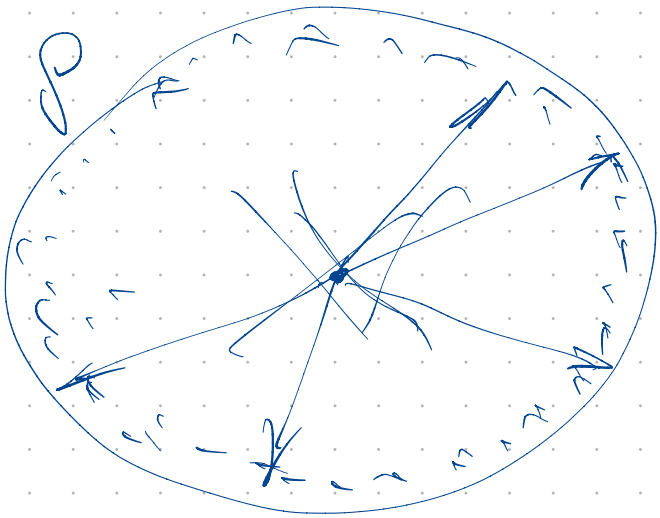
Metric Learning

Dimensionality curse

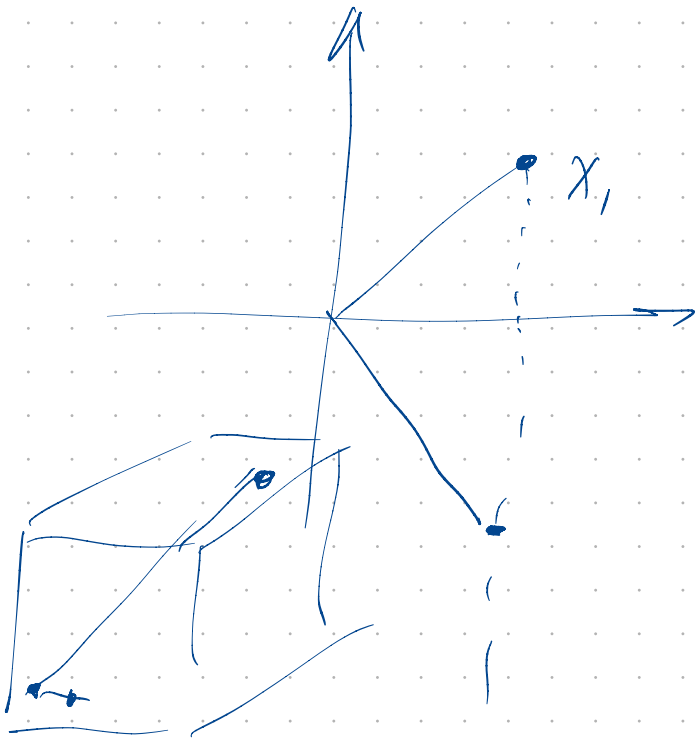
$x_1 \quad x_2 \in \mathbb{R}^M$

$$D_E = \sqrt{\sum_{i=1}^{M} (x_{1i} - x_{2i})^2}$$



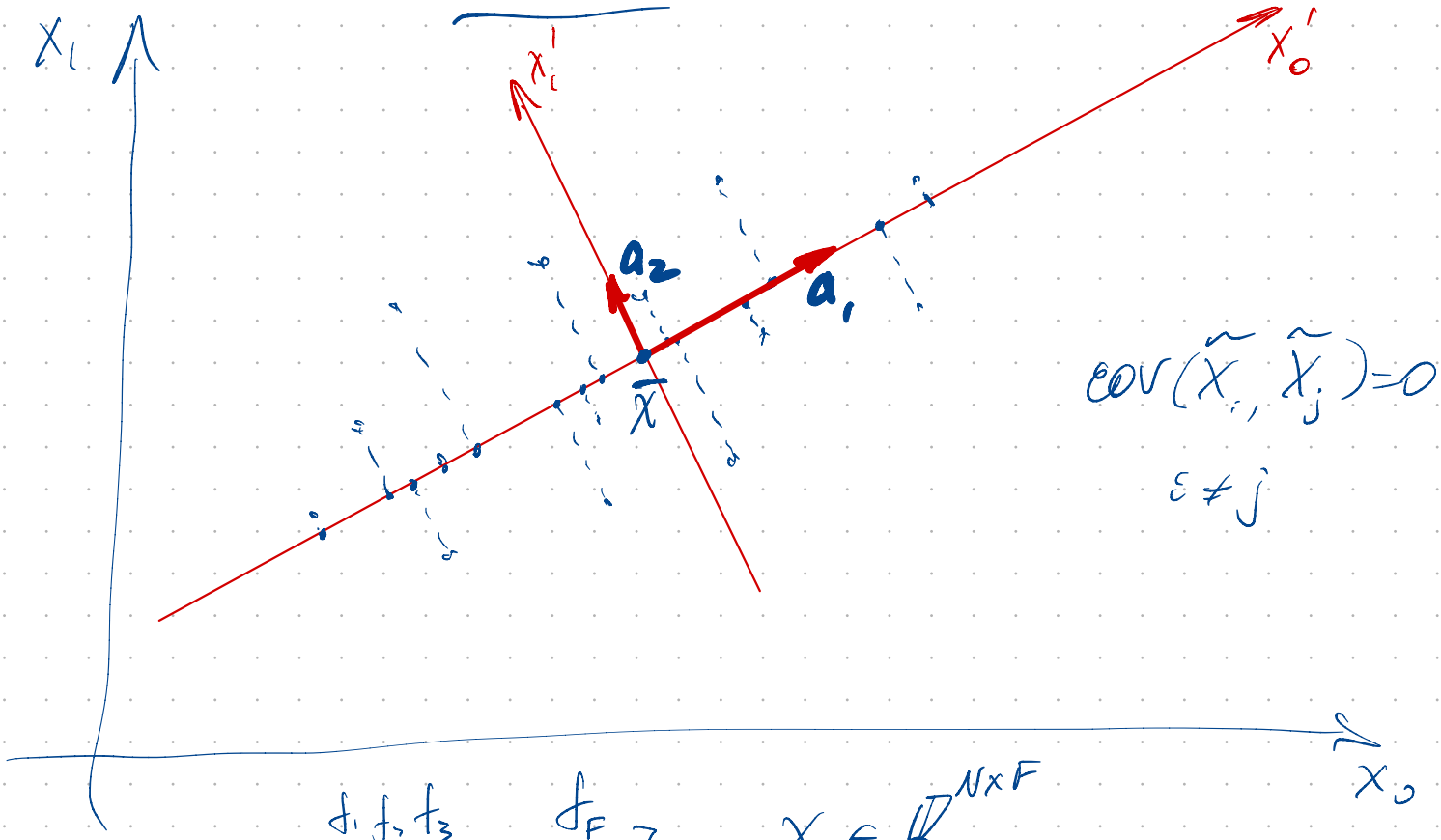
$\in 40 \times 480 \times 3$

$M \sim 10^6$



Principal Components Analysis

PCA (МГК)



$$cov(\tilde{X}_i, \tilde{X}_j) = 0 \qquad i \neq j$$

$$X = \begin{bmatrix} x_0 \\ x_1 \\ \vdots \\ x_N \end{bmatrix} \begin{bmatrix} | & | & | & & | \\ f_1 & f_2 & f_3 & \cdots & f_F \\ | & | & | & & | \end{bmatrix}$$

$$X \in \mathbb{R}^{N \times F}$$

$$X' = X - \bar{X} \qquad \tilde{X} = A X'$$

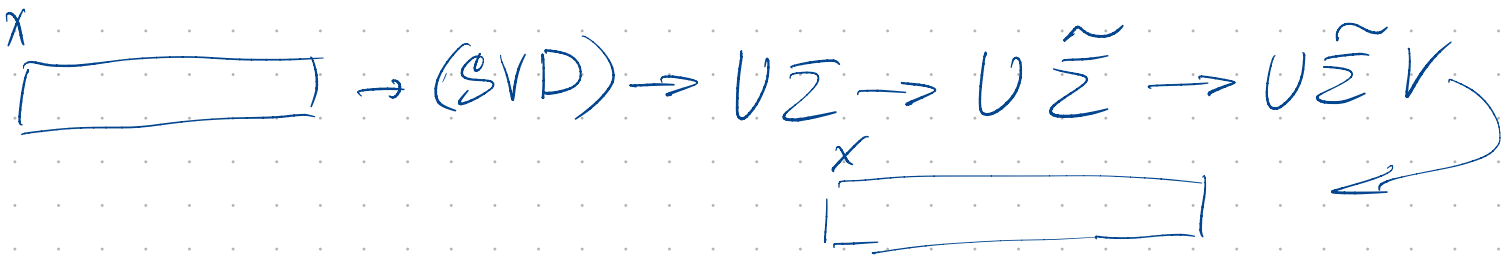
$$\Sigma = cov(\tilde{X}_i, \tilde{X}_j)$$

$$\hat{X} = U \Sigma V^T$$

$$U U^T = V^T U = \mathbb{1} = V V^T = V^T V$$

$$U = \begin{bmatrix} | & | & & | \\ u_1 & u_2 & \cdots & u_N \\ | & | & & | \end{bmatrix} \qquad \Sigma = \begin{bmatrix} \sigma_1 & 0 & & \\ 0 & \sigma_2 & \cdots & \\ & & \sigma_N & \\ 0 & 0 & 0 & 0 \end{bmatrix} \qquad V^T = \begin{bmatrix} | & | & | & | \\ v_1 & v_2 & v_3 & \cdots v_N \\ | & | & | & | \end{bmatrix}$$

$$T = U \Sigma$$



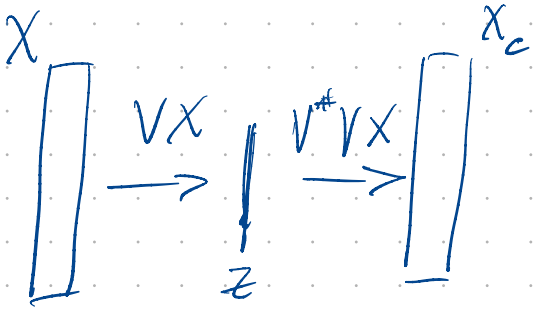
U – векторы гл. компонент ($|u_i| = 1$)

Σ – сингулярные значения, длины гл. компонент.

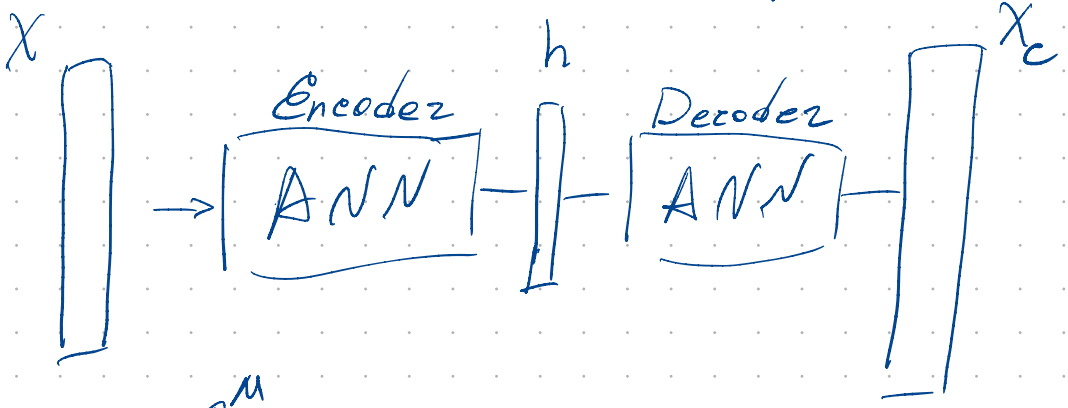
PCA:

$$X = U \Sigma V = V^T U \Sigma$$

$$VX = U\Sigma$$



PCA → нелинейное преобразование



Autoencoder
Автокодировщик

$X \in \mathbb{R}^M$ $h \in \mathbb{R}^H$ $H < M$

$X_c \in \mathbb{R}^M$

$X \to X_c$ $MSE(X_c, X)$: Decoder

$X \to h$ — " — : Encoder

$X_c = D(E(X))$

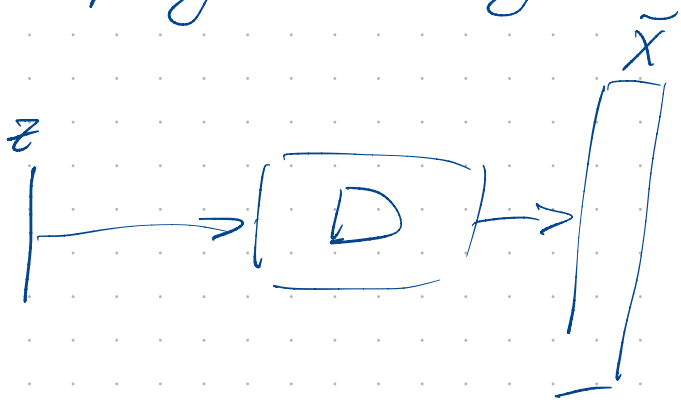
$\mathcal{L} = MSE(X_c, X)$ $MAE(X_c, X)$

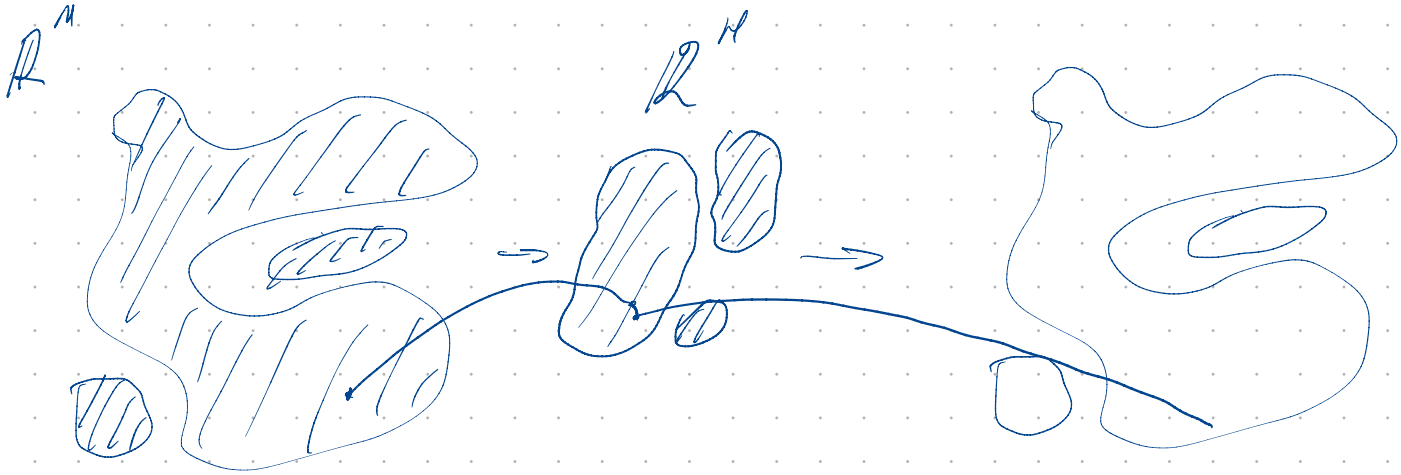
$MAPE(X_c, X)$

$CE(X_c, X)$

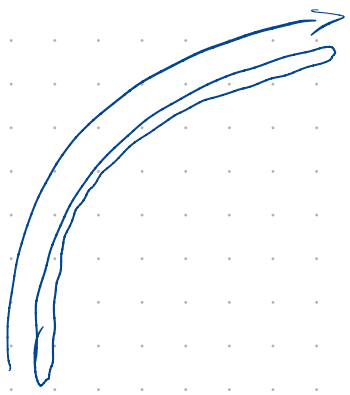
$CE(X_c, X) = -\sum x_i \log(x_{c_i})$

① Порождающая модель: $D(z)$ $z \in \mathbb{R}^H$

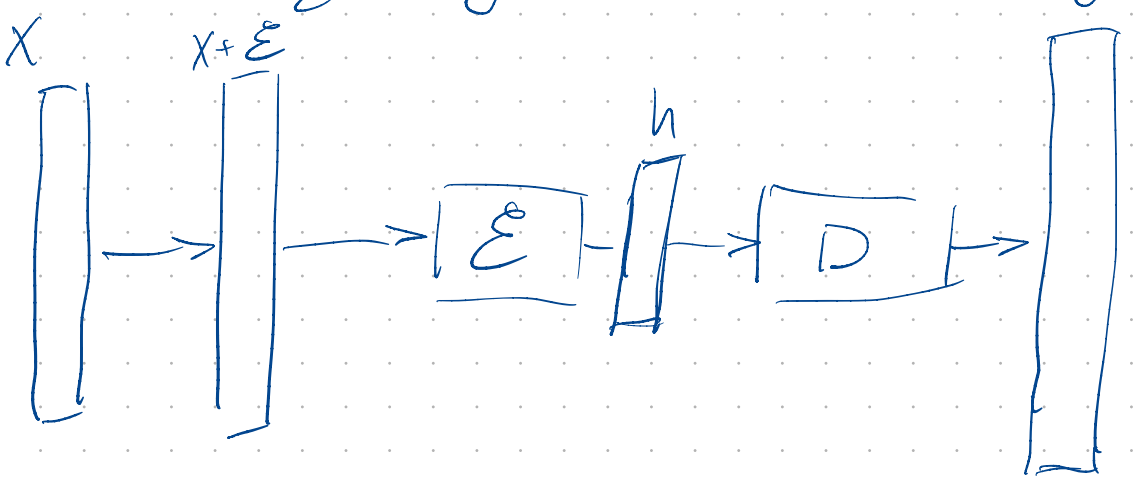




② Сокращение объёма хранимых данных.



(3) Шумоподавляющий автокодировщик.



$$\mathcal{L} = \mathcal{L}(\tilde{X}, X)$$