



MINISTRY OF ECONOMY
DEPARTMENT OF STATISTICS MALAYSIA

Machine Learning Techniques to Classify Individual's Home Activities

Presented by
Ms Chong Kar Yin, Taylor's University

**11th MALAYSIA
STATISTICS CONFERENCE**
"Data and Artificial Intelligence: Empowering the Future"

**19th September
2024**

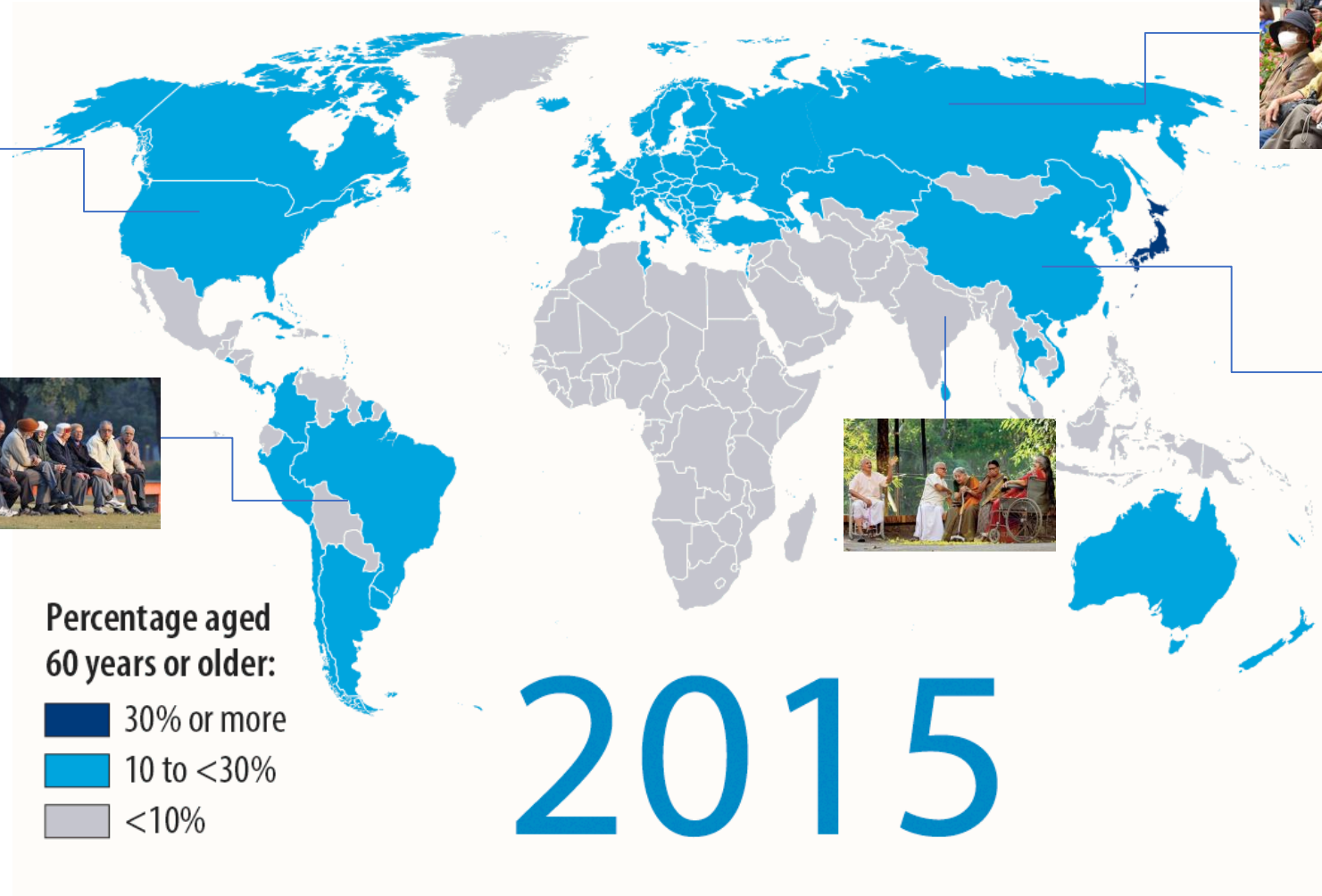
Organized by:



AGING POPULATION: THE CHALLENGE

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THE POPULATION IS GETTING OLDER

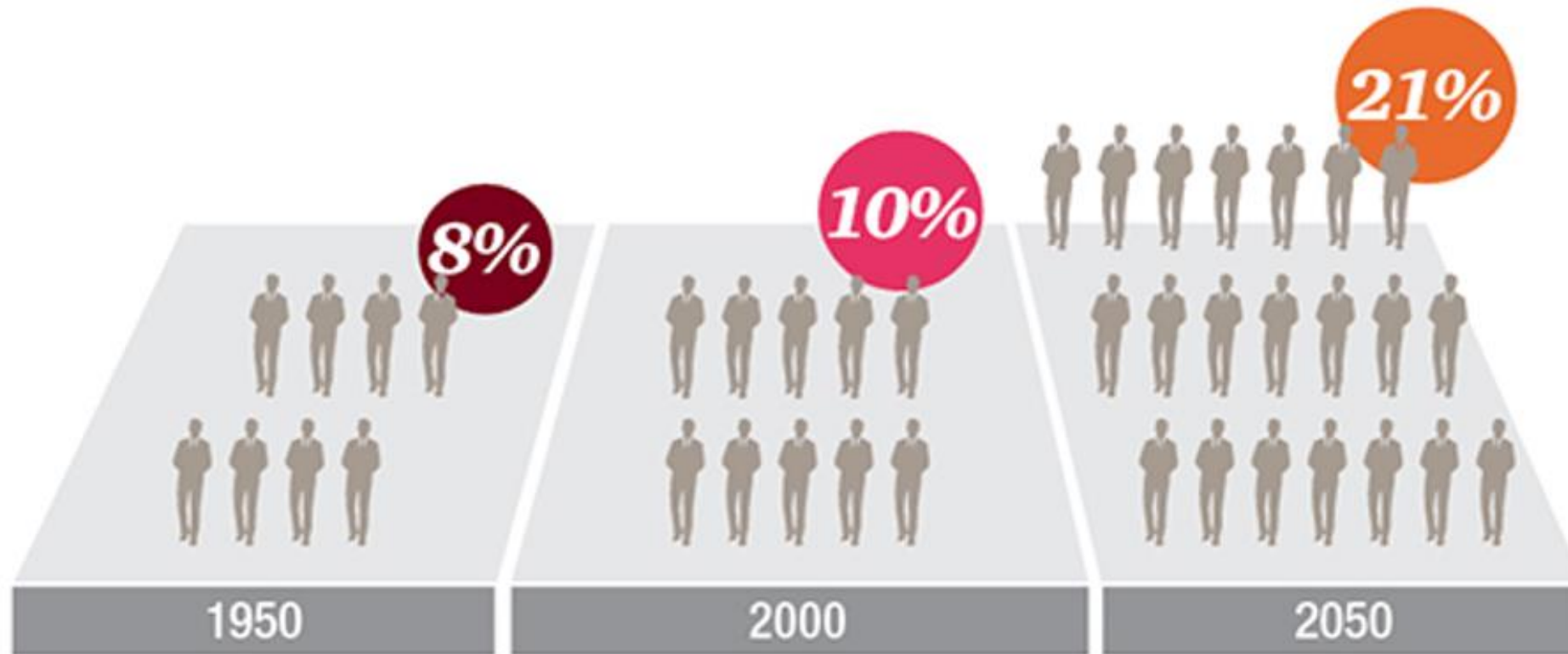


Source: World Health Organization

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THE POPULATION IS GETTING OLDER

Proportion of the world population aged 60 years or more



Source: UN Report World Population Ageing 1950-2050

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WHAT'S THE SOLUTION?



24-Hour Caregivers?

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WHAT'S THE SOLUTION?



Healthcare Investment?

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WHAT'S THE SOLUTION?



**More
Subsidy?**

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WHAT'S THE SOLUTION?



How about Smart Home?

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WHAT'S THE SOLUTION?



IoT *Machine Learning*

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OUR STUDY

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01

Compare machine learning algorithms for classifying ADLs using smart home data.

02 Assess the impact of time-related features on classification accuracy.



01

Compare machine learning algorithms for classifying ADLs using smart home data.

02

Assess the impact of time-related features on classification accuracy.



01

Raw Data

02

Data
Cleaning &
Preprocessing

03

Feature
Engineering

04

Classification

05

Testing &
Evaluation

01

Raw Data



Center of Advanced Studies In Adaptive System

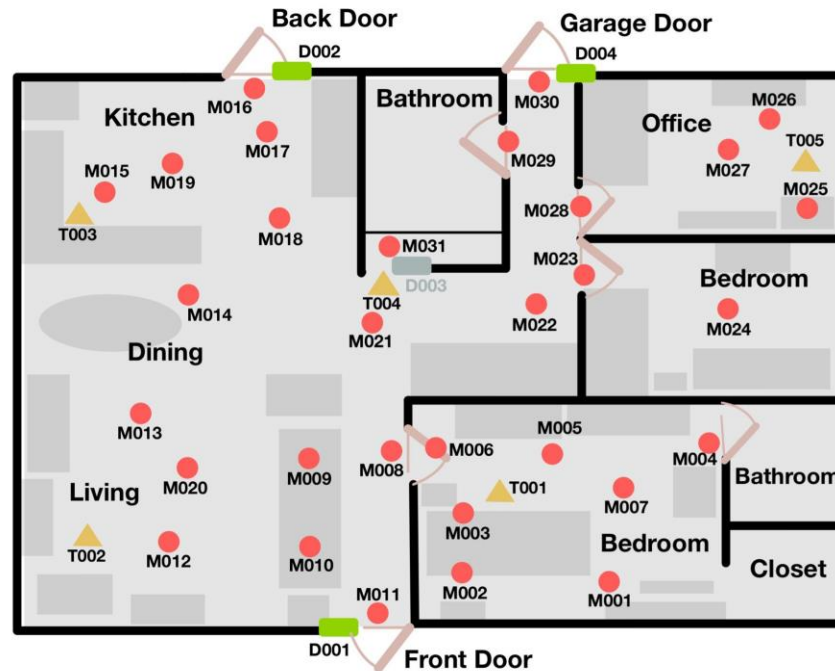


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THE CASAS ARUBA DATASET

----- Collected by WSU



Date	Time	Sensor	Status	Annotation
2011-05-15	04:22:43.082116	M003	ON	
2011-05-15	04:22:44.624551	M003	OFF	Sleeping end
2011-05-15	04:22:46.649038	M005	ON	
2011-05-15	04:22:50.398987	M004	ON	Bed_to_Toilet begin
2011-05-15	04:22:50.472761	M005	OFF	
2011-05-15	04:22:57.782528	T005	21	
2011-05-15	04:22:58.533178	M004	OFF	
2011-05-15	04:22:58.623508	M007	OFF	
2011-05-15	04:25:44.619463	M004	ON	
2011-05-15	04:25:45.993194	M007	ON	
2011-05-15	04:25:50.590135	M004	OFF	Bed_to_Toilet end
2011-05-15	04:25:50.727788	M005	ON	
2011-05-15	04:25:52.659384	M005	OFF	
2011-05-15	04:25:55.446432	M003	ON	Sleeping begin
2011-05-15	04:25:57.258257	M007	OFF	

- Motion Sensors
- ▲ Temperature Sensors
- Door Sensors
- Ignored Door Sensors

02

Data Cleaning & Preprocessing

03

Feature
Engineering

01

ACTIVITY BASED
FEATURES

(e.g. Duration, Sensor Value, etc)

		SDD1	SDD2	SDD3	...	SDD1	DOD1	DOD2	DOD3		
156.89051	2	0	1	8	...	0	0	0	0	Sleeping	Bed_in_Tot
2.68958	1	0	0	0	...	0	0	0	0	Bed_in_Tot	Sleeping
...
17.83056	7	0	0	0	...	0	0	0	0	Work	Sleeping
335.20451	2	0	14	114	...	0	0	0	0	Sleeping	Bed_in_Tot
3.158413	1	0	0	0	...	0	0	0	0	Bed_in_Tot	Sleeping

VS

02

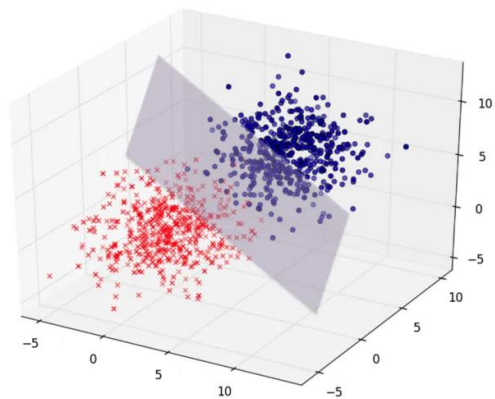
TEMPORAL BASED
FEATURES

(e.g. Time Window, Day of Week etc)

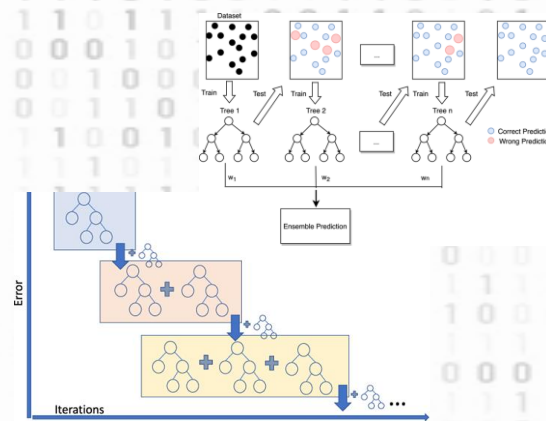
				SDD1	SDD2	SDD3	SDD1	DOD1	DOD2	DOD3		
156.89051	1	Thursday	[4,341]	2	0	1	8	0	0	0	Sleeping	Bed_in_Tot
2.68958	1	Thursday	[261,344]	1	0	0	0	0	0	0	Bed_in_Tot	Sleeping
...
17.83056	2	Friday	[354, 1370]	7	0	0	0	0	0	0	Work	Sleeping
335.20451	2	Friday	[1595, 1440]	1	0	14	114	0	0	0	Sleeping	Bed_in_Tot
3.158413	1	Saturday	[1, 294]	2	0	14	114	0	0	0	Sleeping	Bed_in_Tot
0.128413	1	Saturday	[294, 295]	1	0	0	0	0	0	0	Bed_in_Tot	Sleeping

04

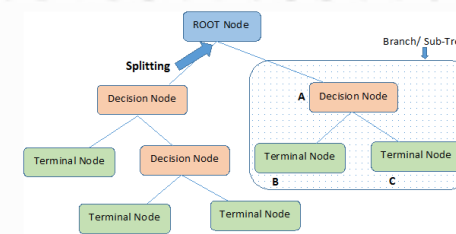
Classification



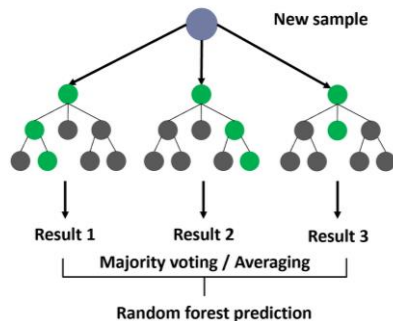
Support Vector Machine (SVM)



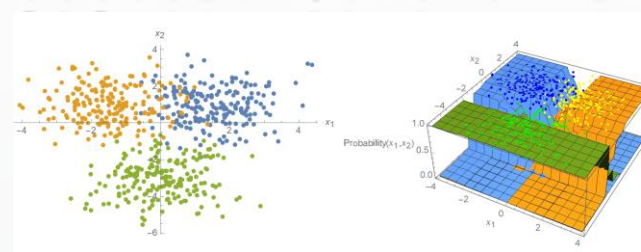
Gradient Boosting (GB)



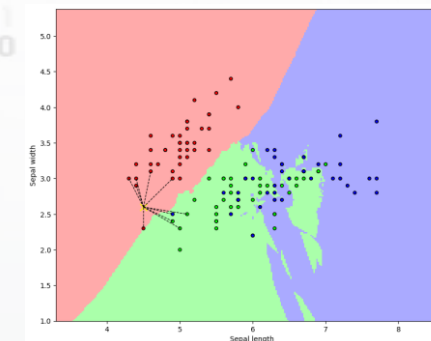
Decision Tree (DT)



Random Forest (RF)



Naïve Bayes (NB)



K-Nearest Neighbor (KNN)

05

Testing & Evaluation

Activity	No. of Instances	Training Set	Validation Set
Relax	2887	2021	866
Meal_Preparation	1572	1100	472
Leave_Home	427	299	128
Enter_Home	427	299	128
Sleeping	398	279	119
Eating	244	171	73
Work	171	120	51
Bed_to_Toilet	156	109	47
Wash_Dishes	63	44	19
Housekeeping	32	22	10
Respirate	6	4	2
Total	6383	4468	1915

Separation Key	No. of Instances	Training Set	Validation Set
Days	220	154	66

 Cross Validation Test

 Evaluation Metrics

- Confusion Matrix
- Precision | Recall
- F1 Score
- Matthews Correlation Coefficient

01

Compare machine learning algorithms for classifying ADLs using smart home data.

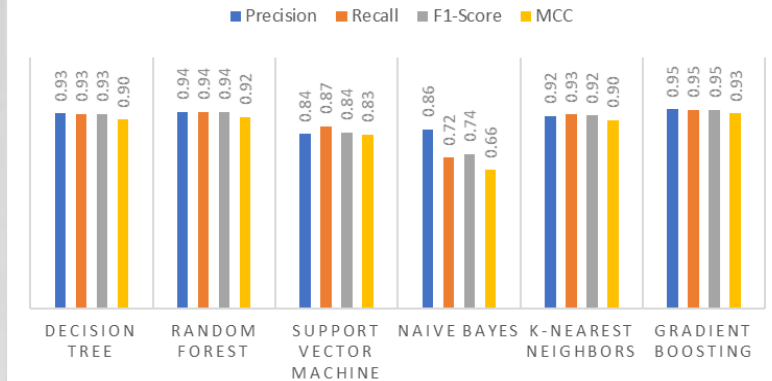
02 Assess the impact of time-related features on classification accuracy.



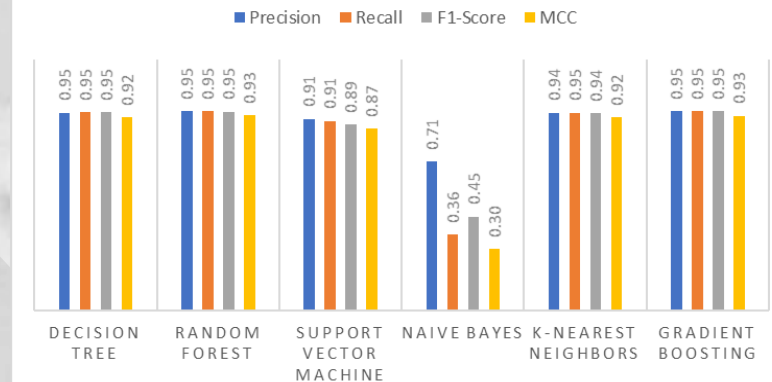
01 Comparing Algorithms

- Gradient Boosting:
Top performing algorithm
- Random Forest & Decision Trees:
Strong performance on complex activities
- Naive Bayes:
Worst performance, struggled with interdependent data

OVERALL PERFORMANCE (ACTIVITY_BASED)



OVERALL PERFORMANCE (DAILY_BASIS)



01

Compare machine learning algorithms for classifying ADLs using smart home data.

02

Assess the impact of time-related features on classification accuracy.



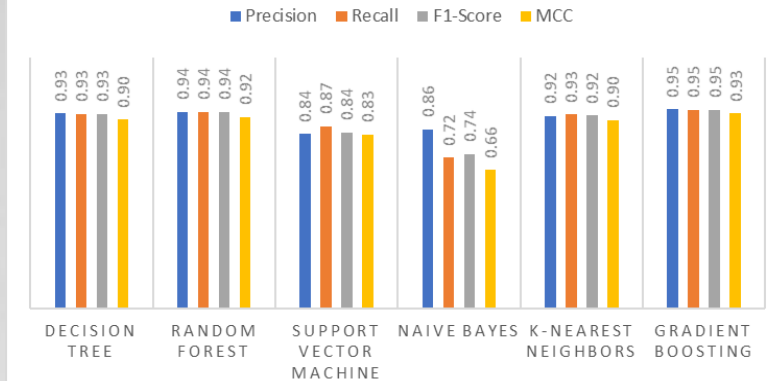
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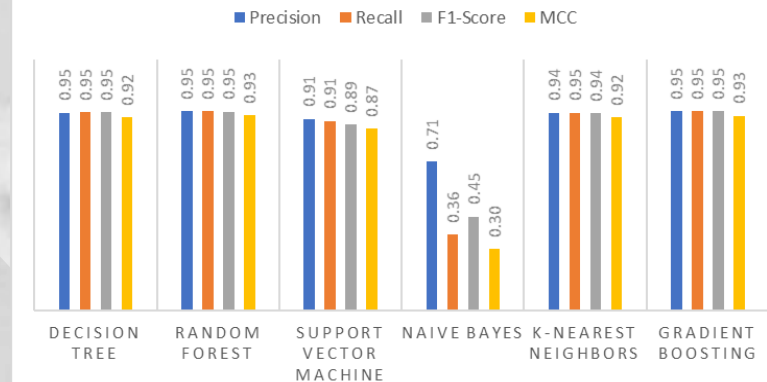
02 Impact of Time Features

- Improved accuracy in most models
- SVM showed the biggest improvement
- Random Forest slightly outperformed Gradient Boosting with time features

OVERALL PERFORMANCE (ACTIVITY_BASED)



OVERALL PERFORMANCE (DAILY_BASIS)



RESULT DETAILS

Activity	Method	TP	TN	FP	FN	Precision	Recall	F1-Score	MCC
Relax	Decision Tree	869	1035	9	2	0.99	1.00	0.99	0.99
	Random Forest	870	1040	4	1	1.00	1.00	1.00	0.99
	Support Vector Machine	869	1030	14	2	0.98	1.00	0.98	0.98
	Naive Bayes	758	1040	4	113	0.99	0.87	0.93	0.88
	K-Nearest Neighbors	868	1037	7	3	0.99	1.00	0.99	0.99
Meal_Preparation	Gradient Boosting	870	1044	0	1	1.00	1.00	1.00	1.00
	Decision Tree	429	1468	6	11	0.99	0.97	0.98	0.97
	Random Forest	437	1466	8	4	0.98	0.99	0.99	0.98
	Support Vector Machine	434	1452	22	7	0.95	0.98	0.97	0.98
	Naive Bayes	167	1461	13	274	0.93	0.38	0.54	0.53
Leave_Home	K-Nearest Neighbors	437	1452	22	4	0.95	0.99	0.97	0.98
	Gradient Boosting	435	1467	7	6	0.98	0.99	0.98	0.98
	Decision Tree	78	1729	71	37	0.52	0.68	0.59	0.57
	Random Forest	71	1746	54	44	0.57	0.62	0.59	0.56
	Support Vector Machine	115	1593	207	0	0.36	1.00	0.53	0.50
Enter_Home	Naive Bayes	1	1797	9	114	0.25	0.01	0.10	0.04
	K-Nearest Neighbors	81	1731	69	34	0.54	0.70	0.61	0.58
	Gradient Boosting	86	1749	51	29	0.63	0.75	0.68	0.66
	Decision Tree	68	1742	36	69	0.65	0.50	0.56	0.54
	Random Forest	83	1734	44	54	0.65	0.61	0.63	0.60
Sleeping	Support Vector Machine	0	1778	0	137	0.00	0.00	0.00	0.00
	Naive Bayes	132	1666	112	5	0.54	0.96	0.69	0.70
	K-Nearest Neighbors	70	1744	34	67	0.67	0.51	0.58	0.56
	Gradient Boosting	88	1750	28	49	0.76	0.64	0.70	0.68
	Decision Tree	139	1774	1	1	0.99	0.99	0.99	0.99
Eating	Random Forest	139	1775	0	1	1.00	0.99	1.00	1.00
	Support Vector Machine	130	1775	0	10	1.00	0.93	0.96	0.96
	Naive Bayes	139	1773	2	1	0.99	0.99	0.99	0.99
	K-Nearest Neighbors	137	1775	0	3	1.00	0.98	0.99	0.99
	Gradient Boosting	140	1775	0	0	1.00	1.00	1.00	1.00
Work	Decision Tree	77	1835	1	2	0.99	0.97	0.98	0.98
	Random Forest	77	1834	2	2	0.97	0.97	0.97	0.97
	Support Vector Machine	71	1836	0	8	1.00	0.90	0.96	0.96
	Naive Bayes	74	1573	263	5	0.22	0.94	0.36	0.41
	K-Nearest Neighbors	78	1835	1	1	0.99	0.99	0.99	0.99
Bed_to_Toilet	Gradient Boosting	79	1835	1	0	0.99	1.00	0.99	0.99
	Decision Tree	51	1861	0	3	1.00	0.94	0.97	0.97
	Random Forest	54	1861	0	0	1.00	1.00	1.00	1.00
	Support Vector Machine	47	1860	1	7	0.98	0.87	0.92	0.92
	Naive Bayes	42	1860	1	12	0.98	0.78	0.87	0.87
Wash_Dishes	K-Nearest Neighbors	53	1860	1	1	0.98	0.98	0.98	0.98
	Gradient Boosting	53	1860	1	1	0.98	0.98	0.98	0.98
	Decision Tree	48	1867	0	0	1.00	1.00	1.00	1.00
	Random Forest	48	1867	0	0	1.00	1.00	1.00	1.00
	Support Vector Machine	0	1866	1	48	0.00	0.00	0.00	0.00
Housekeeping	Naive Bayes	48	1866	1	0	0.98	1.00	0.99	0.99
	K-Nearest Neighbors	48	1865	2	0	0.96	1.00	0.98	0.98
	Gradient Boosting	48	1867	0	0	1.00	1.00	1.00	1.00
	Decision Tree	17	1888	7	3	0.71	0.85	0.77	0.77
	Random Forest	13	1892	3	7	0.81	0.65	0.72	0.72
Housekeeping	Support Vector Machine	0	1895	0	20	0.00	0.00	0.00	0.00
	Naive Bayes	14	1782	113	6	0.11	0.70	0.19	0.26
	K-Nearest Neighbors	0	1895	0	20	0.00	0.00	0.00	0.00
	Gradient Boosting	15	1892	3	5	0.83	0.75	0.79	0.79
	Decision Tree	5	1904	1	5	0.83	0.50	0.63	0.64
Housekeeping	Random Forest	8	1905	0	2	1.00	0.80	0.89	0.89
	Support Vector Machine	4	1905	0	6	1.00	0.40	0.57	0.61
	Naive Bayes	8	1905	0	2	0.44	0.57	0.50	0.58
	K-Nearest Neighbors	7	1905	0	3	1.00	0.82	0.90	0.84
	Gradient Boosting	9	1904	1	1	0.90	0.90	0.90	0.90

Activity	Method	TP	TN	FP	FN	Precision	Recall	F1-Score	MCC
Relax	Decision Tree	919	1037	12	2	0.99	1.00	0.99	0.99
	Random Forest	919	1043	6	2	0.99	1.00	1.00	0.99
	Support Vector Machine	920	1038	11	1	0.99	1.00	0.99	0.99
	Naive Bayes	300	1030	19	621	0.94	0.33	0.48	0.42
	K-Nearest Neighbors	920	1039	10	1	0.99	1.00	0.99	0.99
Meal_Preparation	Gradient Boosting	921	1034	15	0	0.98	1.00	0.99	0.98
	Decision Tree	504	1449	6	11	0.99	0.98	0.98	0.98
	Random Forest	515	1439	16	0	0.97	1.00	0.98	0.98
	Support Vector Machine	507	1441	14	8	0.97	0.98	0.98	0.97
	Naive Bayes	123	1269	186	392	0.40	0.24	0.30	0.13
Leave_Home	K-Nearest Neighbors	508	1443	12	7	0.98	0.99	0.98	0.98
	Gradient Boosting	501	1452	3	14	0.99	0.97	0.98	0.98
	Decision Tree	60	1829	41	40	0.59	0.60	0.60	0.58
	Random Forest	71	1832	38	29	0.65	0.71	0.68	0.66
	Support Vector Machine	98	1712	158	2	0.38	0.98	0.55	0.58
Enter_Home	Naive Bayes	40	1841	29	60	0.58	0.40	0.47	0.46
	K-Nearest Neighbors	66	1826	44	34	0.60	0.66	0.63	0.61
	Gradient Boosting	60	1835	35	40	0.63	0.60	0.62	0.60
	Decision Tree	60	1830	40	40	0.60	0.60	0.60	0.58
	Random Forest	62	1841	29	38	0.68	0.62	0.65	0.63
Sleeping	Support Vector Machine	8	1868	2	92	0.80	0.08	0.15	0.24
	Naive Bayes	33	1851	19	67	0.63	0.33	0.43	0.44
	K-Nearest Neighbors	56	1836	34	44	0.62	0.56	0.59	0.57
	Gradient Boosting	67	1830	40	33	0.63	0.67	0.65	0.63
	Decision Tree	150	1817	0	3	1.00	0.98	0.99	0.99
Eating	Random Forest	152	1816	1	1	0.99	0.99	0.99	0.99
	Support Vector Machine	147	1817	0	6	1.00	0.96	0.98	0.98
	Naive Bayes	145	1778	39	8	0.79	0.95	0.86	0.85
	K-Nearest Neighbors	151	1817	0	2	1.00	0.99	0.99	0.99
	Gradient Boosting	152	1817	0	1	1.00	0.99	1.00	1.00
Work	Decision Tree	59	1903	2	6	0.97	0.91	0.94	0.93
	Random Forest	59	1904	1	6	0.98	0.91	0.94	0.94
	Support Vector Machine	58	1905	0	7	1.00	0.89	0.94	0.94
	Naive Bayes	22	1357	548	43	0.04	0.34	0.07	0.02
	K-Nearest Neighbors	62	1903	2	3	0.97	0.95	0.96	0.96
Bed_to_Toilet	Gradient Boosting	63	1905	0	2	1.00	0.97	0.98	0.98
	Decision Tree	50	1918	2	0	0.96	1.00	0.98	0.98
	Random Forest	49	1918	2	1	0.96	0.98	0.97	0.97
	Support Vector Machine	42	1919	1	8	0.98	0.84	0.90	0.90
	Naive Bayes	30	1914	6	20	0.83	0.60	0.70	0.70
Wash_Dishes	K-Nearest Neighbors	50	1918	2	0	0.96	1.00	0.98	0.98
	Gradient Boosting	49	1918	2	1	0.96	0.98	0.97	0.97
	Decision Tree	44	1925	0	1	1.00	0.98	0.99	0.99
	Random Forest	44	1925	0	1	1.00	0.98	0.99	0.99
	Support Vector Machine	0	1924	1	45	0.00	0.00	0.00	0.00
Housekeeping	Naive Bayes	18	1925	0	27	1.00	0.40	0.57	0.63
	K-Nearest Neighbors	45	1922	3	0	0.94	1.00	0.97	0.97
	Gradient Boosting	44	1925	0	1	1.00	0.98	0.99	0.99
	Decision Tree	13	1954	2	1	0.87	0.93	0.90	0.90
	Random Forest	2	1956	0	12	1.00	0.14	0.25	0.38
Housekeeping	Support Vector Machine	0	1956	0	14	0.00	0.00	0.00	0.00
	Naive Bayes	2	1799	157	12	0.01	0.14	0.02	0.02
	K-Nearest Neighbors	2	1956	0	12	1.00	0.14	0.25	0.38
	Gradient Boosting	12	1956	0	2	1.00	0.86	0.92	0.93
	Decision Tree	5	1964	1	0	0.83	1.00	0.91	0.91
Housekeeping	Random Forest	4	1965	0	1	1.00	0.80	0.89	0.89
	Support Vector Machine	3	1965	0	2	1.00	0.60	0.75	0.77
	Naive Bayes	3	1714	251	2	0.01	0.60	0.02	0.07
	K-Nearest Neighbors	2	1964	1	3	0.67	0.40	0.50	0.52
	Gradient Boosting	5	1965	0	0	1.00	1.00	1.00	1.00

Activity	Method	FP	FN	FP	FN	Precision	Recall	F1 Score	AUC
Relax	Decision Tree	845	2000	0	0	0.00	0.00	0.00	0.00
	Random Forest	870	2040	1	1	1.00	1.00	1.00	0.99
	Support Vector Machine	868	2030	0	2	1.00	1.00	1.00	0.99
	Naive Bayes	778	2040	1	133	0.99	0.87	0.93	0.98
	k-Nearest Neighbors	868	2037	1	2	1.00	1.00	1.00	0.99
Meal_Preparation	Decision Tree	429	1058	0	12	0.99	0.97	0.98	0.97
	Random Forest	427	1048	0	4	1.00	0.98	0.99	0.98
	Support Vector Machine	454	1052	2	7	0.99	0.98	0.99	0.98
	Naive Bayes	507	1041	20	294	0.99	0.98	0.99	0.98
	k-Nearest Neighbors	457	1042	2	4	0.99	0.99	0.99	0.99
Leave_home	Decision Tree	173	2729	17	37	0.93	0.88	0.91	0.91
	Random Forest	171	2746	0	44	0.93	0.84	0.89	0.90
	Support Vector Machine	173	2689	207	0	0.98	1.00	0.99	0.99
	Naive Bayes	171	2707	1	134	0.93	0.93	0.93	0.94
	k-Nearest Neighbors	81	2731	46	34	0.94	0.70	0.81	0.94
Eating	Decision Tree	88	2739	0	28	0.93	0.78	0.86	0.92
	Random Forest	88	2734	0	48	0.93	0.81	0.87	0.93
	Support Vector Machine	88	2734	0	34	0.93	0.81	0.87	0.93
	Naive Bayes	132	2656	132	5	0.94	0.96	0.95	0.97
	k-Nearest Neighbors	70	2744	0	47	0.93	0.81	0.87	0.94
Sleeping	Decision Tree	139	2776	1	2	0.99	0.99	0.99	0.99
	Random Forest	139	2775	0	1	1.00	0.99	1.00	1.00
	Support Vector Machine	139	2775	0	30	1.00	0.99	1.00	0.99
	Naive Bayes	137	2775	0	9	1.00	0.99	1.00	0.99
	k-Nearest Neighbors	139	2775	0	2	1.00	1.00	1.00	1.00
Eating	Decision Tree	77	2804	1	2	0.97	0.97	0.97	0.98
	Random Forest	77	2804	0	4	1.00	0.90	0.95	0.99
	Support Vector Machine	76	2810	0	9	1.00	0.90	0.95	0.99
	Naive Bayes	76	2810	0	13	0.98	0.90	0.94	0.99
	k-Nearest Neighbors	78	2810	1	1	0.99	0.99	0.99	0.99
Work	Decision Tree	53	2800	1	6	0.98	1.00	0.99	0.99
	Random Forest	51	2801	0	3	1.00	0.94	0.97	0.97
	Support Vector Machine	47	2800	1	7	0.98	0.97	0.98	0.97
	Naive Bayes	42	2800	1	11	0.98	0.78	0.87	0.91
	k-Nearest Neighbors	53	2800	1	1	0.98	0.98	0.98	0.98
Bed_To_Toilet	Decision Tree	48	2807	0	0	1.00	1.00	1.00	1.00
	Random Forest	48	2807	0	0	1.00	1.00	1.00	1.00
	Support Vector Machine	48	2806	1	0	0.99	1.00	0.99	0.99
	Naive Bayes	48	2806	1	0	0.99	1.00	0.99	0.99
	k-Nearest Neighbors	48	2807	0	0	1.00	1.00	1.00	1.00
Wash_Dishes	Decision Tree	17	2809	7	0	0.71	0.80	0.77	0.71
	Random Forest	18	2808	6	7	0.84	0.88	0.86	0.73
	Support Vector Machine	2	2809	0	30	0.99	0.90	0.94	0.90
	Naive Bayes	14	2782	133	0	0.11	0.70	0.28	0.24
	k-Nearest Neighbors	2	2809	0	30	0.99	0.90	0.94	0.90
Housekeeping	Decision Tree	3	2809	1	0	0.98	0.75	0.78	0.74
	Random Forest	3	2809	1	0	0.98	0.75	0.78	0.74
	Support Vector Machine	3	2809	0	2	1.00	0.80	0.89	0.89
	Naive Bayes	8	2800	0	1	1.00	0.80	0.89	0.89
	k-Nearest Neighbors	7	2809	0	1	1.00	0.70	0.80	0.80

Activity	Method	FP	FN	FP	FN	Precision	Recall	F1 Score	AUC
Relax	Decision Tree	928	2017	12	0	1.00	1.00	1.00	0.99
	Random Forest	928	2042	1	2	1.00	1.00	1.00	0.99
	Support Vector Machine	920	2038	11	7	1.00	1.00	1.00	0.99
	Naive Bayes	920	2000	20	421	0.96	0.90	0.93	0.98
	k-Nearest Neighbors	920	2039	10	1	1.00	1.00	1.00	0.99
Meal_Preparation	Decision Tree	504	1048	6	11	0.99	0.98	0.98	0.98
	Random Forest	503	1049	6	0	0.97	1.00	0.98	0.98
	Support Vector Machine	507	1041	14	6	0.97	0.98	0.98	0.97
	Naive Bayes	523	1039	100	202	0.80	0.74	0.77	0.93
	k-Nearest Neighbors	508	1043	12	7	0.98	0.99	0.98	0.98
Leave_home	Decision Tree	80	2829	41	40	0.66	0.60	0.63	0.78
	Random Forest	71	2821	38	29	0.65	0.51	0.58	0.82
	Support Vector Machine	68	2732	108	2	0.38	0.98	0.55	0.74
	Naive Bayes	60	2841	27	60	0.68	0.40	0.47	0.84
	k-Nearest Neighbors	68	2828	46	36	0.60	0.66	0.63	0.82
Eating	Decision Tree	80	2803	40	40	0.60	0.60	0.60	0.78
	Random Forest	82	2803	27	30	0.68	0.62	0.65	0.80
	Support Vector Machine	8	2806	2	20	0.80	0.68	0.74	0.94
	Naive Bayes	38	2815	19	67	0.63	0.31	0.43	0.84
	k-Nearest Neighbors	58	2808	34	44	0.62	0.58	0.60	0.80
Sleeping	Decision Tree	132	2817	0	3	1.00	0.99	0.99	0.99
	Random Forest	132	2818	1	1	1.00	0.99	0.99	0.99
	Support Vector Machine	147	2817	0	6	1.00	0.95	0.98	0.98
	Naive Bayes	145	2778	20	8	0.79	0.96	0.86	0.93
	k-Nearest Neighbors	131	2817	0	2	1.00	0.99	0.99	0.99
Eating	Decision Tree	59	2806	2	6	0.97	0.91	0.94	0.92
	Random Forest	59	2806	1	6	0.96	0.91	0.94	0.94
	Support Vector Machine	22	2807	548	43	0.04	0.98	0.07	0.98
	Naive Bayes	62	2805	2	7	1.00	0.88	0.94	0.94
	k-Nearest Neighbors	63	2805	0	2	1.00	0.97	0.98	0.98
Work	Decision Tree	50	2818	2	0	1.00	1.00	1.00	1.00
	Random Forest	49	2818	2	1	0.98	0.96	0.97	0.99
	Support Vector Machine	49	2818	1	8	0.98	0.94	0.96	0.99
	Naive Bayes	20	2814	20	20	0.50	0.50	0.50	0.50
	k-Nearest Neighbors	50	2818	2	0	1.00	1.00	1.00	1.00
Bed_To_Toilet	Decision Tree	44	2825	0	1	1.00	0.98	0.99	0.99
	Random Forest	44	2825	0	1	1.00	0.98	0.99	0.99
	Support Vector Machine	5	2824	1	40	0.00	0.00	0.00	0.00
	Naive Bayes	44	2825	0	17	1.00	0.40	0.57	0.40
	k-Nearest Neighbors	49	2822	0	0	1.00	1.00	1.00	1.00
Wash_Dishes	Decision Tree	12	2804	2	1	0.87	0.91	0.89	0.83
	Random Forest	2	2806	0	10	1.00	0.41	0.50	0.50
	Support Vector Machine	0	2806	0	14	0.00	0.00	0.00	0.00
	Naive Bayes	2	2799	127	12	0.01	0.34	0.20	0.34
	k-Nearest Neighbors	7	2806	0	12	1.00	0.34	0.25	0.34
Housekeeping	Decision Tree	3	2804	1	0	0.80	1.00	0.85	0.75
	Random Forest	3	2805	0	1	1.00	0.80	0.89	0.80
	Support Vector Machine	3	2805	0	2	1.00	0.80	0.75	0.77
	Naive Bayes	3	2784	251	2	0.01	0.40	0.20	0.40
	k-Nearest Neighbors	2	2804	1	0	0.67	1.00	0.80	0.80

- Best-recognized activities: Relax, Meal Preparation, Sleeping, Eating, Work, Bed to Toilet.
- Time-related features improved recognition of time-specific activities like Sleeping and Eating.
- Challenges with recognizing activities like Wash Dishes and Housekeeping.

RESULTS
DETAILS

01

Tree-based methods excelled in handling behavioral variability.

Time-related features offered modest improvements.

02

03

SVM's rigid boundaries didn't handle overlapping activities well.

04

Naive Bayes struggled with feature independence assumptions.



- ✓ Tree-based methods effectively classify ADLs in smart homes.
- ✓ Future research should focus on similar activity recognition and advanced feature engineering.
- ✓ Real-world application in Malaysian smart homes.

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Thank You!

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