NUDGES AND HEURISTICS FOR PUBLIC POLICIES

Boosting decisions with fast and frugal trees

In today's information age decision makers are confronted with a plethora of information to consider and a multitude of decision algorithms to choose from. Hence, good decisions making requires the ability to identify the relevant pieces of information as well as to choose a successful strategy to combine the information and distill it into a choice. Providing people with simple decision strategies that instruct them which information to consider and how to combine it therefore has the potential to boost and improve decision making. In computer science, machine learning is concerned with teaching computers how to extract and combine relevant data in order to make accurate predictions. On the other hand, cognitive psychology and decision science are concerned with understanding the mechanisms and processes behind human decision making. At the intersection of these disciplines lies the potential to develop decision tools that are almost as powerful as state-of-the-art machine learning algorithms but yet simple enough for humans to use. Fast and frugal trees (FFTs) are rooted in this intersection and hold the potential to boost decision performance of both laypeople and experts.

FFTs are a family of simple decision trees that process binary input and deliver binary decisions. They typically consist of only a few decision nodes that have one exit, except for the last node, which has two exits. One simply has to follow the FFTs hierarchical structure, starting from the root node. After each node either an exit or an additional node follows until the tree is exited. FFTs are structured lexicographically and a decision can be potentially made at each node, in which case the rest of the nodes are ignored. This means that in many cases, a decision can be made before considering all pieces of information, and that FFTs pose only simple demands on information processing. Various studies have demonstrated their predictive power (e.g. Laskey & Martignon, 2014; Luan et al., 2011; Martignon et al., 2008) and they have been applied to the fields of medicine (Green & Mehr, 1997; Jenny et al., 2013; van Rooij et al., 2015), finance (Aikman et al., 2014), and military defense (Keller et al., 2014). Further, studies have shown that FFTs are in line with how humans naturally make decisions—that is, they are adapted to human cognition (Dhami & Ayton, 2001; Dhami & Harries, 2001; Snook et al., 2011; Tan et al., 2016). Finally, their simple, graphical representation makes them more transparent and user-friendlier than commonly studied decision algorithms such as logistic regression. FFTs can either be induced from data using an array of algorithms (e.g. Jenny et al., 2013), built based on expert judgment (e.g. Keller et al., 2014), or based on guidelines or advisories (van Rooij et al., 2015). Besides decisions, FFTs can also recommend actions (Keller et al., 2014).

FFTs fall into the third boosting policy approach described by Grüne-Yanoff and Hertwig (2015), which is to build and teach simple, intuitive, and efficient heuristics to support decisions and predictions when knowledge about risks is incomplete and uncertain. FFTs can thus also be considered prediction boosts (Hertwig & Grüne-Yanoff, unpublished manuscript). They can further be tailored to decision makers' goals, for example, to physician's goal to better differentiate between serious and less serious medical cases, as the following example will illustrate. In such situations decision makers might be particularly motivated to use the decision aids.

Emergency physicians frequently encounter patients with nonspecific complaints. These patients tend to report general feelings of weakness, discomfort, fatigue, or dizziness, but not more specific complaints (Nemec et al., 2010) They are often undertriaged (i.e., their initial risk assessments are too low), and the severity of the illness causing their nonspecific complaints is often misjudged (Möckel et al., 2013). This can cause delays in definitive treatment of the underlying cause of their nonspecific chief complaints. Patients presenting to emergency physicians with nonspecific complaints thus pose a particular challenge to the medical decision-making process. We studied physicians’ intuitive judgments of how ill patients look and showed that while these judgments predict morbidity reasonably well in the general population of emergency department patients, physicians overestimated the morbidity of patients with nonspecific complaints with low morbidity and underestimated the morbidity of patients with nonspecific complaints with high morbidity. The physicians’ judgments and subsequent decisions (e.g., does the patient need immediate care?) thus need to be improved. Using a clinical dataset we developed a FFT and compared its ability to predict morbidity to machine learning algorithms. In cross-validation, the FFT performed as well as the best machine learning algorithms and outperformed the physicians’ intuition. Thus, accurate and user-friendly FFTs can improve decision making in the emergency department. This example illustrates FFTs’ potential to boost critical decisions and potentially save lives.

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