No subclass left behind.

Problem setup:

n datapoint $x_1, x_2 \ldots x_n \in \mathcal{X}$

Associated Superclass: $y_1, \ldots y_n \in \mathcal{Y} \in \{1, 2 \ldots B\}$

$x_i \rightarrow$ latent superclass: $z_i \in \{1, \ldots C\}$

$\{1, 2, \ldots C\} \rightarrow$ Partitioned in disjoint set $S_1, \ldots S_B$

such that $z_i \in S_b$ then $y_i = b$

Mean subclass label: z_i determines sup class y_i

$S_b \rightarrow$ set of all subclass comprizes subclass b.

$S(c) \rightarrow$ superclass corresponding to subclass c

Typical Goal: classify examples from $\mathcal{X}$ to correct superclass.

$$\arg\max_{f \in \mathcal{F}} \mathbb{E}_{(x,y)}\left[\mathbb{1}\left(f(x) = y\right)\right] \qquad (1)$$

Modified goal for this research paper:

$$\underbrace{\arg\max_{f \in \mathcal{F}} \min_{c \in \{1, 2, \dots C\}} \mathbb{E}_{(x,y) | z = c} \left[\mathbb{1}(f(x) = y) \right]}_{\text{worst case expected accuracy}} \quad \text{--- (2)}$$

ERM corresponding to 1

$$\arg\min_{f \in \mathcal{F}} \left\{ \mathbb{R}(f) := \frac{1}{n} \sum_{i=1}^{n} \ell(f(x_i), y_i) \right\} \quad \text{--- (3)}$$

ERM corresponding to 2

$$\arg\min_{f \in \mathcal{F}} \left\{ \mathbb{R}_{robust}(f) := \max_{c \in \{1, \dots C\}} \frac{1}{n_c} \sum_{i=1}^{n} \mathbb{1}(z_i = c)\, \ell(f(x_i), y_i) \right\} \quad \text{--- (4)}$$

where, $n_c = \sum_{i=1}^{n} \mathbb{1}(z_i = c)$

overall goal to find $\hat{f}$ such that.

$$\mathbb{R}_{robust}(\hat{f}) - \min_{f \in \mathcal{F}} (R_{robust}(f))$$