CHAPTER 26

Conclusions and Extensions

In this text we exposited the potential outcomes approach to causality, also known as the Rubin Causal Model, and hope to have convinced the reader of its usefulness. In this final chapter we briefly summarize this approach and discuss other topics in causal inference where this approach may be useful. Many of these are areas of ongoing research, and we hope to discuss them in more detail in a second volume.

The starting point of our approach is the notion of potential outcomes. For each unit in a population, and for each level of a treatment, there is a potential outcome. Comparisons of these potential outcomes define the causal effects; we view these as well-defined irrespective of the assignment mechanism, and thus irrespective of what we actually are able to observe. We often place restrictions on these potential outcomes. Most important in the current text is the stability assumption, or SUTVA, that rules out differences between potential outcomes corresponding to different levels of the treatment for units other than the unit under consideration, and rules out unrepresented levels of treatments

We can observe at most one of the potential outcomes for each unit. Causal inference is therefore intrinsically a missing data problem. Given the potential outcomes, there is a key role in our approach for the assignment mechanism, which defines which potential outcomes are observed and which are missing. The current text is largely organized by different types of assignment mechanisms. The simplest is that of a classical randomized experiment where the researcher knows the assignment mechanism entirely. Such assignment mechanisms are discussed in Part II of the text. Then, in the main part of the text, Parts III and IV, we discuss regular assignment mechanisms where we know part but not all of the assignment mechanism. We discuss the importance of the design stage of a study for causal effects where the outcome data are not yet used. At this stage a researcher can carry out preliminary analyses that make the final analyses that do involve the outcome data more credible and robust.

In Part V we examine the unconfoundedness assumption, which implies that units with the same values of the pre-treatment variables but different treatment levels are comparable in terms of potential outcome distributions. First we assess its plausibility, and then we discuss the sensitivity of conclusions based on its possible violations.

In Part VI we discuss some particular, non-regular, assignment mechanisms involving noncompliance with assigned treatments, in particular, instrumental variables settings.

https://doi.org/10.1017/CBO9781139025751.027 Published online by Cambridge University Press

There are many areas of causal inference that we do not discuss in the current text, and which we intend to discuss in a second volume. A partial list of such methods where we feel the potential outcome framework can clarify assumptions and methods includes settings where SUTVA is violated because there are network or peer effects. It also includes generalizations of instrumental variables settings to principal stratification where there are latent strata such that unconfoundedness holds generally only within the strata. We will also discuss treatments that take on more than two values, including both finite unordered discrete cases and continuous dose-response cases. We also plan to discuss dynamic, sequential, treatment settings. Another currently active area of research is regression discontinuity designs, both sharp and fuzzy, where the overlap assumption regarding covariate distributions is not necessarily satisfied, but the extrapolation is limited. A set of methods popular in economics is referred to as difference-in-differences. A related set of methods includes the use of artificial control groups. In epidemiological settings case-control studies are popular, which we intend to discuss from our perspective. Causal methods are now also used in duration settings, which we also intend to address.

NOTES

Many of the topics mentioned in this chapter are the subject of active research. General texts on evaluation methods in economics, with a special focus on regression methods, include Angrist and Krueger (2000) and Angrist and Pischke (2008). A more general social science text is Shadish, Campbell, and Cook (2002). See also Gelman and Hill (2006). Papers on difference-in-differences methods include Abadie (2005), Athey and Imbens (2006), and Blundell, Gosling, Ichimura, and Meghir (2007). For regression discontinuity designs, see Thistlewaite and Campbell (1960), Goldberger (1991), Black (1999), Van Der Klaauw (2002), Imbens and Lemieux (2008), Hahn, Todd, and Van Der Klaauw (2000), Porter (2003), Imbens and Kalyanaraman (2012), Lee and Lemieux (2010), and Lee (2008). Artificial control groups were introduced by Abadie, Diamond, and Hainmueller (2010). For discussions in duration models, see Abbring and Van Den Berg (2003) and Ham and Lalonde (1996). For the notion of the generalized propensity score and multi-valued treatments, see Imbens (2000), Hirano and Imbens (2004), Yang, Imbens, Cui, Faries, and Kadziola (2014), and Imai and Van Dyk (2004). Principal stratification was introduced in Frangakis and Rubin (2002), and a recent application is Frumento, Mealli, Pacini, and Rubin (2012).