



# FOOD BANK DELIVERY SCHEDULING

CDL Quantum Hackathon 2020

Eduard Smetanin - Eunice Ofori-Addo - Santanu Ganguly – Tina Sebastian



JEDI Masters

# PROBLEM EXPLORATION

- Food banks depend on volunteers to deliver meals to the homebound
- Require efficient route planning for faster delivery and volunteer retention
- Number of volunteers can change from day to day

# CURRENT SOLUTIONS

- Paper Based Scheduling
- Classical Software Solutions
- Manual Intervention Required
- Inefficient Routing
- Wasted Time & Effort

Provider Start [1279 Oak Trails, Columbus, OH] on Oak Trails (South). Turn LEFT (East) onto Cleveland Ave.

Route: V 900	Route Desc: Columbus V 900	Phone: 614-278-3152	Date: 6/20/2017
Driver: John Smith			
Driver Signature: John Smith	Mileage: _____		
Miller, Joseph 1561 Cleveland Ave 614-555-7982	1 - Hot		
	Client Signature Is Needed:		
	1 - Milk, 2 %		
	Time: _____		
Was Meal Delivered? Yes: <input type="checkbox"/> No: <input type="checkbox"/>			
Directions: Depart ProviderStart[1279 Oak Trails, Columbus, OH] on Oak Trails (South). Turn LEFT (East) onto Cleveland Ave.			
Driver Instructions: W OF INDIAN TRAILS, N OF DUBLIN CT. Client slow to door; give them time to come to door.			
Davis, Betty 1944 Frank Dr 614-555-8943	1 - Alternate		
	Client Signature Is Needed:		
	1 - Orange Juice		
	Time: _____		
Was Meal Delivered? Yes: <input type="checkbox"/> No: <input type="checkbox"/>			
Directions: At Cleveland Ave turn LEFT (North) onto Kennedy Lane, turn LEFT (West) onto Blachley Circle, turn GHT (North) onto Frank Dr.			
Driver Instructions: S OF BLACHELEY CIRCLE, E OF STANFORD AVE. Open meal and put the meal on the side table. Client has a small dog.			
Ker, Charlie 3432 Main St -555-9361	1 - Hot		
	Client Signature Is Needed:		
	1 - Milk, 2 %		
	1 - Cold		
	Client Signature Is Needed:		
	1 - Milk, 2 %		
	Time: _____		
Was Meal Delivered? Yes: <input type="checkbox"/> No: <input type="checkbox"/>			
Directions: At Frank Dr turn LEFT (East) onto Denmark Dr, turn LEFT (North) onto Main St.			
Instructions: N OF DENMARK DR, W OF BOSTON BLVD. Call client prior to delivery. Client hard of hearing.			
Remain straight on Main St, turn LEFT (West) onto Cleveland Ave, turn RIGHT (North) onto Oak Trails, ProviderEnd [1279 Oak Trails, Columbus, OH]			
Clients on Hold		Route Summary	
		Totals: Alternate 1	
		Totals: Colds 1	
		Totals: Hot 1	
		Total Meals: 4	
		Milk, 2% 3	
		Orange Juice 1	
		Total Beverages: 4	
Thank you for nourishing the human spirit!			
Please complete your delivery record fully before returning ****			

**Upon completion of your route today, please review your delivery record for completeness.**

Did you remember to...  
 Sign the delivery record on the first page?  
 Record your starting and ending mileage?  
 Check "Yes" or "No" for each delivery?  
 Write each delivery time?  
 Obtain all necessary customer signatures?

Today's Date: \_\_\_\_\_

Monday, Wednesday, Thursday, Saturday, and Sunday  
 Hot and Alternate are the SAME MEALS

Tuesday and Friday  
 Hot and Alternate are DIFFERENT MEALS

For Hot and Alternate meals, give each customer a black tray\*, beverage, and checked item below.

<input type="radio"/> Bread	<input type="radio"/> Bus	<input type="radio"/> Orange
<input type="radio"/> Roll	<input type="radio"/> Biscuit	<input type="radio"/> Banana
<input type="radio"/> English muffin	<input type="radio"/> Apple	<input type="radio"/> Applejuice

\*Look for the orange/red sticker, indicating an Alternate meal.

For Cold meals, give each customer a black tray, beverage, and checked item below.

<input type="radio"/> Apple	<input type="radio"/> Banana	<input type="radio"/> Orange
-----------------------------	------------------------------	------------------------------

Kosher, mechanical, pureed and vegetarian hot meals and cold components will be labeled as such.

Questions, call: 614.278.3152 or 614.437.2891

Thank you for nourishing the human spirit!

Today's Date: \_\_\_\_\_

Monday, Wednesday, Thursday, Saturday, and Sunday  
 Hot and Alternate are the SAME MEALS

Tuesday and Friday  
 Hot and Alternate are DIFFERENT MEALS

For Hot and Alternate meals, give each customer a black tray\*, beverage, and checked item below.

<input type="radio"/> Bread	<input type="radio"/> Bus	<input type="radio"/> Orange
<input type="radio"/> Roll	<input type="radio"/> Biscuit	<input type="radio"/> Banana
<input type="radio"/> English muffin	<input type="radio"/> Apple	<input type="radio"/> Applejuice

\*Look for the orange/red sticker, indicating an Alternate meal.

For Cold meals, give each customer a black tray, beverage, and checked item below.

<input type="radio"/> Apple	<input type="radio"/> Banana	<input type="radio"/> Orange
-----------------------------	------------------------------	------------------------------

Kosher, mechanical, pureed and vegetarian hot meals and cold components will be labeled as such.

Questions, call: 614.278.3152 or 614.437.2891

Thank you for nourishing the human spirit!

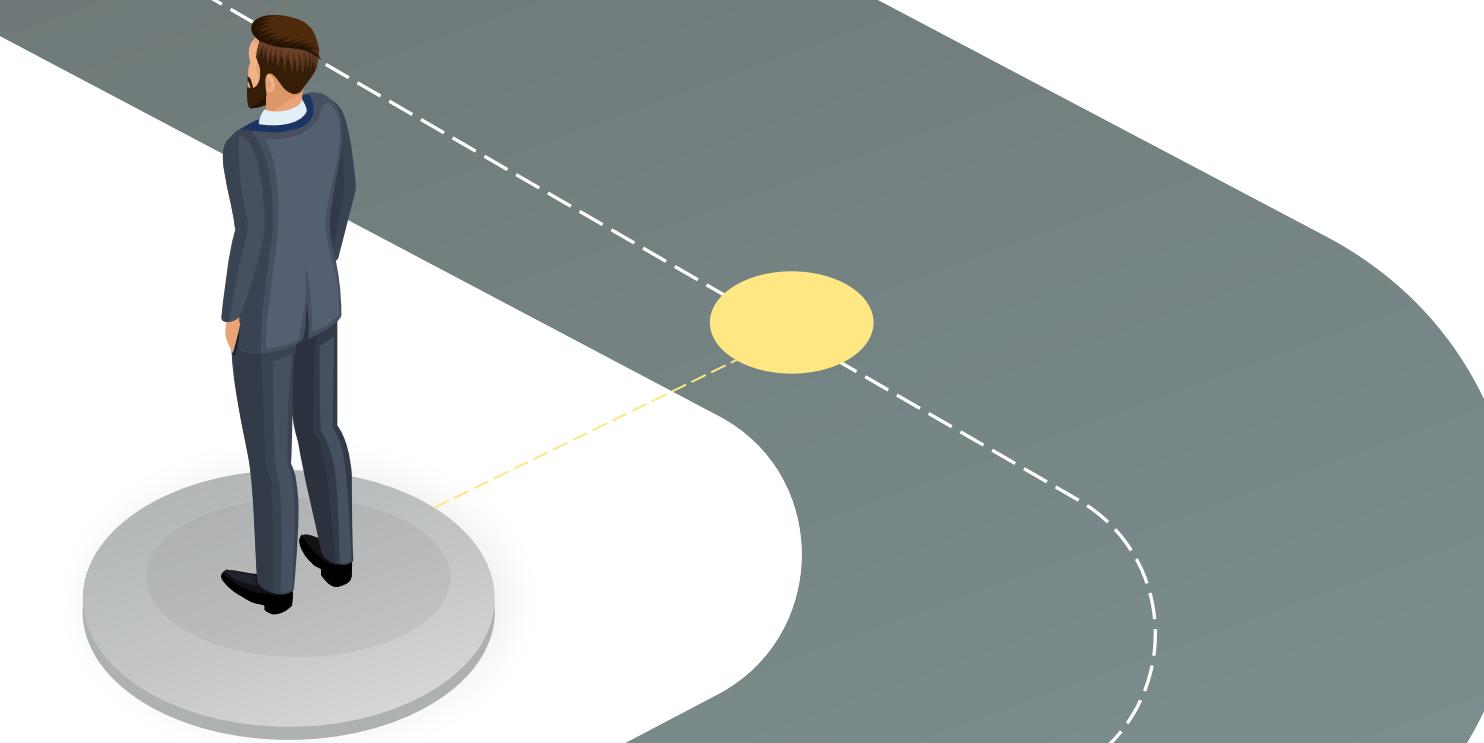
**Upon completion of your route today, please review your delivery record for completeness.**

Did you remember to...  
 Sign the delivery record on the first page?  
 Record your starting and ending mileage?  
 Check "Yes" or "No" for each delivery?  
 Write each delivery time?  
 Obtain all necessary customer signatures?

# PROPOSED SOLUTION



Use Quantum  
Computing



Based on Travelling  
Salesman Problem (TSP)



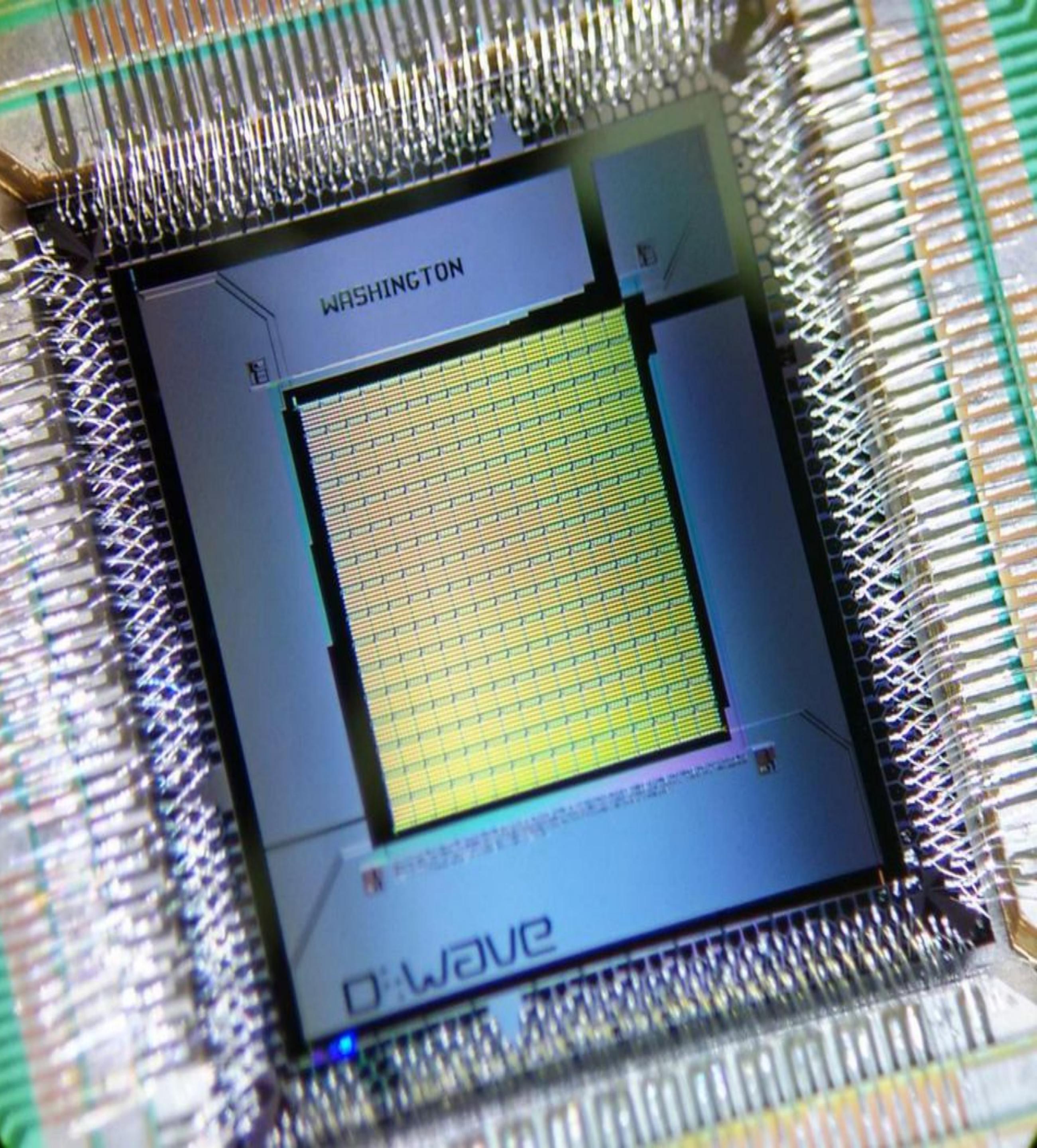
Generate optimized route  
maps based on number of  
volunteers



---

# BUSINESS VALUE

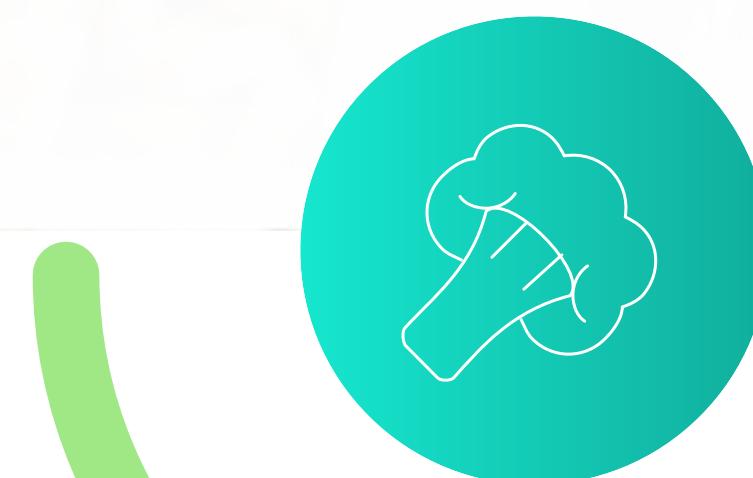
- Food banks and other delivery services
- Warehouse Optimization
- Manufacturing Inventory Management
- Fleet scheduling



# QUANTUM PROCESS OVERVIEW

## INPUT DATA

- LIST OF HOMEBOUND USER ADDRESSES



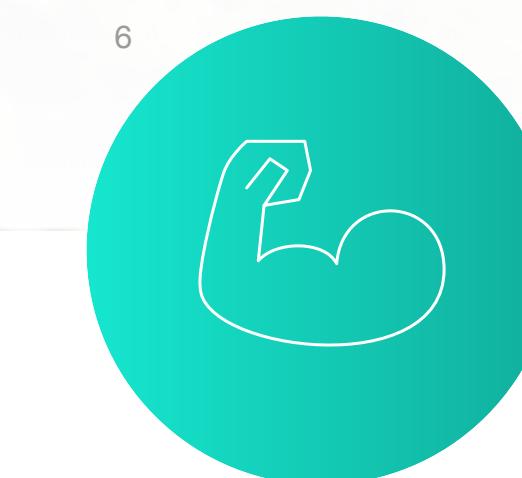
## PRE-PROCESSING

- CALCULATE INTER HOUSE DISTANCES
- CREATE DISTANCE MATRIX



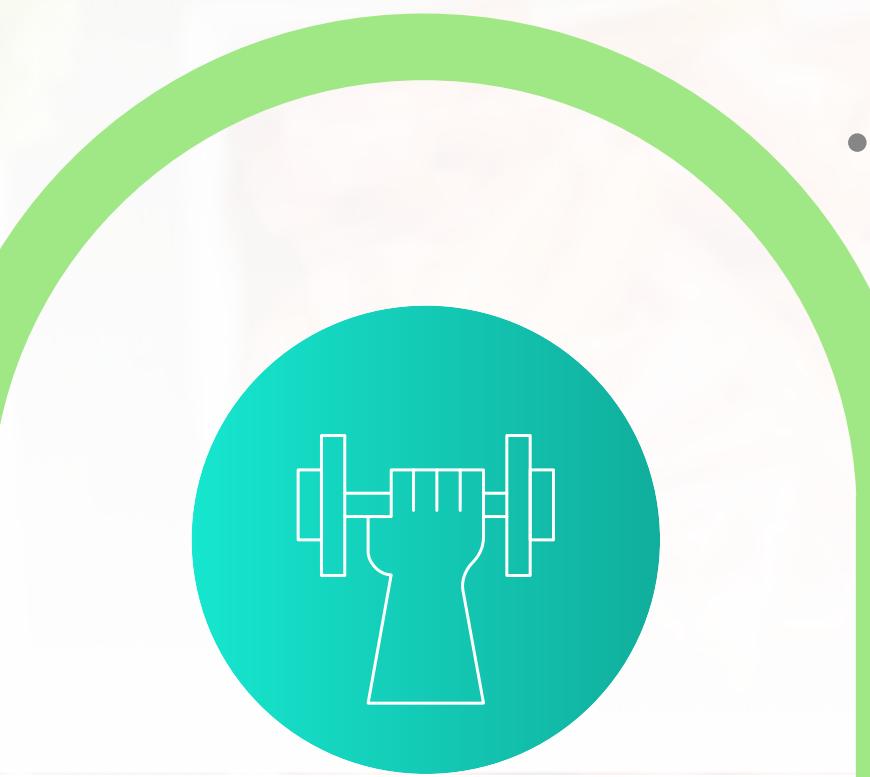
## CONSTRAINT DEFINITION

- APPLY CONSTRAINTS
- PREPARE QUBO



## SOLVE USING DWAVE

- USE LEAP HYBRID SOLVER FOR QUANTUM SOLUTION
- USE QBSOLV FOR CLASSICAL SOLUTION



## GENERATE RESULTS

- MINIMIZE COST AND MILEAGE
- GENERATE SET OF ROUTES FOR EACH VOLUNTEER WITH LEAST ENERGY



THANK YOU

