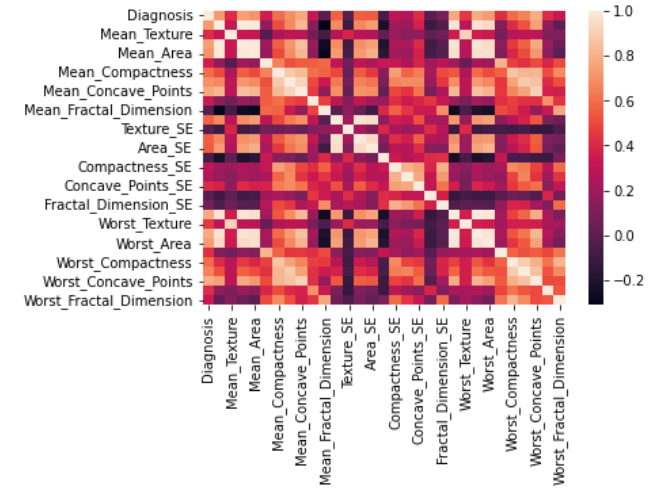


Applications of Machine Learning in the analysis of breast cancer

By Ultan Kearns & Liam Millar

Introduction

- When starting this project we investigated many datasets finally settling on <https://archive.ics.uci.edu/ml/machine-learning-databases/breast-cancer-wisconsin/>
- This dataset is from the University of Wisconsin - a well-known institute of higher learning in the USA
- The main objective of our project was to use ML to predict absence / presence of breast cancer
- We used a combination of both Supervised and Unsupervised learning algorithms
- Cleaning and analyzing the data was our first task
- We noticed diagnosis had M for malignant and B for benign, replaced with 1,0
- Did this so that we could perform numerical operations easier
- We started by showing a heatmap of data
- Did this to analyze relations in the data
- We also played around with the training / test set ratios and finally settled on a 70 / 30 split



	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
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Australia	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	
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Belize	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	
Bhutan	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	
Bolivia	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	
Brazil	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017																																																																																				

Models Used

Linear Regression - to predict and analyze the correlation of 2 features in our dataset

K Means - This is an unsupervised learning technique creating clusters of data based on a centroid

KNN - This is a clustering technique which analyzes data nearest to other data to predict a diagnosis

Naïve Bayes - This is a technique used to predict cancer by taking features of our dataset and using the same weight for each -> Assumes data has same effect on output hence Naïve

Decision Trees - Which were used to predict diagnosis by making a tree of features in our dataset which will either lead to positive or negative diagnosis based on their values

Random Forest - Creates multiple trees then merges the best models to predict our diagnosis

PCA (Principle Component Analysis) - unsupervised dimensionality-reduction which reduced features in our dataset by removing similar features which were highly correlated

Analysis of our models

Linear Regression was used to analyze the strength of the relationship between certain features and our Diagnosis - Also used Cramér's V

Had good results we could see which features were positively correlated with a diagnosis value and the strength of this correlation

K Means - Performed fairly well with 86% accuracy

KNN - Performed better than KNN with 91% accuracy

Gaussian Naïve Bayes - without smoothing or scaling had 90% accuracy on testset

Gaussian Naïve Bayes with scaling had around a 91% accuracy rate - not much improvement

Decision Tree model had an accuracy of 93%

Random forest had around the same degree of accuracy

Entropy Forest had 90% accuracy

PCA Gini Tree had an accuracy of 94%

PCA Random forest had the best accuracy of all our models at 98%

Final Results Table And Conclusion

- Here we can see our final results table
- Notice which models performed correctly and which didn't
- Trial and error process - it took time finding the right ratio of the training / test sets
- Also it took time to analyze the models and determine how we could get the best performance from them
- From our study we determined PCA Random Forest had the best accuracy when predicting the diagnosis
- We also learned the limitations of machine learning in healthcare - should be used as an assistant not an expert as even the best trained models can yield false predictions
- We learned the importance of data cleaning and analysis
- We learned which models worked on our dataset and which didn't - it was a fairly small set of only 570 values!

A. Accuracy of Models

Method Description	Accuracy
PCA Gini Random Forest:	0.98%
cross validation Gini rdm forest:	0.96%
Standard trained Gini rdm forest:	0.95%
cross validation Ent random forest:	0.95%
PCA Gini Tree:	0.94%
Standard trained Ent random forest:	0.94%
Standard trained Gini decision tree:	0.94%
cross validation Ent decision tree:	0.92%
Gaussian Naive Bayes-with scaling:	0.93%
Gaussian Naive Bayes-without scaling:	0.92%
Standard trained Ent decision tree:	0.91%
cross validation Gini decision tree:	0.91%
K Neighbour:	0.90%
K Means:	0.86%
Gaussian Naive Bayes-with smoothing:	0.79%