

Supplementary Material

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1 Additional Details on the Experimental Setting

In this section, we provide a detailed description of the experimental setup to ensure the reproducibility of our results.

Each dataset is split into a development set (training and validation) and a test set using an 80-20 stratified split based on class label distribution. Within the development set, we perform a 5-fold cross-validation to further divide data into training and validation subsets.

For model selection, we conduct hyperparameter tuning for each experimental setting. Across all datasets, we train a feedforward neural network with two hidden layers containing 300 and 100 neurons, respectively, and ReLU activations. A Dropout layer with a rate of 0.2 is applied after the last hidden layer for regularization, while the output layer uses the Softmax function.

Regarding training, we train the neural network for a maximum of 100 iterations at the orchestrator level and up to 30 epochs per learner. Early stopping is applied with a patience of 5 epochs at both levels, based on the scoring functions **S** and **LS**, respectively. At the learner level, we employ the Adam optimizer with a learning rate of $1e^{-4}$, a weight decay factor of $1e^{-4}$, and a batch size of 128. The loss function is the Cross-Entropy, and the fairness threshold is set to $\tau = 0.2$.

Finally, we configure additional hyper-parameters as follows: the weight λ_P in the scoring function is set to 0.5, the proximity constraint threshold δ is fixed at 0.02, the performance budget β is set to 0.05, the performance step ρ_{step} is 0.01, and the tolerance parameter ν_{tot} is 0.05.

The sensitive attributes considered are:

- *Job* $\in$ {Public Employee, Self Employed, Private Employee},
- *Race* $\in$ {White, Black, Asian, Indigenous, Other},
- *Marital Status* $\in$ {Married, Never Married, Divorced, Other}.