CS544 Module4

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Module4

- Data Distributions
    - Discrete
    - Continuous

Prereq Course (CS546)

- Topics from CS546
  - **Module 4**
    - Lecture 4 - Independent events, discrete random variables, binomial distribution, and the approximation of the binomial distribution.
  - **Module 5**
    - Lecture 5 - Geometric distribution, the math expectation and the variance of a random variable, independent random variables, strong law of large numbers, and the properties of distribution functions.
  - **Module 6**
    - Lecture 6 - Continuous distribution functions, density functions, the math expectation, and the variance of a continuous random variable, standard deviation, normal distribution, and the central limit theorem.

Discrete Distributions

- Discrete Random Variables
  - Support
  - Probability Mass Function (PMF)
    - $f_X(x)\ \ i.e.\ P(X = x)$
  - Mean or Expected Value, variance, standard deviation
  - Cumulative Distribution Function (CDF)
    - $F_X(x)\ \ i.e.\ P(X \leq x)$

Bernoulli Trials

- Binomial coefficients

$$\binom{n}{x} = \frac{n!}{x!(n-x)!}$$

- Bernoulli Trials
  - Random experiment with two possible outcomes
  - Probability of success, p
  - Probability of failure, 1-p
  - Review PMF, mean, and variance
  - Repeated trials
    - The trials are independent,
    - Each trial has two possible outcomes (success and failure)
    - The probability of success remains the same from trial to trial.

Binomial Distribution

- Probability distribution for
  - the number of successes in a sequence of Bernoulli trials.
- Two parameters
  - n, the number of trials
  - p, the probability of success
- Review PMF, mean, and variance
- R – dbinom, pbinom, qbinom, rbinom

The 4 Functions

- **d**<name>(x, …) $f_X(x)\ \ i.e.\ P(X = x)$
  - Probability Density function
- **p**<name> (x, …) $F_X(x)\ \ i.e.\ P(X \leq x)$
  - Cumulative Distribution function
- **q**<name>(p, …) smallest x such that $F_X(x) \geq p$
  - Quantile function
- **r**<name>(n, …)
  - **n** random values from the distribution

Hypergeometric Distribution

- Outcomes dependent on previous outcomes
- Sample data selected without replacement
- Three parameters
  - M, # of events of interest
  - N, # of events not of interest
  - K, the sample size without replacement
- Review PMF, mean, and variance
- R – dhyper, phyper, qhyper, rhyper

Geometric Distribution

- # of failures before a success in a sequence of Bernoulli trials
- One parameter
  - p, probability of success

- Review PMF, mean, and variance
- R – dgeom, pgeom, qgeom, rgeom

Negative Binomial Distribution

- # of failures until a total or "*r*" successes in a sequence of Bernoulli trials
- Two parameters
  - p, probability of success
  - r, the total number of successes

- Review PMF, mean, and variance
- R – dnbinom, pnbinom, qnbinom, rnbinom

Poisson Distribution

- Model the frequency with which a specified event occurs during a particular period of time
- One parameter
  - λ, average number of events per unit of time [0,1]

- Review PMF, mean, and variance
- R – dpois, ppois, qpois, rpois

Discrete Uniform Distribution

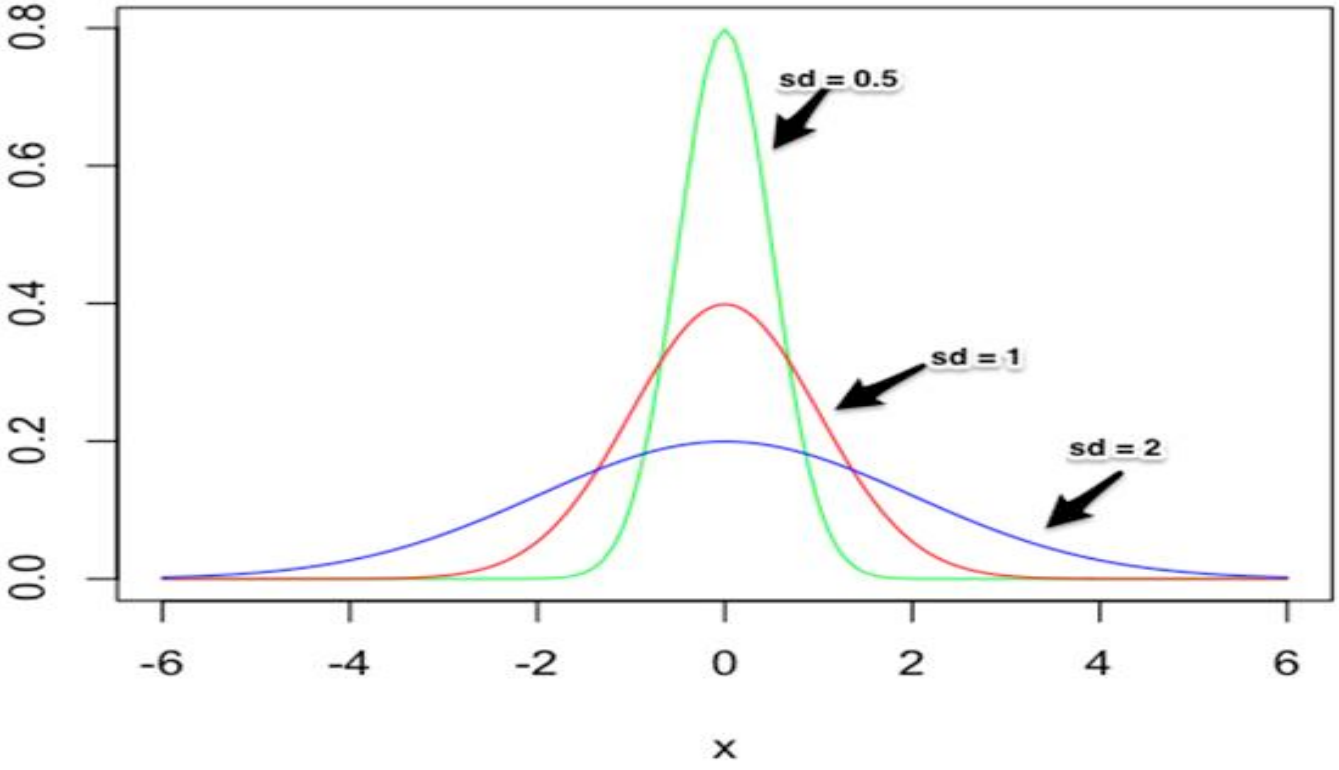
- Each value is equally likely
- Review PMF, CDF, mean, and variance
- R – dunif, punif, qunif, runif
- sample() function
  - sample(x, size, replace = FALSE, prob = NULL)

Continuous Distributions

- Continuous uniform distribution
  - Two parameters (min and max)
  - Review PDF and CDF
- R functions
  - dunif, punif, qunif, runif

Normal Distribution

- Determined by the mean (μ) and standard deviation (σ)
- R functions (dnorm, pnorm, qnorm, rnorm)



Exponential Distribution

- Waiting times, time between arrivals, etc.
- One parameter
  - – λ, mean number of arrivals per unit of time
- R functions
  - – dexp, pexp, qexp, rexp

Project Review

- **Picking the Data Set**

  Look into the following sites as an example and select a data set that interests you.

  - https://www.kaggle.com/datasets
  - http://www.kdnuggets.com/datasets/index.html
  - Any other source of your choice