PURPOSE DRIVEN SUPPLY CHAIN:
A PRESCRIPTIVE APPROACH TO SUSTAINABILITY


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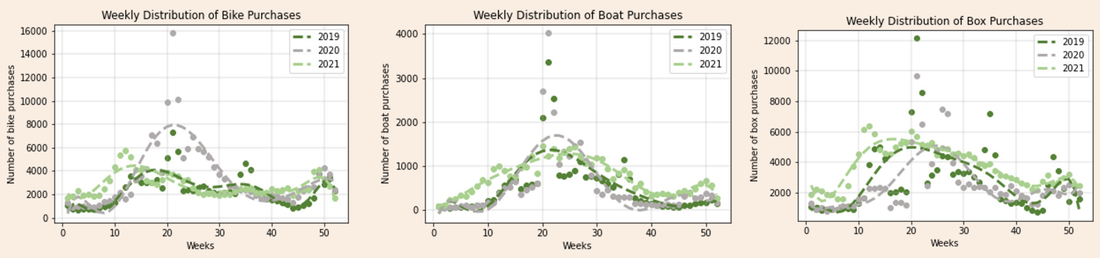
Maintaining REI's commitment to environmental sustainability in supply chain

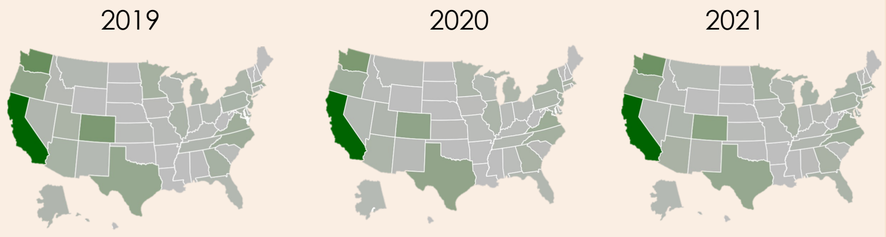
Problem Statement

How do we **predict weekly in-store demand** of BIKES, BOATS & BOXES and accordingly **optimize the REI supply chain** to **minimize operational costs** and **limit environmental impact**?

Data

- Sales
- Events
- Location





Strong **Seasonal Sales** Trends

Strong **Geographic Sales** Trends

Feature Engineering to recover sales trends

End to End Approach

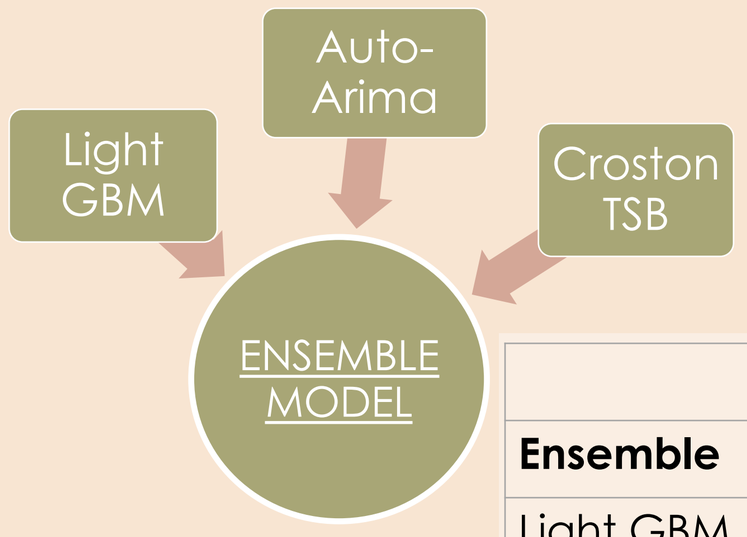
In-Sample: Data → Demand Prediction → Optimization → Shipment & Store Inventory Quantity

Out of Sample: Actual Demand → Actual Unsatisfied Demand → Actual Cost

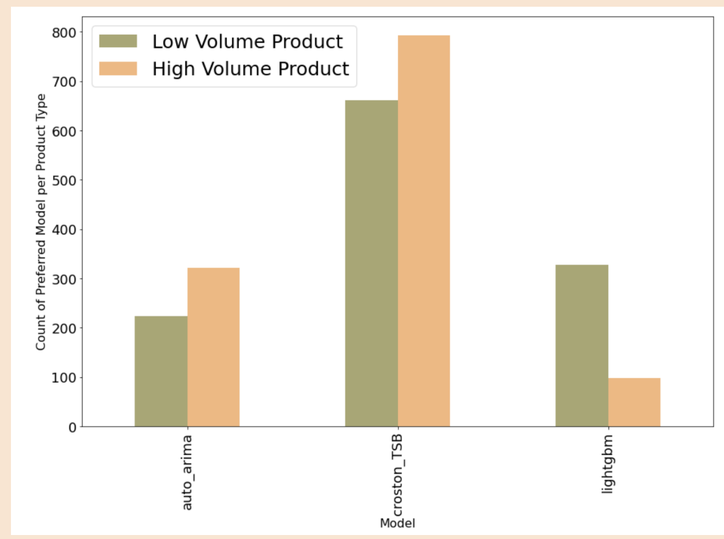
1. Demand Forecasting

How many units of product class c will be purchased at store s on week w?

	LIGHT GBM Features
Geography	Cumulative sum of units in class sold within the year in each store
	Cumulative sum of units in class sold within the year in each Zip1/Zip2/Zip3
Time/Season	Average of past week's sales of class in each store
	Average of past 3 week's sales of class in each store
	Average of past 5 week's sales of class in each store
	Previous year sales of class in the same fiscal week
	Number of company wide events/promotions during that fiscal week



	Val MAE	Test MAE
Ensemble	**0.80**	**1.64**
Light GBM	1.58	3.49
Croston TSB	0.84	1.58
Auto-Arima	0.97	1.75



Selected Model Frequency

2. Optimization

Can we find optimal routes and truck loading to minimize cost and distance traveled?

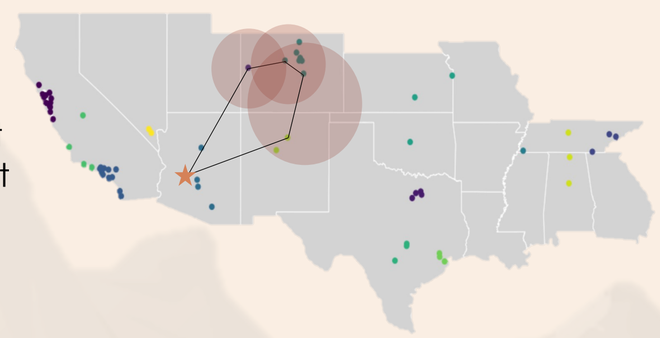
Minimization Objective: Full-Truck Load Transportation Cost + Less-than-Truck Load Transportation Cost + Cost of Unsatisfied Demand

Transportation Constraints:
1. Each truck on a particular route can be an LTL or FTL
2. Quantity sent on a route doesn't exceed truck capacity

Inventory & Capacity Constraints:
1. Items sent to a store + Current Inventory <= Capacity
2. Store inventory is balanced weekly based on sales
3. DC inventory is balanced weekly based on shipment

Sales Constraints:
1. Sales + Unsatisfied Demand = Forecasting Demand

Use of Optimization With:
- **Route** Optimization
  - Baseline Routes (Inspired from practice)
  - Optimized Routes
- Optimization of operations based on **demand**:
  - Perfect Information
  - Forecasts
  - Last Year Sales
- Integration
  - Two-Stage Opt
  - One-Stage Opt



Demand Scenario	Optimized Routes (1-Stage)	Optimized Routes (2-Stage)	Baseline Routes (2-Stage)
Perfect Information	$300,545	$301,661	$302,786
Ensemble Predictions	$1,250,280	$1,251,512	$1,267,118
Last Year Sales	$1,446,542	$1,446,897	$1,459,020

Demand Scenario	Optimized Routes (1-Stage)	Optimized Routes (2-Stage)	Baseline Routes (2-Stage)
Perfect Information	1,183,738 miles	1,267,127 miles	1,733,962 miles
Ensemble Predictions	1,339,258 miles	1,213,922 miles	1,946,641 miles
Last Year Sales	1,276,050 miles	1,302,374 miles	1,975,534 miles

13.5%
decrease in operational costs

37%
decrease in transportation miles and carbon emissions