Foreword

Most profit from innovation comes not from the initial discovery, but often from the first successful or large-scale application of the discovery. This is evident throughout history, from the first wireless telegraph to jet engines for mass air travel, from the first PC operating systems to the development of the Internet. So it is with machine learning – the richest fruits of new science are likely to be picked after translational research from the computer to the marketplace. But where is the low-hanging fruit?

Nearly twenty years ago the term machine learning was practically synonymous with artificial neural networks, even more particularly with the multi-layer perceptron. Applications such as explosives detection, risk scoring, inverse kinematics in robotics, and optical character recognition were gaining ground. Yet other successful commercial products relied on relatively novel algorithms, such reinforcement learning used by the airline marketing tactician. Refinements of these methods are still commercially used today and in some cases are still market leaders.

Just as in the evolution of computing in the last century the bottleneck for real impact moved from hardware development, which severely constrained speed and memory, onto software and algorithms, so it seems that in this century the limiting rate for innovation with machine learning lies increasingly with creativity in the application domain. In this sense, what is of most value now is a comprehensive survey of practical applications, with pointers to new algorithms and promising directions for the future – a handbook of the application of machine learning methods.

The authorship represented in this handbook draws from the state-of-the-art with depth in methodologies and a rich breadth of application areas. In their turn, the plethora of methodologies reviewed in the edited articles is extensive and is representative of the power of non-linear modelling. Amid stalwarts such as adaptive resonance theory and the self-organising map, along with k-means and fuzzy clustering, which are now as well established in large-scale practical applications as traditional statistical linear methods ever were, there are relative newcomers to add to this arsenal, in the form of particle swarms, artificial immune systems and other optimisation tools.

The handbook covers exploratory as well as predictive modelling, frequentist and Bayesian methods which form a fruitful branch of machine learning in their own right. This extends beyond the design of non-linear algorithms to encompass also their evaluation, a critical and often neglected area of research, yet a critical stage in practical applications. Another feature of the real-world is missing data, again an open question as regards flexible and semi-parametric models. Alongside data issues is the important matter of anomaly detection. This is not only because fraud and other hostile behaviour is perforce only recorded exceptionally and usually adapts over time to combat filters put in place to deny this type of behaviour, but also because every inference model, whether linear or not, becomes unreliable outside of its evidence base. For data based models, automatic novelty detection is a requirement, if it this is seldom formally done.

Time series, text, natural language, finance and retail, biometrics and computational medicine, software quality control and heavy industry, dairy products and biomechanics, robotics and computer vision – the
handbook makes a comprehensive map of the fast expansion in machine learning methodologies and their practical applications. A methodological trend that is clear is to move from globally linear to local linear transformations. A second trend is the increasing reliance on kernels. Both approaches move on from the mantra of generic flexible models and occupy the new high ground in machine learning, by shaping together the need for flexibility to model non-linear surfaces, with transparency and control coming from carefully constrained methodological principles.

In summary, this handbook is a clear and lucid introduction to the promising new world of machine learning applications. It will remain a valuable reference, even though it is more than likely that the many of the ideas it introduces will come to fruition much sooner than another twenty years from now!

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