Review Topics

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Regression

- Models
  - Simple regression model SRM marginal slope
    - Scatterplot of y on x, e on x
  - Multiple regression model MRM partial slope
    - Scatterplot matrix of y with $x_1,\ldots,x_k$
    - Collinearity, VIF
  - Fitted values, residuals, errors
- Assumptions
  - Linear equation Transformations (esp. logs)
  - Independence Durbin-Watson test, residuals
  - Constant variance Plot of e on $\hat{y}$
  - Normality Normal quantile plot
- Categorical variables
  - Dummy variables Use in seasonal models
  - Interactions

Inference in Regression

- Coefficients
  - One slope H_0: $\beta_j = 0$ t-statistic, p-value, conf int
  - All H_0: $\beta_1 = \ldots = \beta_k = 0$ F-statistic (Anova table)
    - Test size of R^2
  - Some H_0: some $\beta_j = 0$ Partial F
    - Test collection representing categorical variable
    - Test using Effect Test or by comparison of R^2 in models
    - Importance of avoiding multiple t-tests, multiplicity
- Prediction
  - Components of standard error
    - Random, unexplained variation (RMSE, σ_ε)
    - Extrapolation ("distance value")
  - Intervals
    - Confidence interval for mean $\hat{Y} = E(Y|X_1,\ldots,X_k)$
    - Prediction interval for individual future Y value

Exponential Smoothing

- Simple exponential smoothing
  - Geometrically weighted average of past values
  - Recursive form, updating equation $l_t = l_{t-1} + \alpha(y_t - l_{t-1})$
- Model with underlying state
  - Evolving underlying state $L_t = L_{t-1} + \alpha\, \varepsilon_t$
  - Observation has mean L_{t-1} $y_t = L_{t-1} + \varepsilon_t$
- Prediction
  - Predict y_{n+f} using estimated state $E\, y_{n+f} = L_n$ (same for all f)
  - Error grows as extrapolate $E(y_{n+f}-\hat{y}_{n+f})^2 = \sigma^2(1+(f-1)\alpha^2)$
- Equivalent to IMA(1,1)
  - Exponential smoothing is special case of a non-stationary ARIMA model

Exponential Smoothing

- IMA(1,1)
  - Equation $y_t - y_{t-1} = -\theta a_{t-1} + a_t$
  - Predictions $\hat{y}_{n+1} = y_n - \theta a_n, \quad \hat{y}_{n+f} = \hat{y}_{n+1}$
- Same predictors
  - Equation $l_t = l_{t-1} + \alpha(y_t - l_{t-1})$
  - Predictor of y_t in exponential smooth is l_{t-1}
  - Relabel $l_{t-1} = \hat{y}_t$
  - Equation becomes $\hat{y}_{t+1} = \hat{y}_t + \alpha(y_t - \hat{y}_t)$

    at $t=n$ $\hat{y}_{n+1} = \hat{y}_n + \alpha(y_n - \hat{y}_n)$

    use observations $\hat{y}_{n+1} = y_n + \alpha\, a_n$
  - Prediction equations agree with $\alpha = -\theta$
- Implication
  - If an IMA(1,1) looks like good fit, use expo smoothing
  - If not, some other type of smoothing is appropriate

ARIMA Models

- Stationarity
  - Use differencing to produce stationary series
- Correlation functions
  - Autocorrelation function (TAC versus SAC)
  - Partial autocorrelation function
  - Uses
    - detect non-stationarity
    - identify model
    - evaluate/check residuals
- Different types of dependence
  - Autoregression
    - Geometric weighting of past errors, finite past observations
    - TAC decays geometrically, TPAC cuts off
  - Moving Average
    - Geometric weighting of past observations, finite past errors
    - TAC cuts off, TPAC decays geometrically

ARIMA Models

- Model identification
  - Plots of data
  - Correlation functions
    Do residuals appear uncorrelated?
    - Box-Pierce, Box-Ljung statistics (avoid multiplicity)
    - Accumulate squared residual autocorrelations
  - Selection criteria (AIC, SBC/BIC)
    - Penalized complicated models, reward for parsimonious specification

- Prediction, prediction intervals
  - Extrapolate form of model, recursively using predictions
    - Fill in y_{n+f} with $\hat{y}_{n+f}$, a_{n+f} with 0
  - Predictions revert to mean
  - Prediction standard errors grow toward SD(y_t)

General Comments

- Read questions carefully before answering
- Open textbook (no other books)
  - Buy a calculator if you want to use one.
  - No telephones, laptops, other electronics allowed.
    - Shut off ahead of time to avoid issues.
- Exam structure
  - Brief description of context of data
  - JMP output
  - Short answer
  - Multiple choice
- Get plenty of sleep the night before!