MIT Supply Chain MANAGEMENT

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Route Plan Deviations in Last-Mile Delivery

MIT GLOBAL SCALE NETWORK

January 2018 Poster Session

Motivation / Background

> **1 mile** of reduction in average route distance results in **$50,000,000** of annual cost savings for UPS (in the US).

> Urbanization and new costumers demands are making last-mile delivery optimization **increasingly complex and relevant** to retail companies.

> These companies often do not have the tools and/or capabilities to include costumer specific or environmental constrains such us:
- Time windows (implicit or explicit)
- Congestion patterns

> By analyzing systematic deviations of the delivery crews from the planned route sequence we can identify cases in which their local knowledge can **add value and improve a route**.

Hypothesis & Assumptions

> The starting and ending point of each route is the DC

> There is no real time instructions to drivers. Planned route is released at the start of the route

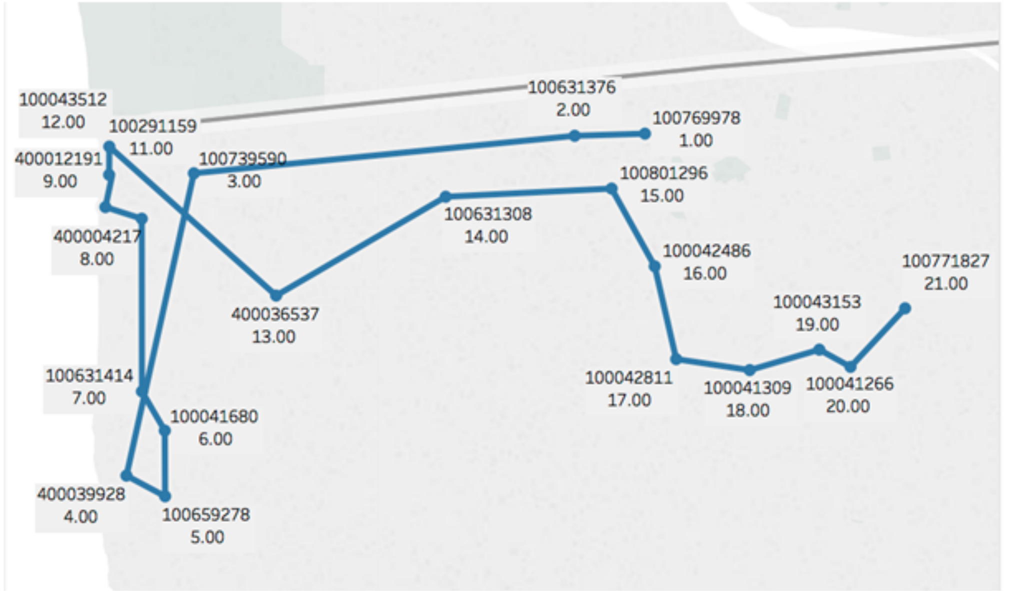
> Optimization software that the company uses is minimizing travel distance and travel time

Relevant Literature

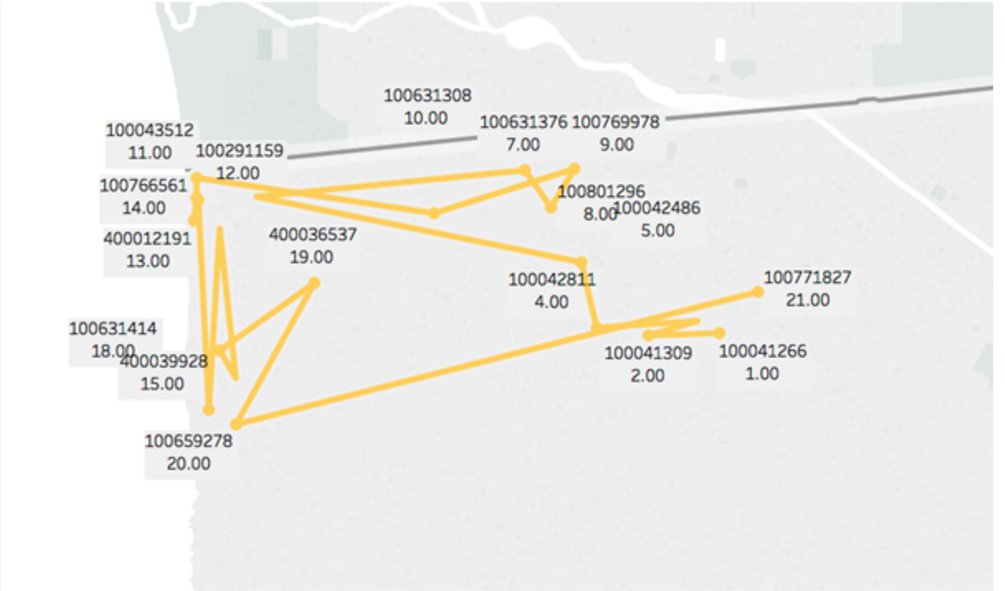
> Vehicle Route Planning (VRP):
- Pillac et al. (2013) *A review of dynamic vehicle routing problems.* Eur J Oper Res, 225:1–11.
- Vidal et al. (2013) *Heuristics for multi- attribute vehicle routing problems: A survey and synthesis.* Eur J Oper Res, 231(1), 1–21.

> Driver Behavior
- Holscher et al. (2011) *Would you follow your own route description?* Cognition 121(2):228–247
- Sun, Y. (2013). *Decision making process and factors routing (Thesis). MIT.*

Planned Route FA0009
(2016 Feb 03 Instance)



Actual Route FA0009
(2016 Feb 03 Instance)



The Problem

> Do delivery crews systematically, consistently and substantially deviate from the planned stop sequences of their routes?

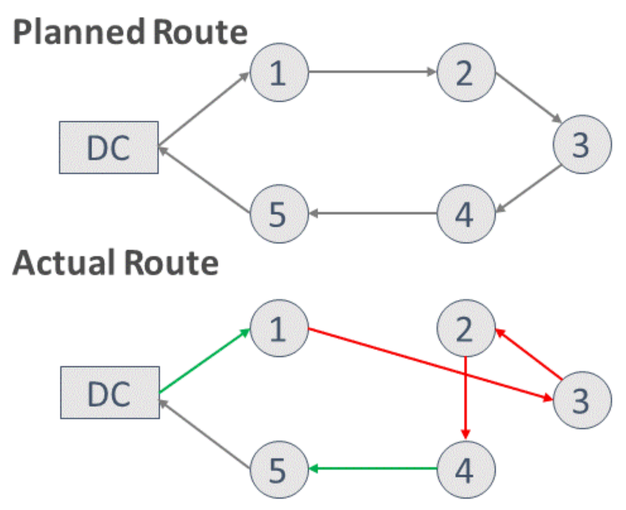
> What drives these deviations and do they add economic value?

> Can we learn from the delivery crews and systematically improve the route planning process?

Methodology

> Create metrics to measure deviations:
- Sequence Deviation = Arcs not followed by driver / Total Arcs
- Distance Deviation = Actual Distance / Planned Distance – 1
- Deviation Impact = Actual Sequence SLD* / Planned Sequence SLD – 1

  ** SLD: Straight Line Distance*



Planned Sequence	Actual Sequence	Sequence Deviation	Distance Deviation (Actual, Planned)	Deviation Impact (Actual SLD, Planned SLD)
1	1	0	(2, 1.5)	(1,1)
2	3	1	(3, 1.8)	(2,1)
3	2	1	(2.3, 2)	(1,1)
4	4	1	(2.6,1.5)	(1,1)
5	5	0	(2.6, 2.2)	(1,1)
DC	-	-	(2.5, 2)	(1,1)
Total		60%	15/11-1 = 36.4%	7/6-1 = 16.7%

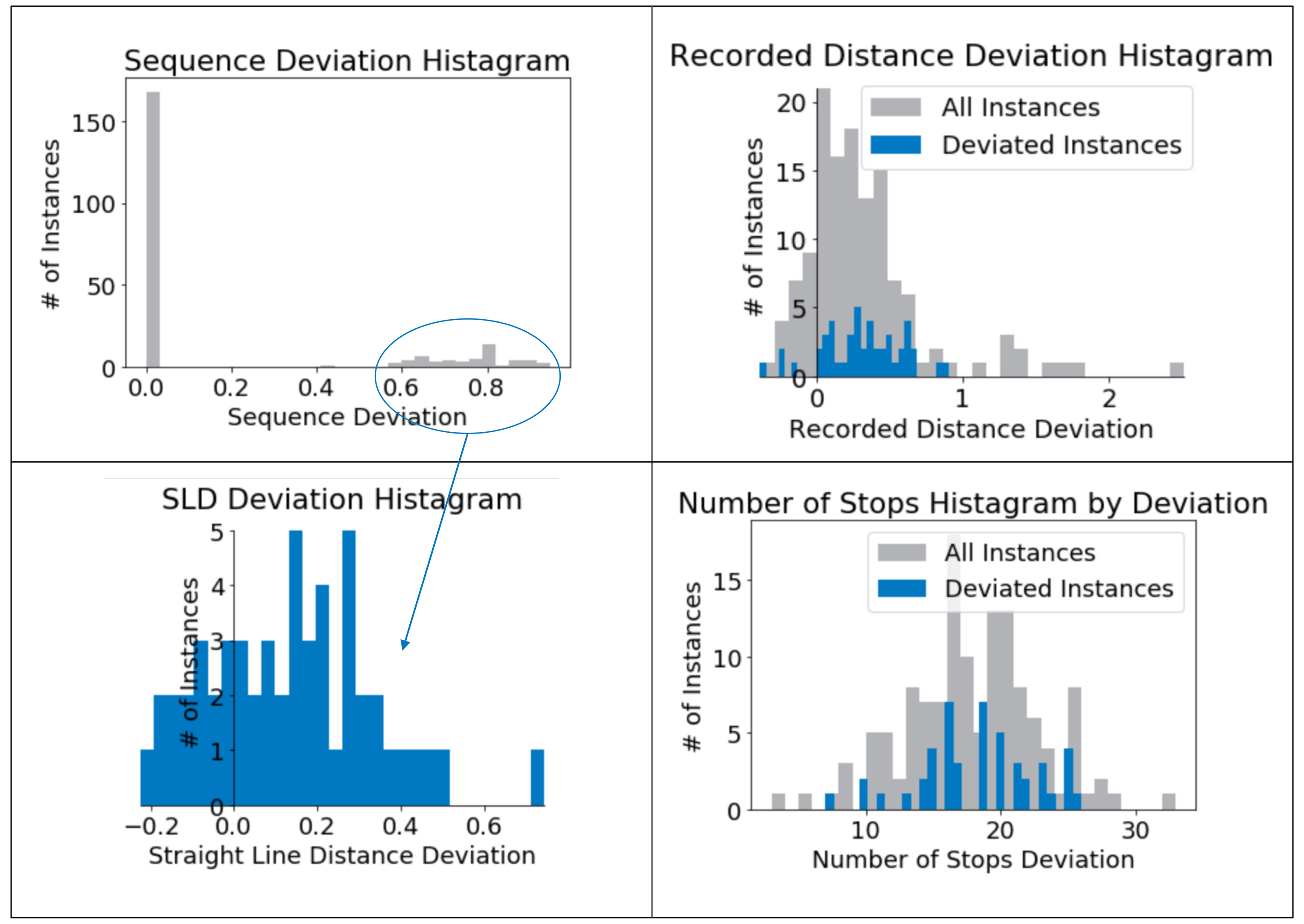
> Extract Insights from drivers behavior based on created metrics

Initial Results

Summary of the database

> Number of routes: 878 (458 in USA, 421 in Mexico)
> Average instances per route: 82
> Average stops per route instance: 15

Defined metric analysis on a specific route



> When routes deviate, more than 60% of planned arcs are not followed
> 1 in every 4 routes deviate, with significant Deviation Impact
> Number of stops is not a key driver for route deviation

Expected Contribution

Devise methods of statistical learning to extract the superior information of delivery crews and make it available to improve future route plans.

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