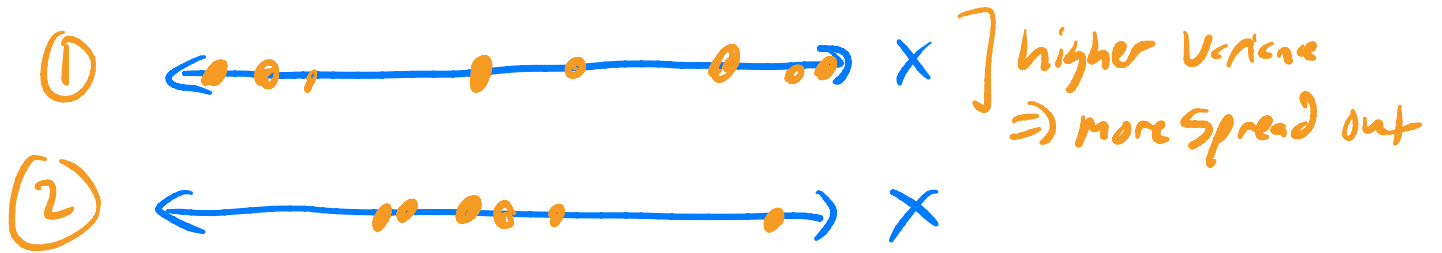


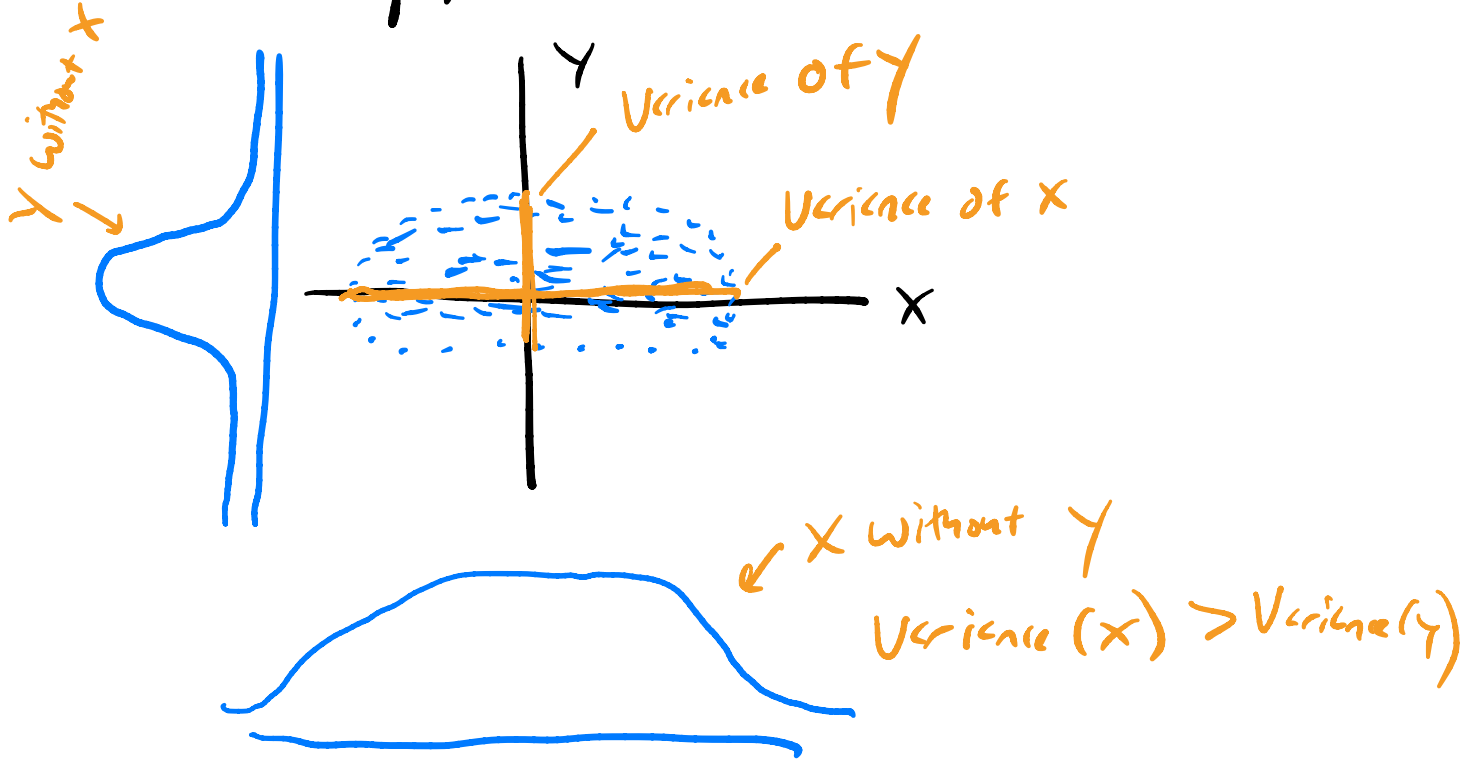
Covariance Matrix

Covariance Matrix

1D data we have plain old Sample Variance: "spread"



2D: Can't simply have one number to describe spread



2D data : organize Variances in Covariance matrix.

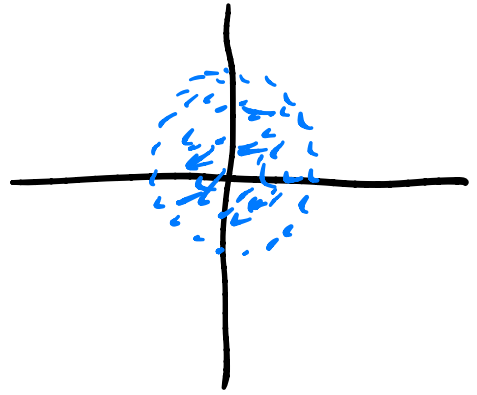
$\Sigma = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}$

Variance(x) → 2
 Variance(y) → 1

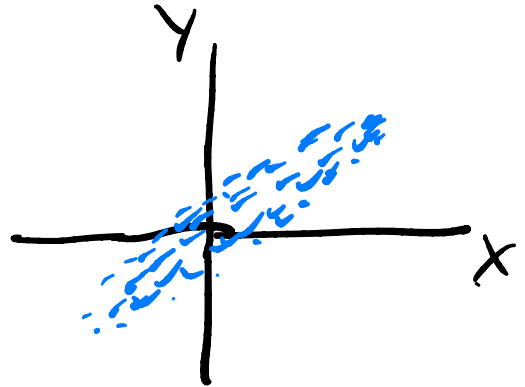
put Variance of each Separate var along this diagonal

Values in Σ not in main diagonal covariance are between $x \neq y$.

$$\Sigma = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{matrix} x \\ y \end{matrix}$$



$$\Sigma = \begin{bmatrix} 1 & 20 \\ 20 & 1 \end{bmatrix} \begin{matrix} x \\ y \end{matrix}$$



in general [20]: Covariance $(x, y) = \text{cov}(x, y)$

$$\Sigma = \begin{bmatrix} \text{cov}(x, x) & \text{cov}(x, y) \\ \text{cov}(y, x) & \text{cov}(y, y) \end{bmatrix} \begin{matrix} x \\ y \end{matrix} = \begin{bmatrix} \text{var}(x) & \text{cov}(x, y) \\ \text{cov}(y, x) & \text{var}(y) \end{bmatrix}$$

$$\star \text{cov}(x, y) = \text{cov}(y, x)$$

\star Covariance matrix Σ must be **Symmetric**
Matrix

$$\Sigma = \begin{bmatrix} 10 & 2 \\ 2 & 5 \end{bmatrix}$$

x
 y

x y

$$\Sigma = \begin{bmatrix} 10 & 1 \\ 3 & 5 \end{bmatrix}$$

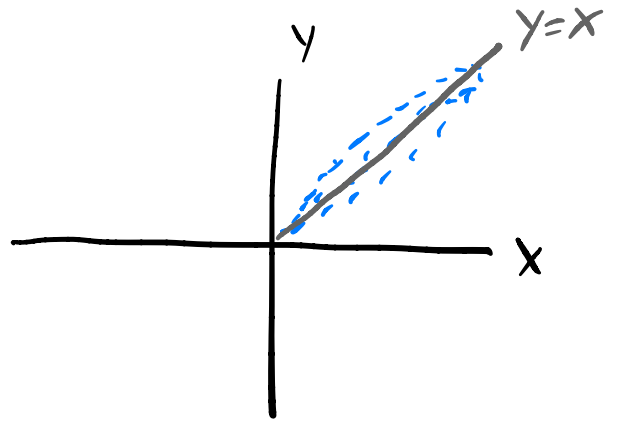
do not match!

doesn't work

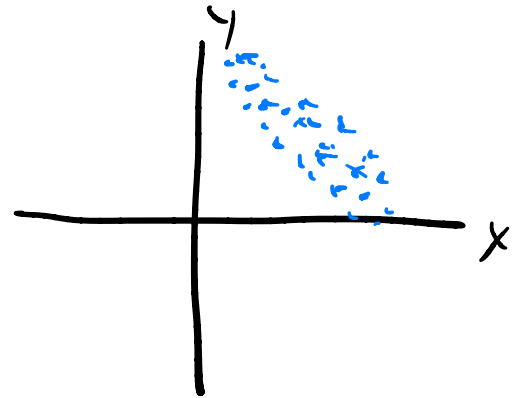
$\text{cov}(x, y) = 1$
 $\text{cov}(y, x) = 3$ } doesn't make sense!

Convergence Worksheet

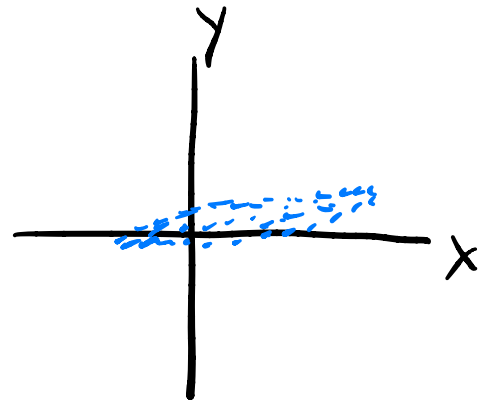
1a)
$$\begin{bmatrix} 10 & 5 \\ 5 & 2 \end{bmatrix}$$



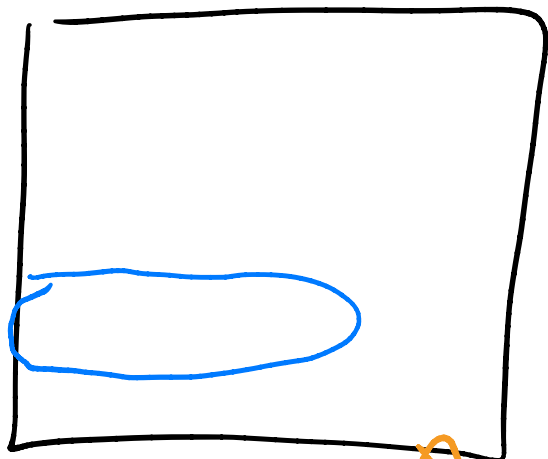
1b)
$$\begin{bmatrix} 10 & -5 \\ -5 & 2 \end{bmatrix}$$



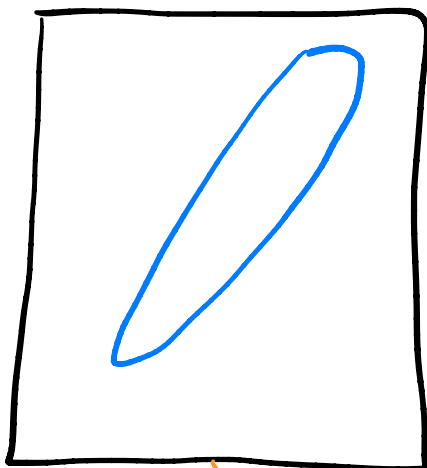
1c)
$$\begin{bmatrix} 5 & 0.1 \\ 0.1 & 2 \end{bmatrix}$$



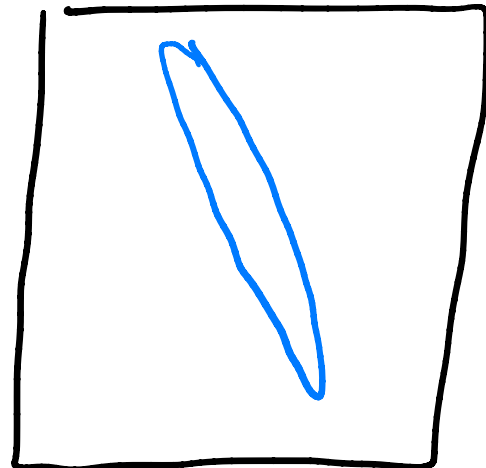
DS 1



DS 2



DS 3



i) $\begin{bmatrix} 7 & 0.1 \\ 0.1 & 7 \end{bmatrix}$

Annotations: "var x" with an arrow pointing to the top-left element (7), and "var y" with an arrow pointing to the bottom-right element (7).

ii) $\begin{bmatrix} 1 & -2 \\ -2 & 5 \end{bmatrix}$

iii) $\begin{bmatrix} 3.25 & -0.03 \\ -0.03 & 0.67 \end{bmatrix}$

iv) $\begin{bmatrix} 1 & 2.5 \\ 2.5 & 7 \end{bmatrix}$

