MMA867 – Predictive Modelling

Assignment One – Individual

Kaggle Name: Vanessa Afolabi

Total Number of Teams on Leaderboard: 4740

Last Position on Leaderboard: 1676

Github: https://github.com/VanessaAfolabi/MMA867---Predictive-Modelling

1. The three competitions I identified are stated below.

    a. **Predict Future Sales**

        Kaggle's Description is as follows:

        "In this competition you will work with a challenging time-series dataset consisting of daily sales data, kindly provided by one of the largest Russian software firms - 1C Company.

        We are asking you to predict total sales for every product and store in the next month. By solving this competition, you will be able to apply and enhance your data science skills."

    b. **House Prices: Advanced Regression Techniques**

        Kaggle's Description is as follows:

        "Ask a home buyer to describe their dream house, and they probably won't begin with the height of the basement ceiling or the proximity to an east-west railroad. But this playground competition's dataset proves that much more influences price negotiations than the number of bedrooms or a white-picket fence.

        With 79 explanatory variables describing (almost) every aspect of residential homes in Ames, Iowa, this competition challenges you to predict the final price of each home."

    c. **Walmart Recruiting – Store Sales Forecasting**

        Kaggle's Description is as follows:

        "In this recruiting competition, job-seekers are provided with historical sales data for 45 Walmart stores located in different regions. Each store contains many departments, and participants must project the sales for each department in each store. To add to the challenge, selected holiday markdown events are included in the dataset. These markdowns are known to affect sales, but it is challenging to predict which departments are affected and the extent of the impact."

    Explanation of my choice.

    The choice I made was Predicting House Prices using Advanced Regression Techniques. It is more of a straightforward regression problem and less of a Time Series problem like the other two options. I also found it to be rather interesting because I enjoy anything related to Real Estate. Also, looking at all aspects of residential homes and how it relates to Sale Prices is a stimulating topic to me.

2. Explanation of the model

Data Preparation

Both the train and test csvs were read as pandas dataframes. The ID column was saved and then dropped from both datasets because ID will not be used in the regression model. The ID column of the test set will be used in the end when preparing the final prediction set to be submitted to Kaggle.

Outlier Removal

I plotted SalePrice against GrLivArea and noticed that there were two outliers where the Greater Living Area was extremely high but the Sale Price was low. This is not a normal case in real life thus these two cases were treated as outliers and removed.

Exploration and Log Transformation of SalePrice

The SalePrice variable in the training set is being predicted and it is important to understand its behavior. A statistical summary of SalePrice was generated showing values such as maximum, minimum and mean. In addition, both a histogram and QQ Plot were generated in order to determine if SalePrice is normally distributed. It turns out that SalePrice is skewed and not normally distributed. To fix this problem, a log transformation was applied to SalePrice. This immediately made SalePrice normally distributed.

Correlations, Heatmaps and Scatterplots

I plotted a Correlation Matrix, HeatMap and Scatterplots to observe the linear relationship between the variables. I observed strong correlations between the following variables, among others.

- BsmtFullBath & BsmtUnfSF
- GarageYrBlt & EnclosedPorch
- GarageYrBlt & OverallCond
- YearBuilt & EnclosedPorch
- LotFrontage & MSSubClass

Imputation of Null values

To deal with the null values in the data, first the training set was concatenated to the test set to create a master file. All imputation of null values was performed on this master file. The first step was generating a list of the variables containing null values. The data description file from Kaggle was used to guide the imputation process for each of the variables containing null values. For some variables, the null values were imputed with the default null value as stated in the data description file. Others were imputed with the maximum value, while others were imputed with the mean values or zeroes. Each variable was imputed separately with accompanying explanations provided in the python notebook. Each categorical variable was also converted to type string to ensure levels in the data values.

Total Square Footage

A new variable called TotalSF was created by summing TotalBsmtSF, 1stFlrSF and 2ndFlrSF. When buying a home, buyers are interested in knowing the Total Square Footage. By adding this variable to the dataset this will enhance the Regression model.

From Integer to Categorical

Through discovery, I found out that the following variables are of type integer when they should be treated as being categorical in the regression model. To fix this problem each of there variables were converted to type string.

- MSSubClass
- OverallQual
- OverallCond
- YrSold
- MoSold
- GarageYrBlt
- YearBuilt
- YearRemodAdd

Box-Cox Transformations for Skewness

All numerical variables with a skewness value above 0.75 were transformed using Box-Cox Transformations. This was also done as an outlier reduction strategy.

Label Encoding

All categorical variables were encoded with values between 0 and n_classes-1. As the scikit learn website states, Label Encoding can be used to normalize labels and to transform non-numerical labels to numerical labels. Instead of having text or string labels these values are transformed to numerical labels.

Dummy Variables

Dummy variables were created for each level of each categorical variable. This is a great feature engineering techniques that enhanced the Regression Modelling process.

Model Building

After all the imputation, feature engineering and data preparation the master file was separated into a train and test set ensuring that the test set had 1459 rows. Many Regression models were built. The following is an output of each Regression model and its corresponding **Root Mean Squared Error (RSME).**

- Linear Regression RSME: 0.12434643448220742
- Ridge Regression RSME: 0.12402213279933252
- Lasso Regression RSME: 0.12361439787506197
- LassoCV Regression RSME: 0.18872479548952584
- ElasticNet Regression RSME: 0.12355496287204451

- BayesianRidge Regression RSME: 0.12485109397482888
- LassoLarsIC Regression RSME: 0.13120025041849642
- Random Forest Regressor RSME: 0.14449664091720715
- KNeighbors Regressor RSME: 0.23778660277251343
- DecisionTree Regressor RSME: 0.19613435009634456
- Support Vector Regressor RSME: 0.39496324569859115
- KernelRidge Regression RSME: 0.2869253478149764

Model Revision

Many techniques were utilized to refine the model. The following techniques were used.

- Regression models by themselves with no other techniques in the Pipeline.
  - Linear Regression
  - Ridge Regression
  - Lasso Regression
  - LassoCV Regression
  - ElasticNet Regression
  - BayesianRidge Regression
  - LassoLarsIC Regression
  - Random Forest Regressor
  - KNeighbors Regressor
  - DecisionTree Regressor
  - Support Vector Regressor
  - KernelRidge Regression

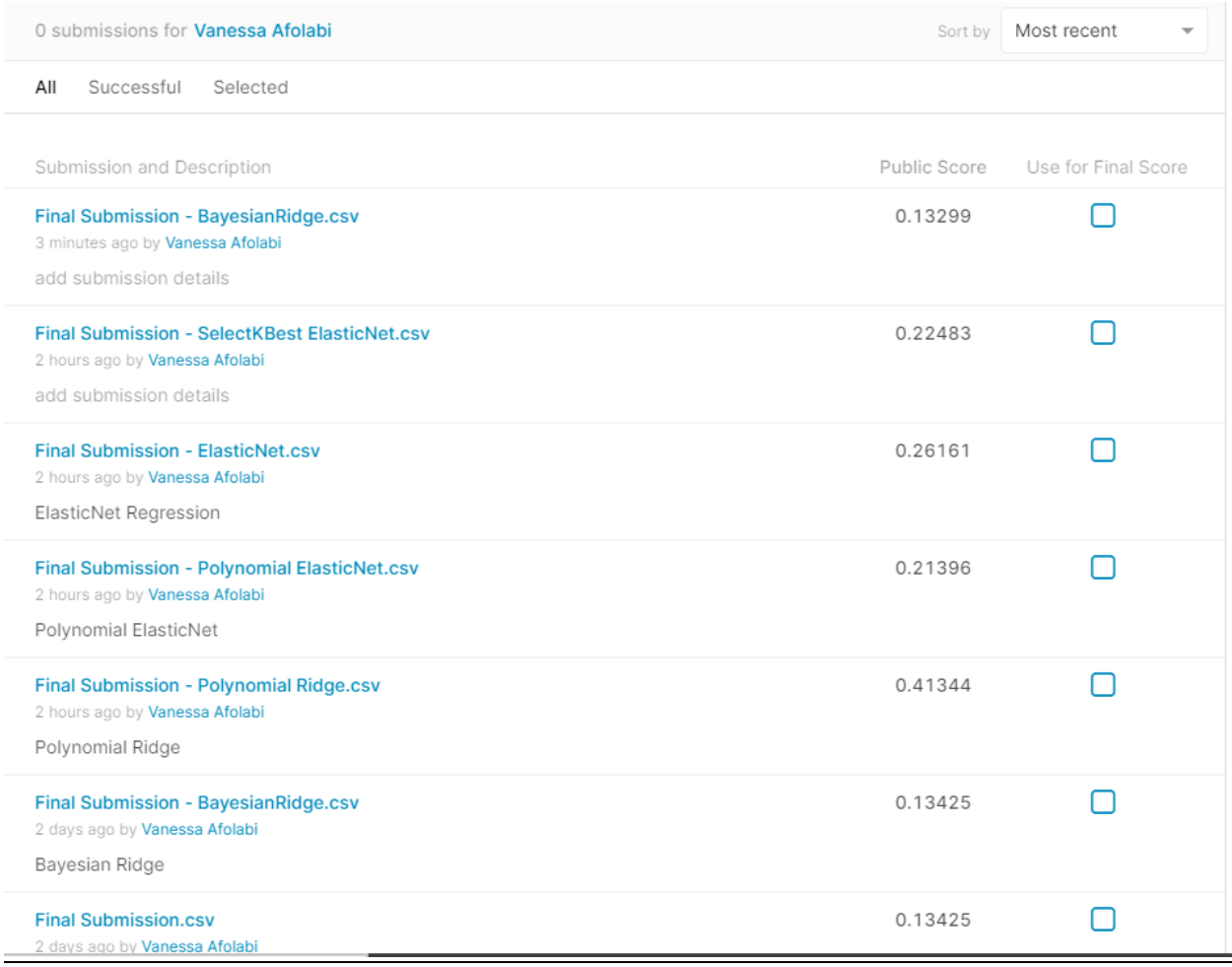
- Regression models with Polynomial Features of degree 2 in the Pipeline
  - Polynomial Ridge Regression
  - Polynomial ElasticNet Regression

- Bagging Regressor using Ridge Regression

- Regression models with SelectKBest in the Pipeline.
  - SelectKBest ElasticNet Regression

Prediction Quality

A couple submissions were made. The following shows he quality of the predictions in Kaggle.



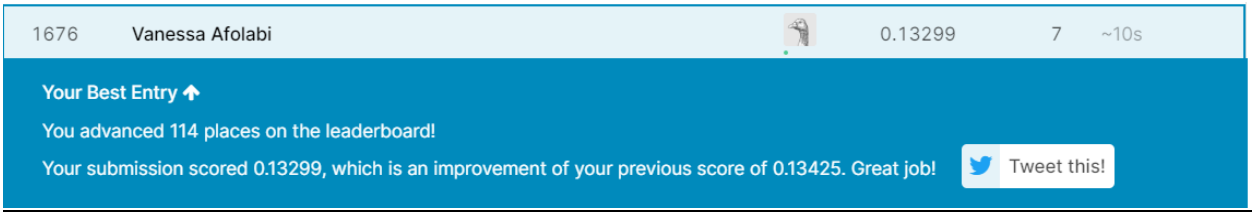
0 submissions for Vanessa Afolabi

Sort by Most recent

All Successful Selected

Submission and Description	Public Score	Use for Final Score
Final Submission - BayesianRidge.csv 3 minutes ago by Vanessa Afolabi add submission details	0.13299	☐
Final Submission - SelectKBest ElasticNet.csv 2 hours ago by Vanessa Afolabi add submission details	0.22483	☐
Final Submission - ElasticNet.csv 2 hours ago by Vanessa Afolabi ElasticNet Regression	0.26161	☐
Final Submission - Polynomial ElasticNet.csv 2 hours ago by Vanessa Afolabi Polynomial ElasticNet	0.21396	☐
Final Submission - Polynomial Ridge.csv 2 hours ago by Vanessa Afolabi Polynomial Ridge	0.41344	☐
Final Submission - BayesianRidge.csv 2 days ago by Vanessa Afolabi Bayesian Ridge	0.13425	☐
Final Submission.csv 2 days ago by Vanessa Afolabi	0.13425	☐

Appendix



Python

https://github.com/VanessaAfolabi/MMA867---Predictive-Modelling

Prediction Output

Id	SalePrice
1461	120206.3
1462	150855.8
1463	188085.1
1464	198755.3
1465	178644.4
1466	170313.7
1467	172111.9
1468	159165.8
1469	186572.5
1470	116577.6
1471	203888.1
1472	95774.87
1473	95485.26
1474	139884.9
1475	97365.79
1476	368362.8
1477	236908.6
1478	279135.1
1479	279449.4
1480	523806.2
1481	319730.7
1482	202598.4
1483	186881.2
1484	153379.5
1485	191331.5
1486	199401.4
1487	310220.9
1488	227504.7

1489	179859.6
1490	245062
1491	195274.3
1492	90950.54
1493	177180.4
1494	281717.5
1495	275627
1496	222524.9
1497	176607.9
1498	158942.5
1499	158311.5
1500	156401.5
1501	175534.8
1502	138320.8
1503	276444.5
1504	223161.1
1505	218141.1
1506	198262
1507	260263.2
1508	202931.2
1509	154568.8
1510	139624.6
1511	152767.7
1512	184630.6
1513	148212.1
1514	145253.6
1515	212940.7
1516	159867.4
1517	165003.6
1518	133600.6
1519	206809.8
1520	119292.8
1521	129410.1
1522	187209.9
1523	106770
1524	128769.2
1525	115741.2
1526	107164.2
1527	102180.1
1528	138214.6
1529	146991.6
1530	169385.4
1531	107455.1
1532	100386.4

1533	155618.3
1534	129120.9
1535	169917.9
1536	115803.4
1537	62656.62
1538	135924.2
1539	189262.3
1540	92347.68
1541	143251.6
1542	144502.8
1543	184667.6
1544	90477.86
1545	104362.6
1546	125940
1547	139138.9
1548	130834.6
1549	113009.7
1550	126902.8
1551	117668.1
1552	131673.7
1553	143683.2
1554	110602.4
1555	178968.2
1556	79252.35
1557	106436.5
1558	94308.19
1559	74852.1
1560	132051.1
1561	135001.1
1562	125021.4
1563	115459.3
1564	172096.6
1565	146444.4
1566	238828.1
1567	76980
1568	227551.1
1569	145322.6
1570	130946.2
1571	133304.3
1572	145790.3
1573	254994.7
1574	114630.4
1575	230093.3
1576	262738.2

1577	178144.6
1578	135872.9
1579	146256.5
1580	186702.6
1581	157896.3
1582	118247.5
1583	308359.3
1584	219847.1
1585	139987.7
1586	61204.7
1587	97469.63
1588	151487.6
1589	98439.03
1590	137800
1591	95221.93
1592	135070.3
1593	118073.6
1594	124297.2
1595	100941.7
1596	205632.8
1597	170148
1598	203516.7
1599	159694
1600	157232.4
1601	69750.11
1602	115199.2
1603	79098.89
1604	261274.1
1605	244152
1606	175502.5
1607	177460.5
1608	219195.2
1609	176049
1610	151086.7
1611	146294.5
1612	183439.8
1613	174581.8
1614	129167.2
1615	99521.66
1616	82579.52
1617	99809.63
1618	118006.4
1619	138591.5
1620	148849.1

1621	145260
1622	135241.2
1623	253352.9
1624	232063.1
1625	110048.8
1626	172485.9
1627	195934.4
1628	275470.9
1629	166617.2
1630	349579.3
1631	199846.5
1632	234375.7
1633	165274.9
1634	188117.2
1635	177521
1636	147351.8
1637	220651.8
1638	182563.6
1639	191074.7
1640	265713
1641	180782.1
1642	238698.5
1643	210436.5
1644	220148.2
1645	231001.8
1646	156263
1647	153838.9
1648	127936.1
1649	141743.1
1650	107917.8
1651	122503.5
1652	97277.23
1653	100437.9
1654	140449.8
1655	124422.4
1656	131512.1
1657	141044
1658	139377.7
1659	99073.98
1660	151108.3
1661	503022.8
1662	371268.1
1663	391891.7
1664	473729.6

1665	309927.7
1666	319053.2
1667	377305.1
1668	345455.2
1669	281936.3
1670	351272.2
1671	268564.3
1672	428692.3
1673	290040.1
1674	235471.9
1675	208174.4
1676	203907.8
1677	224813.9
1678	396405.4
1679	383228.9
1680	328939.7
1681	240788.7
1682	298384.8
1683	183281.4
1684	183737.9
1685	182111.1
1686	167642.5
1687	171515.7
1688	195658.7
1689	196864
1690	200636.6
1691	184109.7
1692	260941.6
1693	171106.2
1694	178809.3
1695	153317.5
1696	286012.4
1697	158656.2
1698	342585.6
1699	303844.8
1700	245813.9
1701	258244.1
1702	250477.7
1703	244281.2
1704	277179.6
1705	235196.1
1706	475943.7
1707	197573.7
1708	193426.1

1709	250896.1
1710	211761
1711	264626.6
1712	245391.8
1713	273644.9
1714	220776.6
1715	196783.6
1716	183944.7
1717	170354.3
1718	136302.9
1719	205765.5
1720	222470.4
1721	170575.2
1722	138474.6
1723	170316.9
1724	201318.7
1725	229212.6
1726	187010
1727	161712.4
1728	181621
1729	161686.8
1730	154366
1731	119965.3
1732	122347.7
1733	108365.9
1734	118898.3
1735	135406.7
1736	105049.6
1737	288262.4
1738	248749
1739	264262.2
1740	234792.5
1741	201958.6
1742	172199
1743	175579.3
1744	329513.3
1745	225682.6
1746	171521.9
1747	216902.2
1748	229680.1
1749	151351.7
1750	123993.7
1751	260598.7
1752	111046.5

1753	157729.4
1754	188668.4
1755	175424.2
1756	126999.2
1757	116647.3
1758	147253.4
1759	161708.7
1760	166156.8
1761	158261.8
1762	176397.4
1763	187413.9
1764	109202.7
1765	193499.5
1766	190493
1767	246993.2
1768	142386
1769	170490.8
1770	152734
1771	114001
1772	138487.9
1773	128045.8
1774	144184.7
1775	128488.9
1776	122652
1777	107802.1
1778	147151.9
1779	117408.8
1780	183189
1781	127348.6
1782	89033.69
1783	145637.9
1784	113640.2
1785	118397.7
1786	137966.1
1787	171156.6
1788	70215.68
1789	89912.86
1790	76198.72
1791	189571.9
1792	168135.3
1793	123602.5
1794	159845.3
1795	137190.7
1796	120210.1

1797	110007.9
1798	112234.8
1799	104305.1
1800	125134.2
1801	134160.6
1802	132679.4
1803	141055.4
1804	147601.8
1805	131856.2
1806	126373.7
1807	129042
1808	126345.2
1809	128859.1
1810	136766.4
1811	109810.9
1812	93521.88
1813	122281
1814	94785.45
1815	55415.92
1816	108097.7
1817	116583.4
1818	160887.6
1819	114289.3
1820	64907.68
1821	125409.9
1822	145359.9
1823	54880.28
1824	123610.2
1825	128618.3
1826	96852.73
1827	94560.79
1828	138404.6
1829	128007.6
1830	143351.8
1831	133884.9
1832	72600.06
1833	142958.1
1834	123526.6
1835	114729.7
1836	130418.6
1837	85180.02
1838	138304.2
1839	108023.9
1840	147202.1

1841	130315
1842	81994.57
1843	122810.2
1844	127128.2
1845	137624.7
1846	153527.6
1847	165130.5
1848	54843.35
1849	119445.7
1850	117490.6
1851	167590.7
1852	127629.3
1853	132177.5
1854	177191.5
1855	153231.4
1856	230399.1
1857	159989.1
1858	132978.4
1859	112955.1
1860	153208.6
1861	112305.5
1862	296779.4
1863	286311.9
1864	286423.8
1865	358392.6
1866	332258.9
1867	220902
1868	306494.3
1869	205562.1
1870	214560.9
1871	244217.2
1872	183220.8
1873	242623.3
1874	145944.1
1875	201245.1
1876	197878.4
1877	210630.6
1878	207469.6
1879	119602.6
1880	126841.3
1881	258234.6
1882	244761
1883	185383.2
1884	207764.8

1885	240911.7
1886	284304.4
1887	218935.7
1888	266685.1
1889	179283.4
1890	117114.9
1891	142153.9
1892	96073.71
1893	129031.7
1894	124603.9
1895	136014.8
1896	127891.8
1897	113776
1898	120052.5
1899	146762.4
1900	133658.1
1901	155356.2
1902	138873.9
1903	191074.1
1904	125501.4
1905	195517.7
1906	146103.9
1907	218440.8
1908	105701.1
1909	128975.8
1910	118610.7
1911	193109.1
1912	336764.6
1913	147552.9
1914	67444.98
1915	294526.5
1916	56361.2
1917	251882.1
1918	138236.1
1919	205498
1920	175531
1921	421970.2
1922	311996.5
1923	235992.2
1924	223370.6
1925	196216.5
1926	406529.8
1927	135152.7
1928	159135.7

1929	133755.7
1930	126673.3
1931	155822.4
1932	150092.2
1933	174952.3
1934	179769.3
1935	165646.1
1936	189414.3
1937	188833.7
1938	186103.6
1939	217079.8
1940	177868.9
1941	173390.1
1942	193353.5
1943	190765.7
1944	337734
1945	373296
1946	141068.8
1947	310066.4
1948	180761.4
1949	274028.4
1950	185852.4
1951	272924.6
1952	221956.4
1953	166481.9
1954	173296.4
1955	138658
1956	345968.8
1957	157776.5
1958	302333.3
1959	145369.6
1960	119984.4
1961	114138.3
1962	98630.52
1963	109382.4
1964	108948.6
1965	134824.3
1966	126829.8
1967	278239.6
1968	434290.4
1969	378350.7
1970	374462.4
1971	409852.6
1972	365921

1973	282643.2
1974	327790.5
1975	503858.2
1976	259977.2
1977	339449
1978	345578.9
1979	332675.7
1980	214389.7
1981	346929.1
1982	208403.5
1983	191533.5
1984	172024.3
1985	226225.9
1986	222439.9
1987	170860.1
1988	183860.3
1989	200226.5
1990	212190.6
1991	232981.8
1992	218416.1
1993	175794.2
1994	247705.9
1995	178662.3
1996	241548.4
1997	293459.3
1998	311949.9
1999	271147.9
2000	300657
2001	280285
2002	249308
2003	265117.9
2004	280408.2
2005	228443.4
2006	200985.8
2007	244230.2
2008	212781.1
2009	203935.6
2010	200635.3
2011	148323.9
2012	168797.4
2013	178697.4
2014	191036.1
2015	194380.1
2016	200143.6

2017	198844.4
2018	113271.2
2019	138744.3
2020	107719.9
2021	86226.14
2022	190583.1
2023	156935.4
2024	286384.2
2025	340782.3
2026	173359.7
2027	162025.5
2028	148192.5
2029	167971.2
2030	250273.7
2031	212428.1
2032	229356.9
2033	231640.7
2034	171198
2035	204349.5
2036	196251
2037	202037.2
2038	273369.3
2039	211124.3
2040	278937.7
2041	326138.2
2042	197432.1
2043	181455.3
2044	188240.8
2045	214655.1
2046	156911.1
2047	151561.4
2048	139968
2049	144875.4
2050	168145.2
2051	101707.2
2052	115906.7
2053	151962.7
2054	98089.94
2055	166120.7
2056	145979.2
2057	113665.8
2058	229491.2
2059	129601.5
2060	188663.4

2061	182196.9
2062	123611.6
2063	116097.2
2064	134889
2065	106565.2
2066	162485.8
2067	104189.8
2068	153990.9
2069	89121.87
2070	114588.6
2071	93768.73
2072	137845.3
2073	137928.4
2074	177174
2075	138773.6
2076	112220.5
2077	151139.4
2078	112206.2
2079	137813
2080	117066
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