Background
Cold-chain logistics refers to the transportation and handling of temperature controlled products and involves unique requirements that set this process apart.

Problem Statement
Amazon's current Freight Inbound (AFI) Network for Cold Chain delivery is dependent on third party shippers and managed by suppliers. This is not cost effective and prevents them from managing their inbound cold supply chain.

Objective
Create an Automated Optimization Tool for inbound cold-chain transportation network that processes the input variables, and generates the most cost efficient execution plan for inbound deliveries based on constraints.

Input Variables & Constraints
- Pickup Zip Code
- Delivery Zip Code
- Pickup Time Window
- Delivery Time Window
- Temperature zone
- Unit counts
- # of Available Trucks

Optimization Engine
- Calculate the routing plan from shipper to HUB
- Calculate the routing plan from HUB to receiving site
- Extra Truck Estimation Function if no feasible solution

Executable Plan
- Optimize delivery route
- Calculate number of each type of truck needed
- Find Total cost for each order
- Recommend alternative routing plan

Validation Process
Compared our results against the results from RoOT (Route Optimization Tool) developed by VillageReach and the ISE Department at University of Washington.

Why RoOT?
It is accessible to us and easy to validate. It can deal with temperature constraints and the parameters used are applicable to the model we made.

Model Comparison
<table>
<thead>
<tr>
<th>Our Model</th>
<th>RoOT</th>
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<tbody>
<tr>
<td>Optimize weekly plans</td>
<td>Optimize one-day delivery</td>
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<tr>
<td>One temperature per truck</td>
<td>Multi-temperature per truck</td>
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<tr>
<td>Specific time windows for pick-up and drop-off.</td>
<td>No time window constraint within the one-day interval.</td>
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<td>No additional constraint on specific number of trucks should be used</td>
<td>One constraint is trying to enforce all the available trucks to be used</td>
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<tr>
<td>One truck per route</td>
<td>One truck for multiple routes</td>
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Validation Results
- 9 Scenarios using different input datasets and having different numbers of available trucks
- Due to the difference in the constraint, our model's results are better (shorter time) than the RoOT model

Impact
With the tool that we created:
- Users will have better sense of their plans and transportation process.
- Amazon will make better decisions about their cold chain transportation.
- Ensure products are delivered on-time and within their temperature range.
- Reduce costs by 40 - 60%, which will allow affordable access.

Deliverables
1. User Interface that allows for upload of a CSV File that contains shipping demand information and outputs the optimized routing schedule.
2. Display the initial demand on a map (order density)
3. Display optimized shipping routes

Truck Analysis Dashboard
- Truck Utilization Analysis Dashboard
- Truck Load Analysis Dashboard
- Truck Load Heatmap Analysis Dashboard

Truck Analysis:
The tool is able to find the optimal # of 16' & 53' trucks which saves delivery cost by over 40 - 60%. Utilization Analysis could be a good reference for resource allocation.

Assumptions
- One DC (Hub), multiple shippers and receiving sites
- Static cost coefficients
- Single temperature zone per truck
- Uniform item dimensions across temperature zone
- Unlimited crossdock capacity
- Ideal transportation (No stops/traffic/accidents)