

**2018 SOA Life & Annuity Symposium**

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**SOCIETY OF  
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## Session 15 PD, Trade-Offs in Modeling: Balancing Competing Goals

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# Model Trade-Offs

SOA Life and Annuity Symposium

Session 15: Trade-offs in Modeling:  
Balancing Competing Goals

Monday, May 7, 2018

Brian D. Holland, FSA, MAAA



# Outline

- 1. Types of trade-offs, or compromises**
- 2. Simple examples with construed data**
- 3. Framework for addressing and discussing them**
- 4. Simple examples using framework**
- 5. Life experience examples**

# Types of compromises

## 1. Communication

- Simplicity vs complexity
- Also means: *short story vs long story*

## 2. Quantification

- Prediction of future, other unobserved?
- Description of past?

## 3. Communication vs Quantification

- Do you want good predictions?
  - or to convince others?
  - or to convince accountants?
  - or to have a short story?

# Communication trade-offs

- **Explaining model choice to those impacted:  
with or without these terms? What is allowed or advisable?**
  - n-fold cross validation
  - Training and hold-back data
  - Ensembling
- **Who is the audience?**
  - Function: supervisor, peer / tech reviewer, model governance, auditor?
  - Profession: actuaries, accountants, statisticians, data scientists, attorneys?
  - ...

# Quantitative compromises: Examples of trade-off

- **Most extreme cases**

Flat average over all cells ↔ Most granular experience available  
(Model complexity trade-off)

- **Number of variables**

Add more or fewer variables or combinations in regression-type

- Why no interactions? Why those interactions?

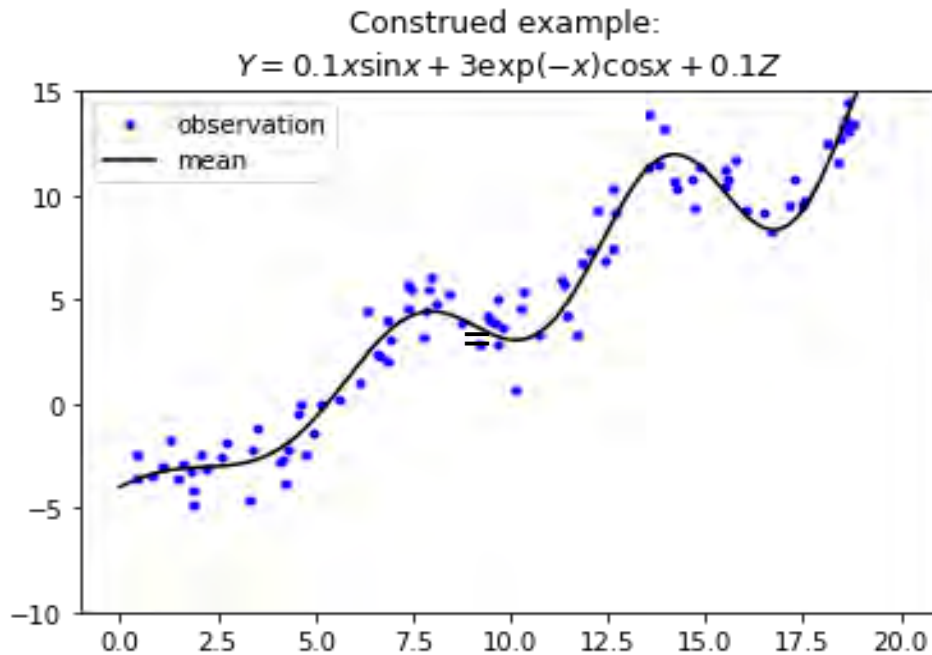
- **Size of coefficients**

Smaller or larger model coefficients

→ If coefficient is zero, do we have it?

- If so: do we have infinite coefficients?
  - If coefficient size is minute, do we have the coefficient?
  - Many large and maybe offsetting coefficients is more complex than fewer.

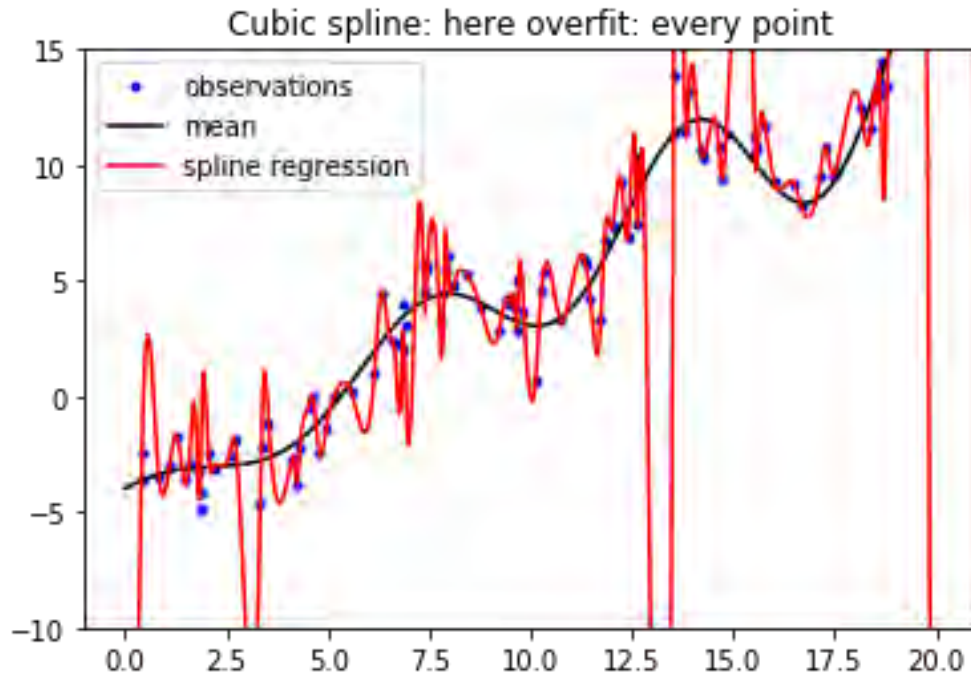
# Simple example – construed data



- Polynomial regression
- Spline regression
- Ridge regression
- Tree models
- ...

**The following slides examine trade-offs with this model.**

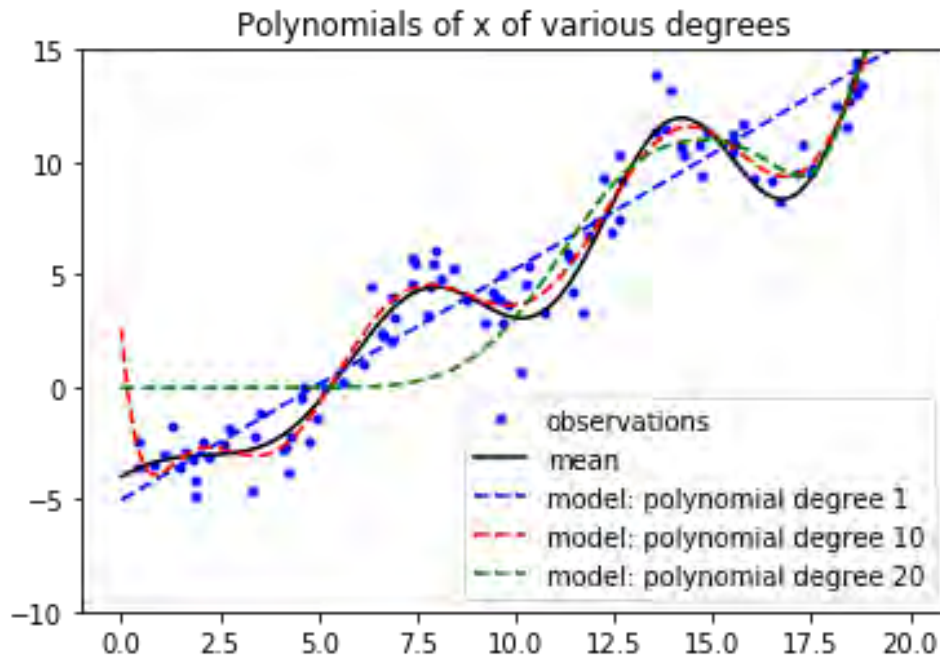
# Simple example: Cubic spline



- Model fits all the points
- Good job? Why, why not?

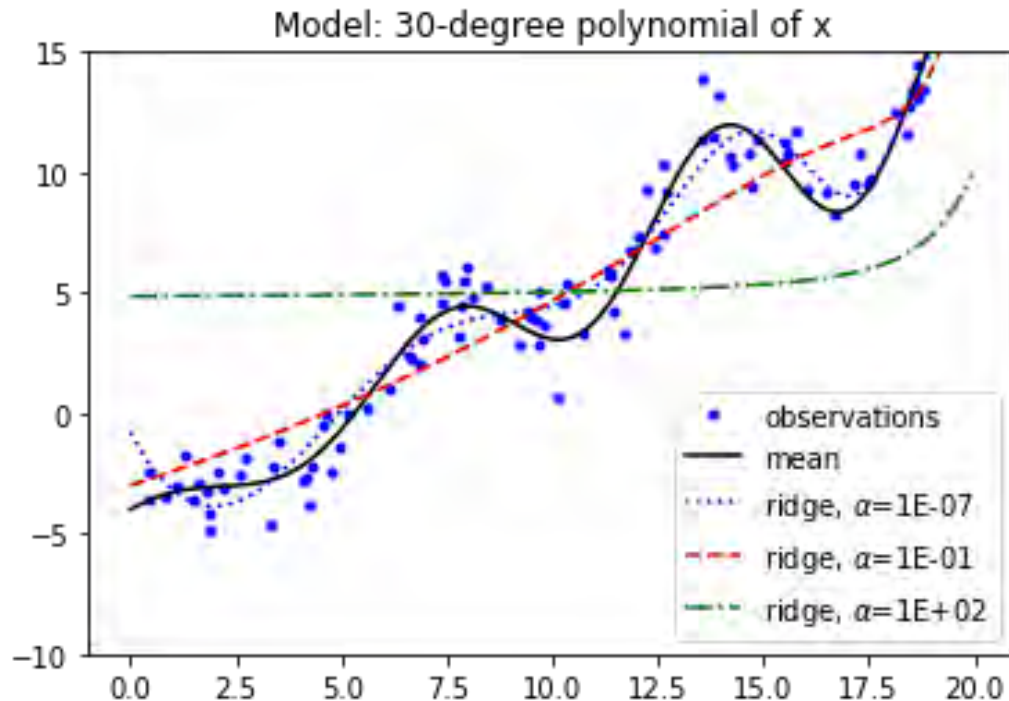


# Simple example: Polynomial Regression



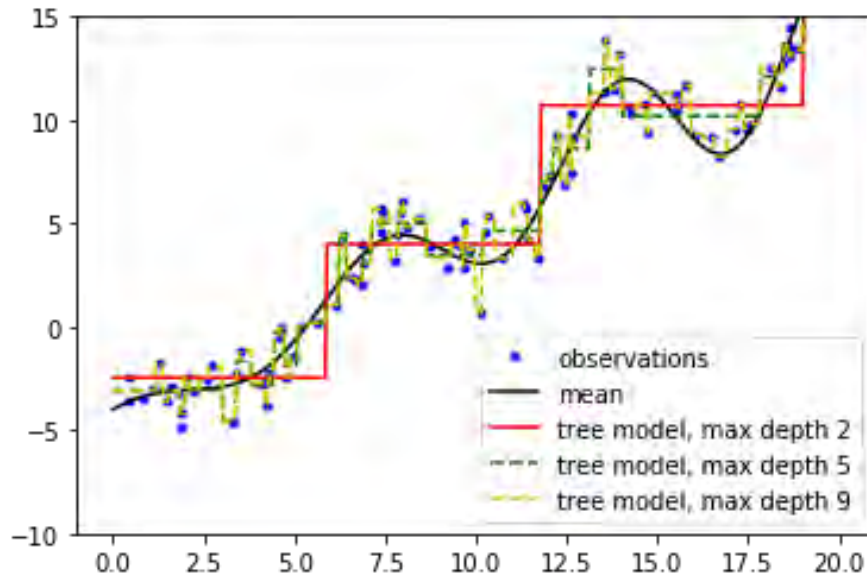
- Higher-degree polynomial terms to capture fit
- Sometimes appear in actuarial work up to 2<sup>nd</sup> order
- How high is too high?
- Extrapolation – watch out

# Simple examples: Ridge regression

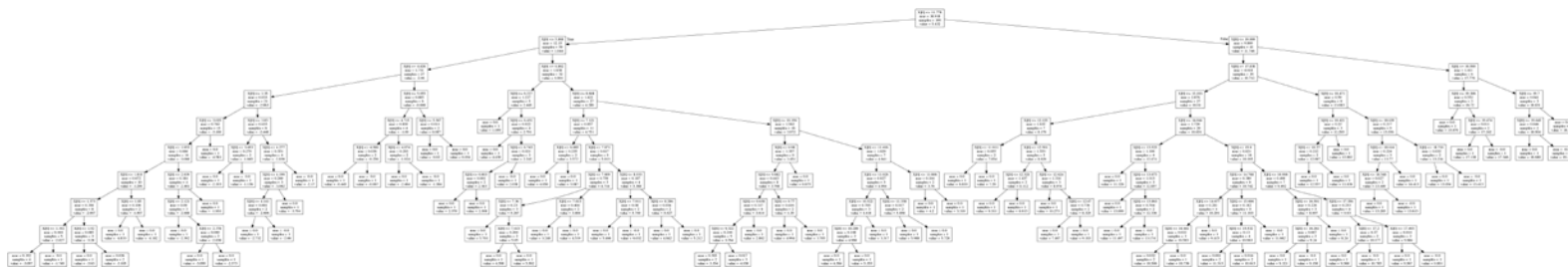
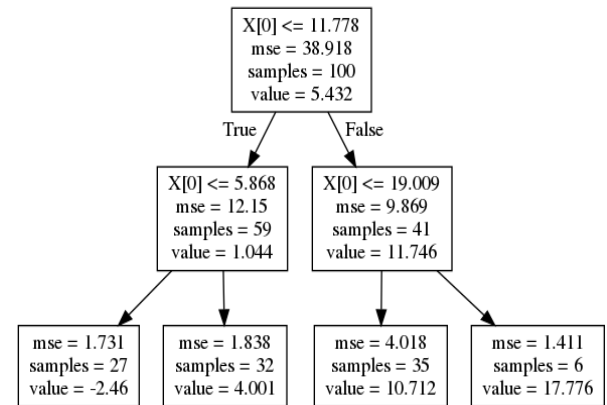


- More examples of range of options: over- and underfit
- Adding **all** polynomial terms, penalizing coefficients
  - How much penalty is appropriate?
  - Spectrum of choices!
  - Once again – how to choose?

# Simple example: Tree



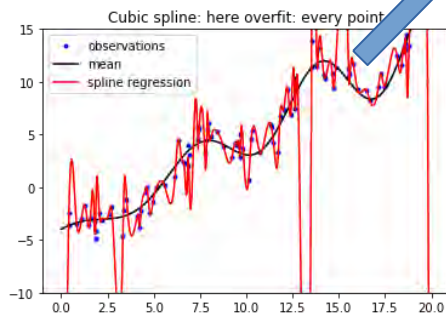
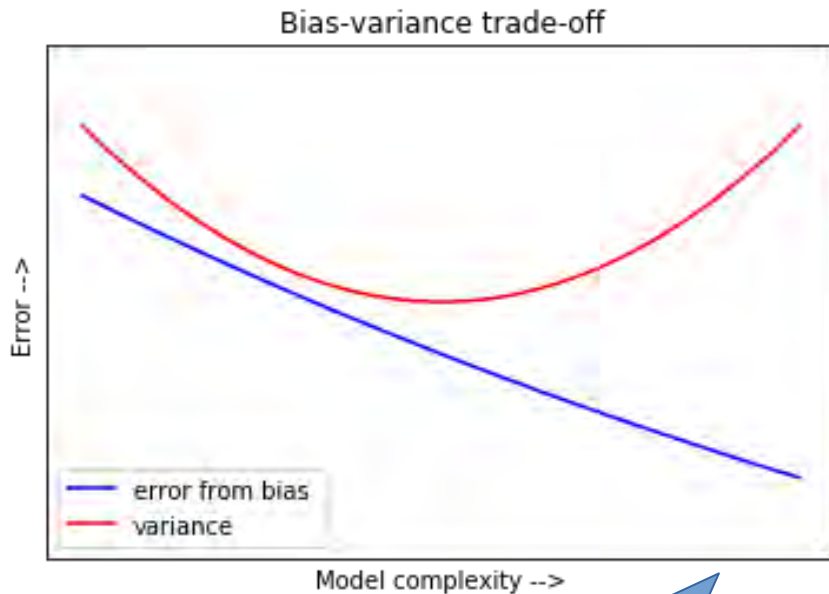
- Tree models:
- Trade-off in fit – but also in explanation.
- Which would you rather explain?
- Beyond this: model-based trees, model more than a constant



# Simple example: Many others possible

- Other types of models
  - Lasso
  - Random forests
  - Combinations
- Doesn't matter for today – the point is:
  - **The trade-off is there.**
  - **How do you deal with it explicitly?**

# Framework for addressing trade-off: Bias-Variance Trade-Off



Concept: the trade-off with increasing model complexity **past a point**

**Simplest model** is a constant: so more complexity should help.

**Past a point, more complexity:**

- means a better fit to experience
- means worse fit to next year

# Bias-Variance Trade-off (cont'd)

## In practice:

1. Split data into training and testing sets (3:1, 4:1 or so).
2. Choose complexity to minimize error vs the testing set.

In data-rich scenarios, training, validation, testing sets. *Out of scope today.*

From Elements of Statistical Learning (Hastie et al.):

- **Bias:** mean of the model (a random variable) vs underlying reality
- **Variance:** ... of the model around the mean of the model

**Your model was randomly generated or calibrated in a sense (random split). That might be a talking point.**

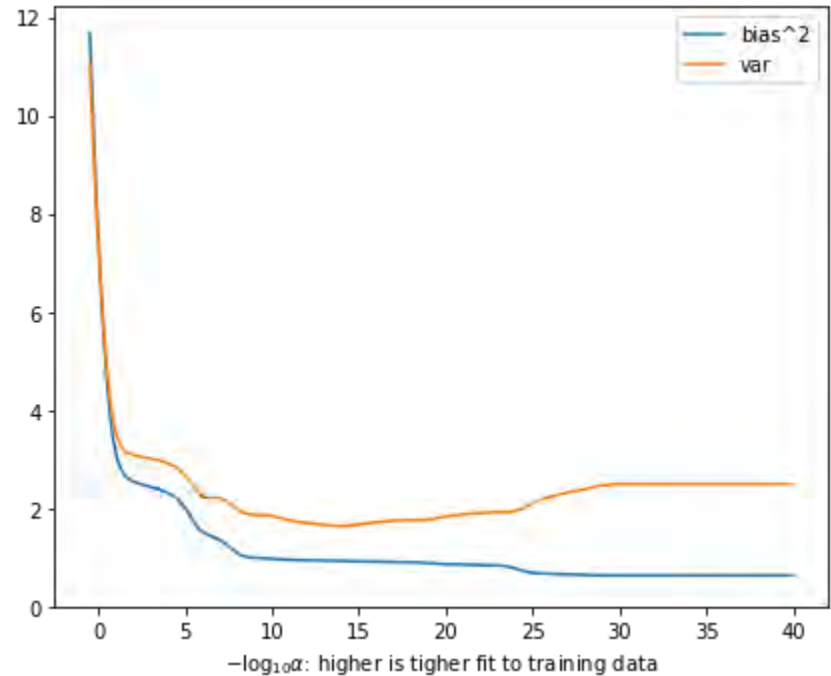
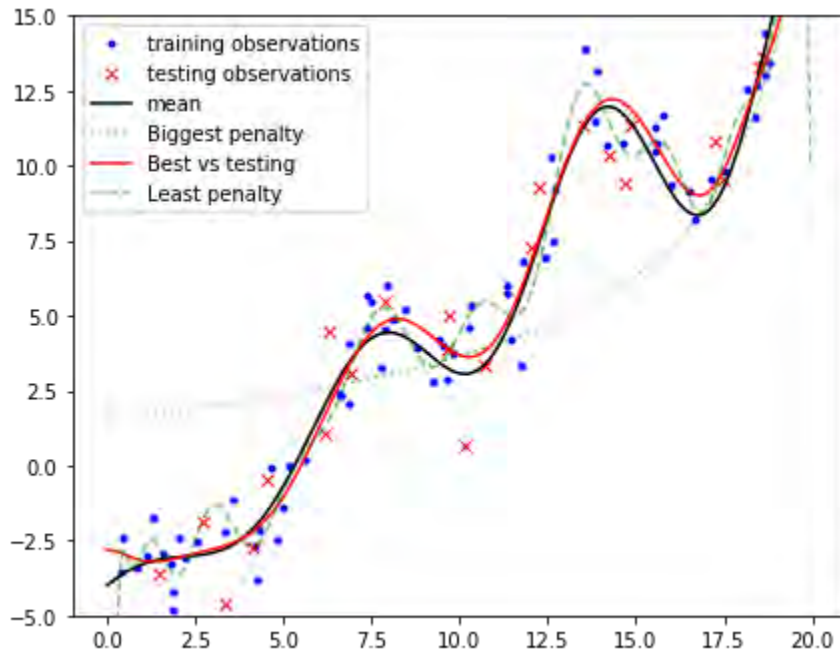
**But remember: it was always random. You're just acknowledging that and dealing with it.**

## Nice reads

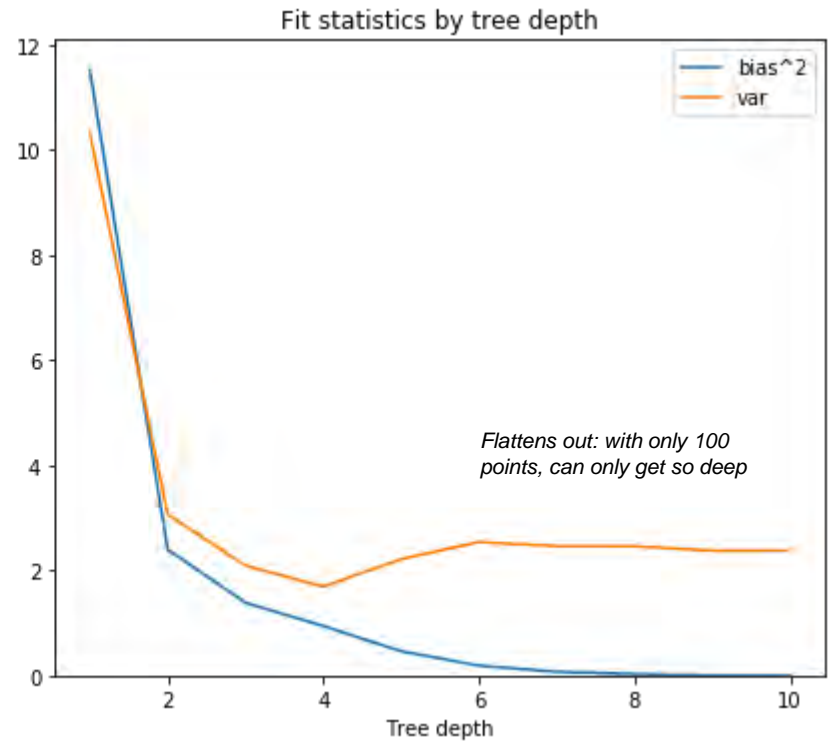
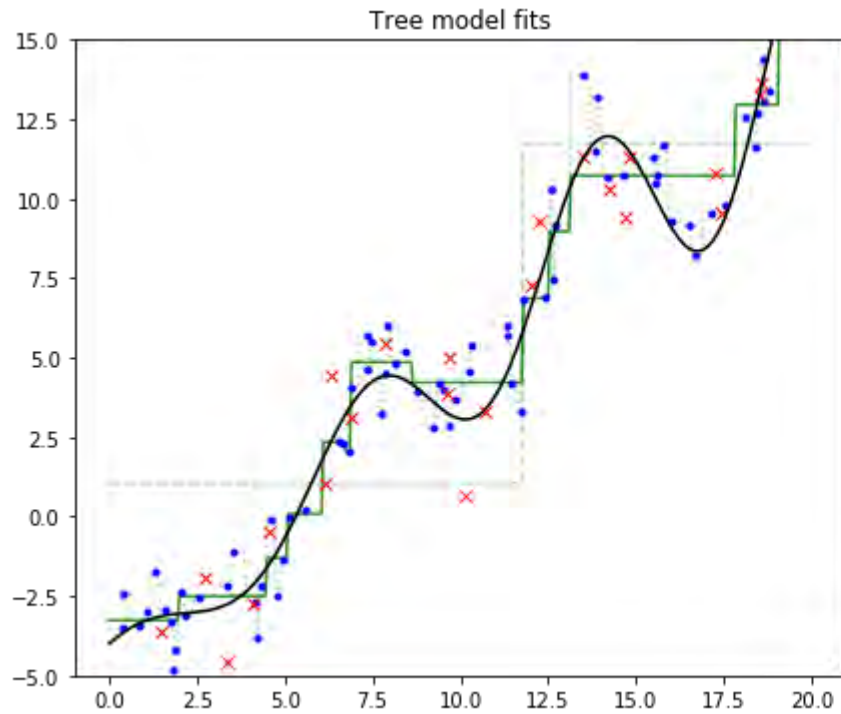
<http://scott.fortmann-roe.com/docs/BiasVariance.html>

<https://jvns.ca/blog/2016/01/02/winning-the-bias-variance-tradeoff/>

# Simple example of framework: Ridge regression on 30<sup>th</sup> degree polynomial: Best fit and worse fits; B-V T-O



# Simple example of framework: Tree model





# Life experience examples

Dataset: from SOA website

*Slides to be updated*

# Model Trade-Offs

*Thanks for your interest*

*Brian D. Hollland, FSA, MAAA*

