DriftMoE: A Mixture of Experts Approach to Handle Concept Drifts

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PROBLEM & MOTIVATION

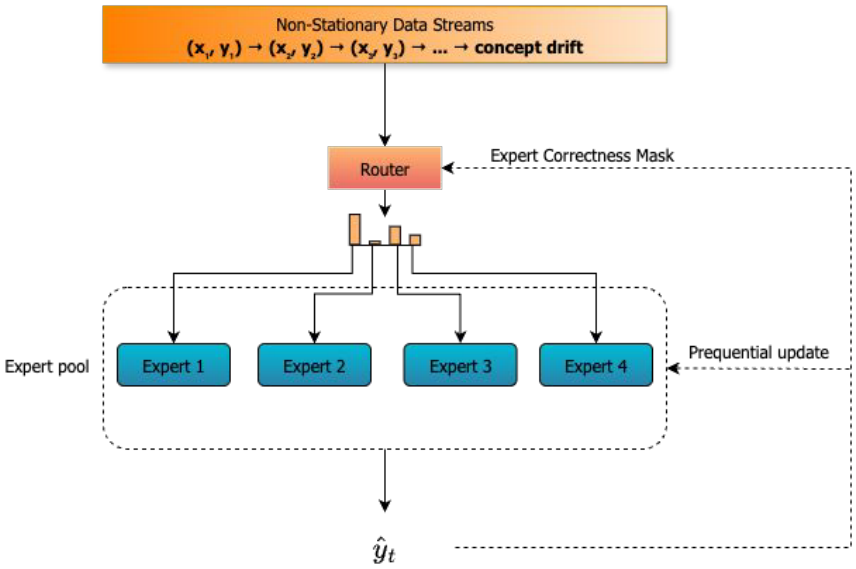
- Concept drift challenges
- On-stationary streams
- Resource constraints

Current Limitations
- False positive detection
- Coarse adaptation
- Simple voting schemes

SOLUTION OVERVIEW

DriftMoE Framework:
- Online MoE architecture
- Co-training approach
- Neural router + experts

Two Variants:
- MoE-Data (multi-class)
- MoE-Task (one-vs-rest)



KEY FEATURES & ARCHITECTURE

- Multi-hot correctness
- Mask training
- Cooperative feedback
- Symbiotic learning
- Resource efficiency:
- Cooperative feedback 12 vs 100+ experts

Technical Details:
- Hoeffding Tree experts
- BCE loss optimization
- Online mini-batches

EXPERIMENTAL SETUP

Category	Stream	Instances	Features	Classes
Synthetic	LED (Abrupt)	1,000,000	24	10
	LED (Gradual)	1,000,000	24	10
	SEA (Abrupt)	1,000,000	3	2
	SEA (Gradual)	1,000,000	3	2
	RBF_m	1,000,000	10	5
	RBF_f	1,000,000	10	5
Real	Airlines	539,383	7	2
	Electricty	45,312	8	2
	Cover Type	581,012	54	7

- 9 benchmarks (6+3 real)
- Prequential evaluation
- 5 state-of-art baseline
- Accuracy, Kappa metrics

KEY FINDINGS

Summary:
- ✔ Competitive accuracy
- ✔ 8x fewer resources
- ✔ Fast drift adaptation

Future Directions:
- ✔ Uncertainty routing
- ✔ Dynamic allocation
- ✔ Cost-sensitive losses

RESULTS & PERFORMANCE

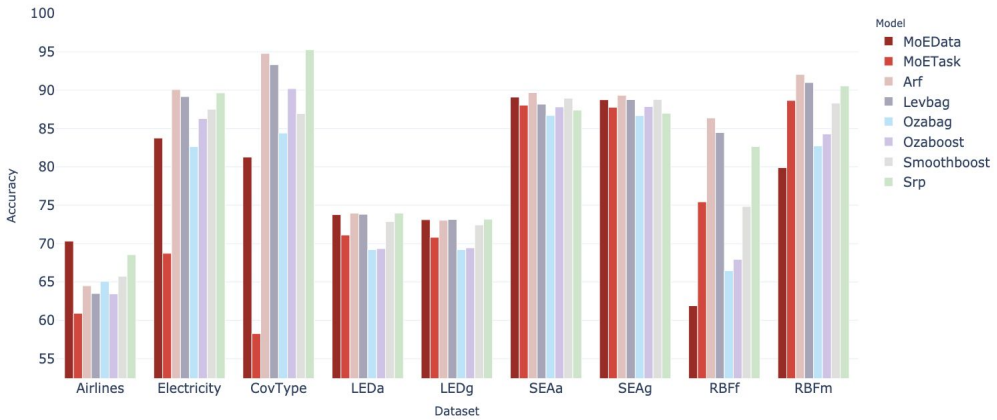


Table 1: DriftMoE Performance Summary

Dataset	MoEData	MoETask
Airlines	**70.33 ± 0.18**	60.92 ± 0.01
CovType	81.28 ± 0.75	58.28 ± 0.31
Electricity	83.76 ± 0.45	68.73 ± 0.85
LED_a	**73.77 ± 0.18**	71.11 ± 0.54
LED_g	**73.11 ± 0.11**	70.82 ± 0.38
RBF_f	61.90 ± 0.20	**75.45 ± 0.11**
RBF_m	79.89 ± 0.48	**88.65 ± 0.07**
SEA_a	**89.09 ± 0.05**	88.04 ± 0.09
SEA_g	**88.74 ± 0.05**	87.76 ± 0.04

CONCLUSIONS

Main Contributions:
- First streaming MoE for concept drift
- Novel co-training framework
- Multi-hot feedback
- Competitive performance with fewer resources

Impact:
- Scalable online learning
- Efficient drift handling

USE CASES

Applications:
- IoT data streams
- Financial markets
- Social media feeds
- Edge computing

Deployment:
- Resource-constrained environments
- Real-time inference
- Adaptive edge devices
- Streaming analytics

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