



IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



VOLUME : 7 ISSUE : 05 Print / Issue Publication Date: 06-Nov-2022



ISSN : 2455-2143



DOI : 10.33564/IJEAST.2022.v07i05.027

Indexed In



WWW.IJEAST.COM

editor@ijeast.com

MACHINE LEARNING TECHNIQUE FOR EARLY PREDICTION OF HYPERTENSION

Aranuwa, F.O

Department of Computer Science, Adekunle Ajasin University,
Akungba – Akoko, Ondo State, Nigeria

Abstract — Machine Learning (ML) has proved to be an invaluable tool in medical research today. It is a branch of artificial intelligence that has the ability to learn from complex data, identify patterns and make decisions with minimal or without human intervention. Efforts in this work is focused at developing an intelligent model for early prediction of hypertension because of the complexity associated with the pattern identification of the syndrome. The study acquired data pertaining to the syndrome from selected healthcare centres in the South West region of Nigeria, one of the largest city in Africa. A retrospective learning using ML analyses was conducted on the data. Three different intelligent classification algorithms namely; Gradient Boosting, Random Forest and SVM were used in the modeling. The datasets were trained and tested, and the performance of the algorithms were compared using standard performance metrics of accuracy and throughput. The results from the experiment indicates that the gradient boosting classifier outclassed other algorithms considered in the work with accuracy of 90.17%. The model has proved to be very suitable for early prediction of the syndrome and, will in no small measure assist the medical practitioners in providing quick and more effective way of detecting early the syndrome in patients. This will subsequently lead to timely treatment of the patients, thereby reducing its death rate in the society. Future work is focused at considering complex patterns of the syndrome and larger database.

Keywords: Hypertension, Gradient Boosting, HBP, Intelligent Technique, Machine Learning

I. INTRODUCTION

Today, hypertension has been adjudicated one of the major causes of sudden and premature death both in the young and old, especially in the Africa continent. The syndrome has a direct relationship with high blood pressure (HBP) and other related health issues that often leads to life-threatening dares such as heart failure, coronary artery diseases, brain and kidney challenges even death if not properly managed (Afeni, Aruleba and Oloyede, 2017; Nimmala, Ramadevi, Sahith and Cheruku, 2018).

By definition, hypertension, is a condition in which the blood vessels have persistently raised pressure (WHO, 2021). Blood pressure is the force that a person's blood exerts against the

walls of its blood vessels (Lawes et al., 2000). According to Felman (2019), hypertension arises when blood pressure is too high beyond default measures. Normal adult blood pressure is expected to be between 120 mm Hg (systolic) and 80 mm Hg (diastolic), but when it goes beyond this level, at two consecutives checkups may lead to high risk of hypertension. Globally, several factors that contribute to higher prevalence of hypertension include physical inactivity, inability to detect the syndrome early or, decreased awareness, smoking habit, unhealthy diet, inaccessibility to effective healthcare delivery and cost of medications.

Figure 1 and Figure 2 show blood pressure categories and recommendations respectively, while Figure 3 depicts hypertension complications.

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

Figure 1: Blood Pressure Category
Source: ((American Heart Association, 2022)

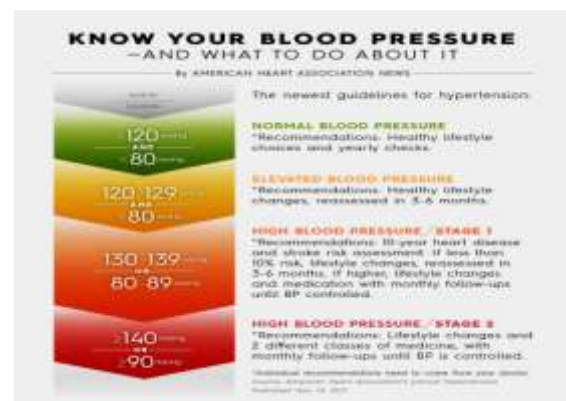


Figure 2: Blood Pressure Recommendations
Source: (American Heart Association, 2017).

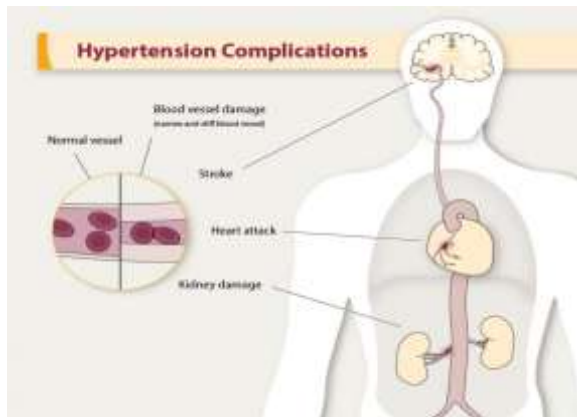


Figure 3: Hypertension Complications

Source: (CDC, 2021)

Normal levels of both systolic and diastolic blood pressure are particularly important for the effective and efficient function of vital body organs such as the heart, brain and kidneys, and for overall health and wellbeing (WHO, 2021). The syndrome can be classified into two main classifications, namely: Primary hypertension; also referred to as essential

hypertension, which tends to develop gradually over some years (Nimmala et al., (2018)). The second class is the secondary hypertension; which tends to appear suddenly due to some underlining conditions as highlighted in (Farran et al, 2013). According to Hannedouche and Krummel (2008), the features of primary secondary hypertension include: gradual increase with slow rate of rise in BP, episodic pallor, and dizziness, snoring, hyper somnolence (obstructive sleep apnea), prostatism (chronic kidney disease), muscle cramps, weakness, weight loss, palpitations, heat intolerance (hyperthyroidism), edema, fatigue, frequent urination (kidney disease or failure), facial rounding, and so on. Risk assessment of the disease is significantly more complicated and depends on multitude of factors and transient environmental conditions that can artificially raise blood pressure readings. Commonly identified risk factors include age, gender, body mass index, obesity, stress, triglycerides, uric acid, lipoproteins, cholesterol, smoking habits, and family history of the disease (Shinde & Rajeswari, 2018).

Table 1 shows blood pressure ranges by Age and Gender according to (Digest et al., 2019).

Table 1: Blood pressure according to Age and Gender

Age	Female	Male
1-2	80/34-120/75	83/38-117/76
3	100/59	100/61
4	102/62	101/61
5	104/65	103/66
6	105/68	104/68
7	106/70	106/69
8	107/71	108/71
9	109/72	110/72
10	111/73	112/73
11	113/74	114/74
12	115/74	116/75
13	117/75	117/76
14	120/75	119/77
15	120/76	120/78
16	120/78	120/78
17	120/80	120/78
18	120/80	120/80
19-24	120/79	120/79
25-29	120/80	121/81
30-35	122/81	123/82
36-39	123/82	124/83
40-45	124/83	125/83
46-49	126/84	127/84
50-55	129/85	128/85
56-59	130/86	131/87
60+	134/84	135/88

With aging, there is usually a dramatic increase in the prevalence of syndrome. By age 70 years, most people do have hypertension. It usually develops in man as from the age of 55 years though with a normal blood pressure at te beginning. By 60 years of age, approximately 60% of the population do have hypertension; by 70 years, about 65% of men and about 75% of women do have hypertension. According to Logan (2011), hypertension especially isolated systolic hypertension, is commonly found in older (60–79 years of age) and elderly people (≥ 80 years of age). Census bureau data and projections reveal that women older than the age of 65 years will make up more than 20% of the population by 2030. Figure 4 shows modifiable and fixed risk factors.



Figure 4: Modifiable and fixed risk factors of hypertension.
 Source: (Hannedouche & Krummel, 2008).

An estimated 1.28 billion adults aged 30-79 years worldwide have hypertension and 46% of adults with hypertension are unaware that they have the syndrome (WHO 2021). About 7.6 million death have been reportedly linked with this disorder annually. About 54% of stroke and 47% of coronary heart disease are attributable to high Blood Pressure. By year 2025, it has been predicted that an estimated population of 1.56 billion adults will be living with hypertension (WHO, 2021). Meanwhile, researchers and clinicians have used different approaches to discover the pattern of the syndrome, as reported in (Afeni et al., 2017; Nimmala et al., 2018; Farran, Channanath, Behbehani, & Thanaraj, 2013; Zhang, Ren, Huang, Cheng, & Hu, 2019; Zhang, Wei, Ren, Cheng, & Zheng, 2018; Li, He, Shao, Ou, & Lin, 2015; Obe, Balanica, & Neagoe, 2015) The reports from these approaches suffers some inadequacies and inefficiency due to the complexity associated with the syndrome. High blood pressure usually has no warning signs or symptoms, and many people do not know they have it. Hence, the need for an intelligent technique such as machine learning for early prediction/detection of the disease to reduce the harm and mortality caused by it.

Machine Learning (ML) has been discovered to be a viable tool for patterns identification in data with vital performance

in medicine (Mbbs, 2019). Khanna and Awad (2015), defined machine learning as branch of artificial intelligence that systematically applies algorithms to synthesize underlying relationships among data and information. ML can be categorized into three categories, namely: Supervised Learning, Unsupervised Learning and Reinforcement Learning, (Abdi, 2016). The supervised learning category applies to what has been learned in the past to new data using labeled examples to predict future events. Unsupervised learning are used when the information used to train is neither classified nor labeled. Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabeled data. While, reinforcement machine learning algorithms is a learning method that interacts with its environment by producing actions and discovers events. Meanwhile, trial and error search and delayed are the most relevant characteristics of reinforcement learning. Ayodele et al, (2010) and Abdi, (2016), highlights some machine learning algorithms which include: Gradient Boosting, Random Forest, SVM, Linear Regression, Logistic Regression, Decision Tree, Naive Bayes , KNN , K-Means. The selected classifiers are type of machine learning boosting techniques for regression and classification problems. According to Brownlee, (2016), Gradient Boosting especially is one of the most powerful machine techniques for building predictive models. Boosting is a method of converting weak learners into strong learners (Grover, 2017; Singh, 2018). It relies on the intuition for the best possible model, and the key idea is to minimize the overall prediction error.

II. METHODOLOGY

This section presents the methodology for the research work. It involves the research design, data collection, data processing, classifications and classifiers evaluation. Figure 5 presented the architecture of the proposed predictive model for the work.

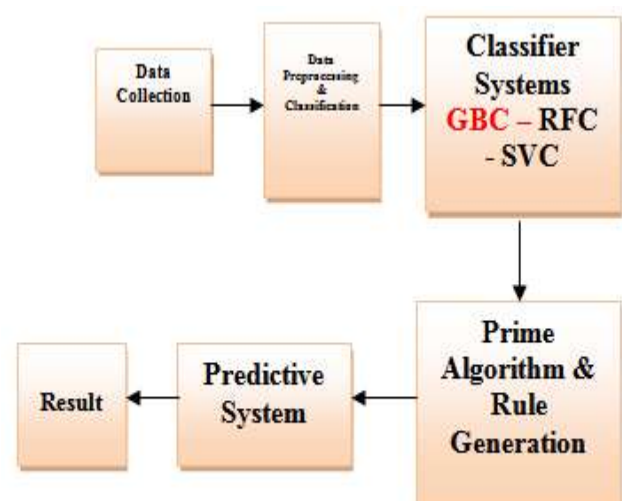


Figure 5: Architecture for the Predictive Model



Data Collection and Processing

A total number of 4,238 hypertension patients' dataset only was acquired due to some professional constraints from some selected health care centres in the Western region of Nigeria. Sixteen major attributes were collated and retrospective

learning was conducted using Machine Learning analyses on the data. Table 2 depicted the selected attributes of the data. The extracted data were subjected to cleaning and filtering processes. Table 3 and Table 4 depicts the formatted data and statistical analysis of the data respectively.

TABLE 2: SELECTED DATA ATTRIBUTES

	Age	diabetes	sysBP	diaBP	BMI	G&FH	DAA
0	39	0	106.0	80.0	26.97	0	0
1	46	1	121.0	81.0	28.73	1	1
2	48	0	127.0	89.0	25.34	0	0
3	50	1	150.0	95.0	28.58	1	1
4	46	1	130.0	84.0	23.10	1	1
5	43	0	180.0	110.0	30.30	0	0
6	63	0	138.0	89.0	33.11	1	1
7	45	0	130.0	89.0	21.68	0	0
8	52	1	141.0	89.0	26.36	1	1
9	43	0	162.0	107.0	23.61	1	1
10	50	0	173.0	96.0	22.91	1	0
11	43	1	151.0	88.0	27.64	1	1
12	46	1	162.0	94.0	26.31	0	1
13	41	0	144.0	88.0	31.31	1	1
14	39	0	134.0	80.0	22.35	1	0
15	38	1	140.0	90.0	21.35	1	1
16	48	1	138.0	90.0	22.37	1	1

Age = Age of patient, diabetes = Presence of Diabetes Melitus, SysBP = Systolic Blood Pressure, diaBP = Diastolic Blood Pressure, BMI = Body Mass index, G&FH = Genetic & family History, DAA = Drug –Alcohol Addiction etc

Data Classification

The normalized data was divided into training and testing set using a 66% and 34% split ratio as shown in Table 5. The obtained data was normalized using *Z*-score normalization in order to make training less sensitive to the scale of features.

Z-score converted the data into [0,1] distribution using equation (1).

$$x'_i = \frac{x_i - \mu}{\sigma} \quad \dots \text{Equation (1)}$$

Where x'_i is the data value, x_i is the data value to be normalized, μ represents the mean of data values in the feature category. The training and testing dataset was done on Anaconda Jupiter Notebook using sklearn library. The training set was used to train the classifiers, the testing set was used to evaluate the predictive model.

Table 3: Sample Data and Data Format Table

Gender	Age	Height	Weight	BP Systolic	BP Diastolic	Cholesterol	Glucose	Insulin	IGF1	IGF2	IGF3	IGF4	IGF5	IGF6	IGF7	IGF8	IGF9	IGF10	IGF11	IGF12	IGF13	IGF14	IGF15	IGF16	IGF17	IGF18	IGF19	IGF20	IGF21	IGF22	IGF23	IGF24	IGF25	IGF26	IGF27	IGF28	IGF29	IGF30	IGF31	IGF32	IGF33	IGF34	IGF35	IGF36	IGF37	IGF38	IGF39	IGF40	IGF41	IGF42	IGF43	IGF44	IGF45	IGF46	IGF47	IGF48	IGF49	IGF50	IGF51	IGF52	IGF53	IGF54	IGF55	IGF56	IGF57	IGF58	IGF59	IGF60	IGF61	IGF62	IGF63	IGF64	IGF65	IGF66	IGF67	IGF68	IGF69	IGF70	IGF71	IGF72	IGF73	IGF74	IGF75	IGF76	IGF77	IGF78	IGF79	IGF80	IGF81	IGF82	IGF83	IGF84	IGF85	IGF86	IGF87	IGF88	IGF89	IGF90	IGF91	IGF92	IGF93	IGF94	IGF95	IGF96	IGF97	IGF98	IGF99	IGF100	IGF101	IGF102	IGF103	IGF104	IGF105	IGF106	IGF107	IGF108	IGF109	IGF110	IGF111	IGF112	IGF113	IGF114	IGF115	IGF116	IGF117	IGF118	IGF119	IGF120	IGF121	IGF122	IGF123	IGF124	IGF125	IGF126	IGF127	IGF128	IGF129	IGF130	IGF131	IGF132	IGF133	IGF134	IGF135	IGF136	IGF137	IGF138	IGF139	IGF140	IGF141	IGF142	IGF143	IGF144	IGF145	IGF146	IGF147	IGF148	IGF149	IGF150	IGF151	IGF152	IGF153	IGF154	IGF155	IGF156	IGF157	IGF158	IGF159	IGF160	IGF161	IGF162	IGF163	IGF164	IGF165	IGF166	IGF167	IGF168	IGF169	IGF170	IGF171	IGF172	IGF173	IGF174	IGF175	IGF176	IGF177	IGF178	IGF179	IGF180	IGF181	IGF182	IGF183	IGF184	IGF185	IGF186	IGF187	IGF188	IGF189	IGF190	IGF191	IGF192	IGF193	IGF194	IGF195	IGF196	IGF197	IGF198	IGF199	IGF200	IGF201	IGF202	IGF203	IGF204	IGF205	IGF206	IGF207	IGF208	IGF209	IGF210	IGF211	IGF212	IGF213	IGF214	IGF215	IGF216	IGF217	IGF218	IGF219	IGF220	IGF221	IGF222	IGF223	IGF224	IGF225	IGF226	IGF227	IGF228	IGF229	IGF230	IGF231	IGF232	IGF233	IGF234	IGF235	IGF236	IGF237	IGF238	IGF239	IGF240	IGF241	IGF242	IGF243	IGF244	IGF245	IGF246	IGF247	IGF248	IGF249	IGF250	IGF251	IGF252	IGF253	IGF254	IGF255	IGF256	IGF257	IGF258	IGF259	IGF260	IGF261	IGF262	IGF263	IGF264	IGF265	IGF266	IGF267	IGF268	IGF269	IGF270	IGF271	IGF272	IGF273	IGF274	IGF275	IGF276	IGF277	IGF278	IGF279	IGF280	IGF281	IGF282	IGF283	IGF284	IGF285	IGF286	IGF287	IGF288	IGF289	IGF290	IGF291	IGF292	IGF293	IGF294	IGF295	IGF296	IGF297	IGF298	IGF299	IGF300	IGF301	IGF302	IGF303	IGF304	IGF305	IGF306	IGF307	IGF308	IGF309	IGF310	IGF311	IGF312	IGF313	IGF314	IGF315	IGF316	IGF317	IGF318	IGF319	IGF320	IGF321	IGF322	IGF323	IGF324	IGF325	IGF326	IGF327	IGF328	IGF329	IGF330	IGF331	IGF332	IGF333	IGF334	IGF335	IGF336	IGF337	IGF338	IGF339	IGF340	IGF341	IGF342	IGF343	IGF344	IGF345	IGF346	IGF347	IGF348	IGF349	IGF350	IGF351	IGF352	IGF353	IGF354	IGF355	IGF356	IGF357	IGF358	IGF359	IGF360	IGF361	IGF362	IGF363	IGF364	IGF365	IGF366	IGF367	IGF368	IGF369	IGF370	IGF371	IGF372	IGF373	IGF374	IGF375	IGF376	IGF377	IGF378	IGF379	IGF380	IGF381	IGF382	IGF383	IGF384	IGF385	IGF386	IGF387	IGF388	IGF389	IGF390	IGF391	IGF392	IGF393	IGF394	IGF395	IGF396	IGF397	IGF398	IGF399	IGF400	IGF401	IGF402	IGF403	IGF404	IGF405	IGF406	IGF407	IGF408	IGF409	IGF410	IGF411	IGF412	IGF413	IGF414	IGF415	IGF416	IGF417	IGF418	IGF419	IGF420	IGF421	IGF422	IGF423	IGF424	IGF425	IGF426	IGF427	IGF428	IGF429	IGF430	IGF431	IGF432	IGF433	IGF434	IGF435	IGF436	IGF437	IGF438	IGF439	IGF440	IGF441	IGF442	IGF443	IGF444	IGF445	IGF446	IGF447	IGF448	IGF449	IGF450	IGF451	IGF452	IGF453	IGF454	IGF455	IGF456	IGF457	IGF458	IGF459	IGF460	IGF461	IGF462	IGF463	IGF464	IGF465	IGF466	IGF467	IGF468	IGF469	IGF470	IGF471	IGF472	IGF473	IGF474	IGF475	IGF476	IGF477	IGF478	IGF479	IGF480	IGF481	IGF482	IGF483	IGF484	IGF485	IGF486	IGF487	IGF488	IGF489	IGF490	IGF491	IGF492	IGF493	IGF494	IGF495	IGF496	IGF497	IGF498	IGF499	IGF500	IGF501	IGF502	IGF503	IGF504	IGF505	IGF506	IGF507	IGF508	IGF509	IGF510	IGF511	IGF512	IGF513	IGF514	IGF515	IGF516	IGF517	IGF518	IGF519	IGF520	IGF521	IGF522	IGF523	IGF524	IGF525	IGF526	IGF527	IGF528	IGF529	IGF530	IGF531	IGF532	IGF533	IGF534	IGF535	IGF536	IGF537	IGF538	IGF539	IGF540	IGF541	IGF542	IGF543	IGF544	IGF545	IGF546	IGF547	IGF548	IGF549	IGF550	IGF551	IGF552	IGF553	IGF554	IGF555	IGF556	IGF557	IGF558	IGF559	IGF560	IGF561	IGF562	IGF563	IGF564	IGF565	IGF566	IGF567	IGF568	IGF569	IGF570	IGF571	IGF572	IGF573	IGF574	IGF575	IGF576	IGF577	IGF578	IGF579	IGF580	IGF581	IGF582	IGF583	IGF584	IGF585	IGF586	IGF587	IGF588	IGF589	IGF590	IGF591	IGF592	IGF593	IGF594	IGF595	IGF596	IGF597	IGF598	IGF599	IGF600	IGF601	IGF602	IGF603	IGF604	IGF605	IGF606	IGF607	IGF608	IGF609	IGF610	IGF611	IGF612	IGF613	IGF614	IGF615	IGF616	IGF617	IGF618	IGF619	IGF620	IGF621	IGF622	IGF623	IGF624	IGF625	IGF626	IGF627	IGF628	IGF629	IGF630	IGF631	IGF632	IGF633	IGF634	IGF635	IGF636	IGF637	IGF638	IGF639	IGF640	IGF641	IGF642	IGF643	IGF644	IGF645	IGF646	IGF647	IGF648	IGF649	IGF650	IGF651	IGF652	IGF653	IGF654	IGF655	IGF656	IGF657	IGF658	IGF659	IGF660	IGF661	IGF662	IGF663	IGF664	IGF665	IGF666	IGF667	IGF668	IGF669	IGF670	IGF671	IGF672	IGF673	IGF674	IGF675	IGF676	IGF677	IGF678	IGF679	IGF680	IGF681	IGF682	IGF683	IGF684	IGF685	IGF686	IGF687	IGF688	IGF689	IGF690	IGF691	IGF692	IGF693	IGF694	IGF695	IGF696	IGF697	IGF698	IGF699	IGF700	IGF701	IGF702	IGF703	IGF704	IGF705	IGF706	IGF707	IGF708	IGF709	IGF710	IGF711	IGF712	IGF713	IGF714	IGF715	IGF716	IGF717	IGF718	IGF719	IGF720	IGF721	IGF722	IGF723	IGF724	IGF725	IGF726	IGF727	IGF728	IGF729	IGF730	IGF731	IGF732	IGF733	IGF734	IGF735	IGF736	IGF737	IGF738	IGF739	IGF740	IGF741	IGF742	IGF743	IGF744	IGF745	IGF746	IGF747	IGF748	IGF749	IGF750	IGF751	IGF752	IGF753	IGF754	IGF755	IGF756	IGF757	IGF758	IGF759	IGF760	IGF761	IGF762	IGF763	IGF764	IGF765	IGF766	IGF767	IGF768	IGF769	IGF770	IGF771	IGF772	IGF773	IGF774	IGF775	IGF776	IGF777	IGF778	IGF779	IGF780	IGF781	IGF782	IGF783	IGF784	IGF785	IGF786	IGF787	IGF788	IGF789	IGF790	IGF791	IGF792	IGF793	IGF794	IGF795	IGF796	IGF797	IGF798	IGF799	IGF800	IGF801	IGF802	IGF803	IGF804	IGF805	IGF806	IGF807	IGF808	IGF809	IGF810	IGF811	IGF812	IGF813	IGF814	IGF815	IGF816	IGF817	IGF818	IGF819	IGF820	IGF821	IGF822	IGF823	IGF824	IGF825	IGF826	IGF827	IGF828	IGF829	IGF830	IGF831	IGF832	IGF833	IGF834	IGF835	IGF836	IGF837	IGF838	IGF839	IGF840	IGF841	IGF842	IGF843	IGF844	IGF845	IGF846	IGF847	IGF848	IGF849	IGF850	IGF851	IGF852	IGF853	IGF854	IGF855	IGF856	IGF857	IGF858	IGF859	IGF860	IGF861	IGF862	IGF863	IGF864	IGF865	IGF866	IGF867	IGF868	IGF869	IGF870	IGF871	IGF872	IGF873	IGF874	IGF875	IGF876	IGF877	IGF878	IGF879	IGF880	IGF881	IGF882	IGF883	IGF884	IGF885	IGF886	IGF887	IGF888	IGF889	IGF890	IGF891	IGF892	IGF893	IGF894	IGF895	IGF896	IGF897	IGF898	IGF899	IGF900	IGF901	IGF902	IGF903	IGF904	IGF905	IGF906	IGF907	IGF908	IGF909	IGF910	IGF911	IGF912	IGF913	IGF914	IGF915	IGF916	IGF917	IGF918	IGF919	IGF920	IGF921	IGF922	IGF923	IGF924	IGF925	IGF926	IGF927	IGF928	IGF929	IGF930	IGF931	IGF932	IGF933	IGF934	IGF935	IGF936	IGF937	IGF938	IGF939	IGF940	IGF941	IGF942	IGF943	IGF944	IGF945	IGF946	IGF947	IGF948	IGF949	IGF950	IGF951	IGF952	IGF953	IGF954	IGF955	IGF956	IGF957	IGF958	IGF959	IGF960	IGF961	IGF962	IGF963	IGF964	IGF965	IGF966	IGF967	IGF968	IGF969	IGF970	IGF971	IGF972	IGF973	IGF974	IGF975	IGF976	IGF977	IGF978	IGF979	IGF980	IGF981	IGF982	IGF983	IGF984	IGF985	IGF986	IGF987	IGF988	IGF989	IGF990	IGF991	IGF992	IGF993	IGF994	IGF995	IGF996	IGF997	IGF998	IGF999	IGF1000	IGF1001	IGF1002	IGF1003	IGF1004	IGF1005	IGF1006	IGF1007	IGF1008	IGF1009	IGF1010	IGF1011	IGF1012	IGF1013	IGF1014	IGF1015	IGF1016	IGF1017	IGF1018	IGF1019	IGF1020	IGF1021	IGF1022	IGF1023	IGF1024	IGF1025	IGF1026	IGF1027	IGF1028	IGF1029	IGF1030	IGF1031	IGF1032	IGF1033	IGF1034	IGF1035	IGF1036	IGF1037	IGF1038	IGF1039	IGF1040	IGF1041	IGF1042	IGF1043	IGF1044	IGF1045	IGF1046	IGF1047	IGF1048	IGF1049	IGF1050	IGF1051	IGF1052	IGF1053	IGF1054	IGF1055	IGF1056	IGF1057	IGF1058	IGF1059	IGF1060	IGF1061	IGF1062	IGF1063	IGF1064	IGF1065	IGF1066	IGF1067	IGF1068	IGF1069	IGF1070	IGF1071	IGF1072	IGF1073	IGF1074	IGF1075	IGF1076	IGF1077	IGF1078	IGF1079	IGF1080	IGF1081	IGF1082	IGF1083	IGF1084	IGF1085	IGF1086	IGF1087	IGF1088	IGF1089	IGF1090	IGF1091	IGF1092	IGF1093	IGF1094	IGF1095	IGF1096	IGF1097	IGF1098	IGF1099	IGF1100	IGF1101	IGF1102	IGF1103	IGF1104	IGF1105	IGF1106	IGF1107	IGF1108	IGF1109	IGF1110	IGF1111	IGF1112	IGF1113	IGF1114	IGF1115	IGF1116	IGF1117	IGF1118	IGF1119	IGF1120	IGF1121	IGF1122	IGF1123	IGF1124	IGF1125	IGF1126	IGF1127	IGF1128	IGF1129	IGF1130	IGF1131	IGF1132	IGF1133	IGF1134	IGF1135	IGF1136	IGF1137	IGF1138	IGF1139	IGF1140	IGF1141	IGF1142	IGF1143	IGF1144	IGF1145	IGF1146	IGF1147	IGF1148	IGF1149	IGF1150	IGF1151	IGF1152	IGF1153	IGF1154	IGF1155	IGF1156	IGF1157	IGF1158	IGF1159	IGF1160	IGF1161	IGF1162	IGF1163	IGF1164	IGF1165	IGF1166	IGF1167	IGF1168	IGF1169	IGF1170	IGF1171	IGF1172	IGF1173	IGF1174	IGF1175	IGF1176	IGF1177	IGF1178	IGF1179	IGF1180	IGF1181	IGF1182	IGF1183	IGF1184	IGF1185	IGF1186	IGF1187	IGF1188	IGF1189	IGF1190	IGF1191	IGF1192	IGF1193	IGF1194	IGF1195	IGF1196	IGF1197	IGF1198	IGF11
--------	-----	--------	--------	-------------	--------------	-------------	---------	---------	------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	---------	-------



Figure 6: Overview of Anaconda Application Window

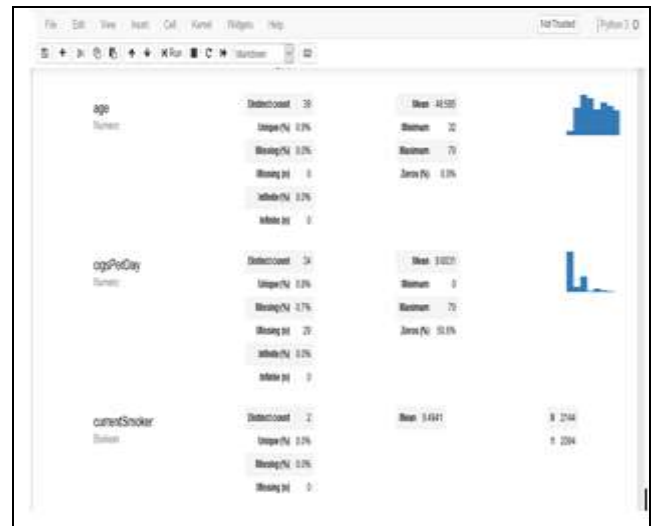


Figure 8: Samples of Attributes Classification

During the experiment, the dataset was fed into the Anaconda platform and Figure 7 shows the dataset information with the number of variables, number of observations and warnings.



Figure 7: showing the data input interface.

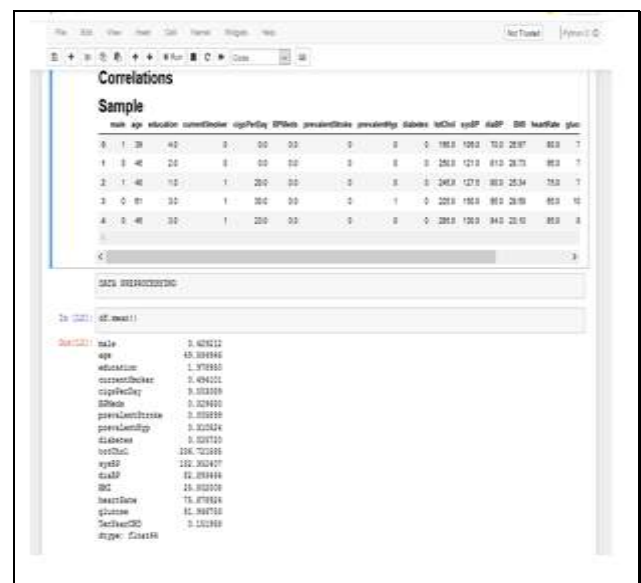


Figure 9: Sampled Correlation Output

Figure 8 and Figure 9 show the samples of attributes classification and correlation output respectively.

The performance of the algorithms in the experiment in terms of accuracy, precision and F1 score metrics are presented in Table 6. Figures 10 depicts the comparison of the algorithm's performance.

Table 6: Classifiers Performance

	RFC	GBC	SVC
ACCURACY	87.97	90.17	89.3
PRECISION	78	85	78
F1 SCORE	80.3	84.47	82.1

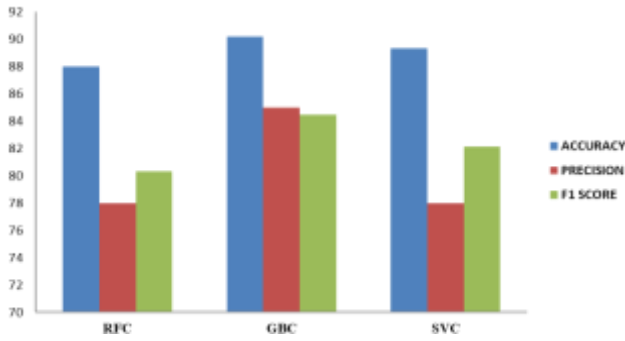


Figure 10: Comparison of the Algorithm's Performance

From the experimental results, the gradient boosting algorithm outperformed all the other algorithm tested in term of accuracy, precision and F1 score metrics with 90.17%, 85.0%, 85.0% respectively. The algorithm successfully learn and classified the input and predict correctly the level of the syndrome in each input during the testing mode. Commonly identified risk factors include age, gender, body mass index, obesity, stress, uric acid, lipoproteins, cholesterol, smoking habits, and family history of the disease.

IV CONCLUSION

Efforts in this work is focused at developing an intelligent model for early prediction of hypertension using a machine learning technique. The objective of the study was critically observed and achieved. The dataset collected was trained and tested with the intelligent classifiers developed for the work. The performance of the algorithms considered were compared using standard metrics of accuracy and throughput (precision and F1 scores). The results from the experiment show that the gradient boosting classifier outclassed other algorithms with an accuracy of 90.17%. The model has proved to be suitable for early prediction of the syndrome. The deployment of this model in our health care delivery system is believe will help to reduce the mortality rate of the syndrome in our society through timely detection and treatment of the syndrome in patients.

V REFERENCES

- [1]. Abdi, A. (2016). Three types of Machine Learning Algorithms List of Common Machine Learning Algorithms. Retrieved from <https://doi.org/10.13140/RG.2.2.26209.10088>.
- [2]. Afeni, B., Aruleba, T., and Oloyede, I. (2017). Hypertension Prediction System Using Naive Bayes Classifier. *Journal of Advances in Mathematics and Computer Science*, 24(2), 1–11. <https://doi.org/10.9734/jamcs/2017/35610>.
- [3]. American Heart Association (2022). Healthy and unhealthy blood pressure ranges Retrieved online on 28/6/2022 at <https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings>.
- [4]. American Heart Association (2017). Understanding Blood Pressure Readings. Retrieved 15/04/2021 at <https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings>.
- [5]. Ayodele, T. O. (2010). Types of Machine Learning Algorithms. *New Advances in Machine Learning*. Retrived 28/6/2022 from www.intechopen.com.
- [6]. Ben-david, S and Shalev-Shwartz, S (2014). *Understanding Machine Learning: From Theory to Algorithms*. Cambridge University Press Retrieved on 25/04/2021from: https://books.google.com.ng/books?id=ttJkAwAAQB&source=gbs_navlinks_s.
- [7]. Brownlee, J. (2016). *A Gentle Introduction to the Gradient Boosting Algorithm for Machine Learning*. *Machine Learning Mastery* Retrieved on 28/04/2021 from <https://machinelearningmastery.com/gentle-introduction-gradient-boosting-algorithm-machine-learning/>.
- [8]. CDC (2021). High Blood Pressure symptoms and causes centres for disease control and prevention retrieved online at: <https://www.cdc.gov/bloodpressure/about.htm#> on 28/6/2022.
- [9]. Digest, M., Does, W., Pressure, B., and To, R. (2019). Blood Pressure Chart : Low , Normal , High Reading by Age.
- [10]. Farran, B., Channanath, A. M., Behbehani, K., & Thanaraj, T. A. (2013). Predictive models to assess risk of type 2 diabetes , hypertension and comorbidity: machine-learning algorithms and validation using national health data from Kuwait — a cohort study. <https://doi.org/10.1136/bmjopen-2012-002457>.
- [11]. Felman, A. (2019). What to know about high blood pressure. (February) Retrieved on 19/09/2022 at: <https://www.medicalnewstoday.com/articles/150109>
- [12]. Grover, P. (2017). Gradient Boosting from scratch – ML Review – Medium. Medium. Retrieved on 28/04/2021 from <https://medium.com/mlreview/gradient-boosting-from-scratch-1e317ae4587d>.
- [13]. Hannedouche, T., & Krummel, T. (2008). [High blood pressure in adults]. *La Revue Du Praticien*, 58(10), 1117–1129. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/18652414>.
- [14]. Khanna, R., & Awad, M. (2015). *Efficient Learning Machines : Theories , Concepts , and Applications for Engineers and System Designers*. Retrieved on 25/05/2021from <https://doi.org/10.1007/978-1-4302-5990-9>
- [15]. Lawes, C. M. M., Hoorn, S. Vander, Law, M. R., Elliott, P., Macmahon, S., & Rodgers, A. (2000).



- High blood pressure- World Health Organization.
 Retrieved from
<https://www.who.int/publications/cra/chapters/volume1/0281-0390.pdf> on 28/04/2021.
- [16]. Li, G., He, Z., Shao, F., Ou, A., & Lin, X. (2015). Patient classification of hypertension in Traditional Chinese Medicine using multi-label learning techniques. 8(3), 4–9. retrieved from <http://www.biomedcentral.com/1755-8794/8/S3/S4>.
- [17]. Logan, AG (2011). Hypertension in Aging Patients. Expert Rev Cardiovasc Ther. 2011;9(1):113-120. Reported in Medscape on 28/6/2022. https://www.medscape.com/viewarticle/734880_1#:~:text=Hypertension%2C%20especially%20isolated%20systolic%20hypertension,treatment%20greatly%20reduces%20cardiovascular%20events.
- [18]. Mbbs, P. S. (2019). Machine learning and blood pressure. Retrieved on 24/4/2021). <https://doi.org/10.1111/jch.13700>
- [19]. Nimmala, S., Ramadevi, Y., Sahith, R., & Cheruku, R. (2018). High blood pressure prediction based on AAA++ using machine-learning algorithms. Cogent Engineering, 5(1), 1–12. Retrieved from <https://doi.org/10.1080/23311916.2018.1497114>.
- [20]. Obe, O. O., Balanica, V., & Neagoe, E. (2015). An ANN-Based Predictive Model for Diagnosis and Forecasting of Hypertension. 9(4), 942–945.
- [21]. Scagliarini, L. (2019). What is Machine Learning ? A definition. 2019. Retrieved 12/06/2021 from <https://www.expert.ai/blog/machine-learning-definition/>
- [22]. Shinde, S. A., & Rajeswari, P. R. (2018). Intelligent health risk prediction systems using machine learning : a review. 7(3), 1019–1023. <https://doi.org/10.14419/ijet.v7i3.12654>.
- [23]. Singh, H. (2018). Understanding Gradient Boosting {Machines}. Medium, 5. Retrieved on 26/05/2021 from <https://towardsdatascience.com/understanding-gradient-boosting-machines-9be756fe76ab>.
- [24]. WHO (2021). What is Hypertension Retrieved on 28/6/2022 at: <https://www.who.int/news-room/fact-sheets/detail/hypertension>

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

ABOUT IJEAST

International Journal of Engineering Applied Science and Technology (IJEAST) is a peer-reviewed, open access journal that publishes high-quality research papers in the field of Engineering, Applied Science and Technology.

IJEAST aims to provide a platform for researchers, academicians, and professionals to share their innovative ideas, research findings, and practical experiences with the global scientific community.

FOCUS AREAS

- Engineering
- Applied Science
- Technology
- Innovation & Development
- Interdisciplinary Studies



PEER REVIEWED

All submissions are rigorously peer reviewed to ensure quality.



OPEN ACCESS

Free and unrestricted access to research for all.



GLOBAL REACH

Connecting researchers and professionals worldwide.



TIMELY PUBLICATION

We ensure a swift and efficient publication process.



For more information, visit our website

www.ijeast.com



INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

✉ editor@ijeast.com

🌐 www.ijeast.com

📍 India



2455-2143