See Syllabus

Credit Card Screening

Good Credit Card to be Good: "False Positive"
Good Credit Card to be Bad: "False Negative"

2 kinds of errors:

\[
\begin{aligned}
B &= \text{card really is good} \\
\bar{B} &= \text{card really is bad}
\end{aligned}
\]

\[
\begin{aligned}
G &= \text{system says good} \\
\bar{G} &= \text{system says bad}
\end{aligned}
\]

\[
\begin{aligned}
\Theta &= \text{system says bad} \\
\Theta^{c} &= \text{system says good}
\end{aligned}
\]

\[
\begin{aligned}
1\% \text{ prevalence} &= P(B) \\
99\% &= P(\Theta^{c} | G)
\end{aligned}
\]

Sensitivity, truth

\[
\begin{array}{c|c|c}
\text{Truth} & \text{G} & \text{B} \\
\hline
\Theta & 0.98 & 0.02 \\
\Theta^{c} & 0.02 & 0.98
\end{array}
\]

\[
\begin{aligned}
\text{specificity} &= P(\Theta^{c} | \Theta) \\
&= 0.995
\end{aligned}
\]

\[
\begin{aligned}
\text{sensitivity} &= P(G | \Theta) \\
&= 0.98
\end{aligned}
\]

\[
\begin{aligned}
\text{false positive rate} &= P(\Theta | G) = 0.02 \\
\text{false negative rate} &= P(\bar{G} | \Theta) = 0.02
\end{aligned}
\]

\[
\begin{aligned}
P(\Theta | B) &= \frac{P(\Theta; B)}{P(B)} = \frac{0.02}{0.02} = 0.02 \\
\text{is the card bad?} \quad \text{[Statistical Inference]} \\
\text{should we deny the transaction?} \quad \text{[Medical Decision Making]}
\end{aligned}
\]

When system says no bank suffers small loss (low)
but not really bad

\[
\begin{aligned}
P\left(\bigcup_{i=1}^{n} A_{i}\right) &= \sum_{i=1}^{n} P(A_{i}) - \sum_{i,j} P(A_{i} \cap A_{j}) + \sum_{i,j,k} P(A_{i} \cap A_{j} \cap A_{k}) - \ldots \quad + (-1)^{n+1} P(A_{1} \cap \ldots \cap A_{n})
\end{aligned}
\]

Simulation-based approximate probabilities

\[
\begin{aligned}
&\text{Button needle} (4.94) \\
&\text{Burglar alarm} (9.03)
\end{aligned}
\]

\[
\text{John von Neumann algorithm for generating}
\]

**Fact**: All possibilities are conditional, conditional on assumptions

\[
P(H) = \sum_{\text{possibly relevant}} P(H | \text{possibly relevant})
\]

\[
P(A \land \ldots \land A_{n}) = \prod_{i=1}^{n} P(A_{i})
\]

\[
P(A_{1} \land \ldots \land A_{n}) = \prod_{i=1}^{n} P(A_{i}) + (-1)^{n+1} P(A_{1} \land \ldots \land A_{n})
\]

\[
P(A_{1} | B_{1}) + P(A_{1} | B_{2}) + P(A_{1} | B_{3}) + \ldots
\]

\[
P(A_{1} | B_{1}) + P(A_{1} | B_{2}) + P(A_{1} | B_{3}) + \ldots + P(A_{1} | B_{n})
\]

\[
\text{LT:}
\]