BIG DIVE

TECH. CUSTOM EDITION

A project by TOP-IX
designed for Intesa Sanpaolo

#DataScience

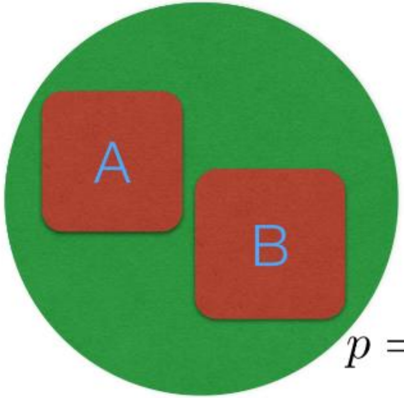
aizoon® AUSTRALIA EUROPE USA
TECHNOLOGY CONSULTING

Recap

- Data-analytic thinking
- Data quality
- Descriptive statistics
- Correlation & causation
- Bias
- Regression
- Comparison between groups

Probability –basic concepts

$$P(A) = \text{Area of A}$$



$$p = 1$$

$$P(A \ or \ B) = P(A) + P(B)$$

Probability –basic concepts

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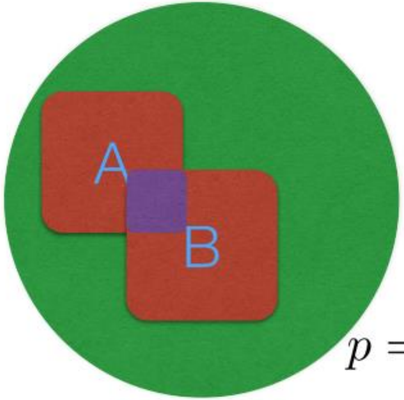
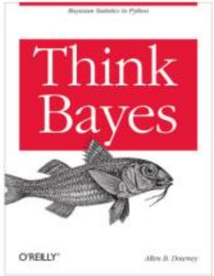


$$p = 1$$

$$P(B|A) = \frac{P(A \; and \; B)}{P(A)}$$

$$P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}$$

Bayes Theorem



$$P(A \; or \; B) = P(A) + P(B) - P(A \; and \; B)$$

$$P(A \; and \; B) = \text{overlap of A and B}$$

Screening test

Your doctor thinks you might have a rare disease that affects **1 person in 10,000**. A test that is **99%** accurate comes out positive. What's the probability of you having the disease?

Bayes Theorem:

$$P\left(disease|positive\ test\right)=\frac{P\left(positive\ test|disease\right)P\left(disease\right)}{P\left(positive\ test\right)}$$

Total probability

$$\begin{aligned}P\left(positive\ test\right)&=P\left(positive\ test|disease\right)P\left(disease\right)\\&+P\left(positive\ test|no\ disease\right)P\left(no\ disease\right)\end{aligned}$$

Finally:

$$P\left(disease|positive\ test\right)\boxed{=0.0098}$$

Screening test

Consider a population of 1,000,000 individuals. The numbers we should expect in the **contingency matrix** are:

	disease	no disease	Marginals
positive	99	9,999	10,098
negative	1	989,901	989,902
Marginals	100	999,900	1,000,000

$$P\left(disease|positive\ test\right) = \frac{TP}{TP+FP} = 0.0098$$

$$P\left(no\ disease|negative\ test\right) = \frac{TN}{TN+FN} = 0.99999$$

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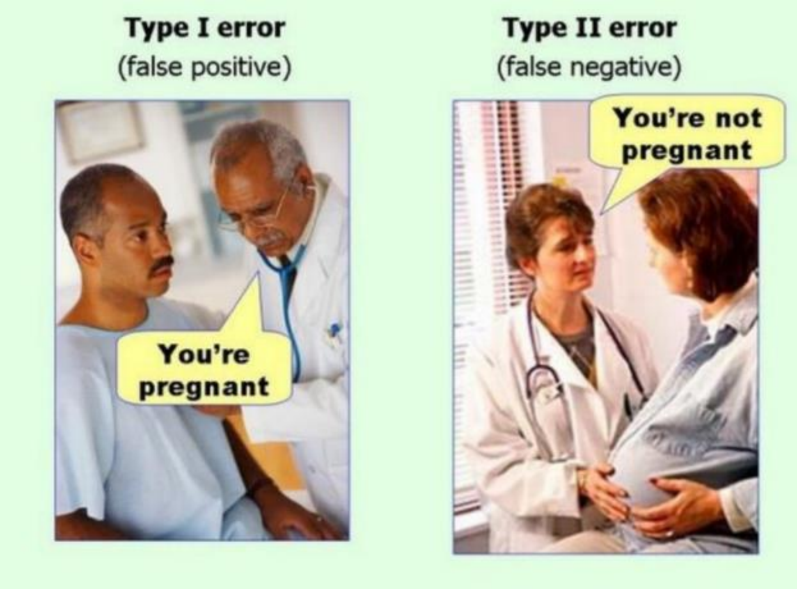


Consider a second screening

Bayes Theorem still looks the same: $P\left(disease|positive\ test\right)=\dfrac{P\left(positive\ test|disease\right)P\left(disease\right)}{P\left(positive\ test\right)}$

but now the probability that we have the disease has been updated: $P^{\dagger}\left(disease\right)=0.0098$

So this time we find: $P^{\dagger}\left(disease|positive\ test\right)=0.4949$

Each test is providing **new evidence**, and Bayes theorem is simply telling us how to use it to **update our beliefs**.

Confusion Matrix

Test \ Feature	positive	negative
positive	TP	FP
negative	FN	TN

$$accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$specificity = \frac{TN}{FP + TN}$$

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

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

harmonic mean

$$F1 = \frac{2TP}{2TP + FP + FN}$$

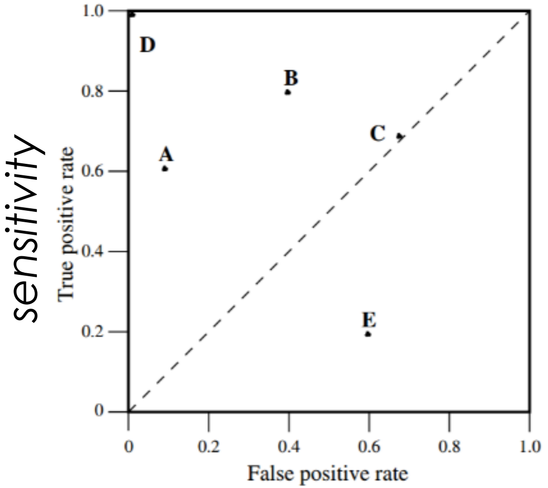
Confusion Matrix – ROC curve

Feature / Test	positive	negative
positive	TP	FP
negative	FN	TN

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

$$specificity = \frac{TN}{FP + TN}$$

Every dot is a model



1- specificity

Confusion Matrix – ROC curve

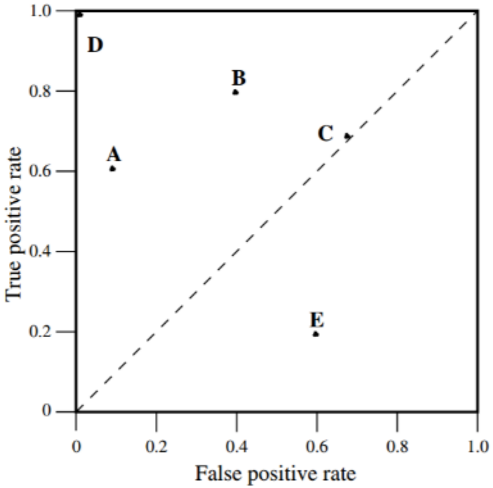
Feature \ Test	positive	negative
positive	TP	FP
negative	FN	TN

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

$$specificity = \frac{TN}{FP + TN}$$

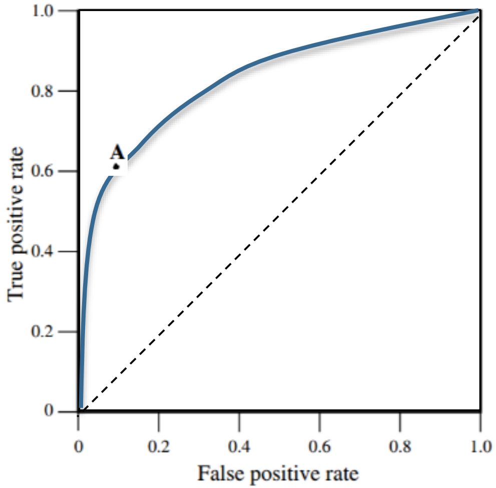
Every dot is a model

sensitivity



1- specificity

Model A performance



Confusion Matrix – ROC curve

Test \ Feature	positive	negative
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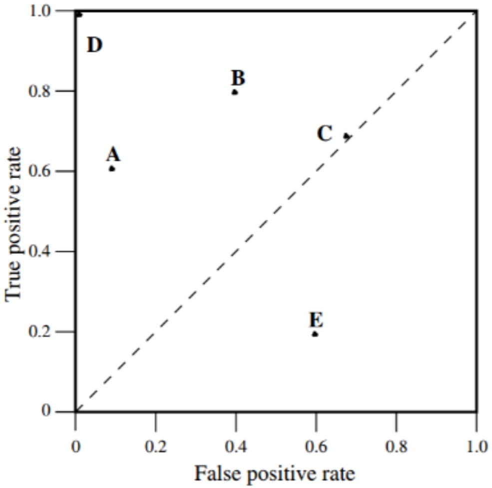
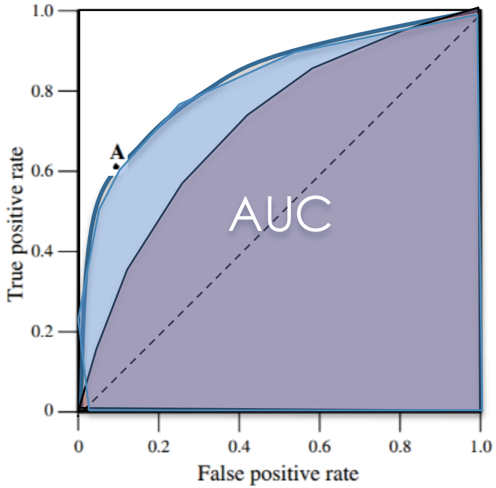
Every dot is a model

sensitivity



1- specificity

Model A performance



ELSEVIER

Pattern Recognition Letters

www.elsevier.com/locate/patrec

An introduction to ROC analysis

Tom Fawcett

Institute for the Study of Learning and Expertise, 2164 Staunton Court, Palo Alto, CA 94306, USA

Available online 19 December 2005

Q & A

Cosa NON abbiamo trattato

- Regressioni (per predizioni) → Modulo Machine Learning
- Riduzione dimensionalità (PCA, ICA…)
- Analisi di serie storiche
- Analisi di sopravvivenza
- Network Bayesiani
- …..