Consumer Aware Warehouse Management
SDMay20-25

Advisor: Goce Trajcevski
Client: Jimmy Paul, Crafty LLC. CTO
Team: Lindsey Sleeth, Omair Ijaz, Andrew Smith, Sam Stifter, Jameel Kelley, Elijah Buscho, Devin Üner
http://sdmay20-25.sd.ece.iastate.edu/

Client Background - Lindsey

Crafty LLC helps companies enhance their employees life at work by providing offices with food, beverage, and event management

Project Motivation - Lindsey

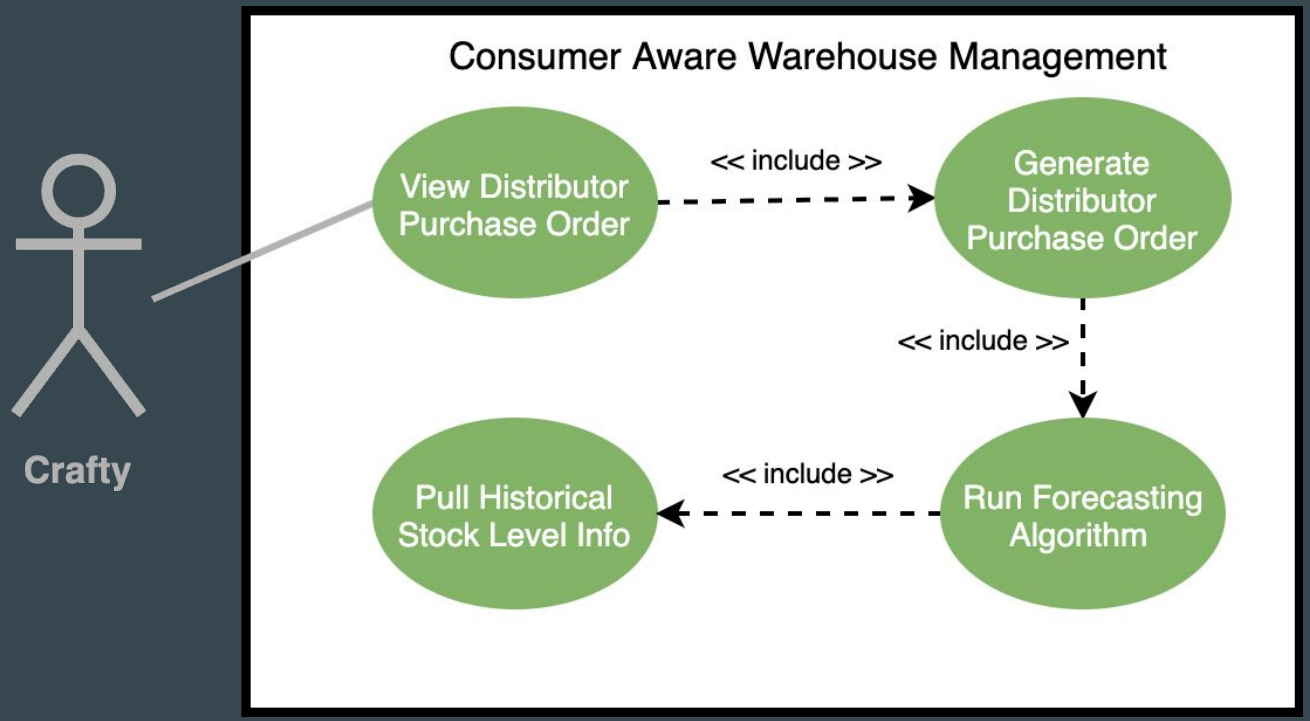
$600,000 Annually
Missed Revenue for
20,000 Missed Items

$100,630 Annually
Lost Value for
15,356 Expired Items

3 Full-Time Employees
Dedicating
50% of Time to Ordering

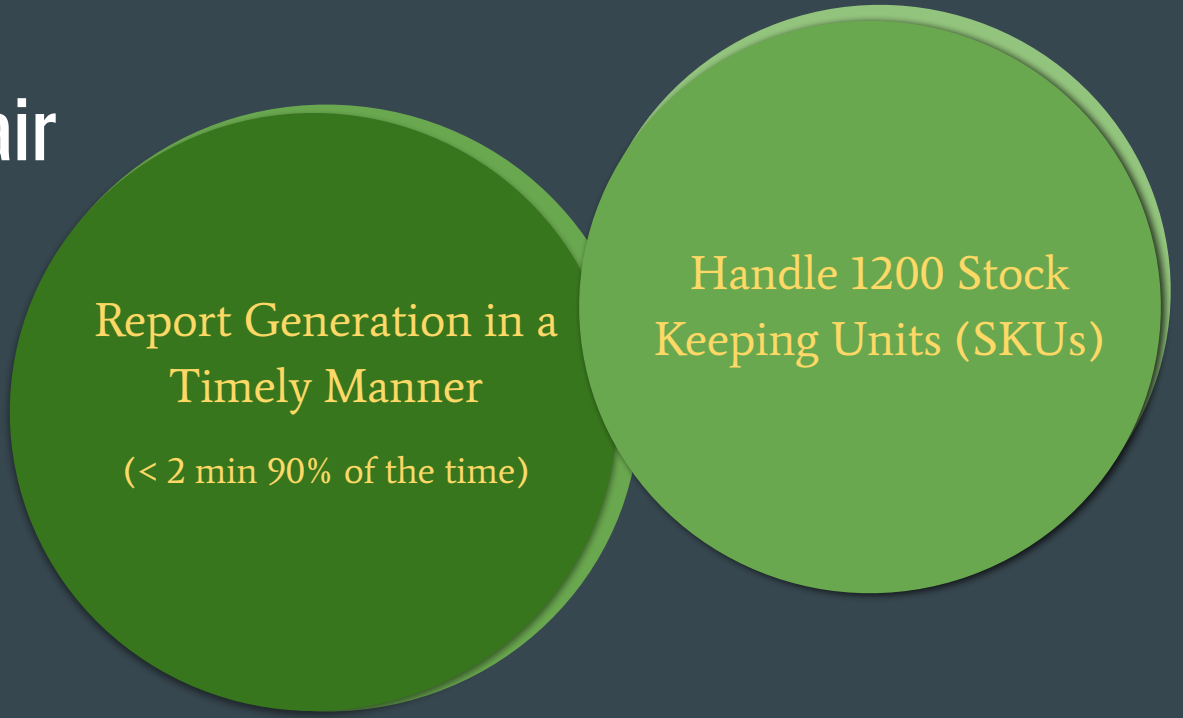
The solution is a forecasting algorithm for inventory management that automates reordering for warehouse stock

Conceptual Design Diagram - Elijah

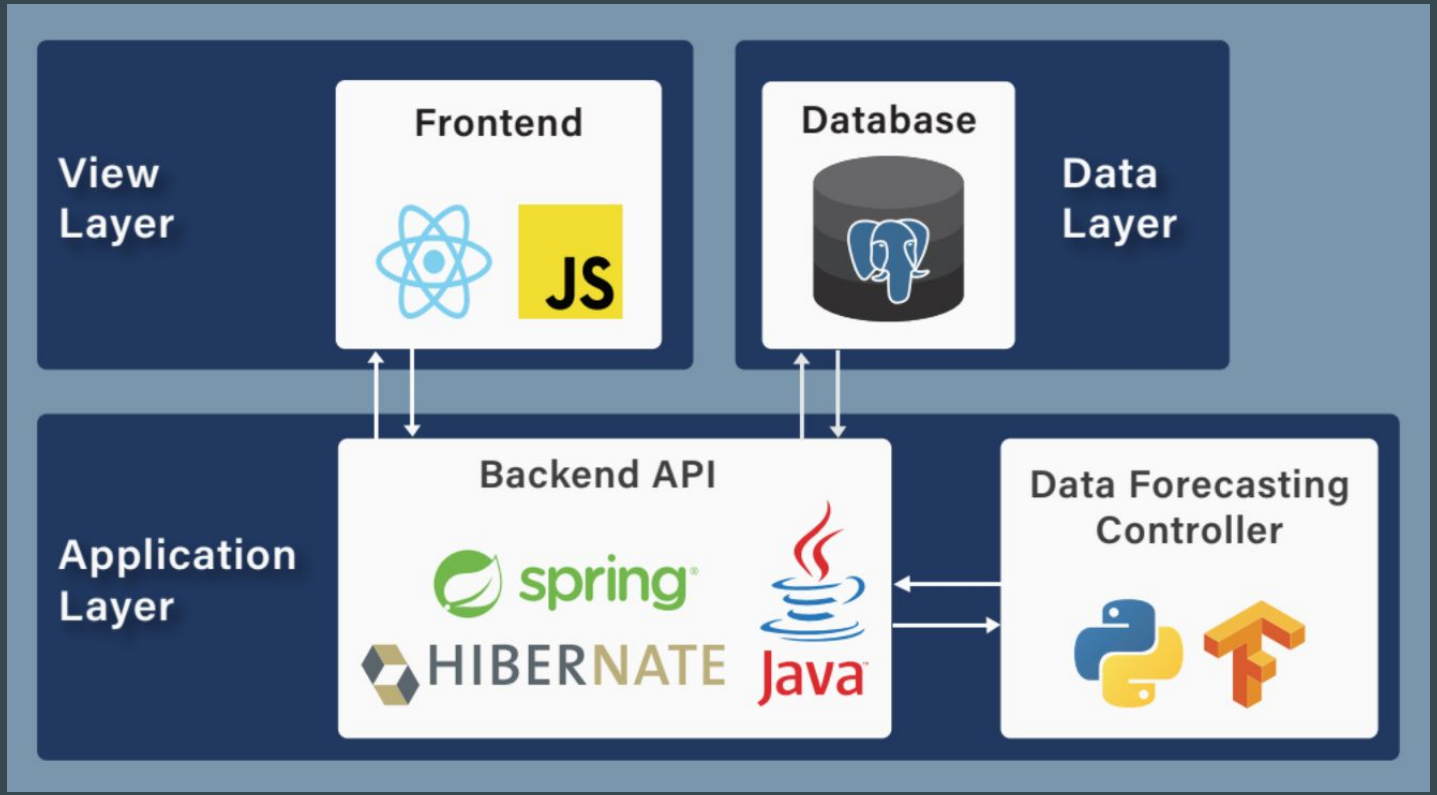


Functional Requirements - Jameel

Non-Functional Requirements - Omair



System Design - Sam



API Design

API Design - List of All Endpoints - Andrew

Get Distributor
/distributor/{distributorID}

List All Distributors
/distributors/{regionID}

Get All Distributors Order Schedules
/distributors/scheduleAll/{regionID}

Get Distributor Order Schedule
/distributor/schedule/{distributorID}

List All Distributors Ones with Products
/distributors/withProducts/{regionID}

List All Distributors Ones with Products to Order
/distributors/withProductsToOrder/{regionID}

Get Distributors Products
/distributor/products/{distributorID}

Get Distributor Products with Order Quantity >0
/distributor/products/withPredictions/{distributorID}

List All Regions
/regions

Get Breweries
/breweries/{regionID}

List History of Missed Items
/missedItemsBySku/{skuID}

List Historical Warehouse Inventory Level
/sku_hist/{skuID}

Add a New Prediction Value
/predictions/add

Get Predictions for a Sku
/predictions/sku/{skuID}

API Design - Historical Warehouse Inventory Level -Andrew

- Called to get the historical warehouse inventory level
- Used to display on a graph for frontend
- Used by algorithm to generate predictions

/sku_hist/{skuID}


```
[
  {
    "createdAt": "2018-04-02T00:30:06.861+0000",
    "count": 51
  },
  {
    "createdAt": "2018-04-02T11:00:10.423+0000",
    "count": 43
  },
  {
    "createdAt": "2018-04-03T11:00:10.828+0000",
    "count": 45
  },
  {
    "createdAt": "2018-04-04T11:00:11.149+0000",
    "count": 46
  }
]
```

API Design - Add a New Prediction Value - Sam

- Make a prediction for Order Quantity
- Update the Database
- Communicates with the Machine Learning Component

/predictions/add

```
{
  "sku_id": 7291,
  "qty_to_order": 10
}
```

API Design - Get Predictions for a Sku - Omair

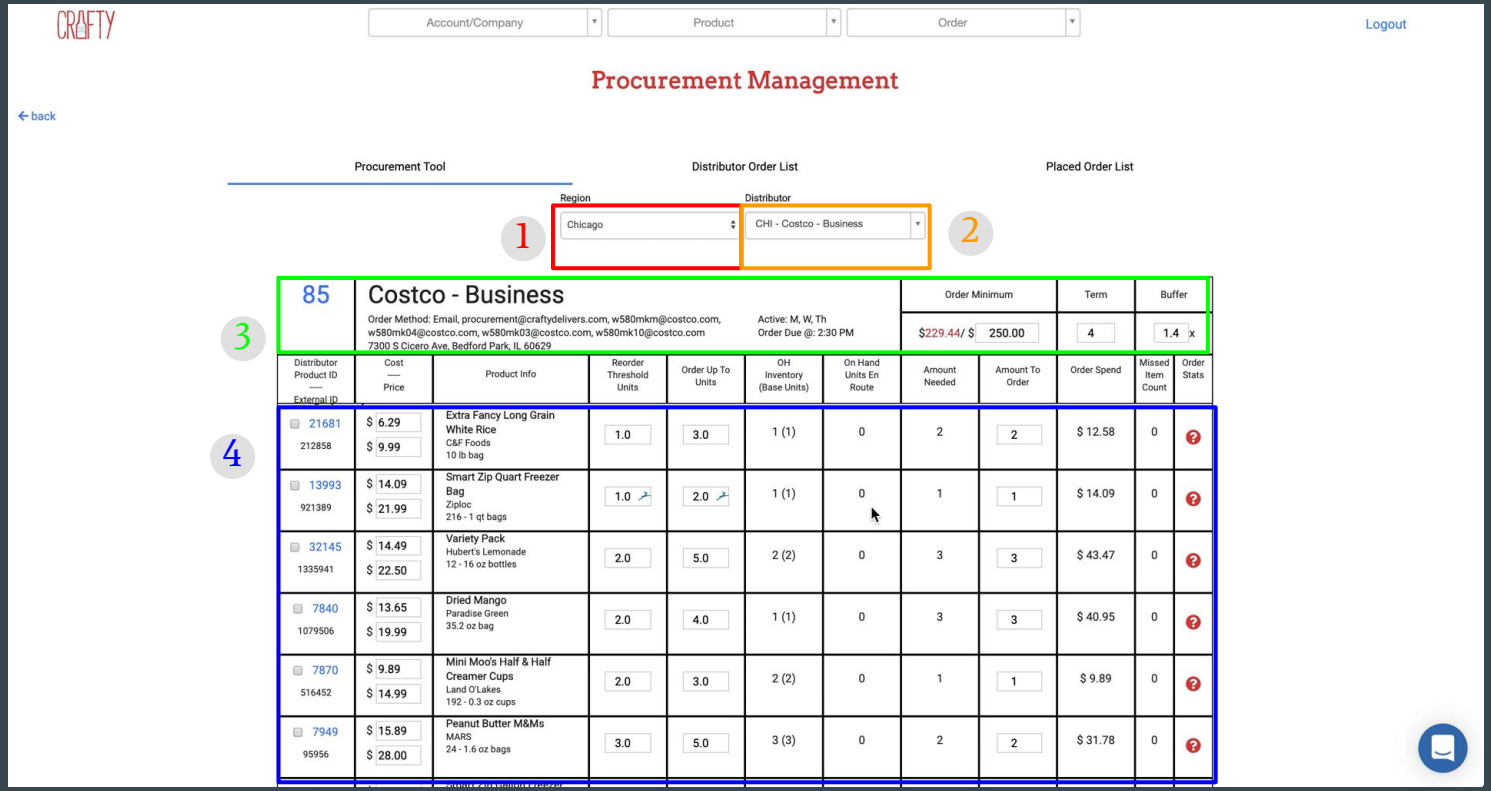
- All predictions are stored
- The most recent prediction for a SKU can be retrieved DB along with the time stamp
- Will be displayed on the frontend

/predictions/sku/{sku}

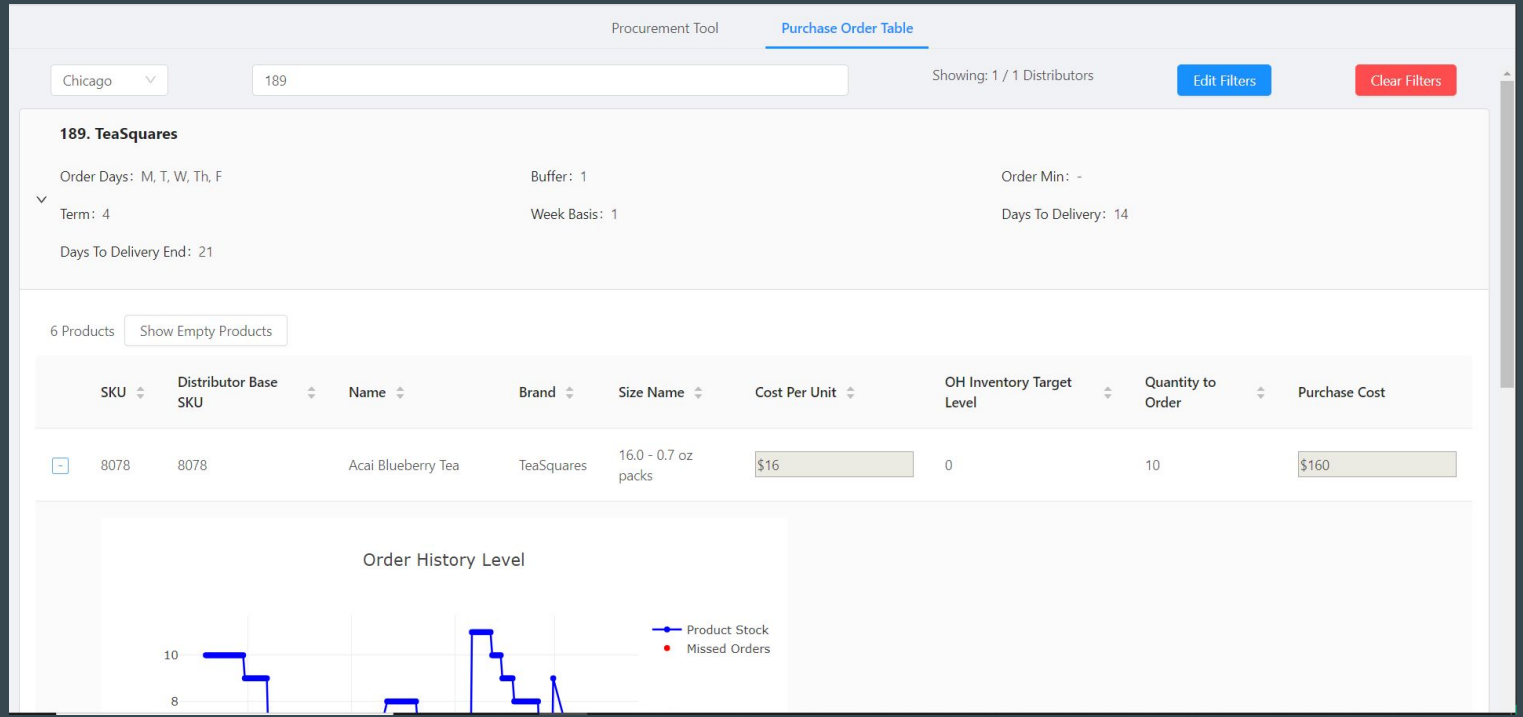

```
{
  "id": 1,
  "sku_id": 7291,
  "qty_to_order": 10,
  "date": "2020-04-06T19:07:09.197"
}
```

Frontend Design

Crafty's System - Lindsey



Demo - Lindsey



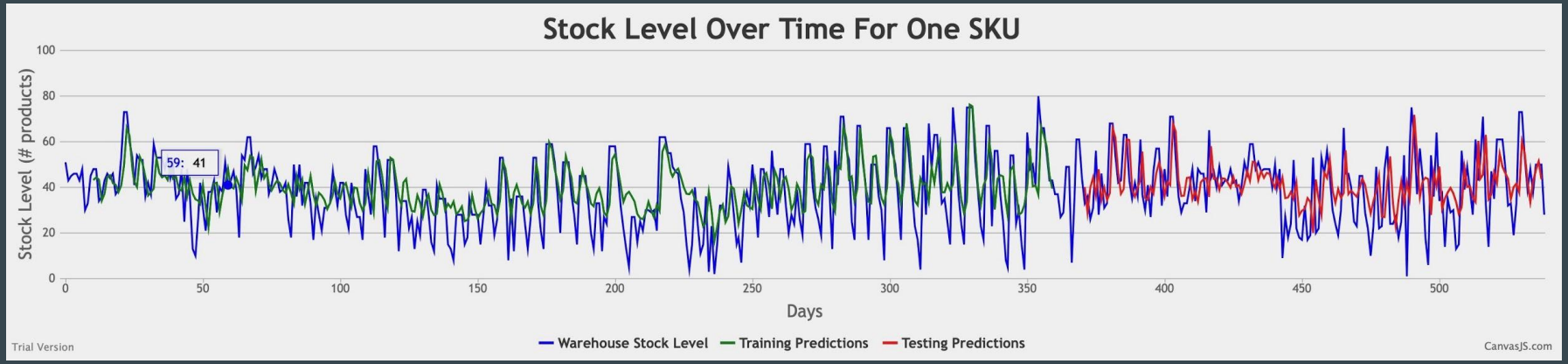
Link

Machine Learning Design

Machine Learning Design - Devin

- Long Short Term Memory (LSTM) neural network
- Capable of predicting long term and short term trends in data
- Created with Keras and Tensorflow

Algorithm Test Plan - Devin



Test Plan - Algorithm - Elijah

- Test SKUs
- Missed Sales
- Client Order History

Test Plan

Frontend - Jameel

- Manual testing of components upon completion
- Using Postman Collection to check API status and return values
- Using Developer Tools to test XHR Requests (time and deserialization to objects)

Backend - Sam

- Manual Tests
  - Create SQL Queries
  - Create Spring Endpoints
  - Compare Endpoint results with SQL results
- CI/CD
  - Compile and Deploy to Server

Engineering Standards and Design Practices - Sam

- Code Review
- Xtreme Programming
- Model View Controller

Lessons Learned - Everyone

- Backend - Omair
  - PostgreSQL databases
  - Working with existing databases can be very difficult to find where and what the data is
  - Complex queries with Spring
  - API design to support a flexible frontend
  - Planning and task distribution is important
- Frontend
  - React Framework
  - API Integration
  - Robust API Integration on Frontend
  - Peer Programming while Teaching
- Algorithm
  - Working with LSTM neural networks
  - Using Tensorflow and Keras
  - Data is important
    - Amount of data
    - Knowledge of data

Thank you!

Questions?

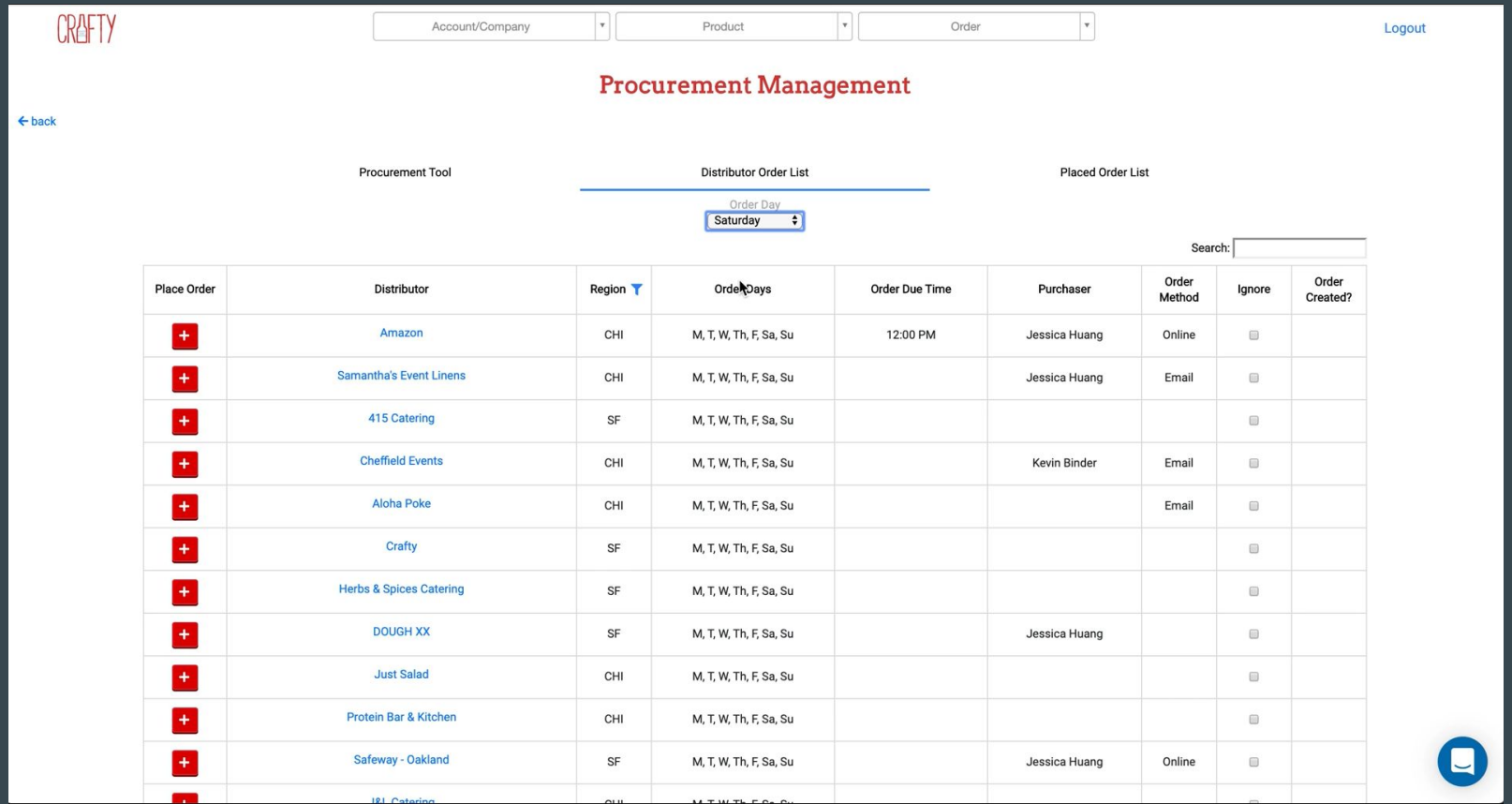
Existing Approaches 1 (Learning Based Approach)

- Input Variables
  - Past Sales
  - Weather
  - Travel Time of Product
- Advantages
  - Better Prediction of Demand
  - Lowers Missed Sales
- Disadvantages
  - Amount of Resources
- Relation to Our Solution
  - Past Sales Data
  - Shipping Time
- Differentiation From Our Solution
  - Too Many Input Variables

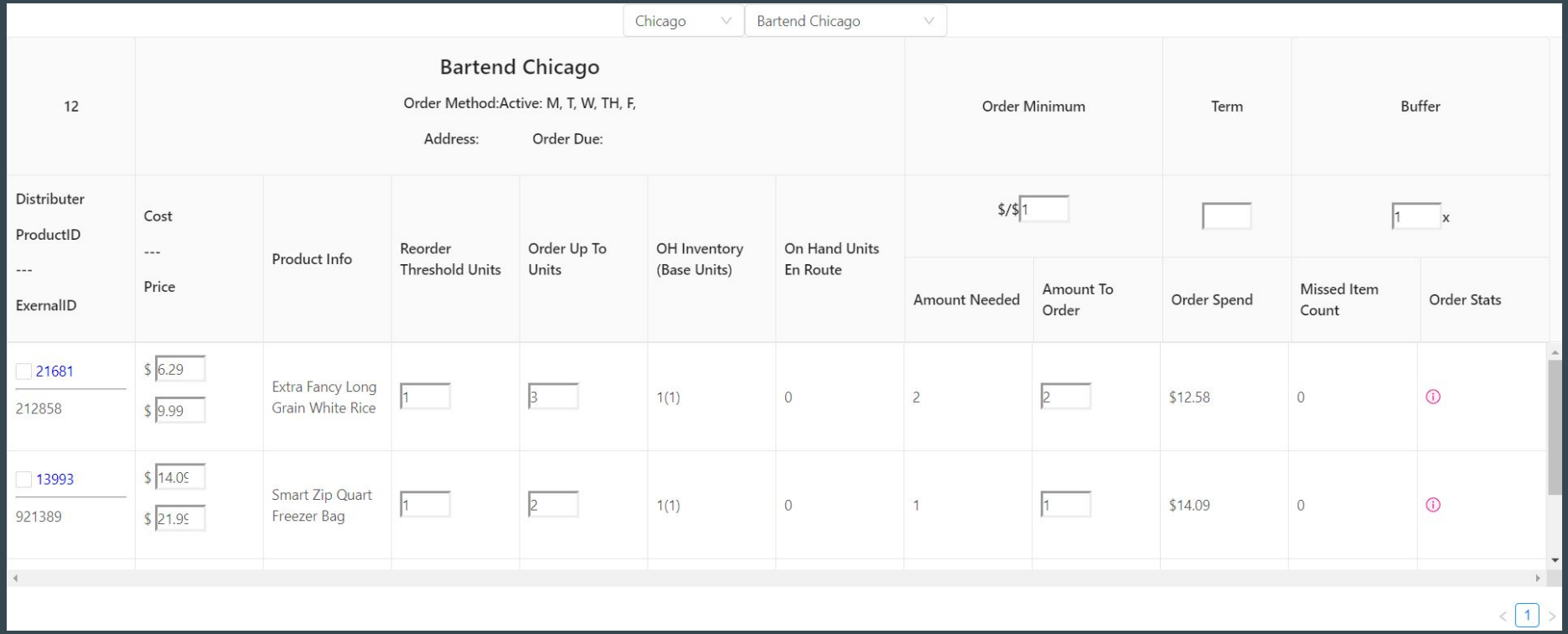
Existing Approaches 2 (Regression Based Approach)

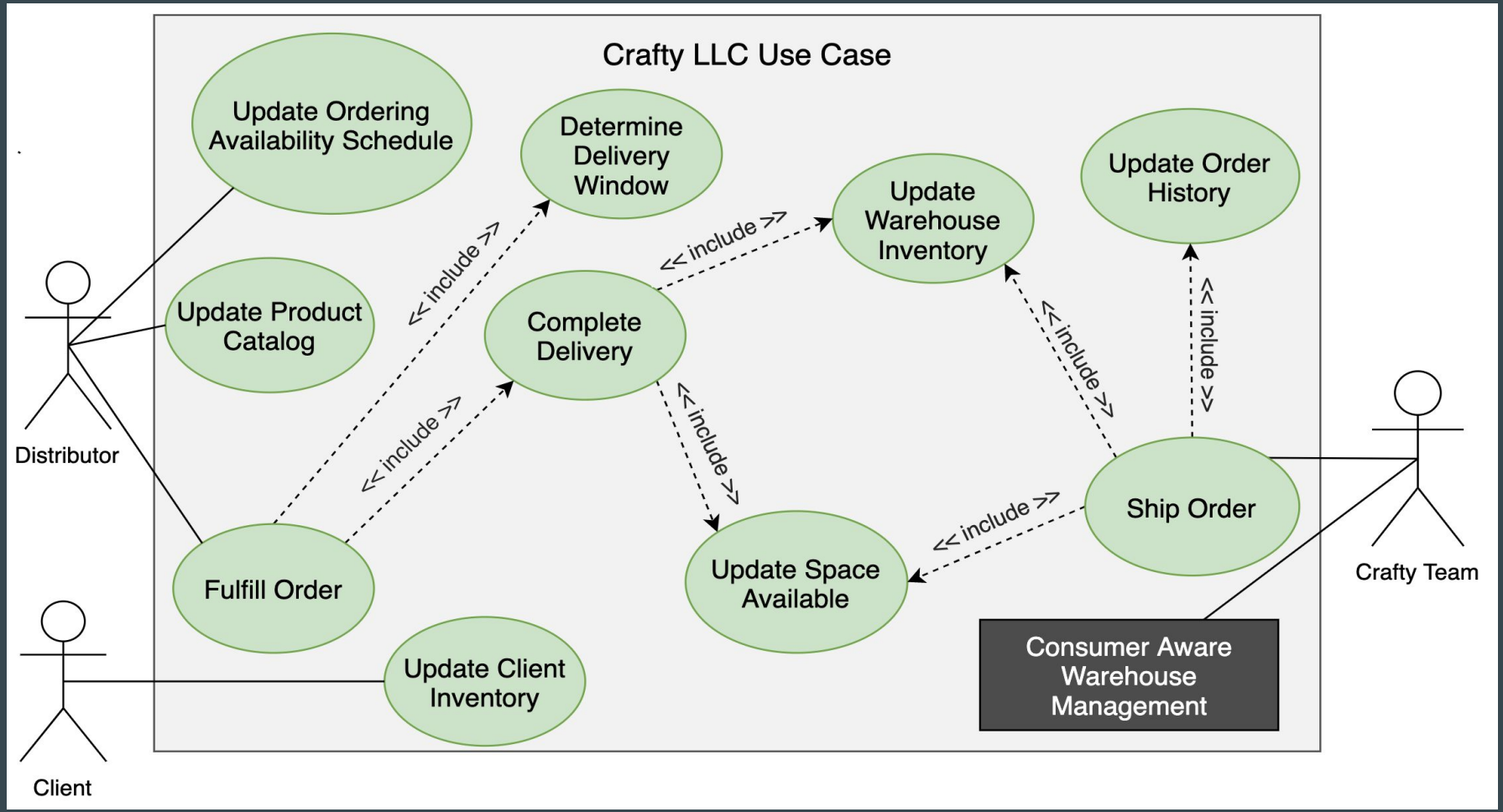
- Input Variables
  - Past Sales
  - Seasonal Changes
- Advantages
  - Little Amount of Resources
- Disadvantages
  - Can’t Handle Spikes in Demand
  - Doesn’t Figure in Shipping Time
- Relation to Our Solution
  - Past Sales Data
- Differentiation From Our Solution
  - Doesn’t Figure in Shipping Time

Distributor Order List



Implementation




Crafty LLC Use Case
Update Ordering Availability Schedule
Determine Delivery Window
Update Warehouse Inventory
Update Order History
Update Product Catalog
Complete Delivery
Distributor
<< include >>
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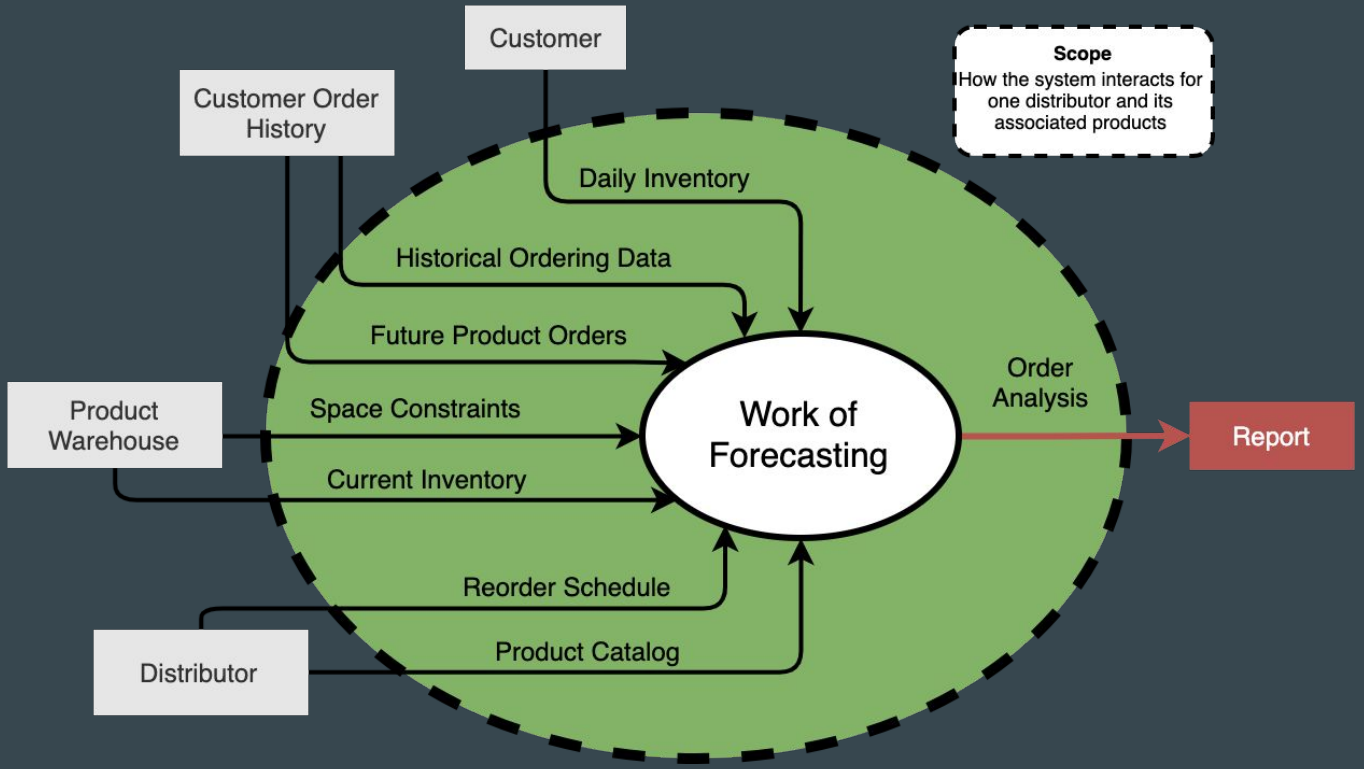
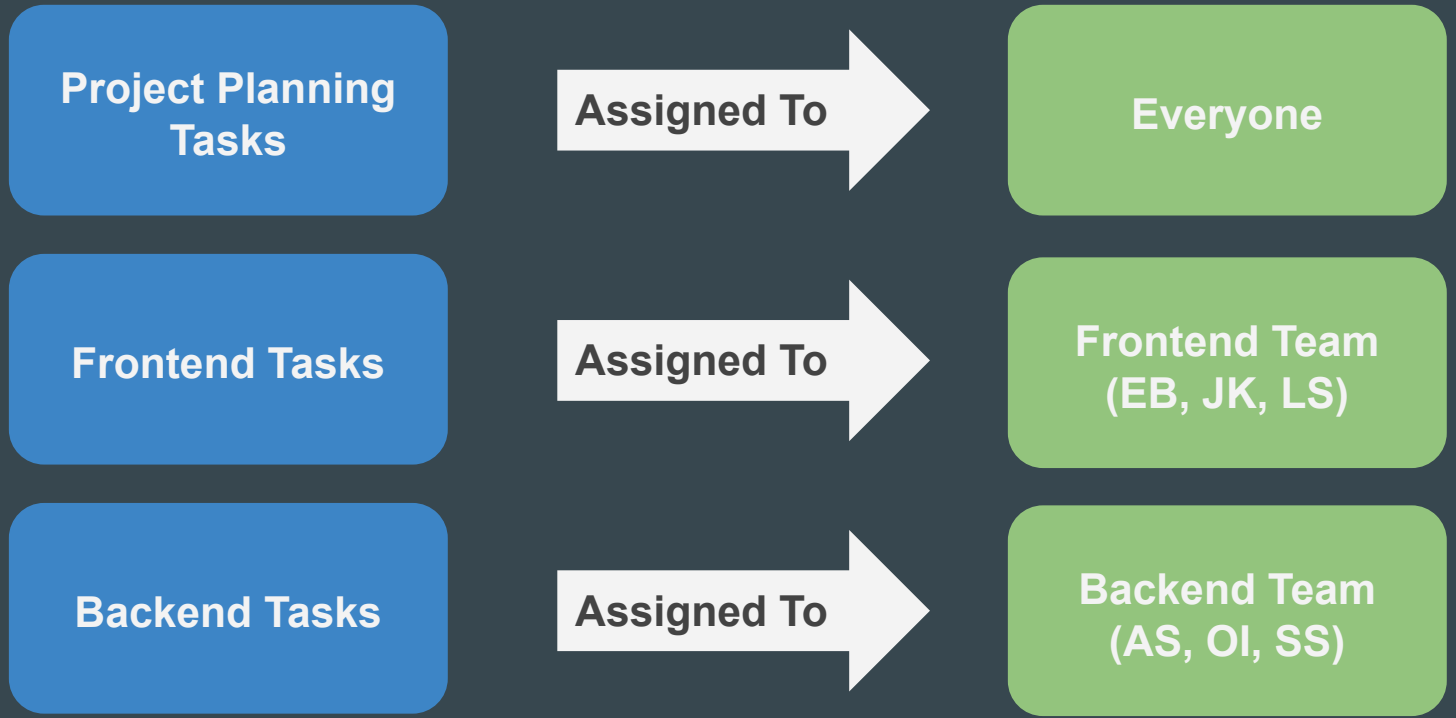
Ship Order
Crafty Team
Fulfill Order
Update Space Available
Update Client Inventory
Consumer Aware Warehouse Management
Client

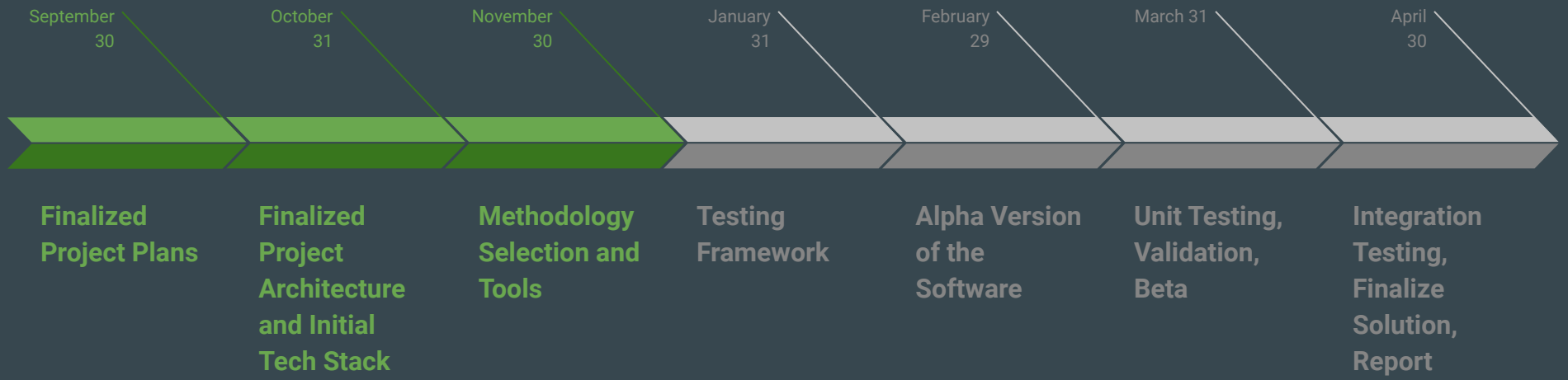
Conceptual Sketch



Project Plan - Tasks



Project Plan - Schedule / Milestones



Project Plan - Risks

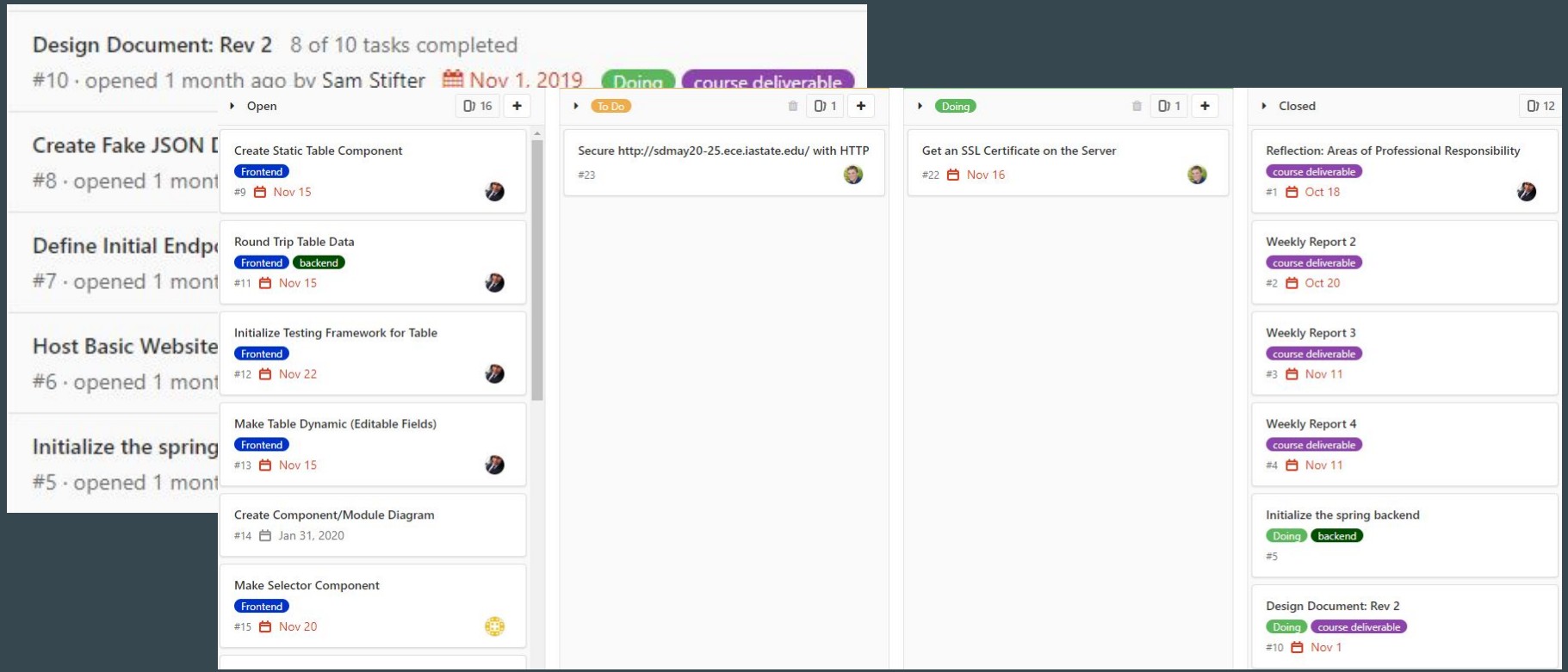
Inaccurate results

Results not clearly understood

Steep learning curve

	Impact			
Likelihood		Minor	Moderate	Severe
	Very Likely	Medium	High	High
	Likely	Low	High	High
	Possible	Low	Medium	High
	Unlikely	Low	Medium	Medium
	Very Unlikely	Low	Medium	Medium

Project Plan - Progress Metrics



Project Vision - Lindsey

Crafty desires a forecasting algorithm for inventory management that automates reordering for warehouse stock