Statistical Optimality of Decision Rules for Humans and Rational Machines Interacting Together

Fully funded PhD Position

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Subject

Cognitive behavior has traditionally been modeled using rationality models, where the human agents are assumed to behave in an unbiased manner. Unbiased decision-makers are often assumed to minimize Bayes risk, which is defined as the expected cost of making decisions [1]. However, in the real world, human agents may have a cognitive bias, due to the limited availability of information and/or other complex behaviors such as emotions, loss-aversion and endowment effect [2–6]. Such complex agents were successfully modeled by Kahneman and Tversky using prospect theory in [3], where human behavior is modeled using weight and value functions over probabilities and costs respectively.

With the advent of the Internet of Things (IoT) and a rapid deployment of smart devices and wireless sensor networks (WSNs), humans interact extensively with machine data. These human decision makers use sensors that provide information through a sociotechnical network. The sensors can be other human users or they can be IoT devices. The decision makers themselves are also part of the network, and there is a need to understand how they will behave.

Another important situation of high interest concerns systems that are designed to emulate human behavior in order to reduce human effort and intervention. One example is the design of self-driving cars by Google and Uber, which move in traffic alongside human-driven vehicles. In contrast, there are other applications where there is a need to steer/nudge human decisions in order to improve the overall performance of the system [7].

As a consequence, it is therefore important to clearly understand how some local human decisions can impact the final decision. The applications related to this research are far reaching and include ***Environmental monitoring, Social networking, Autonomous vehicles, Industry 4.0, Intelligent Tutoring Systems (ITS), Digital health and more***. Recently, in [8], the authors derive optimal decision rules for generic behavioral decision-makers in binary hypothesis testing problems. Assumptions remain quite simple with only a single agent taking a binary decision. More advanced systems with multiple agents, generally named social learning [9], were studied in the literature. As an example, in [10], the authors consider a two-agent (say advisor-learner) sequential binary hypothesis test where the learner infers the hypothesis based on the decision of the advisor, a prior private signal, and individual belief. A similar work for sequential binary hypothesis testing was considered in [11]. Finally, a hierarchical statistical model from psychology experiments was proposed in [12] in order to characterize how people fuse multiple decisions to make their own decisions.

The aim of this thesis is to propose a rigorous statistical study of optimal decision rules given some local decisions from multiple hybrid and heterogeneous agents, i.e. humans and (rational) machines.

We propose to firstly extend and generalize the current state-of-the-art by deriving optimal statistical decision rules in the presence of both humans and rational machines in more complex scenarios. An important aspect that will also be covered in this thesis is the proposition of efficient online inference techniques to estimate, from some local decisions of a human agent, the functions that characterize its behavior regarding the decision to take.

Candidate profile

We are looking for a motivated and talented student holding a Master degree with:

– background in statistics, machine learning, signal processing or applied mathematics
– experience in programming, preferably in Matlab and/or Python.

Details

A fully funded PhD position (three-year contract) is available from September/October 2019 at the Université Bretagne Sud located at Campus Tohannic in Vannes [link] and in the DECIDE team [link] of the CNRS laboratory Lab-STICC.

During the thesis, the student will have the opportunity to collaborate with internationally renowned researchers from institutions such as TUM Create (Singapore), Institute of Statistical Mathematics-Tokyo (Japan), etc.

The student will be supervised by:

– François Septier [link]: francois.septier@univ-ubs.fr
– Alexandru Olteanu [link]: alexandru.olteanu@univ-ubs.fr

The candidate is requested to send us a CV and a motivation letter to apply for this position.

References

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