches are two sides of the same coin" (Hand, 2007, p. 114). Hence, the role of statistics within data science should not be belittled:

> "[…] statistics is the 'grammar of data science.' It is crucial to 'making data speak coherently.' […] it takes statistics to know whether this difference is significant, or just a random fluctuation. Data science isn't just about the existence of data, or making guesses about what that data might mean; it's about testing hypotheses and making sure that the conclusions you're drawing from the data are valid." (Loukides, 2010, June 2)

data science: quite much like statistics but more processual, inventive, algorithmic, and agile

However, the deeply *processual, algorithmic* and *inventive* nature of data science (it is not about finding 'Scientific Truth', but about an endless re-ordering of the data to find interesting or profitable patterns), makes even the scientific hypothetico-deductive method look as a rather "confirmatory"[80] practice:

> "To many, the essence of data mining is the possibility of serendipitous discovery of unsuspected but valuable information. This means the process is essentially exploratory. This is in contrast to the rather optimistically styled 'confirmatory' analysis. (Optimistic because one can never actually confirm a theory, only provide supporting evidence or lack of disconfirming evidence.) Confirmatory analysis is concerned with model fitting – establishing that a proposed model does or does not provide a good explanation for the observed data. Thus much, perhaps most, statistical analysis addresses confirmatory analysis."(Hand, 1999, p. 17)

Hence, what is important in data science is "agile" data analysis: "Faster computations make it easier to test different assumptions, different datasets, and different algorithms". (Loukides, 2010, June 2)

[80] This statement would, of course, make Popper turn in his grave.

Now that all relevant terms have been introduced and clarified in the three steps above, it is time to return to the question how probable ratios appear and work within data science. The image that appears is of a practice in which probable ratios produce a never-ending sequence of *present futures* (see above, chapter one, and Esposito, 2007, pp. 50-67) which can never be refuted by a *future present*. Firstly, there is the inheritance of statistics which replaces the possibility to get an unequivocal '*no!*' of classical refutation by the much more opaque '*probably not…*' and '*…in the* present future *a refutation would definitely be the most rational option as long as one reckons with the disclaimer that improbable does not mean impossible in a* future present' of so-called "practical falsification" (Popper, 2002b, p. 182). Thus not only is the rationality of the probable ratios independent of its actualisation in the future present, but it also *excludes* the impossible: however improbable things are, one can never fully exclude the possibility of their actualisation. Secondly, the algorithmic and processual nature of data science takes this impossibility of refutation and the irrelevance of actualisation in the future present even a step further: the probable ratios are no longer conjectural 'models' that can or cannot be refuted, but are better described as *elements of evolution* ("Evolutionselement", Esposito, 2007):

summary: *what do we learn from the three aforementioned steps?*

probable ratios in data science: a doubled independence of actualization

> "[…] Forecasts [are] themselves a result and a moment of evolution, which it processes in building a more complex world".[81] (*transl. mine*, p. 108)

To give a concrete example: the temporary emergence of the probable ratio 0.945 (e.g., as in: '*this email with VIAGRA in the subject line and 78 undisclosed recipients has a probability of 0.945 to be spam*') is neither a ground for thought (i.e., a 'reason' for the belief of the spam filter) nor a ground for being (i.e., a 'cause' or 'propensity' of the email to be spam) but simply an intermediate result that functions as an 'evolutionary element' within the application of the algorithm. This is no longer about the growth of scientific knowledge, but about adaptation in a rapidly changing environment. Here probable ratio goes *beyond* the notions of subject and object, and *beyond* the notions of ground, cause and reason, becoming an 'event' in its own right, that is in own present future.

probable ratio: not a ground but an evolutionary element

Leibniz's metaphysics: the equation of probability, possibility, and feasability

Let me pause here for a while: is it not extremely strange that I reached the conclusion that probable ratios in data science are *not* about their possibility for actualisation? Is it not common sense that something that is *probable* (e.g., "It is very probable that tails will show up more than once if I toss this coin ten times") is also equally *possible*? The alienating aura that surrounds this conclusion probably follows from our attachment to

[81] "[…] Prognosen [sind] selbst ein Ergebnis und ein Moment der Evolution, die sie beim Aufbau einer komplexeren Welt verarbeitet." (Esposito, 2007, p. 108)

Leibniz's equation of probability, possibility, and feasibility. In *De incerti aestimatione* (1678) Leibniz is unequivocal about the relationship between possibility and probability:

> "Probability is a gradation of possibility"[82] (*transl. mine*)

Earlier, in the *Vorarbeiten zur Characteristica Universalis* (1671-1672) Leibniz had already clarified that he equates possibility with that which is *facile* ('easy', 'feasible' or 'doable'):

> "*Facile* is what is very possible, that is to say, for which little is required"[83] (*transl.* in: Hacking, 1975, p. 127)

Quod facile est in re, id probabile est in mente

In the following sentence of the same entry Leibniz continues:

> "What *is easy* in reality *[facile in re]* is *probable* in the mind"[84] (transl. in: Adams, 1994, p. 203)

Thus one could say that for Leibniz probability reflects the *propensity* (Popper, 1990) or *proclivity*[85] (Hacking, 1971a) in things themselves to come into existence. However, by translating "*facile in re*" simply by *propensity* or *proclivity*, one could easily overlook the close etymological relation between *facile* and *faire* ('to do', 'to make') – a relation that is much stressed by Leibniz himself. In 1714 Leibniz elaborates on how a degree of facility ('makeability' or 'doability') should be understood:

> "The art of conjecture is based on what is more or less easy (*facile*) or, better, more or less doable (*faisable*), for the Latin *facile* derived from *faciendo* literally means doable; for example, with two dice, it is as doable to throw a twelve as to throw an eleven for each can only be done in one way; but it is three times more doable to throw seven, for that can be done by throwing six and one, five and two, and four and three, and one of these combinations is as doable as the other"[86]. (letter to Bourguet, March 1714, in: Leibniz, 1887, p. 569-70; *transl.* in: Sylla, 1998, p. 50-1)

Looking at all of the aforementioned quotations one can conclude that Leibniz's Janus-faced conception of probability is not only a "degree of assent" (belief) but that it also corresponds to the level of "effective propensity towards existence" (Krüger, 1981, p. 49) or what Wilson (1971) has called "Daseinsstreben":

Daseinsstreben

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[82] "Probabilitas est gradus possibilitas", (Leibniz, 1999, p. 94).
[83] "Facile est valde possible, seu cuius pauca sunt requisita", (Leibniz, 1966, p. 492).
[84] "Quod facile est in re, id probabile est in mente", (Leibniz, 1966, p. 492).
[85] When probability emerged in the second half of the seventeenth century, "proclivity" also emerged as one of its synonyms. For instance, Huygens writes in proposition III of *De ratiociniis in ludo aleae* (1657) that there are "*casus aeque in proclivi*, namely events, or chances (translating the Dutch *kans*) that have an equal proclivity to occur". (Hacking, 1975, p. 125)
[86] "L'art de conjecturer est fondée sur ce qui est plus ou moins facile, ou bien plus ou moins faisable, car le latin facilis derivé a faciendo veut dire faisable mot à mot: par exemple, avec deux dés, il est aussi faisable de jetter douze points, que d'en jetter onze, car l'un et l'autre ne se peut faire que d'une seule maniere; mais il est trois fois plus faisable d'en jetter sept, parce que cela se peut fair en jettant 6 et 1, 5 et 2, et 4 et 3; et une combinaison icy est aussi faisable que l'autre". (Leibniz, 1887, p. 569-70; 2010, p. 144-5)

"The possible demands existence by its very nature, *in proportion to its possibility*, that is to say, its degree of essence"[87] (*transl.* in: Hacking, 1971b, p. 603)

Such a notion of "Daseinsstreben"[88], i.e., a predetermined degree of possibility or probability in the *essence* of every thing[89], does of course not sound very credible to the modern mind (Hacking, 1971b, p. 603; Wilson, 1971, p. 610).

…dans l'etat present des choses …

And yet, if we continue reading Leibniz's aforementioned letter to Bourguet (1714) one sentence suddenly seems very modern:

> "One also evaluates plausibilities (*vraisemblances*) *a posteriori*, by experience; one should have recourse to this in the absence of *a priori* ratios (*raisons*); for example, it is equally plausible (*vraisemblable*) that a baby about to be born will be a boy or a girl, because the numbers of boys and girls are found to be nearly equal <u>in this world.</u> We may say that what is done more or done less is also more or less doable <u>in the present state of things</u>, putting all the considerations together which must concur <u>in the production of what is done (*d'un fait*)</u>."[90] (*transl.* in: Sylla, 1998, p. 51, bold emphasis mine)

Once one reads these sentences *without* the idea of a God who guarantees that there is a true and unchangeable nature of probable ratios to be discovered, it suddenly becomes difficult to say how Leibniz can speak of "*dans ce Monde*" and "*dans l'etat present des choses*". Lacking a bird's-eye view over eternity or a God to guarantee that the "*vraisemblances a posteriori*" will continue to correspond to the "*raisons a priori*", Leibniz's "*etat present des choses*" begins to appear as Esposito's "present future": a construction in which the rationality of the probable ratio is irrefutable, but with the imminent "future present" (which is, as the classical problem of induction tells us, completely indifferent to the "present future") always lurking at its borders. How to stay within the rays of the eternal

from one present future…to the next

[87] "Haec autem aliter reddi non potest quam ex generali essentiae seu possibilitatis ratione, posito possibile exigere sua natura existentiam, et quidem pro ratione possibilitatis seu pro essentiae gradu "(Leibniz, 1890, p. 194)

[88] "God must be able to do what can be seen to be best in a rational consideration, i.e. in an intelligible comparison of essences. And a such consideration is essentially not a matter of all or nothing but a measurement and evaluation of degrees or essence or perfection. […] God's assent follows perfection, ours follows conjectured perfection", (Krüger, 1981, pp. 52 and 54). Hacking (1971b, p. 603) summarizes Leibniz's metaphysics in similar terms: "God's role is to conceive possibilities. The creatability of the things will correspond to the degree of possibility in the divine mind. Similarly, in our world the objective propensities of different outcomes to occur are the foundation of our mental expectations, the probabilities, which, as Leibniz had said, are degrees of possibility".

[89] The modern propensity interpretation of probability as developed by, e.g., Popper, locates the propensity or probability not in the *essence* of things but in a *situation* (Popper, 1990). Thus it is argued that probability is not subjective (a degree of belief), but an objective tendency within a certain situation: "…that the propensity of a penny to fall on a flat table with heads up is obviously modified if the table top is appropriately slotted. Similarly, one and the same *loaded* die will have different propensities if the table top is very elastic rather than marble, or if it is covered by a layer of sand". (p. 15)

[90] "On estime encore les vraisemblances a posteriori, par l'experience, et on y doit avoir recours au défaut des raisons a priori: par exemple, il est egalement vraisemblable que l'enfant qui doit naistre soit garçon ou fille, parce que le nombre des garçons et des filles se trouve à peu près egal dans ce Monde. L'on peut dire que ce qui se fait le plus ou

sunshine of the present future, where there is always a rational (even if only 'certain-uncertain) way to proceed? One way to hold the constantly imminent 'future present' at bay can be seen in modern data science: an on-going process of the production (one would almost be tempted to say with Leibniz: "…*mettant toutes les considerations ensemble qui doivent concourir à la production d'un fait*") of present futures.

summary

Where does this leave us? First I tried to describe the workings of data science and to show that the way in which probable ratio unites being and thought in this practice has little to do with the terms in which we normally think about probability and probable ratio: grounds, reasons, causes, the possible, actualisation, etc. Thought from a common sense approach one would expect that data scientific applications are about predicting the future, i.e. about establishing which possibilities are most prone to come into existence. In a popularising article in *Forbes* magazine it says:

> "Thus predictive analytics is emerging as a game-changer. Instead of looking backward to analyze 'what happened?' predictive analytics help executives answer 'What's next?' and 'What should we do about it?'" (Rich & Harris, 2010)

However, using Esposito's distinction between the 'future present' and the 'present future' it became clear that probabilistic ratios do not predict the 'future present' but only relate to the 'present future', i.e. the future as it shows itself in the present. Moreover, because of their probabilistic nature the rationality of probable ratios is irrefutable. Hence probable ratios can be better described as 'evolutionary elements' in an on-going adaptive production of new 'present futures'. While we still might tend to think in terms of Leibniz's metaphysics, equalling makeability, possibility and probability, this triad fits badly with the actual practice of probable ratio in data science. Yet, when reading Leibniz closely, already there we see expressions (such as "*dans l'etat present des choses*") that seem to anticipate the endless sequence of 'present futures' in which the probable ratios of data science enclose us.

enclosed in the endless sequence of present futures

As such an 'endless sequence of present futures' might still sound rather abstract I will try to illustrate this in a more concrete manner. Popper, when explaining his propensity interpretation of probability, i.e., that every situation has a certain objective propensity than can evolve over time, gives a nice example of what I would call, following Esposito, a sequence of present futures:

> "How probable is it that you will live another 20 years? This has its own little mathematical problems. Thus, the probability that you will live another 20 years

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le moins est aussi le plus ou le moins faisable dans l'etat present des choses, mettant toutes les considerations ensemble qui doivent concourir à la production d'un fait". (Leibniz, 1887, p. 570; 2010, p. 145)

> from today – that is that you will be still alive in 2008 – increases for most of you every day and every week as long as you survive, until it reaches the probability 1 on the 24th of August 2008. Nevertheless, the probability that you will survive for another 20 years from any of the days following today goes down and down with every sneeze and with every cough; unless you die by some accident, it is not unlikely that this probability will become close to 0 years before your actual death. […] Nevertheless, the view that the propensity to survive is a property of the state of health *and not* of the situation can easily be shown to be a serious mistake. As a matter of course, the state of health is very important – an important aspect of the situation. But as anybody may fall ill or become involved in an accident, the progress of medical science – say, the invention of powerful new drugs (like antibiotics) – change the *prospects* of everybody to survive, whether or not he or she actually gets into the position of having to take any such drug. The *situation* changes the possibilities, and thereby the propensities" (Popper, 1990, pp. 8 and 14-5)

Of course, what Popper *tries* to show is that his objective understanding of probability is not as essentialist as Leibniz's: Popper underlines that he is talking about the propensity of *situations*, not states, and that these situations can *change*. However, when read through the lens of 'future presents' and 'present futures' one sees how the 'situations' or 'present futures' have to be adapted and reconstructed all the time to incorporate accidents and discoveries, immunizing life against the 'truly' unexpected.

present future - future present

Moving away from the ingrained language of grounds, reasons and the actualization of possibilities, allows me to question the relation between the probable and the possible in a way that I could not have before, namely, what is the relation between the 'present future' and the 'future present'? The obvious answer is of course that there is *no* relation. In fact, how can I even talk of a future present if it is so fully and completely excluded from the 'present futures' generated by the algorithms of data science? Maybe one could say that the 'future present' is absent from the 'present future' in a way which Deacon calls "constitutive" or "specific absence", that is to say that it "is not so much the absence itself that is critical, but how it affects what is left and how this may relate to other things" (Deacon, 2006, p. 120). Thus the 'future present' presents itself as an absence *against* which the endless sequence of present futures is built, presenting itself as uncertain-certainty, or to put it differently, a certainty "*dans l'etat present des choses*" with an inerasable birthmark of the pure uncertainty which it excludes.

an experiment in thinking between *something and something…*

This is thesis is an experiment in thinking a parallax, of evocating a kind of thought that only arises when one thinks "*between* something and something". (Blouin et al., 2005, p. 142, *transl. mine*) Thus both the lawyer, looking for practical advise how to deal with probabilistic reasoning in the courtroom, or the data scientist hoping to find arguments that will help in the decision whether to put "Bayesian", "Frequentist" or "Undecided" on his or her business card, will be disappointed.

…in order to find how probable ratio give rise to a philosophical *affect*

By letting myself become affected by 'the same' ('probable ratio') through two different 'befores' or 'mediations' (law and data science), I tried to find ways in which probable ratio could also begin to affect me in a *philosophical* way.

So did the experiment succeed? Did the traversed trajectory give rise to new affections to think probable reason? My own cautious answer would be: "Maybe – sometimes". The process of thinking was full of pitfalls and slippery slopes. Sometimes, despite all of my outflanking movements to avoid that, I would notice that an attempt was falling flat as my sentences were walking down trodden paths of thought, while on other occasions the notion 'probable grounds' would suddenly appear in the text in ways previously unthought of. For instance, in chapter four, I felt the danger of anachronistic conclusions lurking in Spinner's (1977) reading of Parmenides, and in chapter five it turned out to be difficult to provide the necessary terminological precision without diverting attention from the main questions. Both chapters show that the question how to present a practice (law and data science), and the role played in it by certain notion (probable grounds) in it, is far from a unequivocal enterprise. Not only in the two aforementioned chapters but also in other parts of this thesis have I found myself standing hesitant on theoretical crossroads – unsure about the direction to take. At the same time these moments often also proved to be the most decisive ones, opening possibilities to think things differently. At these points I would also be forced to introduce unusual or novel notions in order to proceed in the intended direction. Thus, before evaluating the philosophical 'harvest' of the parallax between law and data science, I will first recapitulate and defend some of the turns and twists which I took while writing this thesis.

crossroads

1. probable grounds

Crossroad 1: Probable grounds

Many things have been said about probability, and maybe even more about the *principium rationis*. Why not simply write about probability *or* the *principium rationis*? While the

historical and philosophical intertwinement between those notions is undeniable, there has not been, as far as I know, any serious philosophical attempt to think them together as *probable grounds*. On the one hand the supplementary nature of probability and the principle of ground seem quite obvious: not only do the calculus of probabilistic ratios and the *principium rationis* emerge more or less simultaneously, but they also share in the same Janus-faced and reckoning ratio. On the other hand I also clearly see that I risk the allegation that 'probable grounds' or 'probable ratio' are paradoxical jackstraws of my own making. However, introducing the term 'probable ground' has been helpful in several respects. Firstly, because it dissolves the not very fruitful opposition between probability and ground as inductive and uncertain v. deductive and certain. Secondly, it allowed me to move away from the many and often tedious debates about the principle of *sufficient* reason, towards its supplement, the principle of *insufficient* or *probable* reason, which in our modern era seems to have become more important than its counterpart. Last but not least, 'probable ground' is a tool that provides a starting point to think the *relation* between probability and the *principium rationis* – and more in particular the relation between probability and the volatile yet resilient word 'ratio'.

2. affection

Crossroad 2: Affection

'Affection' is the word used in this thesis to point to the fact that 'probable grounds' are not 'things' or 'objects' but 'relations' through which being and thought meet. To speak of probable *ratio* as an *affection* could appear controversial – after all, is *affection* not the counterpart of *ratio*? Although, as I explain extensively in chapter three, I use affection in a very specific, Spinozian sense (i.e., as the relation which arises from a relational *constellation* or a *landscape* which attunes the *affector* and the *affectee* in such a way that there is a space where they can meet and become what they are), I also welcomed the possibility that thinking of ratio as an affection could be a refreshingly disruptive side-effect which could be of help to avoid stepping in all too trodden paths of thought.

3. before

Crossroad 3: Before

In this thesis I named the aforementioned "relational *constellation* or a *landscape* which attunes the *affector* and the *affectee*" the *before*. Of course, I could have used its Latin translation, i.e., the more philosophically common *a priori*, but I feared that its heavy burden of metaphysical connotations would lead me astray. Also I considered using *mediations*, yet was concerned that the word would point me into the direction of 'immediate origins' and 'input-before-mediation'. However, in the process of writing the *before* began to double as both "relational *constellation*" and as the *before* in time. Starting of

with the good intention to explore two practice and traverse each of their *befores* from which the affection of probable grounds or ratios appears, I ended up digging for historical origins – talking about Parmenides' 'principle of reason'-*avant la lettre* and Casuist probabilism.

4. a parallax

Crossroad 4: A parallax

If doing philosophy, as I think, always regards the 'before' or 'a priori' through which thought and being meet, philosophy will always have to struggle with a certain circularity: method and 'object' of study will always, at least partly, coincide. How to proceed? Drawing upon Stengers' notion of the 'ecology of practices' (Stengers, 2005) and Žižek's parallax view (2006), I tries to address this pivotal philosophical-methodological problem. However, a parallax view is like navigating between Scylla and Charybdis. On the one hand there is the risk that one ends up making a *comparison* between two practices in which the incommensurability of the 'before' of each practice disappears as they are measured by a common standard ("Probable ratio in law and data science are very similar is this respect, while in that other respect they show the following differences", etc., etc.). On the other hand there is the risk that *nothing* happens between the two separately traversed trajectories.

5. sticking to the practice itself

Crossroad 5: Sticking to the practice itself

A parallax between practices would seem to imply that these practices are relatively clearly delineated. For instance, when philosophers try to think a parallax between languages (e.g. "ratio" in Latin, "raison" in French and "Grund" in German) the question "Does this word belong to the French language or not?" is less complicated than when one wants to know whether something belongs to a practice. Talking about *the* practice of law or *the* practice of data science is of course rather abstract, and forces one to give more detailed information such as "When?", "Where?", "Which school?" and "Which branch?".

As becomes immediately clear when reading chapter five (on law) and six (on data science) I have not been much of a purist in this respect. When writing about probable grounds in law, I refer to matters as disparate as ancient Greek *Dikē*, seventeenth century views regarding proof, and the use of statistical evidence in a recent Dutch criminal case. With regard to data science things are not much better. The first problem is that the boundaries of this upcoming field are still very much in flux. A second issue is that, similar to what I did in the chapter on law, I easily jump between very different matters: from Leibniz's musings on possibility-probability, to statistics and

data science, while rephrasing their *modus operandi* in terms (e.g., "future present" and "present future") which the practitioners themselves would probably never use.

One explanation was given above: sometimes the tendency to explain things in terms of historical causes and *avant la lettres* (a matter of 'old habits' and that it is far from obvious how to write *differently*) would simply get the better hand of me. However, from a more pragmatic perspective we could ask – is that really a problem? After all, the intention has never between to give *correct*, *exhaustive* or *representative* descriptions of the practice of law and data science, but to use them to allow for *philosophical* thought in-between them.

Apart from this pragmatic outlook there are also two other justifications for having these bric-à-brac assemblages instead of clearly delineated practices.

Firstly, as readers familiar with the history and philosophy of probability might have noticed, the chapters on law and data science show certain similarities with how the emergence of probability is often presented. This account (see e.g. Hacking, 1971b; Hacking, 1975; Sullerot, 2006), in a very simplified and caricatured form, goes as follows: first Leibniz discovers probability through *law*, in which probability has already a slightly Janus-faced status but still is predominantly epistemological (degrees of belief), then he develops a more 'naturalised' and *objective* understanding of probability, as a proclivity within things themselves, but he never fully disentangles the two sides which have turned later into the *subjective* and *objective* interpretation of probability. What I wanted to avoid in writing chapters five and six was exactly this: to write a law-chapter on the origin of the subjective interpretation and a data science-chapter on the origin and unfolding of the objective interpretation, as if already I knew what subjectivity and objectivity are instead of trying to retrace these notion *through* probable ratio.

Not only did I face the challenge to avoid a reduction towards the *subjective* and *objective*, but in the chapter on law I also struggled with the fact that in modern thought the words of law and truth are so conflated ('judgment', 'justification', 'correctness', 'ground', 'reason', etc.) that it becomes very difficult to talk of 'the-legal-as-it-gave-*rise*-to-probable-grounds' instead of 'the-legal-that-is-*already-taken-in*-by-probable-grounds'. In taking recourse to Parmenides, who does not speak of grounds, I hoped to encounter words that would help me to avoid this pitfall.

After these two final justifications of my rather peculiar presentation of the practice of law and of data science, I come to the final point: is there a parallax between them? And did any new affections arise?

A parallax between law and data science

a parallax between law and data science – did something happen?

While trying to stay away from the words *objective* and *subjective* when thinking about law and data science something else emerged: a *before* of probable *grounds* which still lingers on in law but is slowly vanishing, and a *before* of probable *ratio* which is upcoming in data science, for which we not have yet found the right words to describe it. Looking at the trajectory of twists and turns through which 'probable grounds' and 'probable ratio' were constituted – with words like '*Dikē*', 'fairness', 'proof', 'opinion' and 'authority of Nature' – the words ground, ratio and probability began to lose something of their self-evidence. In both law and data science the *words* that we use and the *metaphysics* that they bring along (ground as a solid reason for thought and a cause for being, probability as degree of possibility or propensity towards actualisation, etc.) do not seem to fit very well with what is actually *happening*. Only, how can I *notice* or *say* such a thing if my all my thoughts always traverse those exact same words? In thinking through law and data science I encountered new directions and new words that allowed me to notice and articulate this misfit.

Let me first look at chapter five (on law). In the notion of 'proof' and in Parmenides I found a language that while seemingly saying the *same* – 'proof' as 'ground' and Parmenides as the father of the 'principle of ground'-*avant la lettre* – allowed me to think 'ground' *differently*, namely as always already founded in (legal) uncertainty and both required and guaranteed by a legal need of *dikē* or fairness. Hence, the paths taken throughout chapter four (on probabilist casuistry) and five (on law) allowed me to articulate *ground* in a way that is a new affection: ground as "solid/uncertain encounters of being and thought" under the denominator of something legal like *dikē* or fairness.

Chapter six (on data science) took a fully different route. When realizing that 'possibility' and 'actualization' did not manage to put the right words to what is happening in data science, I was able to restate the practice in Esposito's notion "present future" and "future present". Turning away from the idea that data science tries to predict the degree of possibility that something will actualise in the *future present*, the probable ratios of data science started to affect me in a novel way: as 'evolutionary elements' in the generation of endless *present futures*.

But what about the parallax *between* law and data science? The parallax occurs when one notices that one field of 'legal' words ('*dikē*', 'fairness', 'legal ground') surrounding probable grounds has slipped away, while another field of 'data scientific' words ('evolutionary element', 'present future', 'probabilistic ratio') is upcoming but not yet fully articulated. In the lack of these words lies the parallax which allows for probable grounds to affect us *philosophically*.

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