Editorial
Special Issue on Philosophical Aspects of Pattern Recognition

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The fields of pattern recognition and machine learning can arguably be considered as a modern-day incarnation of an endeavor which has challenged mankind since antiquity. In fact, fundamental questions pertaining to induction, categorization, abstraction, causality, etc., have been on the agenda of mainstream philosophy, under different names and guises, since its inception. With the advent of modern digital computers and the availability of enormous amount of raw data, these questions have now taken a computational flavor.

As it often happens with scientific research, in the early days of pattern recognition there used to be a genuine interest around philosophical and conceptual issues, but over time the interest shifted almost entirely to technical and algorithmic aspects and became driven mainly by practical applications. With this reality in mind, it is instructive to remark that although the dismissal of philosophical inquiry at times of intense incremental scientific progress is understandable to allow time for the immediate needs of problem-solving, it is also sometimes responsible for preventing or delaying

the emergence of true scientific progress.

In recent years there has been an increasing interest around the foundational and/or philosophical problems of pattern recognition and machine learning, from both the computer scientist's and the philosopher's camps.[1] This suggests that the time is ripe to attempt establishing a long-term dialogue between the two communities with a view to foster cross-fertilization of ideas. In particular, it is felt that the present moment is appropriate for reflection, reassessment and eventually some synthesis, with the aim of providing the field a self-portrait of where it currently stands and where it is going as a whole, and hopefully suggesting new directions.

The goal of this special issue was precisely to consolidate research efforts in this area, and to provide a timely and coherent picture of the state of the art in the field. Late in 2013, a call for papers was issued which resulted in 19 submissions and, after a careful review process, nine papers were accepted for publication. The papers were reviewed by philosophically inclined pattern recognition researchers as well as professional philosophers interested in the epistemological problems posed by our domain.

The first two papers in the special issue address questions pertaining to

[1] See, e.g., the ECML 2001 workshop on "Machine learning as experimental philosophy of science" (http://www.csse.monash.edu.au/∼korb/posml.html) with the associated special issue of *Minds and Machines* (vol. 14, no. 4, 2004), the book by G. Harman (a philosopher) and S. Kulkarni (an engineer) on *Reliable Reasoning* (MIT Press, 2007), the NIPS 2011 Workshop on "Philosophy and machine learning" (http://www.dsi.unive.it/PhiMaLe2011/), and the ICPR 2014 tutorial on "Philosophical aspects of pattern recognition" (http://www.icpr2014.org/tutorialpages/philosophicalaspects).

the nature of pattern recognition research. In the first paper, entitled "Pattern recognition between science and engineering: A red herring?" Marcello Pelillo, Teresa Scantamburlo and Viola Schiaffonati aim at reopening a classic discussion as to whether the field of pattern recognition should be considered a part of science or of engineering. Using recent developments in both the philosophy of science and the philosophy of technology, they show how the traditional opposition between science and engineering, motivated by the assumption that the former aims at "truth" and the latter aims at "use," is largely surpassed by contemporary philosophical enquiry, and they instead appear to stand to each other "in a kind of circular, symbiotic relationship." Specific historical examples taken from the pattern recognition and allied fields seem to support this idea, and suggest that our domain should indeed be taken as a case-study for philosophers interested in the interplay between science and technology. Motivated by this analysis, the authors offer some final speculations concerning the notion of progress and performance evaluation.

In the next paper, entitled "On unifiers, diversifiers, and the nature of pattern recognition," Gavin Brown explores another dichotomy which originates from a distinction between two kinds of scientific styles famously put forward by the eminent theoretical physicist Freeman Dyson. According to Dyson, scientists can be divided into two groups, the *unifiers* and the *diversifiers*. Two kinds, as Dyson suggested, typified by two cities, Athens and Manchester, and by two great scientists, Einstein and Rutheford, respectively. Charles Darwin also made a similar distinction between *splitters* ("those who make many species") and *lumpers* ("those who make few").

Brown investigates to what extent this distinction can be transferred from the realm of natural sciences to the field of pattern recognition, and discusses it in relation with other well-known dichotomies in philosophy and science. After speculating about the value of such dichotomies, he concludes that in our own field, although pure unifiers and pure diversifiers do in fact exist, they are rare and most researchers typically sit on the spectrum between the two, adopting "unifying perspectives one day, and be diversifying the next."

In his paper "The disembodied predictor stance," Loizos Michael studies pattern recognition scenarios, which are typically encountered in the social sciences, whereby the announcement of a prediction by an agent can potentially influence the very outcome the agent is trying to predict. Examples of such situations abound and include predicting the stock market or the outcome of an election, and can be found in the context of spam filtering or, more generally, adversarial learning. Michael's starting point is the observation that most research in pattern recognition adopts a "disembodied stance" and is therefore intrinsically unable to deal with this kind of problems. He then invites us to abandon this stance and, after a careful examination of the issues at stake, devotes the rest of the paper to describe a formal "introspective forecasting" framework which tries to accommodate this request. Central to Michael's argument is the idea of interconnectedness, a form of holism which postulates that the characteristics of the world are not completely unrelated, a notion which is also invoked within the probably approximately correct (PAC) learning framework.

The next three papers in the special issue deal with different aspects related to representational issues in pattern recognition and machine learning.

In the paper entitled "Semantics of object representation in machine learning," Birkan Tunç discusses the need for directing philosophical attention to the data modeling problem in machine learning. Indeed, as he notices, while much attention has been devoted so far to the philosophical aspects related to the inferential process in machine learning, little work has been done concerning the semantics of object representations and their epistemic justification. The paper is a preliminary attempt to fill in this gap. After reviewing the basic ingredients of Aristotelian and Galilean epistemologies, Tunç tries to elucidate several philosophical concepts employed (often tacitly) in machine learning, namely abstraction, idealization and latent (or theoretical) variables.

In the next paper, entitled "The dissimilarity representation for finding universals from particulars by an anti-essentialist approach," Robert Duin draws our attention to another all-important philosophical topic, namely the dualism between the essentialist and the anti-essentialist perspectives, the former postulating the existence of intrinsic, "essential" attributes for objects and categories, the latter denying it. He analyzes how these two views correspond to different types of representations in pattern recognition, and argues that the dissimilarity representation, which he introduced earlier, can be best understood adopting an anti-essentialist outlook. The paper touches upon other well-known philosophical issues, such as the dualism between particulars and universals and consciousness, and concludes with a pessimistic note concerning the possibility for a pattern recognition machine to ever attain a form of universal knowledge.

The paper by Frank van der Velde, entitled "Computation and dissipative

dynamical systems in neural networks for classification," offers a contribution to the classical debate between empiricists and rationalists concerning the very possibility of inductive inferences. Using a mathematical analysis of the classification behavior of feedforward neural networks, van der Velde shows that, under certain conditions, forms of induction are indeed possible. The paper explores the role of representation and the nature of the underlying forms of processing and advocates a dynamical system perspective to pattern recognition. Obviously, not all dynamical systems are suited to this purpose as the nature of cognition imposes constraints upon all possible choices. The paper suggests restricting our attention to dissipative systems, whereby the volume of an initial region in state space decreases over time, and discusses how the dissipative nature of networks could have consequences in terms of the representational power and the learning abilities of neural networks.

The next paper by Christian Hennig entitled "What are the true clusters?" offers an analysis of the clustering problem using constructivist philosophy and the notion of active scientific realism recently proposed by Cambridge historian and philosopher of science Hasok Chang. It is argued that the notion of a "true cluster" depends on both the context and the clustering aims, and the paper suggests various desirable characteristics of clusterings as well as various approaches to formalize the notion of context-dependent truth. After discussing some implications of the proposed approach, Hennig concludes the paper by observing that the philosophical considerations put forward here could have a wider applicability in other areas of data analysis whereby the notion of "natural" truth is seen as problematic (see also the paper which opens this special issue).

Pedro Ortega, in his paper entitled "Subjectivity, Bayesianism, and causality," tries to advance a mathematical definition of subjectivity within the framework of Bayesian probability theory. To this end, he draws from the psychoanalytic theory of the subject developed by French philosopher Jacques Lacan. After establishing an intriguing parallel between Lacan's theory and Bayesian probability theory, Ortega notices that Bayesian theory is not quite a complete subjectivist theory as it lacks an important ingredient, namely the notion of causal intervention, which in Lacan's theory corresponds to the so-called *objet petit a* (a term that apparently Lacan did not want to be translated). Motivated by this consideration, the rest of the paper tries to fill in this gap and develops an abstract model of the subject which accommodates causal interventions in a measure-theoretic formalization obtained using ideas from game theory.

In the paper which closes the special issue, entitled "The nature of the visual field, a phenomenological analysis," Jan Koenderink, Andrea van Doorn and Johan Wagemans explore the "mysteries" associated to our visual awareness and its spatial form (the "visual field") using experimental phenomenology. As the authors point out, the visual field is a mental entity of some geometrical nature. But it is a kind of geometry which is difficult to describe and we cannot help ignoring qualities and meanings. In an attempt to understand this geometry, the authors advocate the use of an abstract model of the genesis of visual awareness and discuss several important distinctions of geometrical nature. This description is confronted with known principles of artistic practice and turns out to be related to fields such as ethology, aesthetics and Cassirer's philosophy of symbolic forms.

I hope that the collection of papers assembled in this special issue will provide a timely and interesting sample of research at the interface between pattern recognition and philosophy and will foster further work in this exciting and largely unexplored area. Working on this special issue has been a unique, intellectually rewarding experience. I would like to thank Gabriella Sanniti di Baja for her advice and support in establishing this initiative, and Jefeery Alex, Journal Manager of *Pattern Recognition Letters*, for organizing the review process. I am also grateful to the authors for submitting their work to the special issue and to the reviewers for their careful work in evaluating all the submissions.