Introduction to Forecasting
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Predicting the future

Not an exact science but instead consists of a set of statistical tools and techniques that are supported by human judgment and intuition.
Introduction to Forecasting

• Business forecasting generally attempts to predict future customer demand for a firm’s goods or services.
• Macroeconomic forecasting attempts to predict future behavior of the economy and identify business cycle turning points.
Applications of forecasting

- Operations management: forecast of product sales; demand for services
- Marketing: forecast of sales response to advertisement procedures, new promotions etc.
- Finance & Risk management: forecast returns from investments
- Economics: forecast of major economic variables, e.g. GDP, population growth, unemployment rates, inflation; useful for monetary & fiscal policy; budgeting plans & decisions
- Industrial Process Control: forecasts of the quality characteristics of a production process
- Demography: forecast of population; of demographic events (deaths, births, migration); useful for policy planning
Forecast Methods  two types of forecasting methods:

**Qualitative methods are based on:**
- judgement
- opinion
- past experience
- best guesses
Qualitative Techniques

• Delphi method (technological forecasting)
• Market research
• Panel of consensus (CEFC in Maine)
• Visionary forecasts
• Historical analogies

Useful for long forecast horizons and/or when the amount of historical data is limited.
Quantitative [Statistical] Techniques

Stochastic methods including:
  summary statistics; moving averages;
  exponential smoothing; time series decomposition;
  regression models; trend projections; Box-Jenkins methodology.

Make use of historical data & of a forecasting model.
The three most widely used forecasting models

- time series
- Smoothing models
- regression
Components of Demand Forecasting  2 main factors help determine the type of forecasting method to be used:
- Time Frame
- Behavior & Possible Existence of Patterns
Short to Mid-Range forecasts: from daily to up to two years in length.
commonly used to determine production and delivery schedules
and to establish inventory levels.
Long-Range forecasts: over two years into the future.
usually used for strategic planning; establish long-term goals,
plan new products, enter new markets and develop new
facilities & technology.
Definitions

**Time Series**

A set of chronologically ordered points of data.

In forecasting a time series it is generally assumed that factors which caused demand in the past will persist into the future.
Definitions

*Decomposition Techniques*

Separating a time series into several unobservable components, generally in an additive or multiplicative fashion.

Such components usually include a trend, seasonal, cycle, and residual or irregular.
Definitions

*Seasonal Component*

Regularly occurring, systematic variation in a time series according to the time of year.

Not found in annual data, or data of lower frequencies.
Residential Electricity Sales in Maine
(Millions of kWh)
January 1973 - May 2005
Definitions

**Trend Component**

The tendency of a variable to grow over time, either positively or negatively.
Definitions

Cycle
Cyclical patterns in a time series which are generally irregular in depth and duration. Such cycles often correspond to periods of economic expansion or contraction.

Also know as the business cycle.
The Solar Cycle: 1749 - 1999

Sunspot activity peaks about every 11 years.
US Residents
Less Than 5 Years Old
The Business Cycle
Real GDP: 1947 - 1999
(billions of 1992 dollars)
Nominal GDP: 1990 - 1997

There are seasonal variations in GDP.

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Graph showing the nominal GDP from 1990 to 1997, with fluctuations and an upward trend.
Definitions

*Irregular Component*
The unexplained variation in a time series.
Residential Electricity Demand in Maine

*Irregular Component*
Examples of Time Series Behavior

A *trend* is a gradual, long-term, upward or downward movement in demand.

A current trend is the steady increase in sales of personal computers over the past few years.

A *cycle* is an up-and-down movement in demand that repeats itself over a longer time span.

Automotive sales often behave in a cyclical pattern.

A *seasonal pattern* is a repetitive movement in demand that occurs periodically.

Sales of winter sports equipment is seasonal by nature.
Problem Definition

• Expectations of customer
• Ask questions:
  - Desired form of forecast (e.g. monthly forecasts)
  - Forecast horizon
  - Forecast interval (how often to be revised)
Inputs to the Forecasting Process
(data collection)

• Finding sources of data about the item to be forecast.
• Obtaining information about external conditions --- those factors in the environment that will influence a forecast.
• Determining the needs of the user of the forecast.
Inputs to the Forecasting Process
(data collection)

• Putting together the human & financial resources required to produce a forecast.

• Listing the available alternatives for forecasting techniques.
Data Analysis

Identify the components of a time series.

• Trend: Does the series exhibit some slope when graphed?

• Seasonal: Does the series exhibit regular peaks and troughs during the year?

• Cycle: Are there identifiable cycles which last longer than 1 year?
Data Analysis

Identify the components of a time series.

• Irregular: Are there observations which cannot be associated with either the trend or seasonal components?
  (The Ice Storm of 1998)

• Looking for irregularities is the primary focus of data analysis.
Data Quality

• Check for accuracy.

• Check for conformity: the data must adequately represent the phenomenon for which it is being used.

  Macroeconomic indicators should reflect business cycles.
Data Quality

• Timeliness: When are the data available?
• Preliminary versus revised data?
• Are the data consistent across time?

BLS is experimenting with new measures of employment and the CPI that are not completely consistent with historical data.
Exploratory Data Analysis

• Begin with a plot for your series and look for predominant features.
• Calculate summary statistics for the series.
• Fit a time trend to the series and look for outliers. Calculate (fitted - actual) values.
• Can you decompose the series?
Model Selection & Fitting

• Choose one or more forecasting models
• Fit the model to the data (estimate the unknown parameters, e.g. OLS)
• Evaluate the quality of the model fit
Model validation

• Examine fit to historical data
• Examine magnitude of forecast errors
• Evaluate the quality of the model fit
The forecasting process