Utilization of Multivariate Time Series Method to Forecast Student Enrollment: A Solution to a Methodological Problem

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Enrollment Forecasting

- ✓ Unique for each institution.
- ✓ Accurate enrollment projections are critical.
  - ✓ Fundamentally important for budget, program, and personnel planning.

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Development of an Enrollment Forecasting Model

- ✓ Enrollment forecasting is an iterative and collaborative process that requires the following:
  - ✓ Understanding of institutional, school/college-level, and department-level enrollment goals.
  - ✓ Developing a model that reliably projects future enrollments.

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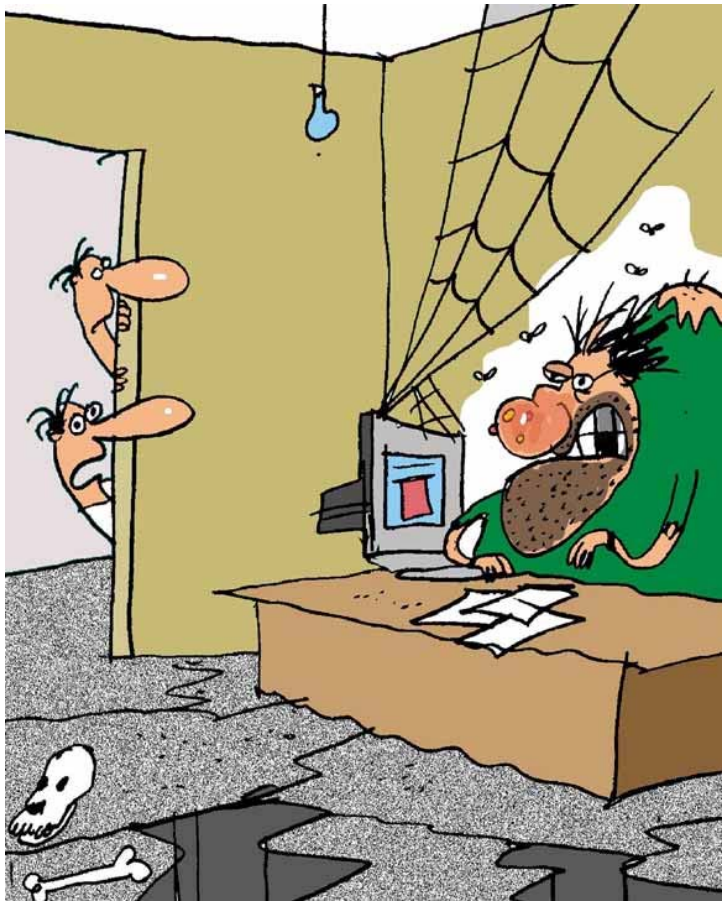
Development of an Enrollment Forecasting Model



- ✓ Time frame in which estimates are needed.
- ✓ Costs associated with forecasting.
- ✓ Ease of implementation and expertise of staff.
- ✓ Availability of data.
- ✓ Model needs to be readily adaptable.

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Techniques for Projecting Student Enrollment

- ✓ Subjective Judgment (Wing, 1974)
- ✓ Ratio Methods (Wing, 1974)
- ✓ Cohort Survival Study (Shaw, 1984)
- ✓ Markov Transition Model (Render & Stair, Jr., 2000)
- ✓ Neural Network Model (Huarng & Yu, 2005)
- ✓ Simulation Method (Chen, 2008)
- ✓ Regression Methods (Howell, 2012)
- ✓ Time Series Analysis (Diggle, 2004)
- ✓ Fuzzy Time Series (Song & Chissom, 1993)

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Multivariate Auto-regressive State-space Model Techniques

- ✓ Utilized within natural and environmental sciences.
- ✓ Different names within different fields:
  - ✓ Dynamic linear modeling (DLM)
  - ✓ Vector Autoregressive (VAR) state-space models

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MARSS Package in R

- ✓ Fit time-varying constrained and unconstrained multivariate autoregressive state-space models with or without covariates.
- ✓ Implements an EM algorithm.
- ✓ Model specification has a one-to-one relationship.
- ✓ Fit degenerative multivariate models.
- ✓ Unbiased Akaike's Information Criterion (AIC) algorithm.

The MARSS Model

$$\mathbf{x}_t = \mathbf{B}\mathbf{x}_{t-1} + \mathbf{u} + \mathbf{w}_t$$

where $\mathbf{w}_t \sim \text{MVN}(0,\mathbf{Q})$

$$\mathbf{x}_0 \sim \text{MVN}(\boldsymbol{\pi},\boldsymbol{\Lambda}) \text{ or } \mathbf{x}_1 \sim \text{MVN}(\boldsymbol{\pi},\boldsymbol{\Lambda})$$

$$\mathbf{y}_t = \mathbf{Z}\mathbf{x}_t + \mathbf{a} + \mathbf{v}_t$$

where $\mathbf{v}_t \sim \text{MVN}(0,\mathbf{R})$

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Current Challenges Utilizing MARSS

- ✓ Some variables are not readily available.
- ✓ Requires a significant amount of computational resources.
- ✓ Provides precise overall estimates
  - ✓ College-level estimates…not so good ☹
- ✓ Missing structural component.

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Variables

- ✓ Enrollment numbers
- ✓ Tuition
- ✓ Financial aid data
- ✓ Standardized test scores
- ✓ Graduation & persistence rates
- ✓ Number of degrees awarded
- ✓ Economic data
- ✓ Number of staff & faculty
- ✓ Competitor institutions

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MARSS Resources

http://www.ecologybox.org

http://fishbox.iugo-cafe.org

http://cran.r-project.org/web/packages/MARSS/index.html

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