

CLASSIFICATION ERRORS

EMMA BEAUXIS-AUSSALET

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RECAP

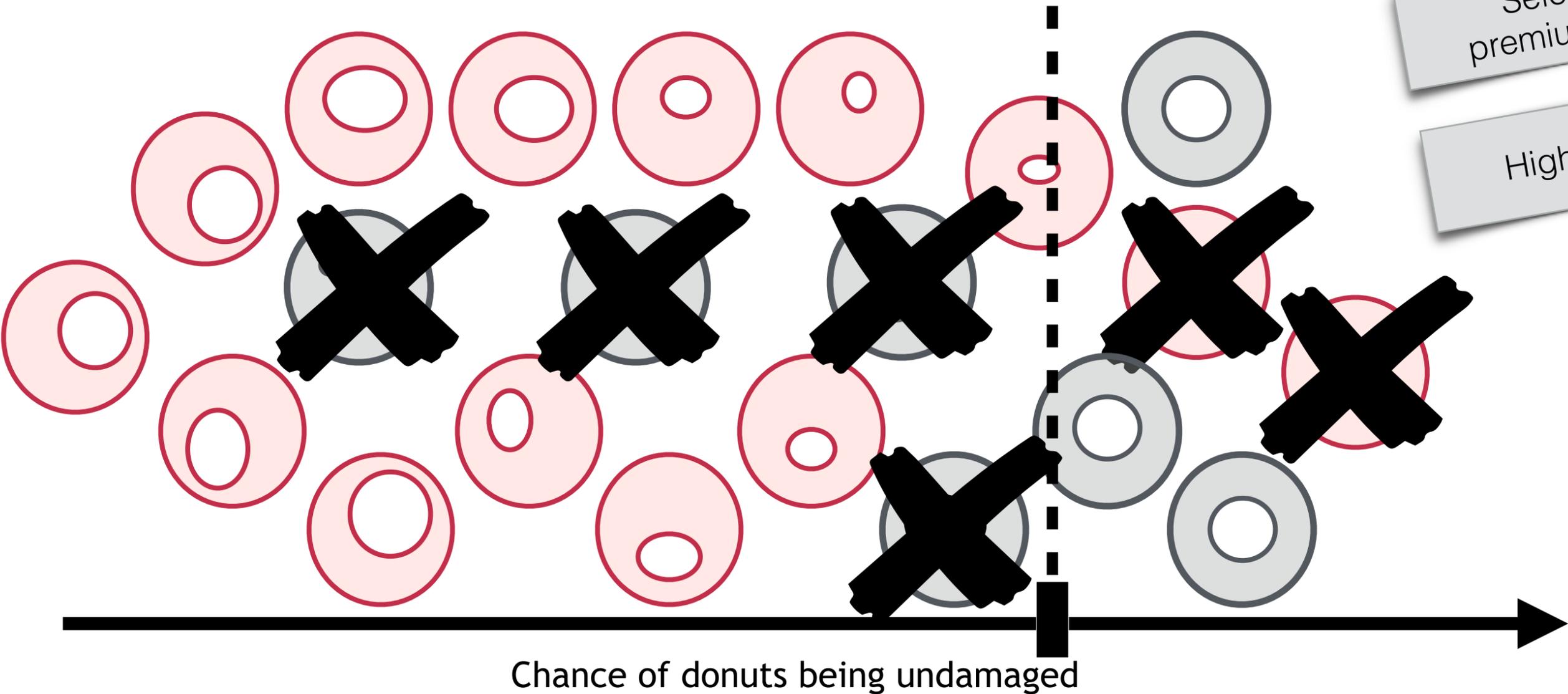
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TUNING THE ERRORS



Tuning parameters can **balance errors between classes**.



Select only premium donuts

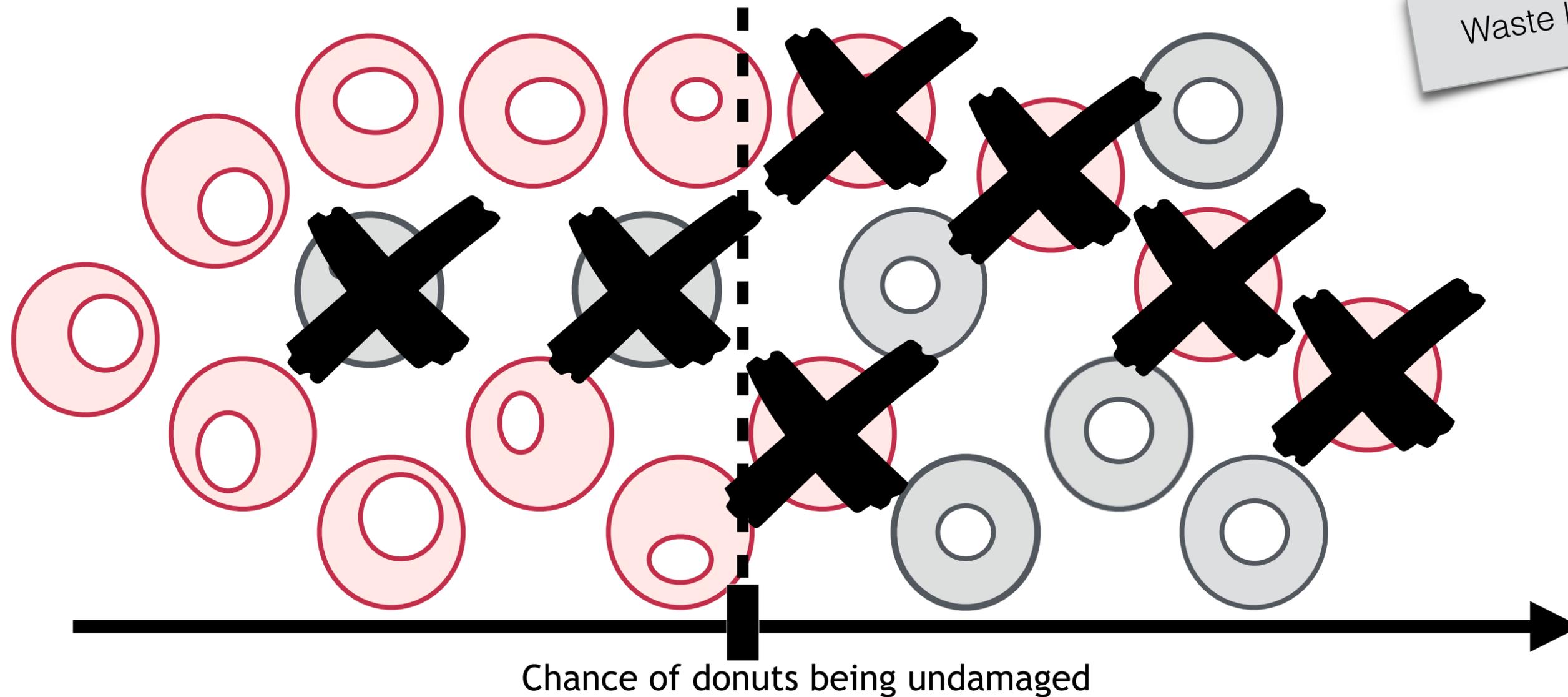
High Precision

TUNING THE ERRORS

damaged

undamaged

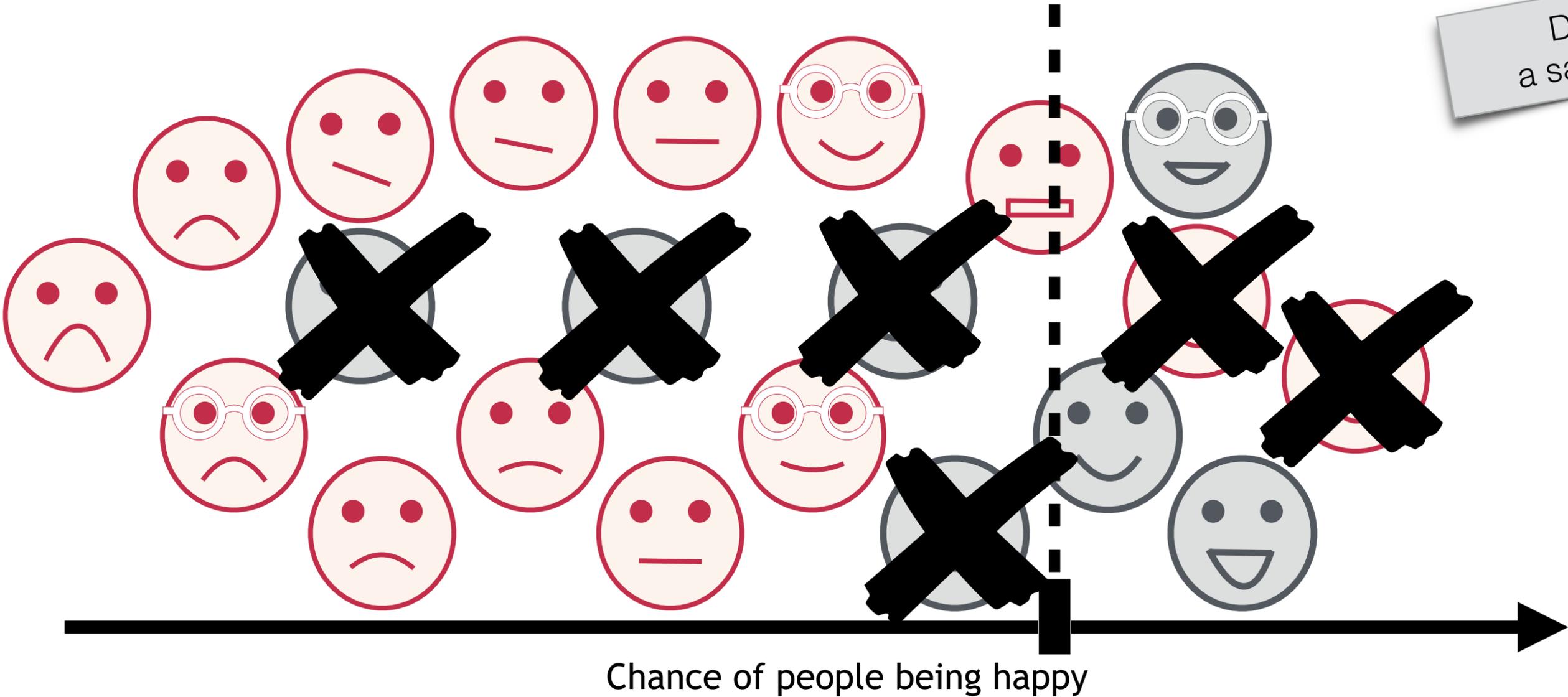
Tuning parameters can **balance errors between classes**.



TUNING THE ERRORS

sad | happy

The **tolerance to errors** depends on the use case.

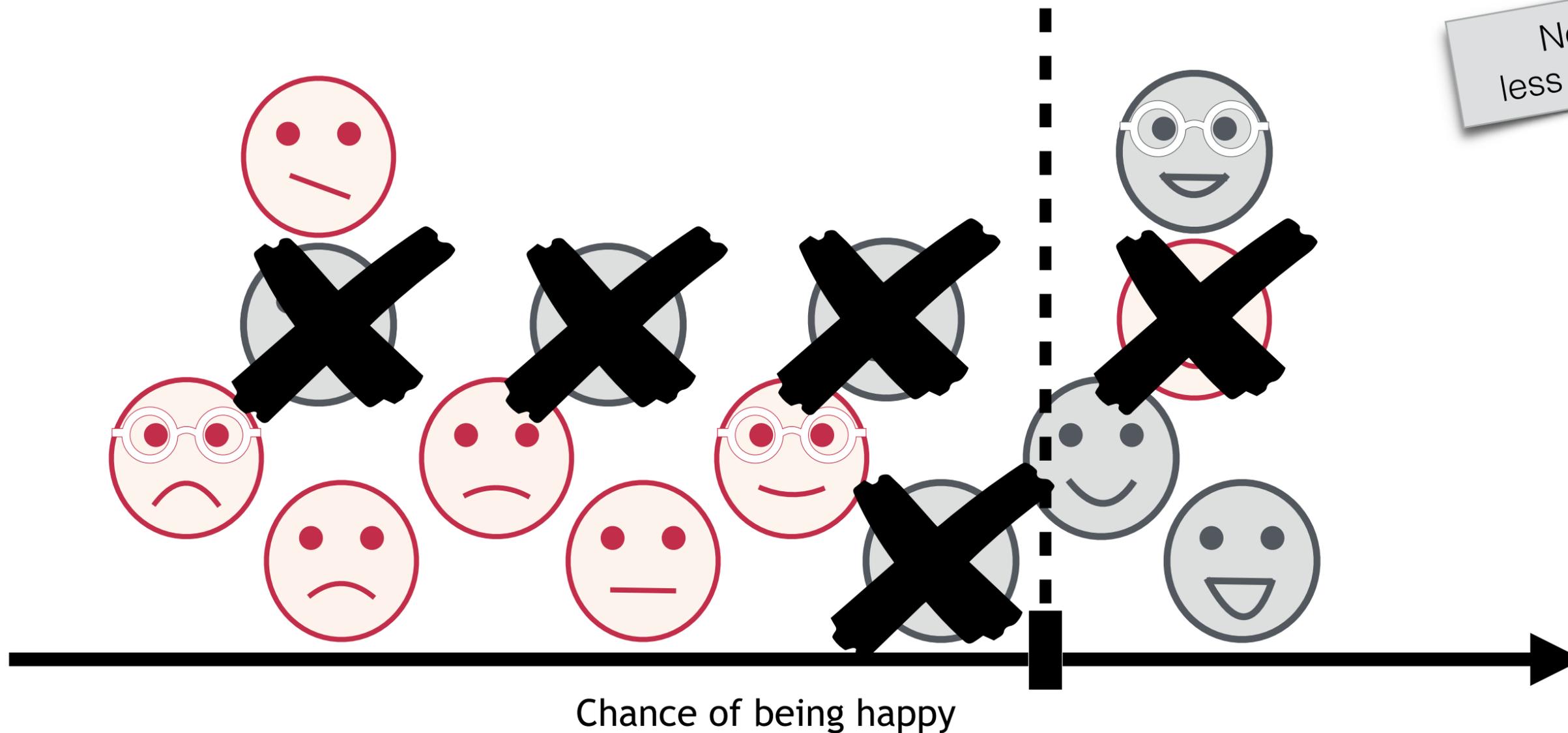


Don't miss a sad customer

TUNING THE ERRORS

sad | happy

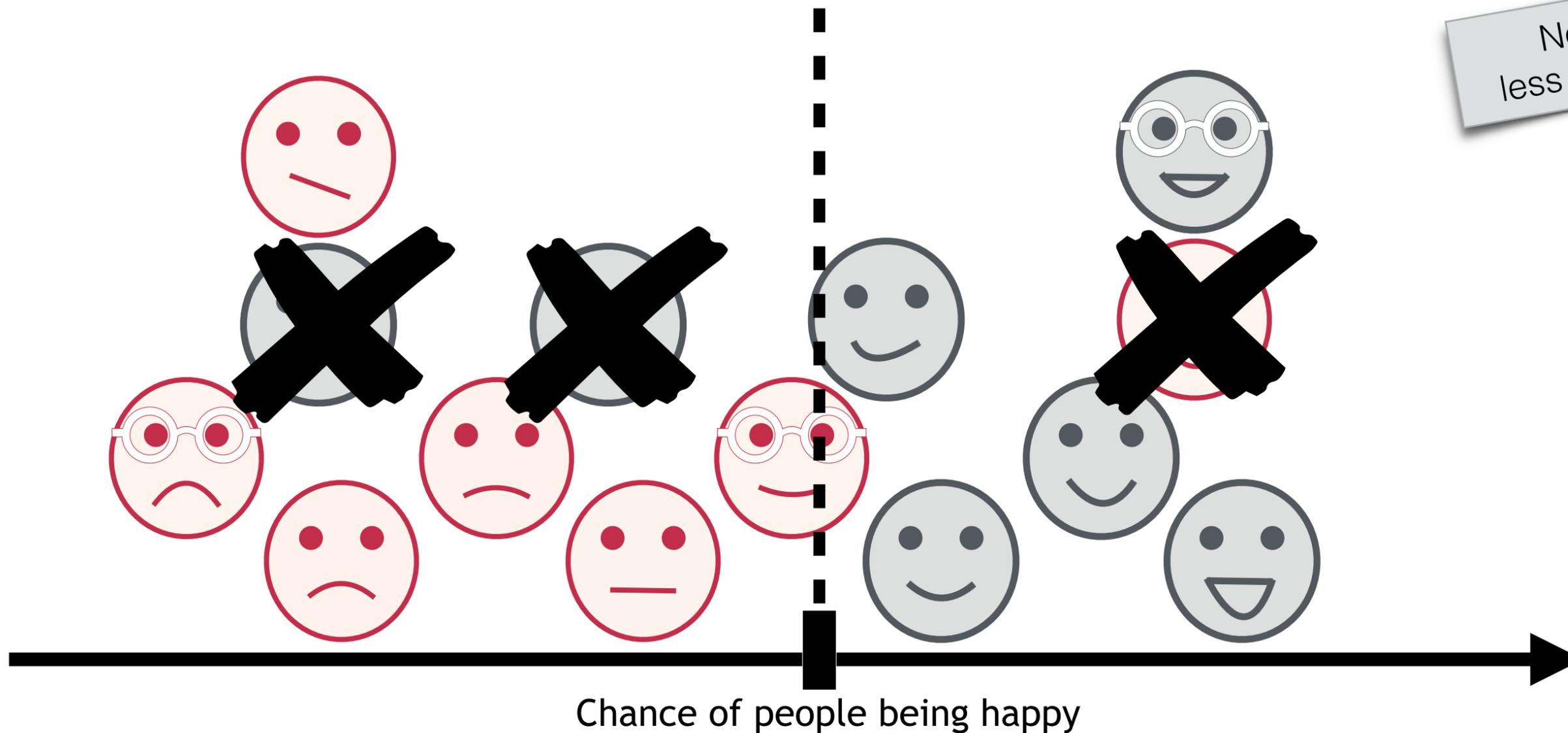
Beware that **class proportions** may vary over time, and affect the errors.



TUNING THE ERRORS

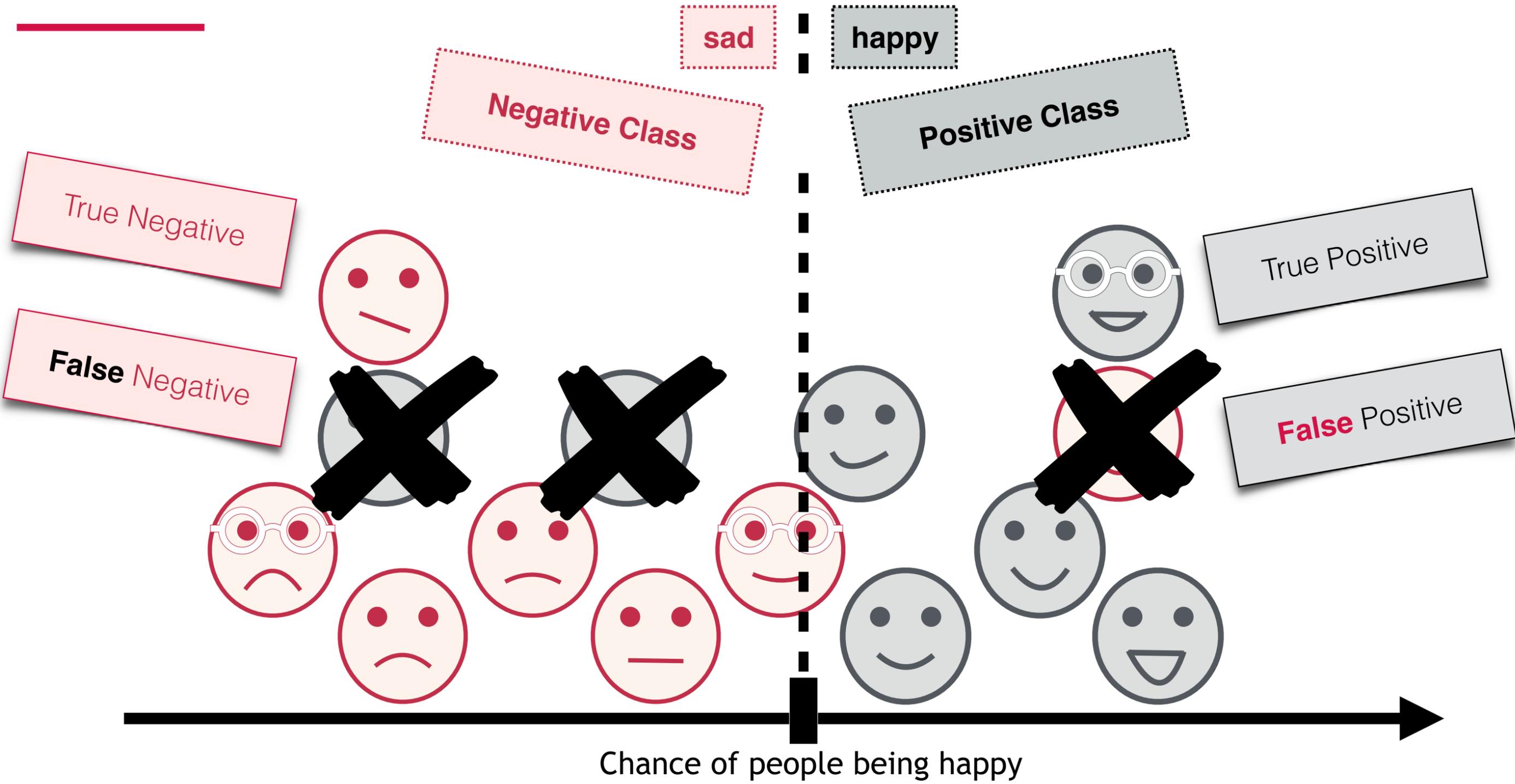


Beware that **class proportions** may vary over time, and affect the errors.



Now we have less sad customers

TERMINOLOGY



ERROR AND BIAS

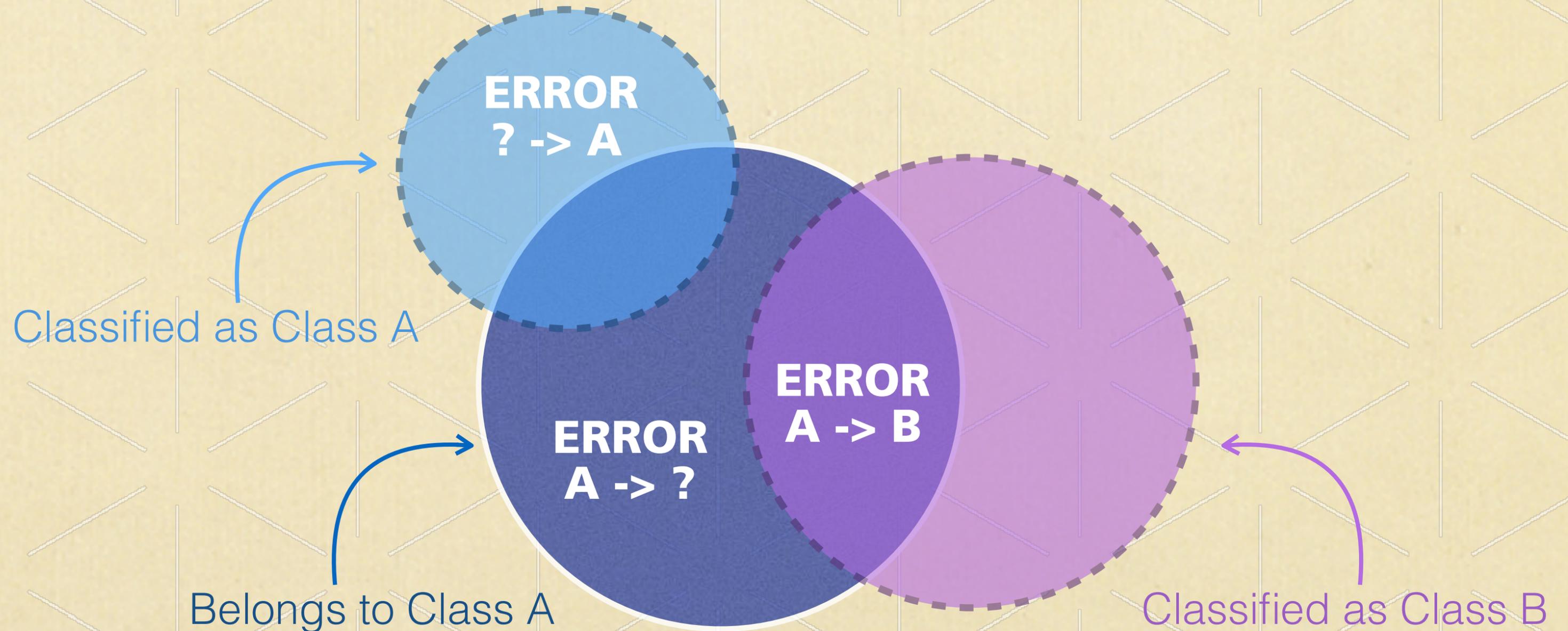
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ERROR

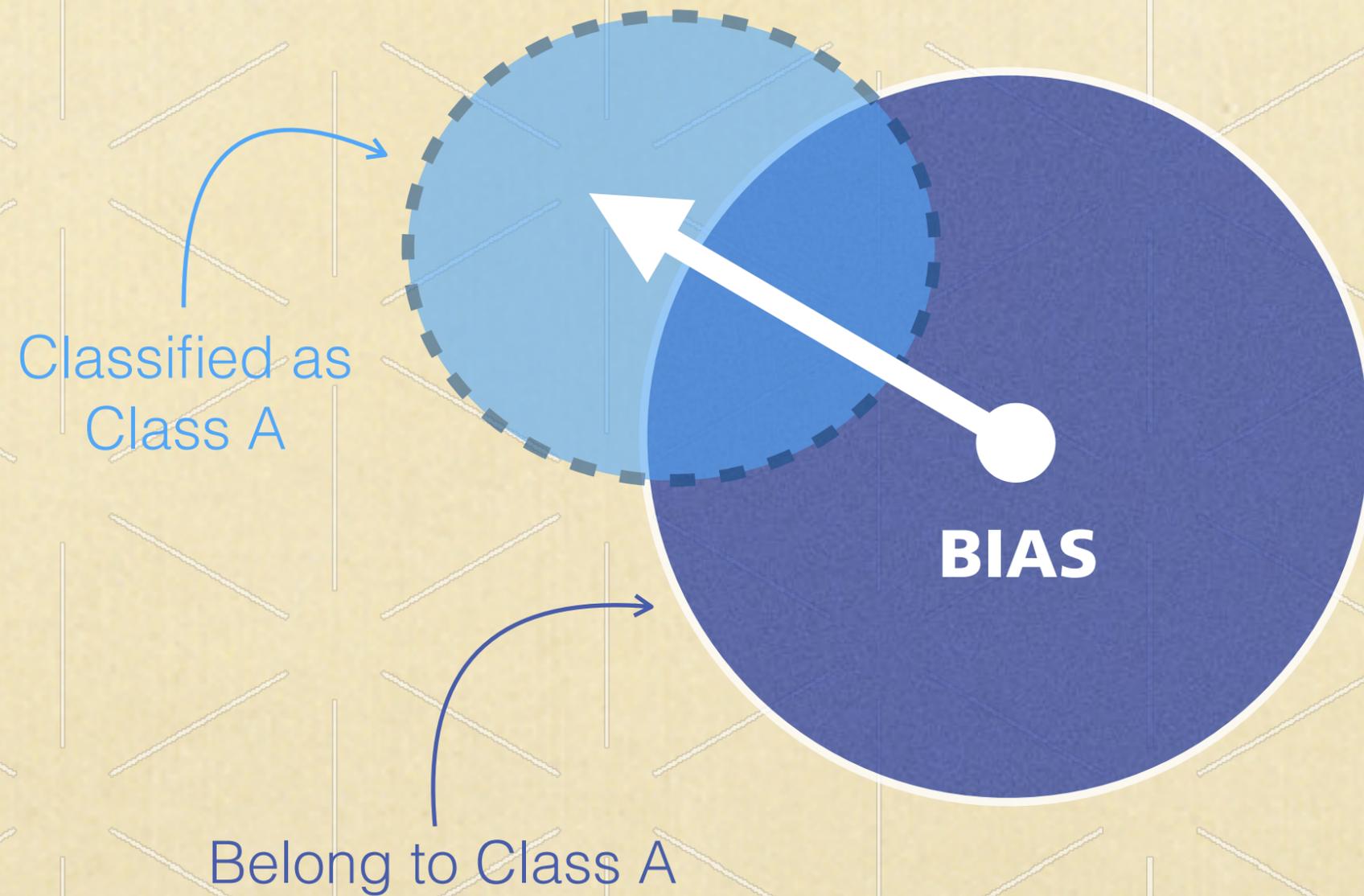
What belongs to Class A is classified as Class B.

It is **directional**: objects from Class A are misclassified into Class B.



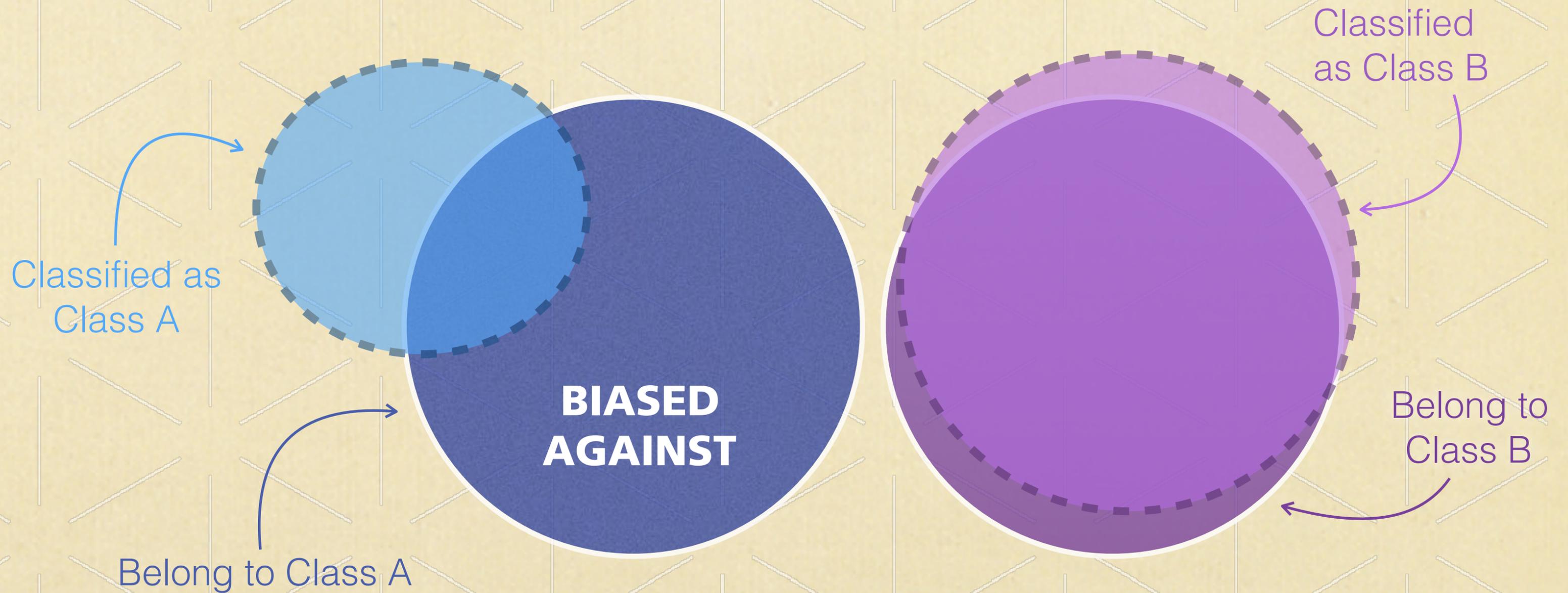
BIAS (1)

Errors systematically occur **for one class**.



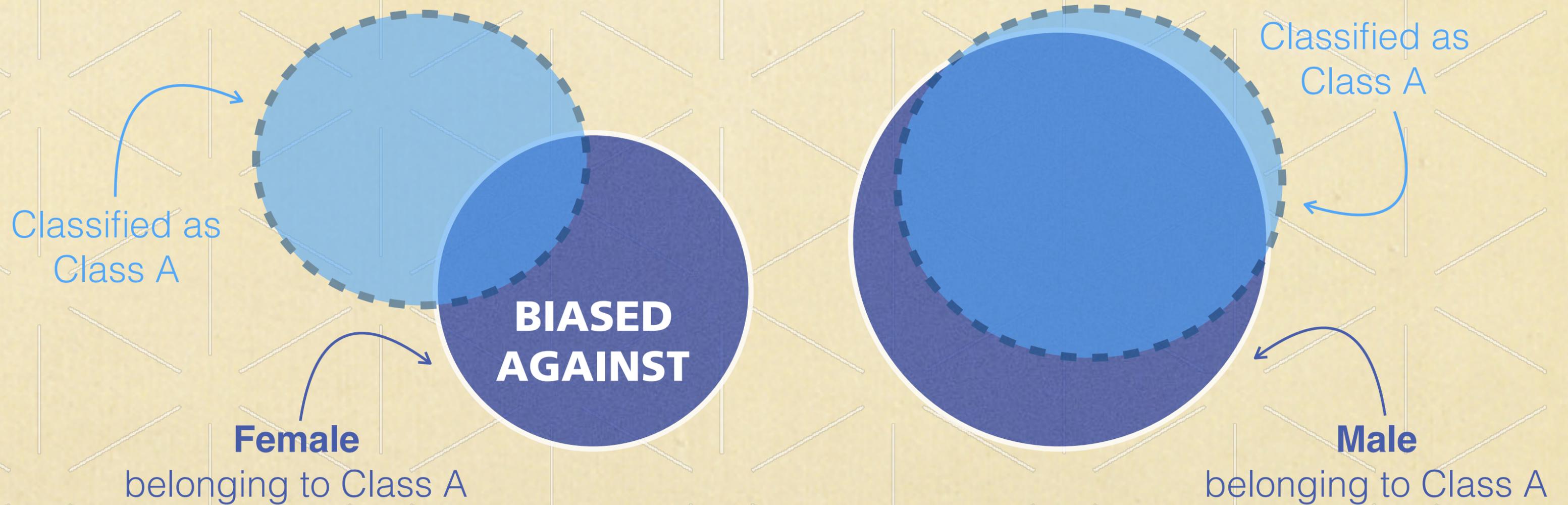
BIAS (2)

Errors systematically differ **between classes**.



BIAS (3)

Errors systematically differ **between groups**.



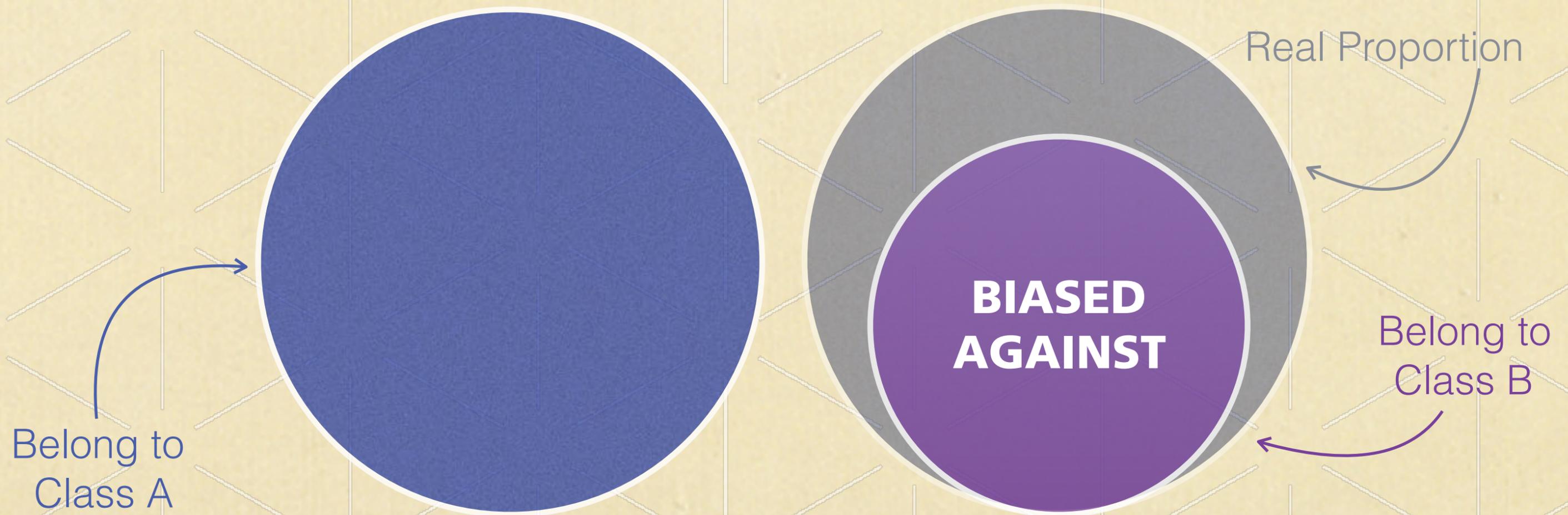
BIAS (4)

Groups are **under-represented** (either in test or training set).
Classification models are more uncertain about them.



BIAS (5)

Classes are **under-represented** (either in test or training set).
Classification models are more uncertain about them.



MEASURE ERROR

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BEWARE OF **ERROR RATES**

We may forget what **denominators** represent.
(experts or non-experts)

$$\textit{Error Rate} = \frac{\textit{Number of Error}}{\quad}$$

ON WHAT?!

THAT'S VERY IMPORTANT...

[1] Hoffrage, Krauss, Martignon, and Gigerenzer (2015)

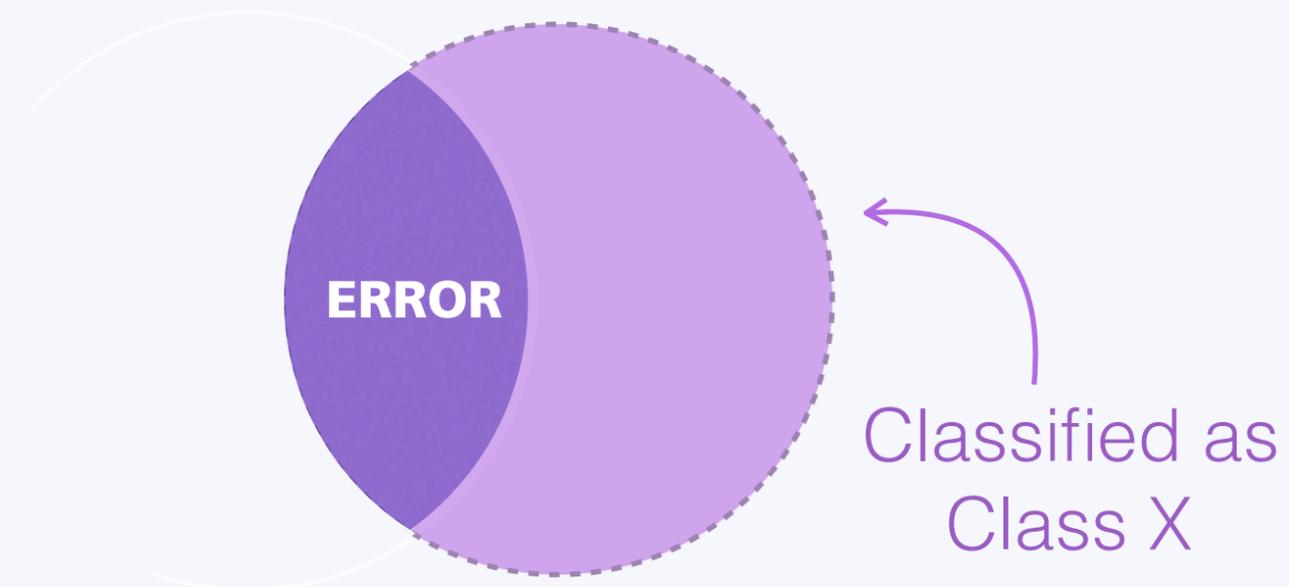
[2] Khan, Breslav, Glueck, and Hornbæk (2015)

[3] Beauxis-Aussalet, van Doorn, and Hardman (2018)

BEWARE OF PRECISION

If **class proportions** vary, precision varies.

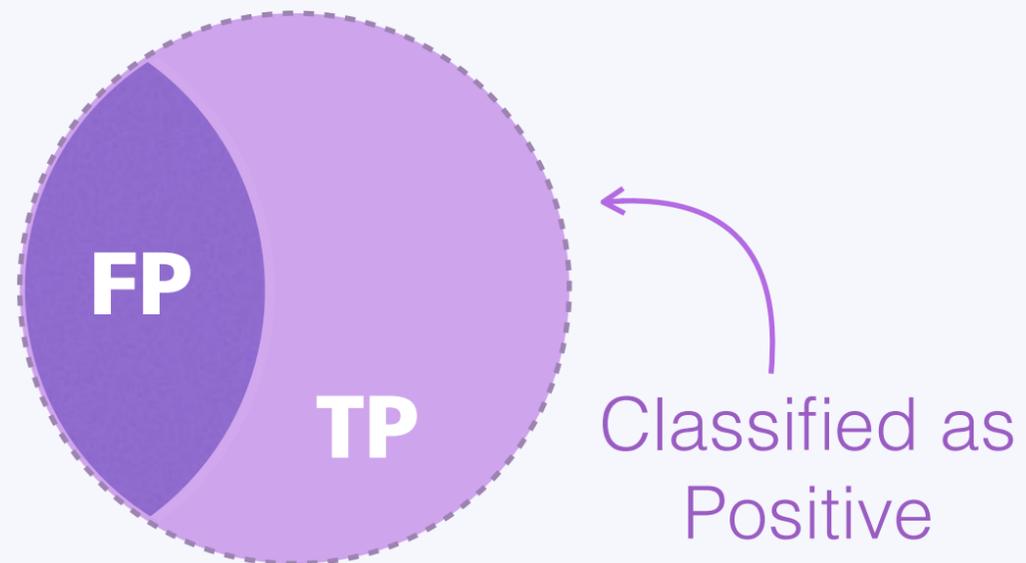
$$\textit{Precision} = \frac{\textit{Number of Objects Correctly Classified as X}}{\textit{Total Number of Objects Classified as X}}$$



BEWARE OF PRECISION

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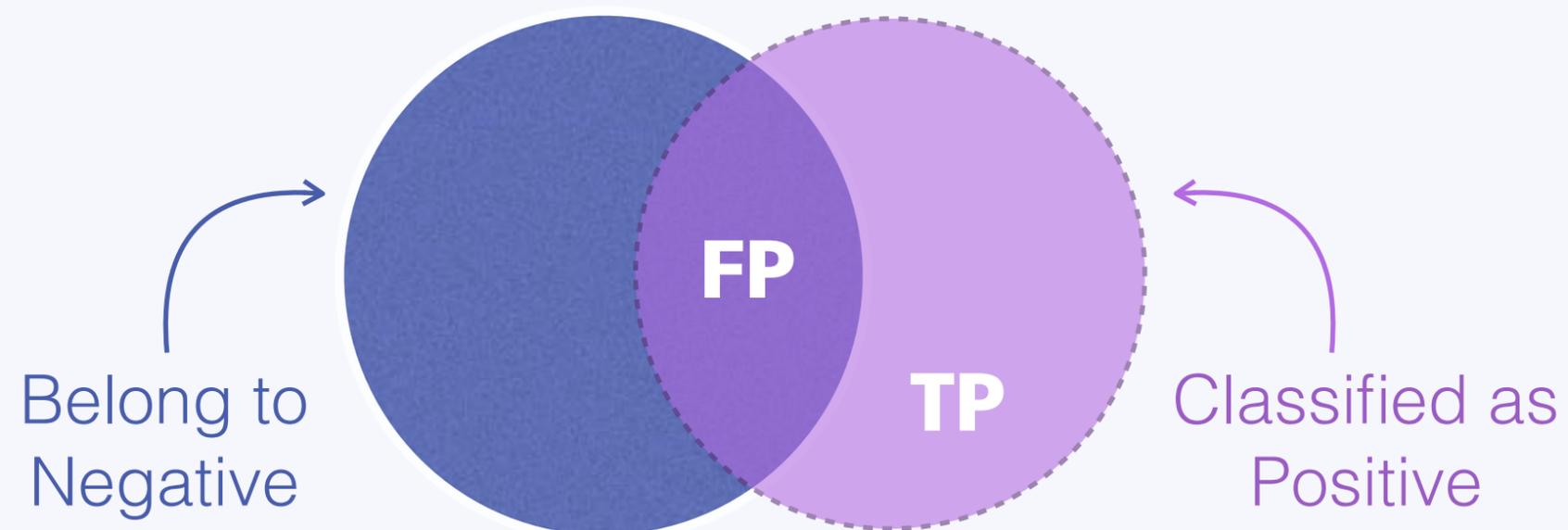
$$\textit{Precision} = \frac{TP}{TP + FP}$$



BEWARE OF PRECISION

If **class proportions** vary, precision varies.

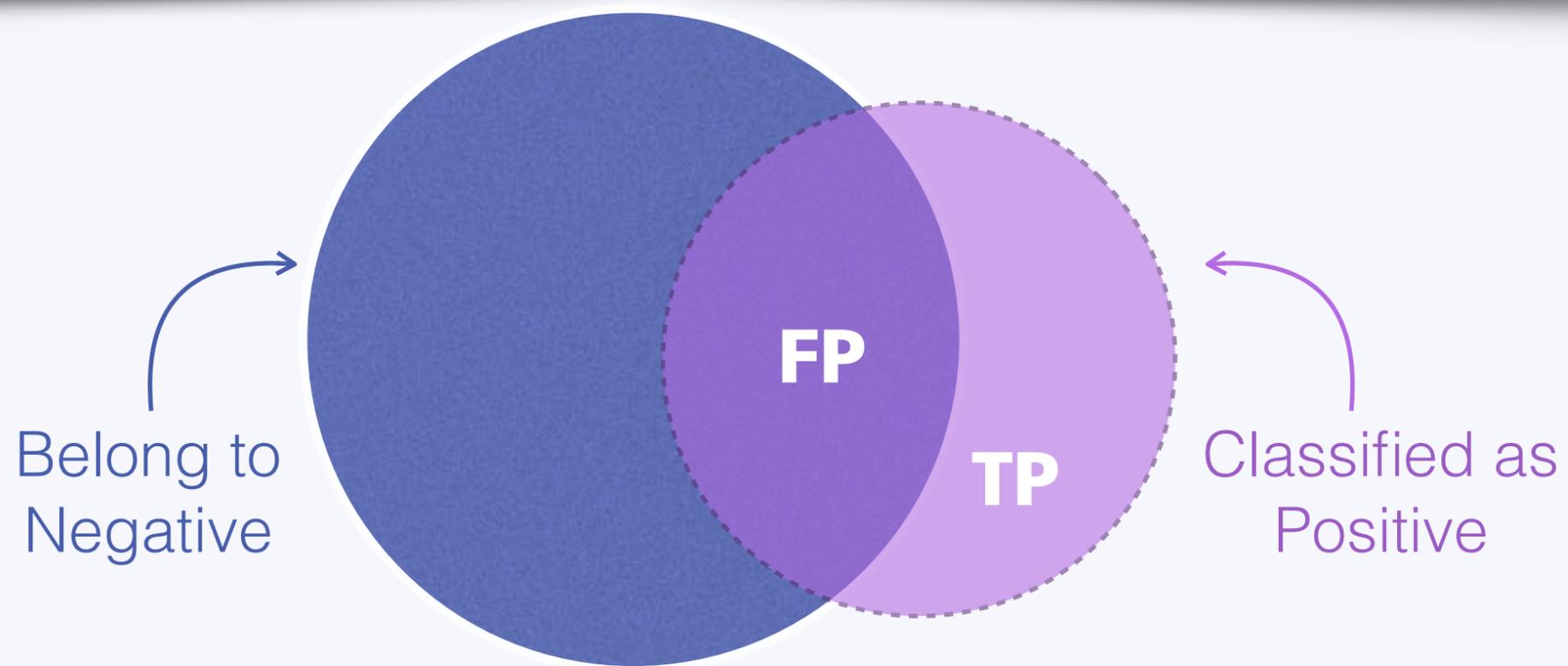
$$\textit{Precision} = \frac{TP}{TP + FP} = \frac{\text{Crescent Moon}}{\text{Circle}}$$



BEWARE OF PRECISION

If **class proportions** vary, precision varies.

$$\textit{Precision} = \frac{TP}{TP + FP} = \frac{\text{shaded half of a circle}}{\text{entire circle}}$$



BEWARE OF PRECISION

If **class proportions** vary, precision varies.

$$\textit{Precision} = \frac{TP}{TP + FP} = \frac{\text{[TP bar]}}{\text{[TP bar] + [FP bar]}}$$



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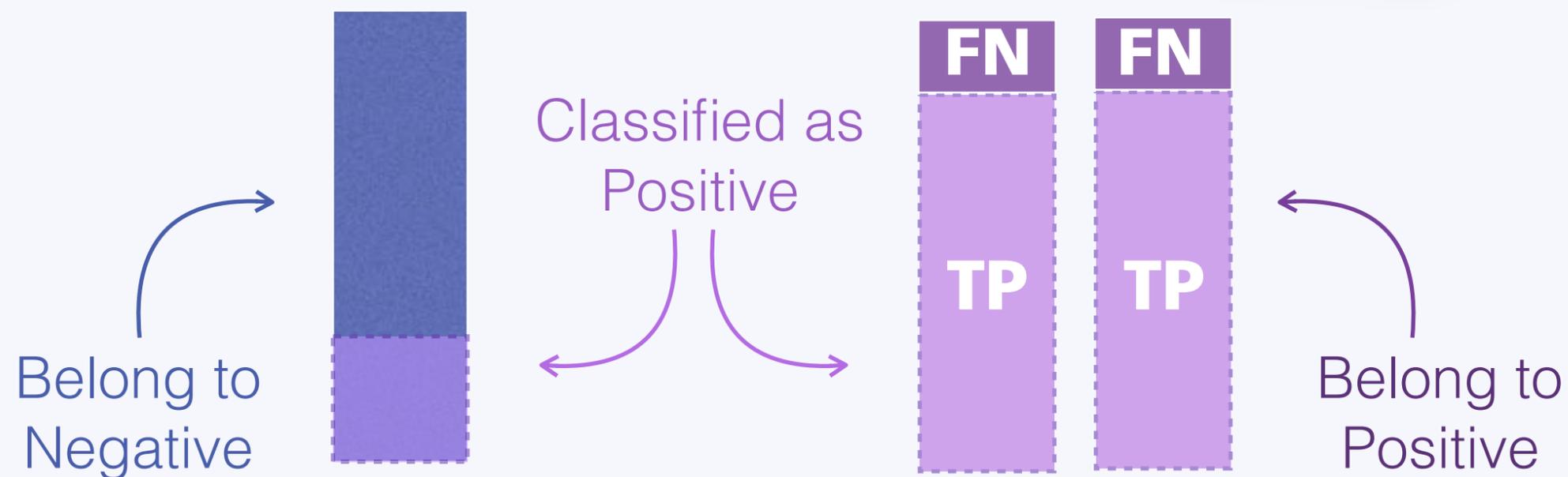


BEWARE OF CLASS PROPORTIONS

Some error rates remain unchanged by class proportions.

e.g., those of ROC curves: TP Rate (a.k.a. Recall) and FP Rate.

$$TP \text{ Rate} = \frac{TP}{TP + FN} = \frac{\text{[TP bar]}}{\text{[TP bar] + [FN bar]}}$$



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$$TP \text{ Rate} = \frac{TP}{TP + FN} = \frac{\text{[TP bar]}}{\text{[TP+FN bar]}}$$



BEWARE OF ACCURACY

It fails to indicate the errors for specific classes or groups.
It varies with class proportions. Biases cannot be identified.

$$\textit{Accuracy} = \frac{\textit{Number of Correct Classifications}}{\textit{Total Number of Classifications}} = \frac{\text{[purple bar]} +}{\text{[purple bar]} + \text{[small purple bar]} + \text{[blue bar]}}$$

Example: We achieve 98% accuracy, but one class is entirely misclassified (a small class $\leq 2\%$ of all objects).

ERROR IN END-RESULTS

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HOW MANY ERRORS IN THE END-RESULTS?

$$\text{Precision} = \frac{TP}{TP + FP} = 0.95$$

$$\text{FP Rate} = \frac{FP}{FP + TN} = 0.1$$

	Positive	Negative
Elements assigned to each class	1000	800

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$$\text{TP} = \text{Precision} \times 1000$$

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

$$\text{TP} = 0.95 \times 1000 = 950$$

$$\text{FP} = 1000 - 950 = 50$$

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$$\text{FP} = 1000 - 950 = 50$$

$$\text{FP Rate} = \frac{FP}{FP + TN} = 0.1$$

$$\frac{50}{50 + \text{TN}} = 0.1$$

$$\frac{50 + \text{TN}}{50} = \frac{1}{0.1}$$

$$50 + \text{TN} = \frac{50}{0.1}$$

$$\text{TN} = \frac{50}{0.1} - 50 = 450$$

$$\text{FN} = 800 - 450 = 350$$

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50

Elements assigned
to each class

**Beware low error rates
may mean high numbers of errors
in practice!**

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