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Elements of Forecasting

Introduction

Dr. Sung Won Kim

Quotes about Forecasting

"Those who have knowledge, don't predict. Those who predict, don't have knowledge.“

—Lao Tzu, 6th Century BC Chinese Poet

http://www1.secam.ex.ac.uk/famous-forecasting-quotes.dhtml

Quotes about Forecasting (cont.)

"Forecasts may tell you a great deal about the forecaster; they tell you nothing about the future."

—Warren Buffett

https://investorplace.com/2016/09/the-worst-phrases-that-stock-market-forecasters-love-to-assert/

Quotes about Forecasting (cont.)

“We have two classes of forecasters: Those who don’t know—and those who don’t know they don’t know.”

—Economist John Kenneth Galbraith

https://www.marketwatch.com/story/5-quotes-that-tell-you-everything-you-need-to-know-about-forecasting-2017-01-11

Subjective Forecasting Methods

Subjective and judgmental methods are often used when there is a limited amount of data available.

Subjective methods may even perform better than quantitative methods.

- Very long-term predictions (e.g., 50 years out)
- Quantitative models do not include the necessary types of data.

Subjective Forecasting Methods (cont.)

Guess

Sales-force composite – ask people closest to the problem to make forecasts. Ask for best, normal, and worst cases

Jury of executive opinion – experts deliberate as a group

Subjective Forecasting Methods (cont.)

Delphi Method

1. Participants are selected.
2. Participants fill out questionnaire.
3. Questionnaire results are summarized.
4. Participants review and consider results to update their forecasts.
5. Repeat until a consensus is achieved.

Disadvantages of Subjective Forecasting

They are almost always biased.

They are not consistently accurate over time.

It takes years of experience for someone to convert intuitive judgement into good forecasts.

Chase,Charles W.,,Jr. (1991). Forecasting consumer products. *The Journal of Business Forecasting Methods & Systems, 10*(1)

What Is Business Forecasting?

Forecasting is the process of predicting future business events.

Forecasting relies on historical data and forecasting techniques.

Forecasting requires managerial oversight to ensure that the correct forecasting techniques are implemented to prevent costly errors.

What Is Time Series Data?

Time series data is a collection of numerical data collected at regular intervals.

Example SPY Closing Prices

Date	Close					
5/21/2019	286.51					
5/22/2019	285.63					
5/23/2019	282.14					
5/24/2019	282.78					
5/28/2019	280.15					

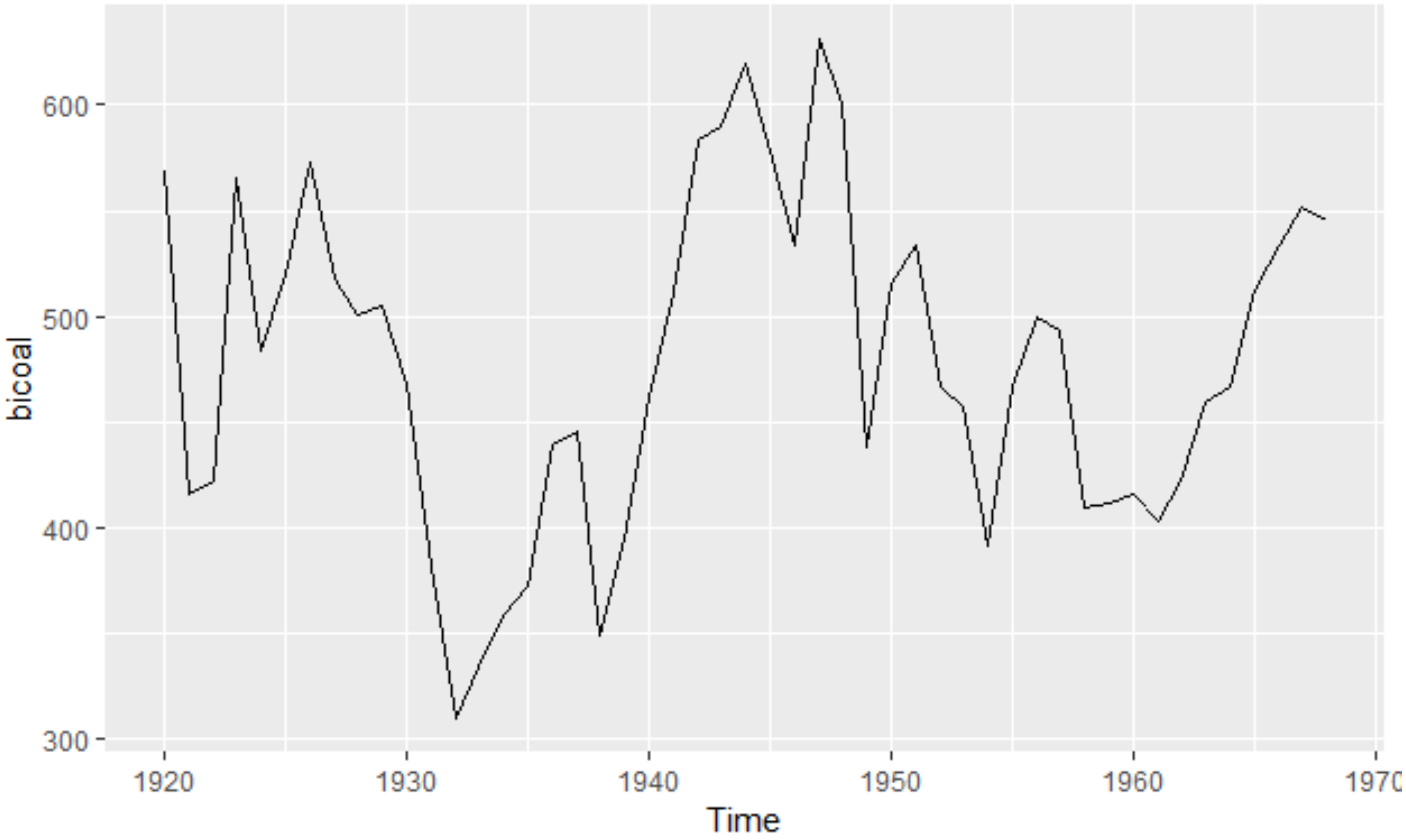
Yahoo Finance

R: Create Time Series

See 10 EOF intro.R

Annual Coal Production: USA 1920–1968

(in tons)



References

Hanke, J. E., Reitsch, A. G., & Wichern, D. W. (2001). *Business forecasting* (9th ed.). Upper Saddle River, NJ: Prentice Hall.

Wilson, J. H., & Keating, B. (1994). *Business forecasting*. Tata McGraw-Hill Education.

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Financial Analytics

Introduction

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What Is Analytics?

Scientific process of uncovering and showcasing patterns in data

Converts raw data into useful knowledge

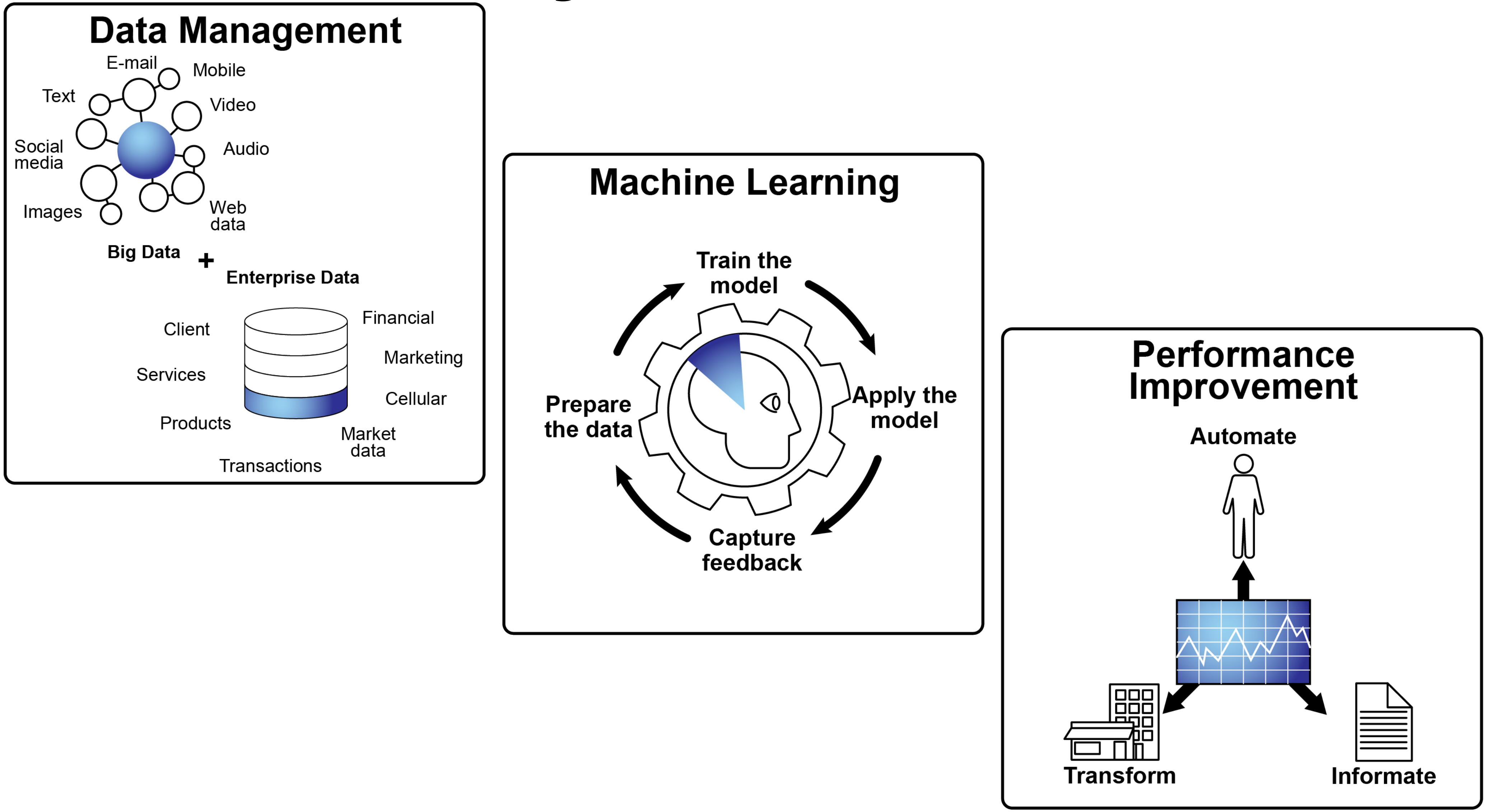
Blend of statistics, computer programming, and mathematical modeling

What Is Financial Analytics?

Example cases of financial analytics:

- Use business operations data to assess a firm’s performance and recommend improvements.
- Evaluate an investment balancing risk and return for a portfolio.
- Assess future risk in property values, policy, and claims. (Risk Management Information Systems)

Financial Analytics: Overview



https://www.digitalistmag.com/customer-experience/2019/01/29/data-driven-analytics-practical-use-cases-for-financial-services-06195123

Financial Analytics: Automate

Algorithmic trading for fast-paced automated trading

Customer credit risk evaluation for credit decisions

Customer complaint management for root-cause analysis and rapid response

https://www.digitalistmag.com/customer-experience/2019/01/29/data-driven-analytics-practical-use-cases-for-financial-services-06195123

Financial Analytics: Informate

Warning predictions based in liabilities

Predicting loan delinquency risk of a customer

Forecasting churn risk for individual customers

Detecting financial crime like fraud, money laundering, etc.

https://www.digitalistmag.com/customer-experience/2019/01/29/data-driven-analytics-practical-use-cases-for-financial-services-06195123

Financial Analytics: Transform

- Growth
- Profitability
- Liquidity
- Cash Flow
- Valuation
- Leverage
- Portfolio Management

https://corporatefinanceinstitute.com/resources/knowledge/finance/types-of-financial-analysis/

Financial Analytics Topics

Time Series Analysis – understanding autocorrelated data

Portfolio Management involves evaluating a group of investment’s risk and return trade-off.

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Elements of Forecasting

Performance Measurements

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Forecast vs. Actual

Actual value (y_t), also called observed value, for a particular variable is obtained by observing the available data.

Forecasted value (f_t), also called predicted value, for a particular variable.

Difference/Distance between actual and forecast values is called residual or error

Distance Measure

Similarity/Positional distance $= \begin{cases} 0 \; if \; y_t = f_t \\ 1 \; if \; y_t \neq f_t \end{cases}$

Absolute distance $= \sum_{t=1}^{n} |y_t - f_t|$

Euclidean Distance $= \sqrt{\sum_{t=1}^{n} (y_t - f_t)^2}$

Performance Measurement

We will discuss some commonly used performance measures.

In the following definitions:

y_t represents the actual value at time t.

f_t represents the forecasted value (estimated value) at time t.

$e_t = y_t - f_t$ represents the forecast error (residual) at time t.

n is the size of the test set.

Performance Measurement

The mean forecast error (MFE)

$MFE = \frac{1}{n}\sum_{t=1}^{n} e_t$, average of all forecast errors, which indicates forecast bias by showcasing direction of error

If MFE = 0 (desirable goal), then forecasts are accurate with minimum bias.

Affected by scale of measurement and data transformation.

It does not penalize extreme error values.

Performance Measurement

The mean absolute value (MAE)

$MAE = \frac{1}{n}\sum_{t=1}^{n}|e_t|$, average of all forecast errors (in absolute terms), which indicates magnitude of overall error

Small values of MAE are desirable.

Affected by scale of measurement and data transformation.

It does not penalize extreme error values.

Performance Measurement

The mean percentage error (MPE)

$MPE = \frac{1}{n}\sum_{t=1}^{n}\left(\frac{e_t}{y_t}\right)\times 100$, average error percentage indicating direction of error.

MPE close to zero is desirable.

Performance Measurement

The mean absolute percentage error (MAPE)

$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{e_t}{y_t}\right| \times 100$, is a percentage of average absolute error without any information about error direction.

Affected by data transformation, but not scale of measurement

It does not penalize extreme error values.

Performance Measurement

The mean squared error (MSE)

$MSE = \frac{1}{n}\sum_{t=1}^{n} e_t^2$, gives overall idea of the forecast errors even if there are positive & negative error values cancelling each other.

No information about error direction

Affected by scale of measurement and data transformation

It does penalize extreme error values.

Performance Measurement

The sum of squared error (SSE)

$SSE = \sum_{t=1}^{n} e_t^2$, total of squared forecast errors.

Properties are same as MSE.

Performance Measurement

The signed mean squared error (SMSE)

$SMSE = \frac{1}{n}\sum_{t=1}^{n}\left(\frac{e_t}{|e_t|}\right)e_t^2$, same as MSE incorporating error direction.

Affected by scale of measurement and data transformation

It does penalize extreme errors.

Performance Measurement

The Theil's U-statistics

$$U = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{n} f_t^2}\ \sqrt{\frac{1}{n}\sum_{t=1}^{n} y_t^2}}$$

Ranges $0 \leq U \leq 1$

U = 0 signifies a perfect fit, which is desirable.

Affected by scale of measurement and data transformation

Performance Measurement

The root mean squared error (RMSE)

$$RMSE = \sqrt{MSE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t^2}$$

Shares same MSE properties

Performance Measurement

The normalized mean squared error (NMSE)

$NMSE = \frac{MSE}{\sigma^2} = \frac{1}{\sigma^2 n}\sum_{t=1}^{n} e_t^2$, it normalizes MSE dividing it by the test variance

A balanced error measure, which signals forecast accuracy.

Smaller NMSE is desirable.