Concept Drift Adaptation for Acoustic Scene Classifier Based on Gaussian Mixture Model

Ibnu Dagigil Id (Human Centric Information Processing Lab, Okayama University)

1. Research Background

- The environment sound can be easily **distorted** by nonstationary noise, diverse sound events, and overlapping audio events in the time or frequency domain.
- Ability to detect and adapt to concept drift in order to prevent degradation in accuracy is important.
- Retrain and redeploy model periodically can be timeconsuming and expensive, while selecting the frequency of updates is also not a straightforward task.
- Majority of sound recognition solutions assume that data come in a sufficient amount and with a representative, **fixed underlying distribution**, which is rarely the case.

3. Experiment Setup

The overall dataset consisted of 12,000 audio segments of ten seconds each, equally distributed between 15 different scenes and annotated with their ground-truth labels. Based on that dataset we generate T1,T2 and T3. Two Test Scenario Used, namely Active Scenario and Passive Scenario



2. Proposed method



4. Result & Discussion

- The experimental results demonstrated that the proposed algorithms work well in detecting and adapting to three types of drift scenarios.
- KD3 demonstrated a better performance than ADWIN except for T1. This is mainly because KD3 takes the entire data distribution into account, while ADWIN uses only its average.
- The drawback of KD3 is its high computational cost
- The adaptation cycle (i.e., the number of data points to update) plays an important role in achieving a good performance in the passive approach
- By comparing the active and passive approaches to detecting concept drifts, the number of data to adapt to the model is a crucial factor impacting the method's accuracy.

ACTIVE APPROACH											
ADAPTOR	DETECTOR	OVERALL ACCURACY			F1 SCORE			EXECUTION TIME			Drift
		Tl	T2	T3	Tl	T2	T2	T1	T2	T3	
CMGMM*	KD3*	0.8373	0.7962	0.7409	0.8432	0.7993	0.7460	128.06	115.07	110.49	39
	ADWIN	0.8471	0.6415	0.6332	0.8518	0.6379	0.6379	83.07	84.22	85.44	32
	HDDM	0.2762	0.2627	0.2990	0.3184	0.2992	0.3406	84.81	84.53	83.11	373
IGMM	KD3*	0.8283	0.7574	0.6622	0.8173	0.7499	0.6488	120.04	128.75	120.50	35
	ADWIN	0.8419	0.5711	0.6057	0.8329	0.5722	0.6063	82.80	84.219	83.08	21
	HDDM	0.2363	0.2507	0.2032	0.2436	0.3055	0.2675	84.37	87.55	84.87	350
PASSIVE APPROACH											
ADAPTOR	ADAPTATION	OVERALL ACCURACY			F1 SCORE			EXECUTION TIME			Drift
ADAPTOR	ADAPTATION	A	OVERAL CCURAC	L CY	1	FI SCOR	E	EXEC	CUTION	TIME	Drift
ADAPTOR	ADAPTATION CYCLE		OVERAL CCURAC T2	L CY T3	1 T1	FI SCOR	E T3	EXEC T1	CUTION	TIME T3	Drift
ADAPTOR	ADAPTATION CYCLE 50	A T1 0.5621	OVERAL CCURAC T2 0.4451	L CY T3 0.4003	1 T1 0.5719	F1 SCOR	E T3 0.4373	EXEC T1 83.178	T2 82.945	TIME T3 83.163	Drift -
ADAPTOR	ADAPTATION CYCLE 50 100	A T1 0.5621 0.7424	OVERAL CCURAC T2 0.4451 0.6547	L CY 0.4003 0.6434	Tl 0.5719 0.7451	T2 0.4615 0.6583	E <u>T3</u> 0.4373 0.6476	EXEC T1 83.178 83.688	T2 82.945 82.265	TIME T3 83.163 83.704	Drift -
ADAPTOR CMGMM*	ADAPTATION CYCLE 50 100 150	A T1 0.5621 0.7424 0.8002	OVERAL CCURAC 12 0.4451 0.6547 0.7437	L CY 0.4003 0.6434 0.7301	Tl 0.5719 0.7451 0.8043	T2 0.4615 0.6583 0.7482	E T3 0.4373 0.6476 0.7327	EXEC T1 83.178 83.688 84.527	T2 82.945 82.265 82.298	TIME T3 83.163 83.704 89.555	Drift - -
ADAPTOR CMGMM*	ADAPTATION CYCLE 50 100 150 200	A T1 0.5621 0.7424 0.8002 0.7602	DVERAL CCURAC T2 0.4451 0.6547 0.7437 0.7073	L CY 0.4003 0.6434 0.7301 0.6904	Tl 0.5719 0.7451 0.8043 0.7663	T2 0.4615 0.6583 0.7482 0.714	E T3 0.4373 0.6476 0.7327 0.7001	EXEC T1 83.178 83.688 84.527 83.414	T2 82.945 82.265 82.298 85.922	TIME T3 83.163 83.704 89.555 84.594	Drift - - - -
ADAPTOR CMGMM*	ADAPTATION CYCLE 50 100 150 200 50	A T1 0.5621 0.7424 0.8002 0.7602 0.5365	DVERAL CCURAC T2 0.4451 0.6547 0.7437 0.7073 0.4209	L T3 0.4003 0.6434 0.7301 0.6904 0.3687	T1 0.5719 0.7451 0.8043 0.7663 0.5458	T2 0.4615 0.6583 0.7482 0.714 0.4319	E 0.4373 0.6476 0.7327 0.7001 0.3888	EXEC T1 83.178 83.688 84.527 83.414 84.467	T2 82.945 82.265 82.298 85.922 82.776	T3 83.163 83.704 89.555 84.594 82.655	Drift - - - - -
ADAPTOR CMGMM*	ADAPTATION CYCLE 50 100 150 200 50 100	A 0.5621 0.7424 0.8002 0.7602 0.5365 0.7324	OVERAL CCURAC 10.4451 0.6547 0.7437 0.7073 0.4209 0.643	L CY T3 0.4003 0.6434 0.7301 0.6904 0.3687 0.6371	T1 0.5719 0.7451 0.8043 0.7663 0.5458 0.736	F1 SCOR T2 0.4615 0.6583 0.7482 0.714 0.4319 0.6448	E T3 0.4373 0.6476 0.7327 0.7001 0.3888 0.6388	EXEC T1 83.178 83.688 84.527 83.414 84.467 82.693	T2 82.945 82.265 82.298 85.922 82.776 82.652	T3 83.163 83.704 89.555 84.594 82.655 82.199	Drift - - - - - -
ADAPTOR CMGMM* IGMM	ADAPTATION CYCLE 50 100 150 200 50 100 150	A 0.5621 0.7424 0.8002 0.7602 0.5365 0.7324 0.8056	OVERAL CCURAC 10.4451 0.6547 0.7437 0.7073 0.4209 0.643 0.7401	L CY T3 0.4003 0.6434 0.7301 0.6904 0.3687 0.6371 0.7291	T1 0.5719 0.7451 0.8043 0.7663 0.5458 0.736 0.8107	T2 0.4615 0.6583 0.7482 0.714 0.4319 0.6448 0.7431	E T3 0.4373 0.6476 0.7327 0.7001 0.3888 0.6388 0.7223	EXEC T1 83.178 83.688 84.527 83.414 84.467 82.693 83.659	T2 82.945 82.265 82.298 85.922 82.776 82.652 82.654	T3 83.163 83.704 89.555 84.594 82.655 82.199 83.453	Drift
ADAPTOR CMGMM* IGMM	ADAPTATION CYCLE 50 100 150 200 50 100 150 200	A T1 0.5621 0.7424 0.8002 0.7602 0.5365 0.7324 0.8056 0.7528	OVERAL CCURAC T2 0.4451 0.6547 0.7437 0.7073 0.4209 0.643 0.7401	L 2Y T3 0.4003 0.6434 0.7301 0.6904 0.3687 0.6371 0.7291 0.6899	T1 0.5719 0.7451 0.8043 0.7663 0.5458 0.736 0.8107 0.7609	F1 SCOR T2 0.4615 0.6583 0.7482 0.714 0.4319 0.6448 0.7431 0.722	E T3 0.4373 0.6476 0.7327 0.7001 0.3888 0.6388 0.7223 0.6981	EXEC T1 83.178 83.688 84.527 83.414 84.467 82.693 83.659 84.597	T2 82.945 82.265 82.298 85.922 82.776 82.652 82.645 84.228	T3 83.163 83.704 89.555 84.594 82.655 82.199 83.453 85.797	Drift







Drift Detection Method Detect concept drift then supply data Calculate Kernel Density Estimation between Current and Previous Window. Calculate variation between windows • The larger window variation, the stronger Concept Drift symptom • Train the incoming data then combine Merge all similar component based on