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Prior-free Tabular Test-time Adaptation

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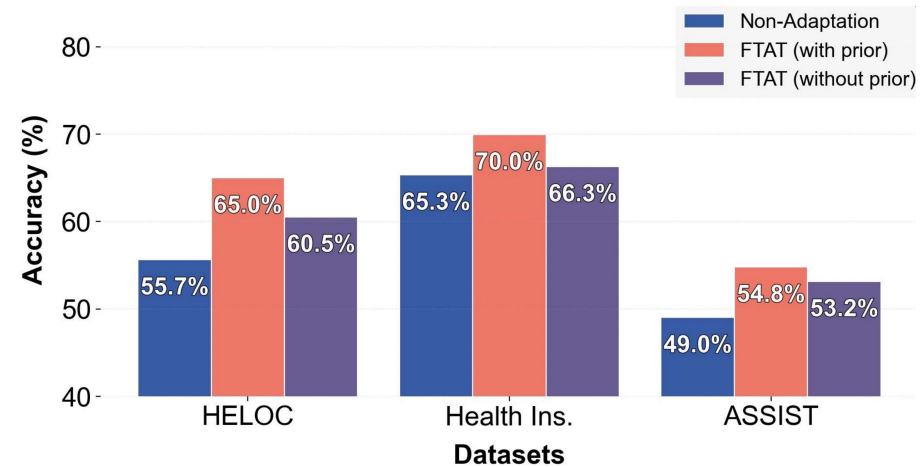
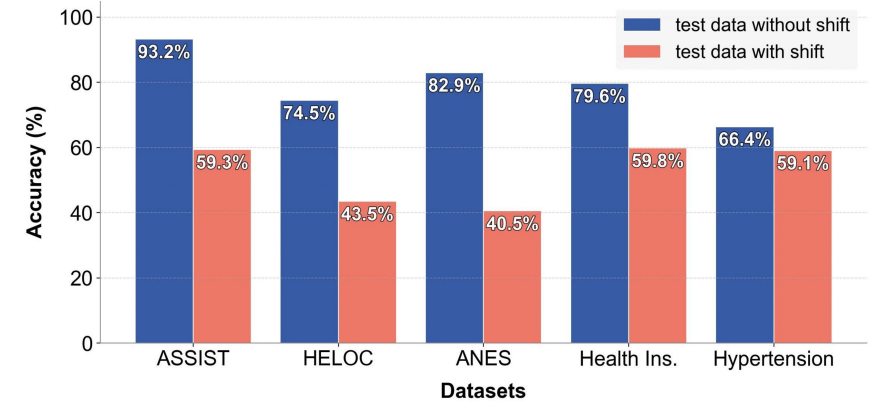
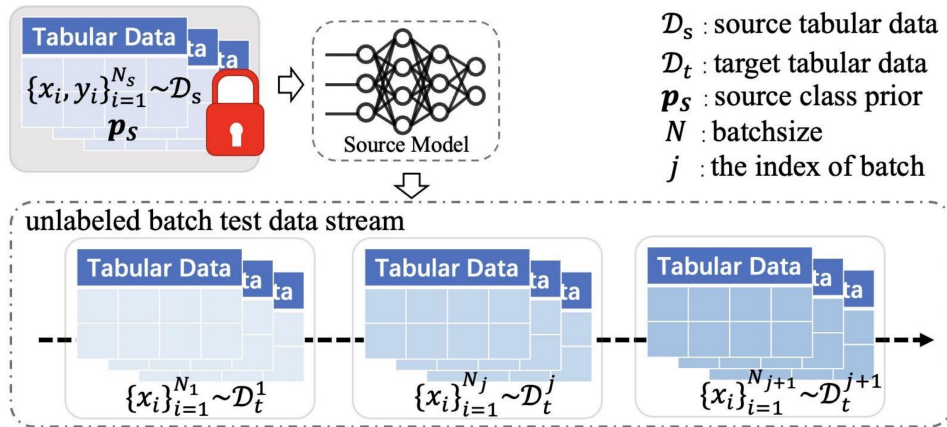
Problem Statement & Motivations

Current tabular TTA setting

- A source-trained model is deployed on unlabeled target data
- Target data often exhibits distribution shifts
- No source-domain data access

Challenge

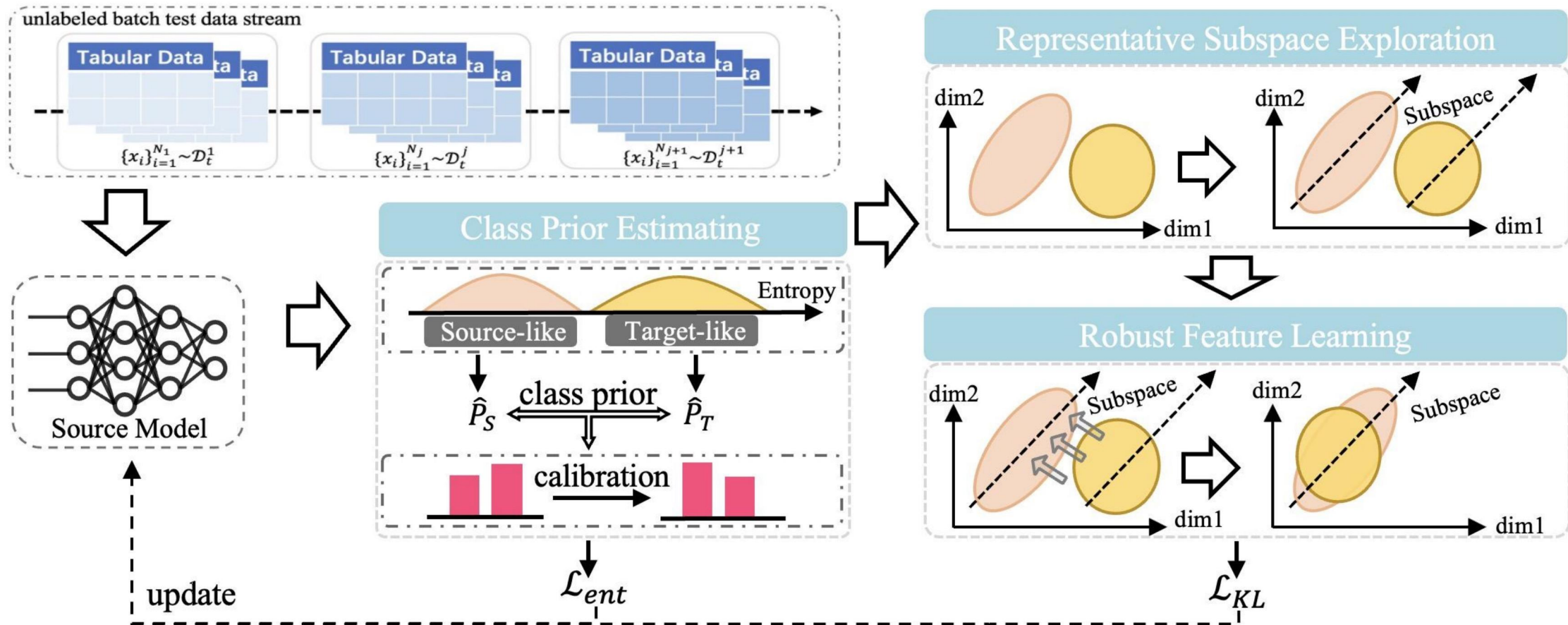
- Without access to the source class prior, performance degrades substantially.
- Label shift and feature shift may occur simultaneously.
- Tabular data often contain many redundant features, which hinder feature alignment.



Key question

How can we adapt tabular models reliably under label shift and feature shift without source data or source priors?

Prior-Free Tabular Test-Time Adaptation (PFT3A)



- **Class Prior Estimating** module for estimating source-target class priors to calibrate prediction, eliminating dependency on source class prior and mitigating label shift
- **Robust Feature Learning** module for learning robust feature by minimizing the Kullback-Leibler (KL) divergence between source-like and target-like features to mitigate feature shift
- **Representative Subspace Exploration** module for eliminating redundant features by projecting feature into subspace to enhance feature alignment.

Experiments

Setup

- Datasets: HELOC, ANES, ASSIST, Hypertension, Health Insurance
- Backbones: MLP, TabTransformer, FT-Transformer
- Metrics: Accuracy, Balanced Accuracy, F1
- Compared Methods:
 - ✓ Typical TTA methods (TENT and EATA)
 - ✓ Continual TTA methods (CoTTA)
 - ✓ Robust FTTA methods (SAR, LAME, ODS)
 - ✓ Tabular TTA method (FTAT)

Table 1: Performance comparison with TabTransformer as backbone. The best is in bold.

Method	HELOC			ANES			Health Ins.			ASSIST			Hypertension			Avg		
	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1
Non-Adaptation	55.66	59.60	44.30	78.95	75.30	84.23	65.35	70.11	65.88	49.04	53.07	58.92	54.87	59.24	46.25	60.77	63.46	59.92
TENT	56.37	59.60	50.34	78.82	75.18	84.14	65.22	70.07	65.62	47.83	53.11	61.27	41.74	50.12	0.78	58.00	61.62	52.43
EATA	56.37	57.04	52.57	78.82	75.18	84.14	65.35	70.11	65.88	45.28	51.44	61.40	54.86	59.24	46.24	59.94	62.60	62.05
LAME	51.71	59.56	44.30	78.57	74.77	84.04	65.35	70.11	65.88	45.12	51.30	61.40	54.87	59.24	46.25	59.12	63.00	60.37
CoTTA	56.37	59.60	50.34	78.82	75.18	84.14	65.35	70.11	65.88	45.51	51.64	61.56	54.87	59.24	46.25	60.18	63.15	61.63
ODS	52.19	56.77	44.70	78.48	74.69	83.97	57.14	64.75	51.33	45.12	51.30	61.40	54.87	59.24	46.25	57.56	61.35	57.53
SAR	56.37	59.60	50.34	78.82	75.18	84.14	65.35	70.11	65.88	45.12	51.30	61.40	54.87	59.24	46.25	60.11	63.09	61.60
FTAT	60.54	63.22	55.81	79.46	76.29	84.34	66.31	70.84	67.19	53.17	55.85	58.94	61.78	61.65	65.62	64.25	65.57	66.38
PFT ₃ A (ours)	66.17	65.17	70.91	80.33	78.72	84.06	74.13	72.67	79.33	59.29	59.15	59.73	63.03	61.39	69.20	68.59	67.42	72.65

PFT3A consistently outperforms the baselines under most metrics across all datasets.

Table 2: Performance comparison with MLP as backbone. The best is in bold.

Method	HELOC			ANES			Health Ins.			ASSIST			Hypertension			Avg		
	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1
Non-Adaptation	54.37	58.25	40.02	79.11	75.66	84.24	65.79	70.68	66.21	55.86	60.81	66.42	58.76	61.69	55.46	62.78	65.42	62.47
TENT	54.35	58.24	39.95	78.07	74.09	83.76	64.30	69.79	63.87	50.87	56.41	63.99	41.67	50.07	0.49	57.85	61.72	50.41
EATA	54.37	58.25	40.02	78.13	74.20	83.79	65.78	70.68	66.21	55.86	60.81	66.42	57.81	61.19	52.87	62.39	65.03	61.86
LAME	43.10	50.00	30.10	63.50	54.60	46.80	63.44	69.14	62.61	45.12	51.30	61.40	58.63	61.64	55.12	54.76	57.34	51.21
CoTTA	54.36	58.25	40.03	78.13	74.20	83.79	65.79	70.68	66.21	55.86	60.81	66.42	58.76	61.69	55.46	62.58	65.13	62.38
ODS	43.10	50.00	30.10	63.50	54.60	46.80	63.45	69.14	62.62	45.12	51.30	61.40	57.12	60.80	51.41	54.46	57.17	50.47
SAR	52.32	56.74	33.16	78.13	74.20	83.79	65.79	70.68	66.21	55.86	60.81	66.42	58.21	61.50	53.81	62.06	64.79	60.68
FTAT	60.89	62.67	59.14	79.29	75.83	84.42	67.25	71.60	68.38	51.84	57.26	64.45	63.28	63.18	66.99	64.51	66.11	68.68
PFT ₃ A (ours)	65.26	62.87	72.43	79.84	79.23	82.94	73.09	73.63	77.20	63.54	65.57	66.45	64.53	61.83	71.93	69.25	68.63	74.19

Table 3: Performance comparison with FT-Transformer as backbone. The best is in bold.

Method	HELOC			ANES			Health Ins.			ASSIST			Hypertension			Avg		
	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1	Acc.	BAcc.	F1
Non-Adaptation	46.26	52.48	13.32	75.47	71.50	81.80	58.33	65.44	54.06	58.32	62.99	67.63	58.88	61.84	55.71	59.45	62.85	54.50
TENT	44.98	51.45	8.11	63.02	54.52	76.19	36.44	50.05	0.24	58.25	62.91	67.57	47.01	53.88	18.83	54.05	57.84	48.68
EATA	45.95	52.23	12.27	74.65	70.16	81.51	57.40	64.86	52.23	48.04	53.85	62.60	58.84	61.82	55.62	57.23	60.24	52.85
LAME	43.14	50.03	0.20	75.37	71.35	81.73	59.08	65.44	55.91	56.54	62.98	67.63	58.78	61.78	55.47	59.40	62.06	51.16
CoTTA	46.26	52.48	10.67	75.47	71.50	81.80	58.33	65.44	54.06	58.25	62.91	67.57	58.88	61.84	55.71	59.44	62.83	53.96
ODS	43.14	50.03	0.20	75.41	71.41	81.75	59.99	65.54	58.37	57.39	62.16	67.14	58.77	61.78	55.45	58.94	62.18	52.58
SAR	43.30	50.20	30.60	75.47	71.50	81.80	58.33	65.44	54.06	58.25	62.91	67.57	59.64	62.24	57.52	59.00	62.46	58.31
FTAT	59.20	61.51	55.52	76.06	73.29	81.38	66.45	70.50	67.85	58.32	62.95	67.56	62.34	63.30	64.13	64.47	66.31	67.29
PFT ₃ A (ours)	65.46	62.70	73.17	76.62	75.42	80.60	73.88	72.84	78.87	59.36	63.53	67.43	64.74	63.07	70.74	68.01	67.51	74.16

PFT3A can be generalized to different backbones, which verifies the robustness and effectiveness.

Thank you!