

## New methods and models for IGS EPDs

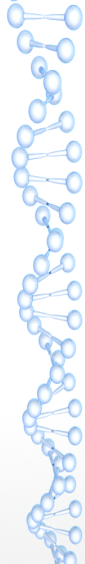
Bruce L. Golden  
Theta Solutions, LLC

## Our team



- Bruce Golden, PhD (Colorado State - Animal Breeding & Genetics)
  - Co-founder - CEO and President
  - Bruce is the principal developer and writer of the command-line tools (in C)
- Dorian Garrick, PhD (Cornell University - Animal Breeding & Genetics)
  - Co-founder - CSO and CFO
  - Dorian focuses on alternative efficient algorithms and approaches
- Daniel Garrick, PhD (Iowa State - Aerospace Engineering)
  - Junior Partner, Software and Product Support Engineer since January 2017
  - Daniel brings expertise in Computational Fluid Dynamics (CFD) including non-linear and linear computing strategies, numerical methods, data processing and visualization

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## Topics

- Using Genomic Data
  - The Marker Effects Model
- Effects of the New Accuracy Calculation
- New and Improved
  - Sustained Cow Fertility
  - Carcass traits

## Evolution of Models

• Sire Model	Single Trait
• Sire and Dam Model	Multi-trait
• Sire MGS Model	Threshold
• Reduced Animal Model	Time to failure
• Animal Model	Random Regression

$$y = Xb + Zu + e$$

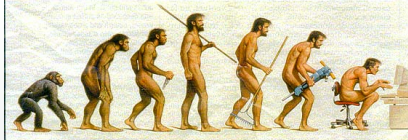
$$\begin{bmatrix} X'R^{-1}X & X'R^{-1}Z \\ Z'R^{-1}X & Z'R^{-1}Z + G^{-1} \end{bmatrix} \begin{bmatrix} b^* \\ u \end{bmatrix} = \begin{bmatrix} X'R^{-1}y \\ Z'R^{-1}y \end{bmatrix}$$

$$\text{var}(u) = G, \text{ e.g., } A_p \otimes G_a (MT) \text{ or } A_p \sigma_e^2 (ST)$$

### What drove this evolution?

- Knowledge of Models?
  - All these models were well known by 1970
- New methods?
  - Maybe a little
- Data?



Accuracy of Prediction  
Reduce PEV  
Enabling Technology



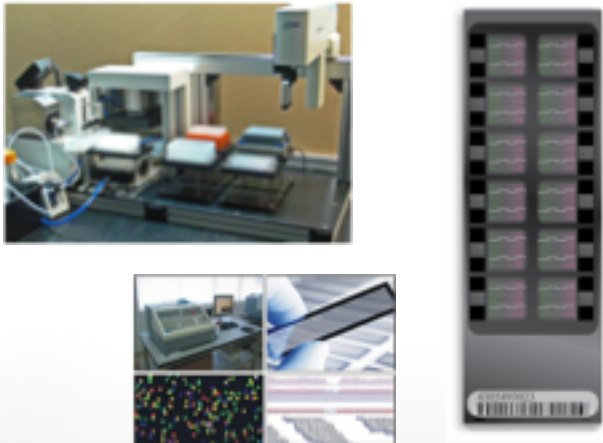
### Pioneering technology built for computer gaming

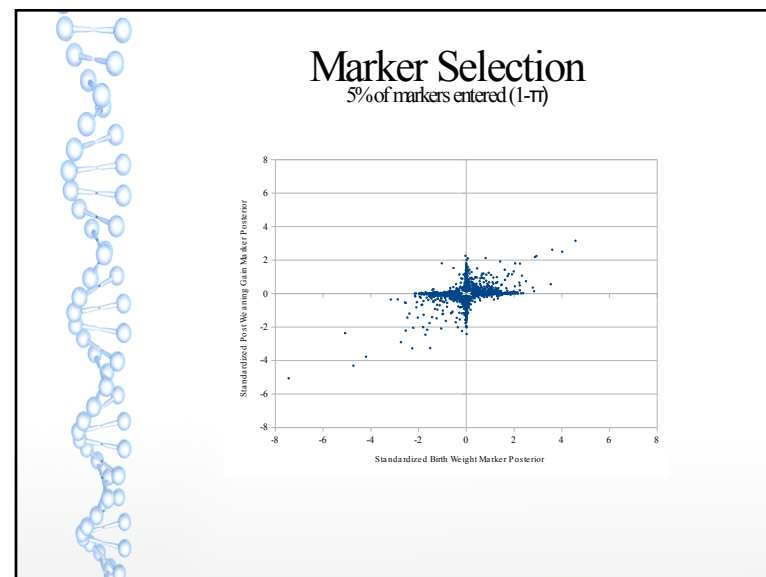
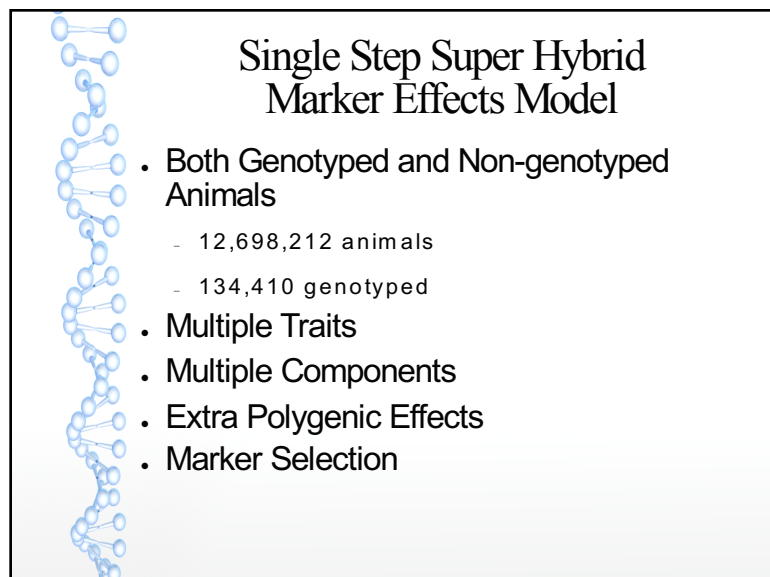
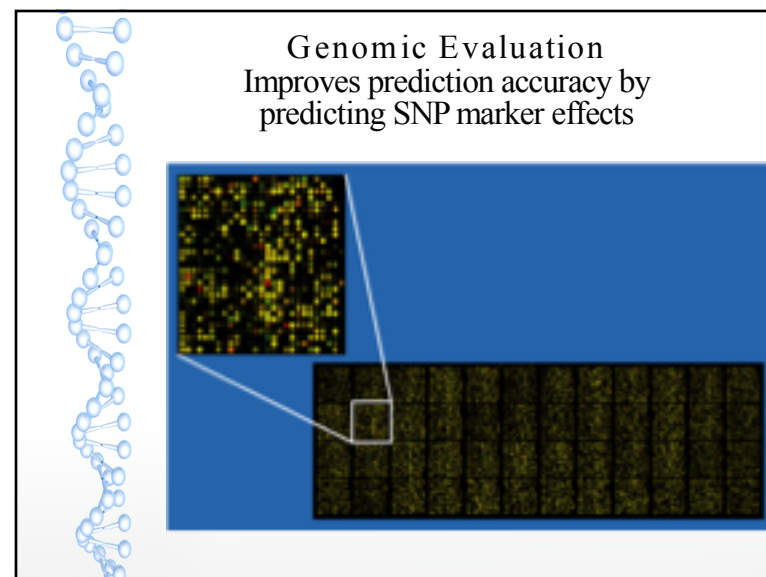
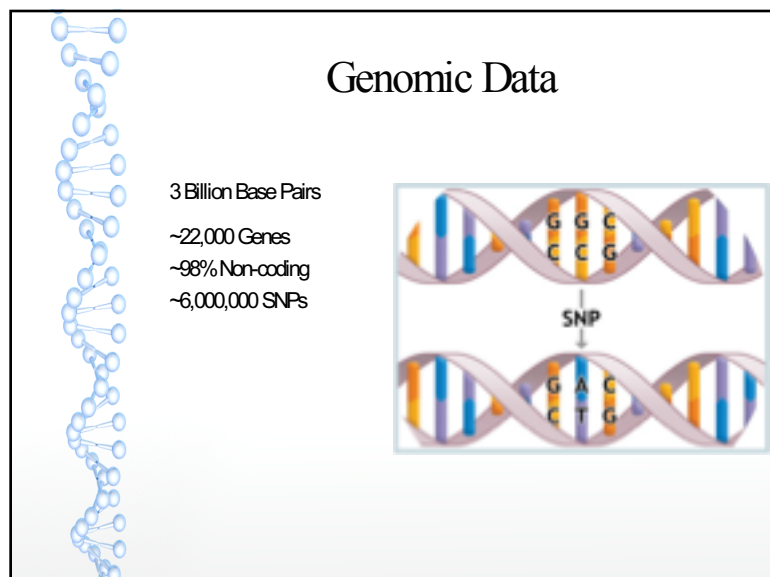


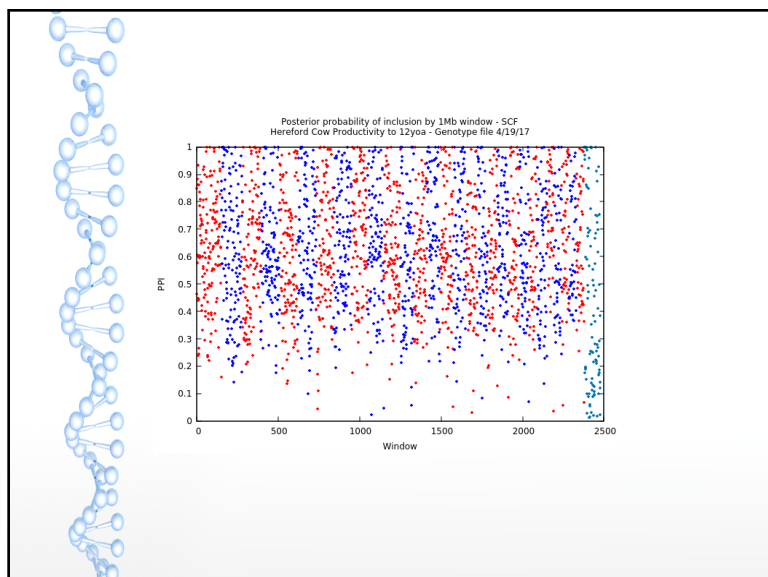
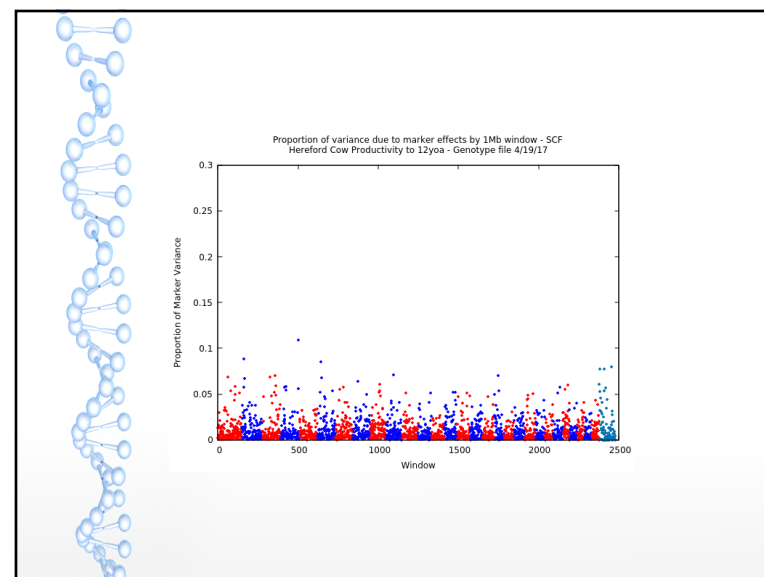
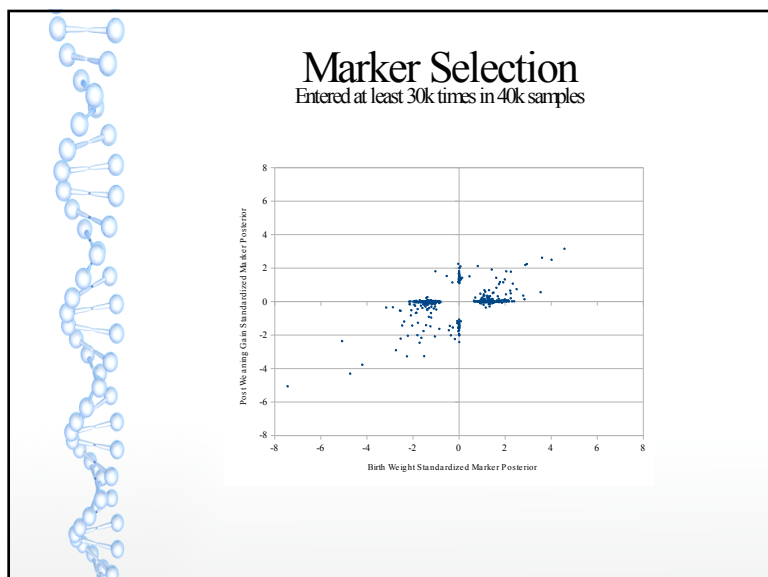
### Genomic Data

### Genomic Data







### Other Effects

- Breed-Year (cluster) additive genetic groups
- Heterosis: two-breed type out-crossing equations
- Contemporary group
- J equation – genetic merit of genotyped animals
- K equation – centering across all loci



## New Accuracy Calculation

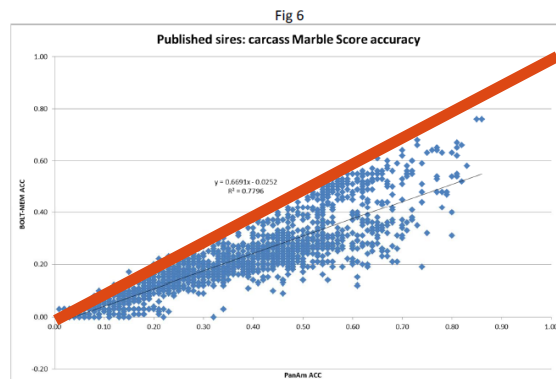
- No “Approximation Bias”
- “Direct” method to estimate Prediction Error Variance (PEV)

$$BIF\ Accuracy = 1 - \sqrt{\frac{PEV}{f \times Genetic\ Variance}}$$

## Reasons for Accuracy Drop

- No approximation bias
  - Correlated traits
  - Additive genetic group contribution
  - Data structural effects
- Data restricted to post Whole TPR
  - Reduced reporting bias
- Fewer traits in the model
  - Mostly same as no approximation bias

## What is the Effect on Accuracy Values?



## Why Cow Fertility?

- CF traits tend to be lowly heritable
- Lots of observations – calving records
- ERT with the most impact in maternal selection index
  - Relatively small changes can make a big difference
    - More calves to sell
    - Fewer replacement females – even more calves to sell
    - Heavier weaning weights of sale calves from older cows
    - Less calving difficulty



## Predictions of Cow Productivity

- Days to Calving
- Calving Interval
- Cow Longevity – proportional hazard model
- Stayability - MAP
  - Snelling, et al., 1995
  - Brigham, et al., 2007
- Random Regression
  - Jamrozik, et al., 2014



## Random Regression Sustained Cow Fertility

- The random (e.g., genetic) effects are described as a curve (polynomial) on age of cow at record
- Observations:
  - 0 – Cow did not have calf at a given age
  - 1 cow had a calf at a given age
  - Missing – unknown if the cow had a calf at a given age



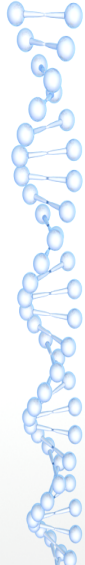
## Our Marker Effects Model

- Year of birth
- Age at first calving
- Random contemporary group (intercept and slope)
- Random permanent environment due to the dam (intercept and slope)
- Genetic marker random effects (intercept and slope)
  - Genotyped
  - Non-genotyped
- Extra polygenic effects(intercept and slope)
- Includes additive genetic groups



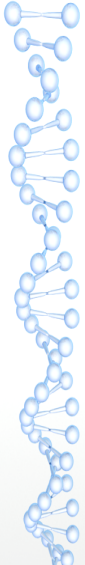
## Advantages of RR Method

- Uses observations in a more sensible way
  - Simultaneous solution to all ages
  - Censoring from culling is “missing” value
- Handles missing values in a more sensible way
  - e.g., donor cow
- Easy to implement an animal model
- Easy to implement genomic information
  - Marker Effects Model
- Faster to obtain answers
  - PCG solver
  - Gibbs sampler
- Often as good or better than MAP or hazard models
- Can use all data to make a prediction at any age.



### IGS Traits Produced

• Birth wt.	Carcass wt.
• Weaning wt.	REA
• Yearling wt.	Marbling score
• Milk	Fat thickness
• Total maternal	[Yield grade]
• Calving ease	Stayability
• Calving ease total maternal	Docility



### IGS Traits Under Development

- Heifer pregnancy
- Dry matter intake
- Days/age to finish