HW1-XAI

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1 Task 1

Population split:

- $P(Blue) = 0.9$
- $P(Red) = 0.1$

Red Group: TP, TN, FP, FN:

- $TP_R = 0.25$
- $TN_R = 0.25$
- $FP_R = 0.25$
- $FN_R = 0.25$

Blue Group: TP, TN, FP, FN:

- $TP_B = 0.6$
- $TN_B = 0.15$
- $FP_B = 0.05$
- $FN_B = 0.2$

Task 1a: Demographic Parity

$$\text{Demographic Parity} = \frac{P(Y = \text{Enrolled in training}|\text{Red})}{P(Y = \text{Enrolled in training}|\text{Blue})}$$

$$\text{Demographic Parity} = \frac{TP_R + FP_R}{TP_B + FP_B}$$

$$\text{Demographic Parity} = \frac{0.25 + 0.25}{0.6 + 0.05} = \frac{0.5}{0.65} \approx 0.769$$

Task 1b: Equal Opportunity

$$\text{Equal Opportunity} = \frac{TPR_R}{TPR_B}$$

where

$$TPR = \frac{TP}{TP + FN}$$

$$TPR_R = \frac{TP_R}{TP_R + FN_R} = \frac{0.25}{0.25 + 0.25} = \frac{0.25}{0.5} = 0.5$$

$$TPR_B = \frac{TP_B}{TP_B + FN_B} = \frac{0.6}{0.6 + 0.2} = \frac{0.6}{0.8} = 0.75$$

$$\text{Equal Opportunity} = \frac{0.5}{0.75} = \frac{2}{3} \approx 0.667$$

Task 1c: Positive Predictive Rate Parity

$$\text{Positive Predictive Rate Parity} = \frac{PPV_R}{PPV_B}$$

where

$$PPV = \frac{TP}{TP + FP}$$

$$PPV_R = \frac{TP_R}{TP_R + FP_R} = \frac{0.25}{0.25 + 0.25} = \frac{0.25}{0.5} = 0.5$$

$$PPV_B = \frac{TP_B}{TP_B + FP_B} = \frac{0.6}{0.6 + 0.05} = \frac{0.6}{0.65} \approx 0.923$$

$$\text{Positive Predictive Rate Parity} = \frac{0.5}{0.923} \approx 0.542$$

Starred task explanation:

All of the metrics are out of range [80%; 125%] and lower than 80%. Firstly, we'd like to improve the two lowest metrics:

- Equal Opportunity
- Positive Predictive Rate Parity

One way to improve these metrics is by increasing the number of False Negatives (at the cost of True Positives) and False Positives (at the cost of True Negatives).

For Equal Opportunity, reducing TPR_B (True Positive Rate for Blue) will result in an increase in Equal Opportunity.

For Positive Predictive Rate Parity, reducing PPV_B (Positive Predictive Value for Blue) will result in an increase in Positive Predictive Rate Parity.

A simple method would be to select enrollments equally randomly (50%/50%) for a subgroup of Blues.

2 Task 2

Here, I trained logistic regression model on adult dataset from benchmark. We can notice that statistical (demographic) parity is much higher compared to equal opportunity and predictive parity value. It means that Logistic Regression predicts that man are 6 times more likely to achieve income over 50k dollars rather than woman.

Metric	**Value**
Statistical Parity	6.1483
Equal Opportunity	1.1091
Predictive Parity	1.0310
Accuracy	0.8474

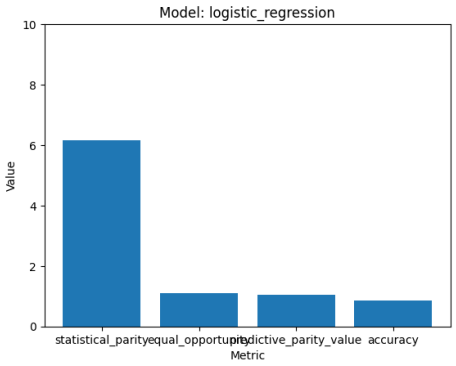

Figure 1: The columns in order are: Statistical parity; Equal opportunity; Predictive parity value; Accuracy

The results of Decision Tree are very similar compared to Logistic Regression results. However, the small differences are: higher statistical parity, equal opportunity, accuracy and smaller predictive parity value.

Metric	**Value**
Statistical Parity	6.5989
Equal Opportunity	1.1230
Predictive Parity	0.9726
Accuracy	0.8563

The class imbalance technique that I used is supplying the dataset with random samples of the underrepresented class with respect to the income (target column). It resulted in higher statistical parity, equal opportunity. It also looks like the predictive parity value is almost 1, but model accuracy is lower.

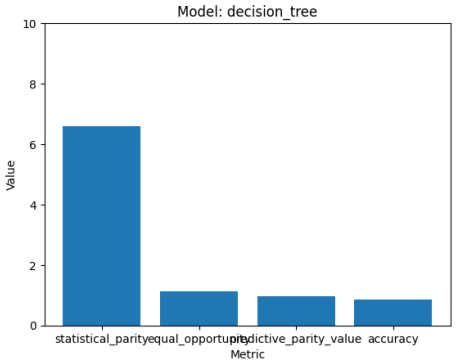

Figure 2: The columns in order are: Statistical parity; Equal opportunity; Predictive parity value; Accuracy

Metric	**Value**
Statistical Parity	7.0338
Equal Opportunity	1.2278
Predictive Parity	0.9970
Accuracy	0.8186

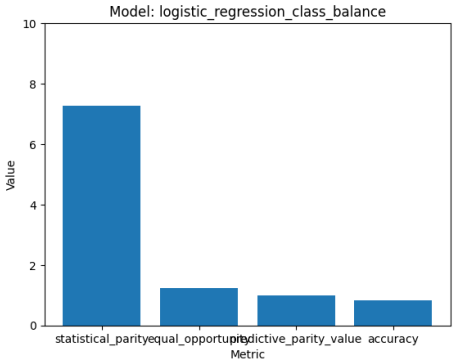

Figure 3: The columns in order are: Statistical parity; Equal opportunity; Predictive parity value; Accuracy

There seems no correlation between Statistical Parity, Equal Opportunity, Predictive Parity vs Accuracy. However, it looks like there might be positive correlation between Statistical Parity and Equal Opporutunity. Moreover, the class balancing made both statistical parity and accuracy worse which can be linked to the fact that man are overrepresented in those having an income above 50k dollars.