Types of errors

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Basic terms

In general, Positive = identified and negative = rejected. Therefore:

True positive = correctly identified

False positive = incorrectly identified

True negative = correctly rejected

False negative = incorrectly rejected

Medical testing example:

True positive = Sick people correctly diagnosed as sick

False positive= Healthy people incorrectly identified as sick

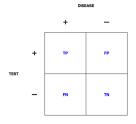
True negative = Healthy people correctly identified as healthy

False negative = Sick people incorrectly identified as healthy.

http:

//en.wikipedia.org/wiki/Sensitivity_and_specificity

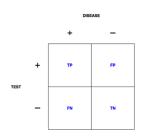
Key quantities



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 \begin{array}{lll} \textbf{Sensitivity} & \rightarrow & \textbf{Pr (positive test} \mid \textbf{disease} \,) \\ \textbf{Specificity} & \rightarrow & \textbf{Pr (negative test} \mid \textbf{no disease} \,) \\ \textbf{Positive Predictive Value} & \rightarrow & \textbf{Pr (disease} \mid \textbf{positive test} \,) \\ \textbf{Negative Predictive Value} & \rightarrow & \textbf{Pr (no disease} \mid \textbf{negative test} \,) \\ \textbf{Accuracy} & \rightarrow & \textbf{Pr (correct outcome)} \end{array}
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http:
//en.wikipedia.org/wiki/Sensitivity_and_specificity
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Key quantities as fractions



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\begin{array}{lll} & \text{Sensitivity} & \to & \text{TP / (TP+FN)} \\ & \text{Specificity} & \to & \text{TN / (FP+TN)} \\ & \text{Positive Predictive Value} & \to & \text{TP / (TP+FP)} \\ & \text{Negative Predictive Value} & \to & \text{TN / (FN+TN)} \\ & \text{Accuracy} & \to & \text{(TP+TN) / (TP+FP+FN+TN)} \end{array}
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//www.biostat.jhsph.edu/~iruczins/teaching/140.615/

http:

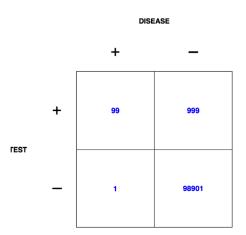
Screening tests

Assume that some disease has a 0.1% prevalence in the population. Assume we have a test kit for that disease that works with 99% sensitivity and 99% specificity. What is the probability of a person having the disease given the test result is positive, if we randomly select a subject from

- the general population?
- a high risk sub-population with 10% disease prevalence?

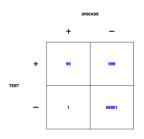
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General population



http:

General population as fractions



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      Sensitivity
      \rightarrow 99 / (99+1) = 99%

      Specificity
      \rightarrow 98901 / (999+98901) = 99%

      Positive Predictive Value
      \rightarrow 99 / (99+999) \approx 9%

      Negative Predictive Value
      \rightarrow 98901 / (1+98901) > 99.9%

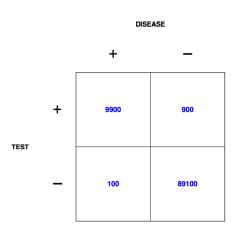
      Accuracy
      \rightarrow (99+98901) / 100000 = 99%
```

//www.biostat.jhsph.edu/~iruczins/teaching/140.615/



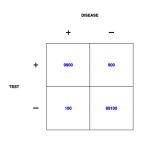
http:

At risk subpopulation



http:

At risk subpopulation as fraction



```
\begin{array}{lll} & \text{Sensitivity} & \to 9900 \: / \: (9900 + 100) = 99\% \\ & \text{Specificity} & \to 89100 \: / \: (900 + 89100) = 99\% \\ & \text{Positive Predictive Value} & \to 9900 \: / \: (9900 + 900) \approx 92\% \\ & \text{Negative Predictive Value} & \to 89100 \: / \: (100 + 89100) \approx 99.9\% \\ & \text{Accuracy} & \to & (9900 + 89100) \: / \: 100000 = 99\% \end{array}
```

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http:

Key public health issue

Vast Study Casts Doubts on Value of Mammograms

By GINA KOLATA FEB. 11, 2014



One of the largest and most meticulous studies of mammography ever done, involving 90,000 women and lasting a quarter-century, has added powerful new doubts about the value of the screening test for women of any age.



It found that the death rates from breast cancer and from all causes were the same in women who got mammograms and those who did not. And the screening had harms: One in five cancers found with mammography and treated was not a threat to the woman's health and did not need treatment such as chemotherapy, surgery or radiation.

 $\underline{\text{The study}}$, published Tuesday in The British Medical Journal, is one of the few rigorous



Nearly 75 percent of American women 40 and over say they had a mammogram in the past year, Damian Dovarganes/Associated Press

http:

Key public health issue



For continuous data

Mean squared error (MSE):

$$\frac{1}{n}\sum_{i=1}^{n}(Prediction_{i}-Truth_{i})^{2}$$

Root mean squared error (RMSE):

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Prediction_{i}-Truth_{i})^{2}}$$

Common error measures

- 1. Mean squared error (or root mean squared error)
- Continuous data, sensitive to outliers
- 2. Median absolute deviation
- Continuous data, often more robust
- 3. Sensitivity (recall)
- If you want few missed positives
- 4. Specificity
- If you want few negatives called positives
- Accuracy
- ▶ Weights false positives/negatives equally
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