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Coarse decision making and overfitting ☆

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Abstract

We study decision makers who willingly forgo decision rules that vary finely with available information, even though these decision rules are technologically feasible. We model this behavior as a consequence of using classical, frequentist methods to draw robust inferences from data. Coarse decision making then arises to mitigate the problem of over-fitting the data. The resulting behavior tends to be biased towards simplicity: decision makers choose models that are statistically simple, in a sense we make precise. In contrast to existing approaches, the key determinant of the level of coarsening is the amount of data available to the decision maker. The decision maker may choose a coarser decision rule as the stakes increase.

JEL classification: D81

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1. Introduction

Despite the breadth of phenomena they explain, classical models of decision making struggle with a large class of observed behavior we shall refer to as *coarse decision making*. By this

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[1] Early versions of this paper were written while the author was a graduate student at the Department of Managerial Economics and Decision Sciences, Kellogg School of Management, Northwestern University.

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we mean the phenomenon of decision makers making coarse choices—their choice does not finely vary with the information they have, even though doing so would be informationally and technologically feasible. They opt instead for decision rules that are less sensitive to state by state variations—'coarse' rules in our terminology.

There is a large literature documenting and modeling manifestations of coarse decision making, we limit ourselves here to a few motivating examples.[2] The literature on bounded rationality studies outcomes when decision makers use *rules of thumb* (or similar coarsenings such as *decision heuristics*, *routines*, and *analogies*).[3] 'Style investing' investment strategies based on asset categories or 'styles' rather than the assets themselves. The literature on rational inattention in macroeconomics studies agents with limited or costly information processing capacity, and therefore rationally choose to ignore some available information.

The goal of this paper is to provide a simple alternate theory of coarse decision making. The central idea is to view decision makers as learning from data using classical/frequentist methods, similar to empirical work. We study a setting where a decision maker must choose a decision rule i.e. a mapping from observables to actions. He has relevant sample data to assist him in this choice. We study a two-stage decision procedure:

1. *Model-selection stage:* Select a 'model,' or 'decision frame' $\mathcal{F}$ consisting of a set of decision rules.
2. *Inference stage:* Select a rule f in $\mathcal{F}$ based on its fit with the sample data.

The decision maker balances two conflicting objectives: (1) A rich decision frame $\mathcal{F}$ improves ability to 'fit' observed samples, but, (2) an unrestricted $\mathcal{F}$ results in 'over-fitting' the sample. Coarseness of the decision frame $\mathcal{F}$ is the result of a compromise between these two concerns.[4]

The more common view of coarse decision making in the literature is that it is a consequence of cognitive and computational limitations suffered by the agents. Our explanation, i.e. that it results from difficulties of inference from limited data, is complementary to this view. In most situations of interest, it is likely that agents have both limited cognition and limited data. We focus here solely on the difficulties posed by learning from limited data because it generates novel insights into the problem.

A first implication of our framework is that behavior will be biased towards statistically simple rules, in a sense we make precise. In the case of categorization, the decision maker relies on a coarse partition of the observables to counter the risk of selecting a rule that tracks the sample data too closely (over-fitting). This leads to under-sensitivity to information: decision makers do not respond to observable changes in signals that are finer than the coarse categories they have selected.

A second implication of our framework is how coarseness of the decision frame varies with the stakes for making the right decision. Decision makers for whom cognitive and computational limitations are binding will likely invest more resources in relaxing these constraints as the stakes increase. On the other hand, heuristics such as coarse categories may continue to be important even in decisions with very large stakes. Our learning-based model implies that increasing the

[2] A broader review of related work is in Section 5.1.

[3] See Cremer et al. [6], Jehiel [16], Mohlin [18] and Samuelson [25], among others.

[4] Although this tension is well-recognized in classical statistics, it has received little attention in the theory literature. The closest paper is Al-Najjar [1] which studies the asymptotic properties of uniform learning, but does not discuss over-fitting or applications to cognitive phenomena.