



**Data Analytics for Information Systems- IS665
Spring 2018**

Project 2 Report

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AUTOMOBILE PRICE ESTIMATION

1. ABOUT THE DATASET

This data set consists of data related to vehicles, this dataset is sourced from UC Irvine machine learning data repository.

2. SOURCE OF DATA OBTAINED

<https://archive.ics.uci.edu/ml/datasets/Automobile>

3. PROJECT OBJECTIVE

Analyze the automobile dataset to determine that factors that help decide the price of an automobile and to develop a model that will enable the customers to estimate the price of automobile based on the listed out make and specifications by the customer.

4. DRIVER AND TARGET VARIABLES

Sr No	Variable name	Target/Driver Variable	Variable Definition
1	Make	Driver Variable	Indicates the manufacturing company of the automobile. (alfa-romero, audi, bmw, chevrolet, dodge, honda, isuzu, jaguar, mazda, mercedes-benz, mercury, mitsubishi, nissan, peugot, plymouth, porsche, renault, saab, subaru, toyota, Volkswagen or Volvo)
2	fuel-type	NA	The type of fuel used by the vehicle (diesel or gas)
3	Aspiration	Driver Variable	Indicates the desired engine performance (Std or Turbo)
4	num-of-doors	Driver Variable	Number of doors in the vehicle (2 or 4)
5	body-style	Driver Variable	The type of chasis of the vehicle (hardtop, wagon, sedan, hatchback or convertible)
6	drive-wheels	Driver Variable	The drive type of the vehicle (2wd or 4wd)
7	engine-location	NA	Location of the engine (Front or Rear)
8	wheel-base	Driver Variable	Distance between the front wheels and the rear wheels (Range: 86.6 to 120.9)

9	Length	Driver Variable	Length of the automobile (Range: 141.1 to 208.1)
10	Width	NA	Width of the automobile (Range: 60.3 to 72.3)
11	Height	Driver Variable	Height of the automobile (Range: 47.8 to 59.8)
12	curb-weight	Driver Variable	The weight of the automobile without occupants or baggage. (Range: 1488 to 4066)
13	engine-type	Driver Variable	Indicates the type of engine used. (dohc, dohcv, l, ohc, ohcf, ohcv or rotor)
14	num-of-cylinders	Driver Variable	Number of cylinders in the engine. (eight, five, four, six, three, twelve or two)
15	engine-size	NA	Size of the engine. (Range: 61 to 326)
16	fuel-system	Driver Variable	Type of the fuel system used. (1bbl, 2bbl, 4bbl, idi, mfi, mpfi, spdi or spfi)
17	Bore	NA	The hollow area inside the cylinder of the engine. (Range: 2.54 to 3.94)
18	Stroke	NA	The size of the piston in the cylinder. (Range: 2.07 to 4.17)
19	compression-ratio	Driver Variable	Compression ratio of fuel and air. (7 to 23)
20	Horsepower	Driver Variable	Power output from the engine. (48 to 288)
21	peak-rpm	NA	RPM on maximum horsepower. (Range: 4150 to 6600)
22	city-mpg	NA	Fuel efficiency in city roads. (Range: 13 to 49)
23	highway-mpg	NA	Fuel efficiency on highway. (Range: 16 to 54)
24	Price	Target Variable	On-road price of the vehicle. (Range: 5118 to 45400)

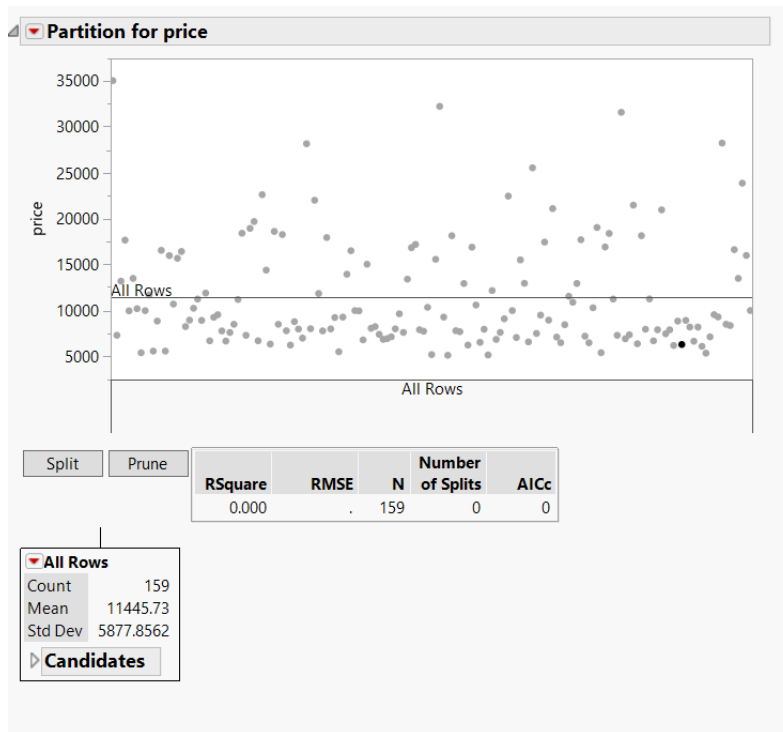
5. DATA SNAPSHOT

	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	length	width	height	curb-weight	engine-type	num-of-cylind...	engine-size	fuel-system	bore	stroke	compression-ratio	horse-power	peak-rpm	city-mpg	highway-mpg	price
1	audi	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	2337	ohc	four	109	mpfi	3.19	3.4	10	102	5500	24	30	13950
2	audi	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	2824	ohc	five	136	mpfi	3.19	3.4	8	115	5500	18	22	17450
3	audi	gas	std	four	sedan	fwd	front	105.8	192.7	71.4	55.7	2844	ohc	five	136	mpfi	3.19	3.4	8.5	110	5500	19	25	17710
4	audi	gas	turbo	four	sedan	fwd	front	105.8	192.7	71.4	55.9	3086	ohc	five	131	mpfi	3.13	3.4	8.3	140	5500	17	20	23875
5	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800	23	29	16430
6	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800	23	29	16925
7	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2710	ohc	six	164	mpfi	3.31	3.19	9	121	4250	21	28	20970
8	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2765	ohc	six	164	mpfi	3.31	3.19	9	121	4250	21	28	21105
9	chevrolet	gas	std	two	hatchback	fwd	front	88.4	141.1	60.3	53.2	1488	l	three	61	2bbl	2.91	3.03	9.5	48	5100	47	53	5151
10	chevrolet	gas	std	two	hatchback	fwd	front	94.5	155.9	63.6	52	1874	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400	38	43	6295
11	chevrolet	gas	std	four	sedan	fwd	front	94.5	158.8	63.6	52	1909	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400	38	43	6575
12	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.41	68	5500	37	41	5572
13	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6377
14	dodge	gas	turbo	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	2128	ohc	four	98	mpfi	3.03	3.39	7.6	102	5500	24	30	7957
15	dodge	gas	std	four	hatchback	fwd	front	93.7	157.3	63.8	50.6	1967	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6229
16	dodge	gas	std	four	sedan	fwd	front	93.7	157.3	63.8	50.6	1989	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6692
17	dodge	gas	std	four	sedan	fwd	front	93.7	157.3	63.8	50.6	1989	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	7609
18	dodge	gas	std	four	wagon	fwd	front	103.3	174.6	64.6	59.8	2335	ohc	four	122	2bbl	3.34	3.46	8.5	88	5000	24	30	8921
19	dodge	gas	turbo	two	hatchback	fwd	front	95.9	173.2	66.3	50.2	2811	ohc	four	156	mfi	3.6	3.9	7	145	5000	19	24	12964
20	honda	gas	std	two	hatchback	fwd	front	86.6	144.6	63.9	50.8	1713	ohc	four	92	1bbl	2.91	3.41	9.6	58	4800	49	54	6479
21	honda	gas	std	two	hatchback	fwd	front	86.6	144.6	63.9	50.8	1819	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	31	38	6855
22	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1837	ohc	four	79	1bbl	2.91	3.07	10.1	60	5500	38	42	5399
23	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1940	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	6529
24	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1956	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	7129
25	honda	gas	std	four	sedan	fwd	front	96.5	163.4	64	54.5	2010	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	7295
26	honda	gas	std	four	wagon	fwd	front	96.5	157.1	63.9	58.3	2024	ohc	four	92	1bbl	2.92	3.41	9.2	76	6000	30	34	7295
27	honda	gas	std	two	hatchback	fwd	front	96.5	167.5	65.2	53.3	2236	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	7895
28	honda	gas	std	two	hatchback	fwd	front	96.5	167.5	65.2	53.3	2289	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	9095
29	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2304	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	8845
30	honda	gas	std	four	sedan	fwd	front	96.5	175.4	62.5	54.1	2372	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	10295
31	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2465	ohc	four	110	mpfi	3.15	3.58	9	101	5800	24	28	12945
32	honda	gas	std	two	sedan	fwd	front	96.5	169.1	66	51	2293	ohc	four	110	2bbl	3.15	3.58	9.1	100	5500	25	31	10345

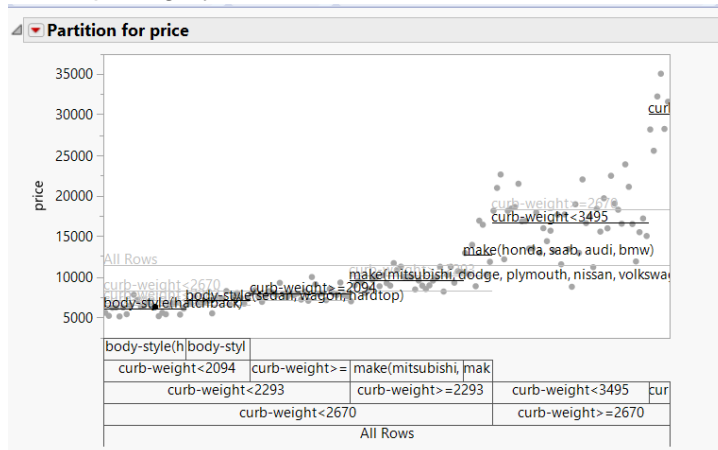
6. PERFORMANCE

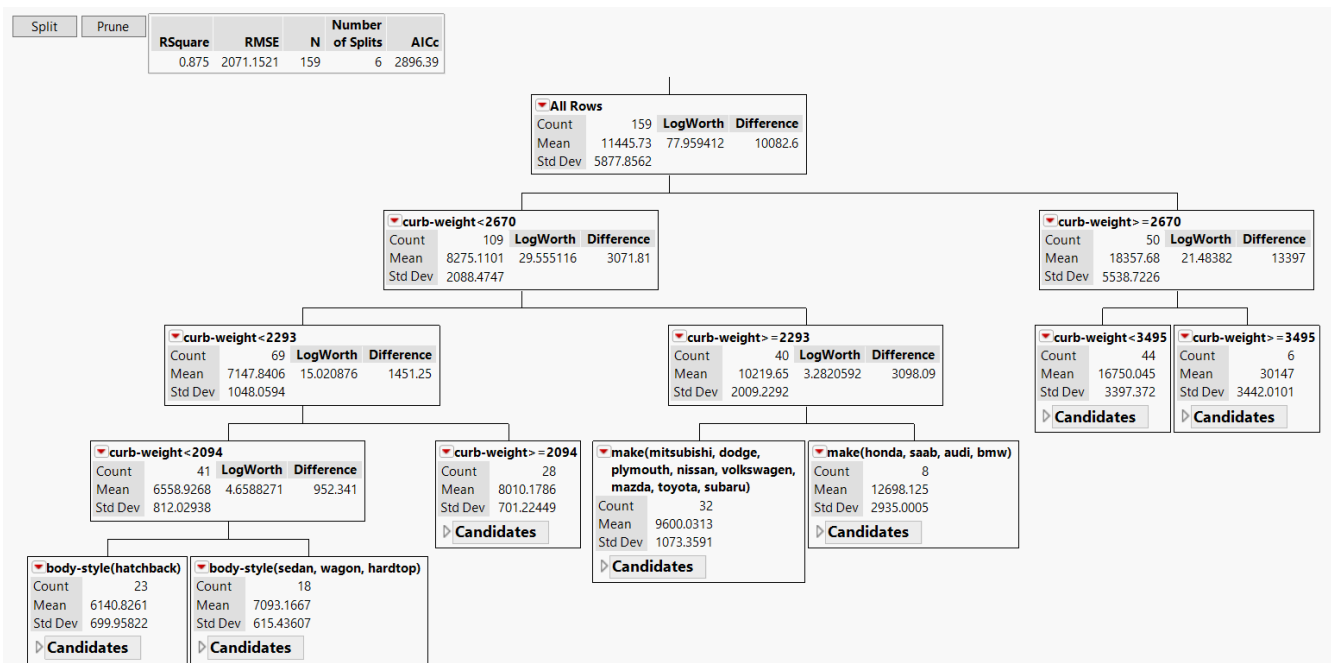
This dataset is a categorical multivariate dataset. In order to predict the price of the automobile (target), predictive algorithms like neural networks, decision tree and linear regression were performed on the dataset to compare the performance and their respective results are discussed below:

6.1. Decision Tree Output

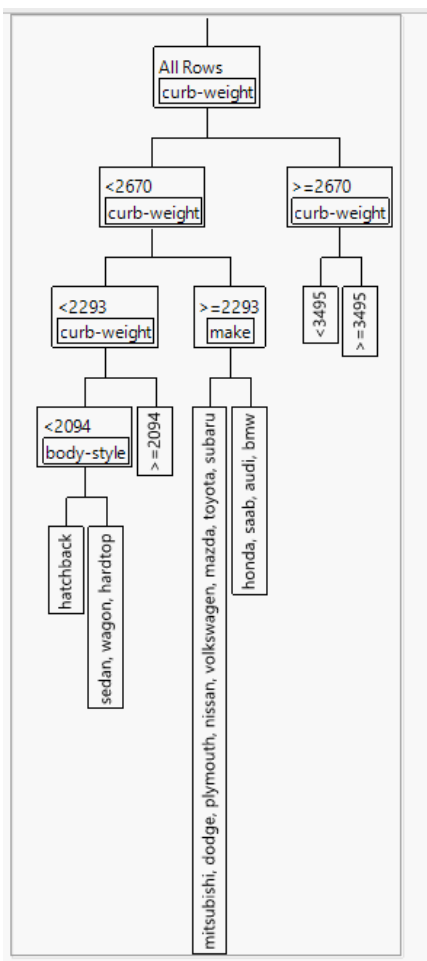


After splitting by best





Small tree view



Leaf Report

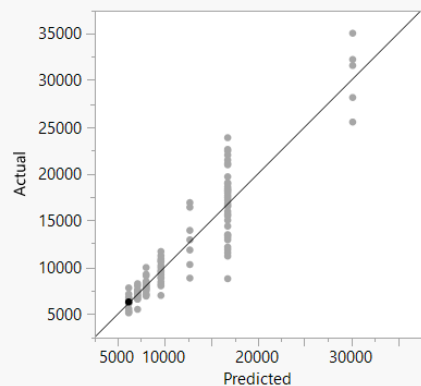
Leaf Label	Mean	Count
curb-weight<2670&curb-weight<2293&curb-weight<2094&body-style(hatchback)	6140.82609	23
curb-weight<2670&curb-weight<2293&curb-weight<2094&body-style(sedan, wagon, hardtop)	7093.16667	18
curb-weight<2670&curb-weight<2293&curb-weight>=2094	8010.17857	28
curb-weight<2670&curb-weight>=2293&make(mitsubishi, dodge, plymouth, nissan, volkswagen, mazda, toyota, subaru)	9600.03125	32
curb-weight<2670&curb-weight>=2293&make(honda, saab, audi, bmw)	12698.125	8
curb-weight>=2670&curb-weight<3495	16750.0455	44
curb-weight>=2670&curb-weight>=3495	30147	6

Prediction Profiler



Actual by Predicted Plot

Training Set



Column Contributions						
Term	Number of Splits	SS				Portion
curb-weight	4	4706128467				0.9852
make	1	61428383.3				0.0129
body-style	1	9158008.98				0.0019
aspiration	0	0				0.0000
num-of-doors	0	0				0.0000
drive-wheels	0	0				0.0000
wheel-base	0	0				0.0000
length	0	0				0.0000
height	0	0				0.0000
engine-type	0	0				0.0000
num-of-cylinders	0	0				0.0000
fuel-system	0	0				0.0000
compression-ratio	0	0				0.0000
horsepower	0	0				0.0000

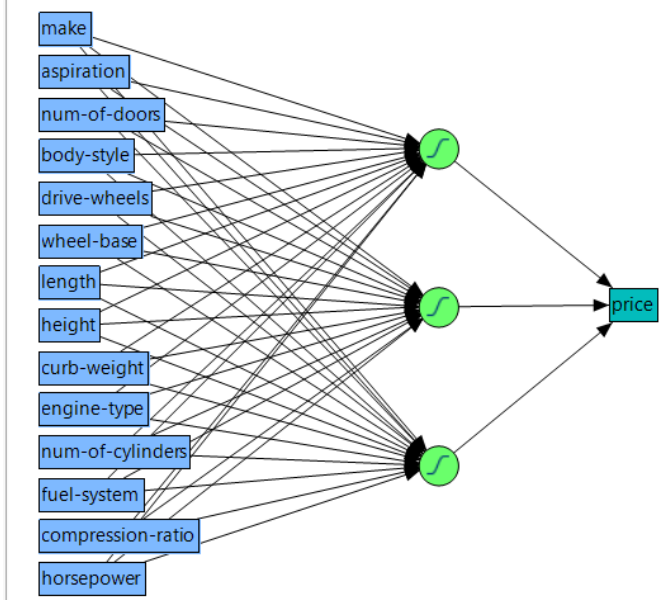
Decision Tree Result Dataset Snapshot

automobile	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	length	width	height	curb-weight	engine-type	num-of-cylinders	engine-size	fuel-system	bore	stroke	compression-ratio	horsepower	peak-rpm	city-mpg	highway-mpg	price	price Predictor
1	audi	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	2337	ohc	four	109	mpfi	3.19	3.4	10	102	5500	24	30	139...	12698.125
2	audi	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	2824	ohc	five	136	mpfi	3.19	3.4	8	115	5500	18	22	174...	16750.045...
3	audi	gas	std	four	sedan	fwd	front	105.8	192.7	71.4	55.7	2844	ohc	five	136	mpfi	3.19	3.4	8.5	110	5500	19	25	177...	16750.045...
4	audi	gas	turbo	four	sedan	fwd	front	105.8	192.7	71.4	55.9	3086	ohc	five	131	mpfi	3.13	3.4	8.3	140	5500	17	20	238...	16750.045...
5	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800	23	29	164...	12698.125
6	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800	23	29	169...	12698.125
7	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2710	ohc	six	164	mpfi	3.31	3.19	9	121	4250	21	28	209...	16750.045...
8	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2765	ohc	six	164	mpfi	3.31	3.19	9	121	4250	21	28	211...	16750.045...
9	chevrolet	gas	std	two	hatchback	fwd	front	88.4	141.1	60.3	53.2	1488	l	three	61	2bbl	2.91	3.03	9.5	48	5100	47	53	5151	6140.826087
10	chevrolet	gas	std	two	hatchback	fwd	front	94.5	155.9	63.6	52	1874	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400	38	43	6295	6140.826087
11	chevrolet	gas	std	four	sedan	fwd	front	94.5	158.8	63.6	52	1909	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400	38	43	6575	7093.1666...
12	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.41	68	5500	37	41	5572	6140.826087
13	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	37	41	5572	6140.826087
14	dodge	gas	turbo	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	2128	ohc	four	98	mpfi	3.03	3.39	7.6	102	5500	24	30	7957	8010.1785...
15	dodge	gas	std	four	hatchback	fwd	front	93.7	157.3	63.8	50.6	1967	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6229	6140.826087
16	dodge	gas	std	four	sedan	fwd	front	93.7	157.3	63.8	50.6	1989	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6692	7093.1666...
17	dodge	gas	std	four	sedan	fwd	front	93.7	157.3	63.8	50.6	1989	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	7609	7093.1666...
18	dodge	gas	std	four	wagon	fwd	front	103.3	174.6	64.6	59.8	2535	ohc	four	122	2bbl	3.34	3.46	8.5	88	5000	24	30	8921	9600.03125
19	dodge	gas	turbo	two	hatchback	fwd	front	95.9	173.2	66.3	50.2	2811	ohc	four	156	mfi	3.6	3.9	7	145	5000	19	24	129...	16750.045...
20	honda	gas	std	two	hatchback	fwd	front	86.6	144.6	63.9	50.8	1713	ohc	four	92	1bbl	2.91	3.41	9.6	58	4800	49	54	6479	6140.826087
21	honda	gas	std	two	hatchback	fwd	front	86.6	144.6	63.9	50.8	1819	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	31	38	6855	6140.826087
22	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1837	ohc	four	79	1bbl	2.91	3.07	10.1	60	5500	38	42	5399	6140.826087
23	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1940	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	6529	6140.826087
24	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1956	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	7129	6140.826087
25	honda	gas	std	four	sedan	fwd	front	96.5	163.4	64	54.5	2010	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	7295	7093.1666...
26	honda	gas	std	four	wagon	fwd	front	96.5	157.1	63.9	58.3	2024	ohc	four	92	1bbl	2.92	3.41	9.2	76	6000	30	34	7295	7093.1666...
27	honda	gas	std	two	hatchback	fwd	front	96.5	167.5	65.2	53.3	2236	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	7895	8010.1785...
28	honda	gas	std	two	hatchback	fwd	front	96.5	167.5	65.2	53.3	2289	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	9095	8010.1785...
29	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2304	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	8845	12698.125
30	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2372	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	102...	12698.125
31	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2465	ohc	four	110	mpfi	3.15	3.58	9	101	5800	24	28	129...	12698.125
32	honda	gas	std	two	sedan	fwd	front	96.5	169.1	66	51	2293	ohc	four	110	2bbl	3.15	3.58	9.1	100	5500	25	31	103...	12698.125

6.2. Neural network output

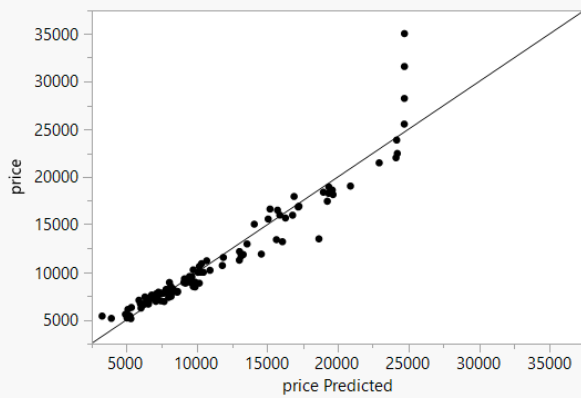
Model NTanH(3)			
Training		Validation	
price		price	
Measures	Value	Measures	Value
RSquare	0.9214488	RSquare	0.8210302
RMSE	1632.0374	RMSE	2503.1898
Mean Abs Dev	947.61831	Mean Abs Dev	1715.6157
-LogLikelihood	934.55144	-LogLikelihood	489.94576
SSE	282335898	SSE	332095827
Sum Freq	106	Sum Freq	53

Diagram

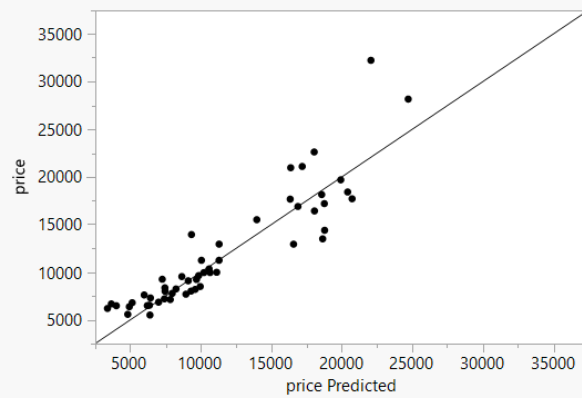


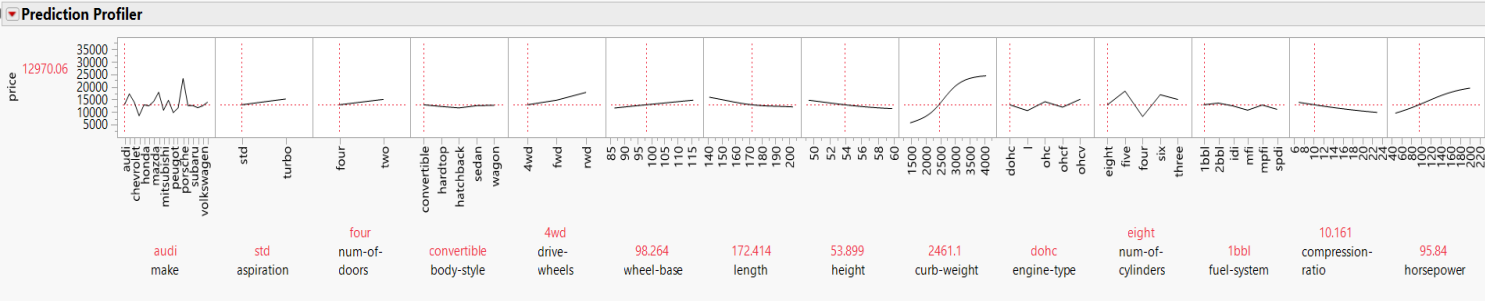
Actual by Predicted Plot

Training



Validation





Neural Net Results Dataset Snapshot

	make	fuel-type	aspiration	num-of-doors	body-style	drive-wheels	engine-location	wheel-base	length	width	height	curb-weight	engine-type	num-of-cylinders	engine-size	fuel-system	bore	stroke	compressi-on-ratio	horse power	peak-rpm	city-mpg	highwa-y-mpg	price	H1_1	H1_2	H1_3	Predicted price
1	audi	gas	std	four	sedan	fwd	front	99.8	176.6	66.2	54.3	2337	ohc	four	109	mpfi	3.19	3.4	10	102	5500	24	30	13950	-0.68...	0.47...	0.41...	9330.2205285
2	audi	gas	std	four	sedan	4wd	front	99.4	176.6	66.4	54.3	2824	ohc	five	136	mpfi	3.19	3.4	8	115	5500	18	22	17450	0.994...	0.99...	0.78...	19246.253986
3	audi	gas	std	four	sedan	fwd	front	105.8	192.7	71.4	55.7	2844	ohc	five	136	mpfi	3.19	3.4	8.5	110	5500	19	25	17710	0.992...	0.96...	0.27...	20729.779639
4	audi	gas	turbo	four	sedan	fwd	front	105.8	192.7	71.4	55.9	3086	ohc	five	131	mpfi	3.13	3.4	8.3	140	5500	17	20	23875	0.997...	0.99...	-0.82...	24169.088996
5	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800	23	29	16430	0.865...	-0.9...	-0.77...	18061.181735
6	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2395	ohc	four	108	mpfi	3.5	2.8	8.8	101	5800	23	29	16925	0.657...	-0.9...	-0.86...	17232.856902
7	bmw	gas	std	two	sedan	rwd	front	101.2	176.8	64.8	54.3	2710	ohc	six	164	mpfi	3.31	3.19	9	121	4250	21	28	20970	0.998...	0.13...	0.98...	16372.509804
8	bmw	gas	std	four	sedan	rwd	front	101.2	176.8	64.8	54.3	2765	ohc	six	164	mpfi	3.31	3.19	9	121	4250	21	28	21105	0.997...	0.42...	0.97...	17191.513594
9	chevrolet	gas	std	two	hatchback	fwd	front	88.4	141.1	60.3	53.2	1488	l	three	61	2bbl	2.91	3.03	9.5	48	5100	47	53	5151	-0.63...	-0.9...	0.99...	3916.7089095
10	chevrolet	gas	std	two	hatchback	fwd	front	94.5	155.9	63.6	52	1874	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400	38	43	6295	-0.90...	-0.8...	0.11...	5340.0929328
11	chevrolet	gas	std	four	sedan	fwd	front	94.5	158.8	63.6	52	1909	ohc	four	90	2bbl	3.03	3.11	9.6	70	5400	38	43	6575	-0.94...	-0.9...	-0.22...	6130.7796041
12	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.41	68	5500	37	41	5572	-0.97...	-0.9...	0.03...	4915.9193414
13	dodge	gas	std	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	1876	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6377	-0.97...	-0.9...	0.03...	4917.9825025
14	dodge	gas	turbo	two	hatchback	fwd	front	93.7	157.3	63.8	50.8	2128	ohc	four	98	mpfi	3.03	3.39	7.6	102	5500	24	30	7957	-0.91...	-0.8...	-0.72...	8016.0899006
15	dodge	gas	std	four	hatchback	fwd	front	93.7	157.3	63.8	50.6	1967	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6229	-0.98...	-0.9...	-0.36...	6064.3111894
16	dodge	gas	std	four	sedan	fwd	front	93.7	157.3	63.8	50.6	1989	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	6692	-0.97...	-0.9...	-0.32...	5974.6996824
17	dodge	gas	std	four	sedan	fwd	front	93.7	157.3	63.8	50.6	1989	ohc	four	90	2bbl	2.97	3.23	9.4	68	5500	31	38	7609	-0.97...	-0.9...	-0.32...	5974.6996824
18	dodge	gas	std	four	wagon	fwd	front	103.3	174.6	64.6	59.8	2535	ohc	four	122	2bbl	3.34	3.46	8.5	88	5000	24	30	8921	-0.94...	-0.9...	-0.93...	8037.6432105
19	dodge	gas	turbo	two	hatchback	fwd	front	95.9	173.2	66.3	50.2	2811	ohc	four	156	mfi	3.6	3.9	7	145	5000	19	24	12964	-0.09...	-0.6...	-0.87...	13549.027348
20	honda	gas	std	two	hatchback	fwd	front	86.6	144.6	63.9	50.8	1713	ohc	four	92	1bbl	2.91	3.41	9.6	58	4800	49	54	6479	-0.95...	-0.3...	0.94...	3997.1832318
21	honda	gas	std	two	hatchback	fwd	front	86.6	144.6	63.9	50.8	1819	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	31	38	6855	-0.89...	-0.0...	0.92...	5149.5257572
22	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1837	ohc	four	79	1bbl	2.91	3.07	10.1	60	5500	38	42	5399	-0.94...	0.06...	0.91...	5233.2728128
23	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1940	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	6529	-0.87...	0.28...	0.88...	6348.5332694
24	honda	gas	std	two	hatchback	fwd	front	93.7	150	64	52.6	1956	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	7129	-0.86...	0.29...	0.87...	6443.7539781
25	honda	gas	std	four	sedan	fwd	front	96.5	163.4	64	54.5	2010	ohc	four	92	1bbl	2.91	3.41	9.2	76	6000	30	34	7295	-0.94...	0.22...	0.65...	6418.2537664
26	honda	gas	std	four	wagon	fwd	front	96.5	157.1	63.9	58.3	2024	ohc	four	92	1bbl	2.92	3.41	9.2	76	6000	30	34	7295	-0.96...	0.10...	0.47...	6555.3407999
27	honda	gas	std	two	hatchback	fwd	front	96.5	167.5	65.2	53.3	2236	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	7895	-0.80...	0.39...	0.37...	8592.382399
28	honda	gas	std	two	hatchback	fwd	front	96.5	167.5	65.2	53.3	2289	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	9095	-0.76...	0.44...	0.31...	9100.3514634
29	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2304	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	8845	-0.89...	0.31...	-0.07...	9185.5065611
30	honda	gas	std	four	sedan	fwd	front	96.5	175.4	62.5	54.1	2372	ohc	four	110	1bbl	3.15	3.58	9	86	5800	27	33	10295	-0.86...	0.37...	-0.15...	9756.9587969
31	honda	gas	std	four	sedan	fwd	front	96.5	175.4	65.2	54.1	2465	ohc	four	110	mpfi	3.15	3.58	9	101	5800	24	28	12945	-0.75...	0.53...	-0.31...	11292.734758
32	honda	gas	std	two	sedan	fwd	front	96.5	169.1	66	51	2293	ohc	four	110	2bbl	3.15	3.58	9.1	100	5500	25	31	10345	-0.38...	-0.8...	-0.56...	10581.948667

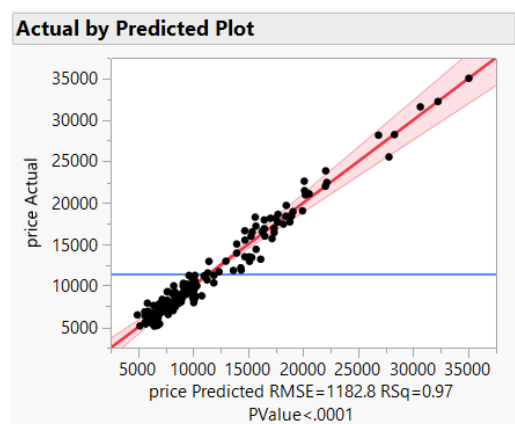
Formula

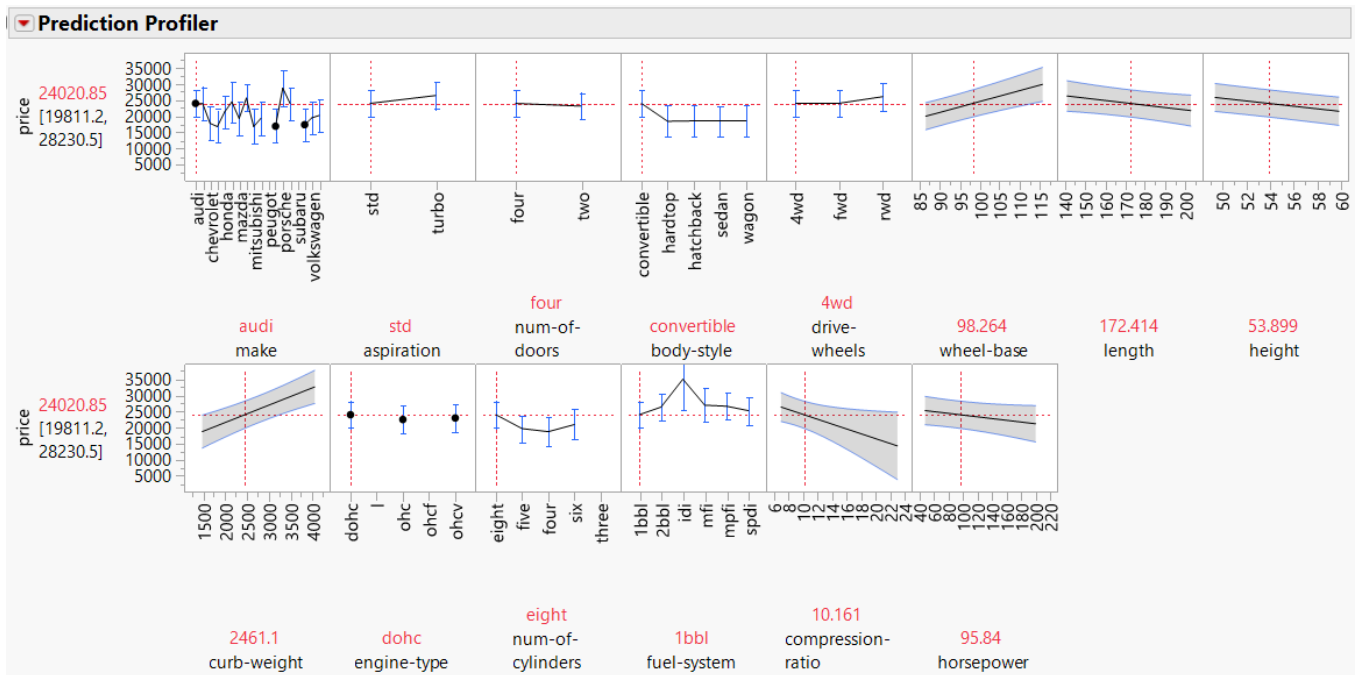
Predicted Price= 13272.2853767542 + 5746.52603802602 * :H1_1 + 2671.59434009672 * :H1_2 + -3031.32022297446 * :H1_3

6.3. Regression output

Summary of Fit	
RSquare	0.971309
RSquare Adj	0.96092
Root Mean Square Error	1161.968
Mean of Response	11445.73
Observations (or Sum Wgts)	159

Effect Summary		
Source	LogWorth	PValue
make	19.778	0.00000
aspiration	5.422	0.00000
wheel-base	5.396	0.00000
curb-weight	4.942	0.00001
height	3.856	0.00014
body-style	2.662	0.00218
drive-wheels	2.283	0.00521
num-of-cylinders	1.859	0.01383
num-of-doors	1.745	0.01800
compression-ratio	1.455	0.03504
length	1.356	0.04403
fuel-system	1.234	0.05833
horsepower	0.963	0.10898
engine-type	0.792	0.16160





Regression Formula

Prediction Expression

23180.930674

$$\begin{aligned}
 & + \text{Match}(\text{make}) \left(\begin{array}{l} \text{"audi"} \Rightarrow 0 \\ \text{"bmw"} \Rightarrow -99.26289042 \\ \text{"chevrolet"} \Rightarrow -6152.037684 \\ \text{"dodge"} \Rightarrow -7146.918923 \\ \text{"honda"} \Rightarrow -2643.219811 \\ \text{"jaguar"} \Rightarrow 485.86714308 \\ \text{"mazda"} \Rightarrow -4643.785349 \\ \text{"mercedes-benz"} \Rightarrow 1636.8076463 \\ \text{"mitsubishi"} \Rightarrow -7156.642839 \\ \text{"nissan"} \Rightarrow -4564.555944 \\ \text{"peugot"} \Rightarrow -7681.637167 \\ \text{"plymouth"} \Rightarrow -7032.507544 \\ \text{"porsche"} \Rightarrow 4745.9670165 \\ \text{"saab"} \Rightarrow -38.92669565 \\ \text{"subaru"} \Rightarrow -6660.141708 \\ \text{"toyota"} \Rightarrow -6559.195643 \\ \text{"volkswagen"} \Rightarrow -4445.044177 \\ \text{"volvo"} \Rightarrow -3721.127383 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + \text{Match}(\text{aspiration}) \left(\begin{array}{l} \text{"std"} \Rightarrow -1210.55487 \\ \text{"turbo"} \Rightarrow 1210.5548703 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + \text{Match}(\text{num-of-doors}) \left(\begin{array}{l} \text{"four"} \Rightarrow 411.93139138 \\ \text{"two"} \Rightarrow -411.9313914 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + \text{Match}(\text{body-style}) \left(\begin{array}{l} \text{"convertible"} \Rightarrow 0 \\ \text{"hardtop"} \Rightarrow -5518.876086 \\ \text{"hatchback"} \Rightarrow -5384.731283 \\ \text{"sedan"} \Rightarrow -5396.425411 \\ \text{"wagon"} \Rightarrow -5342.33963 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + \text{Match}(\text{drive-wheels}) \left(\begin{array}{l} \text{"4wd"} \Rightarrow 0 \\ \text{"fwd"} \Rightarrow 44.82695722 \\ \text{"rwd"} \Rightarrow 2099.4000486 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + 338.78868221 \cdot \text{wheel-base} \\
 & + -73.37478183 \cdot \text{length} \\
 & + -408.0881826 \cdot \text{height} \\
 & + 5.3544976722 \cdot \text{curb-weight} \\
 & + \text{Match}(\text{engine-type}) \left(\begin{array}{l} \text{"dohc"} \Rightarrow 0 \\ \text{"l"} \Rightarrow -1682.782552 \\ \text{"ohc"} \Rightarrow -1477.035318 \\ \text{"ohcf"} \Rightarrow -998.09686 \\ \text{"ohcv"} \Rightarrow -998.09686 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + \text{Match}(\text{num-of-cylinders}) \left(\begin{array}{l} \text{"eight"} \Rightarrow 0 \\ \text{"five"} \Rightarrow -4280.080701 \\ \text{"four"} \Rightarrow -5219.182254 \\ \text{"six"} \Rightarrow -3031.472899 \\ \text{"three"} \Rightarrow -3031.472899 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + \text{Match}(\text{fuel-system}) \left(\begin{array}{l} \text{"1bbl"} \Rightarrow 0 \\ \text{"2bbl"} \Rightarrow 2351.8841837 \\ \text{"idi"} \Rightarrow 10985.893052 \\ \text{"mfi"} \Rightarrow 2953.2538024 \\ \text{"mpfi"} \Rightarrow 2636.3284744 \\ \text{"spdi"} \Rightarrow 1266.4749921 \\ \text{else} \Rightarrow . \end{array} \right) \\
 & + -749.416703 \cdot \text{compression-ratio} \\
 & + -26.80440561 \cdot \text{horsepower}
 \end{aligned}$$

7. VERDICT

Based on the results derived all the methods, we find that the prediction values are closer in the case of decision tree and regression. Neural networks model nonlinearities automatically (according to universal approximation theorem), whereas in case of decision tree and linear regression explicit modelling using transformations (splines etc.) is required for predictions. Hence, in this case decision tree and multivariate regression has outperformed neural nets on this dataset as there are no nonlinearities among variables in the dataset.

8. PRICE ESTIMATION AND BUSINESS SUGGESTIONS

1. The cost of an automobile is elevated to an extent based on its 'Brand Loyalty', beyond which any other features in them, come to play. So it is very important to advertise the brand as much as spending on R&D of the brand.
2. It is evident from the model predictors that rear-wheel drive vehicles are expensive than all-wheel drive vehicles. The rear wheel drive vehicle manufacturers should consider understanding the market demand and adopt.
3. The convertible body style automobiles are highly priced compared to other segments of automobiles. The non-convertible manufacturers should consider developing convertible vehicles to increase their sales and turnover.
4. From the graph, it is noticed that idi diesel engines are priced higher compared to gas engines, the manufacturers could work on cutting costs for idi diesel engines or adopt other technologies to make diesel automobiles more economic and sell more.
5. From the graphs, the curb weight and horsepower are inversely proportional. Prices can be stabilized by optimizing both curb weight and horse power for optimum performance in certain automobiles.

9. REFERENCES

1. JMP 8 Introductory Guide, Second Edition by Marcel Proust
2. <https://www.twelfthroundauto.com/automobile-components-and-parts-101/>