

Shipment Difficulty Model for 3PL Resource Allocation

Motivation / Background

Freight brokers form a vital connection between shippers and the over 900,000 motor carriers registered in the US. Capacity constraints in freight trucking mean that brokerages must leverage their network and resources effectively in order to meet all demand.

There is currently no aggregated metric to define how difficult a shipment will be to fulfill and monitor and no framework for prioritizing brokerage/3PL resource allocation to shipments. Without knowing how many resources a shipment request will draw, brokerages and 3PLs might not know where to prioritize focus, impacting service levels.

Key Question / Hypothesis

What shipment characteristics determine how difficult a full truckload shipment will be to fulfill and monitor?

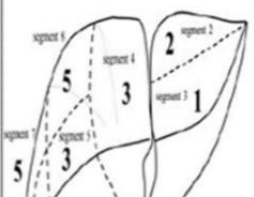
Relevant Literature

- Lee, Ser Yee, Brian K. P. Goh, et al. 2019. "Laparoscopic Liver Resection Difficulty Score—a Validation Study." Journal of Gastrointestinal Surgery 23 (3): 545–55. <https://doi.org/10.1007/s11605-018-4036-y>.
- Ban, Daisuke, Minoru Tanabe, et al. 2014. "A Novel Difficulty Scoring System for Laparoscopic Liver Resection." Journal of Hepato-Biliary-Pancreatic Sciences 21 (10): 745–53. <https://doi.org/10.1002/jhbp.166>.
- Davis, Brian A., and Miguel A. Figliozzi. 2013. "A Methodology to Evaluate the Competitiveness of Electric Delivery Trucks." Transportation Research Part E: Logistics and Transportation Review 49 (1): 8–23. <https://doi.org/10.1016/j.tre.2012.07.003>.



Methodology

Difficulty of laparoscopic liver resection										
10-level index	1	2	3	4	5	6	7	8	9	10
Three-level index	Low			Intermediate			High			
Definition	● For surgeons starting laparoscopic liver resection ● For surgeons with experience of <10 cases of laparoscopic liver resection			● For surgeons who can consistently perform laparoscopic liver resection in "low difficulty" cases ● For the surgeons with experience of 200 and <50 cases of laparoscopic liver resection			● For surgeons who can consistently perform laparoscopic liver resection in "intermediate difficulty" cases ● For surgeons with experience of ≥50 cases of laparoscopic liver resection			
Landmark Operation	Left lateral sectionectomy			Simple hemihepatectomy			Simple and small partial hepatectomy in segment 3 Technical limitation in current laparoscopic surgery			

Tumor location	Tumor size	Score
	<1 cm	0
	≥1 cm	1

Segment	Score
S2	2
S3	1
S4	3
S5	4
S6	2
S7	6
S8	5

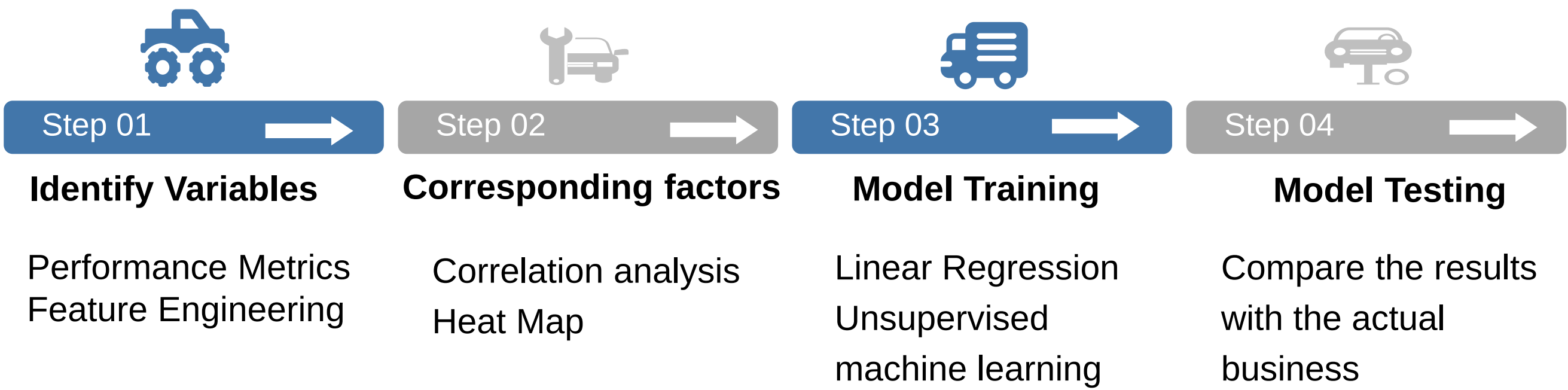
Extent of liver resection	Score
Hd (partial resection)	0
Hi-LLR (left lateral sectionectomy)	2
Hi-S (segmentectomy)	3
Hi-L, 2 (not less than a sectionectomy)	4

Proximity to major vessel	Score
Proximity to major vessel	0
yes	1

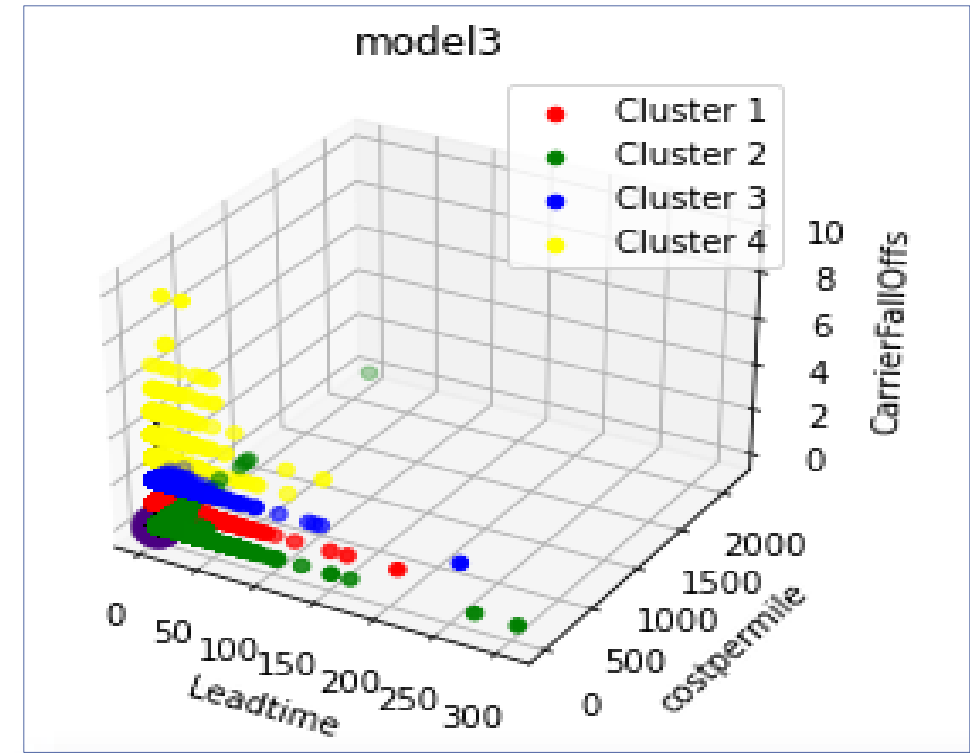
Liver function	Score
Child-Pugh A	0
Child-Pugh B	1

Laparoscopic liver resection: several factors including tumor size, tumor location, proximity of major blood vessels assigned quantitative values.

Values used to create a compound difficulty score.

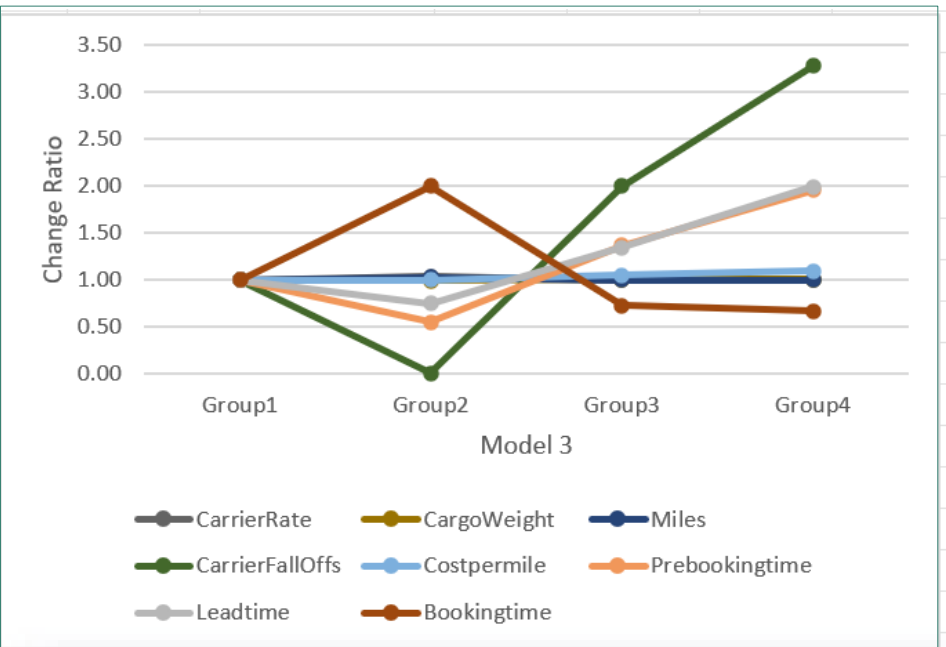


Results



Data Distribution In Model 3

Created four categories of difficulty by considering the relative values.



Model 3 Feature Change Ratio Line Chart

Used unsupervised machine learning to divide data into groups with similar features.

	Total Score Range	Feature	Feature Range	Feature Score
Easy	0-25	Leadtime	<=3.3	0
		Bookingtime	>=1.4	0
		Prebookingtime	<=2.7	0
		Costpermile	<=3.7	0
		CarrierFallOffs	0	0
Normal	26-50	Leadtime	3.3-4.5	5
		Bookingtime	0.8-1.4	5
		Prebookingtime	2.7-5.0	5
		Costpermile	<=3.7	0
		CarrierFallOffs	1	5
More Attention	51-75	Leadtime	4.5-5.9	10
		Bookingtime	0.5-0.7	10
		Prebookingtime	5.0-6.9	10
		Costpermile	3.8-3.9	10
		CarrierFallOffs	2	10
Hard	76-100	Leadtime	>=6	20
		Bookingtime	<=0.4	20
		Prebookingtime	>7.0	20
		Costpermile	>=4	20
		CarrierFallOffs	>=3	20

Final Difficulty Score Model

Graphed the trend lines for each variable by cluster to find the salient features.

Expected Contribution

We aim to provide comprehensive analysis of factors that affect trucking shipments from the initiation of a shipment request to the completion of the shipment. This analysis can be used to establish a difficulty score model to provide third-party logistics companies with suggestions for effective resource allocation.

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