Meta-regression analysis of animal nutrition literature

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VirginiaTech
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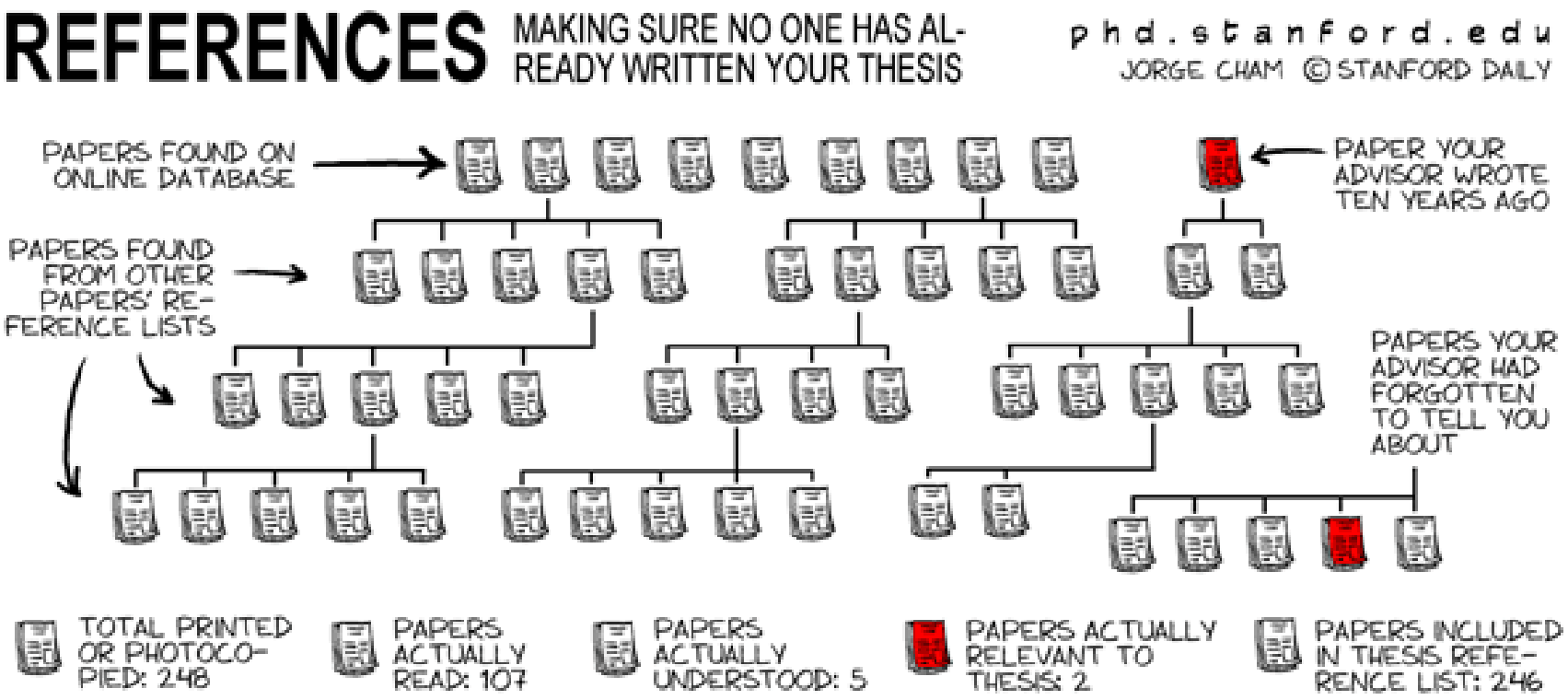
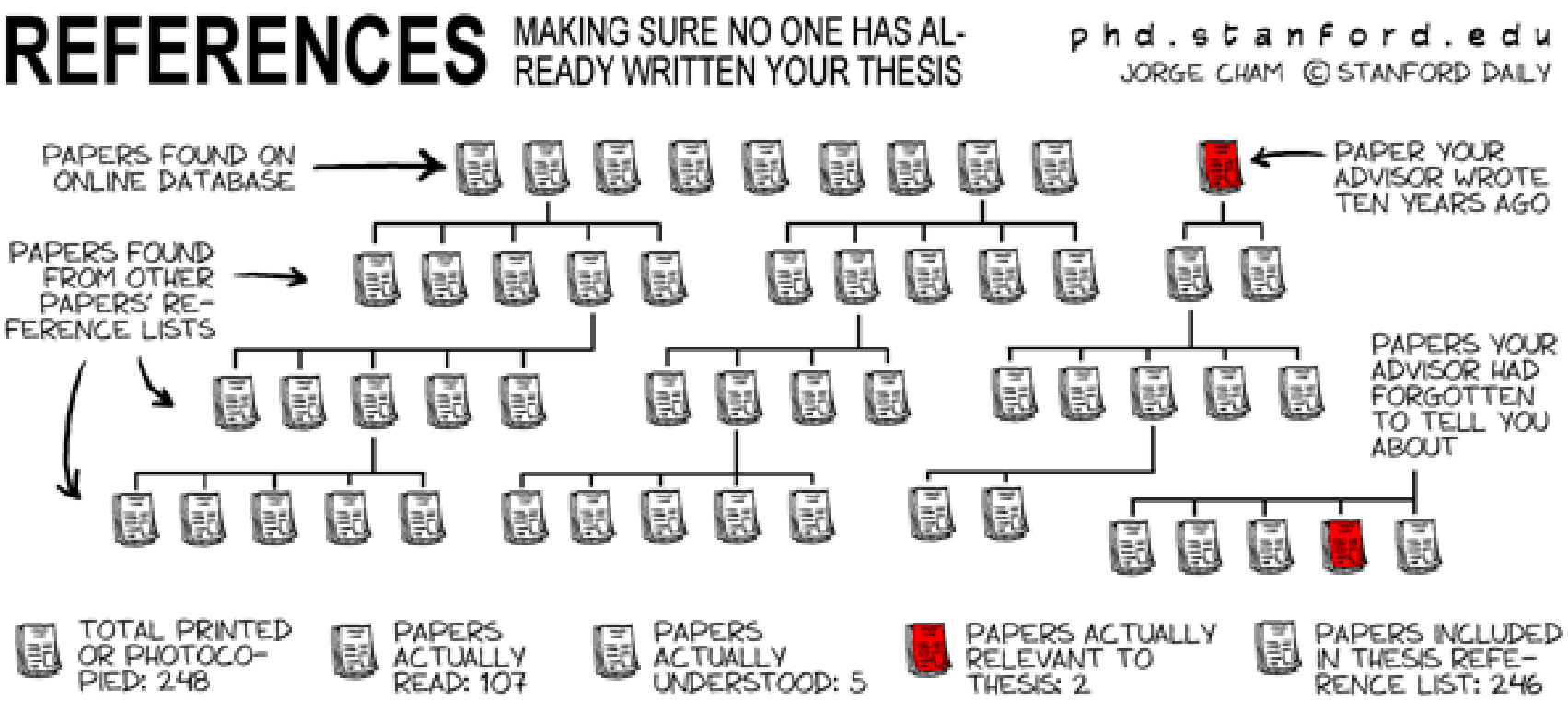
The Literature Review

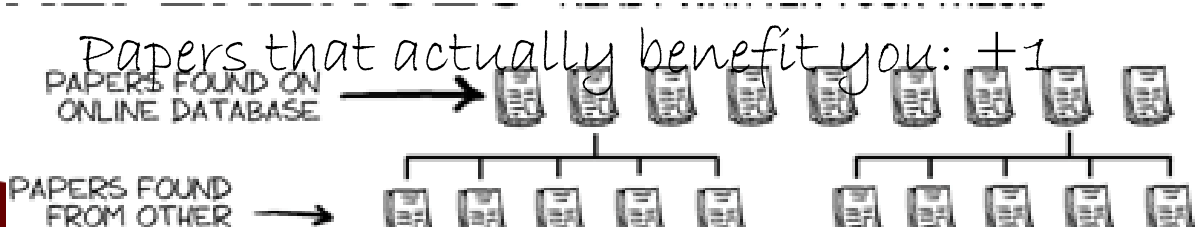


Time per paper: 30 minutes

Total time reading papers: >120 hours

The Literature Review





A Roadmap…

- conduct meta-analyses?
- ef history of meta-analysis
- ing data for meta-analysis
- e modern meta-analysis
- Follow up analyses

Why Summarize Literature?

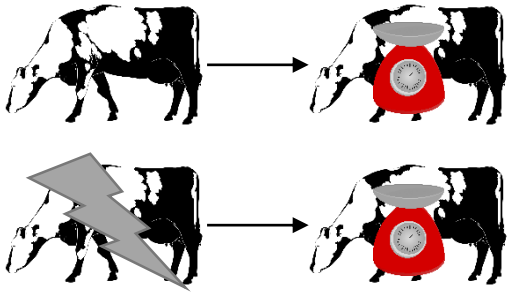
The human brain and the scientific method are limited…

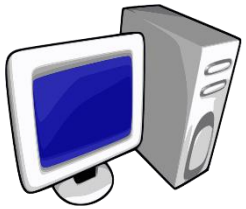
The Hypothesis

The Conclusion

The Experiment

The Analysis





The Common Problem:

Study	1	2	3	4	5
Conclusion					

Quantitative literature synthesis helps simplify reality.

A primary challenge with meta-analysis

Treatment	Milk	SE
1	25.4	1.5
2	30.6	2.8

An Evaluation of Postabsorptive Protein and Amino Acid Metabolism in the Lactating Dairy Cow

M. D. HANIGAN, J. P. CANT, D. C. WEAKLEY, and J. L. BECKETT

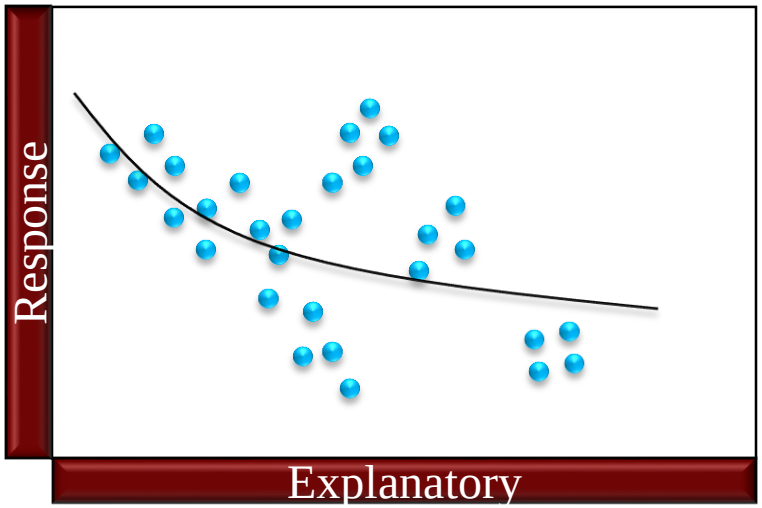
ABSTRACT

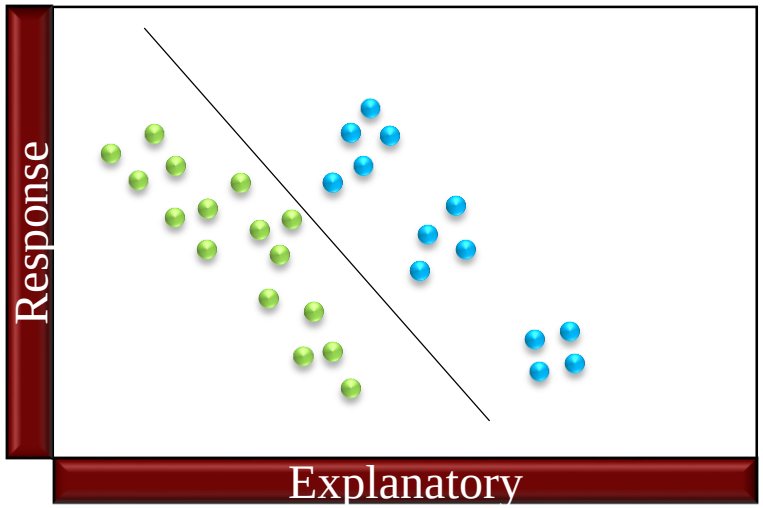
INTRODUCTION

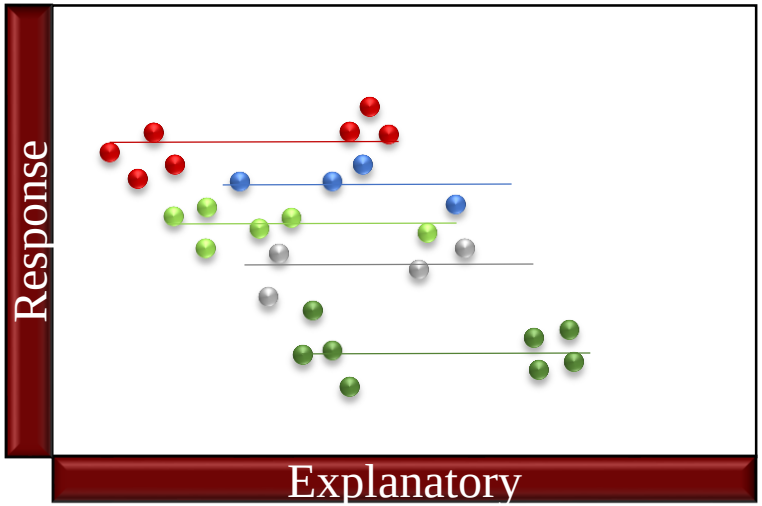
Partitioning Variability

1. Variability within an animal
2. Variability between animals
3. Variability induced by treatments
4. Variability between measurement methods, locations, researchers, etc.
5. Variability associated with everything else you didn't measure

Partitioning Variation







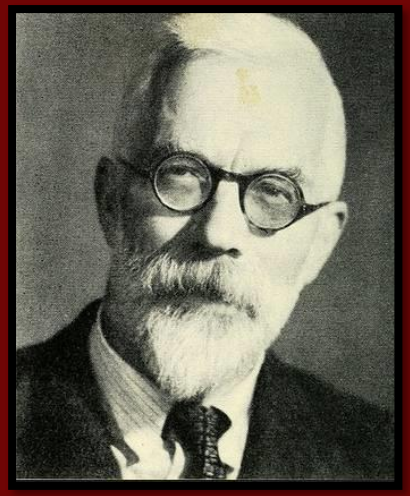
How did meta-analysis come about?

- conduct meta-analyses?
- ef history of meta-analysis
- ing data for meta-analysis
- e modern meta-analysis
- Follow up analyses

The Driving Force Behind Meta-Analysis

The Common Problem:

Study	1	2	3	4	5
Conclusion					



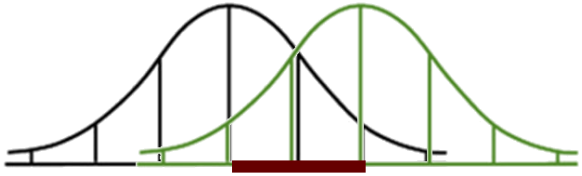
R.A. Fisher (1944) – “When a number of quite independent test of significance have been made, it sometimes happens that although few of none can be claimed individually as significant, yet the aggregate gives an impression that the probabilities are on the whole lower than would often have been obtained by chance”

A Brief History of Advancement

1940, Pratt et al. publish the first summary of identical experiments on the same topic

1944, Fisher notices a pattern

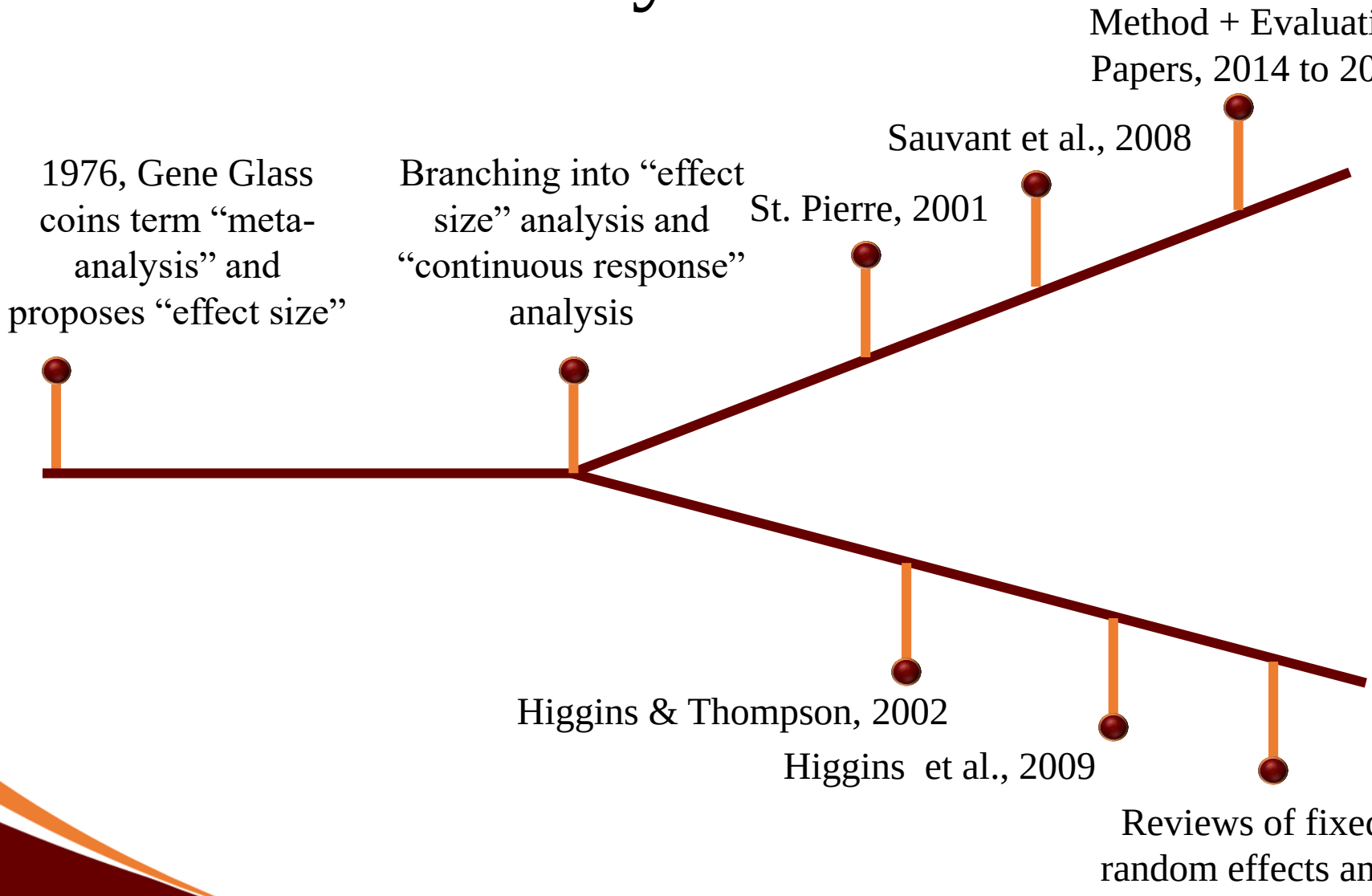
1976, Gene Glass coins term “meta-analysis” and proposes “effect size”



1904, Karl Pearson publishes first summary of studies

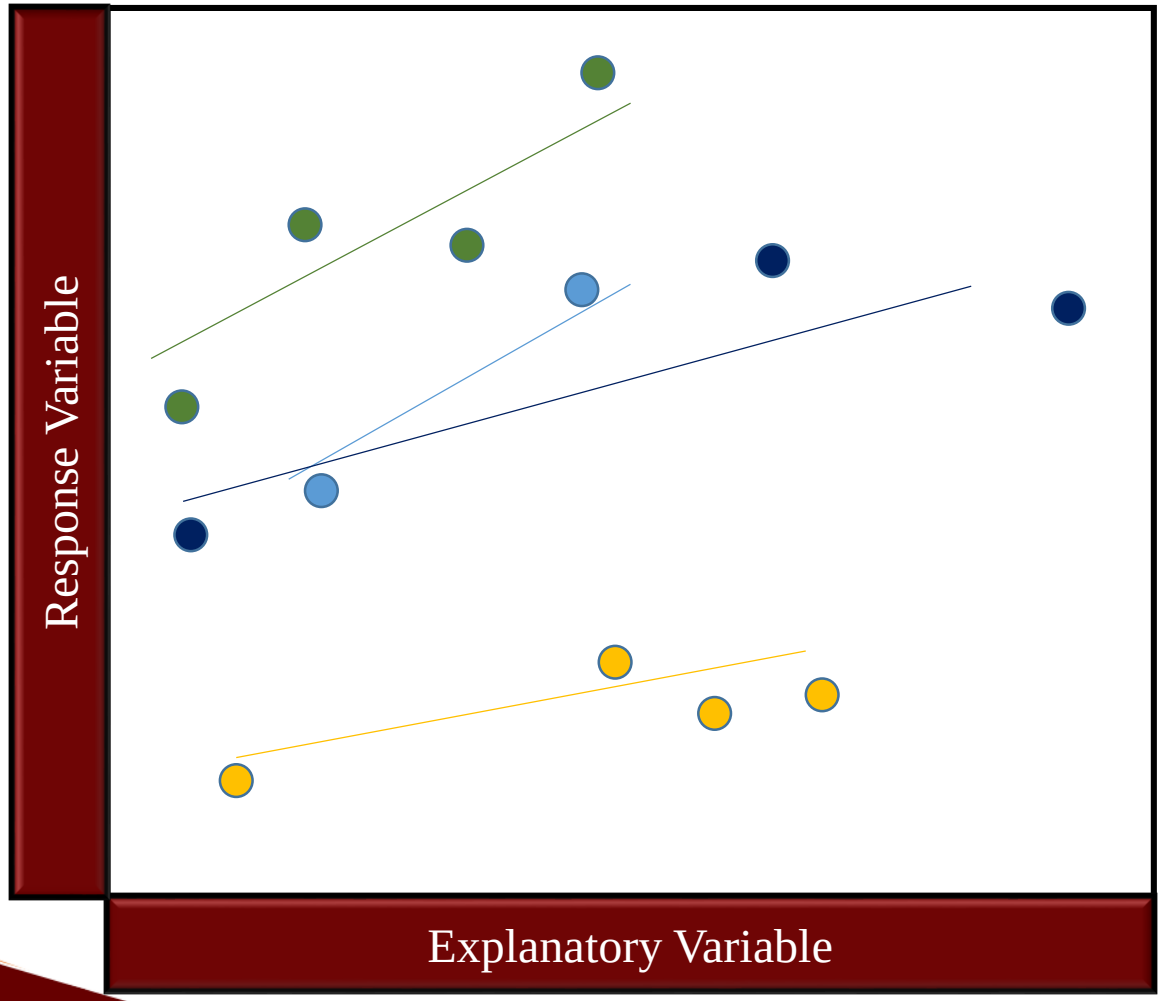
1955, First meta-analysis of the efficacy of a medical treatment

A Brief History of Advancement



The "Modern" Meta-Regression

Using mixed models, weighted for study precision, and a random effect for study to evaluate responses in a continuous variable



First Steps to Conducting Analysis

- conduct meta-analyses?
- ef history of meta-analysis
- ing data for meta-analysis
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- Follow up analyses

Approach to Data Handling

- Select search parameters
- Define all variables of interest
- Formalize inclusion criteria
- Search for papers and record results
- Define exclusion criteria

Google Scholar

Articles (include patents) Case law

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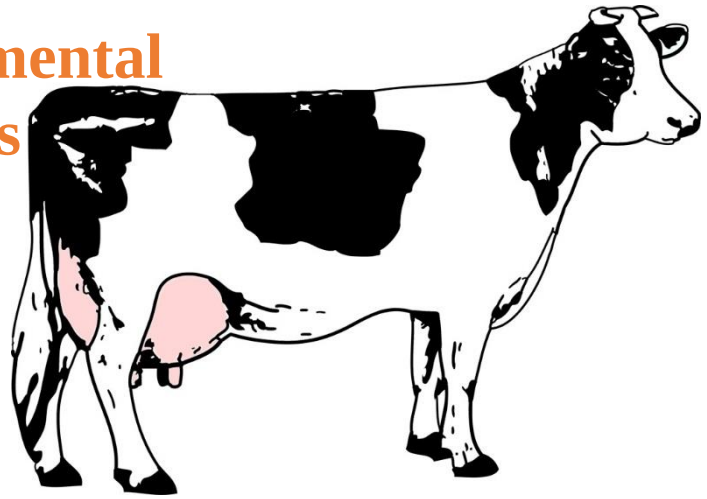
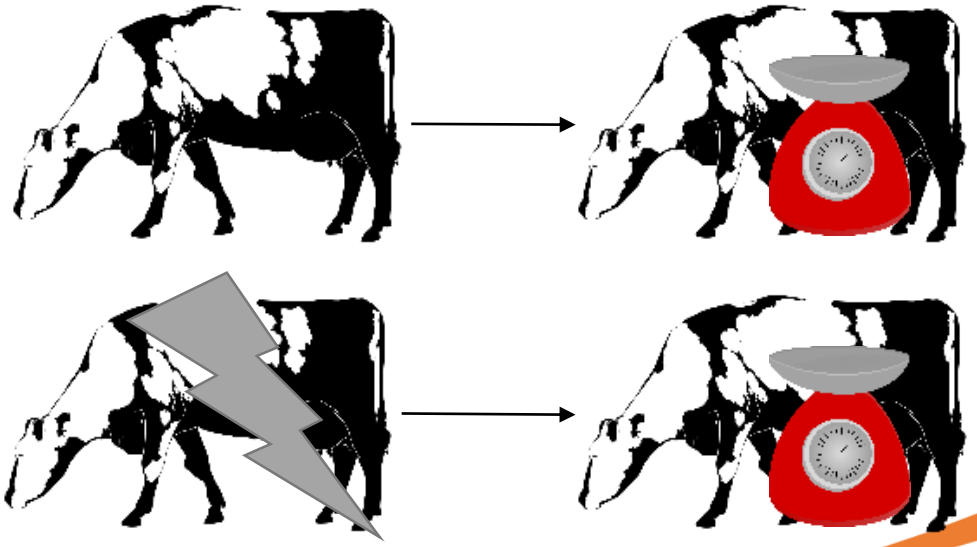
Experimental Subjects



Experimental Designs



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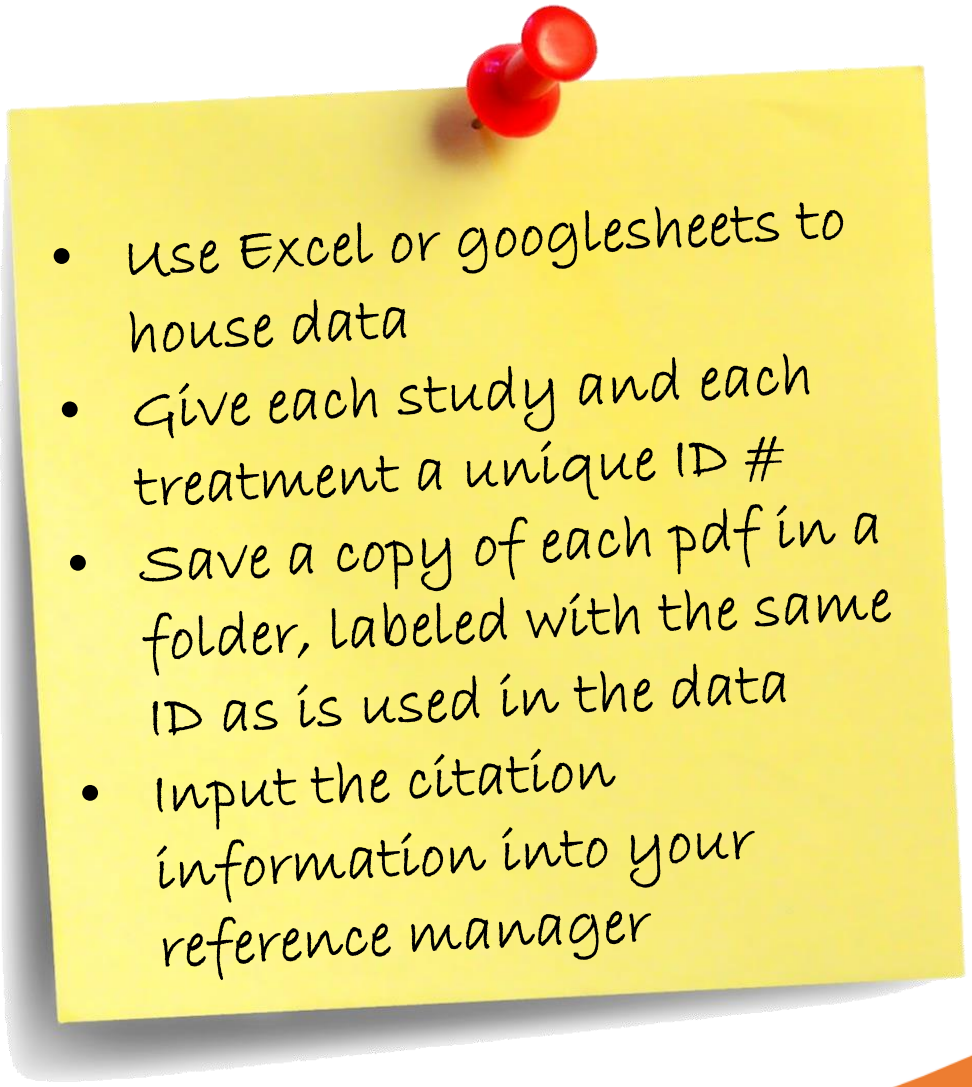

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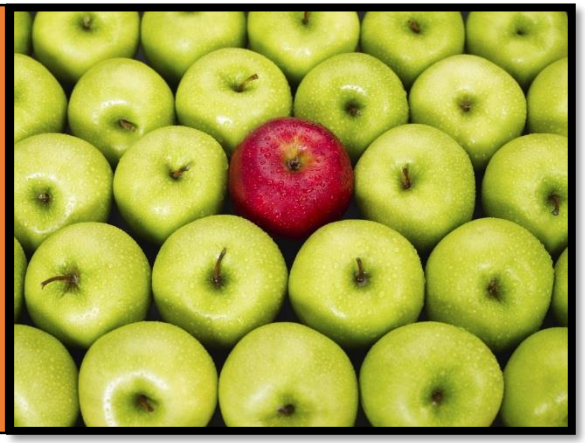
Screen for Outliers



Check Methods

Some Helpful Hints…

- Read papers thoroughly
- Keep a pdf copy of all papers and update citations as you go
- Consider exclusion and inclusion criteria carefully

- Take a listing of papers provided by an external party without vetting
- Exclude papers unless you have to

Conducting the Analysis

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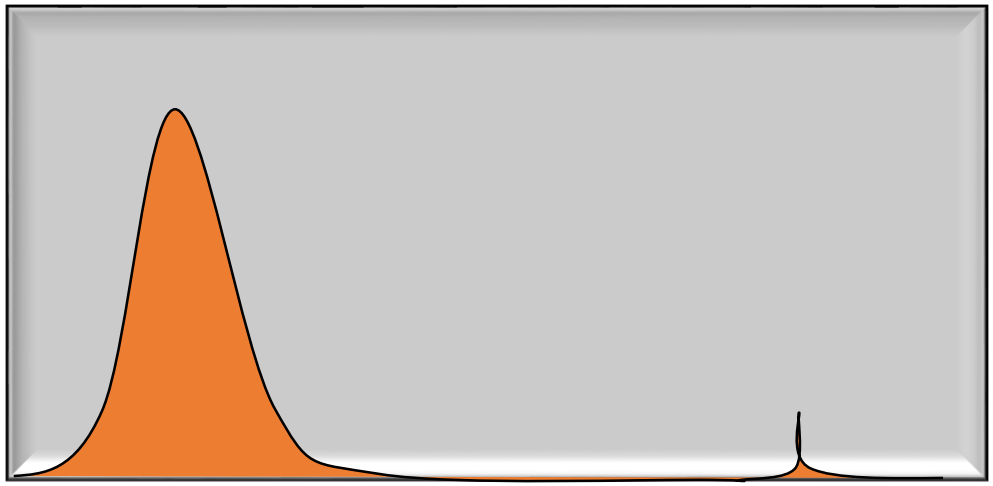
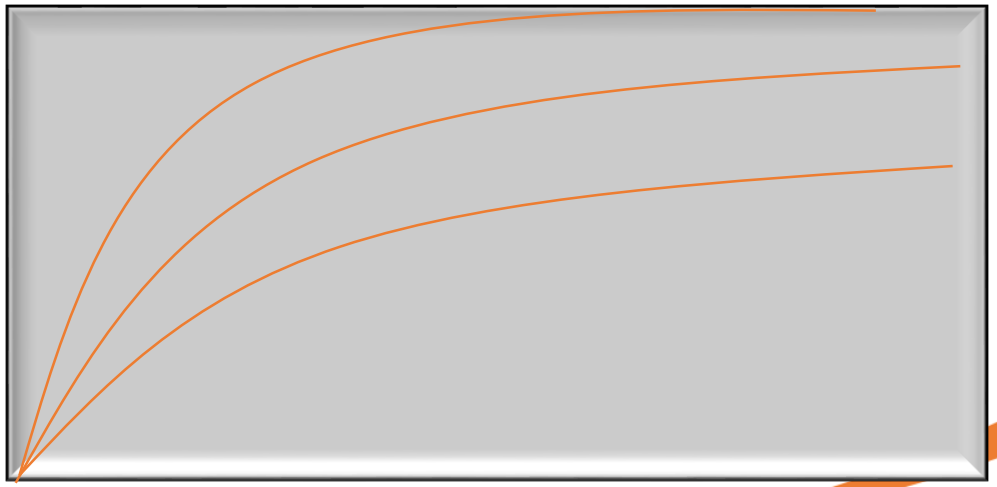
Conducting the Analysis

- Visualize Data and Relationships
- Calculate Weights
- Derive Model (Phase I)
- Re-test Dropped Parameters
- Perform Model Checks





Conducting the Analysis

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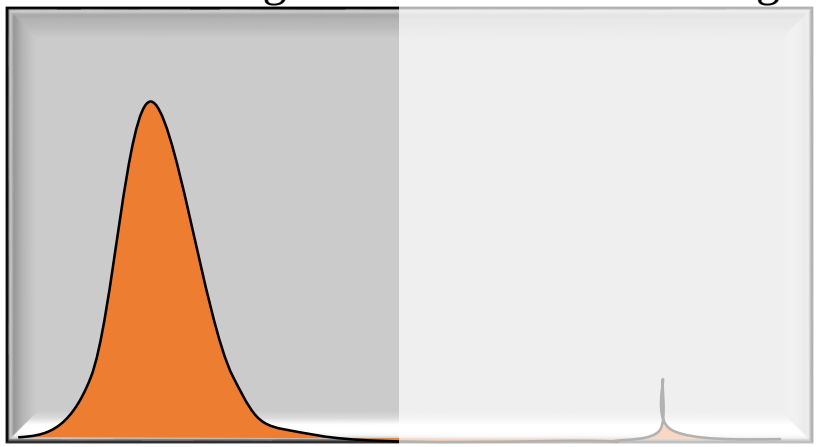
$$Weight = \frac{1}{SE} \; OR \; \frac{1}{SE^2}$$

Standard Errors from Mixed Effects Models are NOT Equal to Those From Fixed Effects Models

$$Standardized\ SE = \frac{SE}{\sum_{i=0}^{j} SE\ /n} \; within\ model\ \ type$$

Weighting by $1/SE^2$ or failing to check the distribution of weights can result in overweighting.



Checking the distribution of weights and curtailing this distribution is a tool to prevent overweighting

Conducting the Analysis

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Protein Variables	AA Variables	Energy Variables
CP		
RUP		
		TDN Intake
	Absorbed Leu	
		NDF, % DM
	Absorbed Met	Starch, % DM

Conducting the Analysis

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Variance Inflation Factors

The degree to which variance of a regression coefficient is inflated because of multicollinearity

$$VIF_k = \frac{1}{1 - R_k^2}$$

Where R_k^2 is the R^2 obtained by regressing predictor "k" on the other predictors

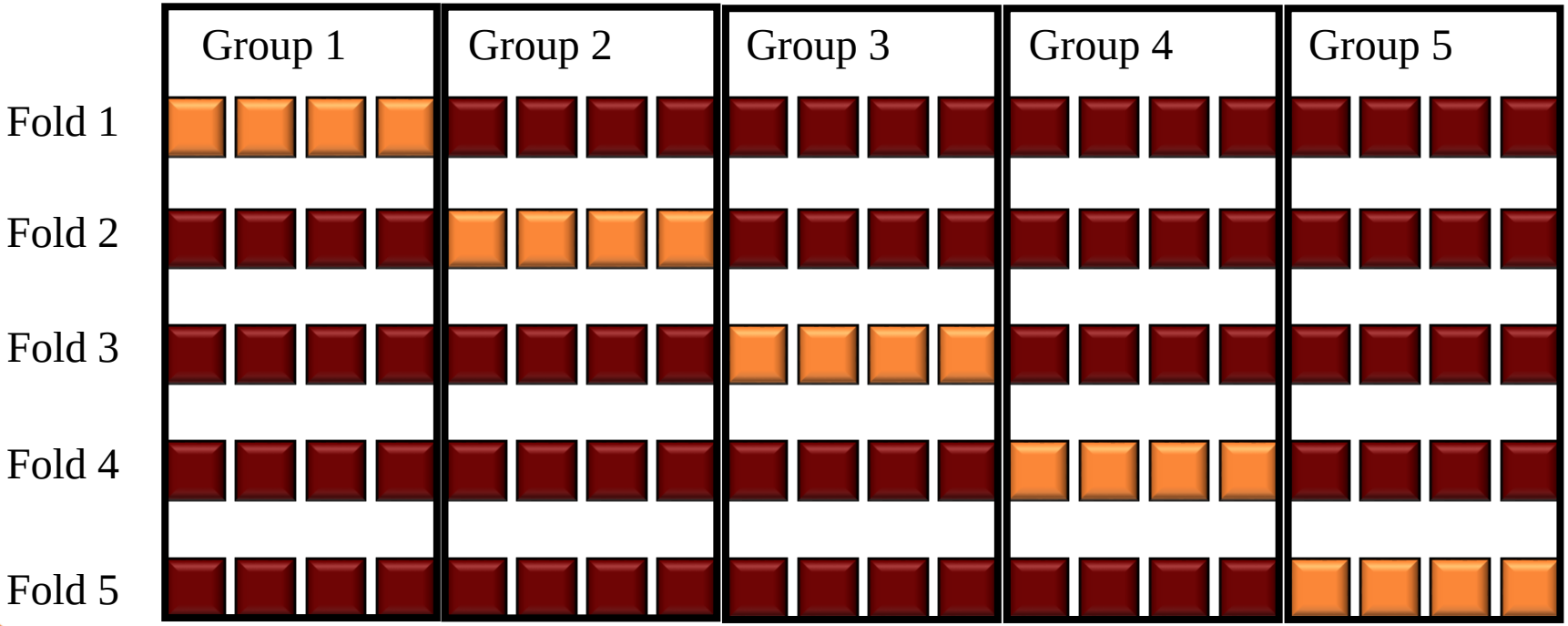
No "set in stone" cutoff; however, published papers have used 5, 10, or up to 100 for variables anticipated to be correlated by calculation

Evaluating and Comparing Models

Statistic	Notes
AICc	Gold standard for comparing models but can only be interpreted if derivation data is identical among models.
RMSE	Standard comparison for models derived using least-squares approaches.
Slope bias	Represents structural issues in a model. The errors scale with the magnitude of the prediction.
Mean bias	Represents an “average” error in the model. All predictions are off by some value.
CCC	Represents the concordance (accuracy and precision) of measured and modeled data.
σ_s	Root estimated variance associated with study.
σ_e	Root estimated error variance. Equivalent to an RMSE for models derived using maximum likelihood.

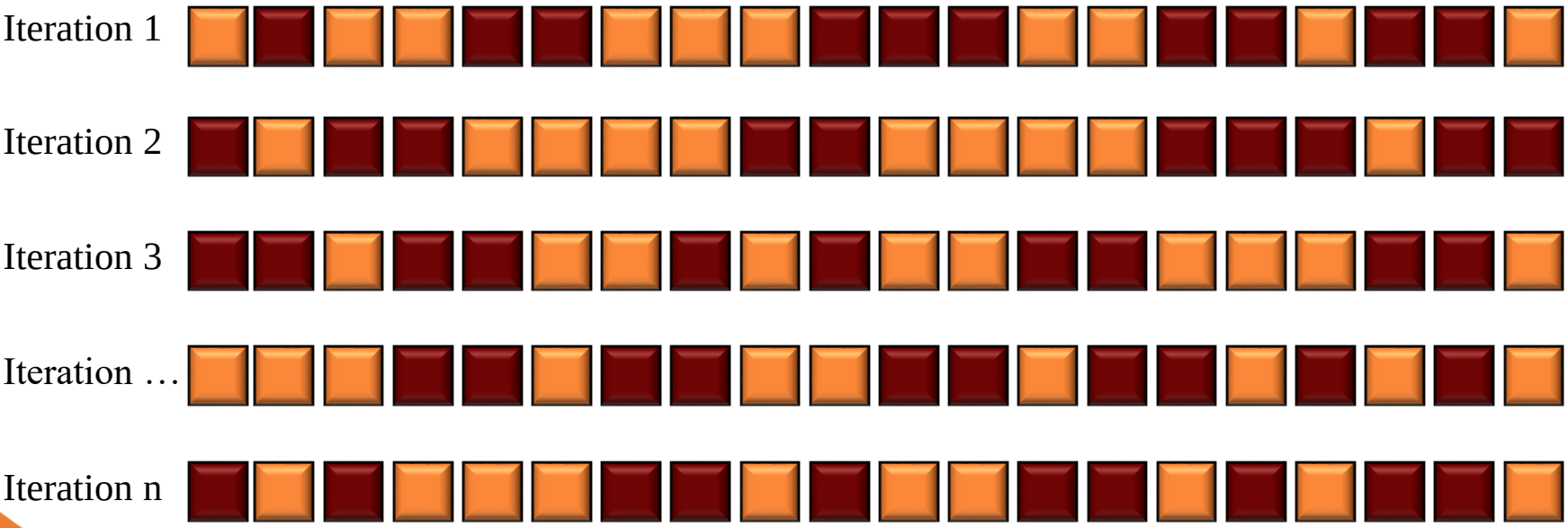
Cross Validation

K-Fold Cross Validation: Split the data into "k" groups and iterate through model derivation and testing so that each group is used for model testing exactly once.



Cross Validation

Monte Carlo Cross Validation: Split the data into 2 groups of user-determined size derive the model against group 1 and test against group 2. Repeat “n” times.



Questions?

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