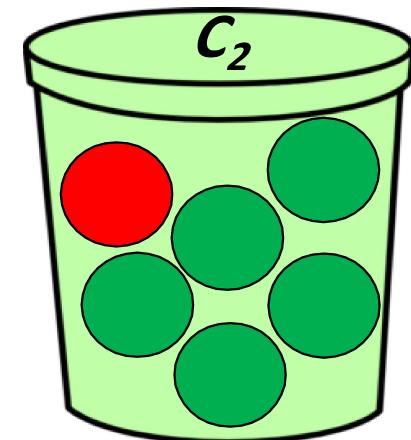
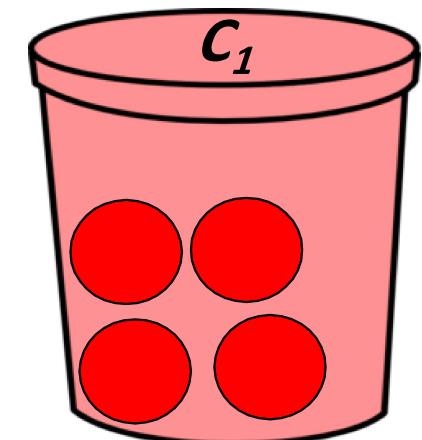
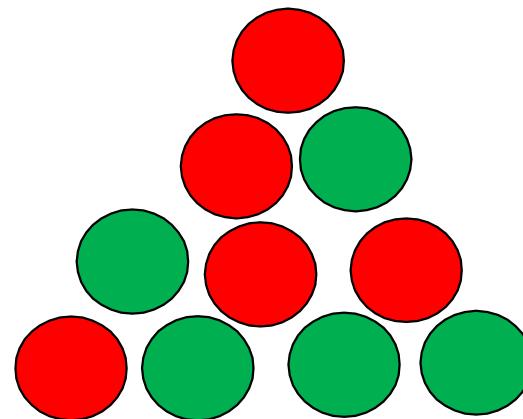


Accuracy

What fraction of the examples are classified correctly?

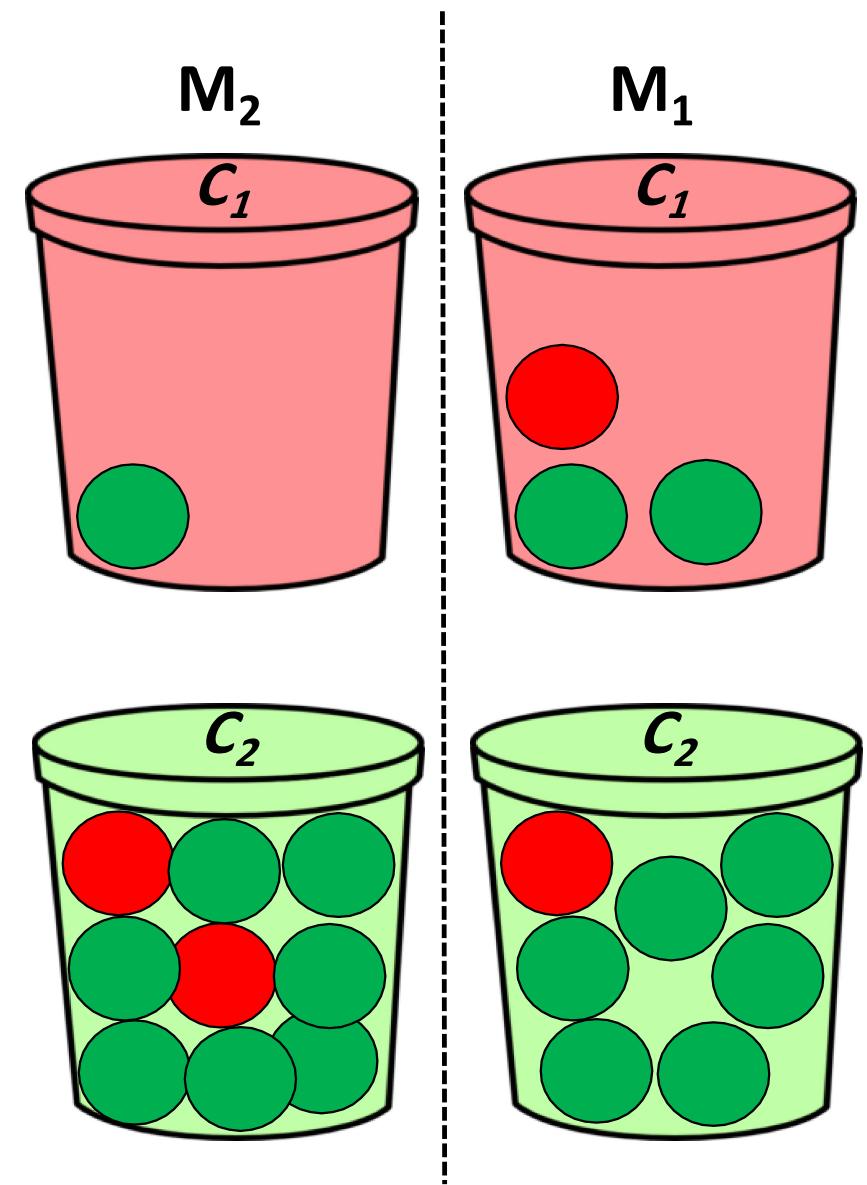
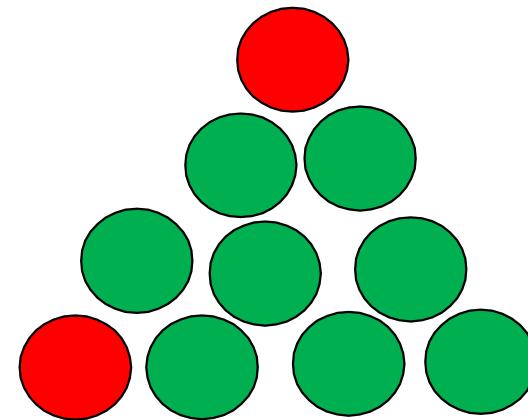
$$\text{Acc} = ?$$

$$= 9/10$$



Accuracy

- $\text{Acc}(M_1) = ?$
- $\text{Acc}(M_2) = ?$



What's the problem?

Problem with Accuracy?

- Imbalanced data (distribution of classes)!
- Some errors matter more than others ...
 - Given medical record, predict patient has COVID or not
 - Given an email, detect spam
- When classes are highly unbalanced, we focus on one **target class** (usually the rare class), denoted as the “**positive**” class.

Precision/Recall/F1
for the target class (positive)

Confusion Matrix

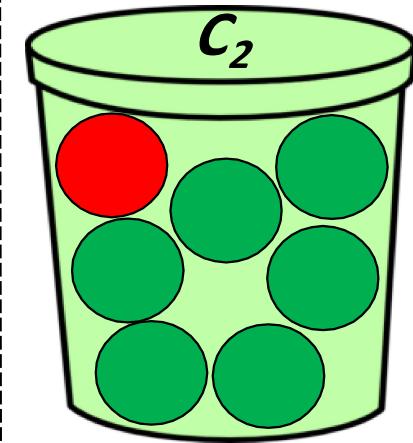
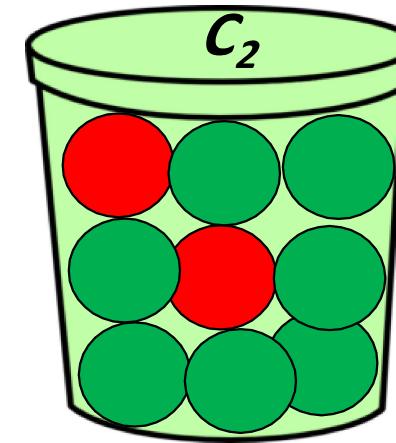
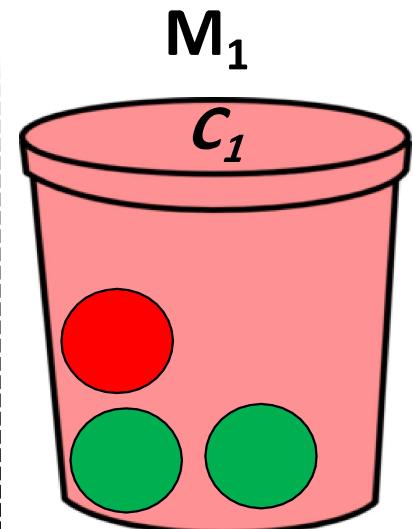
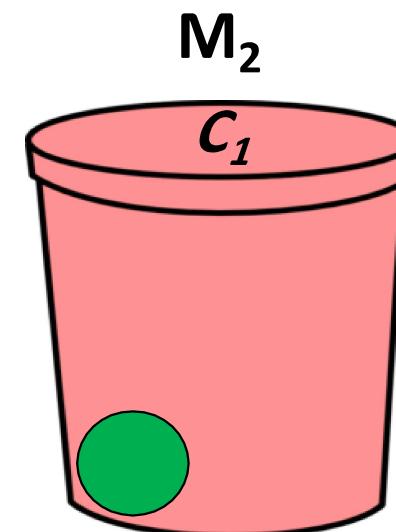
		Actual negative	
		FP	TN
positive		TP	FN
	positive		negative
		Predicted	

Confusion Matrix

		Predicted	
		positive	negative
Actual	negative	?	?
	positive	?	?

		predicted	
		positive	negative
Actual	negative	?	?
	positive	?	?

● positive

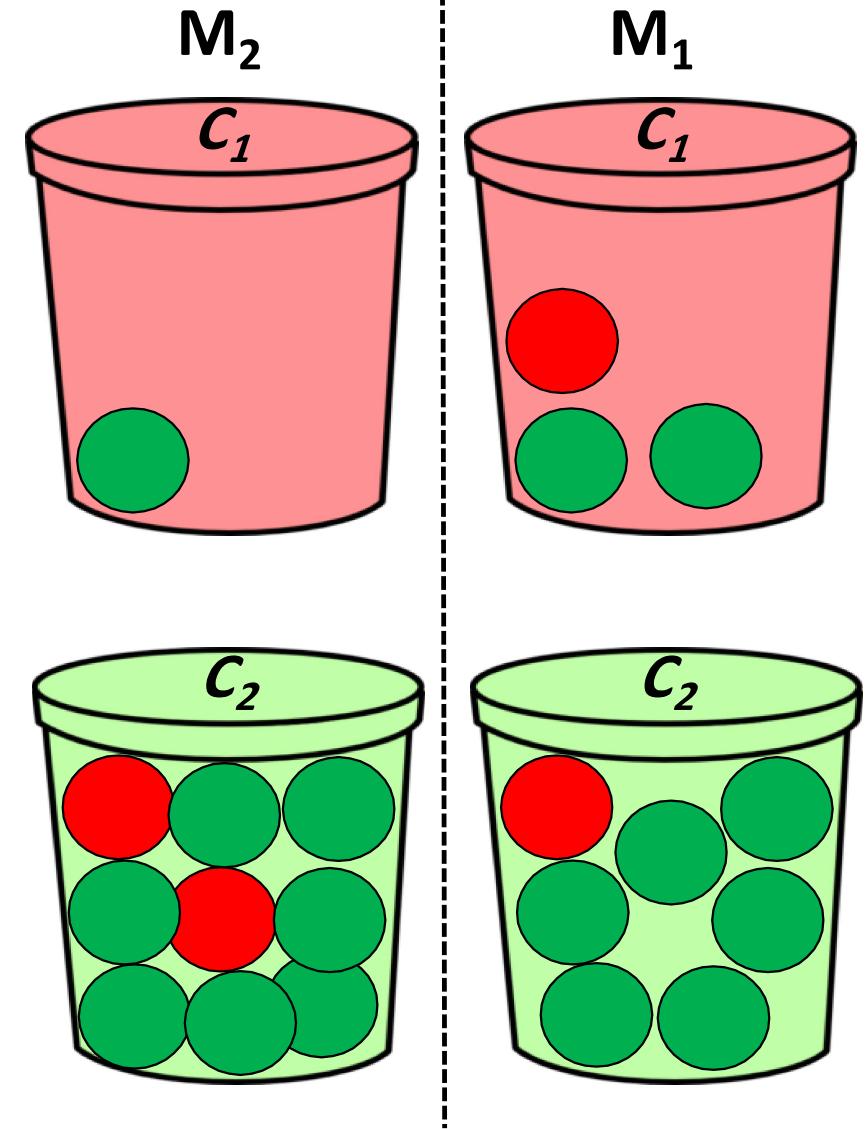


Confusion Matrix

		M ₁
		Actual negative
		M ₂
		positive
		negative
		positive
		negative
Predicted		
positive	2	1
negative	6	1

		M ₂
		Actual negative
		M ₁
		positive
		negative
		positive
		negative
predicted		
positive	1	0
negative	7	2

positive



Precision

		M ₁
		Actual negative
		2
		6
positive	negative	1
	positive	1

Predicted

What fraction of those predicted as positive are actually positive?

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

		M ₂
		Actual negative
		1
		7
positive	negative	0
	positive	2

Predicted

$$P(M_1) =$$

$$P(M_2) =$$

Precision: % of positive predictions that are correct

Recall

		M ₁
		Actual negative
		2
		6
Actual positive	positive	1
	negative	1
Predicted		

What fraction of the actual positive examples are predicted as positive?

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

		M ₂
		Actual negative
		1
		7
Actual positive	positive	0
	negative	2
Predicted		

$$R(M_1) =$$

$$R(M_2) =$$

Recall: % of gold positive examples that are found

A Combined Measure: *F*-measure

- *F*₁ measure

$$F_1 = \frac{2 * P * R}{P + R}$$

– Harmonic mean of *P* and *R*

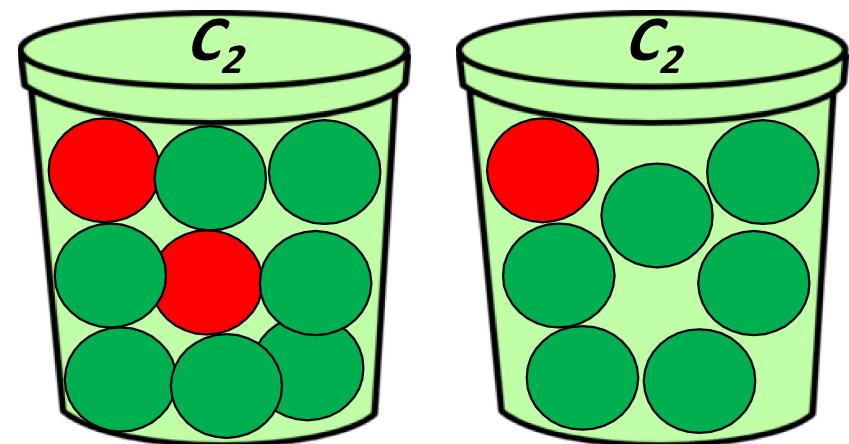
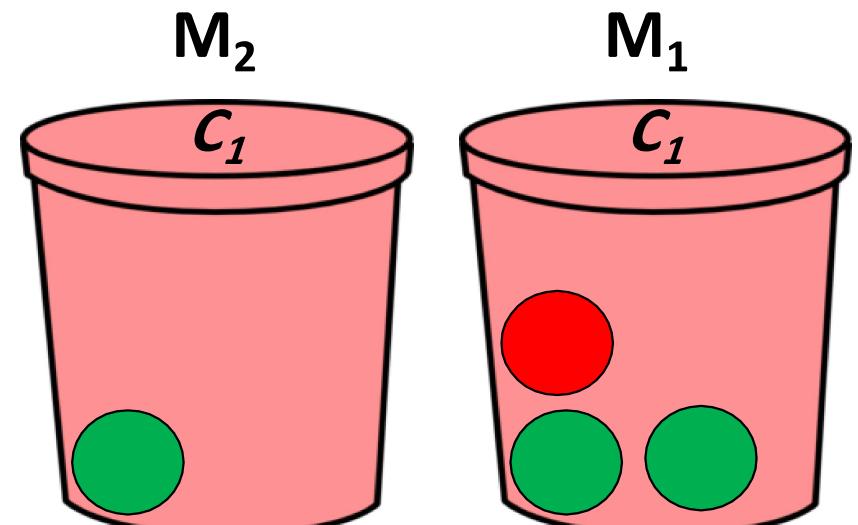
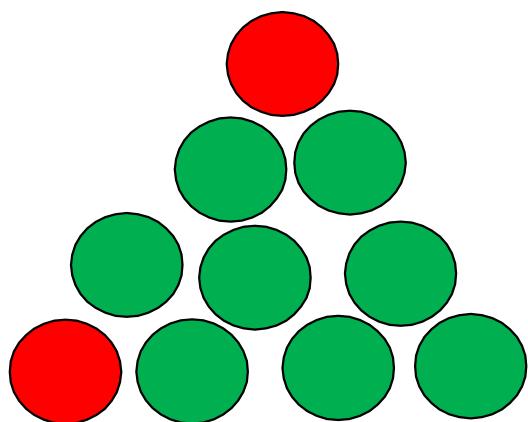
Why?

- Weighted *F* measure

$$F_\beta = \frac{(\beta^2 + 1) * P * R}{\beta^2 * P + R}$$

Binary Classification

	M_1	M_2
Precision	?	?
Recall	?	?
F1	?	?



Binary Classification

	M_1	M_2
Precision	$1/3 = 0.33$	$0/1 = 0$
Recall	$1/2 = 0.5$	$0/2 = 0$
F1	0.4	0

