Latent Variable Model

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Many constructs that are of interest to social scientists can not be observed directly. Examples are preferences, attitudes, behavioral intentions, and personality traits. Such constructs can only be measured indirectly by means of observable indicators, such as questionnaire items designed to elicit responses related to an attitude or preference. Various types of scaling techniques have been developed for deriving information on unobservable constructs of interest from the indicators. An important family of scaling methods is formed by latent variable models.

A latent variable model is a, possibly nonlinear, path analysis or graphical model. In addition to the manifest variables, the model includes one or more unobserved or latent variables representing the constructs of interest. Two assumptions define the causal mechanisms underlying the responses. First, it is assumed that the responses on the indicators are the result of an individual's position on the latent variable(s). The second assumption is that the manifest variables have nothing in common after controlling for the latent variable(s), which is often referred to as the axiom of local independence.

The two remaining assumptions concern the distributions of the latent and manifest variables. Depending on these assumptions one obtains different kinds of latent variable models. According to Bartholomew (see [1][3]), the four main kinds are: factor analysis (FA), latent trait analysis (LTA), latent profile analysis (LPA), and latent class analysis (LCA) (see table).

	Latent Variable(s)	
Manifest Variables	Continuous	Categorical
Continuous	Factor Analysis	Latent Profile Analysis
Categorical	Latent Trait Analysis	Latent Class Analysis

In FA and LTA, the latent variables are treated as continuous normally distributed variables. In LPA and LCA on the other hand, the latent variable is discrete, and therefore assumed to come from a multinomial distribution. The manifest variables in FA and LPA are continuous. In most cases, their conditional distribution given the latent variables is assumed to be normal. In LTA and LCA, the indicators are dichotomous, ordinal, or nominal categorical variables, and their conditional distributions are assumed to be binomial or multinomial.

The more fundamental distinction in Bartholomew's typology is the one between continuous and discrete latent variables. A researcher has to decide whether it is more natural to treat the underlying latent variable(s) as continuous or discrete. However, as shown by Heinen [2], the distribution of a continuous latent variable model can be approximated by a discrete distribution. This shows that the distinction between continuous and discrete latent variables is less fundamental than one might initially think.

The distinction between models for continuous and discrete indicators turns out not to be fundamental at all. The specification of the conditional distributions of the indicators follows naturally from their scale types. The most recent development in latent variable modeling is to allow for a different distributional form for each indicator. These can, for example, be normal, student, log-normal, gamma, or exponential distributions for continuous variables, binomial for dichotomous variables, multinomial for ordinal and nominal variables, and Poisson, binomial, or negative-binomial for counts. Depending on whether the latent variable is treated as continuous or discrete, one obtains a generalized form of LTA or LCA.

References

[1] Bartholomew, D.J., and Knott, M. (1999). *Latent Variable Models and Factor Analysis*. London: Arnold.

[2] Heinen, T. (1996). *Latent Class and Discrete Latent Trait Models: Similarities and Differences*. Thousand Oakes: Sage Publications.

[3] Skrondal, A. & Rabe-Hesketh, S. (2004). *Generalized Latent Variable Modeling: Multilevel, Longitudinal and Structural Equation Models*. London: Chapman & Hall/CRC.