

THE IMPACT OF SPECIAL EVENTS ON FREIGHT SPOT MARKET

SCM 2019 RESEARCH FEST



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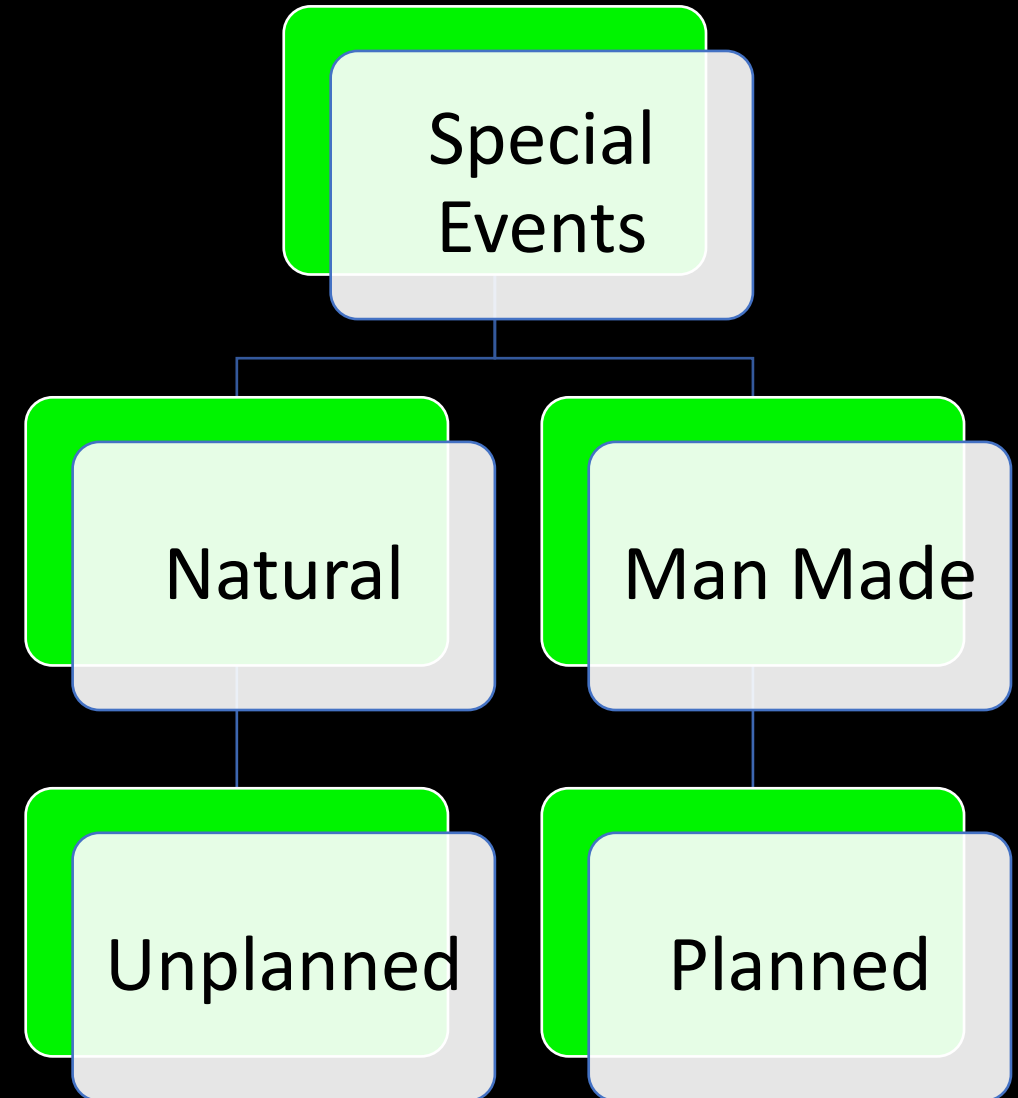
Adam Gard

Outline

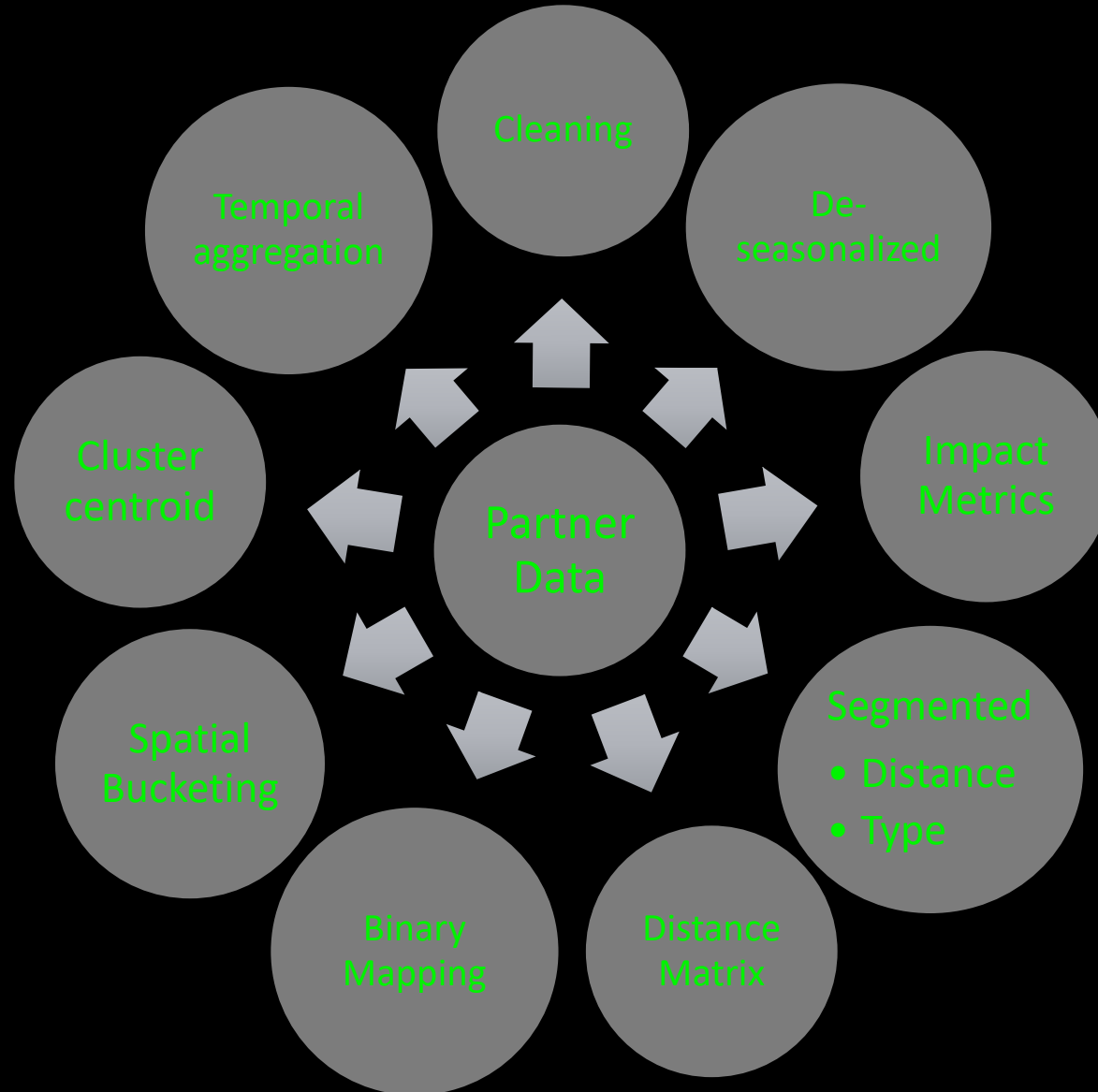
- Hypothesis
- Methodology
- Impact Measurement
- Initial Theory
- Challenges and Limitation
- Sample Models
- Research Time-lapse
- Takeaways

Hypothesis

- We believe changes in freight spot market rate are influenced by natural phenomenon and man made activities
- Market position as time of event is a factor in nature of response



Methodology



Measuring Impact

Dependent variables

- Cost per mile
- Freight Volume

Independent variables

- Inbound/Outbound
- Distance
- Time from event

Other triggers

- Population density
- Normalization of special events

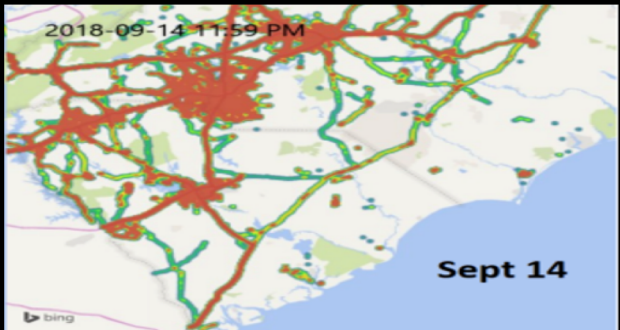


Initial Theory

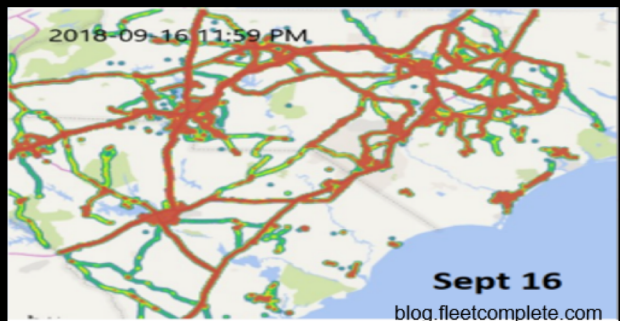
Location vs Time (Florence)



Day Before Landfall



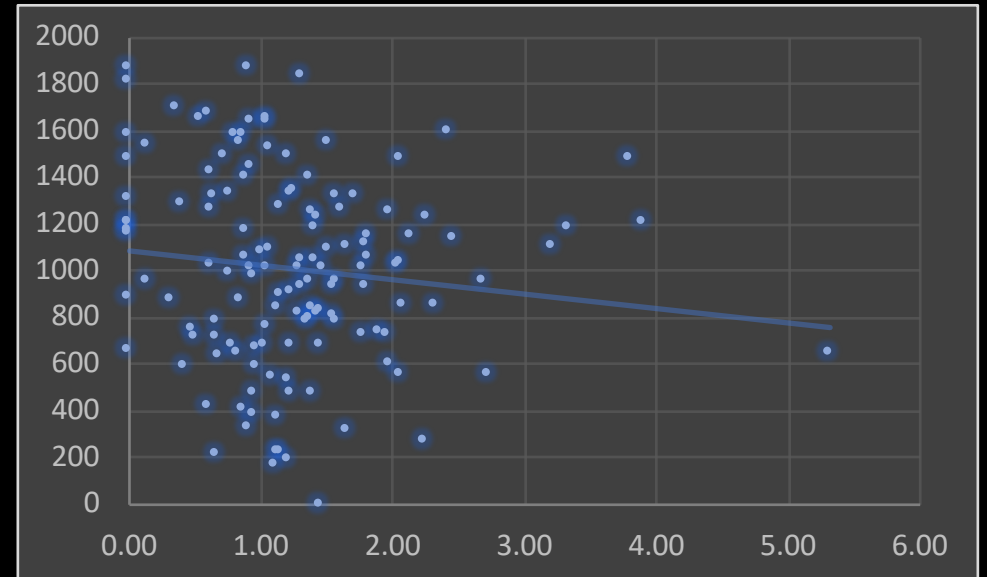
Landfall



2 Days Post Landfall

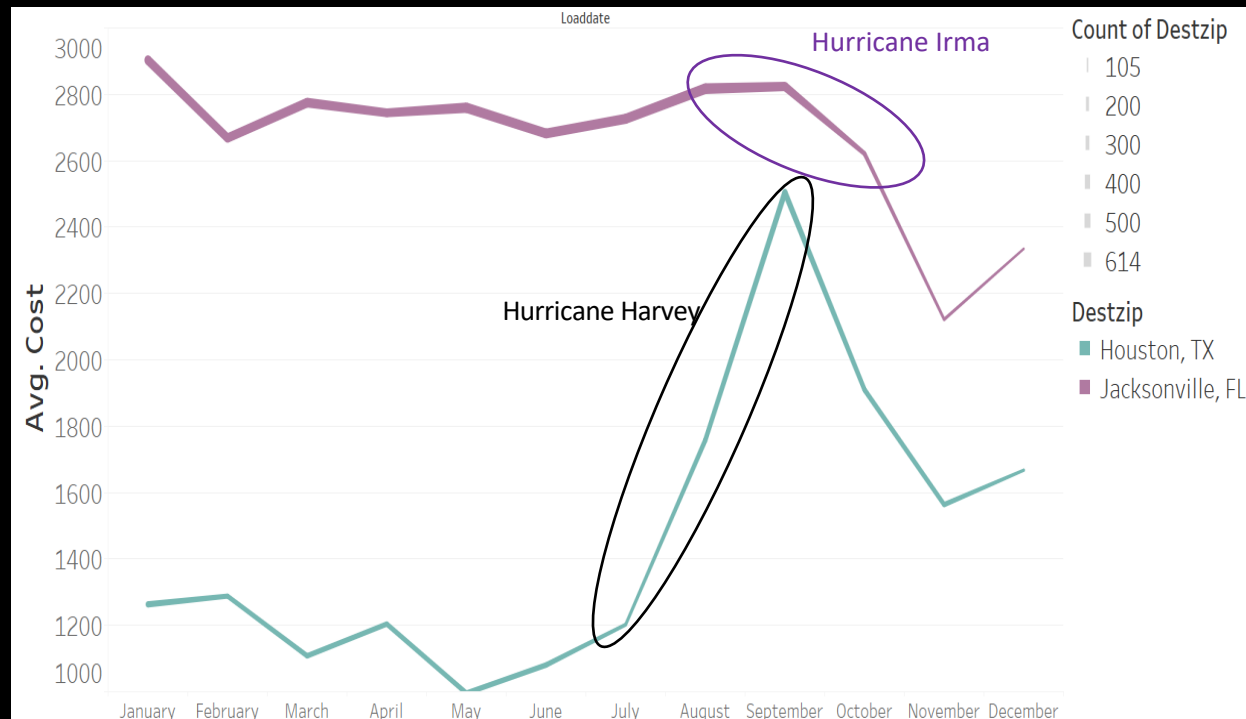
Linear Regression

Linear regression has been the “de facto” method for determining correlation within the transportation sector



Single Variable Linear Regression of Harvey's Landfall

Initial Theory



0.89	0.94	1.00	1.00	0.97	0.95	0.94	0.98	0.95	0.96	0.97	0.94	0.89	0.82	0.97	0.79	1.09	0.90	1.39	0.80	0.94	0.75	1.02
0.95	0.92	0.97	0.91	0.96	0.95	0.92	0.92	0.94	0.94	0.89	0.99	1.23	0.77	0.80	0.94	0.78	0.98	1.23	0.96	0.97	0.76	0.95
0.82	0.98	0.99	0.92	0.96	0.98	0.96	1.01	0.94	0.93	0.85	0.78	1.19	0.92	0.88	0.84	1.15	0.98	1.15	0.69	0.95	0.80	0.97
0.75	0.97	1.00	0.98	0.97	1.00	0.95	0.88	0.86	0.97	0.84	1.00	1.13	0.90	0.91	0.92	1.14	0.96	1.23	1.18	0.98	0.75	0.99
1.06	0.98	1.00	0.94	0.96	1.00	0.98	1.00	1.00	0.79	0.84	0.93	0.94	0.82	0.95	0.85	1.05	0.92	1.31	0.97	1.00	0.84	1.04
1.01	0.93	1.02	0.98	0.94	1.01	0.92	1.01	0.93	0.84	0.89	0.89	1.01	0.80	0.94	0.87	1.06	0.90	1.17	0.79	1.01	0.90	1.04
0.94	0.93	1.07	0.94	0.97	1.02	0.92	0.91	0.86	0.98	0.90	0.78	0.93	0.76	1.03	0.63	1.17	0.98	1.31	0.70	0.98	0.82	1.03
0.92	0.89	1.01	1.03	1.04	1.00	0.99	0.99	0.90	0.75	0.85	0.83	0.99	0.83	1.06	0.76	1.03	0.90	1.16	0.60	0.98	0.77	0.97
1.06	1.03	1.06	1.02	1.03	1.00	0.95	0.92	0.98	1.01	0.86	0.76	0.93	0.81	0.92	0.94	1.12	1.09	1.30	1.05	1.02	0.80	1.04
1.07	0.99	1.02	1.08	1.01	0.98	0.93	1.00	0.95	0.92	0.87	0.91	1.05	0.83	0.92	0.83	1.14	1.00	1.27	1.07	0.98	0.75	0.95
0.95	0.93	1.05	1.00	0.98	1.01	0.93	0.93	0.95	0.72	0.85	0.88	1.08	0.87	0.84	0.81	1.14	1.03	1.35	1.04	1.03	0.80	0.95
0.82	0.94	1.02	1.06	0.95	0.99	0.90	0.84	0.93	1.03	0.80	0.84	1.23	0.80	0.84	0.63	1.88	0.98	1.21	1.15	0.98	0.89	1.04
0.97	1.06	1.01	1.04	0.96	1.02	0.96	0.83	1.17	0.97	0.89	0.77	1.02	1.01	0.93	0.87	0.95	1.09	1.30	1.04	0.99	0.97	0.82

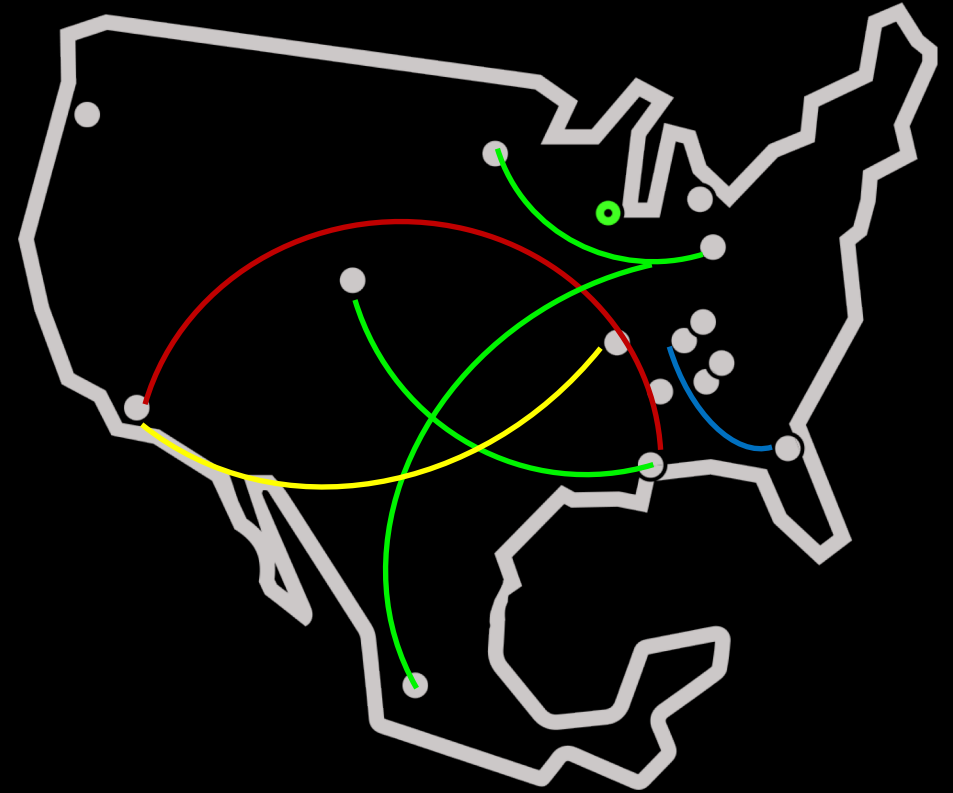
Cost per mile Outbound – Matthew:

1.02	1.01	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.92	0.92	0.93	0.94	0.94	0.95
1.02	1.01	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.92	0.92	0.93	0.94	0.95	0.96
1.02	1.01	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.92	0.92	0.93	0.94	0.95	0.96
1.03	1.01	1.00	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.92	0.93	0.93	0.94	0.95	0.96
1.03	1.01	1.00	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.94	0.94	0.95	0.96
1.03	1.01	1.00	0.99	0.97	0.96	0.95	0.94	0.94	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.94	0.94	0.95	0.96
1.03	1.01	1.00	0.99	0.98	0.96	0.95	0.95	0.94	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.94	0.94	0.95
1.03	1.02	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.94	0.95	0.96	0.96
1.03	1.02	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.94	0.95	0.96	0.97
1.04	1.02	1.01	0.99	0.98	0.97	0.96	0.95	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.93	0.94	0.94	0.95	0.96	0.97
1.04	1.02	1.01	1.00	0.98	0.97	0.96	0.95	0.95	0.94	0.93	0.93	0.93	0.93	0.93	0.92	0.93	0.93	0.94	0.95	0.95	0.96	0.97
1.04	1.03	1.01	1.00	0.99	0.97	0.96	0.96	0.95	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94	0.95	0.96	0.96	0.97
1.04	1.03	1.01	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94	0.95	0.96	0.97	0.98

What's going on?

Challenges and limitations

- Insufficient natural disaster data
- Lack of access to Retail data
- Data gaps
- Limited resources
- No weighting for distance measurements



Models

Train

- Descriptive data set
 - Changes depending on Special Event
 - Correlates with tested KPI
- Data set
 - Ranged from 2012-2016
 - Contains over 27k data points
- Consistent procedures
 - All models followed the same training technique

Validation

- Set expectations
- Supported findings

Test

- Performed tests for each of the KPIs

- Changed minor parameters to test changes

INBOUND	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
-5	1.15	1.20	1.24	1.28	1.31	1.34	1.36	1.37	1.37	1.37	1.36	1.33	1.30	1.27	1.22	1.18	1.12	1.06	1.00
-4	1.09	1.14	1.19	1.23	1.26	1.28	1.30	1.31	1.32	1.32	1.31	1.29	1.27	1.24	1.21	1.16	1.12	1.06	1.00
-3	1.04	1.09	1.14	1.18	1.21	1.23	1.25	1.26	1.27	1.26	1.25	1.24	1.22	1.19	1.15	1.11	1.06	1.01	0.94
-2	1.00	1.05	1.09	1.13	1.16	1.19	1.20	1.21	1.22	1.22	1.21	1.19	1.17	1.14	1.10	1.06	1.01	0.96	0.89
-1	0.96	1.01	1.05	1.09	1.12	1.14	1.16	1.17	1.17	1.17	1.16	1.15	1.12	1.09	1.06	1.02	0.97	0.91	0.85
0	0.92	0.97	1.02	1.05	1.08	1.11	1.12	1.13	1.14	1.13	1.12	1.11	1.08	1.05	1.02	0.97	0.93	0.87	0.81
1	0.89	0.94	0.98	1.02	1.05	1.07	1.09	1.10	1.10	1.10	1.09	1.07	1.05	1.02	0.98	0.94	0.89	0.83	0.77
2	0.86	0.91	0.96	0.99	1.02	1.04	1.06	1.07	1.07	1.07	1.06	1.04	1.02	0.99	0.95	0.91	0.86	0.80	0.74
3	0.84	0.89	0.93	0.97	1.00	1.02	1.04	1.05	1.05	1.04	1.03	1.02	0.99	0.96	0.93	0.88	0.83	0.77	0.71
4	0.82	0.87	0.91	0.95	0.98	1.00	1.02	1.03	1.03	1.02	1.01	1.00	0.97	0.94	0.90	0.86	0.81	0.75	0.69
5	0.81	0.86	0.90	0.94	0.97	0.99	1.00	1.01	1.01	1.01	1.00	0.98	0.96	0.92	0.89	0.84	0.79	0.73	0.67
6	0.80	0.85	0.89	0.93	0.96	0.98	0.99	1.00	1.00	1.00	0.99	0.97	0.94	0.91	0.87	0.83	0.78	0.72	0.66
7	0.80	0.85	0.89	0.92	0.95	0.97	0.99	1.00	1.00	0.99	0.98	0.96	0.94	0.90	0.87	0.82	0.77	0.71	0.65
8	0.80	0.85	0.89	0.92	0.95	0.97	0.99	1.00	0.99	0.98	0.96	0.93	0.90	0.86	0.82	0.77	0.71	0.64	0.64
9	0.81	0.85	0.89	0.93	0.96	0.98	0.99	1.00	1.00	0.99	0.98	0.96	0.94	0.90	0.86	0.82	0.77	0.71	0.64
10	0.82	0.86	0.90	0.94	0.96	0.98	1.00	1.01	1.01	1.00	0.99	0.97	0.94	0.91	0.87	0.82	0.77	0.71	0.65
11	0.83	0.88	0.92	0.95	0.98	1.00	1.01	1.02	1.02	1.01	1.00	0.98	0.95	0.92	0.88	0.84	0.78	0.72	0.66
12	0.85	0.90	0.94	0.97	1.00	1.02	1.03	1.04	1.04	1.03	1.02	1.00	0.97	0.94	0.90	0.85	0.80	0.74	0.67

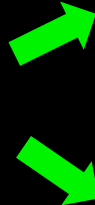
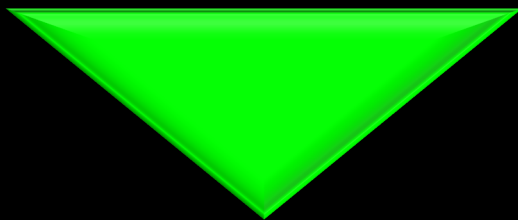
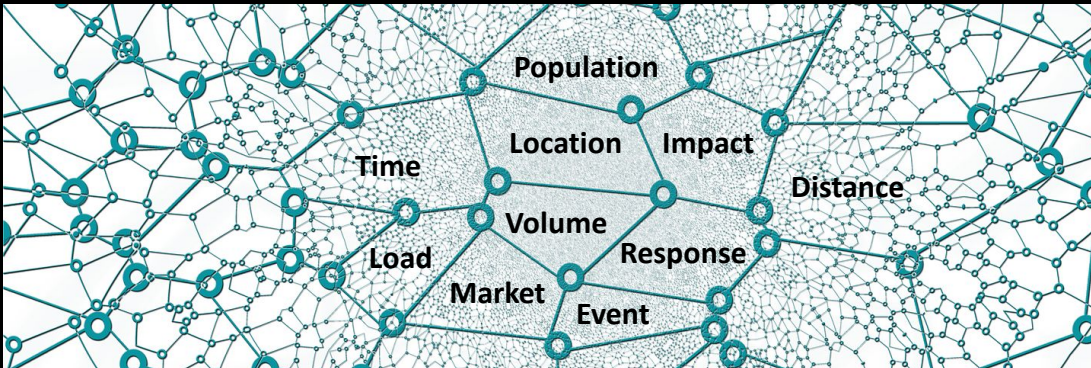
CPM	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
-5	1.00	1.02	1.04	1.06	1.07	1.08	1.08	1.08	1.08	1.07	1.06	1.04	1.02	1.00	0.97	0.94	0.91	0.87	0.83
-4	1.01	1.03	1.05	1.07	1.08	1.09	1.10	1.10	1.09	1.08	1.06	1.04	1.02	1.00	0.97	0.93	0.89	0.85	0.81
-3	1.02	1.04	1.06	1.08	1.10	1.11	1.11	1.11	1.10	1.09	1.07	1.04	1.02	1.00	0.97	0.93	0.89	0.85	0.81
-2	1.03	1.05	1.08	1.09	1.11	1.12	1.12	1.13	1.12	1.12	1.11	1.10	1.08	1.06	1.04	1.01	0.98	0.94	0.90
-1	1.04	1.06	1.09	1.10	1.12	1.13	1.14	1.14	1.14	1.14	1.13	1.12	1.10	1.08	1.06	1.03	1.00	0.96	0.93
0	1.05	1.07	1.10	1.12	1.13	1.14	1.15	1.16	1.16	1.15	1.15	1.13	1.12	1.10	1.08	1.05	1.02	0.99	0.95
1	1.05	1.08	1.11	1.13	1.14	1.16	1.16	1.17	1.17	1.17	1.16	1.15	1.14	1.12	1.10	1.07	1.04	1.01	0.97
2	1.06	1.09	1.12	1.14	1.16	1.17	1.18	1.18	1.19	1.19	1.18	1.17	1.16	1.14	1.12	1.10	1.07	1.03	1.00
3	1.07	1.10	1.13	1.15	1.17	1.18	1.19	1.20	1.20	1.20	1.19	1.18	1.16	1.14	1.12	1.10	1.06	1.02	0.98
4	1.08	1.11	1.14	1.16	1.18	1.20	1.21	1.21	1.22	1.22	1.21	1.21	1.20	1.18	1.16	1.14	1.11	1.08	1.05
5	1.09	1.12	1.15	1.17	1.19	1.21	1.22	1.23	1.23	1.23	1.23	1.22	1.21	1.20	1.18	1.16	1.13	1.10	1.07
6	1.10	1.13	1.16	1.18	1.20	1.22	1.23	1.24	1.25	1.25	1.24	1.23	1.22	1.20	1.18	1.16	1.13	1.10	1.07
7	1.11	1.14	1.17	1.19	1.22	1.23	1.25	1.26	1.26	1.27	1.27	1.26	1.25	1.24	1.22	1.20	1.18	1.15	1.12
8	1.12	1.15	1.18	1.21	1.23	1.25	1.26	1.27	1.28	1.28	1.28	1.27	1.26	1.24	1.22	1.20	1.17	1.14	1.11
9	1.12	1.16	1.19	1.22	1.24	1.26	1.28	1.29	1.30	1.30	1.30	1.29	1.28	1.26	1.25	1.22	1.20	1.17	1.14
10	1.13	1.17	1.20	1.23	1.25	1.27	1.29	1.30	1.31	1.32	1.32	1.31	1.30	1.29	1.27	1.25	1.22	1.19	1.16
11	1.14	1.18	1.21	1.24	1.27	1.29	1.30	1.32	1.33	1.33	1.33	1.32	1.31	1.29	1.27	1.25	1.22	1.19	1.16
12	1.15	1.19	1.22	1.25	1.28	1.30	1.32	1.33	1.34	1.35	1.35	1.35	1.34	1.33	1.31	1.29	1.27	1.24	1.21

OUTBOUND	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
-5	1.41	1.46	1.51	1.54	1.56	1.57	1.58	1.57	1.56	1.53	1.50	1.46	1.41	1.34	1.27	1.19	1.10	1.00	0.89
-4	1.30	1.35	1.39	1.42	1.45	1.46	1.47	1.46	1.45	1.42	1.39	1.35	1.30	1.24	1.17	1.09	1.00	0.90	0.79
-3	1.19	1.25	1.29	1.32	1.35	1.36	1.37	1.36	1.35	1.33	1.30	1.25	1.20	1.14	1.07	0.99	0.90	0.81	0.70
-2	1.10	1.16	1.20	1.24	1.26	1.28	1.28	1.27	1.25	1.21	1.17	1.12	1.06	0.99	0.91	0.83	0.73	0.62	0.62
-1	1.03	1.08	1.13	1.16	1.19	1.21	1.21	1.21	1.20	1.18	1.15	1.11	1.06	1.00	0.93	0.85	0.76	0.67	0.56
0	0.97	1.02	1.07	1.11	1.13	1.15	1.16	1.15	1.14	1.12	1.09	1.05	1.00	0.94	0.88	0.80	0.71	0.62	0.51
1	0.92	0.98	1.02	1.06	1.09	1.11	1.11	1.11	1.10	1.08	1.05	1.01	0.96	0.91	0.84	0.76	0.68	0.58	0.48
2	0.89	0.95	0.99	1.03	1.06	1.08	1.08	1.07	1.05	1.03	0.99	0.94	0.88	0.82	0.74	0.65	0.56	0.46	0.46
3	0.87	0.93	0.98	1.01	1.04	1.06	1.07	1.07	1.06	1.04	1.01	0.98	0.93	0.87	0.81	0.73	0.65	0.55	0.45
4	0.87	0.92	0.97	1.01	1.04	1.06	1.07	1.07	1.06	1.04	1.02	0.98	0.93	0.88	0.81	0.74	0.65	0.56	0.46
5	0.88	0.93	0.98	1.02	1.05	1.07	1.08	1.08	1.06	1.03	0.99	0.95	0.89	0.83	0.75	0.67	0.58	0.48	0.48
6	0.90	0.96	1.01	1.05	1.08	1.10	1.11	1.11	1.10	1.09	1.06	1.02	0.98	0.93	0.86	0.79	0.71	0.61	0.51
7	0.94	1.00	1.05	1.09	1.12	1.14	1.15	1.15	1.13	1.10	1.07	1.02	0.97	0.91	0.83	0.75	0.66	0.56	0.56
8	0.99	1.05	1.10	1.14	1.17	1.19	1.20	1.21	1.20	1.19	1.16	1.13	1.08	1.03	0.97	0.90	0.81	0.72	0.62
9	1.05	1.11	1.16	1.21	1.24	1.26	1.27	1.28	1.27	1.26	1.23	1.20	1.16	1.10	1.04	0.97	0.89	0.80	0.70
10	1.13	1.19	1.24	1.29	1.32	1.34	1.36	1.36	1.34	1.32	1.29	1.24	1.19	1.13	1.06	0.98	0.89	0.79	0.79
11	1.22	1.29	1.34	1.38	1.41	1.44	1.45	1.46	1.45	1.44	1.42	1.39	1.34	1.29	1.23	1.16	1.08	0.99	0.89
12	1.33	1.39	1.45	1.49	1.52	1.55	1.56	1.57	1.57	1.55	1.53	1.50	1.46	1.41	1.35	1.28	1.20	1.11	1.01

OUTBOUND	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
-5	1.44	1.49	1.53	1.55	1.57	1.58	1.59	1.52	1.56	1.53	1.50	1.45	1.40	1.08	1.27	1.18	1.09	1.00	0.89
-4	1.33	1.38	1.41	1.44	1.46	1.47	1.48	1.47	1.45	1.43	1.39	1.35	1.30	1.23	1.16	1.08	0.99	0.89	0.79
-3	1.23	1.28	1.31	1.34	1.36	1.37	1.38	1.37	1.36	1.33	1.30	1.26	1.20	1.14	1.07	0.99	0.90	0.80	0.70
-2	1.14	1.19	1.23	1.26	1.28	1.29	1.30	1.30	1.28	1.25	1.22	1.18	1.12	1.06	0.98	0.90	0.82	0.73	0.63
-1	1.07	1.12	1.16	1.19	1.21	1.22	1.23	1.22	1.21	1.19	1.15	1.11	1.06	1.00	0.93	0.85	0.77	0.67	0.56
0	0.75	0.80	0.84	0.87	0.89	1.17	1.17	1.17	1.15	1.13	1.10	1.08	1.01	0.95	0.88	0.84	0.72	0.62	0.52
1	0.70	0.75	0.79	0.83	0.85	1.12	1.13	1.13	1.11	1.08	1.06	1.02	0.97	0.91	0.84	0.77	0.68	0.59	0.48
2	0.67	0.72	0.76	0.79	0.82	1.10	1.10	1.10	1.09	1.07	1.04	1.00	0.95	0.89	0.82	0.75	0.66	0.57	0.46
3	0.65	0.70	0.74	0.78	0.80	0.82	0.83	0.82	0.81	0.79	1.02	0.98	0.94	0.88	0.81	0.74	0.65	0.56	0.46
4	0.90	0.96	1.00	1.04	1.06	0.82	0.82	0.82	0.81	0.79	1.02	0.99	0.94	0.88	0.82	0.74	0.66	0.57	0.46
5	0.91	0.96	1.01	1.05	1.07	0.83	0.84	0.84	0.83	0.81	1.04	1.00	0.96	0.90	0.83	0.76	0.68	0.59	0.48
6	0.93	0.99	1.03	1.07	1.10	1.11	1.12	1.11	1.11	0.83	1.07	1.03	0.99	0.93	0.87	0.79	0.71	0.62	0.52
7	0.97	1.02	1.07	1.11	1.15	1.16	1.16	1.15	1.14	1.11	1.07	1.03	0.97	0.91	0.84	0.76	0.67	0.57	0.47
8	1.02	1.07	1.12	1.16	1.19	1.20	1.22	1.22	1.21	1.19	1.17	1.13	1.09	1.03	0.97	0.90	0.82	0.73	0.63
9	1.08	1.13	1.18	1.22	1.25	1.27	1.28	1.28	1.28	1.26	1.23	1.20	1.16	1.10	1.04	0.97	0.89	0.80	0.70
10	1.15	1.21	1.26	1.30	1.33	1.35	1.36	1.36	1.36	1.34	1.32	1.28	1.24	1.19	1.13	1.06	0.98	0.89	0.79
11	1.24	1.30	1.35	1.39	1.42	1.44	1.45	1.46	1.45	1.44	1.41	1.38	1.34	1.29	1.23	1.16	1.08	0.99	0.89
12	1.34	1.40	1.45	1.48	1.53	1.55	1.56	1.57	1.56	1.55	1.52	1.49	1.45	1.40	1.34	1.27	1.19	1.10	1.01

Key Takeaways

- As this field of study moves forward, advanced machine learning could provide deeper insights



- Temporal-spatial relationships exist, but their complexity CANNOT be understood by Multivariable Linear Regression

Best Case

Regression Statistics	
Multiple R	0.386444
R Square	0.149339
Adjusted R Square	0.147248
Standard Error	0.569471
Observations	2448

Worst Case

Regression Statistics	
Multiple R	0.16848
R Square	0.028385
Adjusted R Square	0.018742
Standard Error	202.0495
Observations	408

Reality

OUTBOUND	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
0	1.16	0.93	1.19	1.31	1.00	1.30	1.37	1.51	1.22	1.32	1.37	0.84	1.06	1.03	0.86	0.63	0.61	0.35	0.41
1	0.84	0.80	1.02	1.00	1.05	0.96	0.95	1.19	0.91	1.09	1.23	0.54	0.80	0.93	0.64	0.44	1.02	0.58	0.53
2	1.13	0.25	0.90	0.93	0.82	0.68	0.61	0.73	0.72	0.86	0.59	0.47	0.85	0.86	0.58	0.57	0.43	0.29	0.29
3	1.13	0.49	0.60	0.72	0.86	0.41	0.75	0.79	0.95	0.79	0.56	0.96	0.78	0.49	0.86	0.55	0.57	0.90	0.20
4	0.27	0.51	0.60	0.91	0.66	0.78	0.89	1.16	0.90	0.75	0.80	1.10	0.97	0.60	1.05	0.61	0.89	0.83	0.37
5	0.55	1.04	1.03	1.41	0.87	0.98	1.13	1.19	1.27	1.09	1.06	1.27	0.81	0.90	0.80	0.62	0.78	0.23	0.63
6	0.52	1.02	1.23	1.60	0.87	1.17	1.22	1.03	0.98	1.17	1.36	1.04	0.95	1.02	1.04	0.77	1.39	0.58	0.46
7	1.26	0.99	1.15	1.53	1.40	1.41	1.25	1.40	1.29	1.22	1.33	1.07	0.97	1.49	1.12	0.91	0.93	0.29	0.48
8	0.95	0.96	1.21	1.60	1.22	1.27	1.27	1.32	1.33	1.36	1.40	1.13	1.43	1.11	1.26	0.72	1.02	0.36	0.62
9	1.49	1.87	1.00	1.97	1.23	1.39	1.06	1.06	1.09	1.05	1.12	0.82	0.66	1.33	0.76	0.74	0.55	0.45	0.57
10	1.20	0.94	1.19	1.43	1.50	1.44	1.49	2.13	1.66	1.31	1.38	1.14	1.23	1.32	1.44	0.83	1.11	1.50	0.54
11	1.33	1.21	1.42	1.50	1.26	1.65	1.47	1.32	1.53	1.29	1.39	1.12	1.39	1.17	1.31	1.03	1.08	2.22	0.54
12	1.09	1.25	1.42	1.31	1.39	1.35	1.55	1.54	1.52	1.46	1.47	1.17	1.23	1.29	1.48	1.10	1.08	2.56	0.63

Model

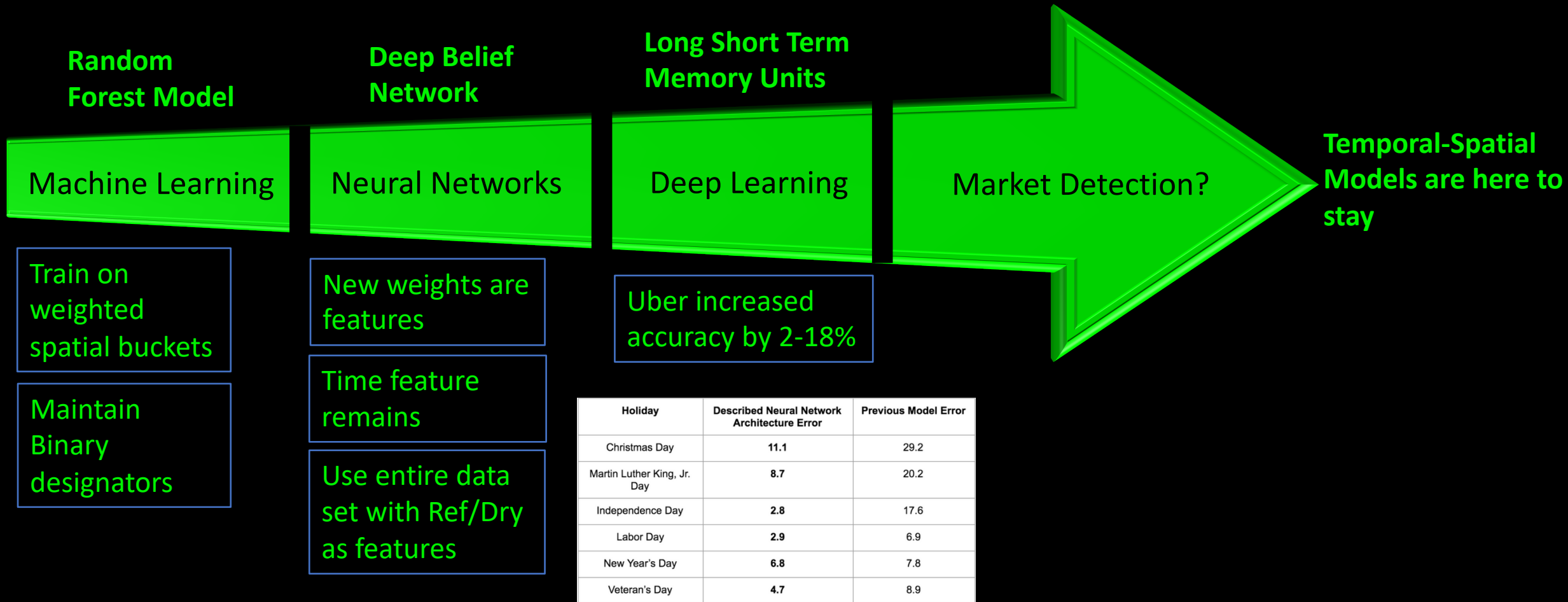
OUTBOUND	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800
0	0.79	0.85	0.90	0.94	0.97	0.99	1.01	1.01	1.01	1.00	0.98	0.95	0.91	0.86	0.81	0.74	0.67	0.58	0.49
1	0.78	0.84	0.89	0.93	0.96	0.99	1.00	1.01	1.00	0.99	0.97	0.94	0.90	0.85	0.79	0.73	0.65	0.57	0.48
2	0.79	0.85	0.90	0.94	0.97	0.99	1.01	1.01	1.01	0.99	0.97	0.94	0.90	0.85	0.79	0.73	0.65	0.57	0.47
3	0.81	0.86	0.91	0.95	0.98	1.00	1.02	1.02	1.02	1.00	0.98	0.95	0.91	0.86	0.80	0.73	0.66	0.57	0.48
4	0.83	0.89	0.94	0.98	1.01	1.03	1.04	1.04	1.04	1.02	1.00	0.97	0.93	0.88	0.82	0.75	0.68	0.59	0.50
5	0.87	0.92	0.97	1.01	1.04	1.06	1.07	1.08	1.07	1.05	1.03	1.00	0.96	0.91	0.85	0.78	0.70	0.62	0.52
6	0.91	0.97	1.01	1.05	1.08	1.10	1.11	1.12	1.11	1.09	1.07	1.04	1.00	0.94	0.88	0.82	0.74	0.65	0.56
7	0.97	1.02	1.07	1.11	1.13	1.15	1.16	1.17	1.16	1.14	1.12	1.09	1.04	0.99	0.93	0.86	0.78	0.70	0.60
8	1.03	1.08	1.13	1.17	1.20	1.22	1.23	1.23	1.22	1.20	1.18	1.14	1.10	1.05	0.99	0.92	0.84	0.75	0.65
9	1.10	1.16	1.20	1.24	1.27	1.29	1.30	1.30	1.29	1.27	1.25	1.21	1.17	1.12	1.05	0.98	0.90	0.82	0.72
10	1.19	1.24	1.28	1.32	1.35	1.37	1.38	1.38	1.37	1.35	1.32	1.29	1.24	1.19	1.13	1.06	0.98	0.89	0.79
11	1.28	1.33	1.38	1.41	1.44	1.46	1.46	1.46	1.46	1.44	1.41	1.37	1.33	1.28	1.21	1.14	1.06	0.97	0.87
12	1.38	1.43	1.48	1.51	1.54	1.56	1.56	1.56	1.55	1.53	1.51	1.47	1.43	1.37	1.31	1.24	1.16	1.07	0.97

- Complete data sets hold the key



- Of 136 Clusters, only 22 had data directly associated with Houston during 2017
- 6.5mil points to 47k

Future Research



Questions



Thank You!