RouteMax

FINAL PROJECT REPORT

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BUSINESS UNDERSTANDING

Based in Boulder, CO, Rudi's Bakery is a national leader in gluten-free and organic bread products. Rudi's has been committed to delivering the freshest products to its customers through a direct store delivery method for over 40 years. Despite their dedication and hard work, the bakery faces challenges with their current delivery routing system, which has not been updated or optimized for decades. This traditional approach to delivery routes has led to increased delivery times, excessive labor work, and inefficiencies in the delivery process.

The company operates 14 direct store delivery (DSD) routes in Colorado, delivering products directly to more than 300 stores in the greater Denver/Boulder area. The challenge for the company is developing an optimal route for each direct store delivery route to increase its service point for stores and minimize fuel and labor costs.

PROBLEM, IMPACT AND OBJECTIVES

A. PROBLEM STATEMENT

At present, Rudi's bakery is focused on the two routes that start from the Colorado Springs bakery location. On these two routes, it services 50 store locations in a combination of the five trips made throughout the week on Mondays, Tuesdays, Thursdays, Fridays, and Sundays. The current routing system needs to consider the most efficient paths between delivery points, resulting in longer delivery times and increased labor costs. This inefficiency not only strains the bakery's resources but also limits its ability to increase the number of deliveries to customers. Consequently, this situation hampers the bakery's potential to boost sales and improve customer satisfaction by ensuring the timely delivery of its products.

The current routing system does not take into consideration the most efficient paths between delivery points, resulting in longer delivery times and increased labor costs. This inefficiency not only strains the bakery's resources but also limits its ability to increase the number of deliveries to customers. Consequently, this situation hampers the bakery's potential to boost sales and improve customer satisfaction by ensuring the timely delivery of its products.

The project aims to structure and optimize the routes most effectively to increase the days of service to the stores and thereby increase sales. Certain constraints need to be considered when optimizing the routes, the most crucial being that Costco needs to be serviced daily, and the other stores need to be serviced a minimum of three times per week.

B. BUSINESS IMPACT

The Route Optimization Project presents a multifaceted opportunity for Rudi's business, promising substantial operational and financial benefits through the optimization of current and future DSD routes and a profound enhancement in our team's professional competencies. Beyond learning to construct the most efficient routes, team members will delve deeply into advanced data analysis, gaining the ability to decipher complex datasets and transform them into actionable business strategies. This project also serves as a platform for refining presentation skills, ensuring that insights and data are communicated effectively and compellingly to stakeholders. Perhaps most importantly, it offers hands-on experience with agile project management methodologies, fostering an environment that values adaptability, continuous improvement, and cross-functional collaboration. In essence, the Route Optimization Project is not just an investment in the logistical backbone of Rudi's business but a strategic commitment to cultivating a more skilled, agile, and data-savvy workforce ready to navigate the complexities of modern business landscapes.

C. OVERARCHING OBJECTIVES

The project aims to address these challenges by developing an optimized delivery routing system for Rudi Bakery. The objectives include:

1. First and foremost, objective is to carry out a literature survey to identify the most suitable models to solve the issue at hand.
2. Evaluate, clean, and modify the data provided so that it can be utilized in the model.
3. Create the model to optimize the delivery routes and test the model to provide consistent results.
4. Optimize and implement a new routing system that establish the most efficient paths between delivery points, reducing travel distance and time.
5. Increase the number of deliveries in an efficient manner such that it increases revenue.

LITERATURE SURVEY

A. LITERATURE SURVEY

With the main objective of optimizing the delivery routes for Rudi's direct store delivery (DSD) numerous academic journals, articles, books, conference papers, and reports were reviewed to understand theories and problems related to route optimization, tracing back to Dantzig and Ramser's seminal 1959 work. Over time, VRP research has expanded to tackle more complex issues, using algorithms like Greedy and Genetic Algorithms, and incorporating machine learning for applications in drone delivery and autonomous vehicles. In exploring route optimization solutions, we were inspired by practical applications like Amazon's last-mile delivery optimization, which exemplifies how advanced routing strategies significantly improve delivery efficiency. Efforts in route optimization have increasingly incorporated Markov Model Optimization for uncertainty management and Excel's Problem Solver for preliminary route planning. The integration of Machine Learning (ML) and Artificial Intelligence (AI) has further revolutionized VRP solutions, offering dynamic, adaptive strategies that traditional methods cannot match.

Given the complexity of our optimization challenges and the need for a sophisticated, scalable solution, we chose Gurobi as our optimization software. Gurobi's proven efficiency and flexibility in handling linear and integer optimization, combined with its capacity to integrate ML and AI techniques, made it the ideal choice for our project. This decision was grounded in a thorough review of current technologies and methodologies, aiming to leverage the most advanced tools in route optimization.

B. GUROBI

Gurobi is a premier optimization software capable of solving a wide range of mathematical problems, including linear and mixed-integer programming. Its Python integration facilitates easy problem modeling and solution finding. Gurobi excels in route optimization due to its advanced algorithms and high-speed computations, making it highly effective for tasks requiring the minimization of travel times or distances under complex constraints. Its efficiency in generating optimal solutions quickly makes it a top choice for industries focused on logistics and transportation, ensuring cost savings and improved operational performance.

DATA AND MODELING

A. DATA EVALUATION AND CLEANING

In the data cleaning process, we first examined the coherence of the geographical coordinates of each store listed across the two datasets. We realized some discrepancies existed between the locations listed in the Sales data sheet and the Route data sheet. This problem was then consulted and verified with clients in the following stand-up meeting. After the initial validation, we cleaned the Route dataset for use in Google API. A new column for zip code was added, and we manually added zip code for each address. After the addresses were corrected and verified, we utilized the Google API to construct a matrix detailing the travel times between each designated stop. This matrix served as a backbone for Gurobi modeling in the next step when we created a model for delivery routes. Once the matrix dataset was established, unique identifiers were assigned to each store address within the dataset. This step was to enable a more efficient data manipulation and analysis process, eliminating potential ambiguities and redundancies.

Upon visually examining the data on a map, we noticed the Castle Rock and Pueblo stops could be merged into a cluster. This was due to their distance from the depot and clear entry and exit points for the clusters. We calculated the time it takes to complete the cluster and added it to the travel time of the stop designated as the entry point so that if that stop was visited, then each stop in the cluster was also visited. This reduced the load on the model as it enabled us to remove (combine) 14 data points with minimal impact on accuracy.

Considering the complexities of the model and producing a cleaner final product, we decided to visually cluster all the data to assign which route the stops would be on. This started with three clusters where stops were assigned to the North or South routes or left as ‘unassigned’. Once the new clusters were run through the model, we started to assign the stops from the unassigned population to either North or South until the model achieved a balance between the delivery times of the two routes. Then, finally, we added an unloading time of 15 minutes to all the data points in the matrix as it was a constant and would further reduce complexities in the model. The new clustered matrix was then loaded into the Gurobi model to determine the optimal routes under our constraints.

B. DUMMY DATA CREATION

The primary purpose of employing a dummy dataset in our analysis was to facilitate a streamlined and efficient testing environment for evaluating our model's performance. This strategic approach enabled us to work with a reduced dataset, mirroring a subset of the original time matrix sourced from the Google API. This ensured manageability and focus in our testing processes. The selection criteria for the dummy data were meticulously designed to challenge the model by necessitating

the choice of two distinct routes, deliberately constructing a scenario in which completing the schedule within the given constraints using a single route was unfeasible. The dummy data set consisted of store lists where the time taken to traverse between them was longer, thus ensuring that all the stores could not be visited within the 9-hour constraint, and neither could all the stores be allotted to one route.

C. MODEL OBJECTIVE

The main objective we were trying to achieve when we started the route model optimization was to maximize the service days while fulfilling the constraints. Weekly meetings with the client led to changes in the model formulation. Ultimately, we adopted a minimized time objective to minimize drive time each day while satisfying the constraints.

D. CONSTRAINTS

The route optimization objective for Rudi's Colorado Springs two routes came with a fixed set of constraints that had to be met for the final model to be feasible. The constraints are mentioned below:

1. It is mandatory to service Costco every day (five days in a week).
2. All the other stores must be serviced a minimum of three times per week.
3. Once a store had been assigned to a route, it was fixed.
4. Origin and endpoint were the same, which is the Rudi's depot.
5. Three consecutive days delivery for non-Costco stores has to be avoided.
6. Maintain a 9-hour shift for every route, that includes the 15 minutes service time for every shop.

During our meetings with the client, it was concluded that constraints 1 and 2 have to be prioritized above all the others throughout the project lifecycle.

E. MODEL EVOLUTION

1. Version 1

We commenced modeling with the objective of maximizing weekly delivery frequencies, starting with time data for all the stores to shape and refine our model. This initial phase aimed to pinpoint the most efficient routes over five working days, utilizing two designated routes originating from a specific point. However, we transitioned to a more manageable dummy dataset to enhance the model's performance and simplify the testing phase. We

employed an optimization solver, Gurobi, to explore various routing scenarios and get the optimized sequence of deliveries.

Despite these efforts, our initial approach of applying all constraints, even with the simplified dataset, led to a deadlock: the model consistently produced infeasible solutions, failing to find an optimized path. To address this, we prioritized our constraints, scrutinizing the feasibility of mandatory visits to Costco five times a week and other stores at least thrice, all within a nine-hour shift. By temporarily sidelining the three-times-a-week visit constraint for stores other than Costco, we sought to identify if this specific requirement was the bottleneck.

This adjustment bore fruit, leading us to a solution. However, we were still far away from the optimized solution for the problem at hand as we could not get the correct sequence of stores on both the routes and we needed to reincorporate the thrice-weekly visit constraint for non-Costco stores.

2. Version 2

During our discussions with the client, it became evident that solving the delivery scheduling problem within a 9-hour shift may be infeasible. This realization prompted us to rethink our strategy comprehensively. We retained the requirement for non-Costco stores to be visited thrice weekly but extended the shift constraint from 9 to 24 hours for both routes. This adjustment aimed to gauge the maximum duration a route would require. Surprisingly, with the dummy data, routes were completed in approximately 12 hours each day, albeit with delivery sequences that needed correction. The challenge lay in the sequential arrangement of store visits, prompting us to test our model with the actual dataset.

When applied to actual data, the model struggled to identify an optimal route efficiently, taking extensive time to converge. Debugging revealed the enormity of the task: optimizing from an astronomical 52 factorial (52!) possibilities. Further complicating our efforts, new client insights necessitated a shift in objectives towards minimizing delivery times. Despite this new goal, the model's convergence remained painstakingly slow, leading us to a pivotal decision to change our approach radically. Rather than letting the model sift through 52! data points to find an optimized route, we opted for a strategy overhaul, seeking a more practical solution to streamline delivery times efficiently.

3. Version 3

This version of the model represents an advanced step in the project, focusing on optimizing Rudi's Bakery delivery schedules by significantly reducing the complexity faced with the initial 52 factorial data points challenge. By analyzing the proximity of stores to each other, the team cleverly collected several delivery points into two clusters, simplifying the route optimization process. These represented stops (in Castle Rock and in Pueblo) are estimated to be completed on the same day. Each cluster was assigned a specific route, with an entry point defined for easier access. The optimized route within each cluster was precalculated using the same algorithm, a strategy that substantially lowers the model's complexity. Further, we visually examined the points and assigned them to either a North or South route, further reducing the complexities of the model.

The model aims to minimize total travel time, incorporating constraints like ensuring non-Costco stores are visited at least three times a week and that Costco is serviced five times a week. Additional constraints provide balanced route assignments and proper sequencing of stops to maintain a logical flow from origins to destinations, including a unique approach to managing cumulative travel time within daily limits.

Significantly, this approach also addresses operational realities by preventing any store from being visited for three consecutive days, aligning with workforce management and logistical efficiency. Parameters set within the model, such as the MIP gap, further refine the search for an optimal solution tailored to fit within practical time and solution constraints. This innovative clustering method streamlines the optimization process and offers a scalable solution to efficiently manage delivery routes, thereby demonstrating a thoughtful and strategic approach to overcoming logistical hurdles. The final model incorporates sales data and ensures the top performers are visited a minimum of 4 days a week.

F. RESULT

In the optimized model, every route begins and concludes at the depot, ensuring that each day's delivery cycle is neatly rounded off at its starting point. The accompanying table details the duration of daily routes carved out by our model, showcasing the efficiency achieved through optimization. Notably, our time data between any two points is averaged across 24 hours for the entire week, rendering the specific sequence of days irrelevant to the model's operation. This approach liberates the model from being tethered to the constraints of a particular weekday, allowing for a fluid and adaptable scheduling framework.

Table 1: Duration of each day for both the routes (see Appendix 1 for detailed optimized route)

	Route 1 (minutes)	Route 2 (minutes)
Day 1	445	512
Day 2	286	234
Day 3	484	537
Day 4	445	468
Day 5	545	555

G. COST

For this project, we managed to keep the tooling costs at an impressive zero. We leveraged a student license for Gurobi, a robust optimization software, which is generously valid for one year, providing us with powerful computational capabilities at no expense. Furthermore, our product management and sprint planning were efficiently handled using Google Sheets, a versatile and cost-effective solution for real-time collaboration and organization. Additionally, the project timeline was meticulously charted using Gantt charts, a tool that is also available for free. These strategic choices in tool selection ensured fiscal prudence and allowed us to access high-quality resources without impacting the project budget.

H. KPI

Key Performance Indicators (KPIs) are vital in project management as they provide a quantifiable measure of progress toward achieving specific goals. They enable teams to assess efficiency, monitor performance, and identify areas for improvement. For instance, monitoring the percentage of delivery days that take less than 9 hours per day helps ensure that operations are running efficiently and within a manageable timeframe, enhancing productivity and reducing overtime costs. Following are the KPIs considered to assess the performance of the model:

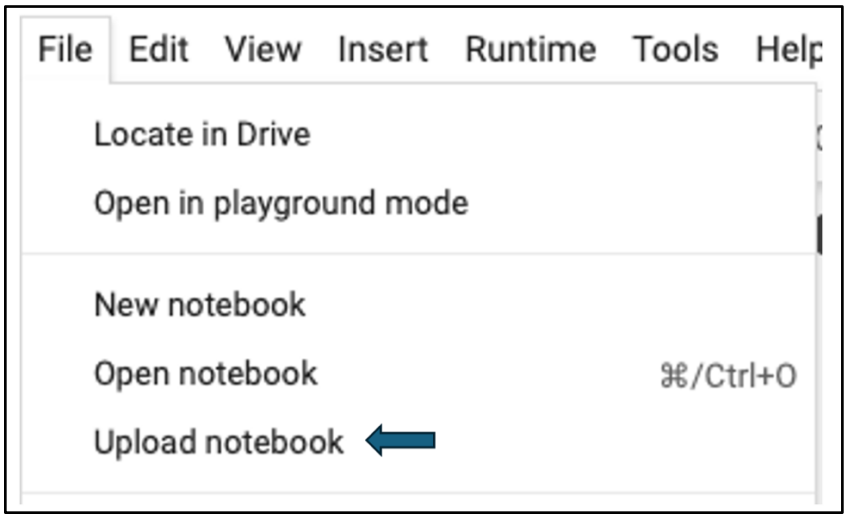
Table 2: Achieved KPIs

KPI Description	Formula	KPI characteristic	Achieved
The percentage of delivery days that takes less than 9hrs/day	$\frac{(\text{No. of days taking} > 9\text{hrs})}{\text{Total number of days}}$	The lower the better	20%
Maximum overshoot on 9-hour delivery constraint	$\frac{(Max.delivery\ time\ - 540)}{540}$	The lower the better	2.7%
The percentage of number of service days for Costco over a week (5 times per week)	$\frac{(\text{No. of service days achieved })}{\text{Total of serving days planned}}$	The higher the better	100%
The percentage of number of non-costco stores that are served greater or equal than 3 times/week	$\frac{(\text{No. of service days achieved })}{\text{Total of serving days planned}}$	The higher the better	133.33%
The percentage of stores that are served 3 times in a row in a week	$\frac{(\text{No. of stores serviced 3 times in a row })}{\text{Total of stores}}$	The lower the better	0%

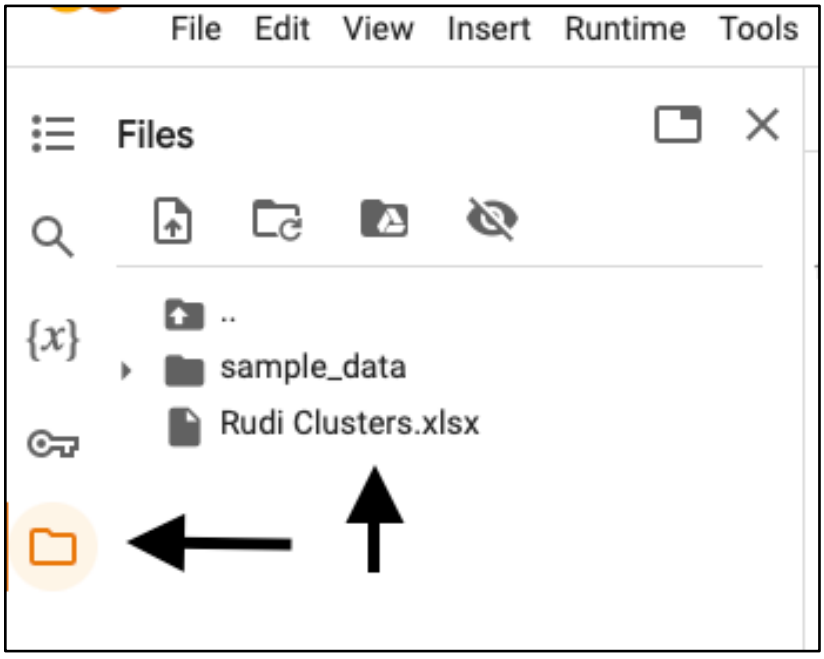
The percentage of day that Start and End at the same spot (Depot)	$\frac{(\text{No. of days with start and end at depot})}{\text{Total of days}}$	The higher the better	100%
Maximum deviation between the actual and achieved delivery time wrt achieved delivery time.	$\frac{(Actual\ Delivery\ time\ - Achieved)}{Achieved}$		12%

GUIDE TO USE THE MODEL.

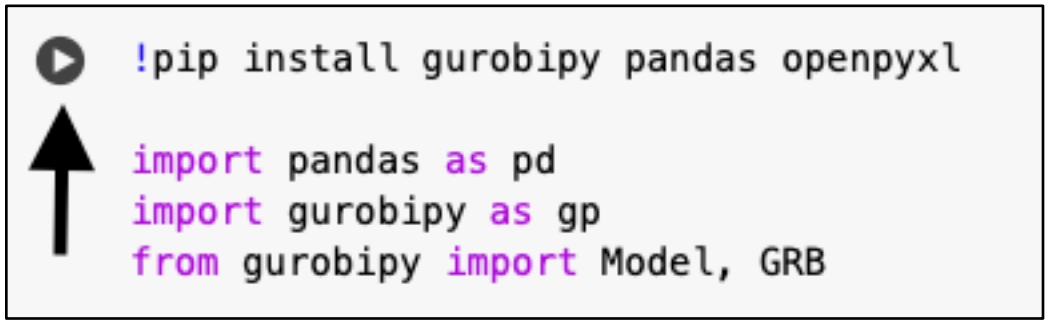
1. Open google's Colab by using the link: "https://colab.research.google.com/".
2. Go to file and upload the ".ipynb" file to Colab.



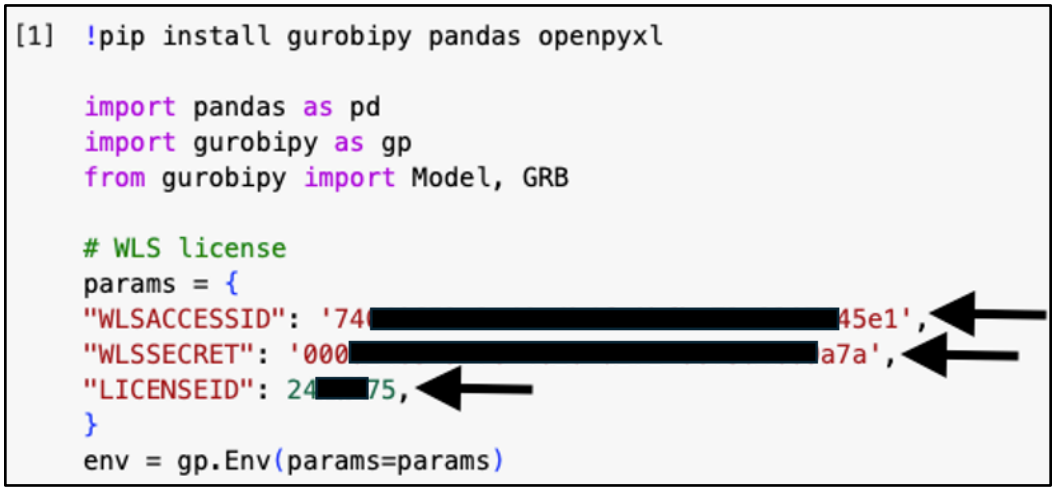
3. Upload the excel data file into Colab by clicking the "folder icon" on the left pane and dragging and dropping the file into the pane.



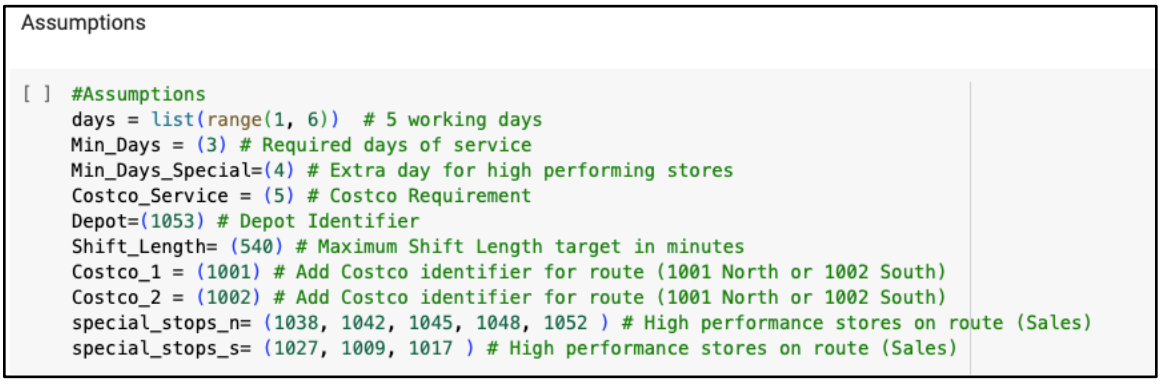
4. Run the code step by step. You can run the code by using “run” button as shown below. Do not run a code block before the previous code block is finished running.



5. Buy Gurobi license from the website: https://www.gurobi.com/. Once you have bought the license, replace the license numbers as shown below in the Colab notebook and run this code block. Keep the formatting same as shown below.



6. If you want to change the conditions for the model, you can go to “Assumptions” in the code and change those assumptions to make the model run on new information.



7. Run the remaining code blocks to get the desired output.

APPENDIX 1: DETAILED ROUTING SOLUTION

A. ROUTE 1

Note: The yellow highlight represents Castle Rock cluster

Table 3: Day 1; Duration: 445 mins

From	Address	To	Address
1053	Depot	1001	5050 N Nevada Ave, CO 80918
1001	5050 N Nevada Ave, CO 80918	1041	1730 Dublin Blvd, CO 80918
1041	1730 Dublin Blvd, CO 80918	1031	6930 N. Academy, CO 80918
1031	6930 N. Academy, CO 80918	1052	7635 N. Academy Blvd, CO 80920
1052	7635 N. Academy Blvd, CO 80920	1048	7298 N. Academy Blvd, CO 80920
1048	7298 N. Academy Blvd, CO 80920	1044	8250 Razorback Rd, CO 80920
1044	8250 Razorback Rd, CO 80920	1042	13415 Voyager Pkwy, CO 80921
1042	13415 Voyager Pkwy, CO 80921	1038	880 S. Perry, CO 80104
1038	880 S. Perry, CO 80104	1035	5544 Promeade Pkwy, CO 80108
1035	5544 Promeade Pkwy, CO 80108	1051	6384 Promenade Pkwy, CO 80108
1051	6384 Promenade Pkwy, CO 80108	1040	5950 Allen Way, CO 80108
1040	5950 Allen Way, CO 80108	1050	4510 Trail Boss Dr, CO 80104
1050	4510 Trail Boss Dr, CO 80104	1043	4400 Front St, Castle Rock, CO 80104
1043	4400 Front St, Castle Rock, CO 80104	1036	750 N. Ridge Rd, CO 80104
1036	750 N. Ridge Rd, CO 80104	1037	624 Highway 105, CO 80132
1037	624 Highway 105, CO 80132	1045	16218 Jackson Creek Pkwy, CO 80132
1045	16218 Jackson Creek Pkwy, CO 80132	1049	1216 West Baptist Rd, CO 80132
1049	1216 West Baptist Rd, CO 80132	1033	1070 West Baptist Rd, CO 80921
1033	1070 West Baptist Rd, CO 80921	1053	Depot

Table 4: Day 2; Duration: 286 mins

From	Address	To	Address
1053	Depot	1039	840 Village Center Dr, CO 80919
1039	840 Village Center Dr, CO 80919	1032	3570 Hartsel Dr, CO 80920
1032	3570 Hartsel Dr, CO 80920	1030	7055 Austin Bluffs Pkwy, CO 80923
1030	7055 Austin Bluffs Pkwy, CO 80923	1046	5550 E. Woodmen Rd, CO 80920
1046	5550 E. Woodmen Rd, CO 80920	1047	9670 Prominet Point, CO 80924
1047	9670 Prominet Point, CO 80924	1034	9225 N. Union Blvd, CO 80920
1034	9225 N. Union Blvd, CO 80920	1029	8750 N. Union, CO 80920
1029	8750 N. Union, CO 80920	1044	8250 Razorback Rd, CO 80920
1044	8250 Razorback Rd, CO 80920	1052	7635 N. Academy Blvd, CO 80920
1052	7635 N. Academy Blvd, CO 80920	1048	7298 N. Academy Blvd, CO 80920
1048	7298 N. Academy Blvd, CO 80920	1041	1730 Dublin Blvd, CO 80918
1041	1730 Dublin Blvd, CO 80918	1001	5050 N Nevada Ave, CO 80918
1001	5050 N Nevada Ave, CO 80918	1053	Depot

Table 5: Day 3; Duration: 484 mins

From	Address	To	Address
1053	Depot	1039	840 Village Center Dr, CO 80919
1039	840 Village Center Dr, CO 80919	1032	3570 Hartsel Dr, CO 80920
1032	3570 Hartsel Dr, CO 80920	1030	7055 Austin Bluffs Pkwy, CO 80923
1030	7055 Austin Bluffs Pkwy, CO 80923	1046	5550 E. Woodmen Rd, CO 80920
1046	5550 E. Woodmen Rd, CO 80920	1034	9225 N. Union Blvd, CO 80920
1034	9225 N. Union Blvd, CO 80920	1029	8750 N. Union, CO 80920
1029	8750 N. Union, CO 80920	1047	9670 Prominet Point, CO 80924

1047	9670 Prominet Point, CO 80924	1042	13415 Voyager Pkwy, CO 80921
1042	13415 Voyager Pkwy, CO 80921	1049	1216 West Baptist Rd, CO 80132
1049	1216 West Baptist Rd, CO 80132	1045	16218 Jackson Creek Pkwy, CO 80132
1045	16218 Jackson Creek Pkwy, CO 80132	1038	880 S. Perry, CO 80104
1038	880 S. Perry, CO 80104	1035	5544 Promeade Pkwy, CO 80108
1035	5544 Promeade Pkwy, CO 80108	1051	6384 Promenade Pkwy, CO 80108
1051	6384 Promenade Pkwy, CO 80108	1040	5950 Allen Way, CO 80108
1040	5950 Allen Way, CO 80108	1050	4510 Trail Boss Dr, CO 80104
1050	4510 Trail Boss Dr, CO 80104	1043	4400 Front St, Castle Rock, CO 80104
1043	4400 Front St, Castle Rock, CO 80104	1036	750 N. Ridge Rd, CO 80104
1036	750 N. Ridge Rd, CO 80104	1001	5050 N Nevada Ave, CO 80918
1001	5050 N Nevada Ave, CO 80918	1053	Depot

Table 6: Day 4; Duration: 445 mins

From	Address	To	Address
1053	Depot	1001	5050 N Nevada Ave, CO 80918
1001	5050 N Nevada Ave, CO 80918	1041	1730 Dublin Blvd, CO 80918
1041	1730 Dublin Blvd, CO 80918	1031	6930 N. Academy, CO 80918
1031	6930 N. Academy, CO 80918	1052	7635 N. Academy Blvd, CO 80920
1052	7635 N. Academy Blvd, CO 80920	1048	7298 N. Academy Blvd, CO 80920
1048	7298 N. Academy Blvd, CO 80920	1044	8250 Razorback Rd, CO 80920
1044	8250 Razorback Rd, CO 80920	1042	13415 Voyager Pkwy, CO 80921
1042	13415 Voyager Pkwy, CO 80921	1038	880 S. Perry, CO 80104
1038	880 S. Perry, CO 80104	1035	5544 Promeade Pkwy, CO 80108
1035	5544 Promeade Pkwy, CO 80108	1051	6384 Promenade Pkwy, CO 80108
1051	6384 Promenade Pkwy, CO 80108	1040	5950 Allen Way, CO 80108

1040	5950 Allen Way, CO 80108	1050	4510 Trail Boss Dr, CO 80104
1050	4510 Trail Boss Dr, CO 80104	1043	4400 Front St, Castle Rock, CO 80104
1043	4400 Front St, Castle Rock, CO 80104	1036	750 N. Ridge Rd, CO 80104
1036	750 N. Ridge Rd, CO 80104	1037	624 Highway 105, CO 80132
1037	624 Highway 105, CO 80132	1045	16218 Jackson Creek Pkwy, CO 80132
1045	16218 Jackson Creek Pkwy, CO 80132	1049	1216 West Baptist Rd, CO 80132
1049	1216 West Baptist Rd, CO 80132	1033	1070 West Baptist Rd, CO 80921
1033	1070 West Baptist Rd, CO 80921	1053	Depot

Table 7: Day 5; Duration: 545 mins

From	Address	To	Address
1053	Depot	1001	5050 N Nevada Ave, CO 80918
1001	5050 N Nevada Ave, CO 80918	1039	840 Village Center Dr, CO 80919
1039	840 Village Center Dr, CO 80919	1031	6930 N. Academy, CO 80918
1031	6930 N. Academy, CO 80918	1048	7298 N. Academy Blvd, CO 80920
1048	7298 N. Academy Blvd, CO 80920	1052	7635 N. Academy Blvd, CO 80920
1052	7635 N. Academy Blvd, CO 80920	1032	3570 Hartsel Dr, CO 80920
1032	3570 Hartsel Dr, CO 80920	1030	7055 Austin Bluffs Pkwy, CO 80923
1030	7055 Austin Bluffs Pkwy, CO 80923	1046	5550 E. Woodmen Rd, CO 80920
1046	5550 E. Woodmen Rd, CO 80920	1034	9225 N. Union Blvd, CO 80920
1034	9225 N. Union Blvd, CO 80920	1029	8750 N. Union, CO 80920
1029	8750 N. Union, CO 80920	1047	9670 Prominet Point, CO 80924
1047	9670 Prominet Point, CO 80924	1042	13415 Voyager Pkwy, CO 80921
1042	13415 Voyager Pkwy, CO 80921	1038	880 S. Perry, CO 80104
1038	880 S. Perry, CO 80104	1035	5544 Promeade Pkwy, CO 80108
1035	5544 Promeade Pkwy, CO 80108	1051	6384 Promenade Pkwy, CO 80108

1051	6384 Promenade Pkwy, CO 80108	1040	5950 Allen Way, CO 80108
1040	5950 Allen Way, CO 80108	1050	4510 Trail Boss Dr, CO 80104
1050	4510 Trail Boss Dr, CO 80104	1043	4400 Front St, Castle Rock, CO 80104
1043	4400 Front St, Castle Rock, CO 80104	1036	750 N. Ridge Rd, CO 80104
1036	750 N. Ridge Rd, CO 80104	1037	624 Highway 105, CO 80132
1037	624 Highway 105, CO 80132	1045	16218 Jackson Creek Pkwy, CO 80132
1045	16218 Jackson Creek Pkwy, CO 80132	1033	1070 West Baptist Rd, CO 80921
1033	1070 West Baptist Rd, CO 80921	1053	Depot

B. ROUTE 2

Note: The orange highlight represents Castle Rock cluster

Table 8: Day 1; Duration: 512 mins

From	Address	To	Address
1053	Depot	1009	3250 Centennial Blvd, CO 80907
1009	3250 Centennial Blvd, CO 80907	1019	707 S 8th St, CO 80905
1019	707 S 8th St, CO 80905	1006	815 Cheyenne Rd, CO 80906
1006	815 Cheyenne Rd, CO 80906	1016	1920 S Nevada Ave, CO 80906
1016	1920 S Nevada Ave, CO 80906	1023	1604 S Nevada Ave, CO 80905
1023	1604 S Nevada Ave, CO 80905	1018	1720 S Nevada Ave, CO 80905
1018	1720 S Nevada Ave, CO 80905	1020	4425 Venetucci Blvd, CO 80906
1020	4425 Venetucci Blvd, CO 80906	1015	6925 Mesa Ridge Pkwy, Fountain, CO 80817
1015	6925 Mesa Ridge Pkwy, Fountain, CO 80817	1027	1601 US-50, CO 81008
1027	1601 US-50, CO 81008	1004	3050 West St, Pueblo, CO 81003
1004	3050 West St, Pueblo, CO 81003	1005	102 W 29th St, Pueblo, CO 81008
1005	102 W 29th St, Pueblo, CO 81008	1022	101 W 29th St, Pueblo, CO 81008
1022	101 W 29th St, Pueblo, CO 81008	1025	1231 S. Prairie Ave, CO 81005
1025	1231 S. Prairie Ave, CO 81005	1028	4080 W. Northern Ave, CO 81005
1028	4080 W. Northern Ave, CO 81005	1026	1017 N. Market Pl, CO 81007
1026	1017 N. Market Pl, CO 81007	1007	6030 Stetson Hills Blvd, CO
1007	6030 Stetson Hills Blvd, CO	1002	5885 Barnes Rd, CO
1002	5885 Barnes Rd, CO	1017	5617 Barnes Rd, CO
1017	5617 Barnes Rd, CO	1008	3620 Austin Bluffs Pkwy, CO 80918
1008	3620 Austin Bluffs Pkwy, CO 80918	1013	1121 N Circle Dr, CO 80909
1013	1121 N Circle Dr, CO 80909	1011	2210 N Wahsatcg Ave, CO 80907
1011	2210 N Wahsatcg Ave, CO 80907	1053	Depot

Table 8: Day 2; Duration: 234 mins

From	Address	To	Address
1053	Depot	1011	2210 N Wahsatcg Ave, CO 80907
1011	2210 N Wahsatcg Ave, CO 80907	1003	1750 W Uintah St, CO 80904
1003	1750 W Uintah St, CO 80904	1012	3275 W Colorado Ave, CO 80904
1012	3275 W Colorado Ave, CO 80904	1002	5885 Barnes Rd, CO
1002	5885 Barnes Rd, CO	1021	3810 Bloomington St, CO
1021	3810 Bloomington St, CO	1007	6030 Stetson Hills Blvd, CO
1007	6030 Stetson Hills Blvd, CO	1014	2890 N Powers Blvd, Colorado Springs, CO
1014	2890 N Powers Blvd, Colorado Springs, CO	1013	1121 N Circle Dr, CO 80909
1013	1121 N Circle Dr, CO 80909	1053	Depot

Table 8: Day 3; Duration: 537 mins

From	Address	To	Address
1053	Depot	1009	3250 Centennial Blvd, CO 80907
1009	3250 Centennial Blvd, CO 80907	1012	3275 W Colorado Ave, CO 80904
1012	3275 W Colorado Ave, CO 80904	1003	1750 W Uintah St, CO 80904
1003	1750 W Uintah St, CO 80904	1019	707 S 8th St, CO 80905
1019	707 S 8th St, CO 80905	1006	815 Cheyenne Rd, CO 80906
1006	815 Cheyenne Rd, CO 80906	1016	1920 S Nevada Ave, CO 80906
1016	1920 S Nevada Ave, CO 80906	1018	1720 S Nevada Ave, CO 80905
1018	1720 S Nevada Ave, CO 80905	1023	1604 S Nevada Ave, CO 80905
1023	1604 S Nevada Ave, CO 80905	1015	6925 Mesa Ridge Pkwy, Fountain, CO 80817
1015	6925 Mesa Ridge Pkwy, Fountain, CO 80817	1027	1601 US-50, CO 81008

1027	1601 US-50, CO 81008	1004	3050 West St, Pueblo, CO 81003
1004	3050 West St, Pueblo, CO 81003	1005	102 W 29th St, Pueblo, CO 81008
1005	102 W 29th St, Pueblo, CO 81008	1022	101 W 29th St, Pueblo, CO 81008
1022	101 W 29th St, Pueblo, CO 81008	1025	1231 S. Prairie Ave, CO 81005
1025	1231 S. Prairie Ave, CO 81005	1028	4080 W. Northern Ave, CO 81005
1028	4080 W. Northern Ave, CO 81005	1026	1017 N. Market Pl, CO 81007
1026	1017 N. Market Pl, CO 81007	1024	7530 Falcon Market Pl, CO
1024	7530 Falcon Market Pl, CO	1010	7915 Constitution Ave, CO
1010	7915 Constitution Ave, CO	1021	3810 Bloomington St, CO
1021	3810 Bloomington St, CO	1002	5885 Barnes Rd, CO
1002	5885 Barnes Rd, CO	1017	5617 Barnes Rd, CO
1017	5617 Barnes Rd, CO	1008	3620 Austin Bluffs Pkwy, CO 80918
1008	3620 Austin Bluffs Pkwy, CO 80918	1053	Depot

Table 8: Day 4; Duration: 468 mins

From	Address	To	Address
1053	Depot	1009	3250 Centennial Blvd, CO 80907
1009	3250 Centennial Blvd, CO 80907	1020	4425 Venetucci Blvd, CO 80906
1020	4425 Venetucci Blvd, CO 80906	1015	6925 Mesa Ridge Pkwy, Fountain, CO 80817
1015	6925 Mesa Ridge Pkwy, Fountain, CO 80817	1027	1601 US-50, CO 81008
1027	1601 US-50, CO 81008	1004	3050 West St, Pueblo, CO 81003
1004	3050 West St, Pueblo, CO 81003	1005	102 W 29th St, Pueblo, CO 81008
1005	102 W 29th St, Pueblo, CO 81008	1022	101 W 29th St, Pueblo, CO 81008
1022	101 W 29th St, Pueblo, CO 81008	1025	1231 S. Prairie Ave, CO 81005
1025	1231 S. Prairie Ave, CO 81005	1028	4080 W. Northern Ave, CO 81005
1028	4080 W. Northern Ave, CO 81005	1026	1017 N. Market Pl, CO 81007

1026	1017 N. Market Pl, CO 81007	1024	7530 Falcon Market Pl, CO
1024	7530 Falcon Market Pl, CO	1010	7915 Constitution Ave, CO
1010	7915 Constitution Ave, CO	1002	5885 Barnes Rd, CO
1002	5885 Barnes Rd, CO	1007	6030 Stetson Hills Blvd, CO
1007	6030 Stetson Hills Blvd, CO	1017	5617 Barnes Rd, CO
1017	5617 Barnes Rd, CO	1014	2890 N Powers Blvd, Colorado Springs, CO
1014	2890 N Powers Blvd, Colorado Springs, CO	1013	1121 N Circle Dr, CO 80909
1013	1121 N Circle Dr, CO 80909	1011	2210 N Wahsatcg Ave, CO 80907
1011	2210 N Wahsatcg Ave, CO 80907	1053	Depot

Table 8: Day 5; Duration: 555 mins

From	Address	To	Address
1053	Depot	1009	3250 Centennial Blvd, CO 80907
1009	3250 Centennial Blvd, CO 80907	1012	3275 W Colorado Ave, CO 80904
1012	3275 W Colorado Ave, CO 80904	1003	1750 W Uintah St, CO 80904
1003	1750 W Uintah St, CO 80904	1019	707 S 8th St, CO 80905
1019	707 S 8th St, CO 80905	1006	815 Cheyenne Rd, CO 80906
1006	815 Cheyenne Rd, CO 80906	1016	1920 S Nevada Ave, CO 80906
1016	1920 S Nevada Ave, CO 80906	1023	1604 S Nevada Ave, CO 80905
1023	1604 S Nevada Ave, CO 80905	1018	1720 S Nevada Ave, CO 80905
1018	1720 S Nevada Ave, CO 80905	1020	4425 Venetucci Blvd, CO 80906
1020	4425 Venetucci Blvd, CO 80906	1027	1601 US-50, CO 81008
1027	1601 US-50, CO 81008	1004	3050 West St, Pueblo, CO 81003
1004	3050 West St, Pueblo, CO 81003	1005	102 W 29th St, Pueblo, CO 81008
1005	102 W 29th St, Pueblo, CO 81008	1022	101 W 29th St, Pueblo, CO 81008
1022	101 W 29th St, Pueblo, CO 81008	1025	1231 S. Prairie Ave, CO 81005

1025	1231 S. Prairie Ave, CO 81005	1028	4080 W. Northern Ave, CO 81005
1028	4080 W. Northern Ave, CO 81005	1026	1017 N. Market Pl, CO 81007
1026	1017 N. Market Pl, CO 81007	1024	7530 Falcon Market Pl, CO
1024	7530 Falcon Market Pl, CO	1010	7915 Constitution Ave, CO
1010	7915 Constitution Ave, CO	1014	2890 N Powers Blvd, Colorado Springs, CO
1014	2890 N Powers Blvd, Colorado Springs, CO	1021	3810 Bloomington St, CO
1021	3810 Bloomington St, CO	1002	5885 Barnes Rd, CO
1002	5885 Barnes Rd, CO	1017	5617 Barnes Rd, CO
1017	5617 Barnes Rd, CO	1008	3620 Austin Bluffs Pkwy, CO 80918
1008	3620 Austin Bluffs Pkwy, CO 80918	1053	Depot