Mathematical Models

Areej Alasiry

Lecture Outline

- Philosophies of Modelling
- A Taxonomy of Models
- Baseline Models

Philosophies of Modeling

Occam’s Razor

- “Simplest explanation is the best explanation”
- Reduce the number of parameters used to develop the model
- Overfitting!
- Simplicity and accuracy trade-off.

Bias – Variance Trade off

- Bias: an error due to incorrect assumptions built into the model
- Variance: an error due to sensitivity to fluctuations in the training set.

- Underfit Vs. Overfit

Nate Silver

- Used quantitative methods!
- Main principles:
  - Think probability
  - Live Vs. dead models
  - The concept of consensus
  - Baysian reasoning

A Taxonomy of Models

Linear Vs Non-Linear Models

- Linear Models
  - Equations
  - Variables weights are represented by coefficients
  - Sum the values to give a score.

- Non-linear Models
  - Higher order polynomials
  - Algorithms
  - Exponentials

Blackbox Vs Descriptive Models

- Blackbox, we don’t understand how the results are achieved
  - Deep learning
  - Neural Networks
- Descriptive models, explain to some extent why such decisions are made
  - Linear regression
  - Decision trees

First Principle Vs. Data-Driven Models

- First principle is a belief of how the system really work
  - Theoretical explanation
  - Discrete events simulation
  - Reasoning
  - Adhoc models
- Data-driven is based on correlation observed between input variables and output variables.
  - General Models

Stochastic vs. Deterministic Models

- Deterministic prediction Model
- Stochastic is randomly determined where probability is employed:
  - Each probability is a value between 0 and 1
  - Must sum to 1
  - Rare events do not have probability zero

Flat Vs. Hierarchical Models

- Hierarchical models used for complex problems that can be split over sub models
- Deep learning is an example of both models

Baseline Models

Baseline Models for Classification

- Uniform or random selection among labels
- The most common label
- The most accurate single-feature model
- Another's model

Baseline Models for Value Prediction

- Mean or median
- Linear regression
- Value of the previous point in time.

Session Mind Map

References

- *The Data Science Design MANUAL. Steven S. Skiena, ISBN: 978-3-319-55444-0 ©2017.[Chapter 7]*