To understand the brain, we need to explain both how sensory signals drive neural responses (encoding), and how neural responses drive behavior (decoding). Models of encoding have grown in sophistication, while detailed models of decoding have lagged behind, mostly considering only linear readout of neural activity. Since these models guide our data analyses, we have been stuck with limited options to analyze experimental data. The standard data analysis method boils down to computing linear correlations between the choices of a behaving animal and its neural activity. This is a reasonable measure for simple tasks and the right brain areas, where the mean activities of neurons encode the relevant task variables. Indeed, recent theoretical work shows how to use this measure to infer a linear readout that explains the animal’s behavior. However, for natural conditions and natural tasks, this is not possible: mean neural responses are confounded by task-irrelevant variables, so those means do not provide information about the task. We show how this induces a nonlinear code. Here we introduce a new way of thinking about decoding that is appropriate for these more challenging, nonlinear natural tasks. This comes with a practical experimental test of the quality of an animal’s nonlinear decoding strategy. When we apply this test to neural responses recorded from primate visual cortex, we find intriguing evidence that animals are using efficient nonlinear decoders.