ECS 132, Spring 2024, Midterm 2 Topics

1. Conditional probability
   - The basics from the Midterm 1 Topics still apply.
   - The additional aspect we introduced was to consider events A_1, A_2, A_3 which are mutually exclusive and exhaustive. Normalization means that:

     $$P(A_1|B) + P(A_2|B) + P(A_3|B) = 1$$

   - Applications: HW5 #1

2. Common parametric distributions for a discrete random variable
   - Bernoulli; $X \sim Bern(p)$
   - Binomial; $X \sim Binom(n, p)$
   - Geometric; $X \sim Geom(p)$
   - Geometric*; $X \sim Geom^*(p)$
   - Poisson; $X \sim Pois(\lambda)$
     - $P(X = k) = \frac{e^{-\lambda}\lambda^k}{k!}$
     - λ is the expected number of events in the time window of interest
     - Superposition of two Poisson processes
   - Know PMF, CDF, E(X) and Var(X) for all the above distributions
   - R functions (e.g., dbinom, pbinom, dpois, ppois, etc.)
   - Applications
     - Coupon Collector problem
     - HW4 #2, 3, 4 on Poisson processes; HW5 #2.3

3. Boxplots and quantiles
   - Median (50th quantile), 25th quantile, 75th quantile
   - Whiskers and outliers
   - Application: HW4 #5

4. Continuous random variable, Y

   - PDF: $f_Y(x)$ needs to satisfy two criteria:

     (a) $f_Y(x) \geq 0$ for all x

     (b) $\int_{-\infty}^{\infty} f_Y(x)dx = 1$

   - CDF: $F_Y(k) = P(Y \leq k) = \int_{-\infty}^{k} f_Y(x)dx$
   - $E(Y) = \int_{-\infty}^{\infty} x f_Y(x)dx$
   - $Var(Y) = E(Y^2) - \left(E(Y)^2\right)$
   - Applications: HW5 #2

5. Common parametric distributions for a discrete random variable

   - Uniform: $Y \sim unif(a, b)$
   - Exponential: $Y \sim Expo(\lambda)$ (λ is the expected number of events per unit time)
   - Normal/Gaussian: $Y \sim N(\mu, \sigma^2)$
   - Standard normal: $Z \sim N(0, 1)$ and $\Phi(z)$ tables
     - If $Y \sim N(\mu, \sigma^2)$ then $\frac{Y-\mu}{\sigma} \sim N(0, 1)$
   - Know PDF, CDF, E(Y) and Var(Y) for all the above distributions
   - Applications: HW5 #3, 4

6. Definitions of sensitivity and specificity

   - Sensitivity, $\eta = P(T = 1|D = 1)$, True Positive Rate
   - Specificity, $\theta = P(T = 0|D = 0)$, True Negative Rate
   - Applications: HW5 #5