```
Permutations: n! ways to permute n items, combination: (k)= k!(n+k)! ways to combine k items chosen from
 Geometric series: \sum_{i=0}^{n-1} ar^i = \frac{a(r^n-1)}{r-1} = \frac{a(1-r^n)}{1-r}, Harmonic series: \sum_{i=1}^{n} \overline{h}_i^* = \ln(n) (approximation)
 A useful approximation: ex >1+x, yx; ex =1+x if |x| is small
  union bound: P(A, U... UAn) < P(A) + ... P(An)
 throw m balk into n bins, Coupon collector: mznlog(n) for balls to end up in every single bin collector.
         if m=n, largest bin alog(n) size
 conditional probability: P(AIB) = P(B), Bayes Rule: P(AIB) = P(A) P(B), independent if p(ANB)=P(A) P(B)
  Expected value: E(x)= \( \times P(X=x) \) \( \times \) A possible values \( \times \). OR \( \times \) \( \ti
  Median of random variable: P(XZm) > = and P(XEm) <= [if Y=aXtb, E(Y) = aE(X)tb,
 variance: E(X-E(X))^2 = E(X^2) - E(X)^2, Std dev: Std(X) = \sqrt{var(X)} Var(Y) = \alpha^2 var(X)
  biased coin with PChearl=p, then Dexpected & loss to get 1st head, (DE(single toss)=p, var=p(1-p)
 Markov Inequality: if X is a positive RV, then Ya>o, P(X>a) < E(X)/a
Linearity of Expectation: E(X,t.-+Xn)=E(X,)+"+E(Xn) whether they are independent or not
                        variance: var(x+...+xn)=var(x1)+...+var(xn) only if they are independent
 charysher Inequality: if RV X has std der or, then Yk>OER, P(IX-E(X))=ko) < 12
E(sum of independent RVs) = X1+...+Xn, E(avg of indep RVs) = n(X1+...+Xn)
floeffding's Inequality: if X1, -1, Xn ∈ [0,1] are indpt and E(Xi)=U, then P(1(th)(X1+11+Xn)-U/>E) < 2e^-2E^2n
Hash table with chaining: T(bucket(x)) lookup (collision = flat to linked list)
                                                                                                                                             primary:06)
 Power of 2 choices: T(log(logn)) lookup (2 hush func, put in less full bucket)
Two-level Hashing: high chance of O(n) lookup (each bucket is another hash table), Fewendary; O(n2+...+nn2)
 Bloom filter: store in items in alon bits, initialize all bits to o, insert: set all hash funcs' result of
          input to true, and return och return Tihix)] & ... de Tihix)], lo bits = P(err) = 1%
Jaccard Similarity: for 2 sets A,BCU, J(A,B) = TAUBI
        min-hash to estimate Jaccard: pick a roudon permutation TI of U, hT(A)= element of A appears
Ristribution Domain Param Mean Var Adensity)
                                                                                                                                 max likelihood of normal:
                                                                     σ<sup>2</sup> <del>√2πσ<sup>2</sup></del> exp(- (x-4)<sup>2</sup>)
                                                                                                                                 P(datalo): P(x,,.., x, lo) = Po(x). P(x)
                        R
                                                         U
Normal
                                                                                                                                take natural by for log-likelihood
                       \mathbb{Z}^+
                                                         λ
Poisson
                                                                                                                                LL(0)= Info(xi)
                                                                    n\rho(lp) P(x=k)=(k)p^k(lp)^{n-k}
                                                        Np
                                        n,p
Binomial
                     0~n
                      (0,-1,n)k
                                       n, (Pi, ..., fx) npi
                                                                                                                              Ifind & that maxes ULD) using Calc
Multinomial
                                                                                                                                Set FRATTIGO =0
```

Laplace smoothing: if it observations (eg. binomial k=2), add &1 to each data, then do MLE covariance: cov(X,Y) = E(XY) - E(X)E(Y), correlation: $corr(X,Y) = \frac{cov(X,Y)}{std(X)std(Y)}$ X,Y independent $\Rightarrow cov(X,Y) = corr(X,Y) = 0$; $corr(X,Y) \neq 0 \Rightarrow dependent$

relationship between density & OPF CDF

point (X, XL): [X, XL OEX, EXCE] , Z= max(X, XL)

May deller I all John MM

g rox wir7014.59

test (ADT - MAN - (A) NIAM) made made

and almost him a policy of property (xxx), + 3 colors of a later.

Action in queby it ky openion RV, ther your Plant is signed

(1) and the state of the state

to the tribute of the property of the second of (i.e. it is a factor of the second of the second of the second

Elydry repolity of the Part Clerity, Dear ykane 3. 1 (14 & (4) + 12) = je

on the entry well to the part of the Xerry of the make flower flower in (x, come x.)

first film ingthe Electronics Tilliaments) pared (comments to sixted to si). I it

Company of the state of the sta

to the ending to be read the action of the large of and of the property and by the above of the larged

town decimal control of the film (xx) wave projects) was selected experienced by

Men ing the in xin in xin we foul are high and this or the political or its many

the second of the control of the second and the control of the con

of proportional forms to attach the most they provide here but the first in the second of the second in the second of the second

(A) A 2 = (B) 1 = 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100 1 | 100

may high be become second perto second probabilist of U. h. Corestand 1. 10 miles

Our risky willing to the air mail and block dust fract (and I wonderly to fight and I are

A conservation of the total energy of the distribution and party in motion of the first of the