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P → Pasadena → source domain

$\{x_i, y_i\}_{i=1}^{n} \sim P$

n → symptoms

y → disease

$x \in \mathcal{X} \quad y \in \mathcal{Y}$

$f \in \mathcal{F}$, l

small $E_P[l(f(x), y)]$

$\min \frac{1}{n} \sum_{i=1}^{n} l(f(x_i), y_i)$

Q → target (San Diego)

$\{x_j\}_{j=1}^{m}$

Source P	target Q
$\{x_i, y_i\}_{i=1}^{n}$	$\{x_j\}_{j=1}^{m}$

Label shift

P

$X|Y \quad \sim \quad X|Y$

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$$E_Q[\ell(f(X),Y)] = E_P[\underbrace{w(Y)}_{\text{importance weight}}\ell(f(X),Y)]$$

↳ importance weighted empirical risk minimization

$$\min \frac{1}{n}\sum_{i=1}^{n} \underbrace{w(y_i)}_{\hat{w}}\ell(f(x_i,y_i))$$

$\hat{w}$ ↗ ↘ we do not know

$g: \mathcal{X} \to R^d$

$$\underbrace{q_g} = E_Q[g(X)] = E_Q[\underbrace{E_Q[g(X)|Y]}]$$

$$= E_Q[E_P[g(X)|Y]]$$

$$= E_P[\underbrace{E_P[g(X)|Y]}\, w(Y)]$$

$$\mathcal{Y} = \{1,\dots k\} \;;\; [T_g]_{\cdot,i} = E_P[\underbrace{g(X)}, \underbrace{Y=i}]$$

$$q_g = T_g w \;;\; w \in R^k \qquad \theta+1 = w$$

$$q_g = T_g\theta + p_g \Rightarrow q_g - p_g = T_g\theta$$

$\hat{q}_g$ $\hat{p}_g$ $\hat{T}_g \Rightarrow \hat{\theta} \to \hat{\theta}+1 = \hat{w}$

$\Rightarrow \hat{\omega} \rightarrow$ importance weighted empirical risk minimizer (ERM)

$\mathcal{Y} \subset R^d \quad ; \omega : \mathcal{Y} \rightarrow R$

$u : \mathcal{X} \rightarrow \mathcal{Y}$

$q_u(y) = E_Q[k(y, u(X))]$

$\rightarrow q_u = E_Q[k^u] = E_Q[E_Q[k^u | Y]]$

$= E_Q[E_P[k^u | Y]]$

$= E_P[E_P[k^u | Y]\, \omega(Y)]$

$E_P[k^u | Y] = h_y^u$

$\omega(Y) = \langle k_y, \omega \rangle$

$= E_P[h_y^u \otimes k_y\, \omega]$

$; T_u(\omega) = E_P[h_y^u \otimes k_y\, \omega]$

$\rightarrow T_u = E_P[h_y^u \otimes k_y]$

$\hookrightarrow q_u = T_u \omega \rightarrow q_u - p_u = T_u \theta$

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$\hat{q}_u, \hat{p}_u, \hat{T}_u \rightarrow \hat{\theta} \rightarrow \hat{w}$

importance weighted ERM

Importance Weighted Estimation & Generalization in Domain adaptation under Label shift.

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