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Bridging Heavy Tails and Artificial Intelligence

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Abstract This editorial opens the special issue. While the origins of AI (Artificial Intelligence) can be traced back to the 1920s and 1930s—with foundational developments by figures such as Gödel and Turing in logic and theoretical computer science—the roots of EVT (Extreme Value Theory) reach back to roughly the same period, marked by pioneering work from Fisher and Tippett. Despite these parallel beginnings, it has taken nearly a century for the two fields to begin meaningfully intersecting. This special issue aims to highlight that the time is now ripe for deeper mutual engagement, with the potential for these synergies to generate novel questions and solutions across both domains.

Keywords Artificial Intelligence, Extreme Value Theory

1 Why now?

> *"It was a lot of fun doing the research, but it was slightly annoying that many people—in fact, most people in the field of AI—said that neural networks would never work [...] My message is this: if you believe in something, don't give up on it until you understand why that belief is wrong."*
>
> Geoffrey Hinton
> (winner of the 2024 Nobel Prize in Physics)

This special issue brings together two themes that continue to dominate the headlines in recent years: Extreme Events and AI. The papers in the issue explore how the interface between AI and EVT can offer novel insights for understanding and responding to the extreme-valued phenomena that increasingly shape our world.

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So why now, if both fields have existed for so long? There are several reasons, but perhaps the most compelling are: *i)* it has become increasingly clear that neural models—echoing the message in the opening quote by Geoffrey Hinton, an Edinburgh alumnus often referred to as the godfather of AI—are effective across a wide range of tasks; *ii)* the frequency and severity of extreme events are clearly on the rise; and *iii)* the availability of large and rich datasets has grown substantially, enabling new methodologies at the interface of AI and EVT.

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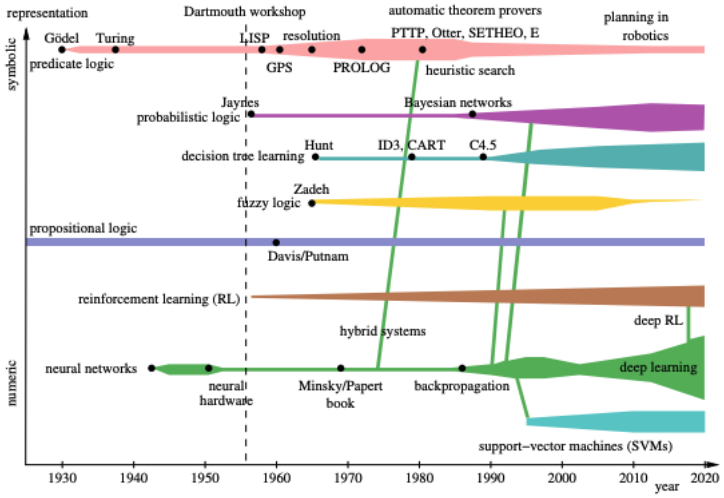

Fig. 1.1 History of various subfields of AI. Reproduced with permission from Ertel (2025).

Tasks and learning scenarios covered in this special issue

Figure 1.1 depicts the history of a variety of AI areas, with its roots going back to McCulloch and Pitts (1943). Figure 1.1 emphasises that logic played a major role in shaping the beginnings of the field, and it also stresses that neural models have been around for many years now. A large body of introductory books on AI cover parts related to logic, and parts related to machine learning—among other topics (e.g., Aggarwal 2021; Ertel 2025). Most developments in this issue relate not to logic but rather to machine learning. Standard tasks in machine learning include, for example, *classification*, *clustering*, *regression*, *ranking*, and *dimension reduction*. Two important types of data are usually distinguished in this context: *training data* (i.e., examples used to train an algorithm) and *test data* (i.e., data used to actually assess the performance of the algorithm). Following standard terminology (e.g., Mohri et al. 2018), below we refer to *learning scenarios* as the actual contexts over which learning takes place. The most commonly known learning scenarios are supervised and unsupervised learning, but there are important scenarios that we will refer to in Section 3.

The articles in the special issue cover a wide range of learning tasks and developments from extreme value theory. Figure 1.2 contains a word cloud of the abstracts of the papers comprising the special issue, and highlights a particular focus on multivariate and extremal dependence modelling, neural networks, regression, and theory.

Fig. 1.2 Word cloud of the abstracts of the nine articles in this special issue.