Supplementary Data for DeliverAI

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This supplementary section of our research paper presents the complete data collected during our experimentation of DeliverAI. As explained in Section VII, we constructed our own simulator for the city of Chicago, using real data of consumer and producer locations and real-time data for the distance and time information of the edges of our Overlay Network (Section IV). Figure 1 shows an enlarged view of Figure 4(B) of the paper, along with consumer, producer, and hotspot locations. Tables III and IV in our research paper already provide the performance metric data of DeliverAI-I and II relative to Baseline 1 and Baseline 2. In Figures 2 and 3 of this supplementary material, we have provided the raw data collected for $DIST_{tot}$, VEH_{tot}, $TIME_{avg}$, and UR_t for DeliverAI-I, DeliverAI-II, Baseline 1 and Baseline 2. Additionally, we have also provided the data for $HOPS_{avg}$ and CDV requirement for all four models for the reference of our readers. Figure 2 shows the data for Gaussian Datasets, and Figure 3 shows the data for Uniform Datasets.

Fig. 1: Figure shows the map of Chicago (divided into census tracts) with the consumer (red) and producer locations (green). A single hotspot location in every census tract is also shown (black X). The part of the city used for the simulation is already represented in Figure 4(B) in the main paper.

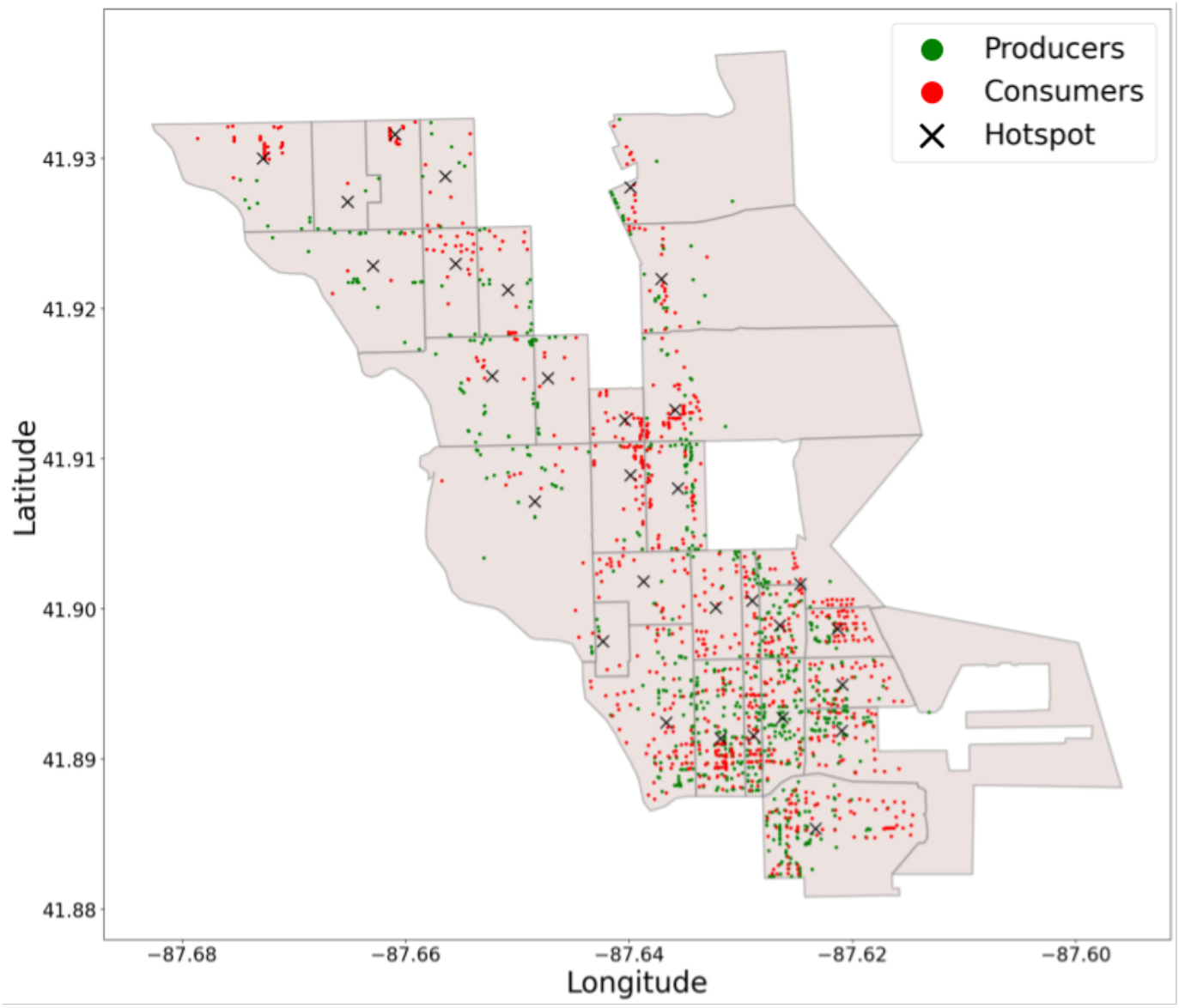


TABLE I: Number of Consumer locations in Chicago. Data collected from OpenStreetMaps (OSM) and Overpass.

Type (OSM Tag)	**Number of Locations**
residential	4185
apartment	2364
house	449
detached	280
hotel	105
office	435
university	200
hospital	59
Total	**8077**

TABLE II: Number of Poducer locations in Chicago. Data collected from OpenStreetMaps (OSM) and Overpass.

Type (OSM Tag)	**Number of Locations**
restaurant	1578
cafe	507
fast food	518
bakery	145
supermarket	87
food court	52
Total	**2887**

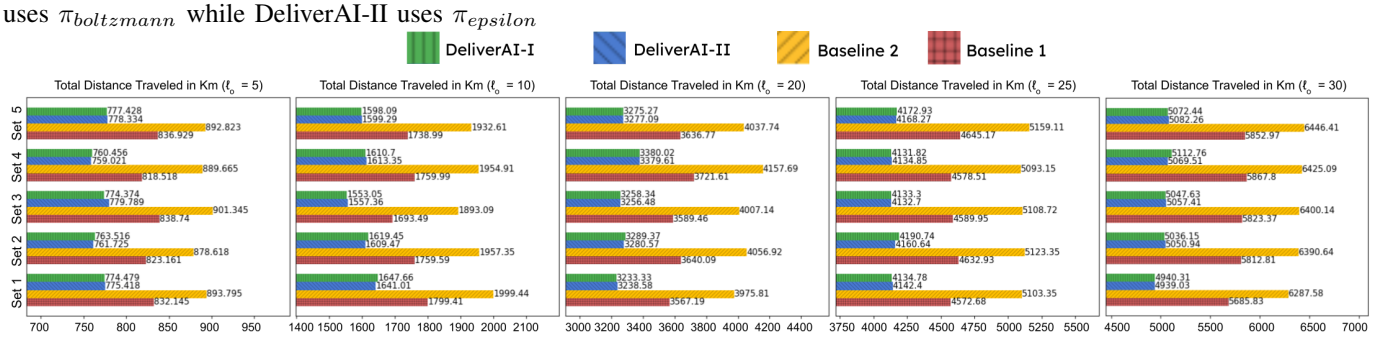
In this supplementary text, we have used an additional performance metric - $HOPS_{avg}$. The data for this metric can be found in Figure 2 and Figure 3.

Delivery Hop: A Delivery Hop (or *hop*) is a discrete and uninterrupted movement of a delivery from one location to another. For instance, a delivery that is taken directly from the producer to the consumer is completed in one hop. A hop results in the handover of the delivery either directly to the end consumer or to the next delivery vehicle in the distribution chain.

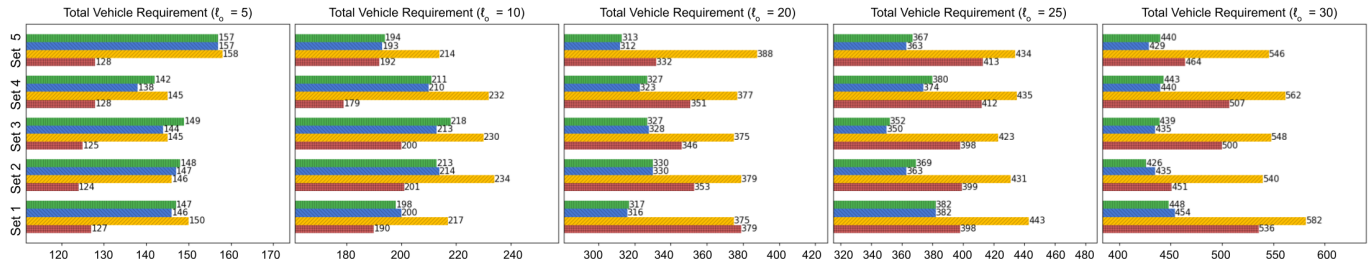
Average Number of Hops ($HOPS_{avg}$): Measures the average (over all the deliveries) number of hops made per delivery. A lower $HOPS_{avg}$ minimizes overhead delays in forming delivery pairs and lowers the risk of food contamination from multiple handovers. Path-sharing in DeliverAI introduces additional stops or hops in the route followed by a delivery. While these stops or hops are useful for forming delivery sharing pairs, we also aim to not allow excessively high $HOPS_{avg}$ as this introduces additional overhead with transfer delays and waiting time, and can even lead to the possibility of food contamination or package misplacement. The data in the following pages shows that food deliveries following the DeliverAI model make 3 to 4 hops (on average) in their journey. In contrast, a point-to-point delivery (like Baseline 1 - main text), completes the delivery routing in one hop.

$$HOP_{avg} = \frac{\sum_i (|d_i^{path}|)}{|D|}$$

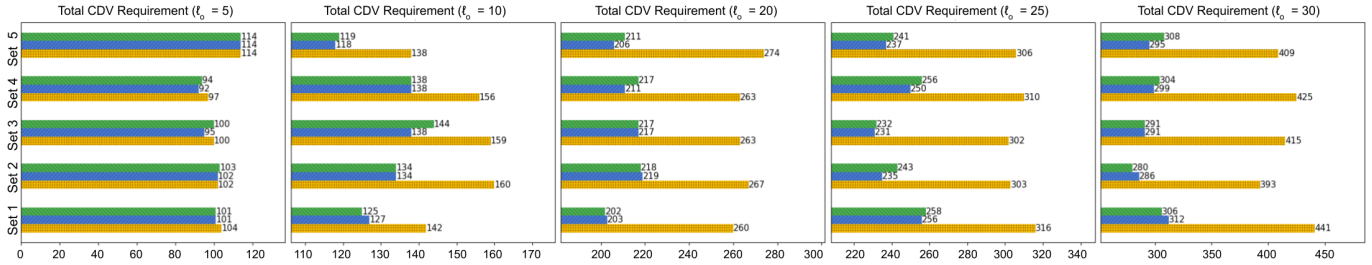
Fig. 2: Performance Metrics for Gaussian Delivery Load Data Sets varying with Delivery Load parameter (l_o) DeliverAI-I uses $\pi_{boltzmann}$ while DeliverAI-II uses $\pi_{epsilon}$



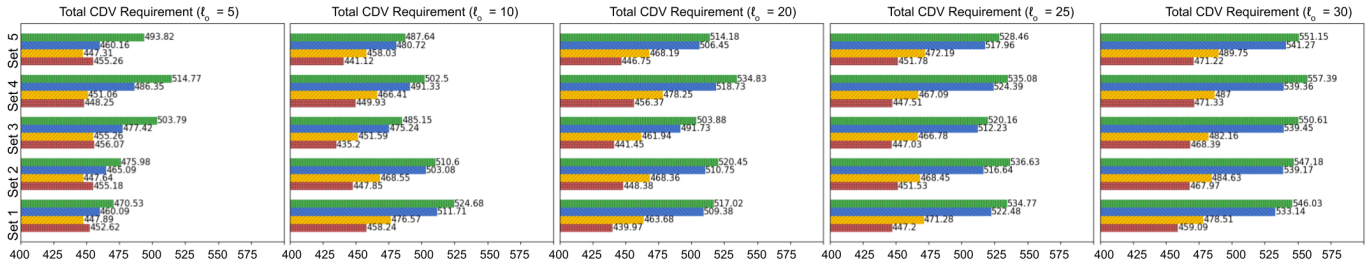
(A) $DIST_{tot}$ in km



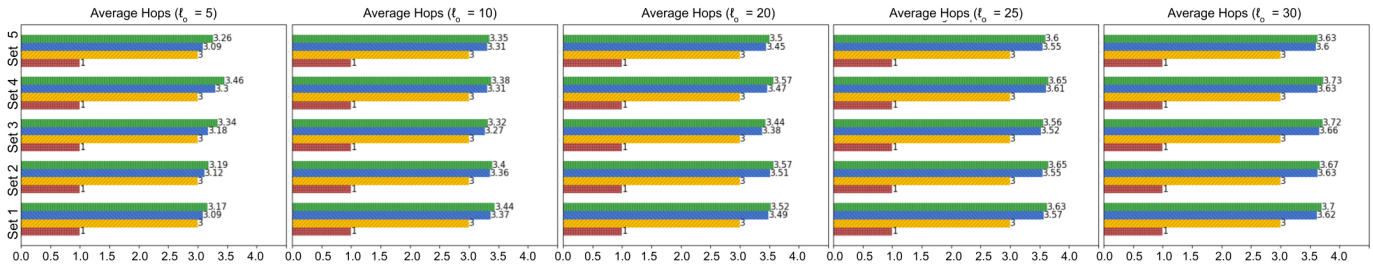
(B) VEH_{tot}



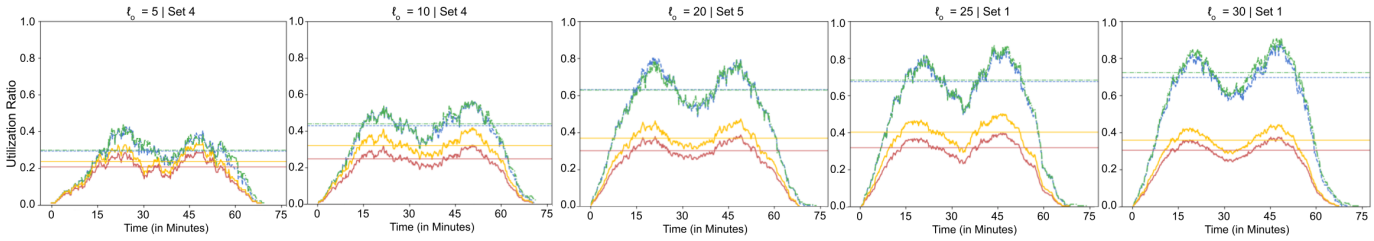
(C) Total CDV Requirement (Baseline1 has no CDVs hence omitted)



(D) $TIME_{avg}$ in seconds

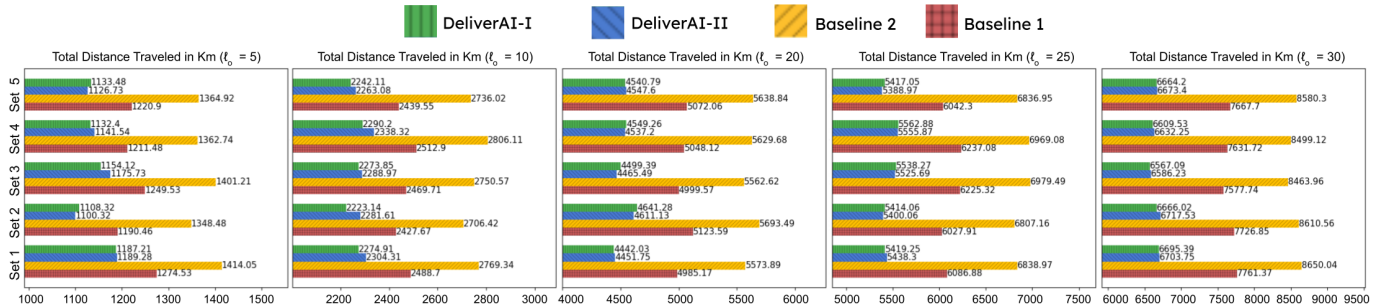


(E) $HOPS_{avg}$ [Baseline1 and Baseline2 have $HOPS_{avg} = 1, 3$ (respectively) by definition]

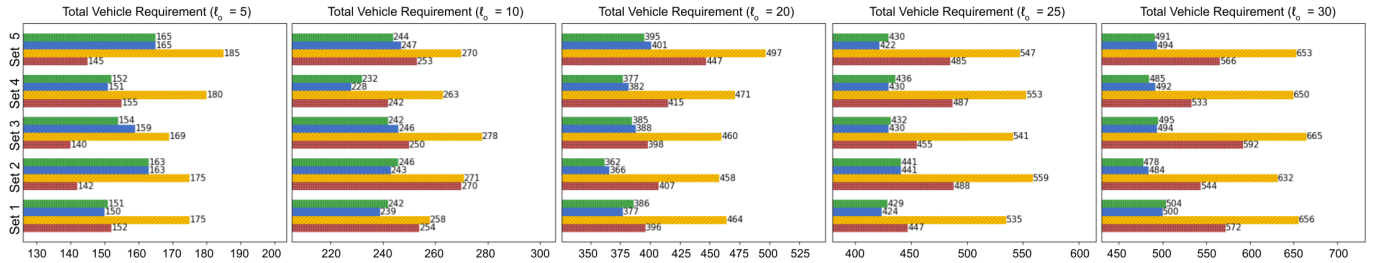


(F) UR_t - Horizontal Lines represent UR_{avg}

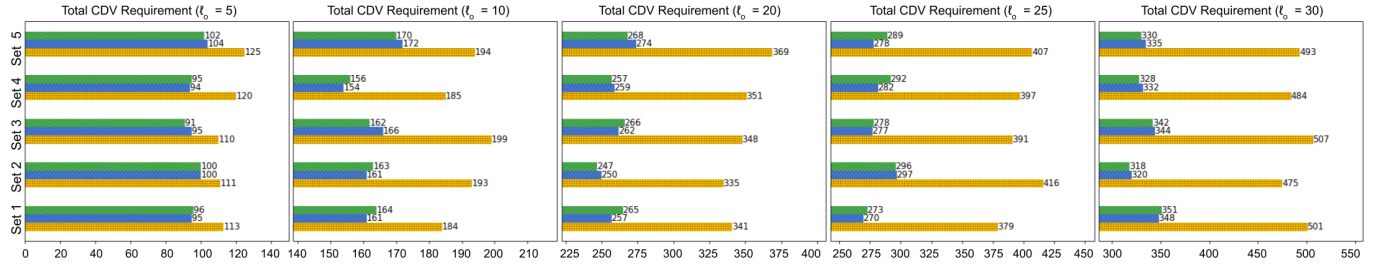
Fig. 3: Performance Metrics for Uniform Delivery Load Data Sets varying with Delivery Load parameter (l_o) DeliverAI-I uses $\pi_{boltzmann}$ while DeliverAI-II uses $\pi_{epsilon}$



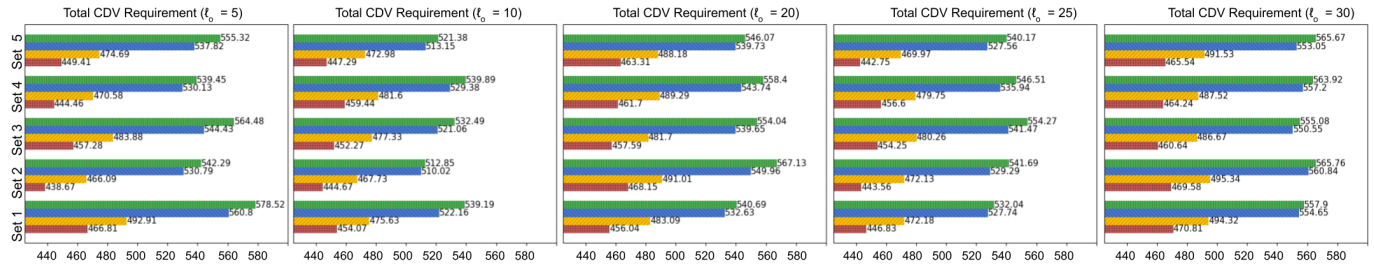
(A) $DIST_{tot}$ in km



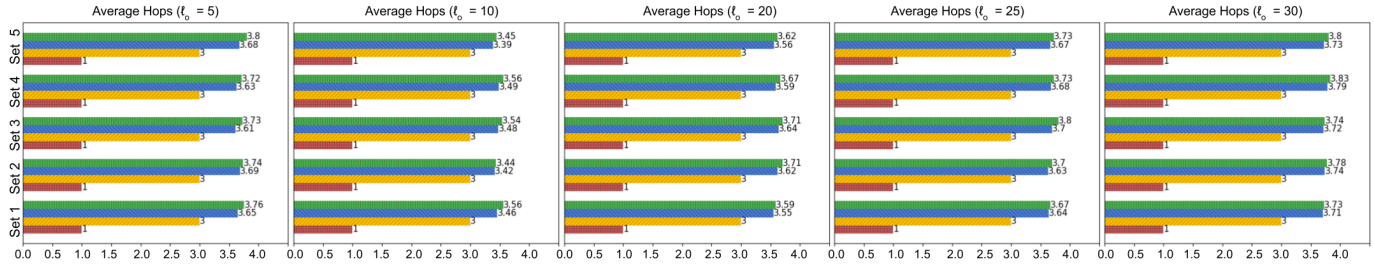
(B) VEH_{tot}



(C) Total CDV Requirement (Baseline1 has no CDVs hence omitted)



(D) $TIME_{avg}$ in seconds



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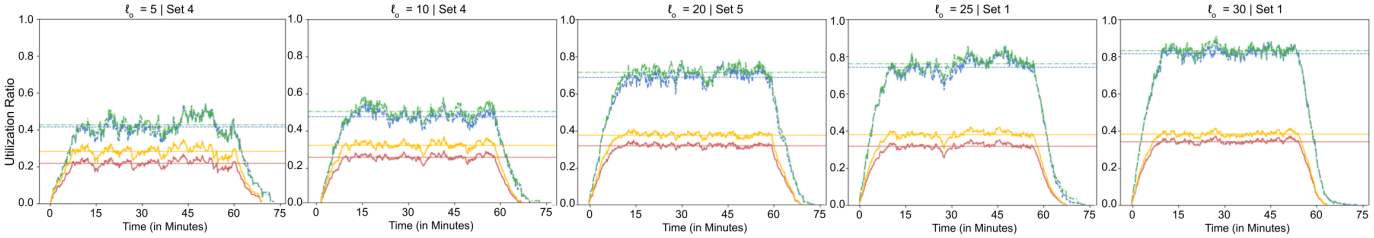

UR_t - Horizontal Lines represent UR_{avg}