

# Forecasting in business

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## Lecture 3



# Forecasting

- **Forecast** – a statement about the future value of a variable of interest
  - We make forecasts about such things as weather, demand, and resource availability
  - Forecasts are important to making informed decisions
  - The shorter the forecast period, the more accurately the forecasts tend to track what happens



# Two Important Aspects of Forecasts

## 1. Expected level of demand

- The level of demand may be a function of some structural variation such as trend or seasonal variation

## 2. Accuracy

- Related to the potential size of forecast error



# Forecasting in business

**Forecasting in business is a decision-making tool used by many businesses to help in budgeting, planning, and estimating future growth. In the simplest terms, forecasting is the attempt to predict future outcomes based on past events and management insight.**



# Forecasts in Business Organizations

- **Accounting.** New product/process cost estimates, profit projections, cash management.
- **Finance.** Equipment/equipment replacement needs, timing and number of funding/borrowing needs.
- **Human resources.** Hiring activities, including recruitment, interviewing, and training; layoff planning, including outplacement counseling.
- **Marketing.** Pricing and promotion, e-business strategies, global competition strategies.
- **MIS.** New/revised information systems, internet services.
- **Operations.** Schedules, capacity planning, work assignments and workloads, inventory planning, make-or-buy decisions, outsourcing, project management.
- **Product/service design.** Revision of current features, design of new products or services.

# Forecast Uses

- **Plan the system**

- Generally, involves long-range plans related to:
  - Types of products and services to offer
  - Facility and equipment levels
  - Facility location

- **Plan the use of the system**

- Generally, involves short- and medium-range plans related to:
  - Inventory management
  - Workforce levels
  - Purchasing
  - Production
  - Budgeting
  - Scheduling



# Features Common to All Forecasts



1. Techniques assume some underlying causal system that existed in the past will persist into the future
2. Forecasts are not perfect
3. Forecasts for groups of items are more accurate than those for individual items
4. Forecast accuracy decreases as the forecasting horizon increases
5. When choosing a forecasting technique, a critical trade-off that must be considered is that between cost and accuracy

# Forecasts Are Not Perfect

- **Random variation** is always present, there will always be some residual error, even if all other factors have been accounted for.
- **Lack of Data** – Without enough data to draw from, making accurate predictions is impossible. Businesses must collect as much data as possible and leverage this knowledge to create reliable forecasts.
- **Poor Quality Data** – Even if businesses have access to plenty of data, it won't do them any good if the quality is poor.



# Elements of a Good Forecast

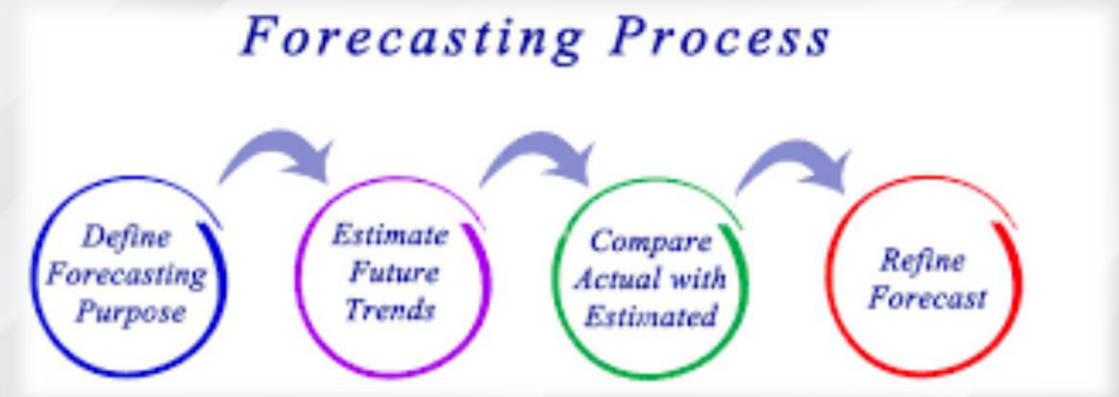
The forecast

- Should be *timely*
- Should be *accurate*
- Should be *reliable*
- Should be expressed in *meaningful units*
- Should be *in writing*
- Technique should be *simple to understand and use*
- Should be *cost-effective*



# Steps in the Forecasting Process

1. Determine the purpose of the forecast
2. Establish a time horizon
3. Obtain, clean, and analyze appropriate data
4. Select a forecasting technique
5. Make the forecast
6. Monitor the forecast errors



# Forecasting Approaches

- **Qualitative forecasting**

- Qualitative techniques permit the inclusion of *soft* information such as:
  - Human factors
  - Personal opinions
  - Hunches
- These factors are difficult, or impossible, to quantify

- **Quantitative forecasting**

- These techniques rely on *hard* data
- Quantitative techniques involve either the projection of historical data or the development of associative methods that attempt to use *causal variables* to make a forecast

# Qualitative Forecasts

Forecasts that use subjective inputs such as opinions from consumer surveys, sales staff, managers, executives, and experts

- **Executive opinions**

- A small group of upper-level managers may meet and collectively develop a forecast

- **Salesforce opinions**

- Members of the sales or customer service staff can be good sources of information due to their direct contact with customers and may be aware of plans customers may be considering for the future

# Qualitative Forecasts cont.

- **Consumer surveys**

Since consumers ultimately determine demand, it makes sense to solicit input from them

Consumer surveys typically represent a *sample* of consumer opinions

- **Other approaches**

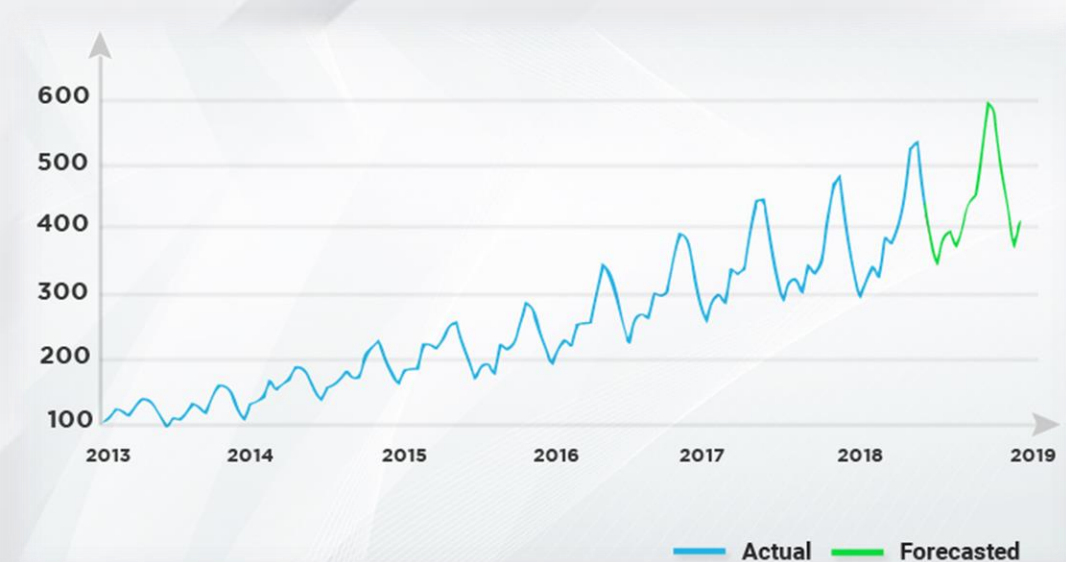
Managers may solicit opinions from other managers or staff people or outside experts to help with developing a forecast.

The Delphi method is an iterative process intended to achieve a consensus

# Time-Series Forecasts

Forecasts that project patterns identified in recent time-series observations

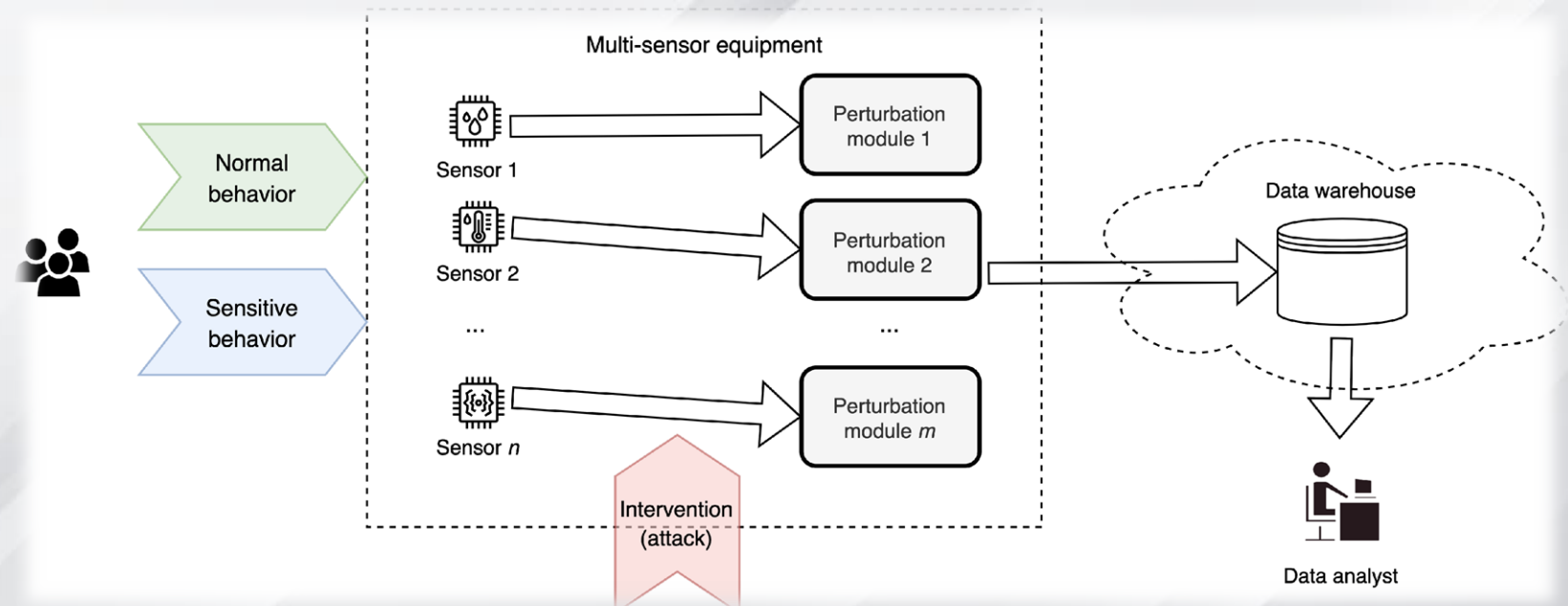
- **Time-series** – a time-ordered sequence of observations taken at regular time intervals
- Assume that future values of the time-series can be estimated from past values of the time-series



# Time-Series Behaviors

Time series data is a collection of observations (behavior) for a single subject (entity) at different time intervals (generally equally spaced as in the case of metrics, or unequally spaced as in the case of events).

- Trend
- Seasonality
- Cycles
- Irregular variations
- Random variation



# Trends and Seasonality

- **Trend**

- A long-term upward or downward movement in data
  - Population shifts
  - Changing income

- **Seasonality**

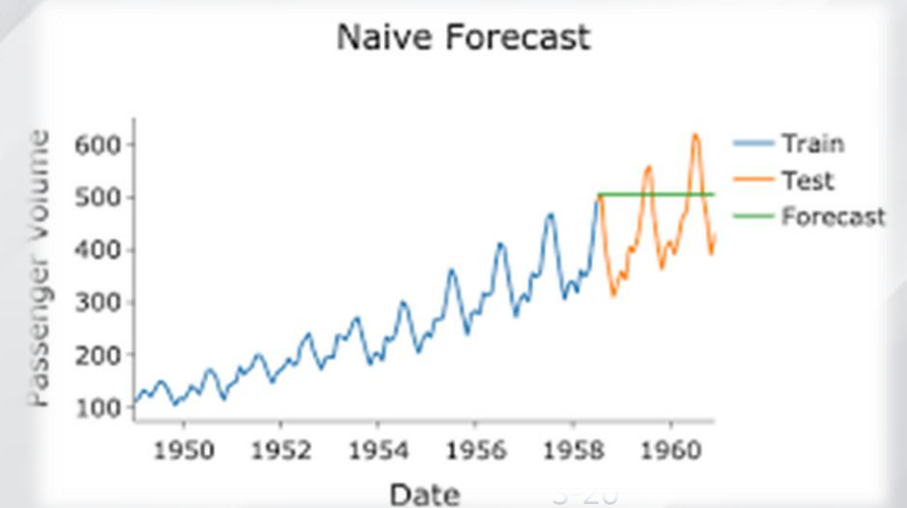
- Short-term, regular variations related to the calendar or time of day
- Restaurants, service call centers, and theaters all experience seasonal demand

# Cycles and Variations

- **Cycle**
  - Wavelike variations lasting more than one year
    - These are often related to a variety of economic, political, or even agricultural conditions
- **Irregular variation**
  - Due to unusual circumstances that do not reflect typical behavior
    - Labor strike
    - Weather event
- **Random Variation**
  - Residual variation that remains after all other behaviors have been accounted for

# Time-Series Forecasting - Naïve Forecast

- **Naïve forecast**
  - Uses a single previous value of a time series as the basis for a forecast
    - The forecast for a time is equal to the previous time period's value
  - Can be used with
    - A stable time series
    - Seasonal variations
    - Trend



# Time-Series Forecasting - Averaging

These techniques work best when a series tends to vary about an average

- Averaging techniques smooth variations in the data
- They can handle step changes or gradual changes in the level of a series
- Techniques
  1. Moving average
  2. Weighted moving average
  3. Exponential smoothing

# What is the averaging technique?

The objectives of various averaging methods are twofold:

- (1) to define the average properties for the multiphase system and correlate the experimental data
- (2) to obtain solvable governing equations that can be used to predict the macroscopic properties of the multiphase system.

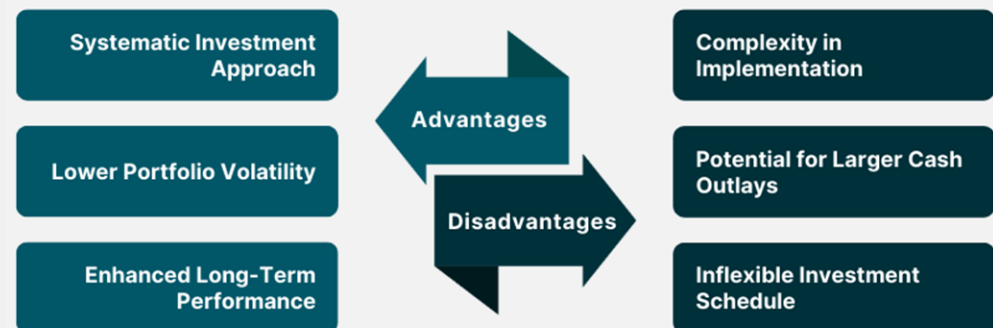
# What is averaging strategy?

- Averaging is a set of trading strategies that involve adjusting the average price of the shares held by buying or selling more shares when the market fluctuates.
- Averaging can be used in different market scenarios and with different objectives.

# What is the advantage of averaging?

Measuring a value several times and then calculating its average value reduces the error in the measured value. If we take the average of averages, it will further reduce the error and thus we will be closer to the true value.

## Advantages and Disadvantages of Value Averaging



# 1. Moving Average

- A moving average is a technical indicator that investors and traders use to determine the trend direction of securities.
- Technique that averages several of the most recent actual values in generating a forecast



# Moving Average (cont.)

- As new data become available, the forecast is updated by adding the newest value and dropping the oldest and then re-computing the average
- The number of data points included in the average determines the model's sensitivity
  - Fewer data points used—more responsive
  - More data points used—less responsive

## 2. Weighted Moving Average

- The most recent values in a time series are given more weight in computing a forecast
  - The choice of weights,  $w$ , is somewhat arbitrary and involves some trial and error

### Weighted Moving Averages

| Week | Sales | 2WMA |
|------|-------|------|
| 1    | 39    |      |
| 2    | 44    |      |
| 3    | 40    | 42.0 |
| 4    | 45    | 41.6 |
| 5    | 38    | 43.0 |
| 6    | 43    | 40.8 |
| 7    | 39    | 41.0 |
| 8    |       |      |

**Weights: 3 and 2**

$$F_7 = \frac{3(43) + 2(38)}{5}$$

# 3. Exponential Smoothing

- Exponential smoothing is a time series forecasting method that uses an exponentially weighted average of past observations to predict future values.
- A weighted averaging method that is based on the previous forecast plus a percentage of the forecast error

# Techniques for Seasonality

Seasonality – regularly repeating movements in series values that can be tied to recurring events

- Expressed in terms of the amount that actual values deviate from the average value of a series
- Models of seasonality
  - Additive
    - Seasonality is expressed as a quantity that gets added to or subtracted from the time-series average to incorporate seasonality
  - Multiplicative
    - Seasonality is expressed as a percentage of the average (or trend) amount which is then used to multiply the value of a series to incorporate seasonality

# Seasonal Relatives

The seasonal percentage used in the multiplicative seasonally adjusted forecasting model

- Using seasonal relatives
  - To *deseasonalize* data
    - Done to get a clearer picture of the nonseasonal (e.g., trend) components of the data series
    - Divide each data point by its seasonal relative
  - To *incorporate seasonality* in a forecast
    1. Obtain trend estimates for desired periods using a trend equation
    2. Add seasonality by multiplying these trend estimates by the corresponding seasonal relative

# Associative Forecasting Techniques

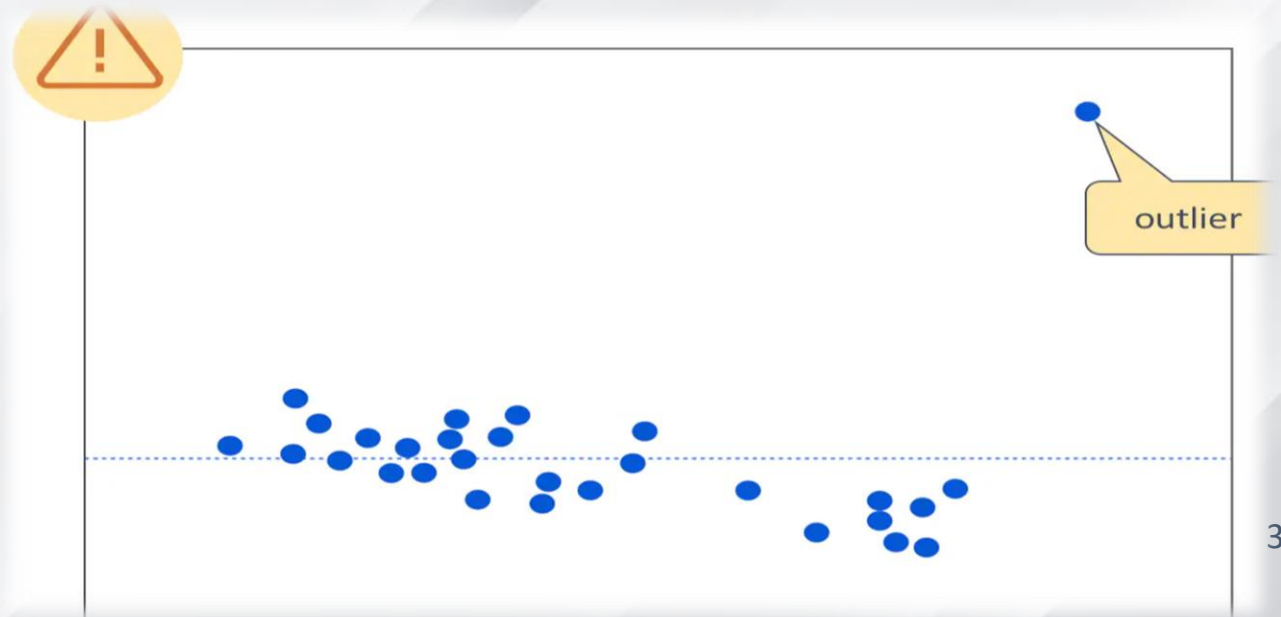
- Associative techniques are based on the development of an equation that summarizes the effects of predictor variables
  - **Predictor variables** – variables that can be used to predict values of the variable of interest
    - Home values may be related to such factors as home and property size, location, number of bedrooms, and number of bathrooms

# Simple Linear Regression

- Regression – a technique for fitting a line to a set of data points
  - Simple linear regression – the simplest form of regression that involves a linear relationship between two variables
    - The object of simple linear regression is to obtain an equation of a straight line that minimizes the sum of squared vertical deviations from the line (i.e., the *least squares criterion*)

# Simple Linear Regression Assumptions

1. Variations around the line are random
2. Deviations around the average value (the line) should be normally distributed
3. Predictions are made only within the range of observed values



# Issues to Consider:

- Always plot the line to verify that a linear relationship is appropriate
- The data may be time-dependent
  - If they are
    - use analysis of time series
    - use time as an independent variable in a multiple regression analysis
- A small correlation may indicate that other variables are important

# Forecast Accuracy and Control

- Allowances should be made for forecast errors
  - It is important to provide an indication of the extent to which the forecast might deviate from the value of the variable that happens
- Forecast errors should be monitored
  - $\text{Error} = \text{Actual} - \text{Forecast}$
  - If errors fall beyond acceptable bounds, corrective action may be necessary

# Monitoring the Forecast

- Tracking forecast errors and analyzing them can provide useful insight into whether forecasts are performing satisfactorily
- Sources of forecast errors:
  - The model may be inadequate due to
    - a. error of an important variable
    - b. a change or shift in the variable the model cannot handle
    - c. the appearance of a new variable
  - Random variation

# Choosing a Forecasting Technique

- Factors to consider
  - Cost
  - Accuracy
  - Availability of historical data
  - Availability of forecasting software
  - Time needed to gather and analyze data and prepare a forecast
  - Forecast horizon

# Operations Strategy

- The better forecasts are, the more able organizations will be to take advantage of future opportunities and reduce potential risks
  - A worthwhile strategy is to work to improve short-term forecasts
    - Accurate up-to-date information can have a significant effect on forecast accuracy:
      - Prices
      - Demand
      - Other important variables
  - Reduce the time horizon forecasts must cover
  - Sharing forecasts or demand data through the supply chain can improve forecast quality



Thank You