Review:

Confusion matrix:

true

	P	N
P	T.P.	F.P.
N	F.N.	T.N.

predicted

$$T = TP + FP + FN + TN$$

$$accuracy = \frac{TP + TN}{T}$$

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

$$recall = \frac{TP}{TP + FN}$$ ← aka "TPR" or "sensitivity" or "hit rate"

$$FPR = \frac{FP}{FR + TN}$$

$$specificity = \frac{TN}{FP + TN}$$ ← FRR = 1 - specificity

Profit Curves:

I have 5 models, each with a different accuracy (a):

$$\begin{bmatrix} a = 0.977 & a = 0.02 & a = 0.98 \\ & a = 0.88 & a = 0.748 \end{bmatrix}$$

which is the best model?
(correct answer is "not enough info")

Okay fine, I'll give you the precision (p) and recall (r):

$$\begin{bmatrix} p = 0.44 & p = 0.02 & p = 0.0 \\ r = 0.6 & r = 1.0 & r = 0.0 \\ & p = 0.115 & p = 0.0672 \\ & r = 0.75 & r = 0.9 \end{bmatrix}$$

which is the best model?
(correct answer is "not enough info")

What else do you want to know?
(correct answer is "description of prediction problem" and/or "a confusion matrix")

Okay fine.

Domain : Fraud detection ('Fr' vs. 'Not')

positive case → negative case →

Confusion matricies:

true

	Fr	Not
Pred Fr	12	15
Not	8	965

true

	Fr	Not
Pred Fr	20	980
Not	0	0

true

	Fr	Not
Pred Fr	0	0
Not	20	980
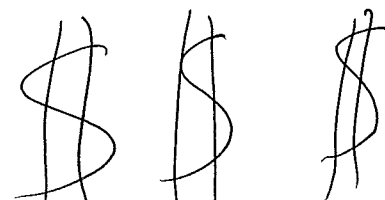
true

	Fr	Not
Pred Fr	15	115
Not	5	865

true

	Fr	Not
Pred Fr	18	250
Not	2	730

Now... which model is better?
(crickets... maybe model X?)

New question: which of these results would the business owner be interested in?
(accuracy? precision? recall? F_1?)
confusion matrices?

Answer: None of them. He wants:

$ $ $

money money money

Let's create costs & benefits of each outcome.
We'll put these in the shape of a confusion
matrix to match what we already have.

Cost-benefit Matrix:

benefit T.P.	cost. F.P.
cost F.N.	benefit T.N.

For our bank, we look at history + ~~present~~
personnel costs:

Cost-benefit Matrix:

-5	-5
-1000	0

Let's now calculate the "expected profit" of each of
our original 5 models:

$$profit = -8.135 \qquad profit = -5.0 \qquad profit = -20.0$$

$$profit = -5.650 \qquad \boxed{profit = -3.340} \leftarrow winner!$$

Other examples:

- Sending mail (direct mail marketing)

- predicting cancer

- betting ~~at~~ ~~the~~ ~~casino~~ on football   (the booky keeps the 'juice', so getting $>50\%$ isn't enough)

- predicting spam — how much would a user prefer to see a spam email vs miss a legit one?