a) f = f(x,..., xn) b) k-th: 8fx = 8f c) 8fe R

2 $f(x) = \frac{c}{c} \times x$ $f(x) = \frac{c}{c} \times x$ $\frac{c}{c} \times x$ $\frac{d}{dx} = \frac{dx}{dx} = \frac{dx$

3) $f(x) = ||x||_2^2 = \sum_{i=1}^{h_1} V_i^2$ $k - th: \partial f_k = \partial f_k = 2 ||x|| > 8 + = 2 ||x||$

 $\begin{array}{ll}
\Theta & f(x) = \|x\|_{\mathbf{B}}^2 = x^T B x = \sum_{i,j} b_{ij} x_i x_j \\
\nabla f(x) - ? & B = B^T \text{ and } B > 0 : B \in S_{++}^n \\
k - th : P f_k = \frac{\partial f}{\partial x_k} = \sum_{i} b_{ik} x_i + \sum_{j} b_{kj} x_j - \sum_{i} b_{kj} x_j - \sum_{j} b_{$

6)
$$f(x) = ||Ax - b||_{2}^{2} = x^{T}A^{T}Ax + b^{T}b - 2b^{T}Ax$$

$$-2b^{T}Ax$$

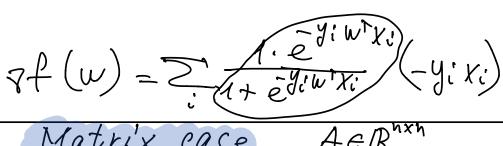
$$A^{T}A = (A^{T}A)^{T} \quad \nabla f(x) = 2A^{T}Ax - 2A^{T}b$$

$$A^{T}A \ge 0 \qquad A^{T}Ax = A^{T}b$$

ATAX = ATB if $A \in \mathbb{R}^{n \times n}$ and nonsingular $\Rightarrow Ax = b$ $f(x) = ||Ax - b||_2^2 + ||A||_2^2$, |A > 0

 $8f = 2A^{7}Ax - 2A^{7}b + 2\alpha x = 2(A^{7}A + \alpha I)x - 2A^{7}b$

- 7) Chavin rule: f(x) = sin(cTx) qf = cos(cTx).c
- 8) $f(w) = \sum_{i=1}^{n} l_{i}g(1+e^{-y_{i}^{i}w^{T}x_{i}})$ $x_{i} \in \mathbb{R}^{n}$ $i^{1}=1,...,m$ $y_{i} \in \mathbb{R}$ i=1,...,m



Matrix case AERnxh

f: R"x" > R tr(A) = \(\frac{1}{2} \alpha_{ii}

1) tr(X) = \frac{2}{xiii}

File 2 \text{0 xik} = \frac{1}{0} \text{otherwise} \text{0 > otherwise}

(1) tr(AX)= Zin ais Xii $\frac{\partial (...)}{\partial \chi_{pq}} = \alpha_{pq} = \alpha_{pq}^{T} \Rightarrow \forall f = A^{T}$

3 tr (AXBX) = Zinh, aix bulkei Zinh, aix bulkei Zinh, aix bulkei Zinh aix bulkei jep keg

lep izq

lep izq

lep izq

lep xizq

by xiz by xiz ajq - of ATXTB + BTXTAT

4)
$$f(A) = x^T A \times = \overline{Z} \cdot a_{c;X_i \times j}$$

 $\frac{\partial f}{\partial a_{pq}} = x_p x_q \rightarrow \overline{Y} + \underline{Z} \cdot x^T \in \mathbb{R}$ -rank-one matrix $x^T \times -s$ calar

$$X \cdot \operatorname{adj}(X) = \operatorname{det}(X) T = \frac{\partial (\operatorname{det}(X))}{\partial X} = (\operatorname{adj}(X))^{T} =$$

=(X')' det(X)

Applications:

n) maximum likelihood estimation of covariance matrix in multivariat Gaussian distribution

2) log dut(X) - barrier function in the internior point methods for solving constrained convex optimization problem. More details see in book convex optimization by S. Beyd & L. Vomdenberghe.