Stats for Data Science

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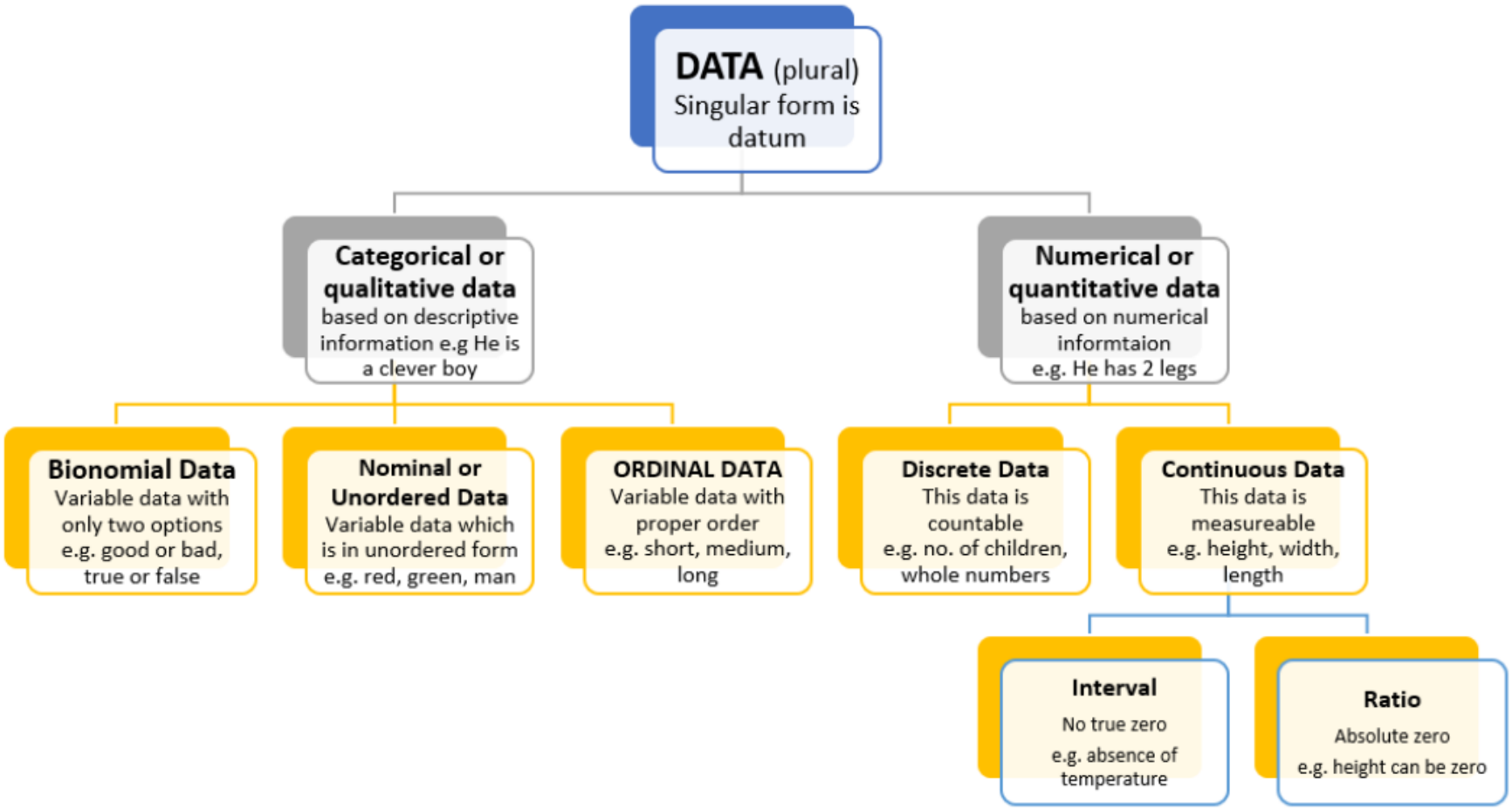
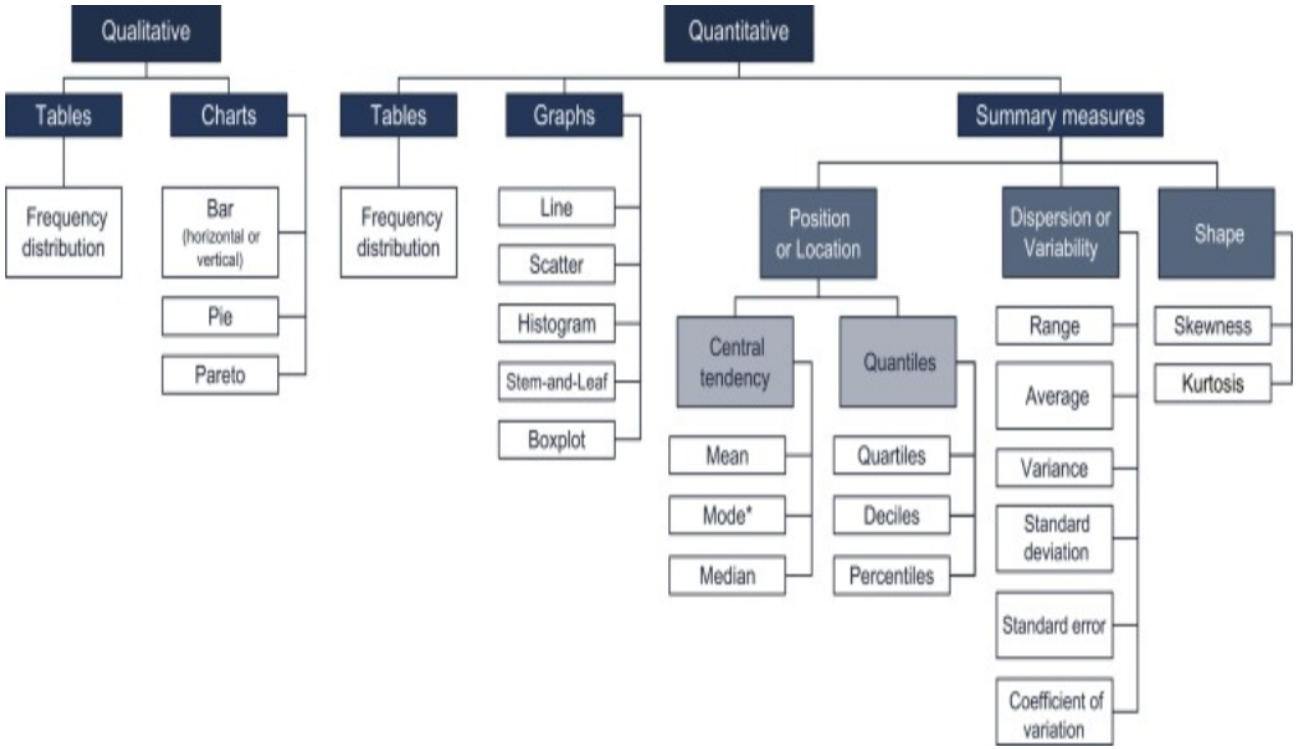
Initial Terminologies



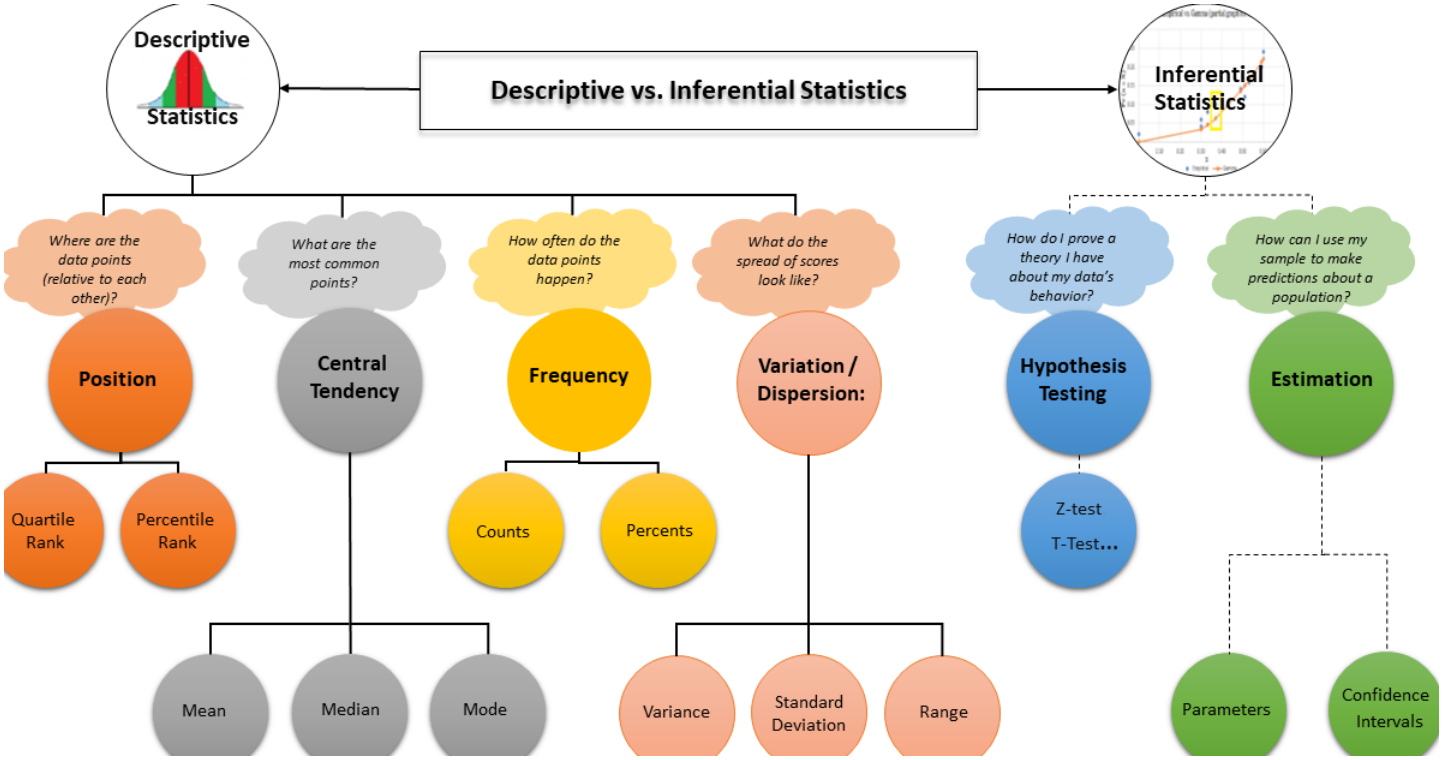
Types of Analysis

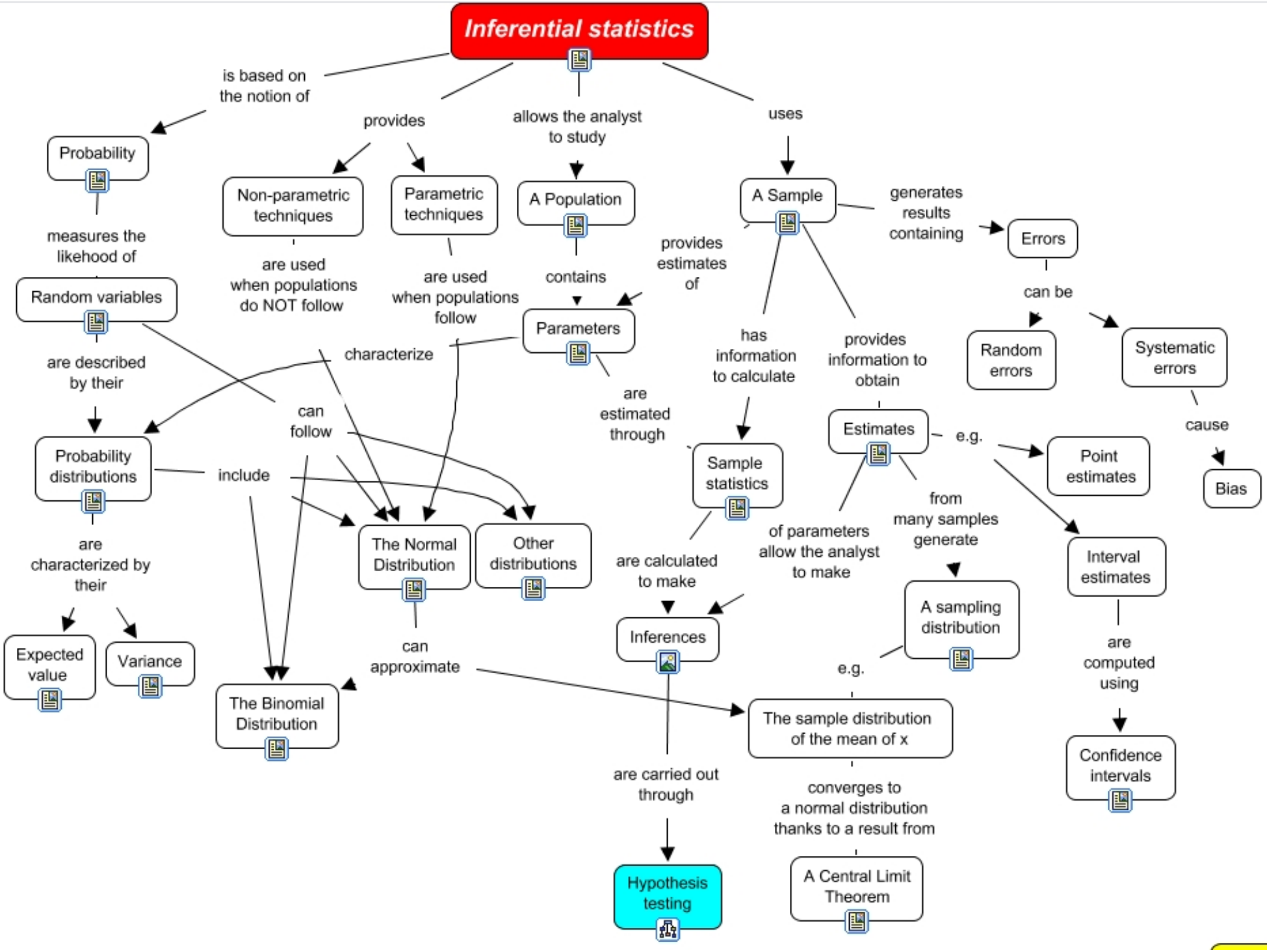
- Qualitative Analysis/Non-Statistical Analysis gives generic information (uses text, sound and other forms of media).
- Quantitative Analysis/Statistical Analysis: collecting and interpreting data.



Types of Statistics

- Descriptive Statistics: provides descriptions of the population.
- Inferential Statistics makes inferences and predictions from sample to generalize a population.




Inferential statistics
is based on the notion of
provides
allows the analyst to study
uses
Probability
measures the likehood of
Random variables
are described by their
Probability distributions
are characterized by their
Expected value
Variance
Non-parametric techniques
are used when populations do NOT follow
Parametric techniques
are used when populations follow
A Population
contains
Parameters
characterize
are estimated through
provides estimates of
A Sample
generates results containing
Errors
can be
Random errors
Systematic errors
cause
Bias
has information to calculate
provides information to obtain
Sample statistics
Estimates
e.g.
Point estimates
Interval estimates
are computed using
Confidence intervals
can follow
include
The Normal Distribution
Other distributions
The Binomial Distribution
can approximate
are calculated to make
of parameters allow the analyst to make
Inferences
from many samples generate
A sampling distribution
e.g.
The sample distribution of the mean of x
converges to a normal distribution thanks to a result from
A Central Limit Theorem
are carried out through
Hypothesis testing

Contingency Table and Probabilities

Joint, Marginal and Conditional

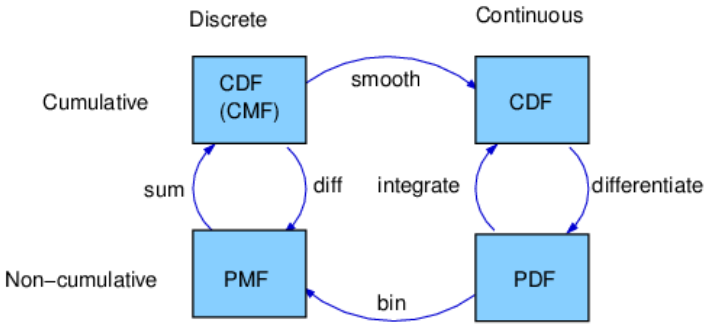
- Joint probabilities for rain and wind:

	no wind	some wind	strong wind	storm
no rain	0.1	0.2	0.05	0.01
light rain	0.05	0.1	0.15	0.04
heavy rain	0.05	0.1	0.1	0.05

- Marginalize to get simple probabilities:
  - $P(\text{no wind}) = 0.1 + 0.05 + 0.05 = 0.2$
  - $P(\text{light rain}) = 0.05 + 0.1 + 0.15 + 0.04 = 0.34$
- Combine to get conditional probabilities:
  - $P(\text{no wind}|\text{light rain}) = \frac{0.05}{0.34} = 0.147$
  - $P(\text{light rain}|\text{no wind}) = \frac{0.05}{0.2} = 0.25$

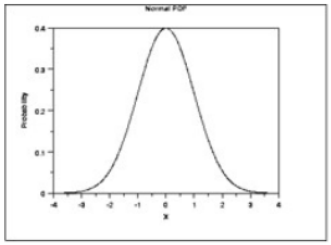
PMF, CMF, PDF, CDF

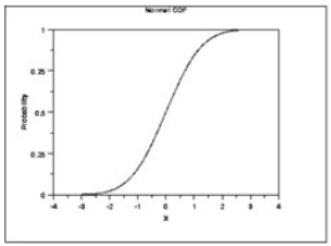
- A PMF, "f" returns the probability of an outcome: $f(x) = P(X = x)$

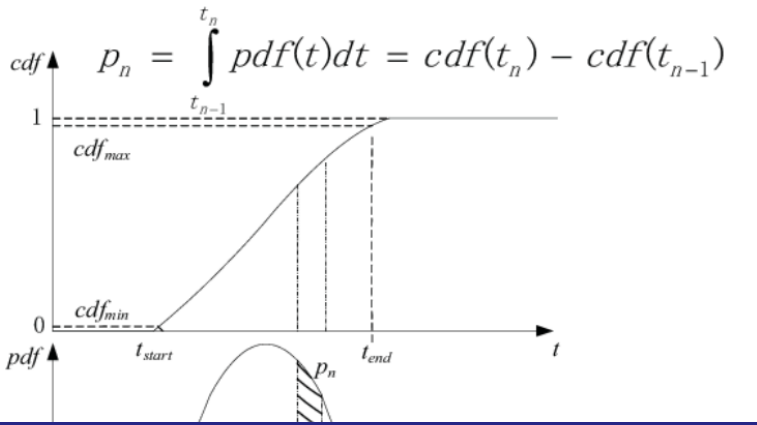


- Reliability function & Hazard Function

- Probability density function (p.d.f.) denote f
- Probability mass function (p.m.f.) denote f
  f(x)=P(X=x)
- Cumulative distribution function (c.d.f.) denote F
  F(x)=P(X≤x)

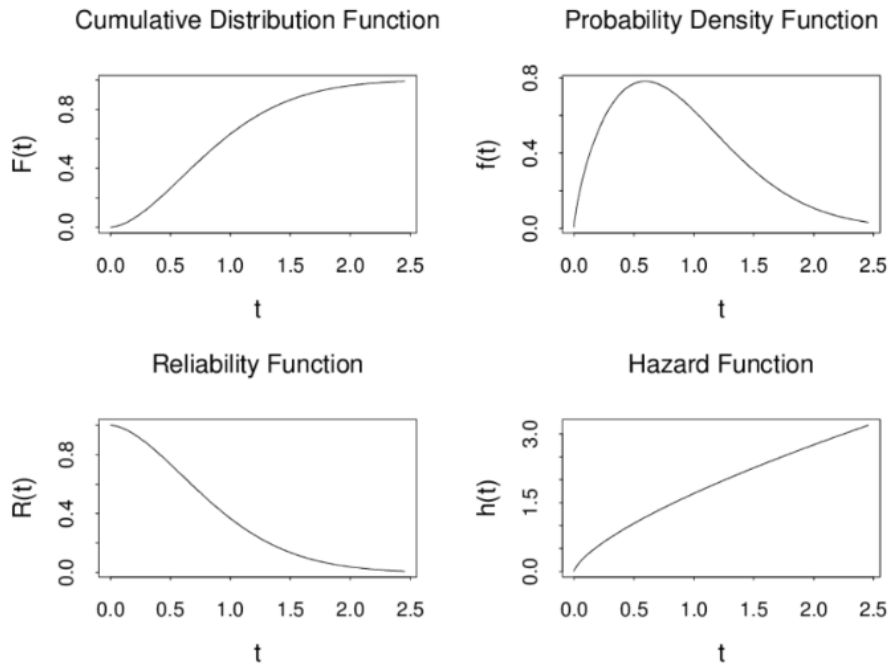


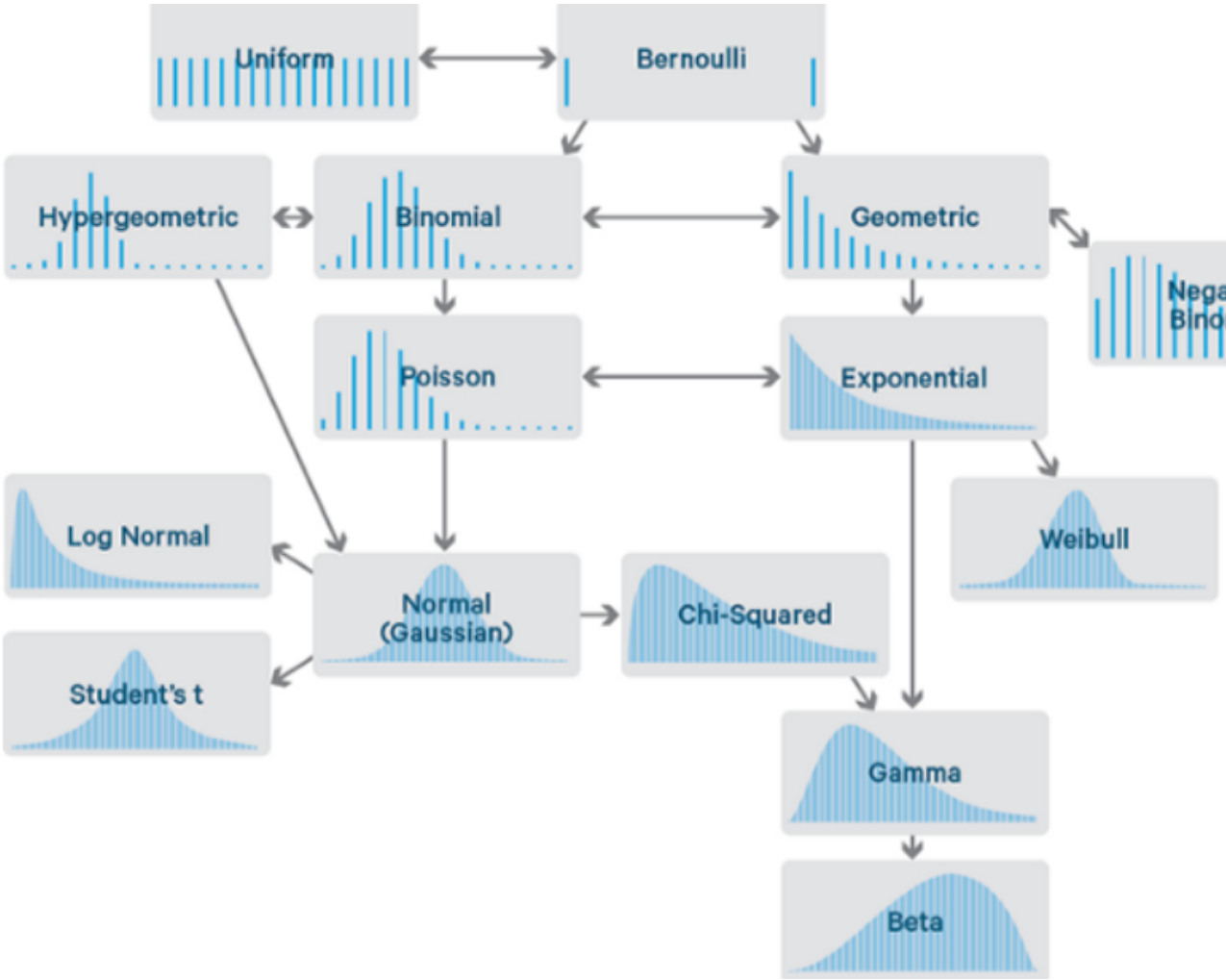




PMF, CMF, PDF, CDF

- Reliability function & Hazard Function





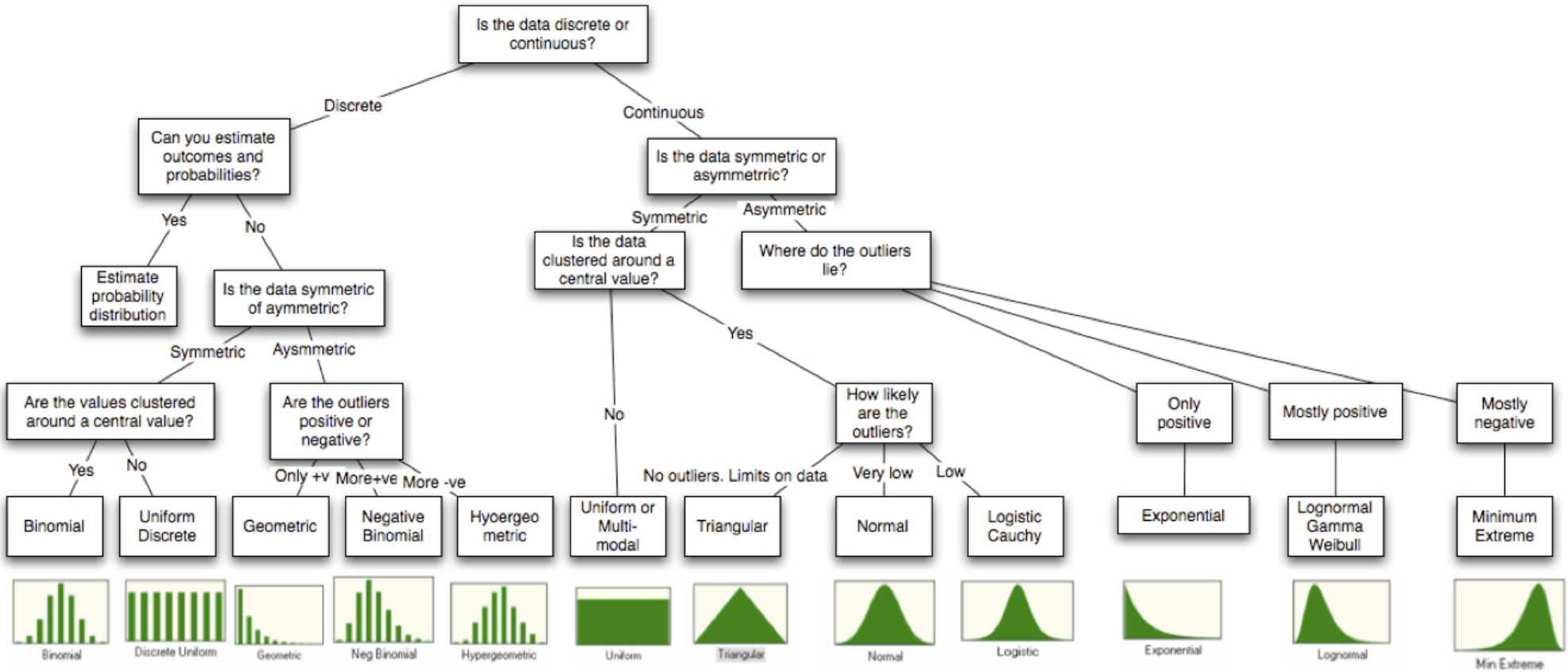
Discrete

1. Uniform Discrete or Rectangular
2. Binomial
3. Hypergeometric
4. Poisson
5. Geometric

Continuous

1. Uniform
2. Normal/Gaussian
3. Student's T
4. chi-squared
5. Exponential
6. Beta
7. Triangular
8. Gamma

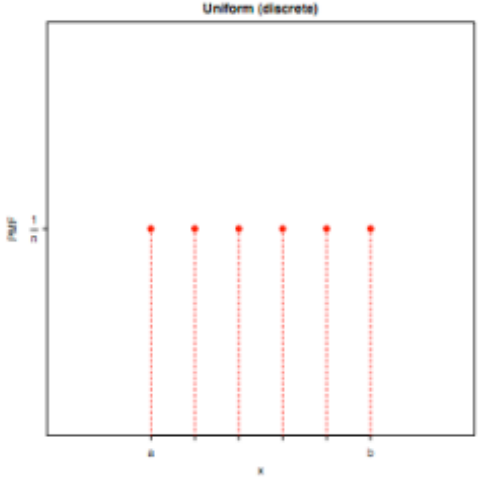
Figure 6A.15: Distributional Choices

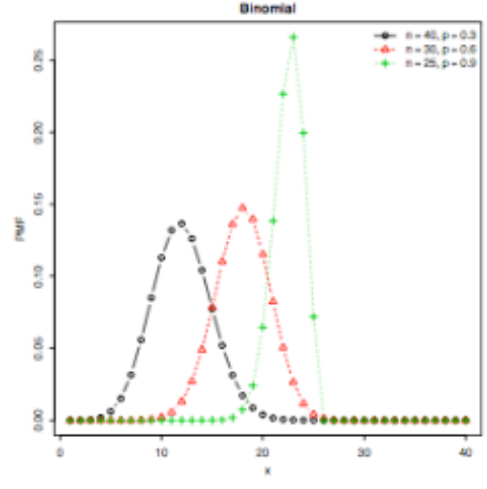


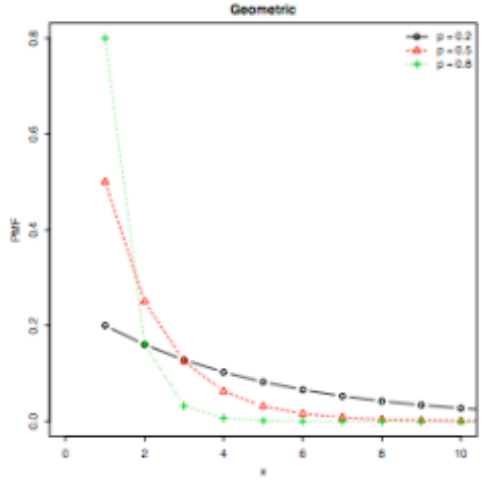
1.1 Discrete Distributions

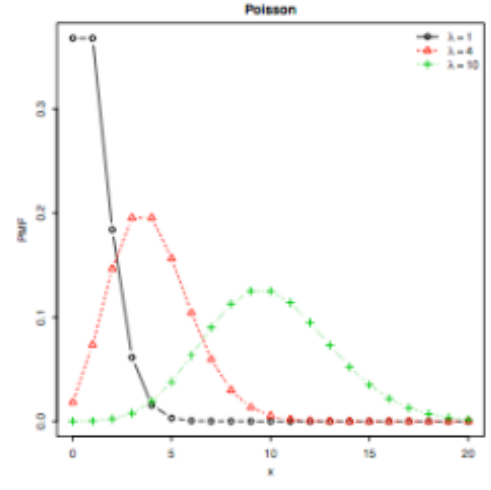
CDF/CMF PMF Expected Val of RV Var of RV

	Notation[1]	$F_X(x)$	$f_X(x)$	$\mathbb{E}[X]$	$\mathbb{V}[X]$	$M_X(s)$
Uniform	$\text{Unif}\{a,\dots,b\}$	$\begin{cases} 0 & x<a \\ \frac{\lfloor x\rfloor-a+1}{b-a} & a\le x\le b \\ 1 & x>b \end{cases}$	$\frac{I(a<x<b)}{b-a+1}$	$\frac{a+b}{2}$	$\frac{(b-a+1)^2-1}{12}$	$\frac{e^{as}-e^{-(b+1)s}}{s(b-a)}$
Bernoulli	$\text{Bern}(p)$	$(1-p)^{1-x}$	$p^x(1-p)^{1-x}$	p	$p(1-p)$	$1-p+pe^s$
Binomial	$\text{Bin}(n,p)$	$I_{1-p}(n-x,x+1)$	$\binom{n}{x}p^x(1-p)^{n-x}$	np	$np(1-p)$	$(1-p+pe^s)^n$
Multinomial	$\text{Mult}(n,p)$		$\frac{n!}{x_1!\dots x_k!}p_1^{x_1}\cdots p_k^{x_k}\quad \sum_{i=1}^k x_i=n$	np_i	$np_i(1-p_i)$	$\left(\sum_{i=0}^k p_i e^{s_i}\right)^n$
Hypergeometric	$\text{Hyp}(N,m,n)$	$\approx\Phi\left(\frac{x-np}{\sqrt{np(1-p)}}\right)$	$\frac{\binom{m}{x}\binom{m-x}{n-x}}{\binom{N}{x}}$	$\frac{nm}{N}$	$\frac{nm(N-n)(N-m)}{N^2(N-1)}$	
Negative Binomial	$\text{NBin}(n,p)$	$I_p(r,x+1)$	$\binom{x+r-1}{r-1}p^r(1-p)^x$	$r\frac{1-p}{p}$	$r\frac{1-p}{p^2}$	$\left(\frac{p}{1-(1-p)e^s}\right)^r$
Geometric	$\text{Geo}(p)$	$1-(1-p)^x\quad x\in\mathbb{N}^+$	$p(1-p)^{x-1}\quad x\in\mathbb{N}^+$	$\frac{1}{p}$	$\frac{1-p}{p^2}$	$\frac{p}{1-(1-p)e^s}$
Poisson	$\text{Po}(\lambda)$	$e^{-\lambda}\sum_{i=0}^x\frac{\lambda^i}{i!}$	$\frac{\lambda^x e^{-\lambda}}{x!}$	λ	λ	$e^{\lambda(e^s-1)}$





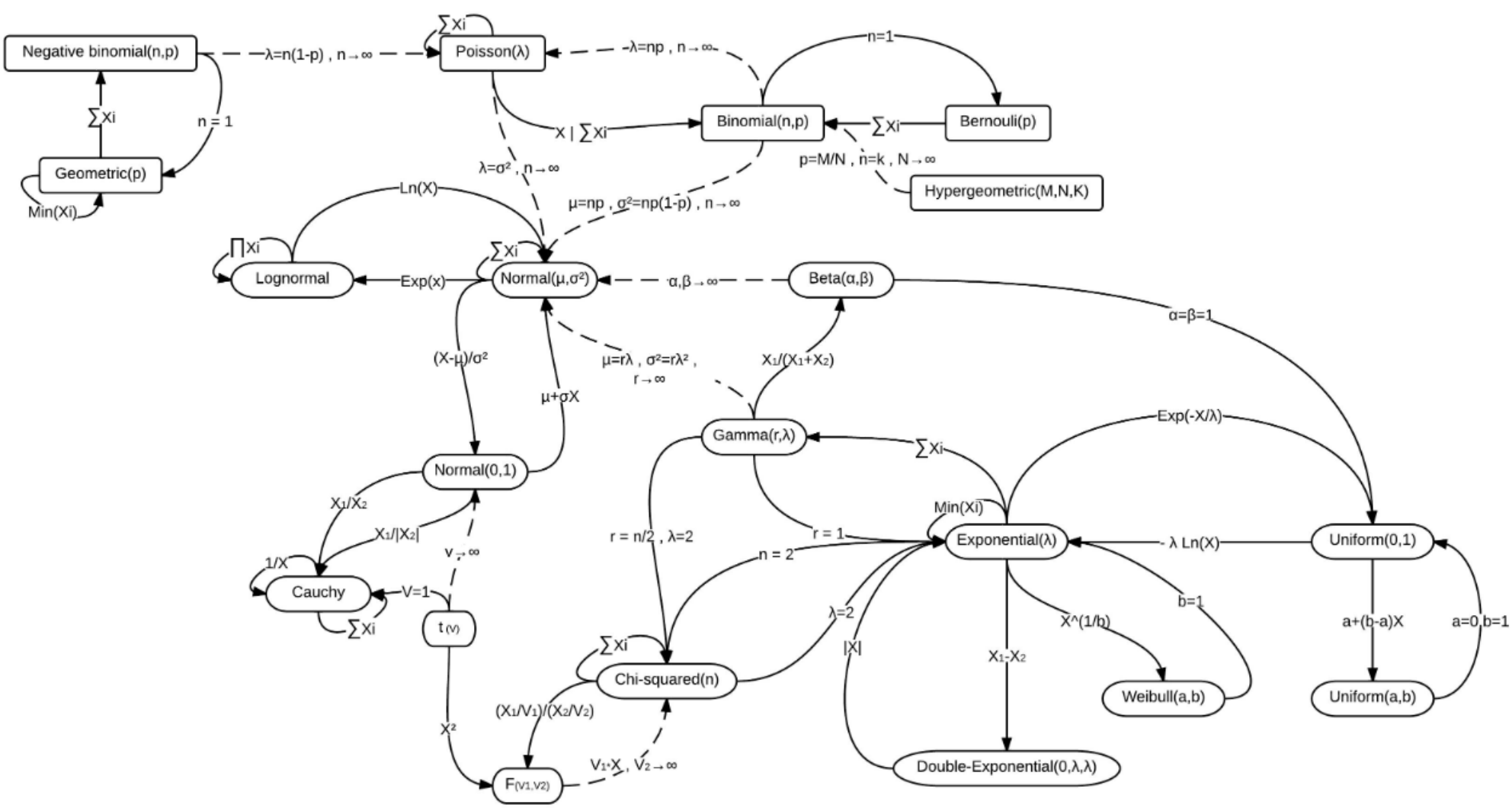




1.2 Continuous Distributions

	Notation	$F_X(x)$	$f_X(x)$	$\mathbb{E}[X]$	$\mathbb{V}[X]$	$M_X(s)$
Uniform	$\text{Unif}(a,b)$	$\begin{cases} 0 & x<a \\ \frac{x-a}{b-a} & a<x<b \\ 1 & x>b \end{cases}$	$\frac{I(a<x<b)}{b-a}$	$\frac{a+b}{2}$	$\frac{(b-a)^2}{12}$	$\frac{e^{sb}-e^{sa}}{s(b-a)}$
Normal	$\mathcal{N}(\mu,\sigma^2)$	$\Phi(x)=\int_{-\infty}^{x}\phi(t)\,dt$	$\phi(x)=\frac{1}{\sigma\sqrt{2\pi}}\exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\}$	μ	σ^2	$\exp\left\{\mu s+\frac{\sigma^2 s^2}{2}\right\}$
Log-Normal	$\ln\mathcal{N}(\mu,\sigma^2)$	$\frac{1}{2}+\frac{1}{2}\,\text{erf}\left[\frac{\ln x-\mu}{\sqrt{2\sigma^2}}\right]$	$\frac{1}{x\sqrt{2\pi\sigma^2}}\exp\left\{-\frac{(\ln x-\mu)^2}{2\sigma^2}\right\}$	$e^{\mu+\sigma^2/2}$	$(e^{\sigma^2}-1)e^{2\mu+\sigma^2}$	
Multivariate Normal	$\text{MVN}(\mu,\Sigma)$		$(2\pi)^{-k/2}\lvert\Sigma\rvert^{-1/2}e^{-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)}$	μ	Σ	$\exp\left\{\mu^T s+\frac{1}{2}s^T\Sigma s\right\}$
Student's t	$\text{Student}(\nu)$	$I_x\left(\frac{\nu}{2},\frac{\nu}{2}\right)$	$\frac{\Gamma\left(\frac{\nu+1}{2}\right)}{\sqrt{\nu\pi}\Gamma\left(\frac{\nu}{2}\right)}\left(1+\frac{x^2}{\nu}\right)^{-(\nu+1)/2}$	0	0	
Chi-square	χ^2_k	$\frac{1}{\Gamma(k/2)}\gamma\left(\frac{k}{2},\frac{x}{2}\right)$	$\frac{1}{2^{k/2}\Gamma(k/2)}x^{k/2}e^{-x/2}$	k	$2k$	$(1-2s)^{-k/2}\ s<1/2$
F	$\text{F}(d_1,d_2)$	$I_{\frac{d_1 x}{d_1 x+d_2}}\left(\frac{d_1}{2},\frac{d_1}{2}\right)$	$\frac{\sqrt{\frac{(d_1x)^{d_1}d_2^{d_2}}{(d_1x+d_2)^{d_1+d_2}}}}{x\text{B}\left(\frac{d_1}{2},\frac{d_1}{2}\right)}$	$\frac{d_2}{d_2-2}$	$\frac{2d_2^2(d_1+d_2-2)}{d_1(d_2-2)^2(d_2-4)}$	
Exponential	$\text{Exp}(\beta)$	$1-e^{-x/\beta}$	$\frac{1}{\beta}e^{-x/\beta}$	β	β^2	$\frac{1}{1-\beta s}\ (s<1/\beta)$
Gamma	$\text{Gamma}(\alpha,\beta)$	$\frac{\gamma(\alpha,x/\beta)}{\Gamma(\alpha)}$	$\frac{1}{\Gamma(\alpha)\beta^\alpha}x^{\alpha-1}e^{-x/\beta}$	$\alpha\beta$	$\alpha\beta^2$	$\left(\frac{1}{1-\beta s}\right)^\alpha\ (s<1/\beta)$
Inverse Gamma	$\text{InvGamma}(\alpha,\beta)$	$\frac{\Gamma\left(\alpha,\frac{\beta}{x}\right)}{\Gamma(\alpha)}$	$\frac{\beta^\alpha}{\Gamma(\alpha)}x^{-\alpha-1}e^{-\beta/x}$	$\frac{\beta}{\alpha-1}\ \alpha>1$	$\frac{\beta^2}{(\alpha-1)^2(\alpha-2)^2}\ \alpha>2$	$\frac{2(-\beta s)^{\alpha/2}}{\Gamma(\alpha)}K_\alpha\left(\sqrt{-4\beta s}\right)$
Dirichlet	$\text{Dir}(\alpha)$		$\frac{\Gamma\left(\sum_{i=1}^k\alpha_i\right)}{\prod_{i=1}^k\Gamma(\alpha_i)}\prod_{i=1}^k x_i^{\alpha_i-1}$	$\frac{\alpha_i}{\sum_{i=1}^k\alpha_i}$	$\frac{\mathbb{E}[X_i](1-\mathbb{E}[X_i])}{\sum_{i=1}^k\alpha_i+1}$	
Beta	$\text{Beta}(\alpha,\beta)$	$I_x(\alpha,\beta)$	$\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}x^{\alpha-1}(1-x)^{\beta-1}$	$\frac{\alpha}{\alpha+\beta}$	$\frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$	$1+\sum_{k=1}^{\infty}\left(\prod_{r=0}^{k-1}\frac{\alpha+r}{\alpha+\beta+r}\right)\frac{s^k}{k!}$

Types of Distributions



relation btw various dist

Bernoulli and Binomial: Bernoulli Distribution is a special case of Binomial Distribution with a single trial.

Poisson and Binomial: Poisson Distribution is a limiting case of binomial distribution under the following conditions:
The number of trials is indefinitely large or $\lim_{x \to \infty}$. The probability of success for each trial is same and indefinitely small or $\lim_{x \to 0}$. $np = \lambda$, is finite.

Normal and Binomial: Normal distribution is another limiting form of binomial distribution under the following conditions:
The number of trials is indefinitely large, $\lim_{n \to \infty}$. Both p and q are not indefinitely small. **Normal and Poisson Distribution**: The normal distribution is also a limiting case of Poisson distribution with the parameter $\lim_{\lambda \to \infty}$.

Beta ad Binomial

Prior and Posterior

1. Conjugate prior for binomial $x|p\ Bin(n,p); p\ Beta(a,b)[prior]$
   $f(p|X=k) = usebayes$
   $replacewithbetaabdbin$
   $p|X\ Beta(a+X, b+n-x)$

Poisson event per unit time
how many calls do you get in a day
The number of printing errors at each page of the book
Num of metro arrivals in t time
The number of arrivals reported in an area on a day.
The number of soldiers killed by horse-kick per year
Air conditioners in a lifetime

exponential time per event
What about the interval of time btw the calls
Num of pages before until x num of printing errors
Length of time btw metro arrivals,
Length of time between arrivals at a gas station
Num of years btw horse-kick deaths in the army
The life of an Air Conditioner

Standard Uniform Density

parameters a = 0 and b = 1, so the PDF for standard uniform density is given by:

$$f(x) = \begin{cases} 1, & 0 <= x <= 1 \\ 0, & \textit{otherwise} \end{cases} \tag{1}$$

Normal Distribution

Standard Normal Distribution $\mu = 0$; $\sigma = 1$

The 68-95-99.7 rule: Given a normally distributed random variable: $P(\mu - \sigma \leq X \leq \mu + \sigma) \approx .68$ =>68% of samples fall within 1 SD of the mean

$P(\mu - 2\sigma \leq X \leq \mu + 2\sigma) \approx .95$

$P(\mu - 3\sigma \leq X \leq \mu + 3\sigma) \approx .997$

characteristics of Normal distribution:

1. Mean = median = mode
2. The distribution curve is bell-shaped and symmetrical about the line x=μ.
3. The total AUC = 1.
4. Exactly half of the values are to the left of the center and the other half to the right.

Student's t distribution

characteristics

1. Underlying dist is Normal
2. Pop dist is unknown
3. sample size is too small for CLT to apply

$z \sim \frac{\bar{x}-\mu}{\sigma/\sqrt{n}} \longleftrightarrow t_{n-1} \sim \frac{\bar{x}-\mu}{s/\sqrt{n}}$ **t test measures**

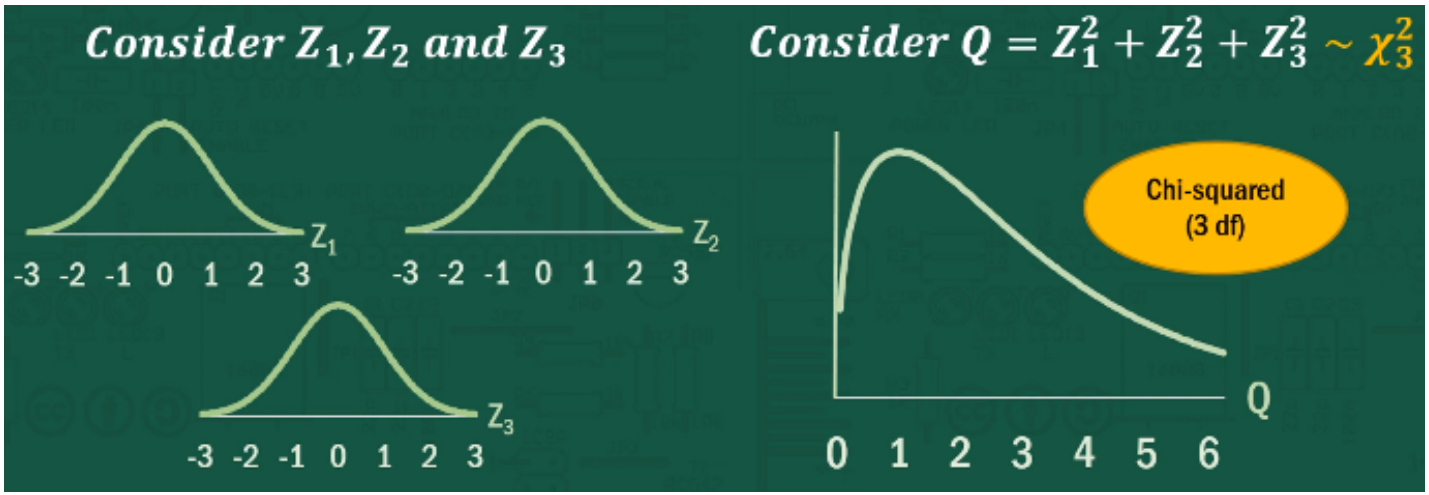
1. to test hypothesized population mean $\frac{\bar{x}-\mu}{s/\sqrt{n}}$
2. regression $\frac{b-\beta}{SE(b)}$ (uses Std error, as pop std dev is known)
3. 2 sampled t-test: assessing the diff btw 2 pop $\frac{(\bar{x_1}-\mu_1)-(\bar{x_2}-\mu_2)}{\sqrt{\frac{s_1^2}{\sqrt{n_1}}+\frac{s_1^2}{\sqrt{n_1}}}}$

Chi-squared dist

comes directly from a normal dist (square of selection from standard Normal Distribution) so sample size should be large enough (>5) s.t. CLT applies

for k degrees of freedom: $\chi^2_k = \sum_{i=1}^{k} Z_i^2$

$\chi = \sum \frac{(obs-exp)^2}{exp}$ with DF = (row-1)(col-1)



Binomial, bernoulli, hyper-geometric

Repeat Bernoulli n times and it's Binomial.
Hypergeometric is Binomial without replacement
the properties of a Binomial Distribution are

1. Each trial is independent.
2. There are only two possible outcomes per trial.
3. A total number of n identical trials are conducted.
4. The probability of success and failure is same for all trials. (Trials are identical.)

Hypergeometric

1. Discrete
2. equivalent to Binomial, without replacement
3. N = total population
   m=total items of interest in population
   n=sample size
4. region bounded by 0 and m

Characteristics of Poisson distribution:

1. Event are not Independent.
2.

Poisson

1. Discrete
2. events in fixed region of opportunity (or time interval, t)
3. region bounded by 0 and ∞

Characteristics of Poisson distribution:

1. Independent event.
2. The probability of success over a short interval must equal the probability of success over a longer interval.
3. The probability of success in an interval approaches zero as the interval becomes smaller.
4. The rate at which event occurs is constant (λ)

Poisson RV, X = number of events in t.

mean number of events in t, $\mu = \lambda$*t

The PMF of X: $P(X = x) = e^{-\mu} * \frac{\mu^x}{x!}$

Exponential Dist

inverse of Poisson: rate parameter or mean for poisson $= \lambda$ and mean for expo $= \beta = 1/\lambda$
Exponential distribution is widely used for survival analysis.
Memoryless-ness:
events must occur at constant rate
events must be independent of each other
probab of event occurring in first min = probab of the event occuring in (t+1)min
probab of first visitor on website in first min = p
probab of first visitor on website in second min = (1-p)p
probab of first visitor on website within third min = $(1\text{-}p)^2p$
Each minute graph dropping $\rightarrow$ exponential decay

Memorylessness

Memoryless property: $P(X >= s+t|X >= s) = P(X >= t)$

$P(X >= s) = 1 - CDF = 1 - P(X <= s) = e^{-\lambda s}$

$P(X >= s+t|X >= s) = \frac{P(X>=s+t, X>=s)}{P(X>=s)}$

$P(X >= s+t|X >= s) = \frac{P(X>=s+t)}{P(X>=s)}$

$P(X >= s+t|X >= s) = \frac{e^{-\lambda(s+t)}}{e^{-\lambda s}}$

$P(X >= s+t|X >= s) = e^{-\lambda t}$

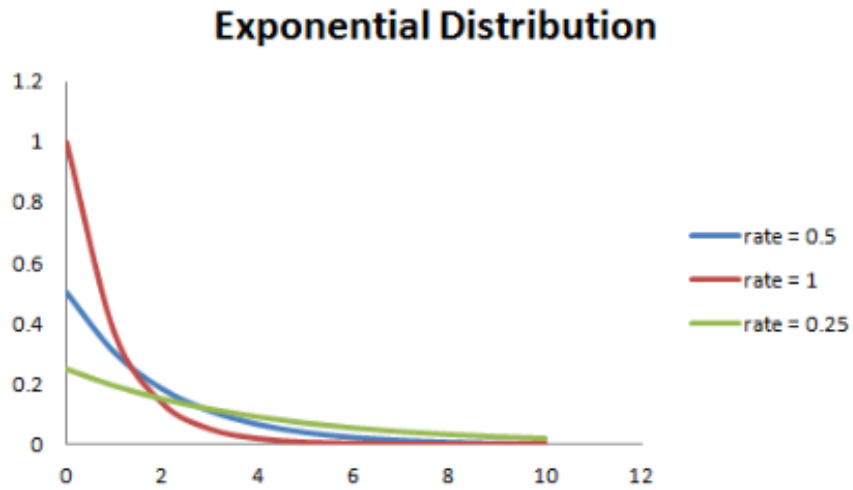
Memoryless property:

$E(X|X > a) = a + E(X - a|X > a)$

$E(X|X > a) = a + 1/\lambda$

failure rate of any device at time t, given that it has survived up to t; $\lambda = \frac{1}{\beta} > 0$

area under the density curve



to the left of x $P\{X \leq x\} = 1 - e^{-\lambda x}$

to the right of x $P\{X > x\} = e^{-\lambda x}$

$P\{x1 < X \leq x2\} = e^{-\lambda x1} - e^{-\lambda x2}$

- Variable and Random Variable (RV)
- Parameter and Hyper-parameter
- Mean, Median, Mode
- mode sucks for small samples
- Range, IQR
- Standard Deviation (σ): Measure of the how spread out data is from its mean.
- Variance (σ^2): It describes how much a random variable differs from its expected value. It entails computing squares of deviations.The average of the squared differences from the Mean.
    1. Deviation is the difference bw each element from the mean.
    2. Population Variance = avg of squared deviations
    3. Sample Variance = avg of squared differences from the mean

EXPECTED VALUE

Discrete random variable $E(X) = \sum_x x\, p_x(x)$

- Provided $\sum_x |x|\, p_x(x) < \infty$. If the sum diverges, the expected value does not exist. **For the jar full of numbered balls**
- A ball is selected at random; all balls are equally likely to be chosen $P(X = x_i) = \frac{1}{N}$.
- Say n_1 balls have value v_1, and n_2 balls have value v_2, and $\ldots n_n$ balls have value v_n. Unique values are v_i, for $i = 1, \ldots, n$. Note $n_1 + \cdots + n_n = N$, and $P(X = v_j) = \frac{n_j}{N}$. $E(X) = \frac{\sum_{i=1}^{N} x_i}{N}$

Continuous random variable $E(X) = \int_{-\infty}^{\infty} x\, f_x(x)\, dx$

- Provided $\int_{-\infty}^{\infty} |x|\, f_x(x)\, dx < \infty$. If the integral diverges, the expected value does not exist.

Sometimes the expected value does not exist

Need $\int_{-\infty}^{\infty} |x|\, f_x(x)\, dx < \infty$

For the Cauchy distribution, $f(x) = \frac{1}{\pi(1+x^2)}$.

$$
\begin{aligned}
E(|X|) &= \int_{-\infty}^{\infty} |x| \frac{1}{\pi(1+x^2)}\, dx \\
&= 2\int_{0}^{\infty} \frac{x}{\pi(1+x^2)}\, dx \\
&\quad u = 1+x^2,\ du = 2x\, dx \\
&= \frac{1}{\pi}\int_{1}^{\infty} \frac{1}{u}\, du \\
&= \ln u|_1^{\infty} \\
&= \infty - 0 = \infty
\end{aligned}
$$

$=>$ an integral "equals" infinity, it is unbounded above.

For a RV X with PDF $\rho(x)$. The variance($\mathbb{V}$) and the standard deviation(σ_X) of X, are defined by
Variance $\sigma^2 = (1/n)\sum_{i=1}^{n}(x_i - \mu)^2$

$$\mathbb{V} = \mathbb{E}\left[(X - \mathbb{E}[X])^2\right] = \mathbb{E}[X^2] - \mathbb{E}[X]^2 = \int_D (x - \mathbb{E})^2 \, dP.$$

$$\mathbb{V} = \int_D x^2 \, dP - \mathbb{E}^2.$$

$$\sigma_X = \sqrt{V[X]} \qquad = \sqrt{E[X^2] - E[X]^2}$$

$$\mathbb{V} = \sqrt{\int_D x^2 \rho(x) \, dx - \left(\int_D x\rho(x) \, dx\right)^2}.$$

If one interprets the PDF ($\rho(x)$) as the density of a rod at location (x), then:
The mean, ($\mu = \int x\rho(x)\,dx$), gives the center of mass of the rod.
The variance, ($V = \int (x-\mu)^2\rho(x)\,dx$), gives the moment of inertia about the line ($x = \mu$).
The standard deviation, ($\sigma = \sqrt{V}$), gives the radius of gyration about the line ($x = \mu$).

Std error vs std deviation

$$\text{std error} =$$

coeff of variation

$CV = \frac{sd}{\bar{x}}, where \bar{x} = samplemean$
$x = [1, 2, 3] => \bar{x} = 2$ and $S_x = 1 => CV(x) = 1/2$
$y = [101, 102, 103] => \bar{y} = 102$ and $S_y = 1 => CV(y) = 1/102$
Higher the CV means higher fluctuations in the dataset

skewness and kurtosis

skewness

mode skewness $= \frac{mean - mode}{stddev}$

in skewed data: mode = 3(median) - 2(mean)

for small dataset, use below:

median skewness $= \frac{3(mean - median)}{stddev}$

$$skewness = \begin{cases} approx\_symmetric, & -0.5 <= x <= 0.5 \\ moderately\_skewed, & 0.5 < |x| < 1 \\ highly\_skewed, & |x| > 1 \end{cases} \quad (2)$$

kurtosis: same mean or sd but diff peakedness

higher peaked => higher kurtosis

Moments

I moment: $\frac{\sum x}{n} => $ **mean** $=>$ considered as values from 0

second moment: $\frac{\sum x^2}{n} =>$values further from 0 will be higher,
so instead we take centralized
second (centralized) moment: $\frac{\sum (x-\mu)^2}{n} =>$ variance

third (centralized) moment: $\frac{1}{n}\frac{\sum (x-\mu)^3}{\sigma^3} - >$ skew
but since we don't have population mean, we have sample mean,
we adjust the above value with degrees of freedom

II (centralized) moment: $\frac{\sum (x-\bar{x})^2}{n-1} =>$ **variance**

III (centralized) moment: $\frac{n}{(n-1)(n-2)}\frac{\sum (x-\bar{x})^3}{s^3} =>$ **skew**

IV moment: $\frac{n(n+1)}{(n-1)(n-2)(n-3)}\frac{\sum (x-\bar{x})^4}{s^4} - \frac{3(n-1)^2}{(n-2)(n-3)} =>$ **kurtosis**

Central Limit Theorem(CLT)

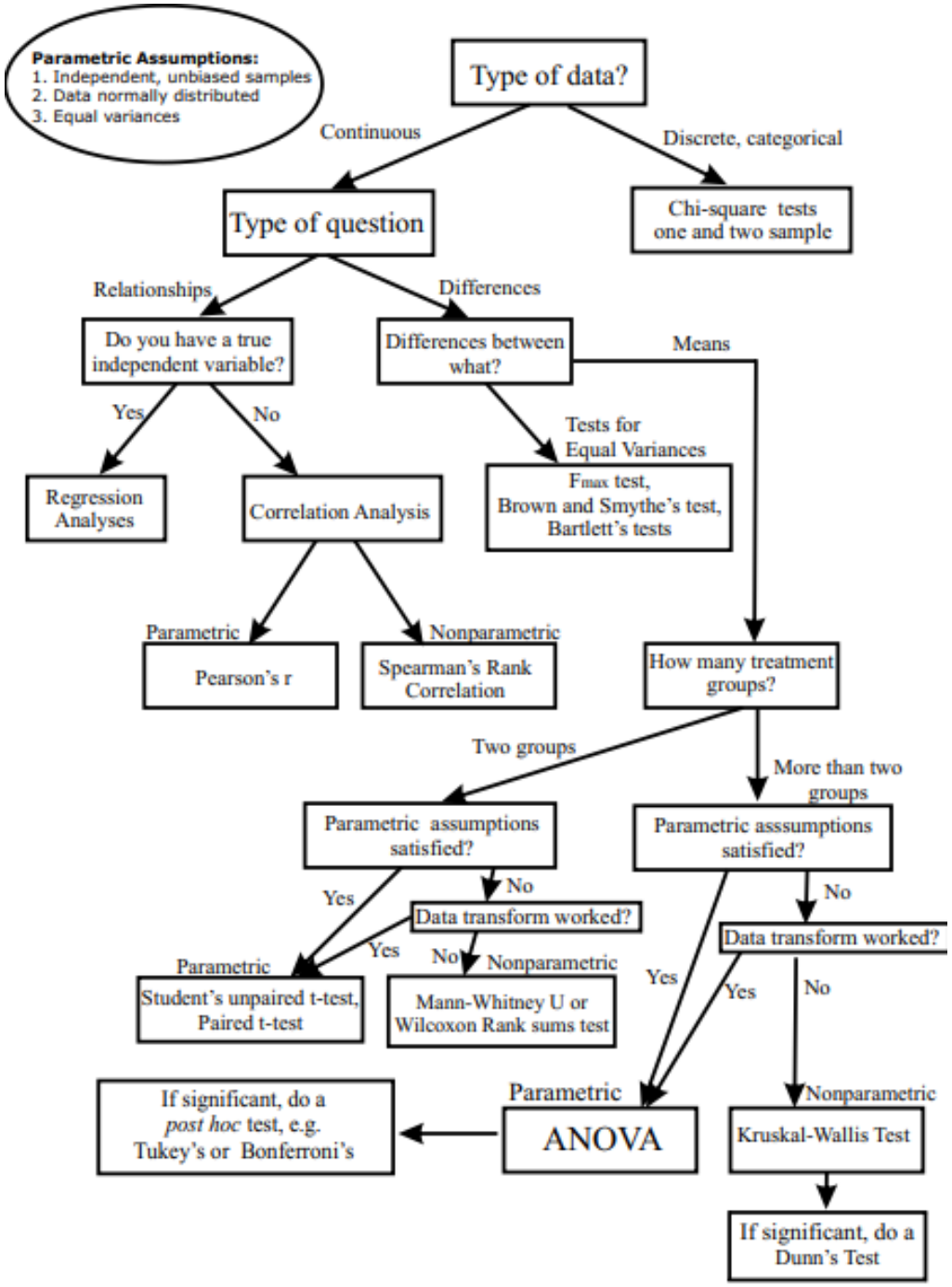
CLT: as n $\uparrow$, the distribution of sample mean or sum approaches a Normal Dist

Law of large num

law of averages

p_value

p-value is the probab of getting a sample as extreme as ours, given H_0 is true
when population std dev is known then we use z-statistics, if unknown then we use t-statistics
t-statistics assumes that underlying distribution is normal
t-distribution is bell curved, defined by it's DF (degrees of freedom)



1. $H_0 : \mu = 100$; $H_1 : \mu \neq 100$
2. if H_0 is true, how extreme is our sample?
3. Measure of extremeness, $z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$
4. $\uparrow$ z value, more likely to reject H_0
5. either reject H_0 or do not reject H_0 because there's less evidence to reject it (given α level of significance)

		CONDITION determined by "Gold Standard"			
	TOTAL POPULATION	CONDITION POS	CONDITION NEG	PREVALENCE CONDITION POS / TOTAL POPULATION	
TEST OUT-COME	TEST POS	True Pos TP	*Type I Error* False Pos FP	*Precision* Pos Predictive Value PPV = TP / TEST P	False Discovery Rate FDR = FP / TEST P
	TEST NEG	*Type II Error* False Neg FN	True Neg TN	False Omission Rate FOR = FN / TEST N	Neg Predictive Value NPV = TN / TEST N
	ACCURACY ACC ACC = (TP + TN) / TOT POP	*Sensitivity (SN), Recall* Total Pos Rate TPR TPR = TP / CONDITION POS	*Fall-Out* False Pos Rate FPR FPR = FP / CONDITION NEG	Pos Likelihood Ratio LR + LR + = TPR / FPR	Diagnostic Odds Ratio DOR DOR = LR + / LR -
		Miss Rate False Neg Rate FNR FNR = FN / CONDITION POS	*Specificity (SPC)* True Neg Rate TNR TNR = TN / CONDITION NEG	Neg Likelihood Ratio LR - LR - = TNR / FNR	

Type I Error: Reject H_0 when H_0 is true

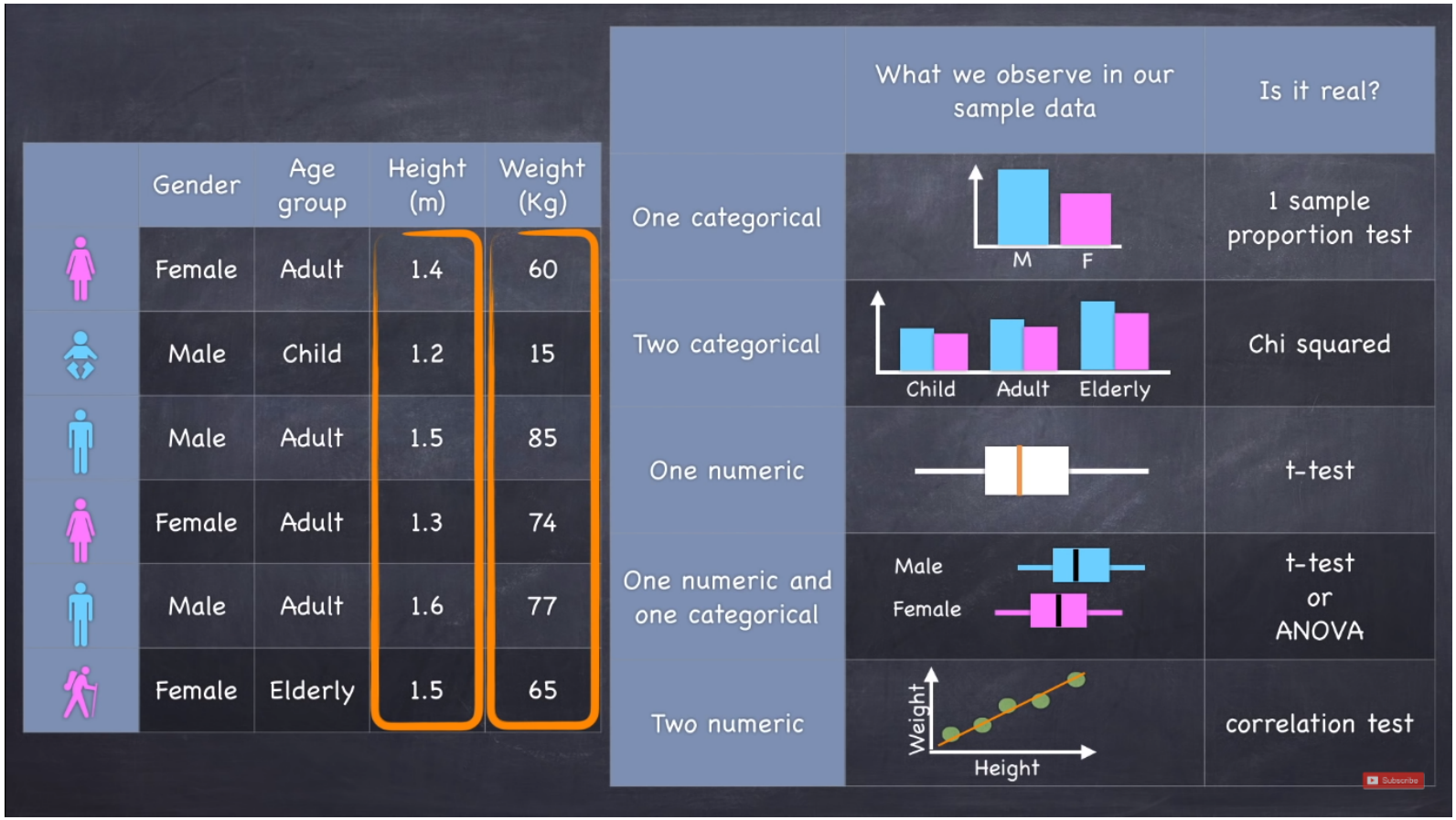
Prob of Type I Error $=$ level of significance $= \alpha$ 5% (generally)

Type II error: Not reject H_0 when H_0 is false

Prob of Type II Error $= \beta$ and power of hypothesis test $=$ 1-β

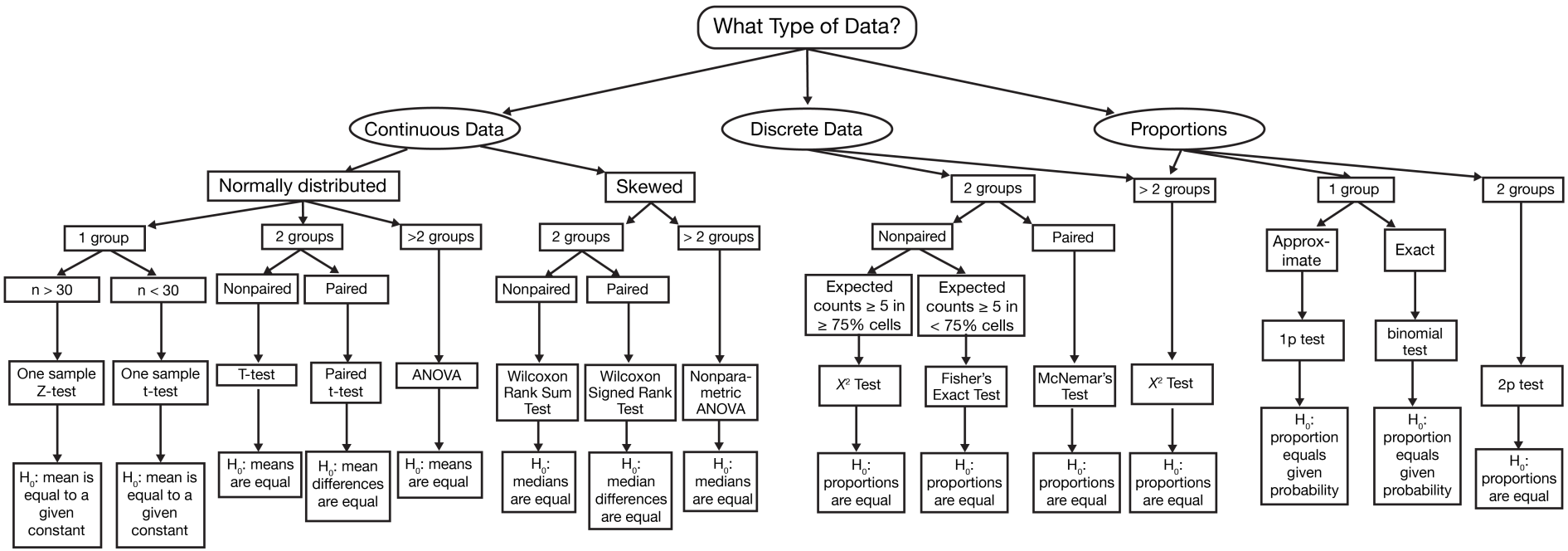
1-β $=$ prob of rejecting a H_0 when H_0 is false

test statistics



t-test, anova, chi-square, correlation test

Flow chart: which test statistic should you use?



When can AB test fail

1. in the case of a **referral program**, The referrer and Referee could be split across test and control groups causing spillover on the control or variant group
2. Novelty effects: Prompts and CTA tend to exhibit novelty effects, if not measuring their performance over the long term using a holdout a wrong attribution and/or customer fatigue can happen.
3. What-if scenarios: If you are looking to understand the impact of **not having launched a product**, for instance a subscription offering on a website. A/B test wouldn't be the right fit.

Class Imbalance

Univariate and Multivariate Analysis

Dimensionality Reduction

Under and Over Sampling

blocs

title of the bloc

bloc text

title of the bloc

bloc text

title of the bloc

bloc text

MACHINE LEARNING
chi square
big O notation
book - kevin murphy
Precision Recall tradeoff How to choose the method of predictive modelling. algorithms Bayesian Modelling (Topic Modelling), NLP, Bayesian Nonparametric Techniques, Social Network Analysis, Sentiment Analysis - https://www.springboard.com/blog/machine-learning-interview-questions/ - https://www.quora.com/What-is-the-difference-between-supervised-and-unsupervised-learning-algorithms
https://blog.udacity.com/2016/04/5-skills-you-need-to-become-a-machine-learning-engineer.html
https://towardsdatascience.com/how-to-build-a-data-science-portfolio-5f566517c79c
http://www.smdi.com/evolution-machine-learning

Thank You!