ABSTRACT

One of the central challenges in online advertising is attribution, namely, assessing the contribution of individual advertiser actions including e-mails, display ads and search ads to eventual conversion. Several heuristics are used for attribution in practice; however, there is no formal justification for them and many of these fail even in simple canonical settings. The main contribution in this work is to develop an axiomatic framework for attribution in online advertising. In particular, we consider a Markovian model for the user journey through the conversion funnel, in which ad actions may have disparate impacts at different stages. We propose a novel attribution metric, that we refer to as counterfactual adjusted Shapley value, which inherits the desirable properties of the traditional Shapley value while overcoming its shortcomings in the context of our application. Furthermore, we establish that this metric coincides with an adjusted "unique-uniform" attribution scheme. This scheme is efficiently implementable and can be interpreted as a correction to the commonly used uniform attribution scheme. We supplement our theoretical developments with numerical experiments inspired by a real-world large-scale dataset.