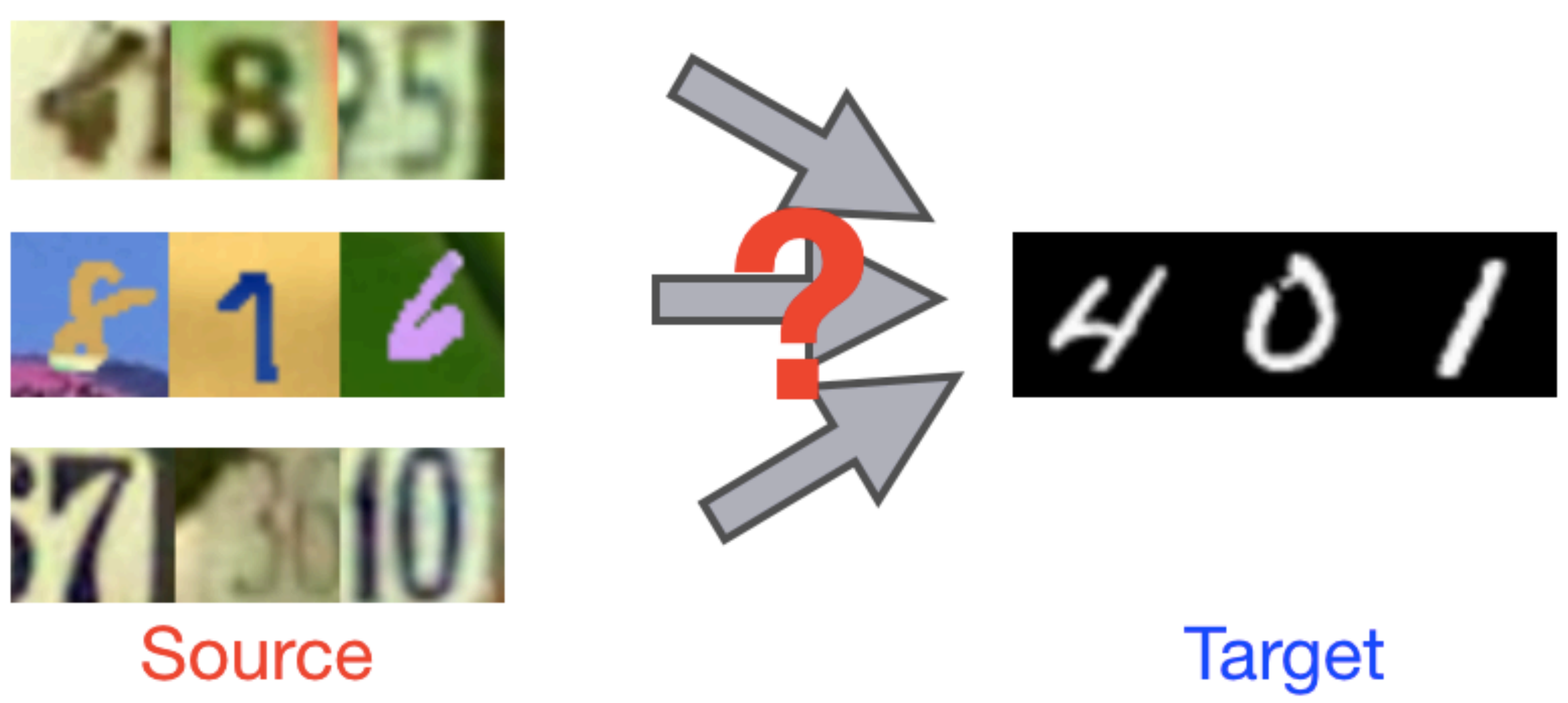
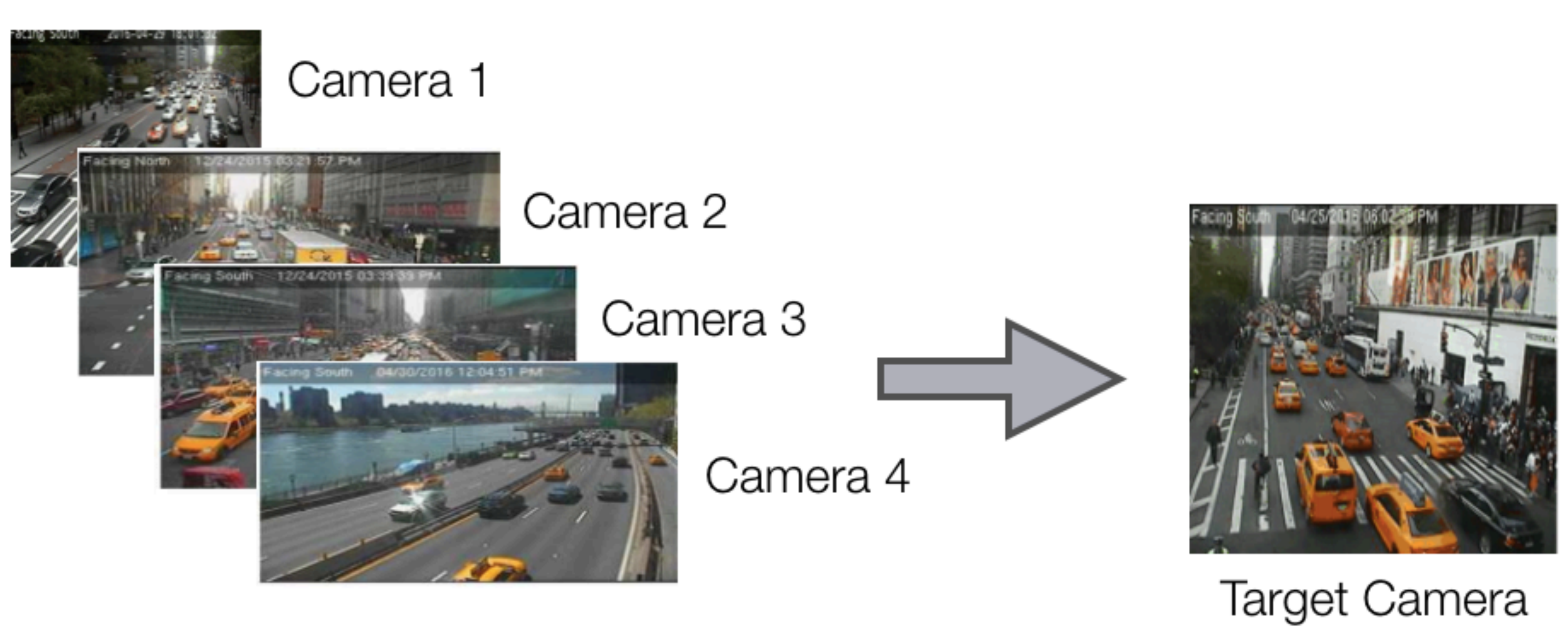
Multiple Source Domain Adaptation with Adversarial Learning

Han Zhao†, Shanghang Zhang†, Guanhang Wu†, João Costeira♭, José Moura† & Geoffrey Gordon†
†Carnegie Mellon University, ♭Instituto Superior Técnico

Motivation

Domain adaptation: Source $\neq$ Target





Summary

- We theoretically analyze the multiple source domain adaptation problem with $\mathcal{H}$-divergence (Ben-David et al, 2010).
- We propose a model based on our theoretical results using adversarial neural networks for domain adaptation under multiple source setting.
- We conduct extensive experiments on real-world datasets, including both natural language and vision tasks, and achieve superior adaptation performances on all the tasks.

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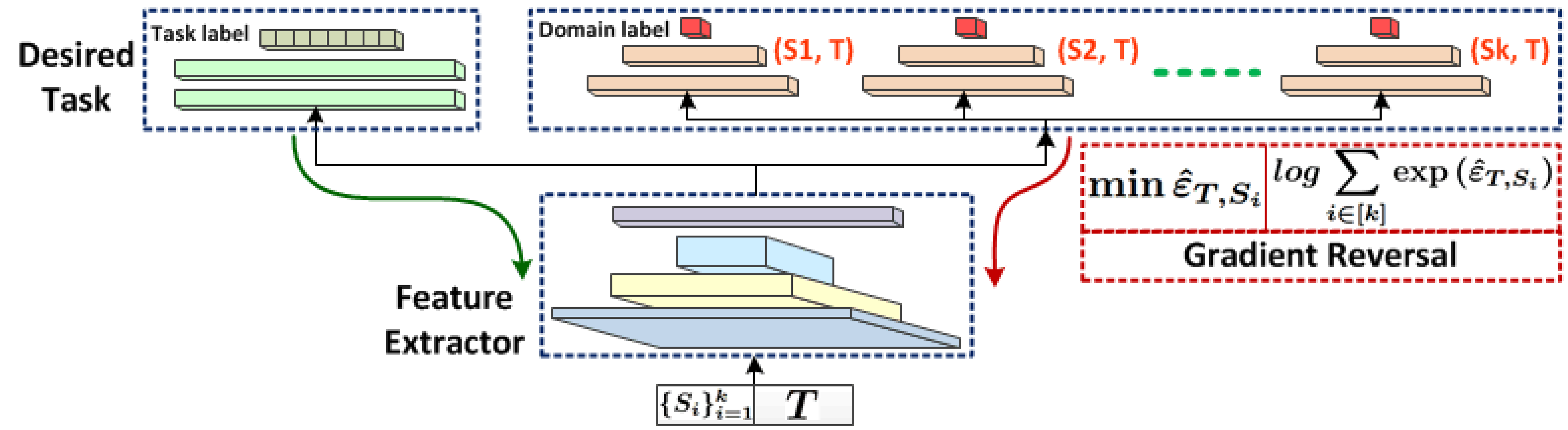
Analysis and Models



Theorem (informal): $\mathcal{H}$ is a hypothesis class and $VC\dim(\mathcal{H}) = d$. $\widehat{\mathcal{D}}_T$ and $\{\widehat{\mathcal{D}}_{S_i}\}_{i=1}^k$ are m samples generated from each domain. $d_{\mathcal{H}}(\mathcal{D}, \mathcal{D}')$ is the $\mathcal{H}$-divergence that measures the distance between distributions $\mathcal{D}$ and $\mathcal{D}'$. Then for $\delta \in (0,1)$, $\forall h \in \mathcal{H}$, w.p. $\geq 1-\delta$:

Hard version:

$$\varepsilon_T(h) \leq \max_{i\in[k]} \hat{\varepsilon}_{S_i}(h) + \frac{1}{2} d_{\mathcal{H}\Delta\mathcal{H}}(\widehat{\mathcal{D}}_T; \{\widehat{\mathcal{D}}_{S_i}\}_{i=1}^k) + O\left(\sqrt{\frac{1}{m}\left(\log\frac{k}{\delta} + d\log\frac{me}{d}\right)}\right) + \lambda,$$

and

Soft version:

$$\varepsilon_T(h) \leq \log \sum_{i\in[k]} \exp(\hat{\varepsilon}_i(h)) + O\left(\sqrt{\frac{1}{m}\left(\log\frac{k}{\delta} + d\log\frac{me}{d}\right)}\right) + \lambda^*$$

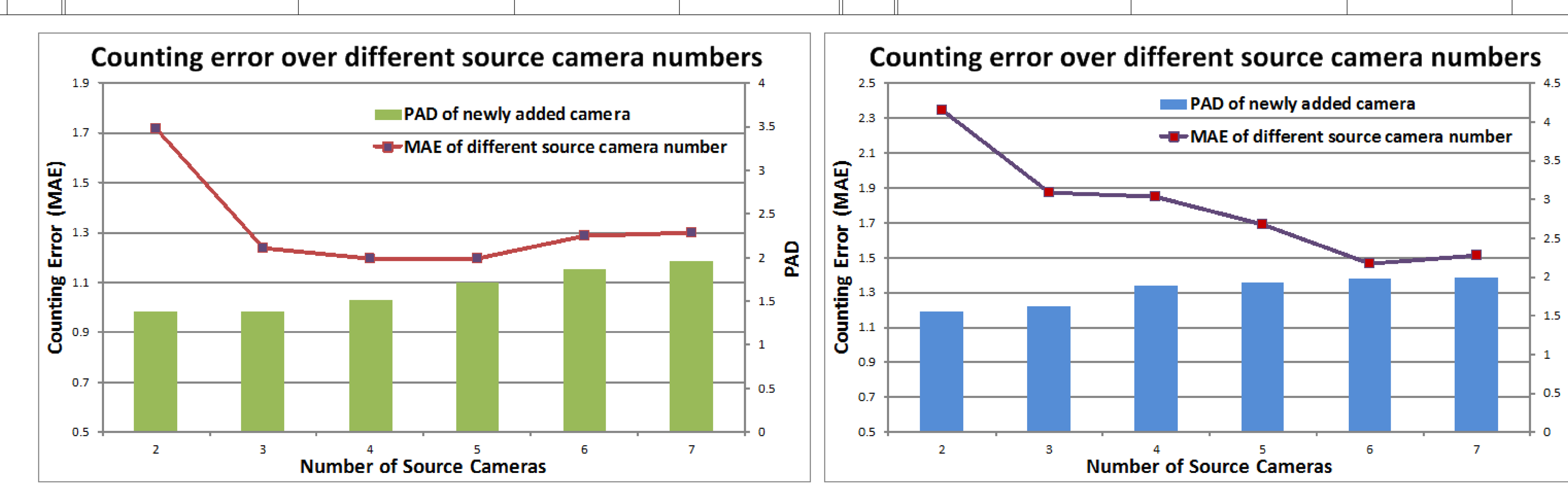
Experiments

Datasets:

- WebCamT (Zhang et al, 2017), public dataset for vehicle counting. Image resolution: 352×240.
- 8 cameras. 6 as sources and each of the rest two as target. 2,000 images for each domain.

Table: Counting error statistics. S is the number of source cameras; T is the target camera id.

S	T	Ours		DANN	FCN	T	Ours		DANN	FCN
		Hard-Max	Soft-Max				Hard-Max	Soft-Max		
2	A	1.8101	**1.7140**	1.9490	1.9094	B	2.5059	**2.3438**	2.5218	2.6528
3	A	1.3276	**1.2363**	1.3683	1.5545	B	1.9092	**1.8680**	2.0122	2.4319
4	A	1.3868	**1.1965**	1.5520	1.5499	B	**1.7375**	1.8487	2.1856	2.2351
5	A	1.4021	**1.1942**	1.4156	1.7925	B	1.7758	**1.6016**	1.7228	2.0504
6	A	1.4359	**1.2877**	2.0298	1.7505	B	1.5912	**1.4644**	1.5484	2.2832
7	A	1.4381	**1.2984**	1.5426	1.7646	B	1.5989	**1.5126**	1.5397	1.7324



(a) Camera A (b) Camera B