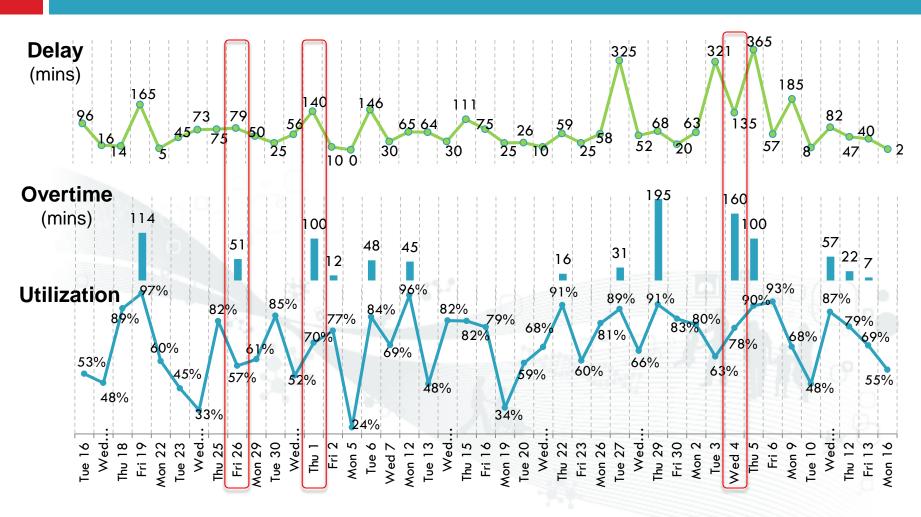
System Engineering in Healthcare Operations Management – Reduce Waste of Healthcare Resources

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Operating Room (OR) performance



Working hour: 8:30-16:30

Our field

Operations Research Systems Engineering Management Sciences Industrial Engineering Operations Management Business Analytics Decision Analysis Decision Sciences

Systems Engineering

- Decision-making and efficiency
 - + Applied math—simulation, optimization, probability
- Past Manufacturing
- Trend Service
 - + Pricing, gambling, healthcare









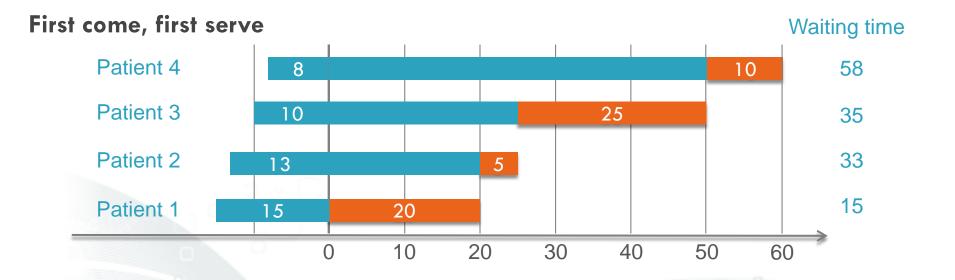




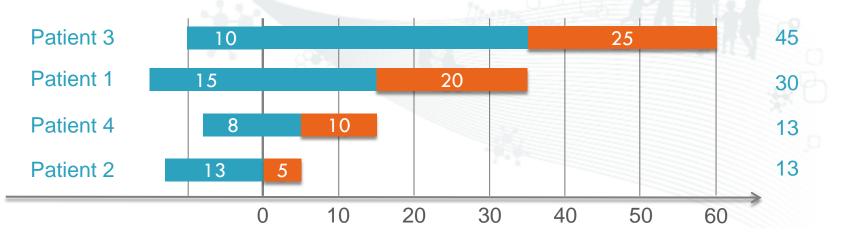
Scheduling patients for treatment

	Current waiting time	Estimated consultation time
Patient 1	15	20
Patient 2	13	5
Patient 3	10	25
Patient 4	8	10

Two appointment rules



Shortest consultation time first

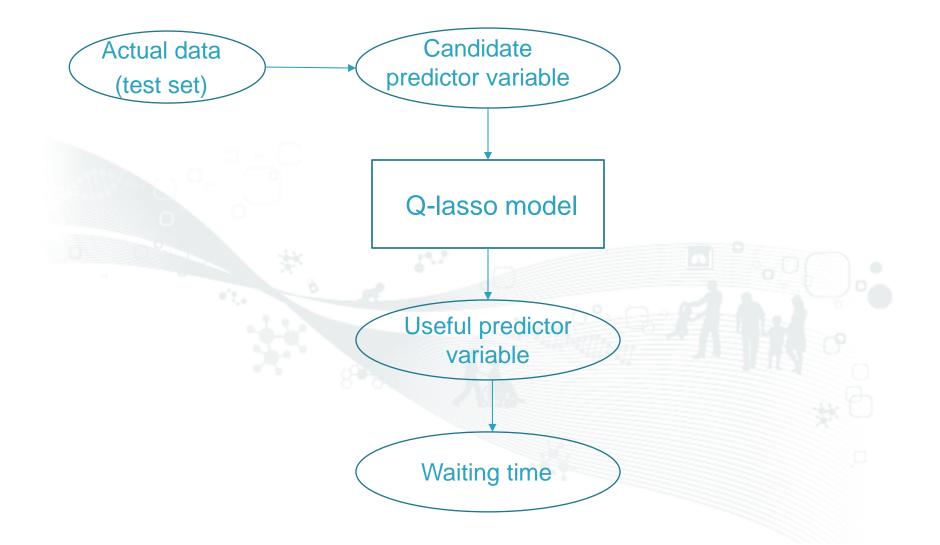


Accurate ED Wait Time Prediction

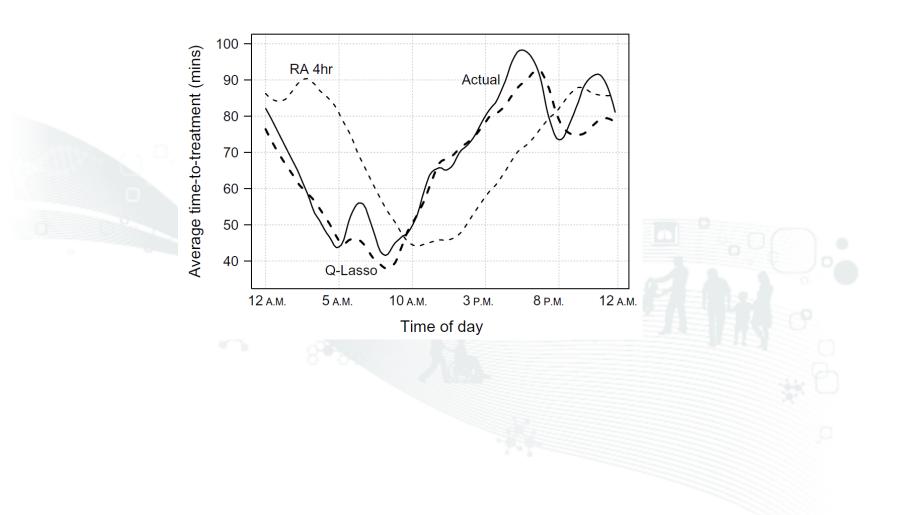
- Many benefits from providing estimation
- Estimates are misleading to patients and has called for improved accuracy (The American College of Emergency Physicians, 2012)
 - Underestimate
 Actual waiting > 6hrs, i.e., 8hrs
 - Overestimate
 - □ Actual waiting < 6hrs, i.e., 4hrs



Model



Results



Project on Elderly Care

- Hong Kong Christian Service (HKCS)
 - + Established in 1952
 - + Provides elderly support service
- Meal Delivery Service
 - + Lunch and dinner delivery service
 - + Service region: public housing estates



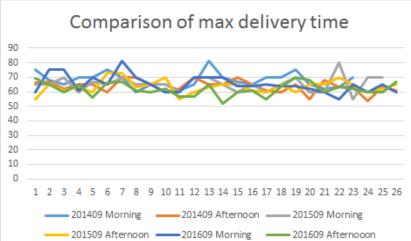


Team members: LI Jiewei, YU Ho Chi, YU Rong, ZHANG Mengyuan @ HKUST

Data Analysis

- Total 12 routes in meal delivery
 - + 6 in Region One by walking
 - + 6 in Region Two by van
- Each staff carry a trolley at a time
- Allowed arrival time
 - + Lunch: 11:00 AM 12:00 NN
 - + Dinner: 4:30 PM 5:30 PM





- Max delivery time
 80 81 minutes
- At least one delivery route exceeds the 60-minutes limit in every session

Our Work

Travel Time Matrix

From To	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Ε	F	G	H
0	0	207	233	303	332	42	236	2\$0	9999	0000	301	355	312	9999	9990	9999	9999	9999	9999	9999	9999	0000	420	9999	9999	9999
1	207	0	41	126	153	165	227	256	9999	9999	271	325	282	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9995
2	233	41	0	91	122	192	229	283	9999	9999	241	295	252	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
3	303	126	91	.0	31	261	151	226	9999	9999	163	217	174	9999	99999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
4	332	153	122	31	0	292	129	204	9999	9999	141	195	152	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
5	42	165	192	261	292	0	203	273	0000	9999	336	385	339	0000	9999	9999	0000	9999	9999	0000	9999	0000	9999	0000	0000	9999
6	236	227	229	151	129	203	0	75	9999	9999	133	187	144	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
7	2:80	256	283	226	204	273	75	0	9999	9999	208	262	219	99999	9999	9999	9999	9999	9999	9999	99999	9999	9999	9999	9999	9999
8	9999	9999	9999	9999	9999	9999	9999	9999	Ô	66	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	99999	9999	9999	9999	9999	105
9	9999	9999	9999	9999	9999	9999	9999	9999	66	0	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	36
10	301	271	241	163	141	336	133	208	9999	9999	0	62	134	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
11	355	325	295	217	195	385	187	262	9999	9999	62	0	120	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
12	312	282	252	174	152	339	144	219	9999	9999	134	120	0	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
13	9999	9999	9999	99999	9999	9999	99999	9999	9999	9999	99999	9999	9999	0	189	86	86	45	136	62	125	197	9999	9999	36	9999
14	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	189	0	103	103	155	61	138	72	146	9999	9999	46	9999
15	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	86	103	0	15	131	63	137	74	186	9999	9999	52	9999
16	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	86	103	15	0	131	63	137	74	186	9999	9999	52	9999
17	99999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	-45	155	131	131	0	94	25	88	171	9999	9999	15	9999
18	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	136	61	63	63	94	0	74	II	154	9999	9999	13	9999
19	99999	9999	9999	9999	9999	9999	9999	9999	99999	9999	9999	9999	9999	62	138	137	137	25	74	0	63	196	9999	9999	34	9999
20	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	125	72	74	74	\$\$	11	63	0	163	9999	9999	24	9999
21	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	197	146	186	186	171	154	196	163	0	9999	9999	146	9999
E	9999	9999	9999	9999	9999	9999	99999	9999	105	36	9999	9999	9999	0000	9999	9999	9999	9999	9999	9999	9999	9999	0	210	9999	9999
F	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	36	46	52	52	15	13	34	24	146	9999	0	9999	9999
G	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	0	210
H	450	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	0

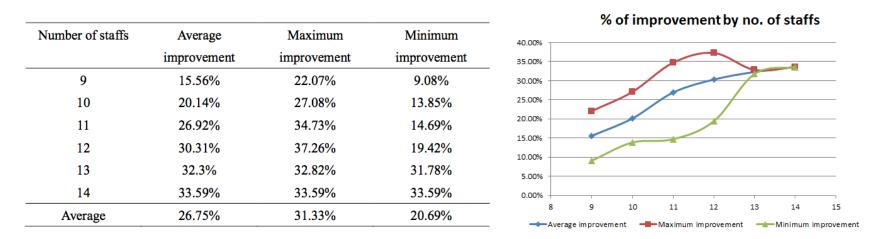
const char* filename = "/Users/Yurong/Desktop/updatedcost.dat"; if (argc >= 2) filename = argv[1]; ifstream file(filename); if (!file){ cerr << "ERROR: could not open file" << filename << "for reading" << endl; throw (-1); }

// input data from the file (travel cost)

Service Time Matrix

Node 0	Node 1	Node 2	Node 3 Node	4 Node 5	Node 6	Node 7	Node 8	Node 9	Node 10	Node 11	Node 12	Node 13	Node 14	Node 15	Node 16	Node 17	Node 18	Node 19	Node 20	Node 21	Node 22	Node 23	Node 24	Node 25	Node 26	
	a 175	174	175	176	1.00	1451 (1	15 12	16	15 13	181 12	60 27	m	222	227	222 0	271	222 0	17 2	27 2	221	222 2	27 2	22	1771	222 17	114

Result & Discussion



The average, maximum and minimum improvement for different sizes of problems

Other Applications

- Personalized Diabetes Management
- Combination Chemotherapy
- Bed management
- Emergency Department
- Ambulance reallocation
- Inventory of medicines

Ongoing practice in the world

- MIT --- Mass General Hospital
- Wharton --- Penn Medicine, Children's Hospital of Philadelphia
- Columbia --- New York City hospital
- University of Pittsburgh --- University of Pittsburgh Medical Center
- Tel Aviv University --- Rambam Hospital
- National University of Singapore --- NUH, KTPH
- Shanghai Jiao Tong University --- Rujin Hospital

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