

Research Experience for Teachers: Mitigating Natural Disasters



NDSU

NORTH DAKOTA STATE UNIVERSITY

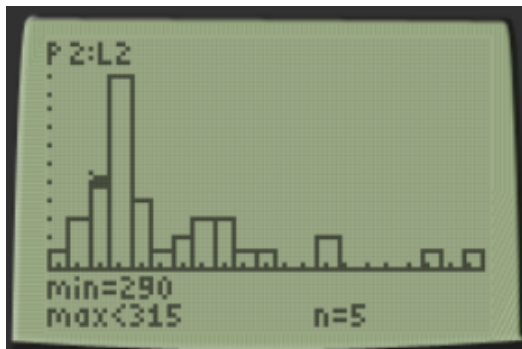
Get a Move on: Do Autonomous Vehicles improve Traffic Flow?

Unit Assessment

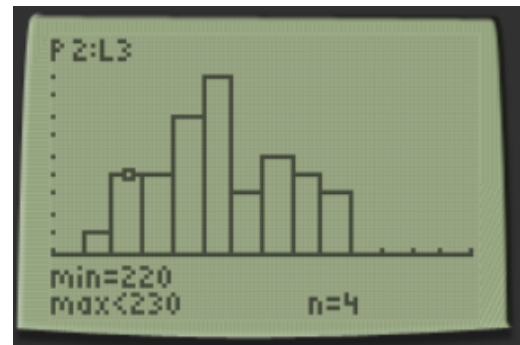
1. Describe the shape of the distribution using the suggestions in the word bank.

Curved	Symmetric	Slanty	Bi-modal
Skewed Left	Skewed Right	Uniform	Skewed Over
Mound Shaped	Crescent Shaped	Wiggly	

a. 90% AV – Cautious



b. 90% AV – Normal



2. Using the Queue stop data for both the **0% AV** and the **90% Aggressive AV**.

a) Construct and label Box Plots.

b) Report the mean, standard deviation, the intervals, and the percentage of observations that fall within 1, 2, and 3 standard deviation of the mean.

Queue stops		0% AV	90%AV Cautious	90%AV Normal	90%AV Aggressive	Sort ascending order	
Run	TIME INT	S	QSTOPS	QSTOPS	QSTOPS	QSTOP S	90%AV Aggressive QSTOPS
1	900-1800	2	312	436	297	235	228 211
1	1800-2700	2	299	390	284	269	233 214
1	2700-3600	2	234	316	223	220	233 220
1	3600-4500	2	247	290	243	231	234 220
2	900-1800	2	258	302	246	239	238 221
2	1800-2700	2	258	322	246	232	240 222
2	2700-3600	2	285	385	274	260	243 224
2	3600-4500	2	303	439	279	258	244 227
3	900-1800	2	271	316	259	249	246 228
3	1800-2700	2	291	446	270	261	247 229
3	2700-3600	2	249	290	242	235	248 231
3	3600-4500	2	233	281	222	214	249 231
4	900-1800	2	228	307	213	211	252 232
4	1800-2700	2	273	318	246	229	254 234
4	2700-3600	2	289	707	282	274	258 234
4	3600-4500	2	329	1594	296	241	258 235
5	900-1800	2	267	330	256	240	262 235
5	1800-2700	2	248	332	237	222	264 235
5	2700-3600	2	280	441	267	246	265 239
5	3600-4500	2	312	587	294	280	267 240
6	900-1800	2	254	276	240	227	269 241
6	1800-2700	2	243	338	253	224	271 241
6	2700-3600	2	301	342	282	258	273 244
6	3600-4500	2	246	323	238	234	275 245
7	900-1800	2	311	479	276	247	277 246
7	1800-2700	2	262	448	259	248	278 246
7	2700-3600	2	289	320	266	246	280 247
7	3600-4500	2	275	335	257	247	285 247
8	900-1800	2	238	289	228	221	285 248
8	1800-2700	2	252	339	245	234	289 249
8	2700-3600	2	306	426	284	265	289 253
8	3600-4500	2	285	742	274	266	291 258
9	900-1800	2	240	244	238	228	299 258
9	1800-2700	2	264	361	255	244	301 260
9	2700-3600	2	269	364	257	245	303 261
9	3600-4500	2	233	313	228	220	306 265
10	900-1800	2	244	411	239	231	311 266
10	1800-2700	2	278	351	256	241	312 269
10	2700-3600	2	265	502	250	235	312 274

10 3600-4500 2 277 573 261 253 329 280

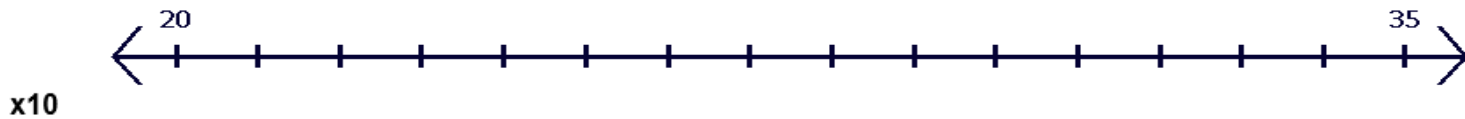
2a. Carefully construct and label both box plots using the number lines below.

0% AV:

Median: _____

Range: _____

IQR: _____



90% aggressive AV:

Median: _____

Range: _____

IQR: _____



2b. **0% AV:**

\bar{x} = _____ s = _____

$(\bar{x} - s, \bar{x} + s)$: (_____, _____)

_____ % of observations

$(\bar{x} - 2s, \bar{x} + 2s)$: (_____, _____)

_____ % of observations

$(\bar{x} - 3s, \bar{x} + 3s)$: (_____, _____)

90% Aggressive AV

\bar{x} = _____ s = _____

$(\bar{x} - s, \bar{x} + s)$: (_____, _____)

_____ % of observations

$(\bar{x} - 2s, \bar{x} + 2s)$: (_____, _____)

_____ % of observations

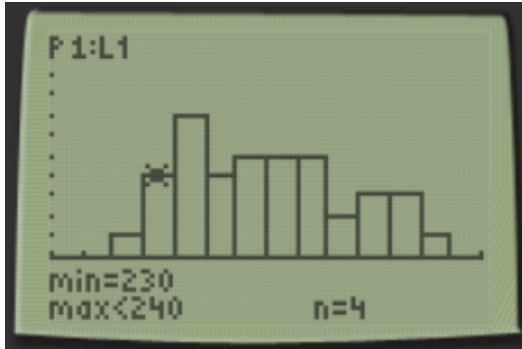
$(\bar{x} - 3s, \bar{x} + 3s)$: (_____, _____)

_____ % of observations

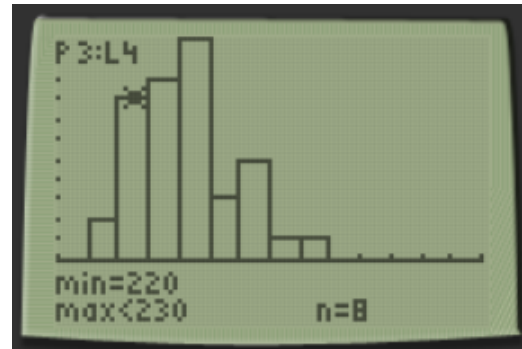
_____ % of observations

3.

a. 0% AV



b. 90% AV – Aggressive



a. Let the random variable X be the number of queue stops in a 15 minute interval when the traffic is 100% human driven vehicles (0% AV).

Find $P(X < 240)$

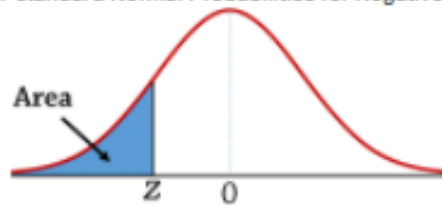
Find $P(X > 300)$

b. Let the random variable X be the number of queue stops in a 15 minute interval when the autonomous vehicle saturation is 90% with aggressive driving behavior.

Find $P(X < 240)$

Find $P(230 < X < 280)$

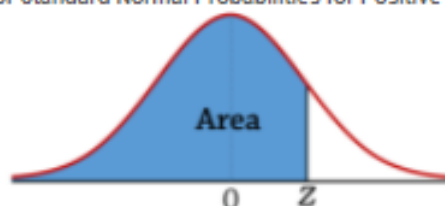
Table of Standard Normal Probabilities for Negative z-scores



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
-3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
-3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
-3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
-3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
-2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
-2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
-2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
-2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
-2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
-2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
-2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
-2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
-2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
-2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
-1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
-1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
-1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
-1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
-1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
-1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
-1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
-1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
-1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
-1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
-0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
-0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
-0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
-0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
-0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
-0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
-0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
-0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
-0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
-0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Figure 1. Table of Standard Normal Probabilities for Negative z-scores. Table entries are "less than" areas.

Table of Standard Normal Probabilities for Positive z-scores



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Figure 2. Table of Standard Normal Probabilities for Positive z-scores. Table entries are "less than" areas.