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Subsampling (1999)
Dimitris N. Politis, Joseph P. Romano and Michael Wolf
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Historically, the idea of using subsamples in statistical inference goes back to Mahalanobis (1946), who used it under the name 'interpenetrating network of subsamples' to asses and control non-sampling errors as well as to estimate standard errors in the study of crop yields. Other early contributors to the methodology based on subsampling include, Quenouille, Tukey, Hartigan, and McCarthy. The popularity of the resampling method, Bootstrap, in the eighties was to some extent responsible for the revival of interest in the subsampling method. In general, subsampling distribution gives a relatively low accuracy approximation to the true sampling distribution of an estimator. One of the main attractions of the bootstrap is, its ability to automatically correct the skewness (second order correction), which as shown by the reviewer, cannot be achieved by the the subsampling method for even simple studentized statistics. However, the subsampling method provides inference tools for a wide variety of situations, where methods based on bootstrap are not easily accessible or not available. This is more apparent in the time series context. The book under review compiles recent developments to the subsampling methodology. To a large extent, it is based on the papers published by the authors and their collaborators. It contains a generous collection of examples to illustrate the methodology. At several points in the book, the flow of the presentation goes more like a journal article, often referring to various external sources for the details in the arguments. I wish the authors limited this to a fewer instances.

The book consists of two parts; the first seven chapters provide the basic theory of the bootstrap and subsampling, and the second part deals with extensions of the basic theory, implementation issues and applications. Chapter 1 is devoted to basic consistency properties of the bootstrap in the context of independent data. Construction of confidence intervals and the hypothesis tests are the main topics covered here. This serves as a good introduction to bootstrap methods in a graduate course. Basic notions of subsampling in the case of independent data are presented in Chapter 2. Some simple asymptotic results are given and subsampling is compared to bootstrap in this chapter. In Chapter 3, the chapter on subsampling for stationary time series, the subsampling methodology for the i.i.d. setup is extended to the case of dependent stationary observations that satisfy certain strong mixing type conditions. Issues involved in hypothesis testing, bias reduction, variance estimation, and construction of confidence intervals

are also discussed in this chapter. In Chapter 4, the theory on subsampling for stationary time series, is extended to nonstationary observations. The subsampling methodology for random fields has a direct analogy to subsampling time series. In Chapter 5, the theory on time series is extended to random fields. The use of subsampling for inference in the context of homogeneous, discrete as well as continuous parameter, random fields is demonstrated. Subsampling for marked point processes, where the time index points are generated by a Poisson process, are discussed in Chapter 6. In Chapter 7, estimation of the sampling distribution of an estimator taking values in a general abstract space is considered. Results on subsampling the empirical process as well as spectral measure are presented in this chapter. The theory in Chapters 4-7 is developed under strong mixing type conditions for dependent data. Complex situations where the convergence rate of the estimator is unknown are addressed in Chapter 8. Application of the subsampling method to dependent data involves choosing appropriate blocks. Issues in connection with block sizes are discussed in Chapter 9. As mentioned above, unlike bootstrap, second order approximations are not possible with the subsampling method. However, using finite population correction, some improvements to the estimates of error terms in approximating the sampling distributions are discussed in Chapter 10. In Chapter 11, two different subsampling approaches are discussed for inference for the mean, when the observations are heavy-tailed (infinite variance case). Chapter 12 is devoted to autoregressive processes. A practical application of the subsampling method to dividend yields is given in Chapter 13.

The first three chapters of this book can be included in a graduate course on resampling method. This book serves as a good reference to researchers working in resampling methods.

Mahalanobis, P. C. (1946). Report on the Bihar crop survey: Rabi season 1943-44. *Sankhyā, Ser. A*, **7**, 269-280.

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