

# Rethinking Operational Research: learning on-demand delivery policies with supervised deep learning

# Problem

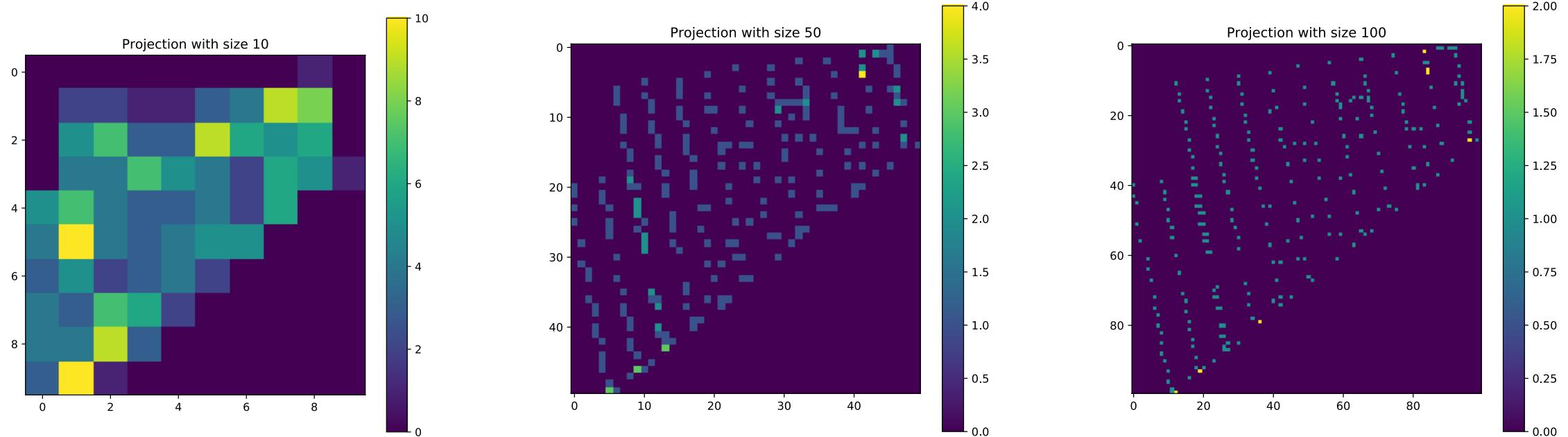
- Dial-a-ride problem
- Electric autonomous vehicles
  - Battery constraints → not considered
  - Sharing rides
- Covered area of  $5\text{km}^2$
- Fixed fleet size: 30 vehicles
- Optimal policy given by 2-stage algorithm

# Method

- Planar representation



# Method

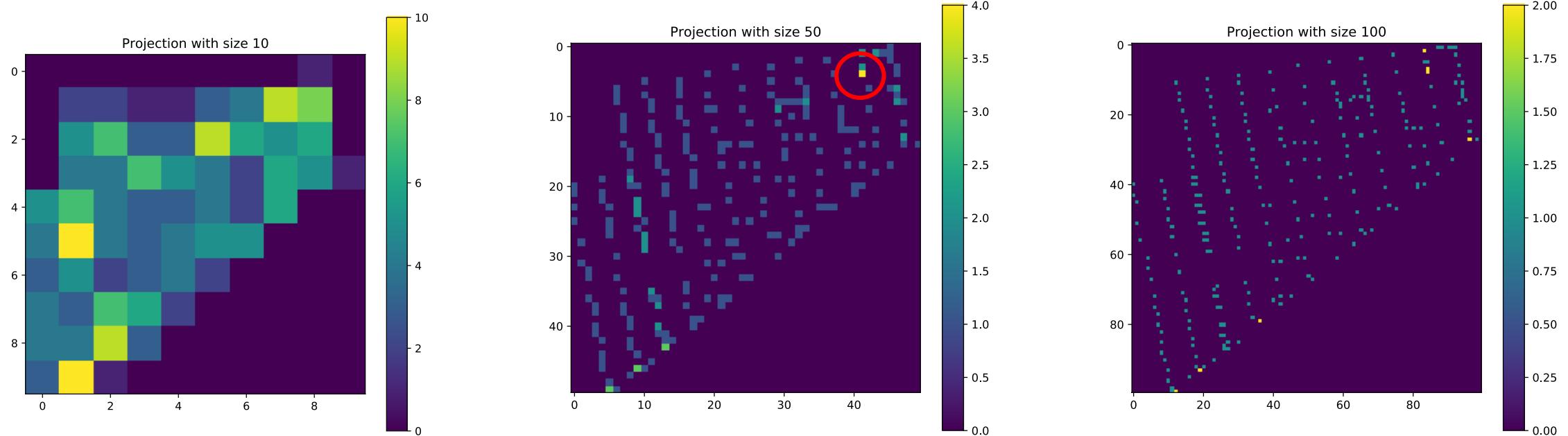


> 90% collision  
Up to 10 nodes in a single point

< 10% collision  
Up to 4 nodes in a single point

< 3% collision  
Up to 2 nodes in a single point

# Method



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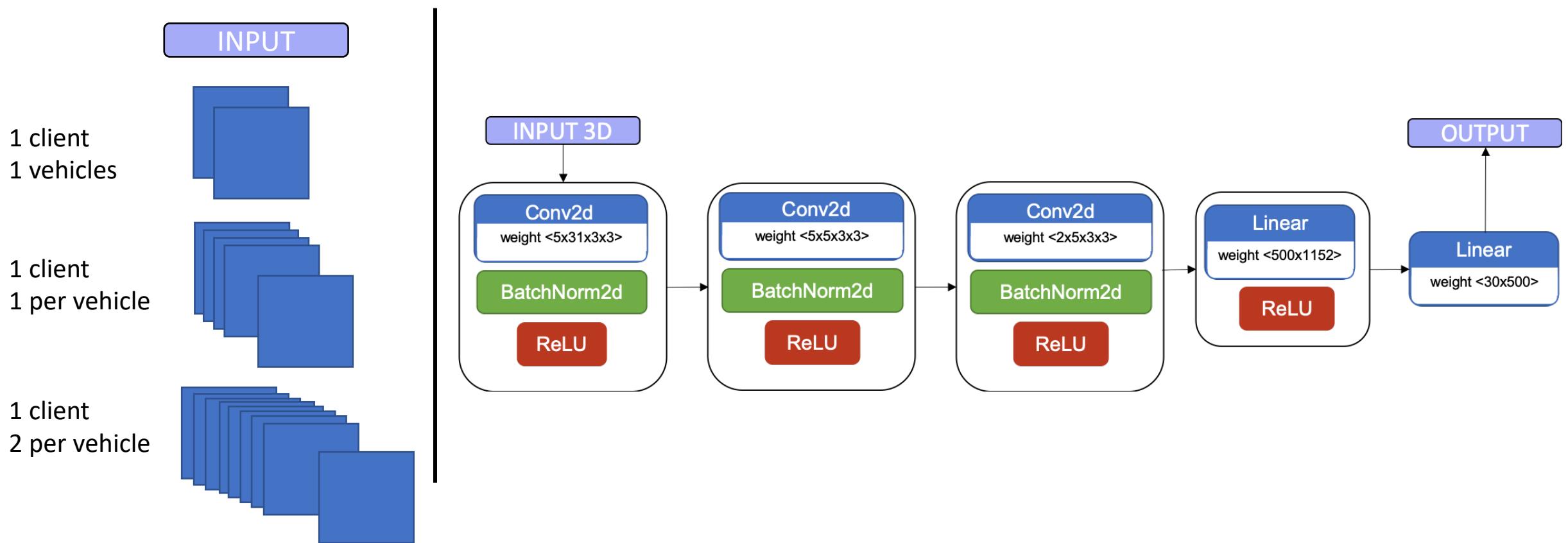
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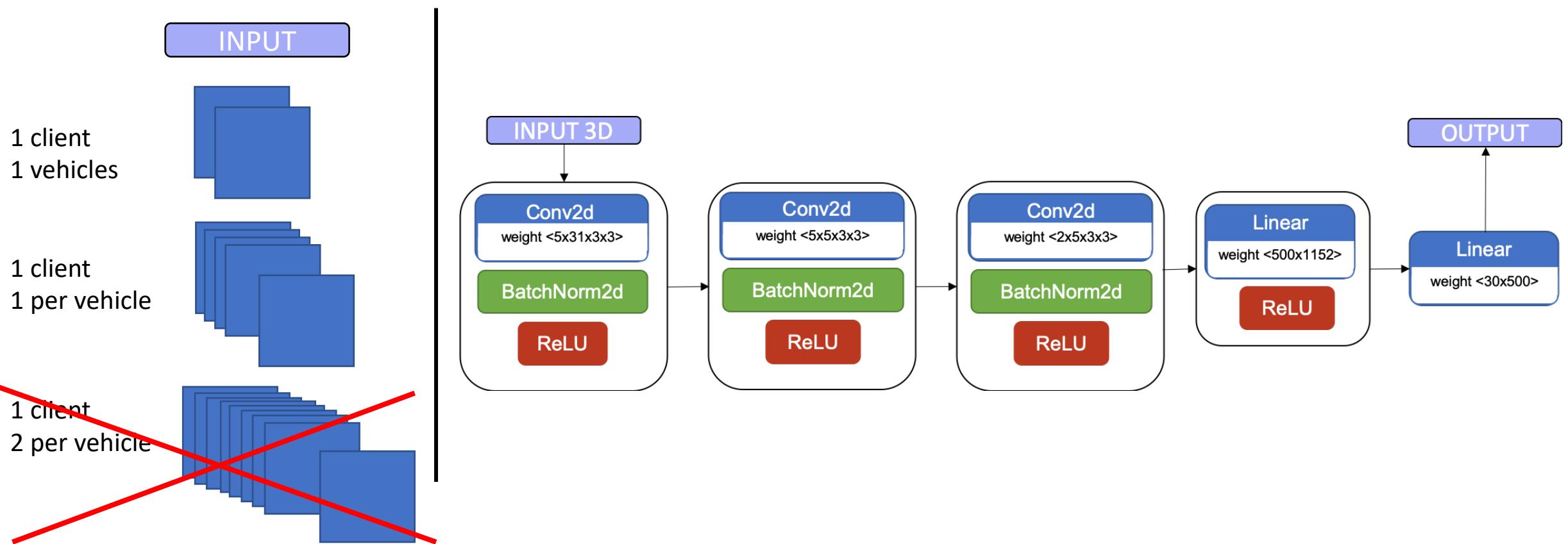
# Method

- Architectures



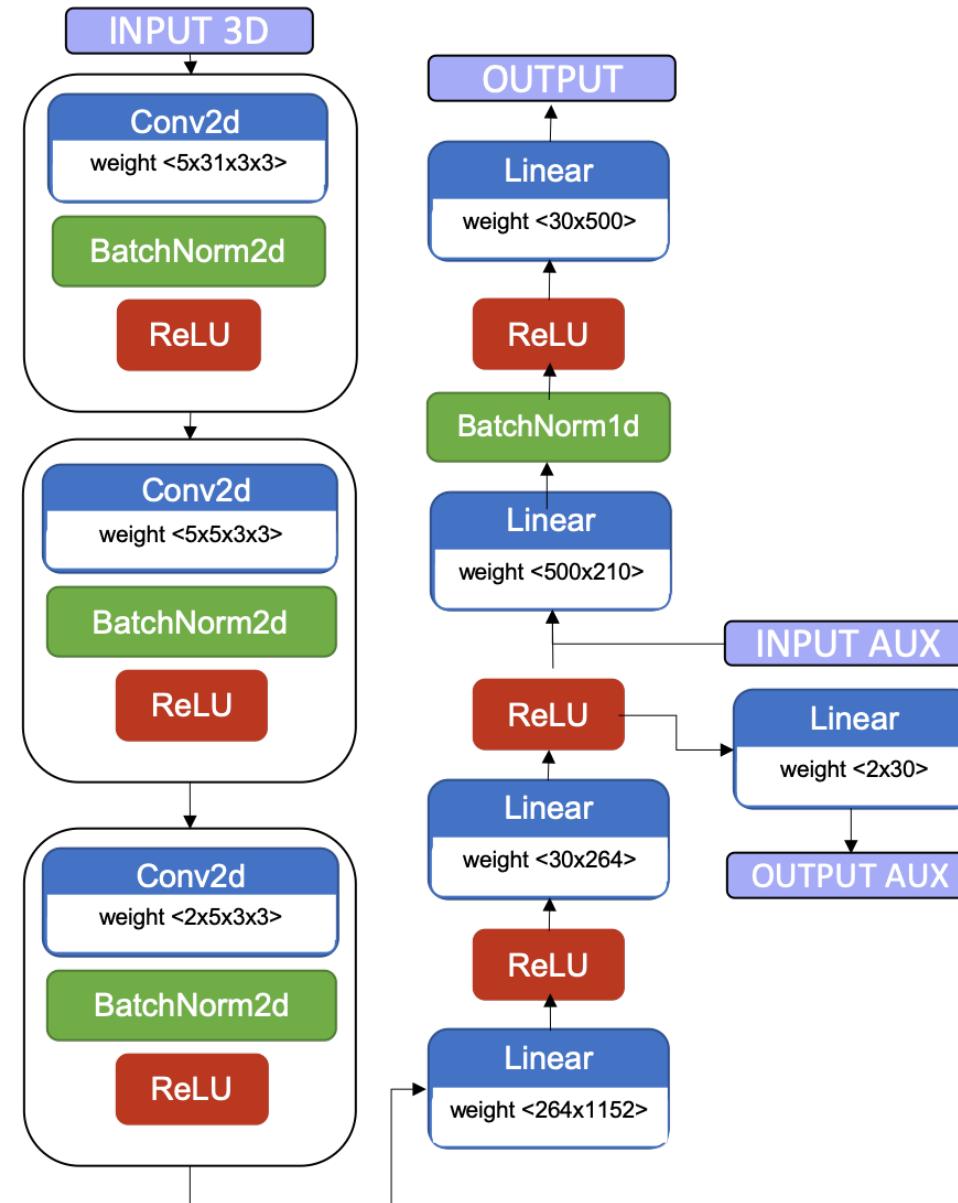
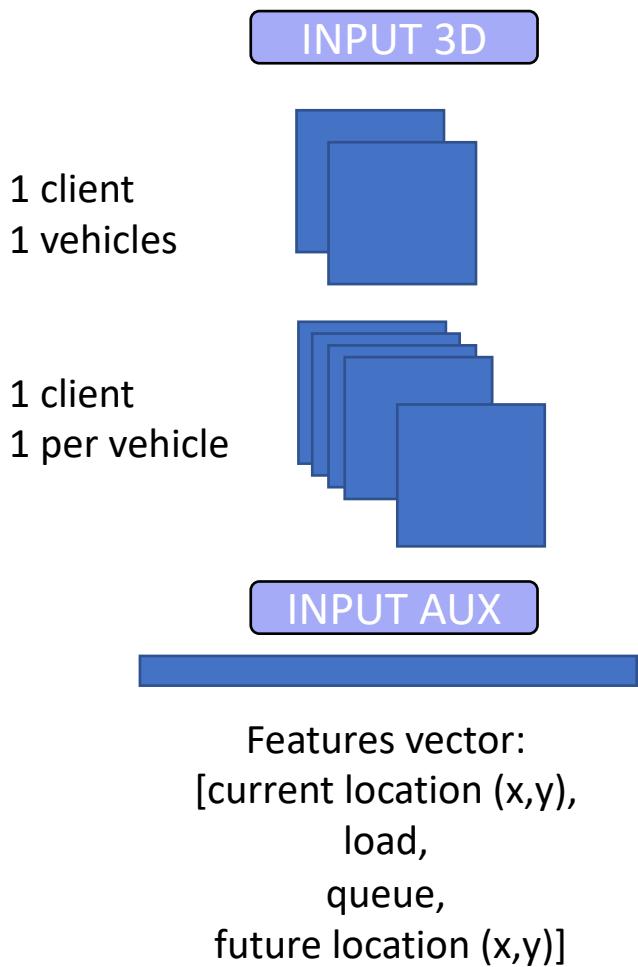
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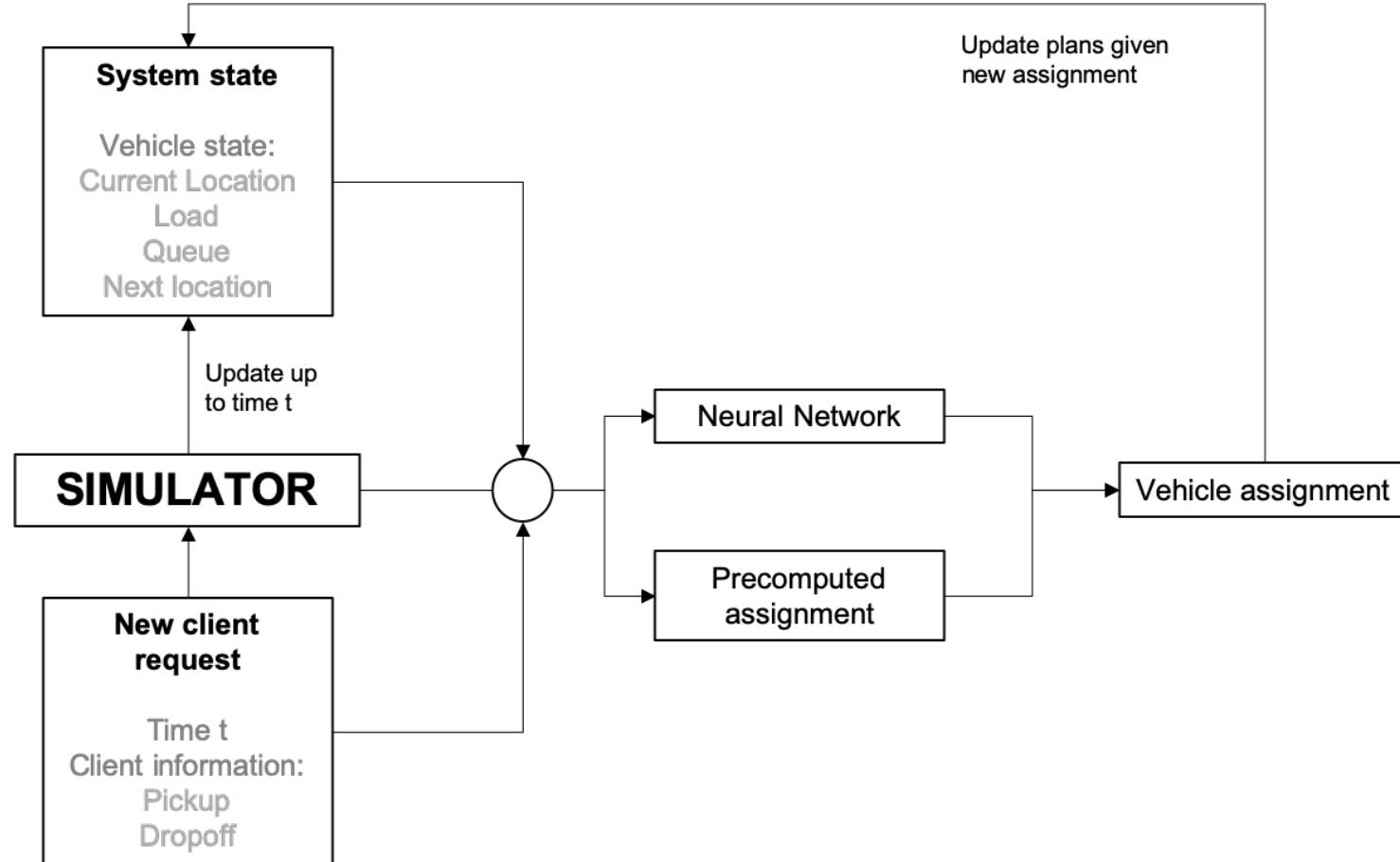
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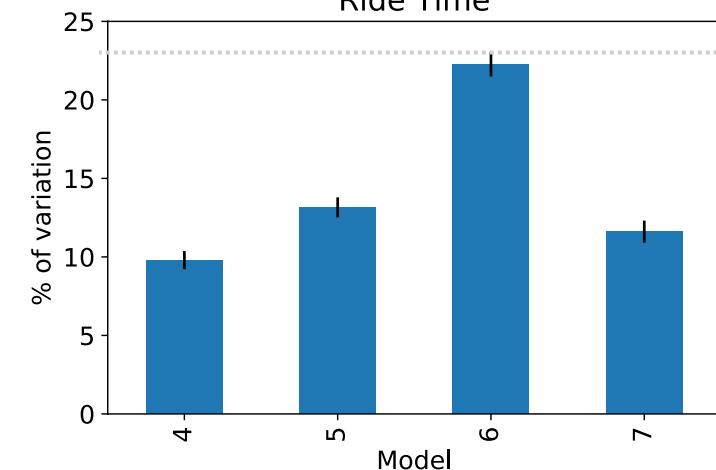
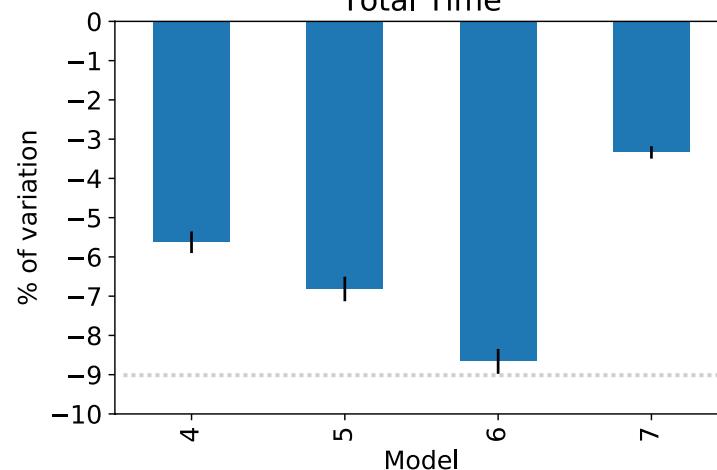
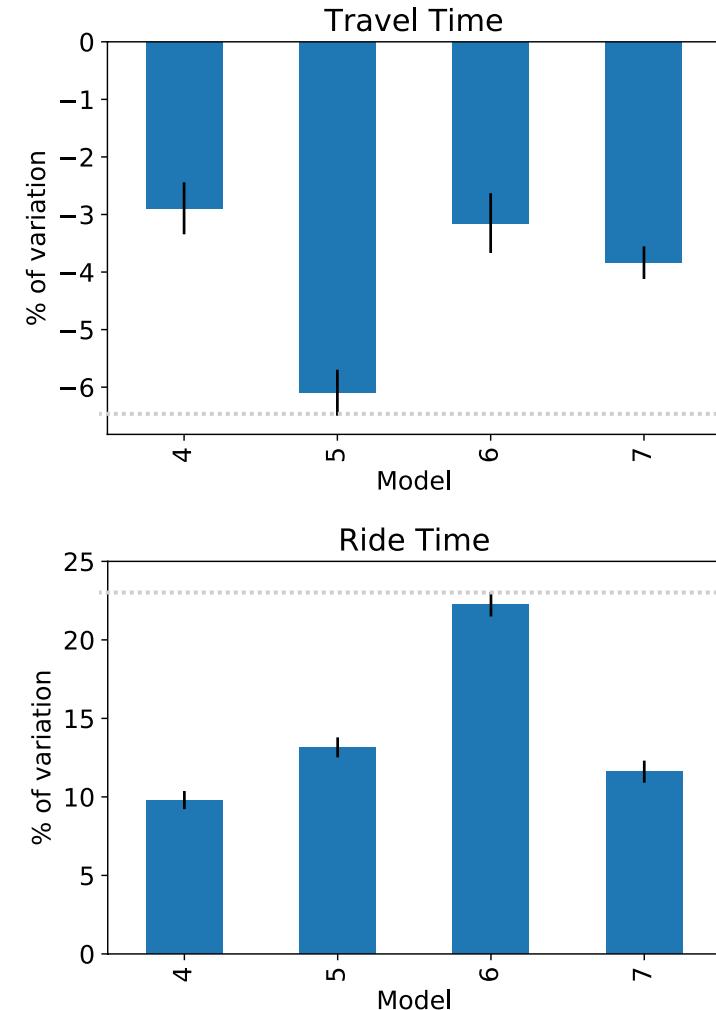
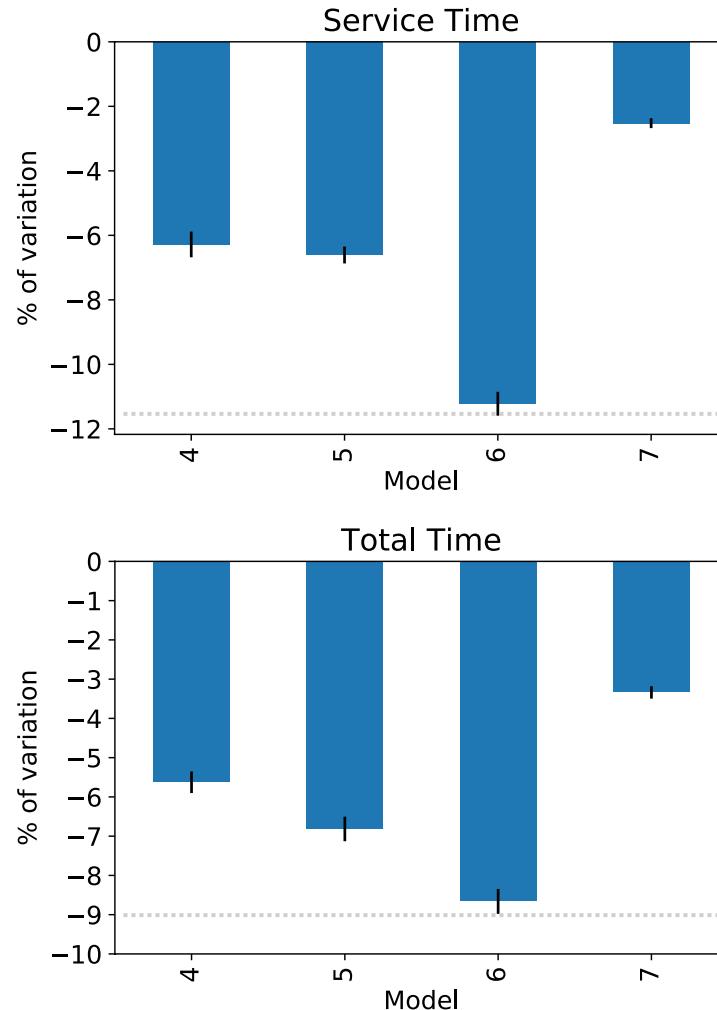
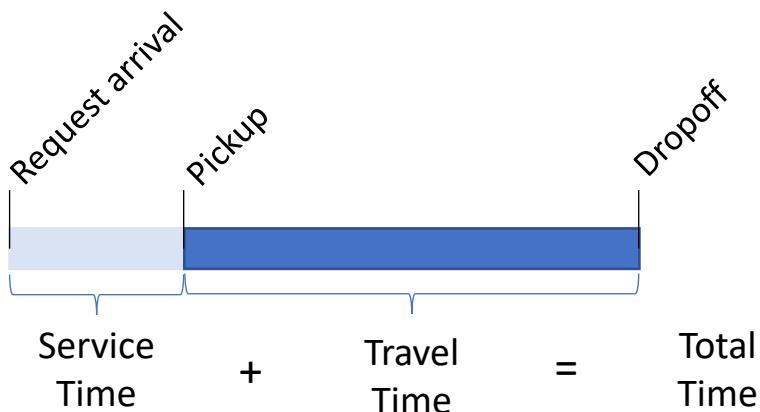
# Experiments CHANGE TABLE

	Model	Parameters	Accuracy	Num. Parameters
No auxiliary input	1 <b>Single Input Single Output</b>	Im size = 30x30	$0.138 \pm 0.003$	594911
	2 <b>Single Input Double Output</b>	Im size = 30x30 Weight = 0.5	$0.124 \pm 0.003$	597217
	3 <b>Single Input Double Output</b>	Im size = 30x30 Weight = 0.99	$0.137 \pm 0.003$	597217
Auxiliary input	4 <b>DI - DO 31x30x30</b>	Im size = 30x30 Weight = 0.99	$0.243 \pm 0.005$	435740
	5 <b>DI - DO 31x50x50</b>	Im size = 50x50 Weight = 0.99	$0.248 \pm 0.004$	1153820
	6 <b>DI - DO 2x30x30</b>	Im size = 30x30 Weight = 0.99 Single channel for vehicles	$0.237 \pm 0.001$	434435
	7 <b>DI - DO 2x50x50</b>	Im size = 50x50 Weight = 0.99 Single channel for vehicles	$0.242 \pm 0.004$	1152515

# Experiments



# Results



# Results

	Service Time	% difference	Travel Time	% difference	Total Time	% difference	Ride Time	% difference	Vehicles
<b>Opt Policy</b>	<b>1157.37</b>	-	<b>1287.52</b>	-	<b>2444.89</b>	-	<b>20872.30</b>	-	<b>23</b>
<b>Model 1</b>	1647.35	-42.34	1412.39	-9.70	3059.74	-25.15	12023.39	73.60	14
<b>Model 2</b>	4734.23	-309.05	1360.72	-5.68	6094.95	-149.29	3983.95	140.46	4
<b>Model 3</b>	12028.73	-939.32	1227.45	4.67	13256.18	-442.20	999.41	165.29	1
<b>Model 4</b>	1223.34	-5.70	1274.90	0.98	2498.24	-2.18	21879.27	10.43	22
<b>Model 5</b>	1218.94	-5.32	1296.79	-0.72	2515.73	-2.90	19890.21	11.28	22
<b>Model 6</b>	1255.40	-8.47	1313.01	-1.98	2568.41	-5.05	17927.21	15.37	21
<b>Model 7</b>	1206.21	-4.22	1271.30	1.26	2477.51	-1.33	18918.66	9.36	21

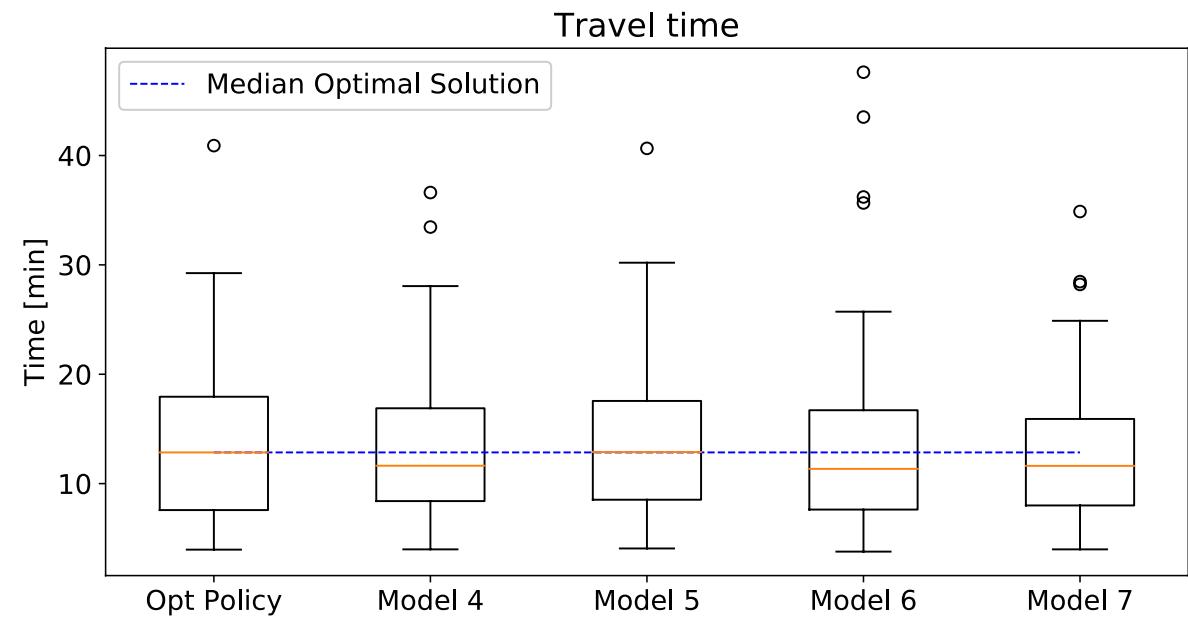
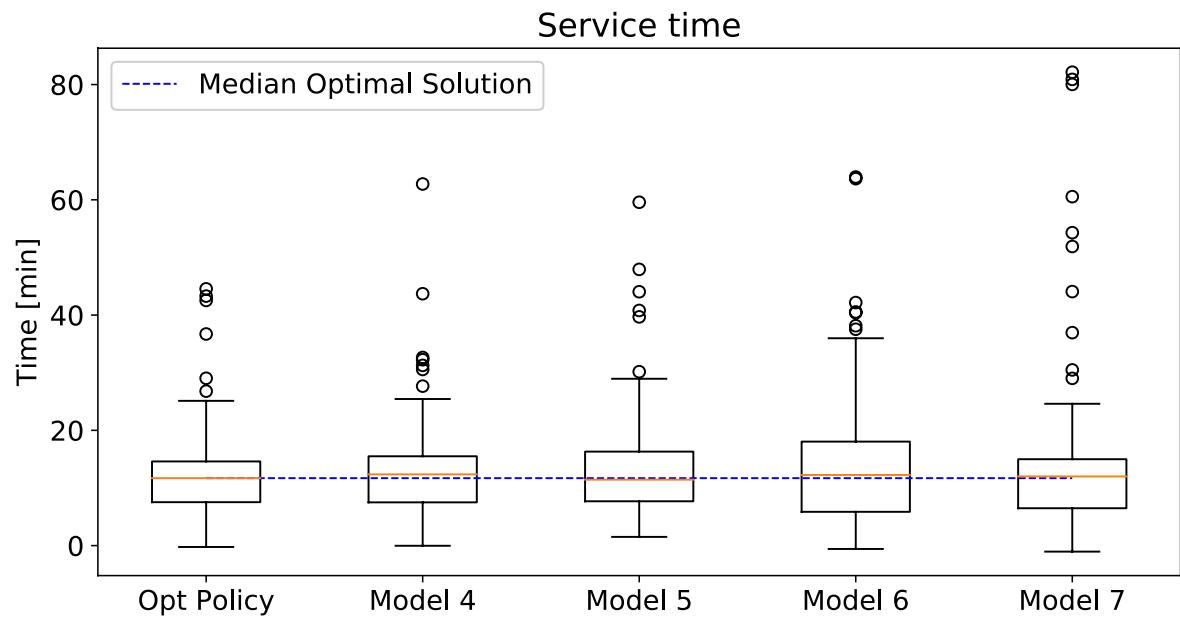
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# Future work

- Improve vehicle planning
- Introduce battery constraint
- Introduce real traffic conditions (requires modifying target policy)