A Primer on Modeling Approaches for Research

A key component and outcome in research is the concept and development of models. Modeling is a comprehensive technique to explain a system and/or to study the effects of different components and multiple factors, and to make predictions about behavior. There are many types of models based on the framework and assumptions being used. Some common terms and useful scientific models are provided in this document.

**Mathematical model**: A representation of a system using mathematical concepts and language.

**Statistical model**: A set of probability distributions based on measurable factors and variables collected during research. Statistical models form the basis for epidemiological and clinical studies.

**Computer model**: Via a computer and the incorporation of mathematical and system design processes, it is the study of complex behaviors and making predictions about those behaviors or a set of patterns.

**Simulation model**: A type of computer model that helps create and evaluate complex systems to understand future or “what if” case scenarios. Simulation models are beneficial as they help to predict variations in current systems based on changing circumstances.

**Microsimulation model**: A type of computer model that uses individual units (the micro level), variables and/or behaviors to simulate and predict change in the behavior of a larger group (macro level). They are a common and important tool in policy analyses whereby individual behaviors can help predict the impact of a policy change on the behaviors and outcomes in the general public. They can also be used to show alternative approaches in policy development.

**Forecasting**: A statistical technique and model that examines past and present data and current trends to predict future trends. There are many types of forecasting methods, from simple ones such as averages and regressions models, to more complex ones such as:

**Straight line forecasting**: A simple method where the future trend will remain constant as a past trend. For example, if the previous trend was a 10% increase, then the forecast will also be a 10% increase for the next year.
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**Average forecasting**: A simple forecasting methodology where the forecasts of all future values are equal to the average (or “mean”) of the historical data.

**Simple moving average**: This technique uses an average of a specified number of the most recent observations where each observation received the same importance or weight.

**Weighted moving average**: This technique uses an average of a specified number of the most recent observations where each observation receives the different importance or weight.

**Exponential smoothing**: This technique is a weighted moving average procedure where weights decline exponentially as data get older. In other words, new data points receive more weight than old data points.

**Autoregressive moving averages**: ARIMA is a technique composed of three methods: an autoregression, a moving average and an integration that accounts for the non-stationarity of the time series. ARIMA is more powerful than exponential smoothing if the data are considerably long and the correlation between past observations is stable.

**Simple linear regression**: Statistical modeling technique that estimates the observed relationship to an expected relationship between one independent variable and one dependent or outcome variable.

**Multivariate linear regression**: Statistical modeling technique that estimates the observed relationship to an expected relationship between multiple independent variables and one dependent outcome variable.

**Model validation**: Process of determining the degree to which a simulation model and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model.