

Chapter 4

ACTIONS, PLANS, AND DIRECT EFFECTS

*He whose actions exceed his wisdom,
his wisdom shall endure.*

Rabbi Hanina ben Dosa (1st century A.D.)

Preface

So far our analysis of causal effects has focused on primitive interventions of the form $do(x)$, which stood for setting the value of variable X to a fixed constant, x , and asking for the effect of this action on the probabilities of some response variables Y . In this chapter we introduce several extensions of this analysis.

First (Section 4.1), we discuss the status of actions vis-à-vis observations in probability theory, decision analysis, and causal modeling, and we advance the thesis that the main role of causal models is to facilitate the evaluation of the effect of *novel* actions and policies that were unanticipated during the construction of the model.

In Section 4.2, we extend the identification analysis of Chapter 3 to conditional actions of the form “do x if you see z ” and stochastic policies of the form “do x with probability p if you see z .” We shall see that the evaluation and identification of these more elaborate interventions can

be obtained from the analysis of primitive interventions. In Section 4.3, we use the intervention calculus developed in Chapter 3 to give a graphical characterization of the set of semi-Markovian models for which the causal effect of one variable on another can be identified.

We address in Section 4.4 the problem of evaluating the effect of sequential plans—namely, sequences of time-varying actions (some taken concurrently) designed to produce a certain outcome. We provide a graphical method of estimating the effect of such plans from nonexperimental observations in which some of the actions are influenced by their predecessors, some observations are influenced by the actions, and some confounding variables are unmeasured. We show that there is substantial advantage to analyzing a plan into its constituent actions rather than treating the set of actions as a single entity.

Finally, in Section 4.5 we address the question of distinguishing direct from indirect effects. We show that direct effects can be identified by the graphical method developed in Section 4.4. An example using alleged sex discrimination in college admission will serve to demonstrate the assumptions needed for proper analysis of direct effects.