```
PCA n = [x, m, x] diagonalises uncorelate neasurment 1 diamension
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONVCX (0-014 & Q
                                                                                                                                                                                                                                                                                            A = UZVT V: ATA U: AAT
    II All = [ | aij = Trace (AAH)
                                                                                                                                                                                                                                                                         z - 2 U= AV Σ - 1 VT = E - 1 UTA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         linear f(x) = ot x affine

seponated f(x) = e x f(x) = otx + b
                                                                                                                                                                                                                                                                                                                                                                                                                                  X= X - M
                                                                                                                                                                                                                                                                                                                                                                                                                                 covanauce matrix: T= " xx" > poline
   | All = [ | aij | convex print ation | | All = | E = | aij | Z
                                                                                                                                                                                                                                                                         . deterministic Polynom = 0 ciema
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Exponential f(x) = C

All mans
f(x) = f(x) + f(x)

f(x) = f(x) + f(x)

f(x) = f(x) + f(x)

f(x) = f(x) + f(x)
                                                                                                                                                                                                                                                                        E = Veigouralus
elyonvalue into AAT /ATA,
                                                                                                                                                                                                                                                                                                                                                                                                                   eigen decomposition; Z = UAUT 1; = 0;2
                                                                                                          There \begin{cases} \frac{1}{2} |A_{ij}| & = \sum_{i=1}^{n \ln \left[ \frac{n}{2} \cdot n_{ij} \right]} \int \int \frac{1}{2} |A_{ij}| dx dx \\ \int \frac{1}{2} |A_{ij}| & = \sum_{i=1}^{n} |A_{ij}| & = \sum
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             f (2x) = (2 | f(x)
                                                                                                                                                                                                                                                                                                                                                                                                  new basis Zh = UT X aha Karhunen Loeve
                                                                                                                                                                                                                                                                              -> sette of get up ... find onthogonal ux
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          epigraph: [(x,t) | x & dom f, f(x) < t]
projections on convex sets one unique
  (\|x\|_{1}) = \sqrt{x_{1}^{2} + x_{1}^{2} + \dots + x_{n}^{2}}
                                                                                                                                                                                                                                                                                                                                                                                                 reconstruction Xopp=Uk Ek=UkUKX Hotelin
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            inhersections are convex log ( = n
                                                                                                           6+(48) = 6+ (8A)
                                                                                                                                                                                                                                                                         [PEA] drop small sinjular values,
                                                                                                           6+ (cA) = c · t+(A)
                                                                                                                                                                                                                                                                            rduce A to A = U, Z V
      || X | oo = max | X | + (A10) = + (A) + + + (B) Euclidian!
                                                                                                                                                                                                                                                                                                                                                                                                                   err = 1 = 11 x - x 11 = 11 x - x 11 =
      Il Allo = max Z laiji Honogenous: (1411 = 12/1141
                                                                                                                                                                                                                                                                              Reduced SVD best | rouk (5) / = 11 (VRVX -14) · XII2 using: ILAII F
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             f(x^{(n)}) - f(x^{(n)}) \leq \frac{c}{t} convergence rate
                                          nejen len
                                                                                                                                                                                                                                                                               A = argmin | | A-B||2 = k
                                                                                                                                                                                                                                                                                                                                                                                                                        convert into lincolly une
                        absolute row som
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Word embedding word in context
                                                                                                                                                                                                                                                                                                                                                                 Gradient V Ca, 6>= (Va). 6 + a (Pb)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      L(0,w) = \frac{7}{2} \frac{0}{2} log po (w(+44) | w(+))
                                                                                                                                                                                                                         AAT = (UDVT) (VOTUT)
    11.11 = Z or nuclear
                                                                                                                     nol : 11A11=0 => A=0
                                                                                                                                                                                                                                                                                                                                                               11 v-w112 = cv-w, v-w> = 11 v112 + 11 w119 - 2 cv-w>
                                                                                                                                                                                                                              = U D In o U C = ULU T
    max 11x112 = max loit natrix operador
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     I: window of offerts & = agras L(0;w)
                                                                                                                                                                                                                                                                                                                                                               (fg)'=f'g+f.g' | (fg)'= f'g-f.g'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Was (xu, bu) ER dot log -bilineat
       Alternative Himinications f(v,v) = \frac{1}{121} \sum_{i \in \{1\} \in I} (a_{ij} - c_{ij}, v_{ij})^2
V = asymm f(v,v) \quad V = asymm f(v,v
                                                                                                                                                                                                                        oLSA topic: word distribution p (wlz)
                                                                                                                                                                                                                                                                                                                                                                      \log_b(x) = \frac{\log_b(x)}{\log_b(x)} \left| \frac{\alpha}{b} - \frac{c}{d} \right| = \frac{ad - cb}{b \cdot a'}
                                                                                                                                                                                                                     occount = MIX of topics p(zld) k topics
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ( og po ( w | w ) = < xu , xw > + bw + co,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    unspecific: but > po (ulu') + Vu'
                                                                                             Optimization: ** radialization (%) - beta (
    collaborative fillering, ALS!
                                                                                                                                                                                                                                                                                                                                                                              ((sin x)' = cos x (cos x)'= - sin x (10) x)' = 1x
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     specific: <(xwixwi) + ⇒po(ului) +
    Lagrangiam x 20 hj (x)=0
                                                                                                                                                                                                                                                                                                                                                                                        (+on x) = sec 2 x | (sec x) = sec x - tan x
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    soft-max Po (w lw) = exp [(xw,xu, >+bw]
    L (×,λ,ν) 3:(x) ≤ 0
                                                                                                                                                                                                                                                                                                                                                                                           (a^{x})' = a^{x} \cdot \ln(a) | (z^{y})' = c^{x} | (c^{-x})' = -c^{-x}
   = f(x) + \lambda^{T} j(x) + v^{T} h(x)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   partition to (") = E exp[cx, x, 13 +by]
                                                                                                                                                                                                                                                        t di in document di coo ce usuce matrix X = XI
                                                                                                                                                                                                                                                                                                                                                                                                 (logaz) = 1 in (a.b) = ln (a) + ln (b)
    = f(x) + [ ] x; g; (x) + [ ] x; h; (x)
  Lagragion Duel
                                                                                                                                                                                                                                                    L (U,V) = = | x1j log e(uj | J;)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     \theta = \left( \left( \mathbf{x}_{\omega_1} \mathbf{b}_{\omega_2} \right)_{\omega \in \mathcal{U}} \right) \in \mathbb{R}^{\left( d+1 \right) \cdot \left[ \mathbf{V} \right]}
                                                                                                                                                                                                                                                                                                                                                                                                       In ( 5) = In (a) - In (b) sub gradient
                                                                                                Assume, x^{\mu} is local ninthern,

\eta \nabla_{x} \perp (x^{\mu}, \lambda^{\mu}, v^{\mu}) = 0 feasibility
 D(x,v) = 12 f L (x, x, v)
                                                                                                                                                                                                                                                 = E Log E elwite ) e (alli) EM belov.
                                                                                                                                                                                                                                                                                                                                                                                                              In (ar) = n. In(a) | Vy f(x12
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  L(\theta_{1}w) = \sum_{t=1}^{T} \sum_{A \in I} \left[ b_{w(t+A)} + \right]
 fasibler: vihi(a)=0 xig;(x)<0
                                                                                                4 71 (x*) =0, h; (x*) =0, 1; 20
                                                                                                                                                                                                                          with Ever=141 Ever=146
                                                                                               3) x j; (x*) = 0 complex
                                                                                                                                                                                                                                                                                                                                                                                                                        In\left(\sqrt[p]{x}\right) = \frac{\ln(x)}{n} \left(\frac{1}{2}(x) + \frac{1}{2}(x-x)\right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 < x = (+ +4) , x = (+) > -
                                                                                                                                                                                                                             and us; 30 and vs;
 (パ,v*) = atg rax の(1,v)
                                                                                                          = f(x") = L (x", x, v")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Log Z exp [ < xu (+1 > + bv ]
 D(\lambda, v) \leq D(\lambda^2, v^2) \leq f(x^4) \leq f(x)
                                                                                                                                                                                                                              variational parenete via Jensen
            which to prink min (in) - mer 3(Av) X = UTV, we probability vector
                                                                                                                                                                                                                              [og E 93ij | vsi vsj | 2 th 9sij [log vsi +log vsj -log 9sij]
                                                                                                                                                                                                                                                                                                                                                                                                                                    context vector main vocabulary V, context vocab ( xu , v 6 V ;
                                                                                                       U nuisance parened
LMP(v: | x) x TT v = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                    log p. (ulu') = < 20, 1/2 + 60
                                                                                                                                                                                                                                    E-sky yelj = vel vej =
                                                                                                                                                                                                                                                                                                                                                                                                                                    negative sampling \sigma(t) = \overline{(1+e^{-t})} k: non negative samples
                                                                                                                                                                                                                                      expectation that was a
                                                                                                                                                                                                                                                                                                                                                                                                                                     ρ(θ) = = Σ τ in σ (f (ψ(+4), ψ(+))) + k Fv [ in σ (-f (ν, ψ(+)))]
                                                                                                                                                                                                                                       M-skp Uzl = Zjxij 4elj

Zjxij
p (x | V, x) = \( p \) (x | V| u) p (u | x) du \( \frac{1}{2} \) \( \frac{1}{2} \) \( \frac{1}{2} \)
                                                                                                                                                                       Vej = har {O, Vej}
                                                                                                                                                                                                                                                                                                                                                                                                                                      f(v,w) = c /w, xw1 + b,
 for each di: sample u. ~ Dirichlet (x) = int galk out xi = zuei vzi
                                                                                                                                                                                                                                                                                                                                                                                                                                           normalised p (w) = Sep[h(w)] unappolised p(w) = cxp[h(w)] use 2 sided loss
                                                                                                                                                                                                                                       Glove Ne privi.ich
used that wt, 15t 21; = vid = product to effect sample 2t nulti (v; 1 = Latel; sam out inhapped sample wt ~ Hulli (v; a) = observable
                                                                                                                                                                                                                                        nij occurric of ui in confect wi
                                                                                                                             inh portable counts than PCA; counts
                                                                                                                                                                                                                                        nij occurric of u; in confect u;

objective Po (wilus) = exp[<xi, r;> + b; + c;]

Helinx decomposition xw,d.1=1 xu,d=6 xv,d=1 = cv xv,d=1
1 - (nij) | mij = log nij X = [xun ... X = [xun ... X = [xun ... Yuli]] / affine cupodi
                                                                                                                                                                                                                                         H(0,N) = Ff(n;j) (10g n;j - log Po (w;luj))
                                                                                                                                                                                                                                          H(\theta,N) = \lim_{t \to \infty} \left\{ 1, \left( \frac{n}{n-n} \right)^{\frac{1}{n}} \right\} 
weighing f(n) = \min \left\{ 1, \left( \frac{n}{n-n} \right)^{\frac{1}{n}} \right\} 
= \lim_{t \to \infty} \left\{ 1, \left( \frac{n}{n-n} \right)^{\frac{1}{n}} \right\} 
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= \lim_{t \to \infty} \left\{ 1, \left( \frac{n}{n-n} 
  a) dimension reduction; similar to pLEA, different sompling / objective
 VI MO ALS, (x; - UTy) = ||x,|| - 2x, UTv; + v, UUTv; ) normal equations
  ∇v; (...) = 0 ⇔ (νυ<sup>⊤</sup>| v; = U×; (υ∪<sup>⊤</sup>) ∨ = Uχ
                                                                                                                                                                                                                                            gradient descent too capacitive one = 0 old - 1 PoH(O,N) 1 >0 0 = ((xw)weV, (tw)wec) embeddings
    K-Means of (x1 = arg min Iluj-x11 point to aluste
                                                                                                                                                                                                                                            vj conhuld € IRd
   2 2ij := { 1 ! { r(x_i) = j = organiz ||x_i - v_z||^2 \frac{1}{j=1} \frac{1}{j=1}} \]

6 otherwise (V:)
                                                                                                                                                                                                                                         The Gaussian P(x, p, \sigma) = \frac{1}{\sqrt{2\pi^2}} \exp\left[-\frac{(x-p)^2}{2\sigma^2}\right] in the property P(x, p, \sigma) = \frac{1}{\pi} \frac{1}{\sqrt{2\pi^2}} \exp\left[-\frac{(x-p)^2}{2\sigma^2}\right]
                                                                                                                               Alkernating minimisation
 willy white Exceptioner = 1 | \( \( \frac{1}{\tau} \) \( \frac{1}{\tau} \) = \( \frac{1}{\tau} \) \( \frac{1}{\tau
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Gaussian densities
                                                                                                                 until & state came
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0; = (m; , Z;)
                                                                                                                                                                                                                                                       is the model P(x_1 \Theta) = \sum_{j=1}^{k} \pi_j P(x_j \Theta_j) = (\pi_j \Theta_{x_1} ..., \Theta_k) \in \mathbb{R}^{k+k \cdot m_j}
 \nabla_{v_j} J(v_i t) = \sum_{i=1}^n \pm i j \left( \frac{1}{2} \nabla_{v_j} || x_i - v_j ||^2 \right) = 0
                                                                                                                                                                                                             Gaussian Michae Model P(x; 0) = = x; p(x; \mu_j, \mu_j, \mu_j) zstup model sample closer from in Cate goicel (x) given j, sample a data x ~ last model assignment to coke goicel distribution point from the jth compound Noticel (\mu_j, \mu_j)

= 401/4 \ \frac{1}{2} = \frac{1}{2} \f
\Rightarrow) \quad v_{ij}^{*} = \frac{\sum_{i=1}^{n} z_{ij}^{*} x_{i}^{*}}{\sum_{i=1}^{n} z_{ij}^{*}} \quad , \quad \text{if } \sum_{i=1}^{n} z_{ij}^{*} \geq 1
                                                                                                                                                                                                       cluster index j : Latent variable => outcome x
                                                                                                                                                                                               Pr (si = 1) = Ti or Pr (s) = Ti Ti ti Tout distribution all dator P (x, z; 0) = Ti [Ti, P(x, 0)] Dayes P (A16) = P (B1)
PLE & = arg max \( \tag{ \int \pi_{i=1}^k \pi_{i} \pi_{(x_i, \theta_i)}}\)

no closed form solution
                                                                                                                                                                                       Posterior for assignments P_{\Gamma}(x_j=a|x) = \frac{P_{\Gamma}(x_j=a) \cdot p(x_j=a)}{-1} = \frac{W_{\Gamma} \cdot p(x_j \cdot \theta_{\Gamma})}{-1}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                \prod_{j} * = \underbrace{A}_{n} \underbrace{\sum_{j} q_{ij}}_{ij} \underbrace{\Theta_{j} = \left( \lambda_{ij}, \Sigma_{j} \right)}_{i}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      \mathcal{L}_{j}^{*} = \frac{\mathcal{L}_{i=1}^{n} \cdot \mathbf{q}_{ij}^{n} \cdot (\mathbf{x}_{i} - \boldsymbol{\mu}_{j})}{\mathcal{L}_{i}^{n} - \boldsymbol{\mu}_{j}} \frac{(\mathbf{x}_{i} - \boldsymbol{\mu}_{j})^{T}}{\mathbf{x}_{i}^{n} - \boldsymbol{\mu}_{j}}
   \label{eq:continuous} \begin{array}{ll} \mathsf{L} \circ \mathsf{g} & \mathsf{p}(x_i \, \Theta) \, = \, \mathsf{log} \, \left[ \, \sum_{j \neq i}^k \pi_{ij} \, \mathsf{p}(x_i \, \Theta_j) \right] \\ &= \, \mathsf{log} \, \left[ \, \sum_{j \neq i}^k \pi_{ij} \, \frac{\pi_{ij} \, \mathsf{p}(x_i \, \Theta_j)}{\tau_i} \right] \end{array}
                                                                                                                                                                            The R Lagrangian = = 1 7; [log p(=; Oj)+log v; -log v; +\ (\frac{b}{2} v; -1) Maxin Satron Step recompose cluster que & claye
                                                                                                                                                                         to best lover bound on leg litter should be to the standard of the standard of
 \frac{1}{\log x} \cdot \log x - \log x \cdot (x_i, x_i) = -\sum_{i=1}^{n} \log x_i \cdot (x_i, x_i)
                                                                                                                                                                                                                                                                                                                                                                                                          Otthogonal transform
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       A is positive semi-definite
                                                                                                                                                                                                                                                                                                                                                                                                            pacis change == UTX
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         If VTAVZO
    AIC (B|X) = - log p(X; 0) + k(0) ) nord -
                                                                                                                                                                                                                                                                                                                                                                                                              twincole: 222
                                                                                                                                                                                                                                                                                                                                                                                                              innose: 2=UZ
reconstruction enter 11 x-2 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          A = 8 5 ; v (0 5 B) =
    Parlises conferry work = smaller Alc ) 10g n = smaller Alc ) 1812 value
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           (DV) T(BV) = NBV 11 2 20
                                                                                                                                                                                                                                                                                                                                                                                                              Projection
                                                                                                                                                                                                                                                                                                                                                                                                           (1-0)^T) V = V - < 0, V > U
        h(6) = k.d + (k-1) fixed co vorience notice
       W(0) = K. (d4 d(d+1)) + (4-1) full covernities : Non free parencles
                                                                                                                                                                                                                                                                                                                                                                                                           idempotent (00 T) [v-2011 > 0] = <011>0 - <011>0 = 0
```

```
consolutional layer 2 (metions a 3rd function, detect edges; per ling layer reduce size/sale nor as any padding fully-connected layer square loss/
    We noted to the state of f^{\sigma}(x_1 v) = \sigma \left( u_0 + \sum_{i=1}^{n} u_{i, X_i} \right) = \sigma \left( v_{i, X_i} \right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Pixel CNN : generated pixels fed book into the pretwork!
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Tribron grows conditional distribution p(x) = \prod_{i=1}^{n} p(x_i|x_{a_1-1}x_{i-1})
                                                                                                                                                              1 bin ( functor
          took = logisty
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          folly out dishipotion e^{(\epsilon)} = e^{(x_a | x_{a_1} \dots, x_n)} = e^{(x_a | x_{a_1-1} \times_a)} e^{(x_2 | x_{a_1-1} \times_n)} \dots
                                                                                                                                                                                                                                                                                         consolution T_{RM} (x; w) = or \left(b + \sum_{k=1}^{2} \frac{v_{kk}}{v_{kk}} \cdot \frac{v_{kk}h_k!}{v_{kk}h_{k}} + 1\right)
                                                                                                               Square loss Y^{*}, Y \in \mathbb{R}
L(Y^{*}, Y) = \frac{1}{2}(Y^{*}, Y)^{2}
LEARDING
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Zextrene motels
all vonich les independed p(x)=p(x)p(x)...p(x)
   RelU(x) = af(x) = const
                                                                                                                                                                                                                                                                                                          and results of class berz 42-2 add results of class
                                                                                                          (1-4) (4-4) (4-4)
                                                                                                                                                                                                                                                                                             learning (ilks \theta \theta \end{align* \text{end} \text{e} \tag{\tau} \text{e} \tag{\tau} \text{e} \text{e} \tag{\tau} \text{e} \text{e}
           units/layers reproduction relarget
   Fy (x) = \sigma(\varphi_x), j=1. As = \sigma(\varphi_x), \varphi = \sigma(
                                                                                                                                                                                                                                                                                            Segmentation labelling the pixels of an image in deconvolution
                                                                                                                                                                                                                                                              Example max (Relu (Izk))

Spoke Coding == uTx basis change
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           As original eigenl U-dictionary \|U^Tx\|^2 = \|x\|^2 (Energy passening)

Thincola small values of z \to cohindc is equality \hat{x} = U_{z}^2, U = (U^T)^{-1} x = \frac{T}{2} + \frac{1}{2}(x) \cdot U_{z}^2 |z_{z}| + \frac{1}{2}(x) \cdot U_{z}^2 |z
                                                                                                                  = \max \left(0_1 \sum_{\substack{d \in \mathcal{S}_2 \\ d \in \mathcal{S}_2}}^{i,j} \sum_{\substack{-k \in i_i, j \neq k \\ (i,j) \neq k}} (T_{\alpha})_{i_1 + i_2 i_3 i_4 j_4 j_5} \cdot (k_{\alpha}^{\ell})_{i_1 j_2}\right)
  Y = 0 (L) (W (L) (L-4) (... ( (1) (W (4) ) ... ))
                                                                                                                                         Duck propagation TALL TILL July Former vs. Hear | Hour & Former fix basis soud non and of 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            - Signal compression - I maje compression
   W= W" x = x Y = Wx
                                                                                                                                                                                                                                                                                                             global support - local support PCA data dependent basis send Uk and Zaik Discrete cosine transform
                                                                                                                                                                                                                                                                                                         Sinc alive food - localized signed

Overcomplete Dictionaries UDAL, LD JPEG 8x8 pale 1- 2 D = 64 vector would a fourier!

O(0 leg 0) - 0(0) or 0(0 leg 0)

ONE outhorounal basis might not be charged outhorous L coherence nex [U.T.v.]
  binary classification: logistic
                                                                                                                                         (1-12) 0-1 Tol((++", +(x+10))
 Y_{4} = P(Y_{2}A)_{x} = \frac{1}{1+e^{-u^{T}x}}
                                                                                                                                           via partial deviceding layor
The four output, Laper to

Y_A = P(Y = h \mid X) = \frac{\nabla^{1} X}{\nabla^{1} X}

The four output, Laper to

V_A = P(Y = h \mid X) = \frac{\nabla^{1} X}{\partial x^{1}}

The four output, Laper to

V_A = P(Y = h \mid X) = \frac{\partial x^{1}}{\partial x^{1}} \times \frac{\partial x^{1}}{\partial x^{1}} = 0

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The four output is the four output, Laper to

V_A = P(Y = h \mid X) = 0

The f
                                                                                                                                           start from output, Layer to Layer Justice
                                                                                                                                                \vec{J} = \frac{\partial x^+}{\partial x} + \vec{J}(\vec{y} = \frac{\partial x_i^+}{\partial x_i} = u_{ij} + s' \left( u_i^+ x \right)
                                                                                                                                                                                                                                                                         Gabor world's emple -(n_1-\mu_1)^2 -(n_2-\mu_2)^2 \times \cos((\cdot, (n_1\cos\theta+n_2\sin\theta)))

\int_{-\infty}^{\infty} \int_{-\infty}^{\infty
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             m(B)=0, if B outling our basis
                                                                                                                                         \frac{3x_{i}^{(t-u)}}{3x_{i}^{(t-u)}} = \sum_{j} \frac{3x_{j}^{(t-u)}}{3x_{j}^{(t-u)}} \frac{3x_{j}^{(t-u)}}{3x_{j}^{(t-u)}}
    P(Y=11x) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    4 ([8 ]) > 1 ([8 ]) W
                                                                                                                                                                                                                                                                            Reconstruction such that x=Uz " 11211, > convex problem /relaxation Additive Noise x=Uz+n, n~ N(0,0]
                                                                  14 e - CV1 x >
                                                                                                                                    =\int_{\{i\}} \frac{3^{\frac{n}{4(i-p)}}}{3^{\frac{n}{4(i-p)}}} = \int_{\{i,j\}} \frac{1}{4^{i-j}} \int_{\{i-p,-q\}} \frac{1}{2^{(i-p)}} \frac{1}{4^{(i-p)}}
    Regularised Richminisation
                                                                                                                                                                                                                                                                           Find: 2*6 ang rim 11216 s.t. [1x-Uz] 2 < Dorz OR 2*6 eng min 11x-Uz| 2 s.t. [131] = K (epa ty)
   training set . { (x, x, 1: t... T}
                                                                                                                                                                                                                             Coding with noise n= Ur 2=Uz+n=Uz+Ur=U(z+r) original signal space Morsole y instead of x!
   Expiriant risk: L(\theta, x) = \frac{1}{T} \sum_{t=1}^{L} l(\gamma_{t}, \gamma(x_{t}, \theta))
                                                                                                                                                                                                                               conpressive sensing compress while gathering x: linear combination

x=UE s.L. II allock Yk = < Wkx > k = 1,..., M Y=Wx = WUZ = .02 with 0=WU = IRAPD; and U gives stable reconstruction
    0° (~",...,~")
  L_2 regularization L_{\lambda}(\theta, X) \approx L(\theta, X) + \frac{\lambda}{2} \|\theta\|_2^2
                                                                                                                                                                                                                             if N < 0: K much shown them x sufficient conditions 1. W= Gassian tember projection, wij ~ N (0, 1) 2. N ≥ ck log ( 1) Reconstruction Find sparsest & 6 organia liebo, s.t. Y = 0 ≥ 1) convex optimisation 2) matching pusseit \ , large course on the new of a new of 
   Dictionery Learning x = U. Z.
otoms = cols of U HAMEN FROM FOW

sparse lupanting restore missing pixels
                                                                                                                                                                                                                   Herefive great minimischoin of cooling step 2 to or mine 11x-Ut ZII column sependel residual 1180 = = Trij = = 00; 11 12 N independent sporte coding steps

2 military matter
                                                                                                                                                                                                                               2) Dictionary update ut+1 & arg ming | | X - UZ tex | | = 1, 2 for Isolate Rt | | | X - [ + 1 - 1 - 2 tex | | = | | X - ( - 2 tex | 1 - 2 
   (0+,2+) € alluin ||X-05|| = => convex
                                                                                                                                                                                                                                                                                                                                                                                                                                                        540: ( = 0 Z V = Z 0; 0; 47 0 = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | = 0 | 
    K-SVD: orlight U for 1=1+0 L: N= (n/2 in *0, 15 n × N) archive date painls; R = X(1,N) - U2(1,N) moderal; J = 2(1,N); h = = 1 in y : J = R<sup>T</sup>h; U(1,1) = h; 2(1,N) = J<sup>T</sup>; end sparse coding muture *25.1

A) studen about, scope up n N(O(Io), Up = 100 in the form control overlapped dictionery Estimate speech: \hat{X} = U^{(0)} is interferent to the control of the control overlapped dictionery (stimula speech size of the control of the control overlapped dictionery (stimula speech size of the control overlapped dictionery)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Lectaing vis 6-500 (0, 2) & arg min [1 x-U2|| 2 s.b. (10 =1) || 1 =1 for d. 1 ... , L and (12 11 = 5 K)
       Robust PCA X = Loutenby S pure proto/poise
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          s.t. || 2 (1) || 0 + || 2 (1) || 0 = K
                                                                                                                                                                                                                                                                                                                                                                                       · Extendeble to matria completion · vidro: foregood background colseftenes & = U(s) E(s)
       min touch(L)+p || S || 0 s.t. Lts=x "" || Lll +p || S || 4 : separate, Appyr!
                                                                                                                                                                                                                                                                                                                                                                                         web date authoris . Denoise and in
     11. 117: CONVEX MIRRETIES OF CONTINUITY PRINCIPAL COMPONENT PHISVIT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                X_{4,\chi} \simeq \ \frac{- \ b \ \pm \sqrt{b^2 - 4 \alpha \, c^4}}{}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SVD: UZ=AV
                                                                                                                                                                                                                                                                                      Augmented Lagrangian L_{p}(x,\lambda) = f(x) + \lambda^{T}(Ax-b) + \frac{p}{2} \|Ax-b\|_{2}^{2}
     11.11 : convex elevation of ranh
     convex optimisation min ((x) s.t. Ax=b
                                                                                                                                                                                                                                                                                     not separable alone : -> use ADMA instruct of
       Lagragian L (x, x) = f(x) + x (Ax-b)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Optimality conditions
                                                                                                                                                                                                                                                                                    Method of multipliers
     Dual function D() = inf L(x, )
                                                                                                                                                                                                                                                                                       x^{t+1} = \operatorname{argmin}_{K} L_{P}\left(x,\lambda^{\ell}\right) \qquad \lambda^{t+1} = \lambda^{t} \cdot p\left(Ax^{t+1} - b\right) \qquad {}^{q}xL\left(x,\lambda\right) = \nabla_{x}f(x) + A^{T}\lambda \stackrel{!}{=} O = \nabla_{x}L_{P}\left(x^{t+1},\lambda^{\ell}\right)
    Duel problem mary D(X), I & augmany D(X)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       = 8x f(x +1) + AT (x++ (Ax++1-b)) = 2 f(x+1) + AT 1+1
     Recover optimal solution: X* & arg minx L (x, )
                                                                                                                                                                                                                                                                                      Alternating Direction nethed of Mullipliers (ADM)
            nal Ascent: gradient for dual problem
                                                                                                                                                                                                                                                                                                x = arg min Lp (x = 1 x t , x t) countries and goul
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        A : \begin{pmatrix} 3 & 2 \\ 2 & -1 \end{pmatrix} \quad AA^{T} = \begin{pmatrix} A & 8 \\ 2 & A^{T} \end{pmatrix} \quad (A^{T} - \lambda^{T}) - (A^{T}
              the step size sequence
     \nabla D(\lambda) = Ax^{-1} - b for x^{+} \in a_{1} and L(x, \lambda)
                                                                                                                                                                                                                                                                                             x2 + 1 := or 1 min Lp (x41 x2, xt) passkp size; always dual (casible

\Sigma = \begin{pmatrix} \sqrt{15} & 6 & 0 \\ 0 & \sqrt{10} & 0 \end{pmatrix}^{2\times 3} \qquad \Rightarrow \lambda^2 - 3^{\frac{1}{2}} + 22^{\frac{1}{2}} = 0

\Rightarrow \lambda^2 - 3^{\frac{1}{2}} + 22^{\frac{1}{2}} = 0

\Rightarrow (\lambda^{-2} \cdot 1) (\lambda^{-q}) > 0

    If f(a) seperated => Lagrangian seperates of the seconomition L_i(x_i, \lambda) := f_i(x_i) + \lambda^T A_i x_i should
                                                                                                                                                                                                                                                                                              \lambda^{t+1} := \lambda^{t} + \rho \left( A_{1} \times_{\lambda}^{t+1} + A_{2} \times_{\lambda}^{t+1} - b \right) = \lambda^{t} + \rho \left( A_{x}^{t+1} - b \right)
       minimise x : xi ++ = arganin Li(xi, xt)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \begin{pmatrix} -8 & 8 \\ 9 & -8 \end{pmatrix} v_1 \stackrel{!}{=} \overrightarrow{0} \Rightarrow \stackrel{!}{:} \begin{pmatrix} 1 \\ 1 \end{pmatrix} \qquad \begin{pmatrix} 8 & 8 \\ 9 & 8 \end{pmatrix} \Rightarrow \stackrel{!}{:} \begin{pmatrix} -1 \\ 1 \end{pmatrix}
                                                                                                                                                                                                                                                                                                L_{V}\left(X_{1},X_{2},\lambda\right) = f_{1}(x_{1}) + f(x_{2}) + \lambda^{T}\left(A_{1}X_{1} + A_{2}X_{2} - b\right) + \frac{P}{2} \|A_{1}X_{1} + A_{2}X_{2} - b\|_{2}^{2}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Uz > \frac{1}{2} \left( \frac{1}{2}, \frac{1}{4} \right) \left( \frac{500}{930} \right) = \frac{1}{2} \left( \frac{5}{5}, \frac{3}{3}, \frac{9}{9} \right)
     x *** = x + y も ( L A; x to 1 - b) => paullel possible!
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        \forall A_1 = A_2 : \begin{pmatrix} 3 & 7 & 7 \\ 3 & 5 & 5 \end{pmatrix} \begin{pmatrix} x^{12} & x^{12} & x^{23} \\ x^{12} & x^{12} & x^{12} & x^{12} \\ x^{12} & x^{12} & x^{12} & x^{12} \end{pmatrix} = \frac{2}{3} \begin{pmatrix} 2 & 3 & 0 \\ 2 & -7 & 0 \end{pmatrix}
     ADM for RPCA FA(xA) = 1161(x F2(x2) = p 11511 a
                                                                                                                                                                                                                                                                                                                               Robust PCA can be perfect: L"=Lo S==So
    L_{\rho}\left(L_{1}S_{1}\lambda\right)=\|L\|_{x}+\mu\|S\|_{4}+<\lambda_{1}vcc\left(L_{1}S_{1}-x\right)>+\frac{\rho}{2}\|L_{1}S_{1}-x\|_{\rho}^{2}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   RP(A does not with, if x is low wh & space! (4 example)
        Lett: at & min to (1' 2 f 1/7 f)
                                                                                                                                                                                                                                                                                                                             O NOT Spoke Lo = UZV = I Fiv: Vi | r= rank (Lo)
                                                                                                                                                                                   L ADMM updates
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Van =1 → 3 = 2.5 - 2Vaz €> 2VaL = -0.5
        Stat := atg min Lp (Ltat, S, Xt)
                                                                                                                                                                                              For RPCA
     λ + 1 = x + p vcc (L + 5 + x)
                                                                                                                                                                                                                                                                                                                                                 \|u^Te_j\|^2 \leq \frac{vr}{n}
                                                                                                                                                                                                                                                                                                                                                                                                                       =>principal components
                                                                                                                                                                                                                                                                                                                                                11vte; 112 = 7r
     Individual Prince Minimisation
                                                                                                                                                                                                                                                                                                                                                                                                                      must not be space/spate!
                                                                                                                                                                                                                                                                                                                                            |UV^T|_{ij}^2 \leq \frac{vr}{n^2}
        organin Cp (Lisix) = Dp-1 (x-s-p-1 mat/x)) = Lte1 ~
                                                                                                                                                                                                                                                                                                                        High probability ( square matrices)
        or grin (p(L1-1) = Spp-1 (x-L-p-1 mot ()) = 5414 - 11
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               High probability for recramouran
                                                                                                                                                                                                                                                                                                                       If Lo cohecert, v>0
        mat (x +1) = mat (xt) + p (L+1+ s+1-x)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Ps , Cr : posi five
                                                                                                                                                                                                                                                                                                   and rank (20) = Pr n x-1 (log n).5
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       minimize of PCP with p= ==
        S_ (4) = = = (1) - max (1) - T10) (mohris: do for all clonents)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 w144 "
                                                                                                                                                                                                                                                                                              and spatisty polition of conditionality msp pon2) recovers another Links states
     DT (X) = UST (Z) VT, where SVO X =UZVT
```