Actuaries & Regulators 4 Ever 2 Gether

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Irreconcilable Differences

Regulatory Issues

- The Regulatory Goals
- The Changing Regulatory Framework
- “Excuse me. What did you say?”
- The New Challenges for Regulators
- Prove It To Me!!!

vs.

Actuarial Issues

- Breaking the Language Barrier
- The Regulatory Process
- Statistical Modeling Tools
- Common Modeling Filing Issues
- Actuarial Standards of Practice
- Modeling Review Checklists

Reconciling Our Differences

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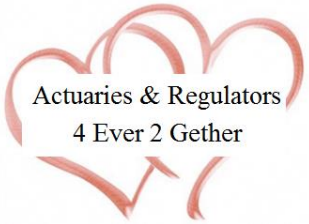

Regulatory Issues

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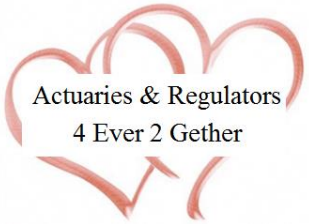

Regulators Prime Concerns

Rating Statutes Require

- Rates Not Inadequate
- Rates Not Excessive
- Rates Not Unfairly Discriminatory

Non-Statutory Requirement

- Whim of the Department's Leader

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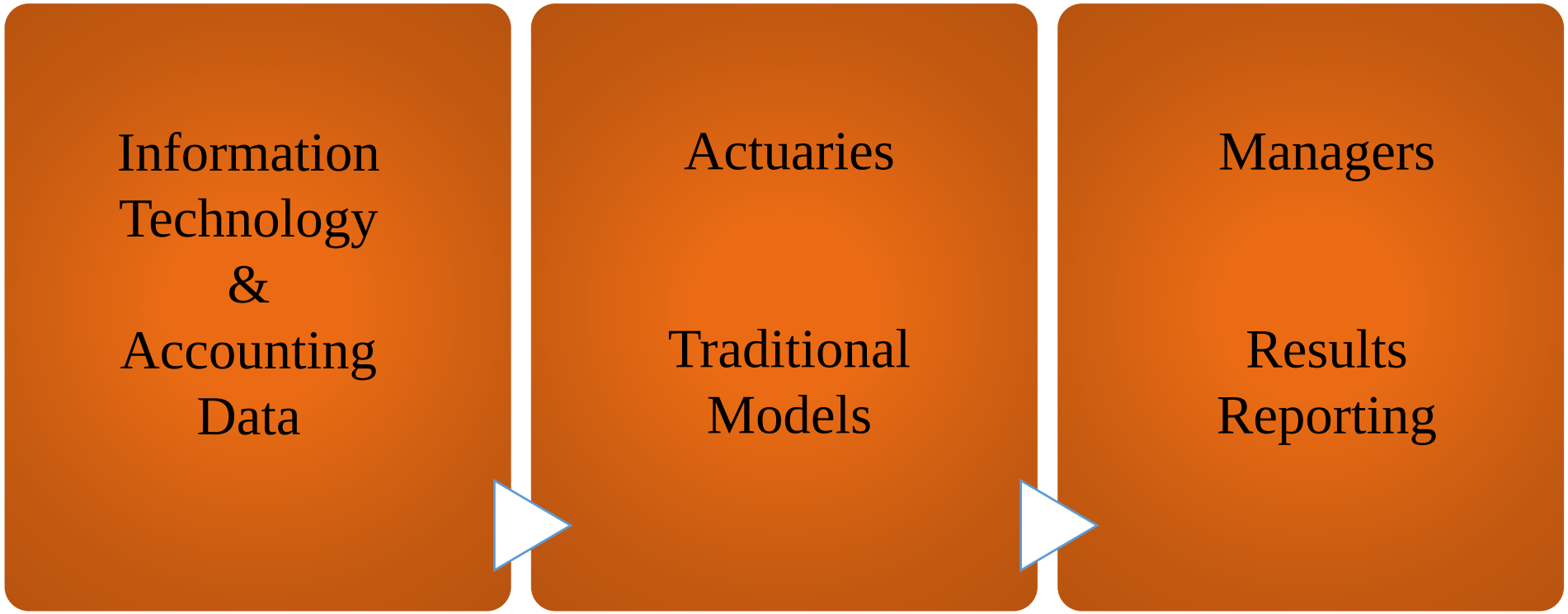
Old Insurance Company Framework



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Old Regulatory Framework

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Data: Trust But Verify

+ Models: Review of Calculations

+ Results: Reasonability Test

= Effective Oversight

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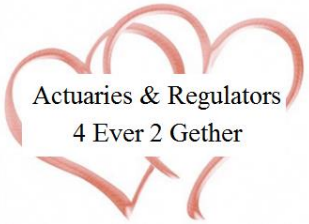
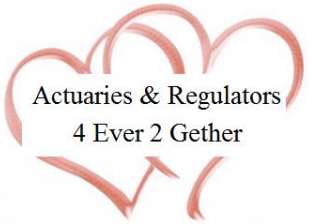


Regulatory Reaction to the "New Deal"

Company	→ **Regulators**	→ **Company**	→ **Regulators**
We have a new rating variable for separating risk. We are calling it Credit Score.	Seems to us that this is discriminatory and not an appropriate rating variable.	New Data is the New Deal! Credit score reliably separates risk and is statistically significant.	Well, maybe it is and maybe it isn't but for now we are saying NO!



New Insurance Company Framework

Actuaries

Traditional Models

Complex Models

Internal Data
Third Party Data
Outside Experts
Statisticians
Data Scientists

Managers

Results Reporting

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New Regulatory Framework

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Data: **Can we trust & verify new data sources?**

+ Models: **How do we review complex models?**

+ Results: **What do the new results mean?**

= ???????

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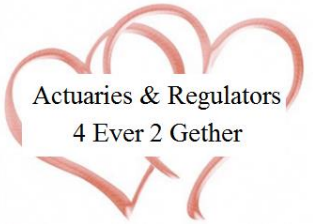
Why is New Paradigm Shift Difficult?



- Sophisticated modeling calls for **skills** that regulators naturally lack.
- Sophisticated modeling requires **knowledge** that is often not in our educational backgrounds.
- Modeling is often **interdisciplinary**.
- The modeling field is constantly **changing**, bringing in concepts from math, statistics, natural and behavioral sciences, and computer science.

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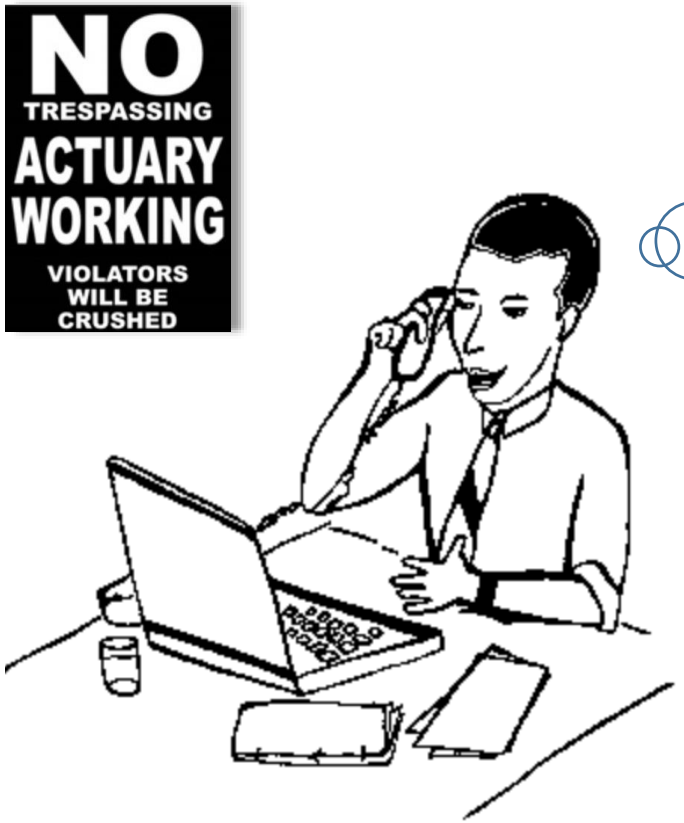

The Poisson Distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time and/or space if these events occur with a known average rate and independently of the time since the last event.

The Office of the Actuary

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Blah blah blah probability distribution blah blah blah blah average rate blah blah blah blah blah the last event.

The Office of the Regulator

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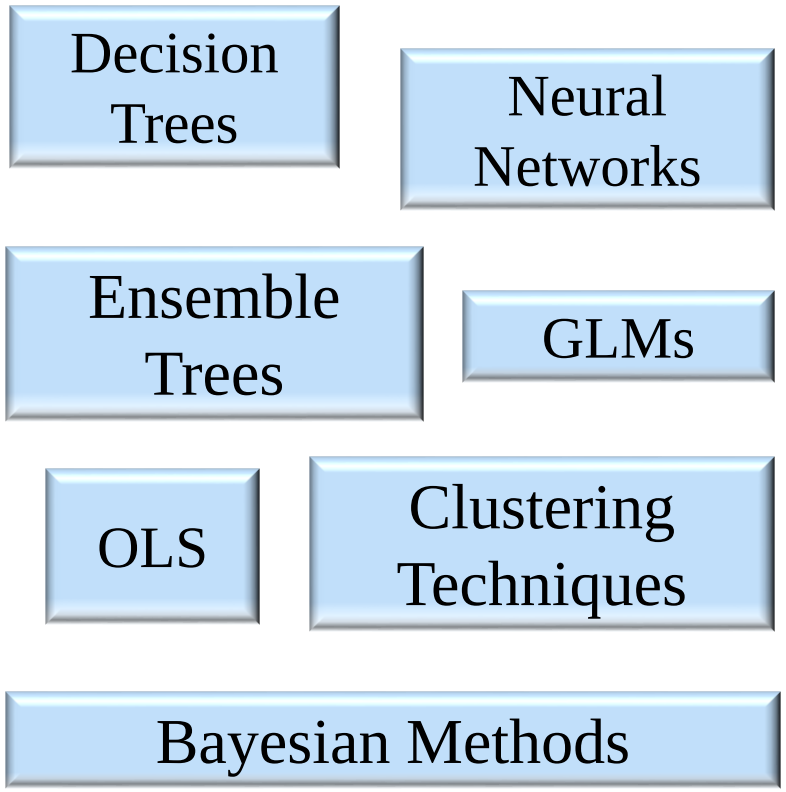
Types of Predictive Models

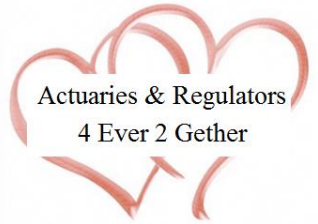


- Predictive modeling is a growing discipline, spanning many industries and it is constantly changing in definition and application.
- GLMs are common in insurance (NOW), but other techniques are beginning to be adopted.
- Software tools are rapidly moving towards point & click interfaces, diminishing the need to know complex computer languages.

Why is New Paradigm Shift Difficult?

- Modeling process naturally lacks transparency.
- Data verification is much more difficult.
- Lots of problematic language and acronym problems.
- The jobs of regulators has not changed, but challenges have grown.

Regulatory Considerations



Use of Restricted Classes

Specific Rates by Jurisdiction

Dislocations and Capping Limitations

- ✓ *Not enough information to evaluate the model.*
- ✓ *Is it protected class information?*
- ✓ *Is the net effect discriminatory even if not intended?*

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In the end what do regulators need?

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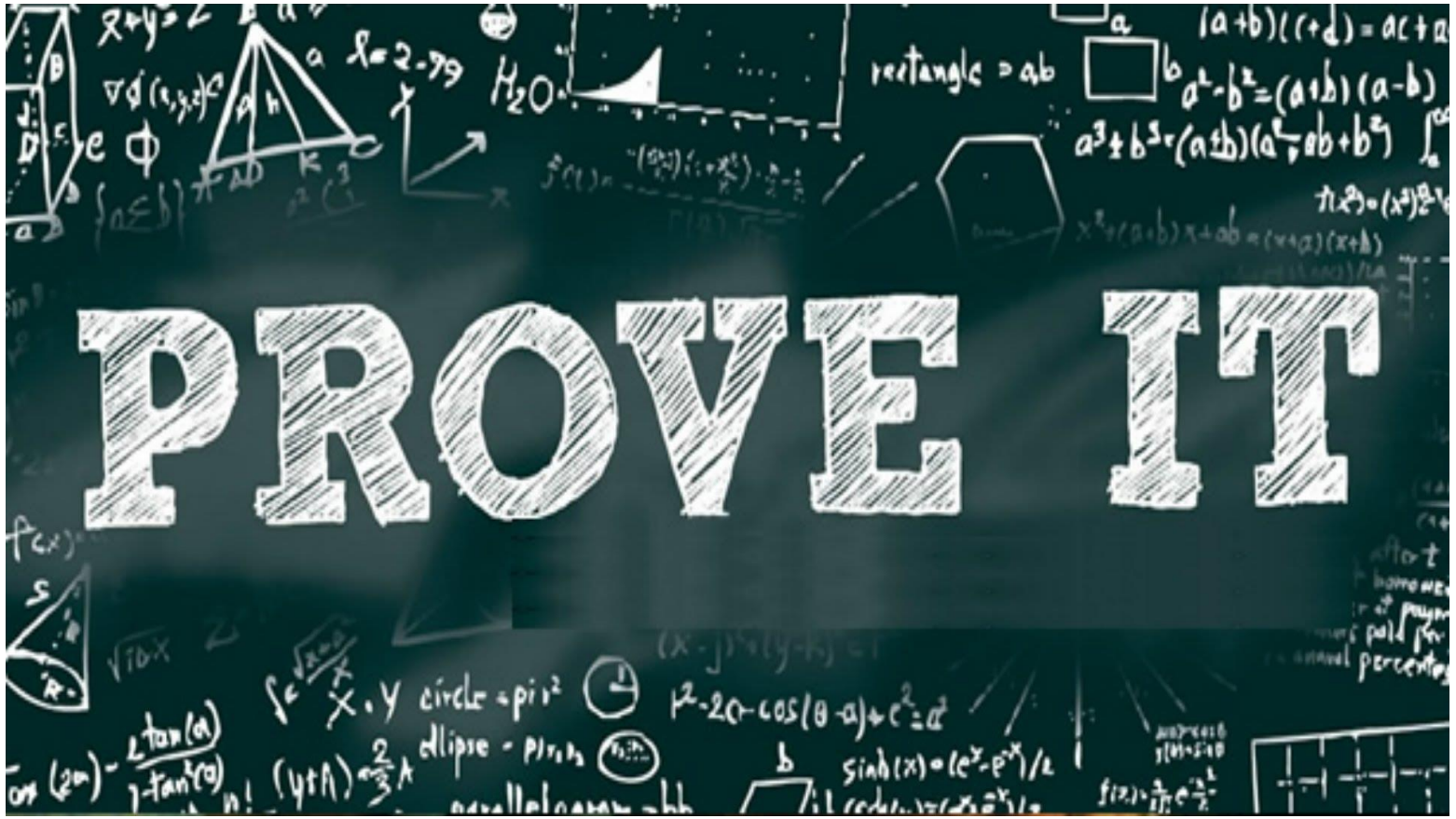

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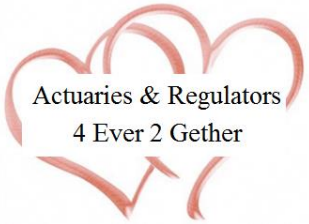

Actuarial Issues

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Elasticity, theory & Application

Question: What is elasticity? How to derive elasticity formulas for different model? How do we apply it?

Answer: Elasticity: % of change of the dependent variable if we have 1% change in the independent variable.

① For simple linear model: $y=\alpha+\beta x \Rightarrow$ Elasticity $= \beta \cdot \frac{x_0}{y_0}$

Why?: elasticity $= \frac{\Delta y/y_0}{\Delta x/x_0}$ Where x_0: mean of independent var., y_0: mean of dependent var.

$= \frac{y-y_0}{y_0} \Big/ \frac{x-x_0}{x_0} = \frac{b(x-x_0)}{y_0} \cdot \frac{x_0}{x-x_0} = b \cdot \frac{x_0}{y_0}$

② For log linear model: $\log y = a+bx \Rightarrow$ Elasticity $= 100 \cdot [e^{0.01 \cdot bx_0} - 1]$

Why?: elasticity $= \frac{\Delta y/y_0}{\Delta x/x_0} = \frac{y-y_0}{y_0} \cdot \frac{x_0}{x-x_0} = \frac{e^{bx} - e^{bx_0}}{e^{bx_0}} \cdot \frac{x_0}{x-x_0}$

$= [e^{b(x-x_0)} - 1] \Big/ \frac{x-x_0}{x_0} = [e^{bx_0 \cdot \frac{x-x_0}{x_0}} - 1] \Big/ \frac{x-x_0}{x_0}$

Now, the change of x: $\frac{x-x_0}{x_0} = 0.01 = 1\%$

$= 100[e^{0.01 \cdot bx_0} - 1]$

③ For Logit Model: $\log \frac{p(y=1)}{1-p(y=1)} = a+bx$

denote $y = p(Y=1)$, then $\log \frac{y}{1-y} = a+bx \Rightarrow y = \frac{e^{a+bx}}{1+e^{a+bx}}$

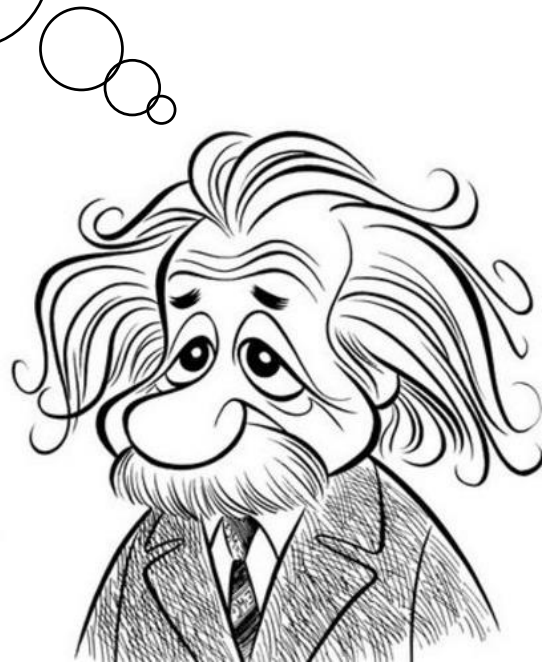
Now, elasticity $= \frac{y-y_0}{y_0} \Big/ \frac{x-x_0}{x_0} = \left[e^{b(x-x_0)} \cdot \frac{1+e^{a+bx_0}}{1+e^{a+bx}} - 1\right] \Big/ \frac{(x-x_0)}{x_0}$

if $\frac{x-x_0}{x_0} = 1\%$, $x = 1.01\, x_0$

$\Rightarrow$ Elasticity $= 100 \cdot \left[e^{0.01 \cdot bx_0} \cdot \frac{1+e^{a+bx_0}}{1+e^{a+1.01 \cdot bx_0}} - 1\right]$

Ask an actuary a simple question and get complicated answer.

Gee Whiz!!!



Source: https://www.timetoast.com/timelines/cartoon-timeline-of-albert-einstein

Remember the KISS Principle!!!

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Breaking the Language Barrier

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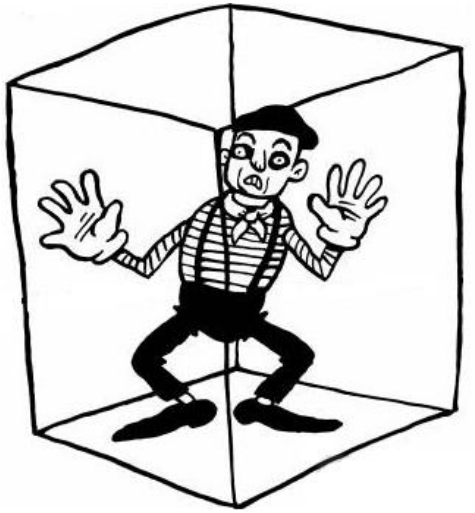
The Black Box

+ Actuaries =



The Glass Box

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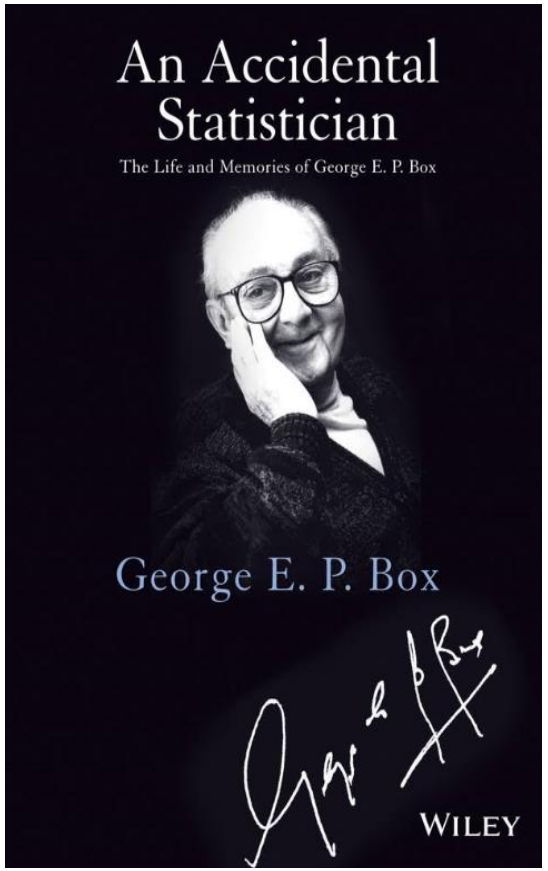
How do YOU know the model is “right”?



“Essentially, all models are wrong, but some are useful.”

- George E.P. Box

Recognizing the “wrong” model is easier than qualifying the “right” model.

The model is only a model of the phenomena and not the real thing. We can’t remove the human element from the modeling process.

The Regulatory Process

- Prevent unfair discrimination in risk selection & pricing
- Regulatory are keenly interested in
  - Model variables
  - Reliance on other models
- Any model relied upon must be included in the filing
- Regulators disallow unfairly discriminatory variables & models
- Consult with legal counsel on variable selection

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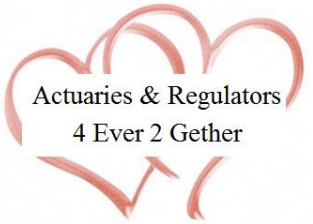
Big Data Analytics
Data Reduction Techniques



Descriptive

Descriptive statistics used to condense big data into easily digestible nuggets of information.

Predictive

Probability based forecasts allowing for extrapolations to future time periods where data does not exist.

Prescriptive

A predictive model that uses feedback data to improve information used in decision making.

Dr. Michael Wu, Chief Data Scientist
Lithium Technologies

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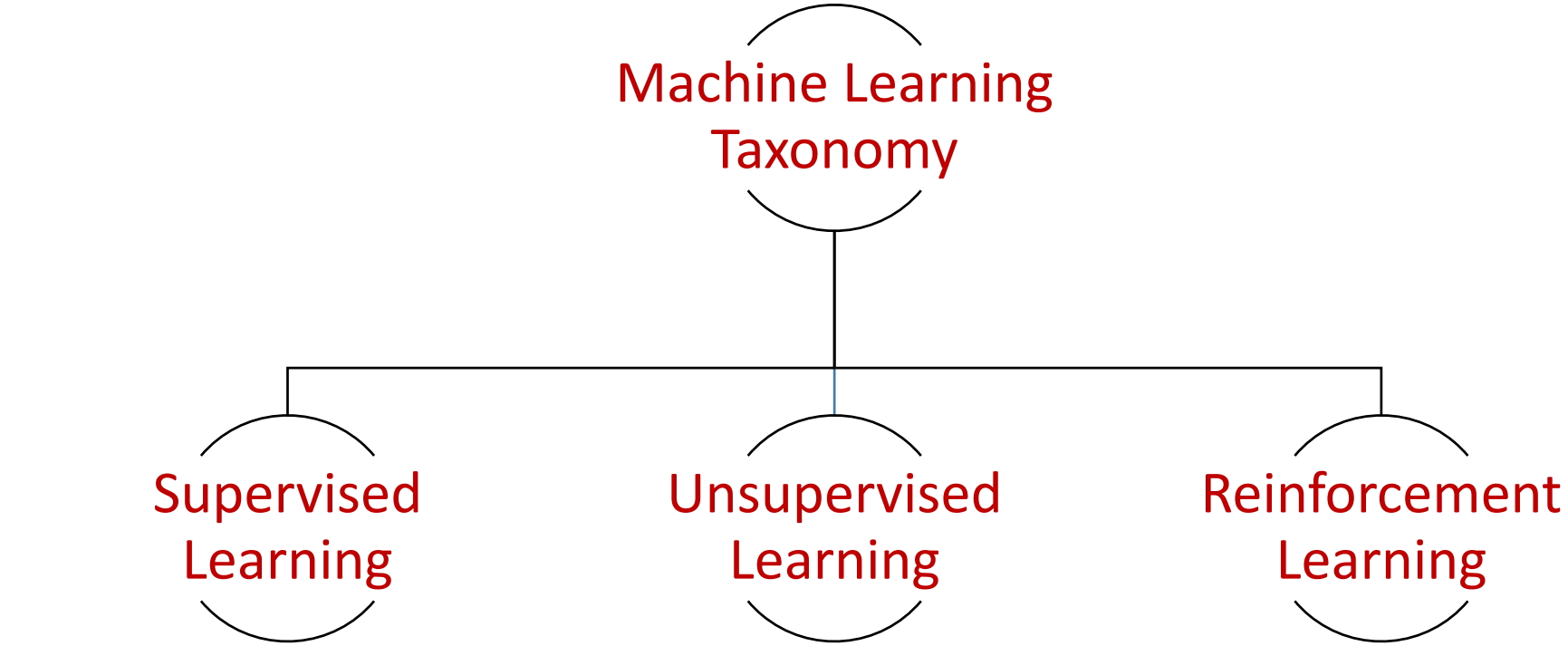
Machine Learning Taxonomy



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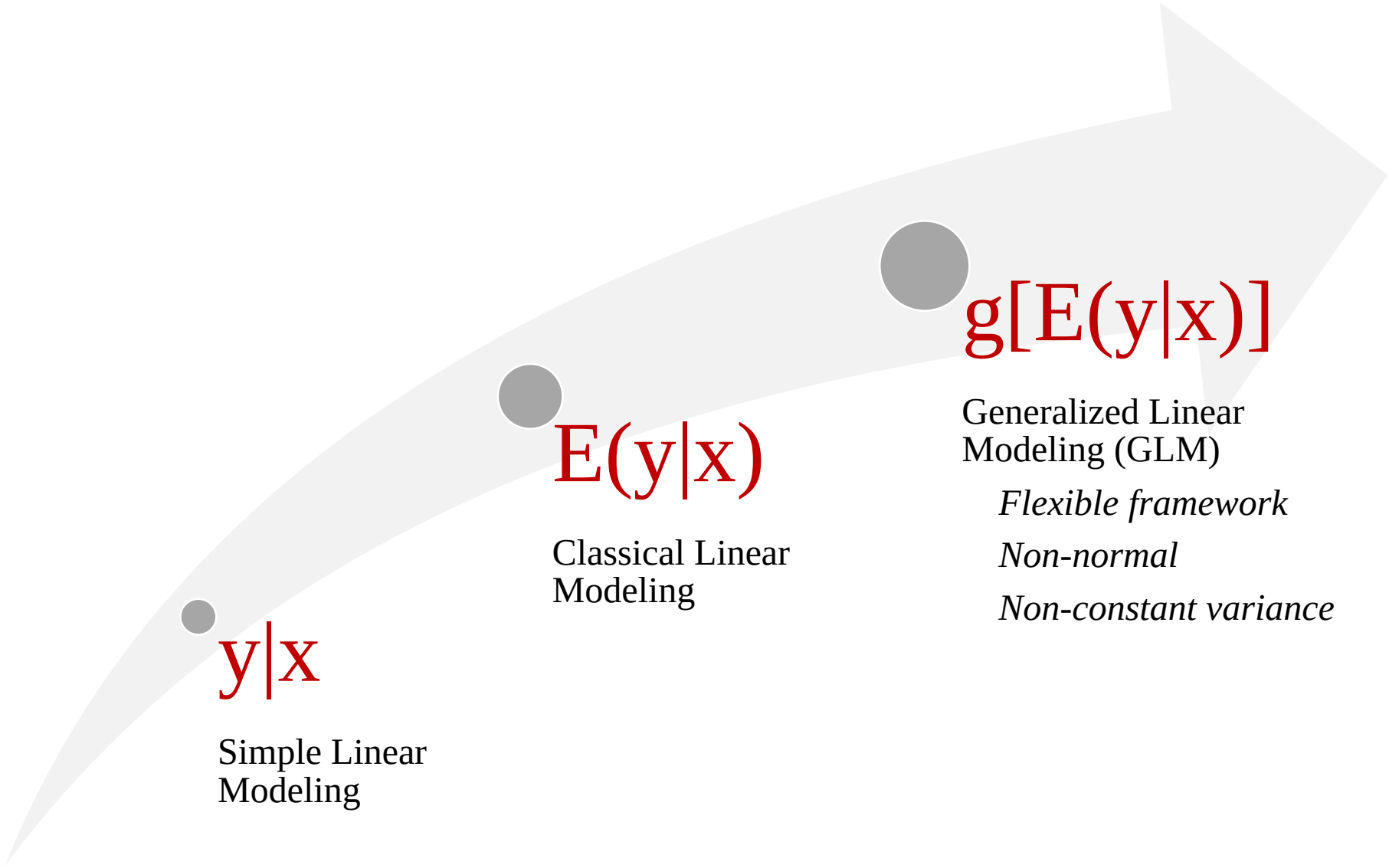

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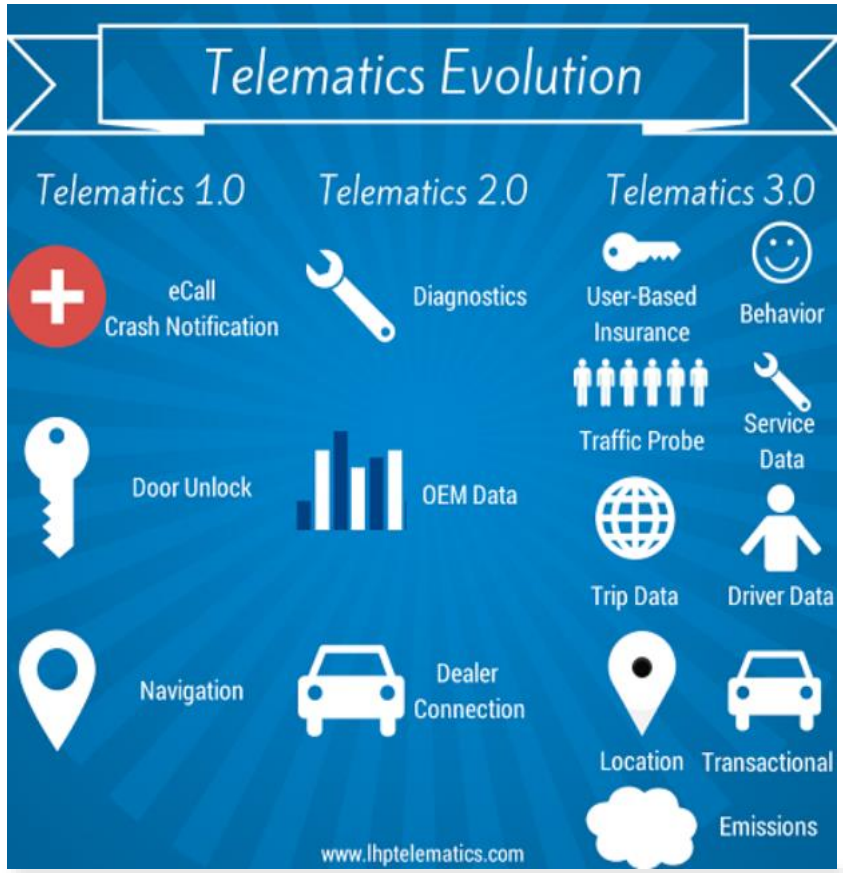

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Driving & Driver Data Variables (DDDVs)

(≤ 100k Car Years of Data)

- Time of Day
- Trip Distance
- Trip Duration
- Driving Route – GPS Locations
- Braking Patterns: Harsh or Moderate
- Acceleration Patterns: Harsh or Moderate
- Average Speed: Low, Moderate, High
- Changes in Speed During Trip
- Driving Consistency Patterns
- Idling Patterns: Excessive or Normal
- Speeds in Excess of Posted Speed Limits
- Increased Fuel Consumption due to Improper Shifting
- Engine Performance Indicators

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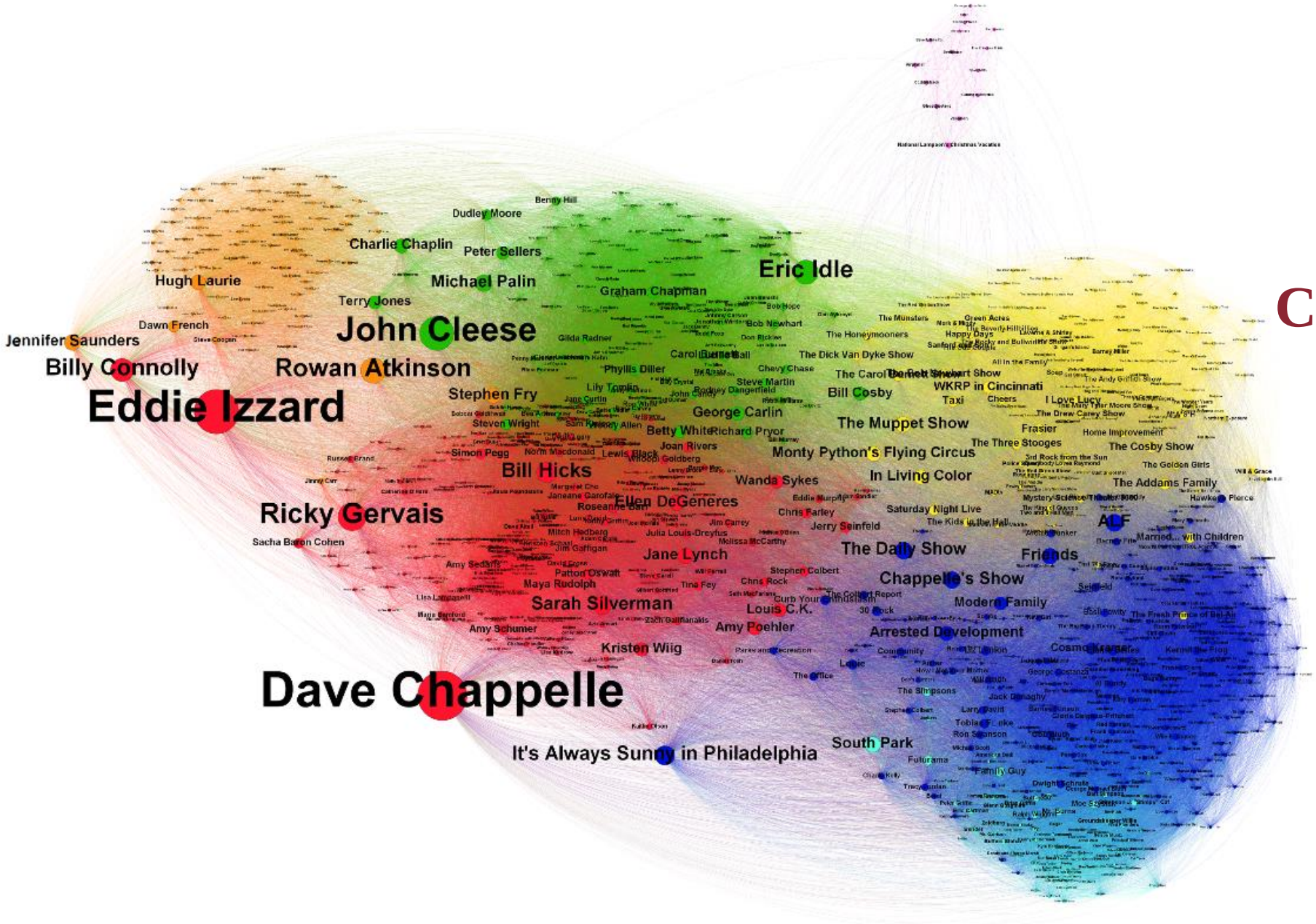
A Cluster Analysis of Comedic Categories



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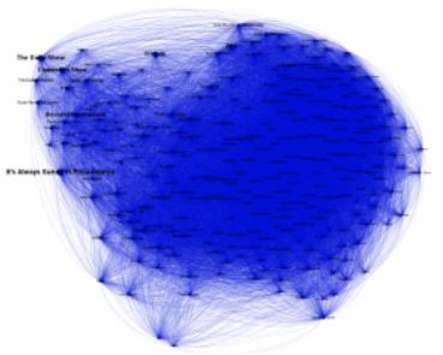
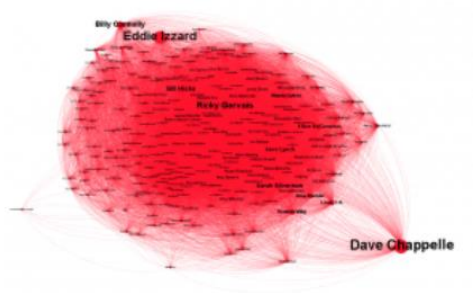
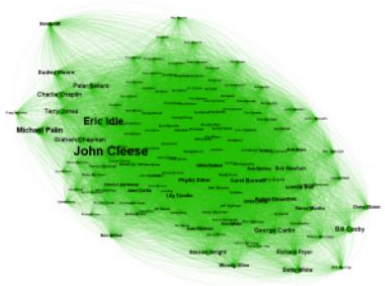
Naming the Clusters



American TV Shows and Characters: 26% of comedy, central nodes = It's Always Sunny in Philadelphia, ALF, The Daily Show, Chappelle's Show, and Friends.

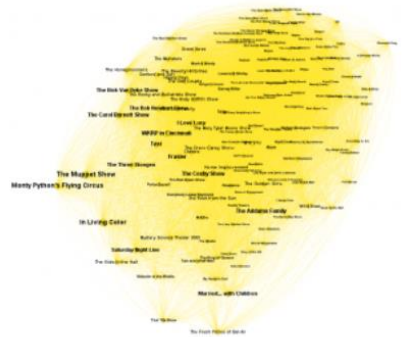
Contemporary Comedians on American Television: 25% of nodes, includes Dave Chappelle, Eddie Izzard, Ricky Gervais, Billy Connolly, and Bill Hicks.

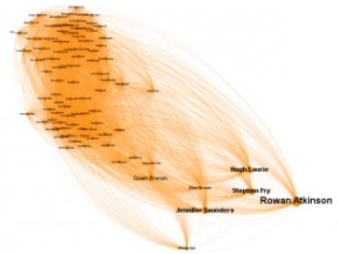




Classic Comedians: 15% of comedy, central nodes = John Cleese, Eric Idle, Michael Palin, Charlie Chaplin, and George Carlin.

Classic TV Shows and Characters: 14% of comedy, central nodes = The Muppet Show, Monty Python's Flying Circus, In Living Color, WKRP in Cincinnati, and The Carol Burnett Show.





British Comedians: 9% of comedy, central nodes = Rowan Atkinson, Jennifer Saunders, Stephen Fry, Hugh Laurie, and Dawn French.

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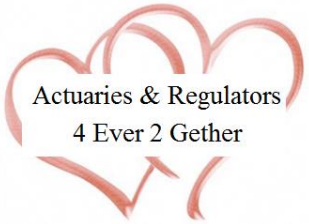

Common Issues with Statistical Modeling Filings

1. Incomplete disclosures wrt data, methodology, results.
2. Companies often don't want their "secret sauce" made public.
3. Analysis of company results often conflict with disclosures.
4. Use of obscure variables that mask discriminatory practices.
5. Statistical violations wrt data elements & model assumptions.
6. Inadequate analysis and justification of modeling assumptions.
7. Lack of transparency in converting model results to pricing factors.

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Actuarial Standards of Practice (ASOPs)

ASOP 23: Data Quality

ASOP 41: Communications

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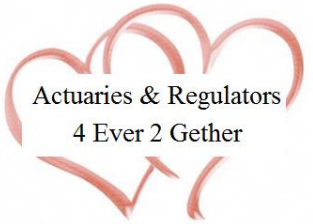
ASOP 23: Data Quality



1. Appropriate for the Analysis
2. Audited for Accuracy
3. Statistically Credible
4. Selected Using Statistical Sampling Methods
5. Comprehensive in Describing the Problem
6. Numerical, Census, and Classification in Data Type
7. Inspected for Reasonableness and Consistency

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ASOP 23: Data Quality

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STANDARD OF PRACTICE

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose—The purpose of this actuarial standard of practice (ASOP) is to give guidance to the actuary in the following:

a. selecting the data that underlie the actuarial work product;

b. relying on data supplied by others;

c. reviewing data;

d. using data; and

e. making appropriate disclosures with regard to data quality.

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ASOP 23: Data Quality

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STANDARD OF PRACTICE

1.2 Scope—This standard applies to actuaries when providing professional actuarial services in all practice areas. Other actuarial standards of practice may contain additional considerations related to data quality that are applicable to particular areas of practice or types of actuarial assignment.

This standard does not require the actuary to audit data.

If the actuary departs from the guidance set forth in this standard in order to comply with applicable law (statutes, regulations, and other legally binding authority), or for any other reason the actuary deems appropriate, the actuary should refer to section 4.

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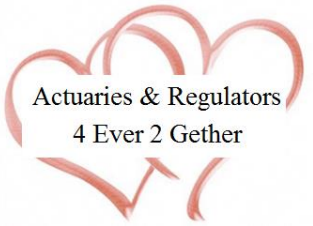
ASOP 41: Actuarial Communications



Section 3. Analysis of Issues and Recommended Practices

3.1.1 Form and Content—The actuary should take appropriate steps to ensure that the form and content of each actuarial communication are appropriate to the particular circumstances, taking into account the intended users.

3.1.2 Clarity—The actuary should take appropriate steps to ensure that each actuarial communication is clear and uses language appropriate to the particular circumstances, taking into account the intended users.

3.1.3 Timing of Communication—The actuary should issue each actuarial communication within a reasonable time period, unless other arrangements as to timing have been made. In setting the timing of the communication, the needs of the intended users should be considered.

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ASOP 41: Actuarial Communications

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3.1.4 Identification of Responsible Actuary—An actuarial communication should clearly identify the actuary responsible for it. When two or more individuals jointly issue a communication (at least some of which is actuarial in nature), the communication should identify all responsible actuaries, unless the actuaries judge it inappropriate to do so. The name of an organization with which each actuary is affiliated also may be included in the communication, but the actuary's responsibilities are not affected by such identification. Unless the actuary judges it inappropriate, the actuary issuing an actuarial communication should also indicate the extent to which the actuary is available to provide supplementary information and explanation.

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Modeling Review Checklists

When reviewing models, scrutinize

1. Analysis qualifying the suitability of the data
2. Suitability & fair discriminatory use of data elements
3. Construction of dependent and independent data elements
4. The statistical sampling techniques applied to build modeling data
5. Due diligence performed to select statistical techniques to apply to data
6. The application of model results to price and classify policies
7. Routines for monitoring the continued fit of models to future insureds

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Regulatory Modeling Checklists

Tasks to Perform

1. Review Purpose and Objectives of Model
2. Analyze Data Analysis and Cleansing Performed
3. Review Model Specifications and Pretesting Support
4. Critique Model Results and Assess Quality of Results
5. Assess Completeness of Support to Implement Model
6. Analyze Monitoring Metrics to Measure Continued Model Fit

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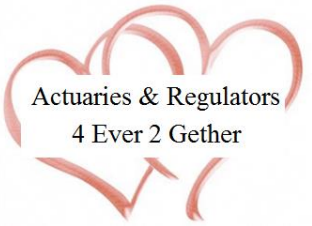
Reconciling Our Differences



- Breaking the Language Barrier
  - Educating Regulators
  - Educating Company Actuaries
- Our Common Interests
- The Trade Secret Conflict
- Modeling Review Checklists
- Regulatory Modeling Checklists

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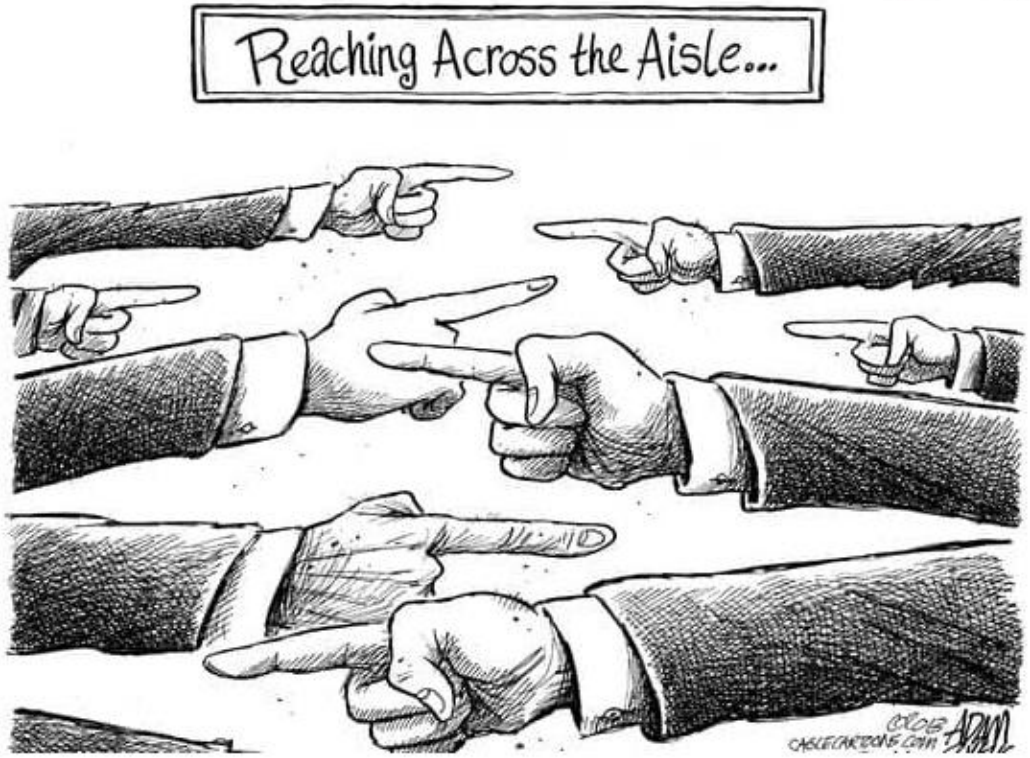
We Have Common Interests

1. Protection of the Consumer
2. Adequate & Fair Rates
3. Statistical Model Credibility
4. Improved Regulatory Guidance
5. Improved Communications



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Ending with Humor

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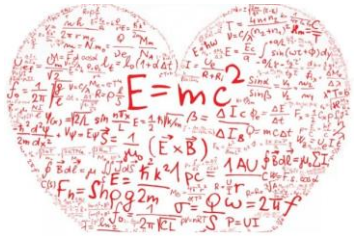
What is black with one cream and two sugars?

Coffee for a Regulator!

What did God say when he created Actuaries?

"Go figure!"
They took him literally.



Ask an Actuary

Any Questions ???

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