TABLE 1: OVERVIEW OF FORECASTING METHODS

Forecasting method	Description/preferred application	Current usage		References	
		Among actuaries	Within business generally	Basic	More advanced
A. Extrapolative methods					
1. Simple moving average	This method averages the last n observations of a time series. It is appropriate only for very short or very irregular data sets, where features like trend and seasonality cannot be meaningfully determined, and where the mean changes slowly.	Widely used	Widely used	[1, 2]	
2. Exponential smoothing, such as the Holt-Winters method	A more complex moving average method, involving parameters reflecting the level, trend and seasonality of historical data, usually giving more weight to recent data. Widely used in general business because of its simplicity, accuracy and ease of use. This method's robustness makes it useful even when historic data are few or volatile. It is a frequent winner in forecasting competitions.	Generally not used	Widely used for time-series analysis.	[2-5]	[6]
3. Autoregressive moving average (ARMA)—aka Box-Jenkins	An even more complex class of moving average models, capable of reflecting autocorrelations inherent in data. It can outperform exponential smoothing when the historical data period is long and data are nonvolatile. But it doesn't perform as well when the data are statistically "messy."	Generally not used	Widely used	[2, 7]	[6]
B. Explanatory variable methods					
1. Regression analysis	Fitting a curve to historical data using a formula based on independent variables (explanatory variables) and an error term. Although these methods are relatively simple, and are helpful both in analyzing patterns of historical data and for correlation analysis, they are not generally recommended for forecasting. They have performed poorly in forecasting competitions.	Widely used	Widely used	[2, 8, 9]	[6, 10]
2. Predictive modeling	An area of statistical analysis and data mining, that deals with extracting information from data and using it to predict future behavior patterns or other results. A predictive model is made up of a number of predictors, variables that are likely to influence future behavior.	Gaining in popularity	Widely used	[11-13]	
3. Artificial neural networks	Patterned after the neural architecture of the brain, these methods allow for nonlinear connections between input and output variables, and for learning patterns in data.	Generally not used	Sometimes used	[2, 14-16]	
4. Econometric modeling	Systems of simultaneous equations to represent economic relationships.	Generally not used	Widely used	[17, 18]	[19]

TABLE 1: OVERVIEW OF FORECASTING METHODS continued

Forecasting method	Description/preferred application	Current usage		References	
		Among actuaries	Within business generally	Basic	More advanced
C. Simulation modeling methods					
1. Cell-based modeling	Modeling of individual homogeneous units (cells) over time, such as age/sex cells in pension forecasting. These models are usually deterministic, but may be stochastic. They are useful to model large systems.	Frequently used	Frequently used	[20]	
2. System dynamics simulation	Simulation of a system as a whole over time, incorporating feedback loops as well as stocks and flows. Such methods are useful for complex systems.	Generally not used	Becoming more widely used	[21]	[22]
3. Multi-agent simulation	A computer representation that employs multiple interacting agents and behavioral rules to mimic the behavior of a real system. This method is especially useful for modeling complex adaptive systems.	Generally not used	Becoming more widely used	[23-25]	[26, 27]
D. Judgmental methods	These methods rely on expertise and intuition, rather than on statistical analysis of historical data. Such methods are particularly useful when historical data is scarce. Many of the methods of "futurism"—such as the Delphi method, visioning and scenario building—fall under this category.	Frequently used, usually on an informal basis	Frequently used, often on a structured basis	[2, 28-30]	
E. Composite methods					
1. Bayesian forecasting	This family of methods combines statistical methodology with structured integration of human judgment: new evidence is used to update a statistical forecast, based on application of Bayes' theorem. These methods are good for highly seasonal data with short history.	Generally not used	Generally not used	[31]	[32]
2. Other	Combinations of forecasting methods usually perform better in forecasting competitions. The use of composite methods will increase as decision makers are increasingly called on to combine their intuitions with data-based decision making from forecasting models.	Generally not used	Generally not used	[2, 33, 34]	

REFERENCES (refer to last two columns in the references section in the chart)

1 Wikipedia. Moving average. Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Moving_average*

2 Makridakis, S. G., Wheelwright, S. C., & Hyndman, R. J. (1998). *Forecasting: Methods and Applications* (3rd ed.). New York: John Wiley & Sons.

3 Armstrong, J. S. (2001). *Principles of Forecasting: A Handbook for Researchers and Practitioners* (Section 8: "Extrapolation of time-series and cross-sectional data"). Boston, MA: Kluwer Academic.

4 Gardner, E. S. (1985). "Exponential Smoothing: the State of the Art," *Journal of Forecasting*, 4(1), 1-28.

5 Wikipedia. "Exponential Smoothing." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Exponential_smoothing*

6 Montgomery, D. C., Jennings, C. L., & Kulahci, M. (2008). *Introduction to Time Series Analysis and Forecasting*. Hoboken, N.J.: 34.: Wiley-Interscience.

REFERENCES continued

[7] Wikipedia. "Autoregressive Moving Average Model." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Autoregressive_moving_average_model*

[8] Sykes, A. O. "An introduction to Regression Analysis." Retrieved June 1, 2009, from *http://www.law.uchicago.edu/Lawecon/WkngPprs_01-25/20.Sykes.Regression.pdf*

[9] Wikipedia. "Regression Analysis." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Regression_analysis*

[10] Fox, J., & Fox, J. (2008). *Applied Regression Analysis and Generalized Linear Models* (2nd ed.). Los Angeles: Sage.

[11] Cousins, M., & Stark, J. W. C. (2003). "A Predictive Modeling Primer." Paper presented at the Annual Meeting, Orlando.

[12] Cumming, B., et al. (2002). "Predictive Modeling." Paper presented at the Health Spring Meeting, San Francisco.

[13] Senensky, B. (2008). "Predictive Modeling." *CompAct* (SOA Technology Section newsletter), July 2008.

[14] Armstrong, J. S. (2001). *Principles of Forecasting: A Handbook for Researchers and Practitioners* (Section 8: "Neural Networks for Time-Series Forecasting"). Boston, MA: Kluwer Academic.

[15] Shapiro, A. F., Pflumm, J. S., & DeFilippo, T. A. (1999). "The Inner Workings of Neural Networks and Genetic Algorithms." *Actuarial Research Clearing House,* 1, 415-426.

[16] Wikipedia. "Artificial Neural Network." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Artificial_neural_network*

[17] Armstrong, J. S. (2001). *Principles of Forecasting: A Handbook for Researchers and Practitioners* (Section 11: "Econometric Forecasting"). Boston, MA: Kluwer Academic.

[18] Wikipedia. "Econometrics." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Econometrics*

[19] Spanos, A. (1986). *Statistical Foundations of Econometric Modelling.* Cambridge; New York: Cambridge University Press.

[20] Anderson, J. M. (2000). "Computer Models for Retirement Policy." Paper presented at the Spring Retirement Meeting, Las Vegas.

[21] Wikipedia. "System Dynamics." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/System_dynamics*

[22] Sterman, J. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World.* Boston: Irwin/McGraw-Hill.

[23] Epstein, J. M., Axtell, R., & 2050 Project. (1996). *Growing Artificial Societies: Social Science from the Bottom Up.* Washington, D.C.: Brookings Institution Press.

[24] Gilbert, G. N. (2008). "Agent-Based Models." Los Angeles: Sage Publications.

[25] Wikipedia. "Agent-Based Model." Retrieved June 1, 2009, from *http://en.wikipedia.org/wiki/Agent-based_model*

[26] Miller, J. H., & Page, S. E. (2007). *Complex Adaptive Systems: An Introduction to Computational Models of Social Life.* Princeton, N.J.: Princeton University Press.

[27] North, M. J., & Macal, C. M. (2007). *Managing Business Complexity: Discovering Strategic Solutions with Agent-Based Modeling and Simulation.* Oxford; New York: Oxford University Press.

[28] Adler, M., & Ziglio, E. (1996). *Gazing Into the Oracle: the Delphi Method and Its Application to Social Policy and Public Health.* London: Jessica Kingsley Publishers.

[29] Lawrence, M., Goodwin, P., O'Connor, M., & Onkal, D. (2006). "Judgemental Forecasting: A Review of Progress Over the Last 25 Years." *International Journal of Forecasting*, 22, 493-518.

[30] Surowiecki, J. (2004). *The Wisdom of Crowds: Why the Many are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies, and Nations* (1st ed.). New York: Doubleday.

[31] Geweke, J., & Whiteman, C. (2004). "Bayesian Forecasting" in *The Handbook of Economics Forecasting*. Retrieved June 1, 2009, from *http://www.biz.uiowa.edu/faculty/cwhiteman/bayesianforecasting.pdf*

[32] West, M., & Harrison, J. (1997). *Bayesian Forecasting and Dynamic Models* (2nd ed.). New York: Springer.

[33] Armstrong, J. S. (2001). *Principles of Forecasting: A Handbook for Researchers and Practitioners* (Section 13: "Combining Forecasts"). Boston, MA: Kluwer Academic.

[34] Lapide, L. (2008, June 1, 2009). "Thinking About Composite Forecasting." *The Journal of Business Forecasting.* Retrieved Summer 2008, from *http://ctl.mit.edu/public/jbf_summer_2008.pdf*