IST 402 Week 13 Scribing Notes

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Week 13 Applications of Machine learning continued

Allocating interventions based on Predicted Outcomes (Homelessness Services Case Study)

Homeless people are increasing in number

-Homeless System à Federally funded system which assigns homeless people to 5 different kinds of housing

-4 housing programs

         - Emergency shelter

         - Transitional Housing

         - Rapid Rehousing

         - Homelessness Prevention

         - Permanent Supportive Housing

Can we improve the assignment process using AI

Fairness needs to be kept in mind

Interpretability of ML models

-       Your take?

-       How important is interpretability

-       Cost vs benefit

Causal Inference

-       Need counterfactual estimates of different interventions before you can let the ML model decide which intervention/service you want to make an assignment to

Homeless Person assigned to Service A à Does not re-enter the system

Homeless person Assigned to Service B à Re-enters the system

But are there any confounding variables that can explain this change.

So how much can we potentially improve outcomes?

* What is each kind of data
* Household Characteristics (Feature)
* Which of the 5 services was assigned to them (Feature)
* Predictor -> Whether they re-enter the Homeless system within 2 years of exit (Label) (Is this a good metric?) (Looking at 2 years)

Their Approach:

* Clean this data to create a dataset
* Train an ML model on this that supports causal inference
* BART (Bayesian Additive Regression Trees)
* Provides counterfactual estimates for re-entry under different services
* See if the ML model is a good approximation of the real datasets
* (missed)

How did their Model do?

* Ground Truth (from their dataset) -> 43.04% households re-enter
* Prediction from BART model -> 43.72% households re-enter
* Fairly accurate - proved in the paper

How to Optimize

* Equation solved

After Optimization of Assignments -. 31.88% households re-enter

Reduction by 27.88%

Is the Optimized Solution Pareto Improving?: No

* What is Pareto-Improving?
* Pareto Frontier??
* 33.17% assigned to services which drop their probability to re-enter
* 34.21% assigned to the same service
* 32.62% probability of re-entry increases

Thursday, Nov 21 Notes

Covering 2 Papers

1. Decision Trees
2. Bagged Decision Trees - Ensemble method
3. Boosted Decision Trees - Ensemble method

Looking at the standard decision tree

* Can be read as an if statement
* Each leaf node is associated with a decision
* Start from the top and follow the decisions to a leaf and with that leaf is your answer
* Oblique Splits: Decision boundaries which are not aligned with your axes
* Internal nodes test attributes
* Is determined by attribute value
* Branching is an output value

Decision tree algorithm

* Choose an attribute on which to descend at each level
* Condition on earlier (higher) choices
* Generally, declare an output value when you get to the bottom
* In the orange/lemon example…

Expressiveness

For Discrete Input, discrete-output case:

* Decision trees can express any function of the input attributes
* E.g., for boolean functions, truth table row -> path to a leaf

For Continuous Input, Continuous Output case

* Can approximate any function arbitrarily closely

2) Bagged Decision Tree

* Instead of training different models on the same data, train the same model multiple times on different data sets, and “combine” these “different” models
* Bagging stands for Bootstrap Aggregation
* Takes original data set D with N training examples
* …

3) Boosting

* Take a weak learning algorithm
* Only requirement: Should be slightly better than random
* Turn it into an awesome one by making it focus on difficult cases

Going over 2 Articles

* Water Mains break a lot, cutting water supply
* A problem in older cities, Syracuse is a prime example
* Looking to predict which water mains will break

Current Strategies

* A reactive system, fix the mains after they break
* Meaning residents won’t have water
* Want an AI solution

Plan

* Frame it as a binary classification problem of whether a water main break will occur in a given city block within the next 3 years
* Result: Precision of 62% in the top 1% of our predictions
* Two ways in which system can be used
* 1) for preventative maintenance on the top 1% of the riskiest breaks
* 2) To use the risk scores to…

Paper 2

Animals are at a constant threat of being poached using traps and wires illegally

* How do you predict future poacher activity from past data
* “Missing” poaching data
* Limited patrol resources
* Imperfect observations
* Consequences
* Uncertainty in negative labels
* Class imbalance

Solving

* Booster Decision tree
* Built-up Ensemble
* A mixture of DT creates the most accurate data, used as an ensemble

Results

* Infrequent Hot Spots
* Predicted Hotspots
* Trespassing
* Poached Animals
* Snaring

Other notes on Decision Tree’s

A classification tree has a descrete output

Regression tree has a continuous output

Algorithm

* An attribute at each level can be labeled true or false
* Output/solution at the bottom
* Boolean functions can be used to create a truth table

Creating a Decision Tree

* Pick the best attribute at each level and split the tree
* Repeat until a final solution is identified

Keep in mind…

* A good decision tree is…
  + not small enough to the point where it is inaccurate
  + Not too large so the solution is efficiently found
  + Regularization is necessary in order to ensure decision trees are compact