RECAP: PERFORMANCE MEASURES FOR BINARY CLASSIFICATION

- We encourage readers to first go through Chapter 04.08 in I2ML.
- In binary classification ($\mathcal{Y} = \{-1, +1\}$):

		True Class y		
		$+$	$-$	
Classification	$+$	TP	FP	$\rho_{PPV} = \frac{\#TP}{\#TP + \#FP}$
$\hat{y}$	$-$	FN	TN	$\rho_{NPV} = \frac{\#TN}{\#FN + \#TN}$
		$\rho_{TPR} = \frac{\#TP}{\#TP + \#FN}$	$\rho_{TNR} = \frac{\#TN}{\#FP + \#TN}$	$\rho_{ACC} = \frac{\#TP + \#TN}{TOTAL}$

- F_1 score balances Recall (ρ_{TPR}) and Precision (ρ_{PPV}):

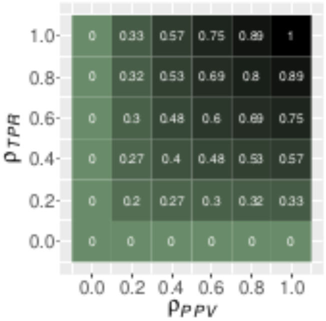
$$\rho_{F_1} = 2 \cdot \frac{\rho_{PPV} \cdot \rho_{TPR}}{\rho_{PPV} + \rho_{TPR}}$$

- Note that ρ_{F_1} does not account for TN.
- Does ρ_{F_1} suffer from data imbalance like accuracy does?

F_β IN BINARY CLASSIFICATION

- F_1 puts equal weights to $\frac{1}{\rho_{PPV}}$ & $\frac{1}{\rho_{TPR}}$ because $F_1 = \frac{2}{\frac{1}{\rho_{PPV}} + \frac{1}{\rho_{TPR}}}$.
- F_β puts β^2 times of weight to $\frac{1}{\rho_{TPR}}$:

$$F_\beta = \frac{1}{\frac{\beta^2}{1+\beta^2} \cdot \frac{1}{\rho_{TPR}} + \frac{1}{1+\beta^2} \cdot \frac{1}{\rho_{PPV}}}$$
$$= (1 + \beta^2) \cdot \frac{\rho_{PPV} \cdot \rho_{TPR}}{\beta^2 \rho_{PPV} + \rho_{TPR}}$$



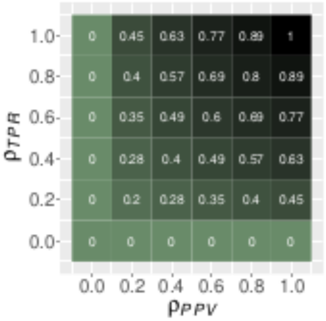
- $\beta \gg 1 \rightsquigarrow F_\beta \approx \rho_{TPR}$;
- $\beta \ll 1 \rightsquigarrow F_\beta \approx \rho_{PPV}$.

G SCORE AND G MEAN

- G score uses geometric mean:

$$\rho_G = \sqrt{\rho_{PPV} \cdot \rho_{TPR}}$$

- Geometric mean tends more towards the **lower** of the two combined values.
- Geometric mean is **larger** than harmonic mean.



- Closely related is the G mean:

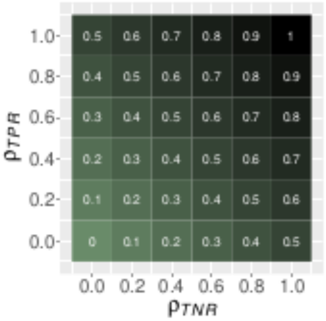
$$\rho_{Gm} = \sqrt{\rho_{TNR} \cdot \rho_{TPR}}.$$

  It also considers **TN**.
- Always predicting "negative": $\rho_G = \rho_{Gm} = 0 \rightsquigarrow$ Robust to data imbalance!

BALANCED ACCURACY

- Balanced accuracy (BAC) balances ρ_{TNR} and ρ_{TPR}:

$$\rho_{BAC} = \frac{\rho_{TNR} + \rho_{TPR}}{2}$$



- If a classifier attains high accuracy on both classes or the data set is almost balanced, then $\rho_{BAC} \approx \rho_{ACC}$.

- However, if a classifier always predicts "negative" for an imbalanced data set, i.e. $n_+ \ll n_-$, then $\rho_{BAC} \ll \rho_{ACC}$. It also considers TN.