LINEAR AND DIFFERENTIAL CRYPTANALYSIS: ANOTHER VIEWPOINT

Fedor Malyshev, Andrey Trishin

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$$(x_1, \ldots, x_k, b) = (a, y_1, \ldots, y_k)C$$

PROBABILISTIC LINEAR RELATIONS

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Theorem 2. (Malyshev F. M.)

$$p_{D',D''} = \sum\nolimits_{\mathfrak{D} \in W(D',D'')} \tilde{p}_{\mathfrak{D}} +$$

$$+ \frac{1}{2^M} \sum\nolimits_{(L',L'') \in V_N^* \times V_M^*} (-1)^{D'L' + D''L''} \sum_{\substack{\mathfrak{L}_1, \mathfrak{L}_2 \in \mathfrak{M}(L',L''): \\ \mathfrak{L}_1 \neq \mathfrak{L}_2}} \tilde{\delta}_{\mathfrak{L}_1} \tilde{\delta}_{\mathfrak{L}_2}.$$

Theorems 1 and 2 are proved based on the separation of the cipher functional scheme into nonlinear part and *linear medium*.

Theorem 1 has been proved in special cases:

Daemen J., Govaerts R., Vandewalle J. Correlation matrices / Advances in Cryptology – FSE'1994. – LNCS, 1995, vol. 1008, pp. 275–285.

Daemen J. Cipher and hash function design strategies based on linear and differential cryptanalysis / Doctorial Dissertation, March 1995, K.U. Leuven.

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Theorem 2 follows from Theorem 1 and the fact taken from

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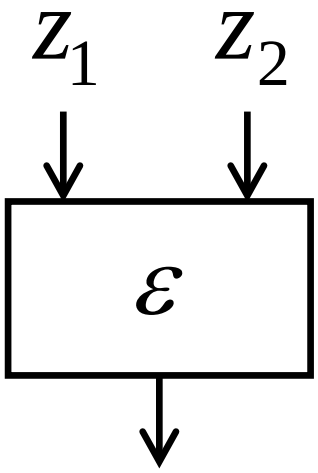
Theorem 2 has been proved in a different smart way by Fedchenko V.A.

UNIVERSAL FUNCTIONAL SCHEME



$$g_\varepsilon,\ \varepsilon = 0,1$$

$$\overline{z}_1 z_2 \cdot \varepsilon + z_1 \overline{z}_2 \cdot \overline{\varepsilon}$$

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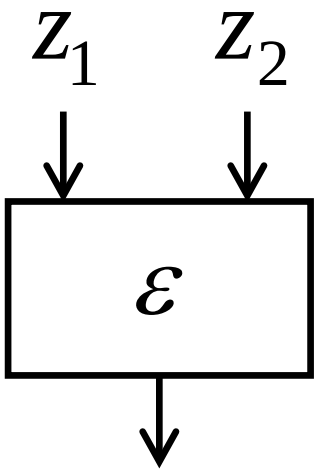

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If $l_i'' \neq 0$ then $\left|\delta_{l_i', l_i''}^{g_\varepsilon}\right| = 1/2.$

If $d_i' \neq 0$ then $p_{d_i', d_i''}^{g_\varepsilon} = 1/2.$

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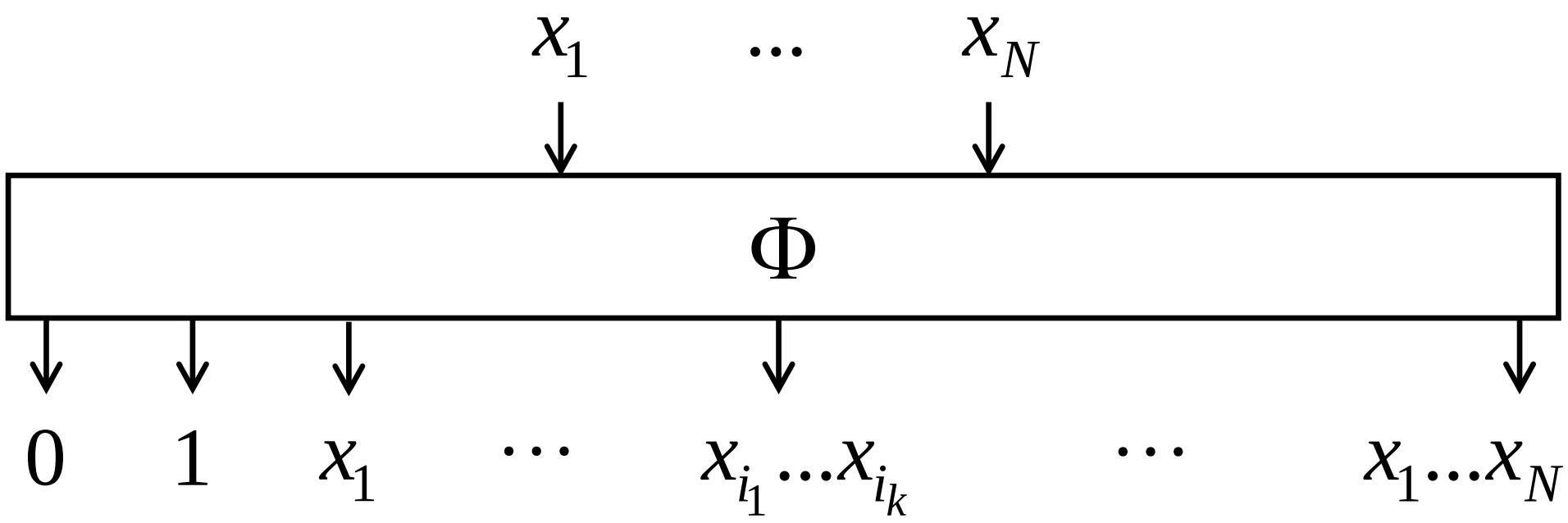

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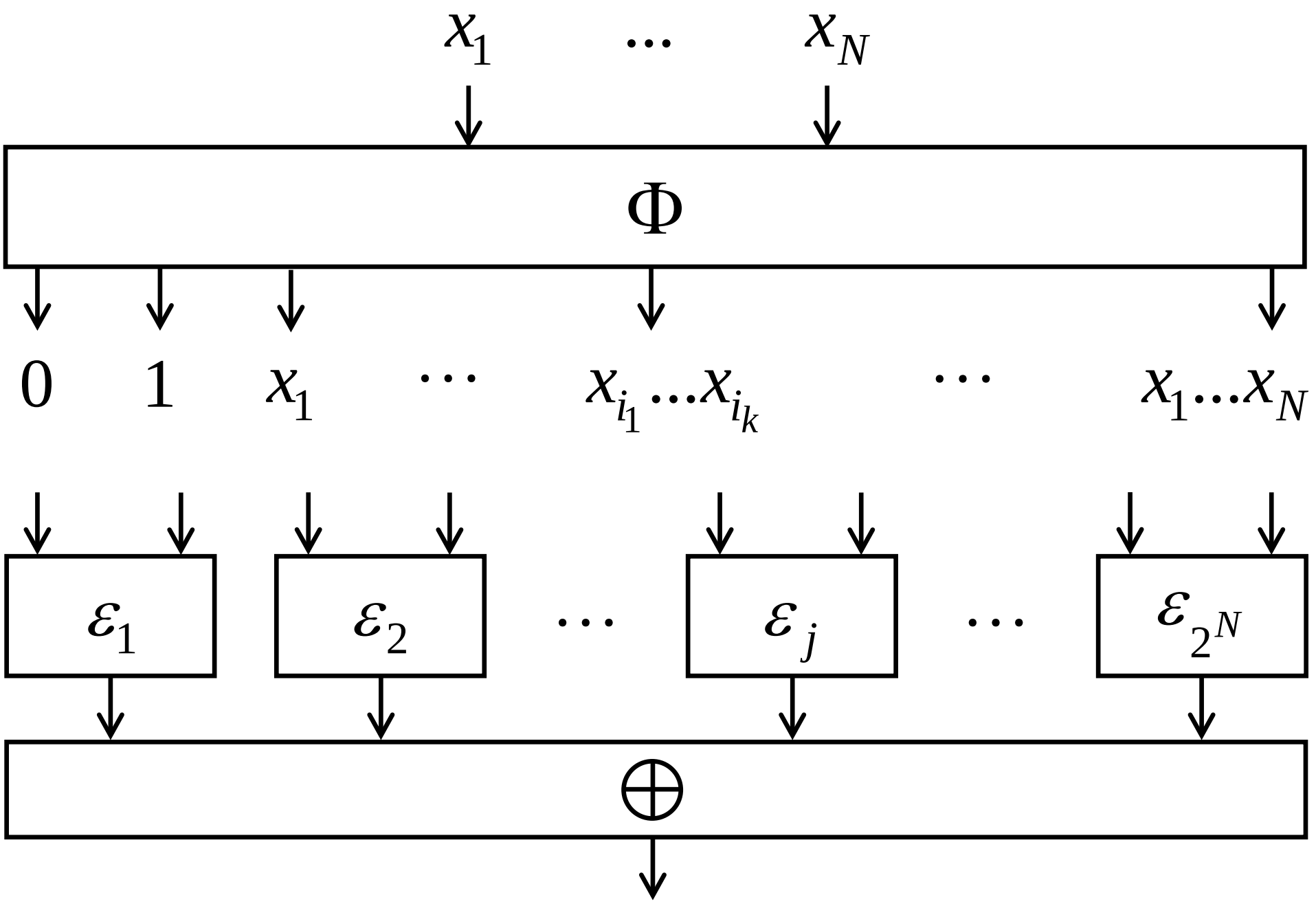

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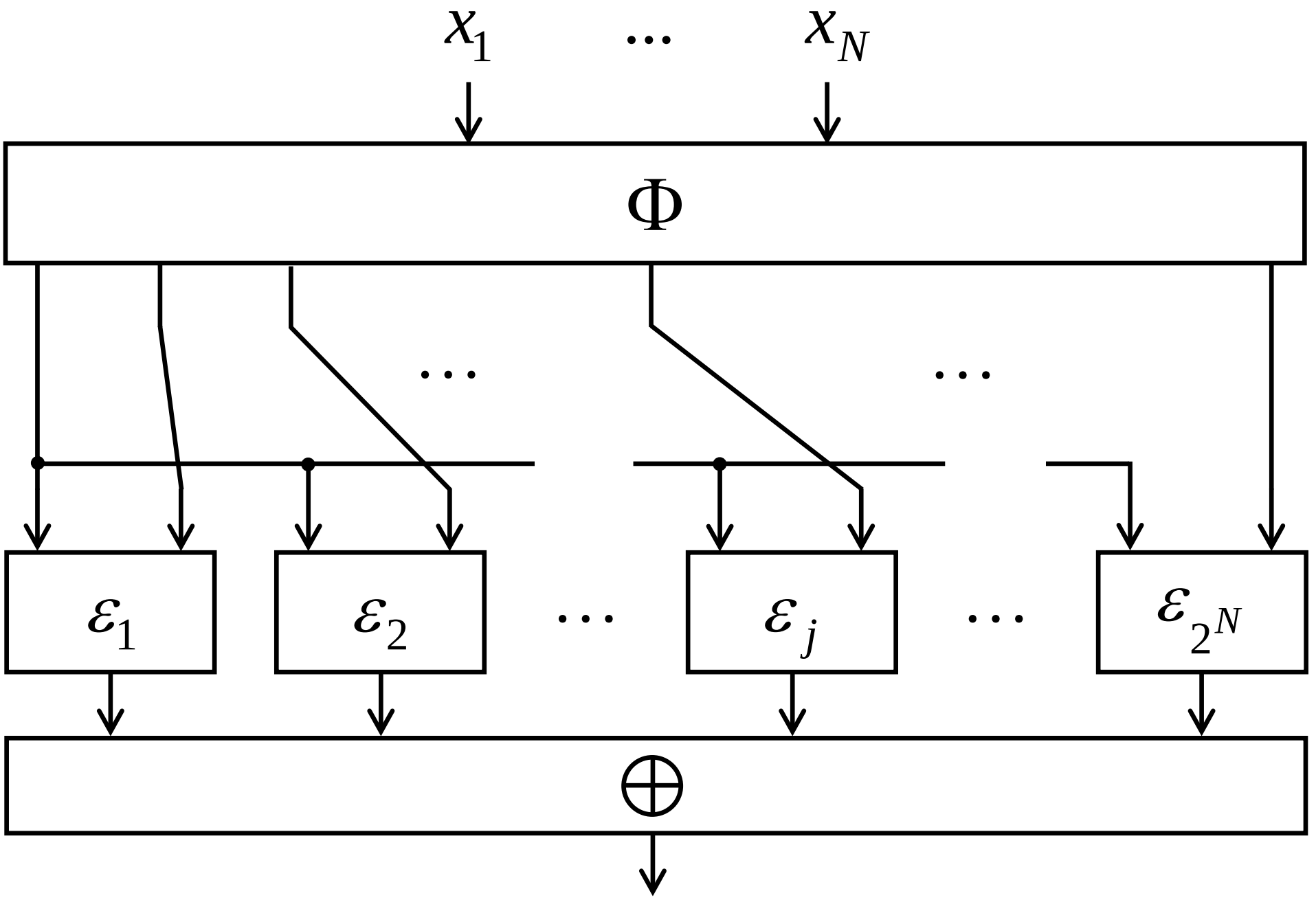

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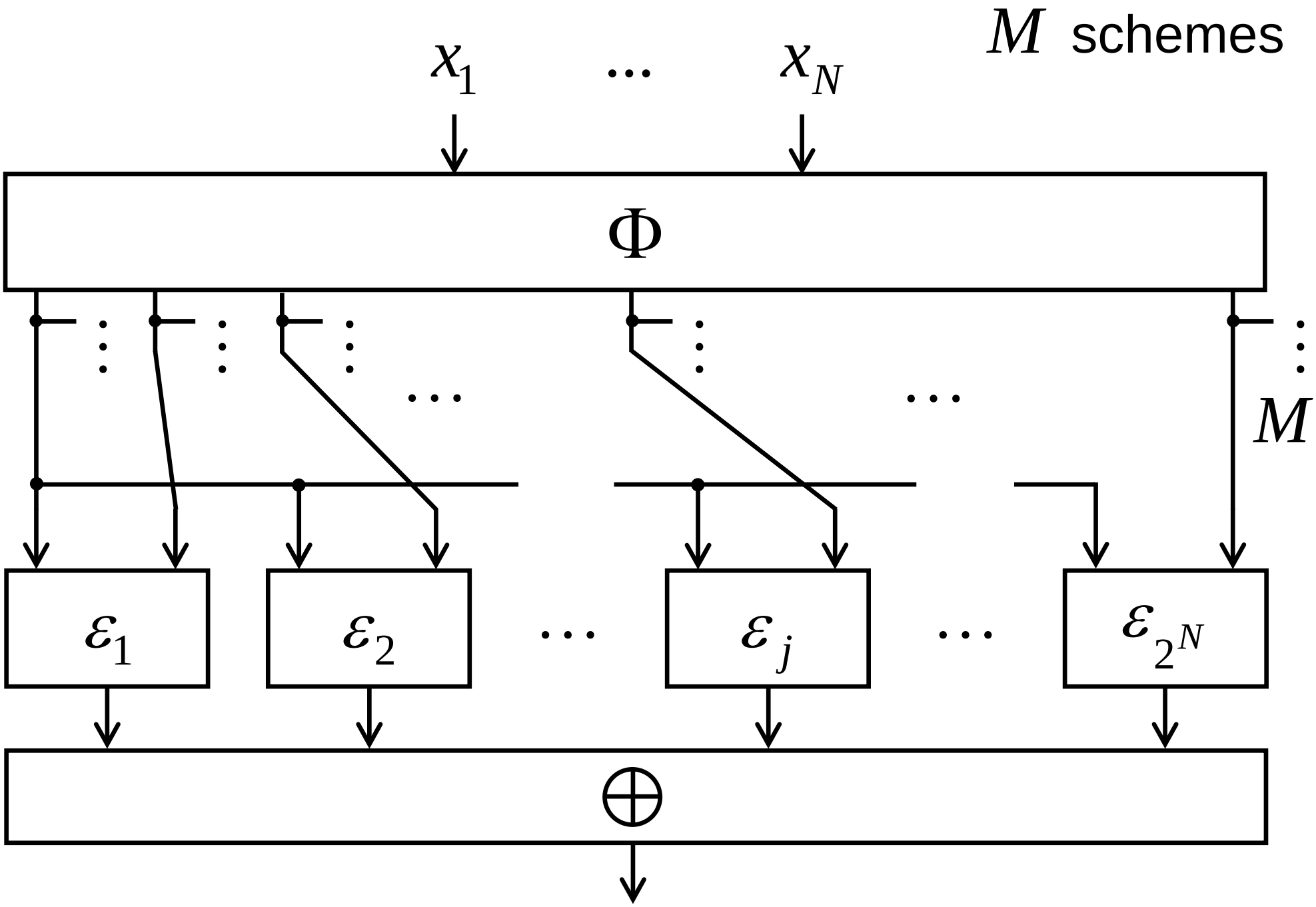

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the same linear medium C;

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We have come to a complete absurdity

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Let see more examples.

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Two systems $\mathfrak{L}_1$, $\mathfrak{L}_2$ have been found such that:

$$\left|\tilde{\delta}_{\mathfrak{L}_1}\right| = \left|\tilde{\delta}_{\mathfrak{L}_2}\right| = 0,03...$$

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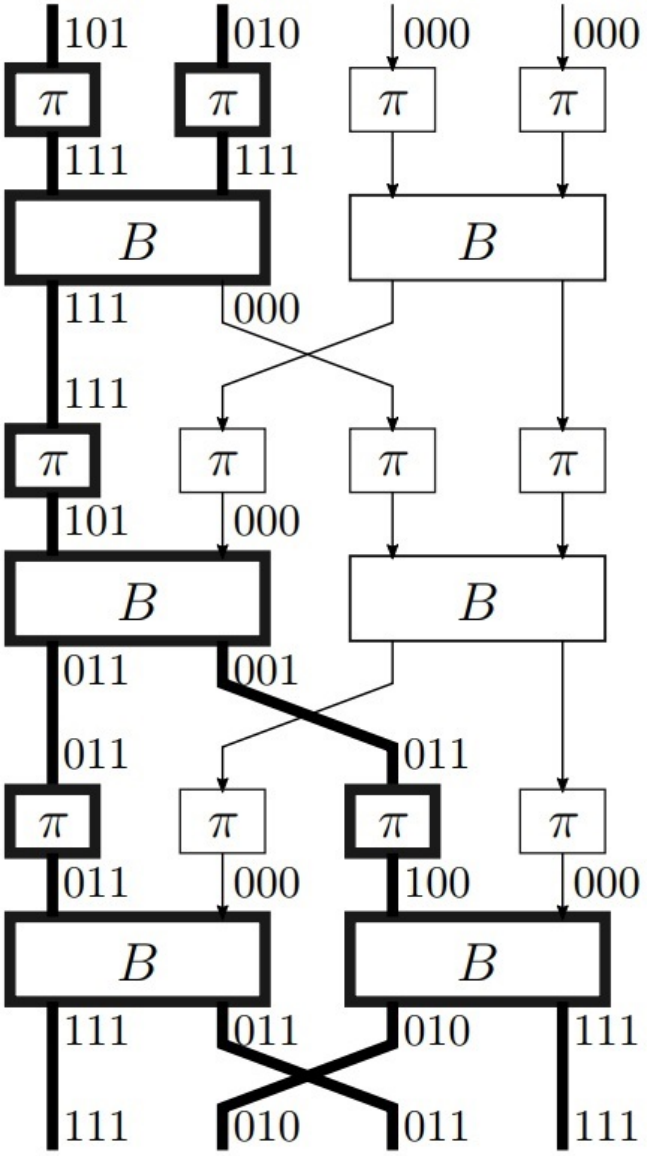

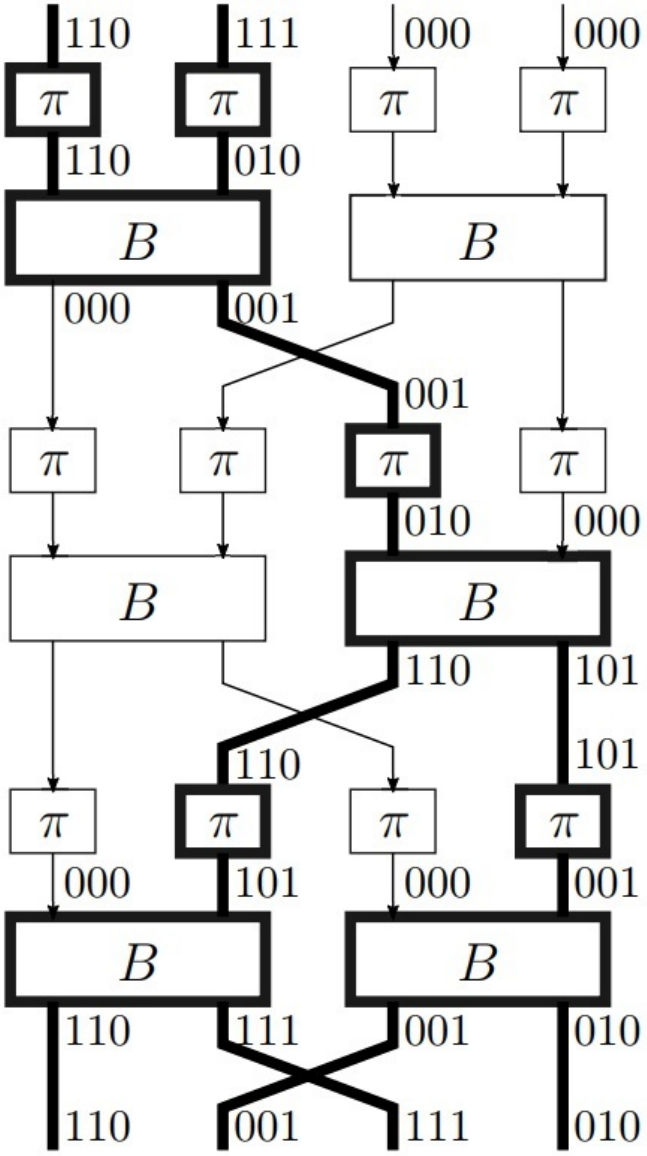

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SO, METHODS DO NOT ALWAYS WORK

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PROBLEM: In what cases the methods work?

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IT IS IMPORTANT TO VERIFY THE RESULTS !

METHODOLOGY OF EXPERIMENTS

$$\text{Is } \tilde{\delta}_{\mathfrak{L}} \approx \delta_{L',L''}?$$

Is $\tilde{\delta}_{\Sigma} \approx \delta_{L',L''}$?

if $\tilde{\delta}_{\Sigma}$ is significant

Obtain
an empirical
estimations

δ^*

Is $\tilde{\delta}_{\Sigma} \approx \delta_{L',L''}$?

if $\tilde{\delta}_{\Sigma}$ is significant

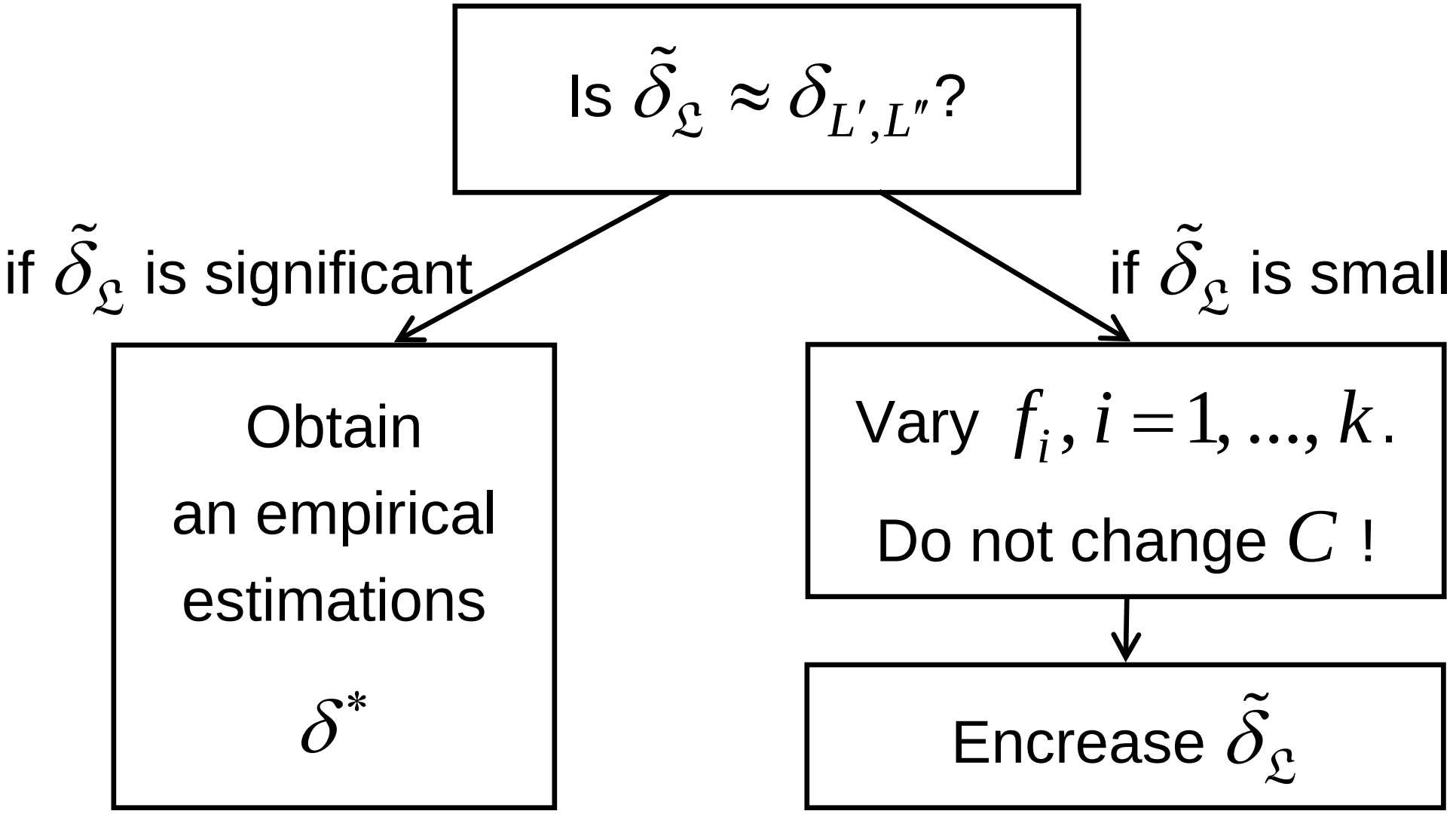
Obtain an empirical estimations δ^*

if $\tilde{\delta}_{\Sigma}$ is small

Vary $f_i, i = 1, ..., k$.

Do not change C !

METHODOLOGY OF EXPERIMENTS



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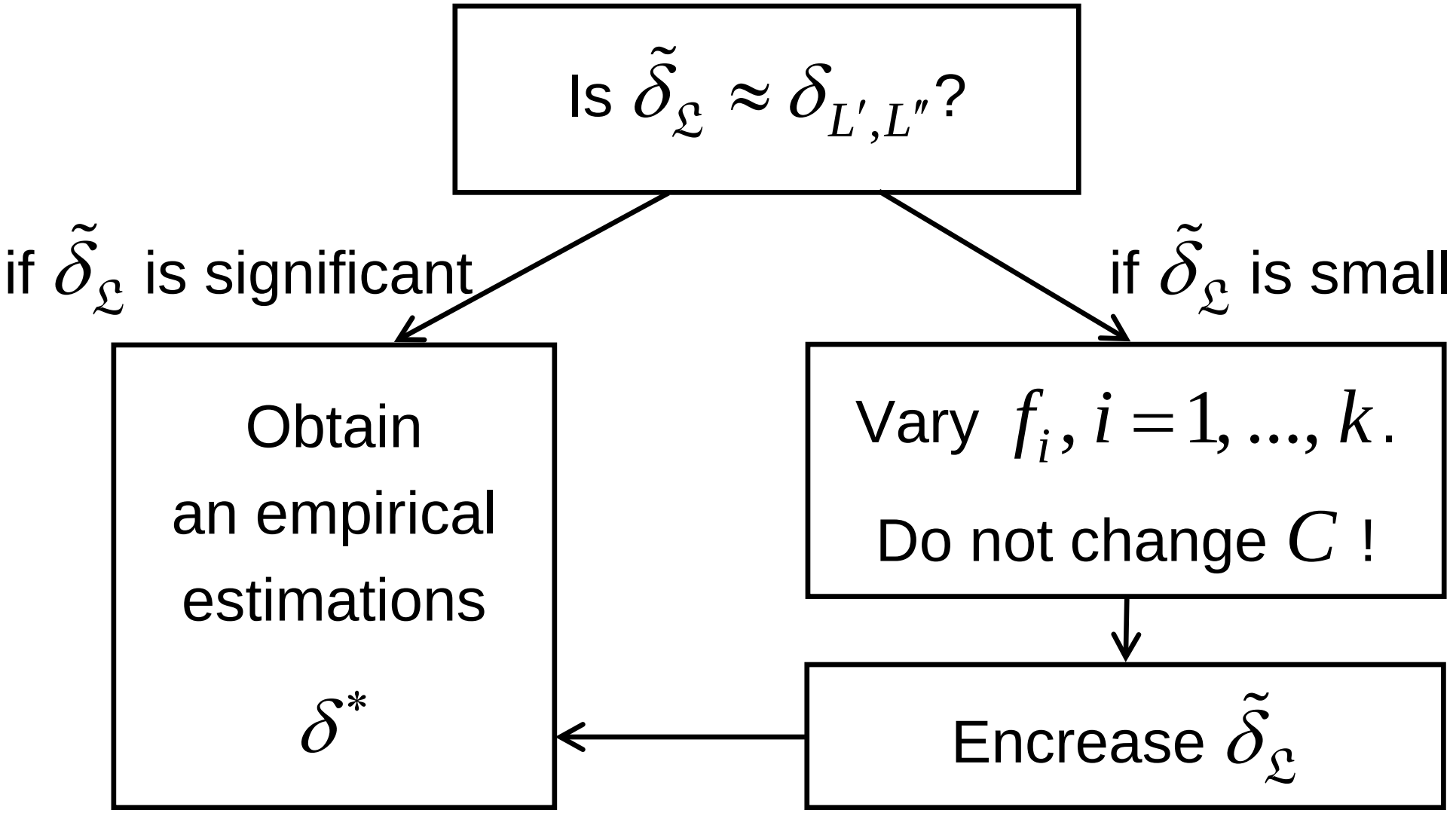

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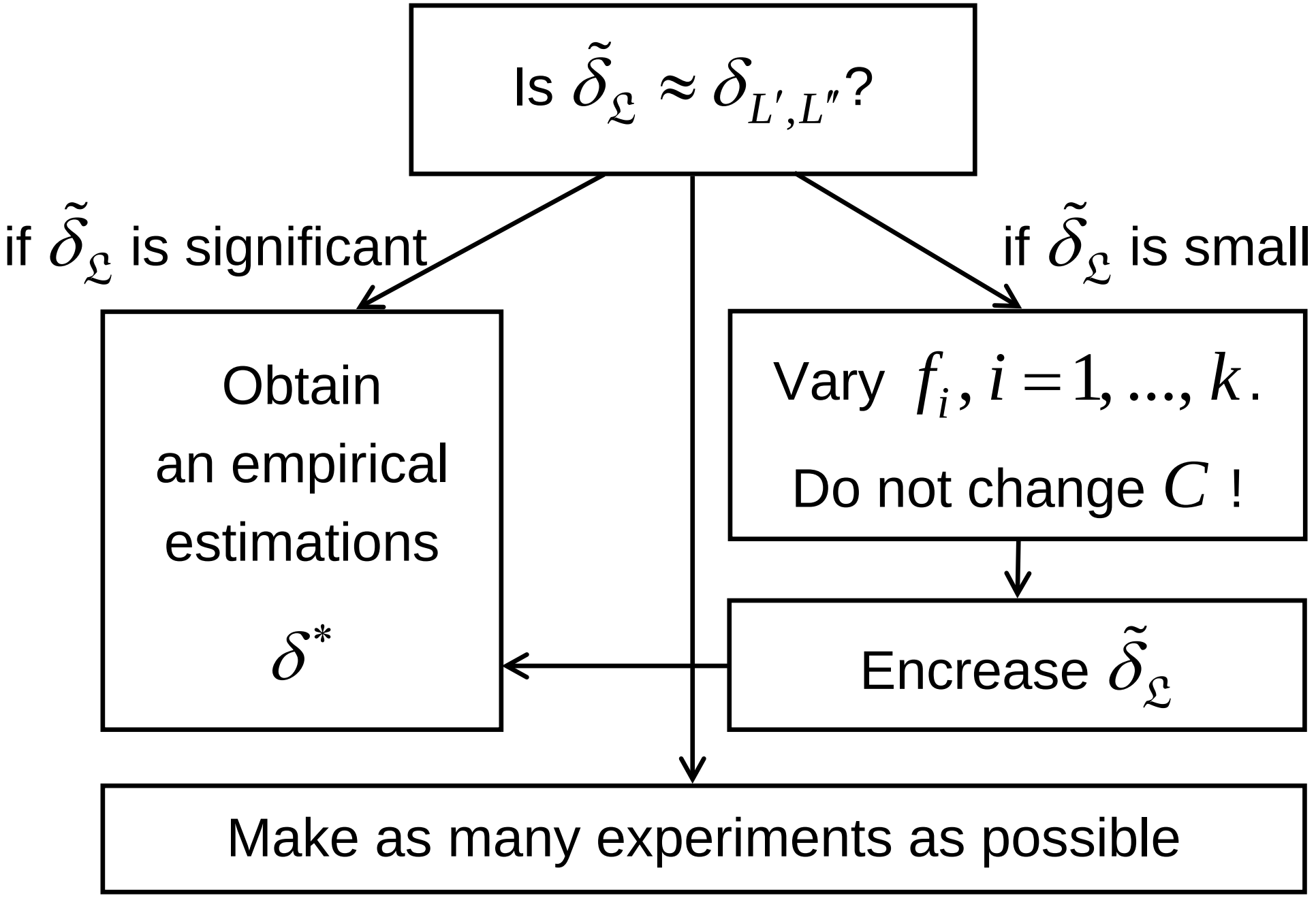

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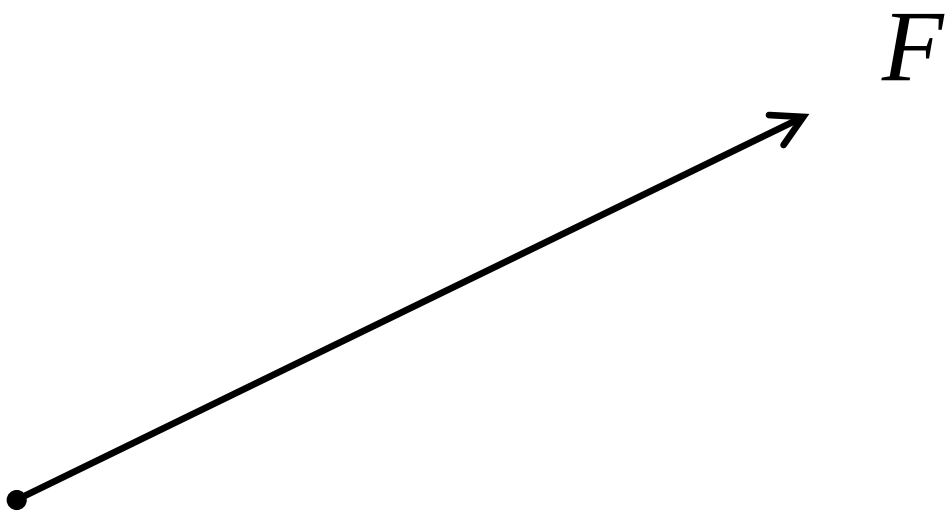

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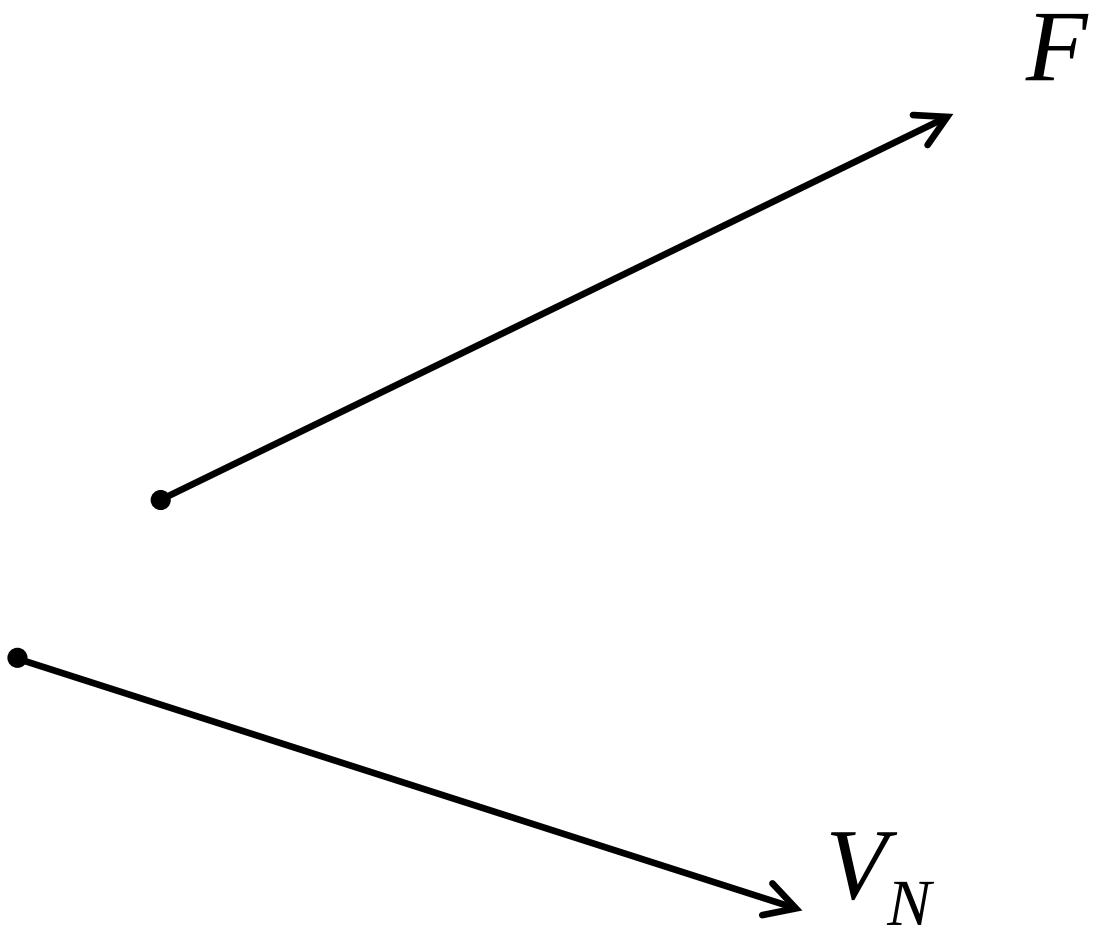

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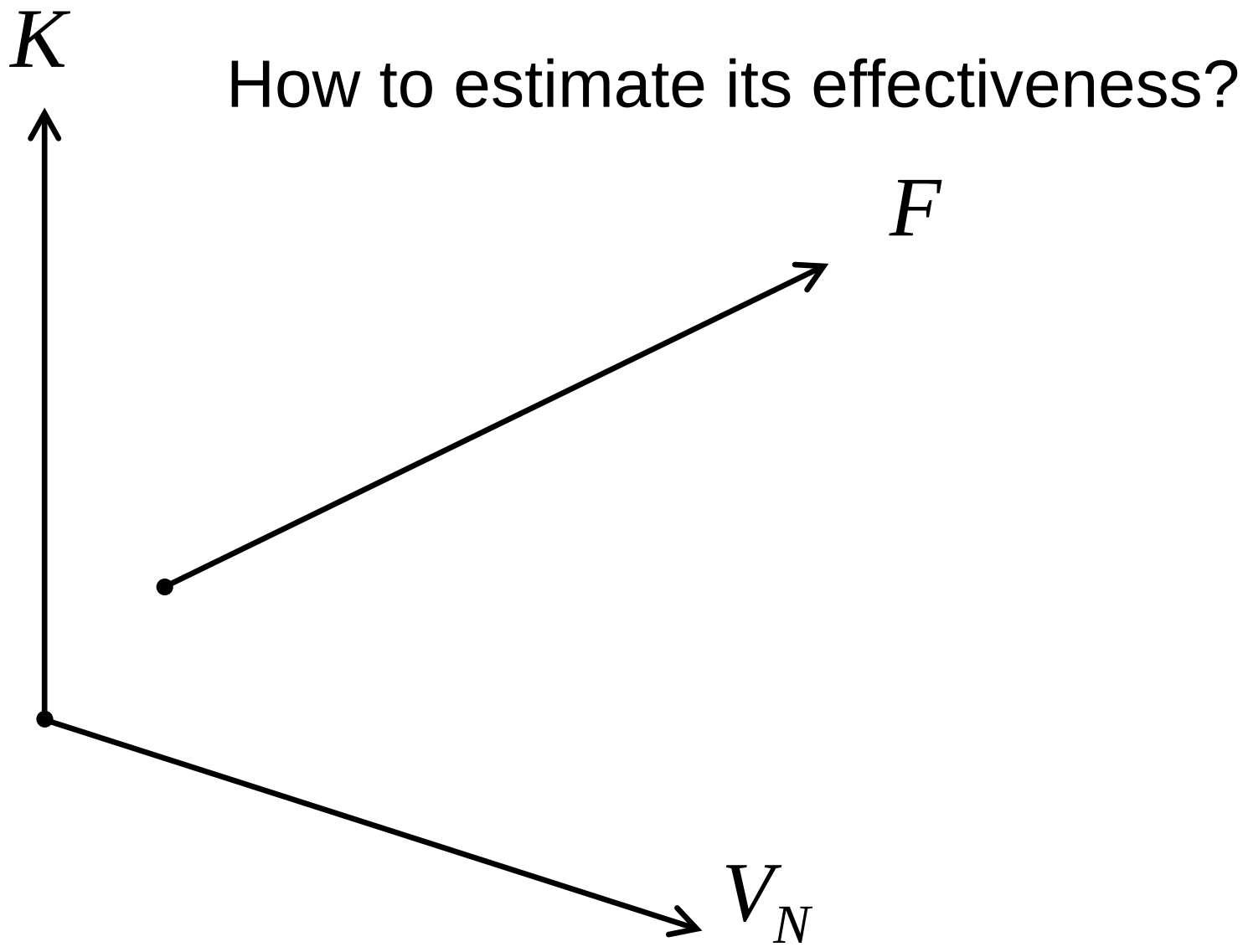

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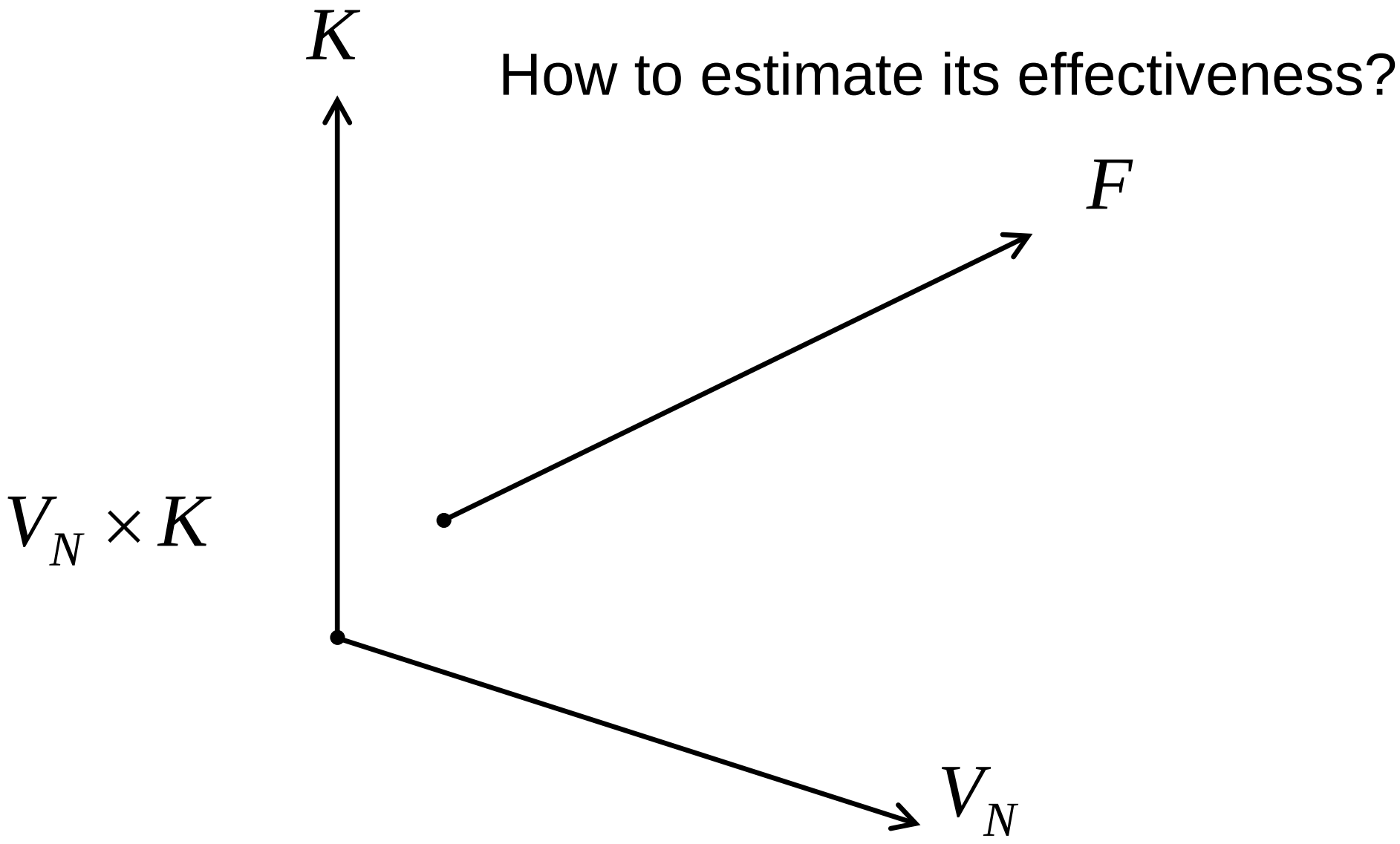

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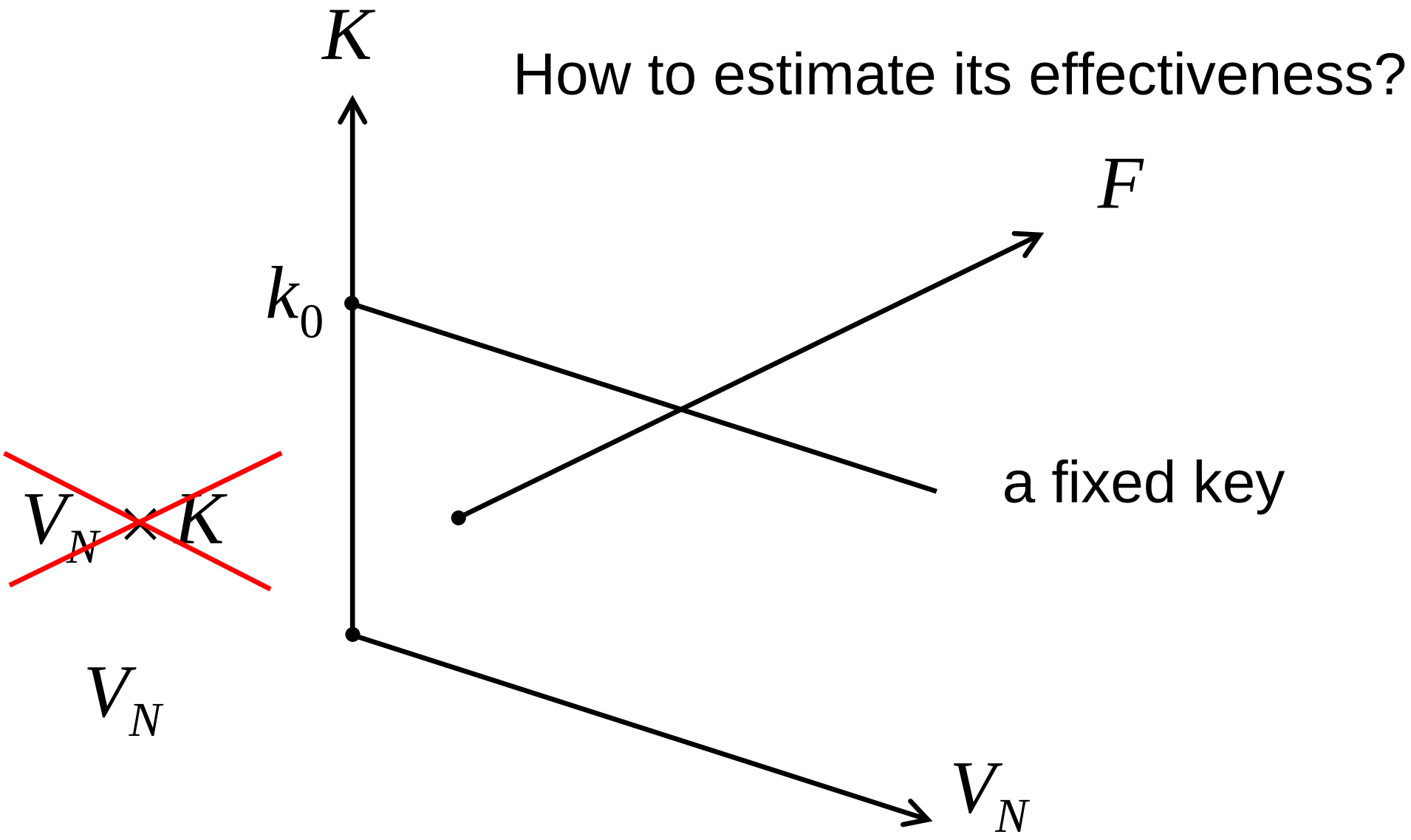

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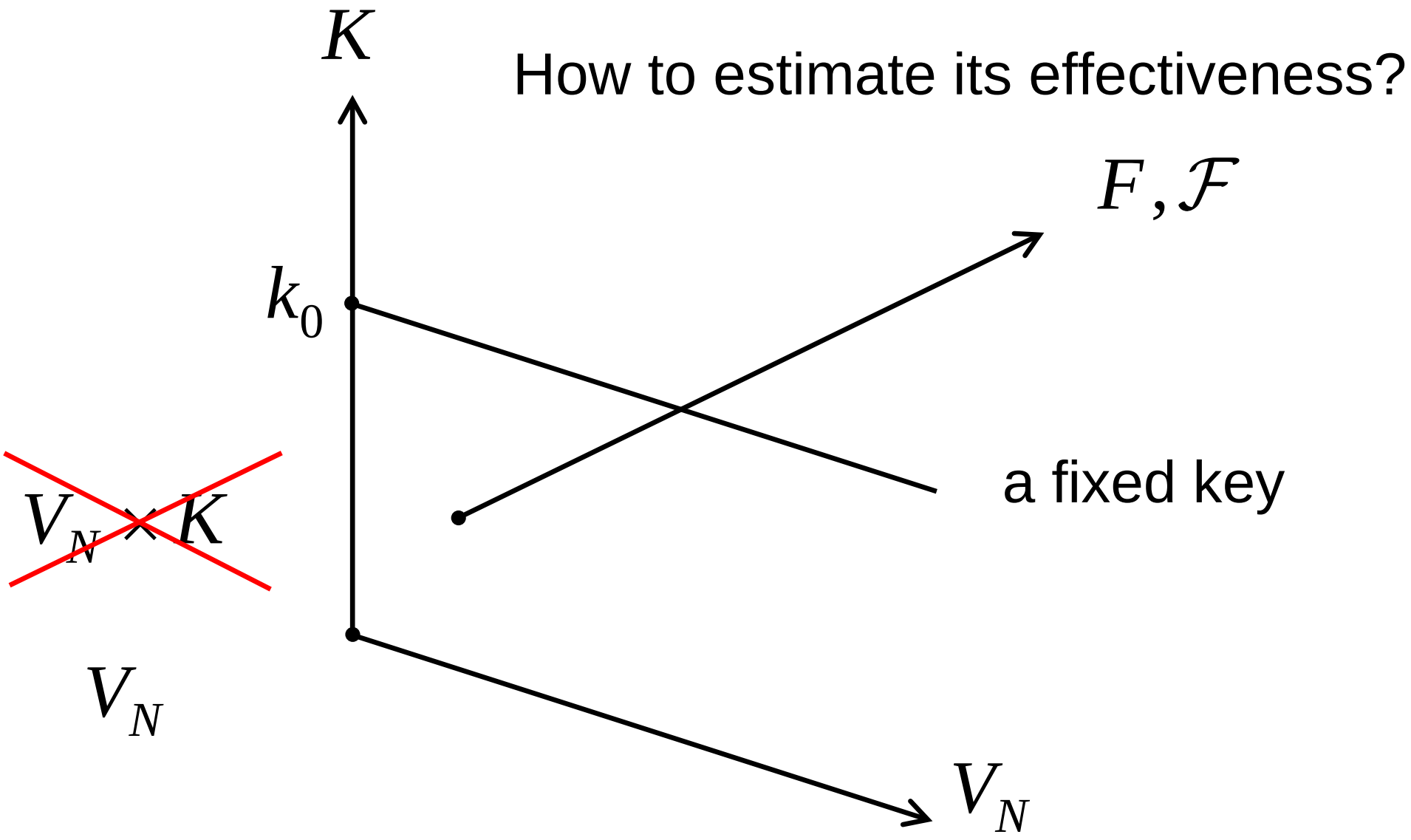

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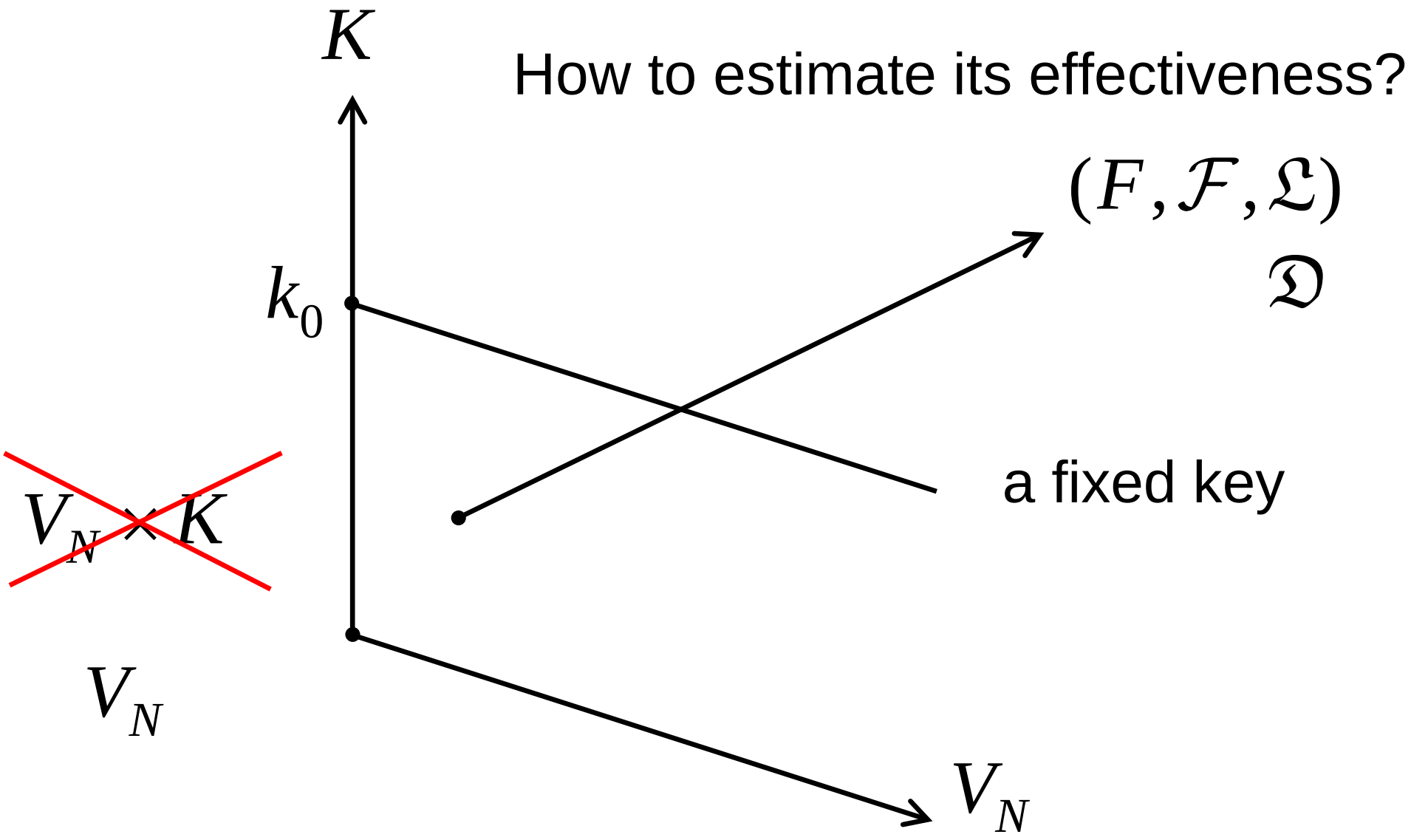

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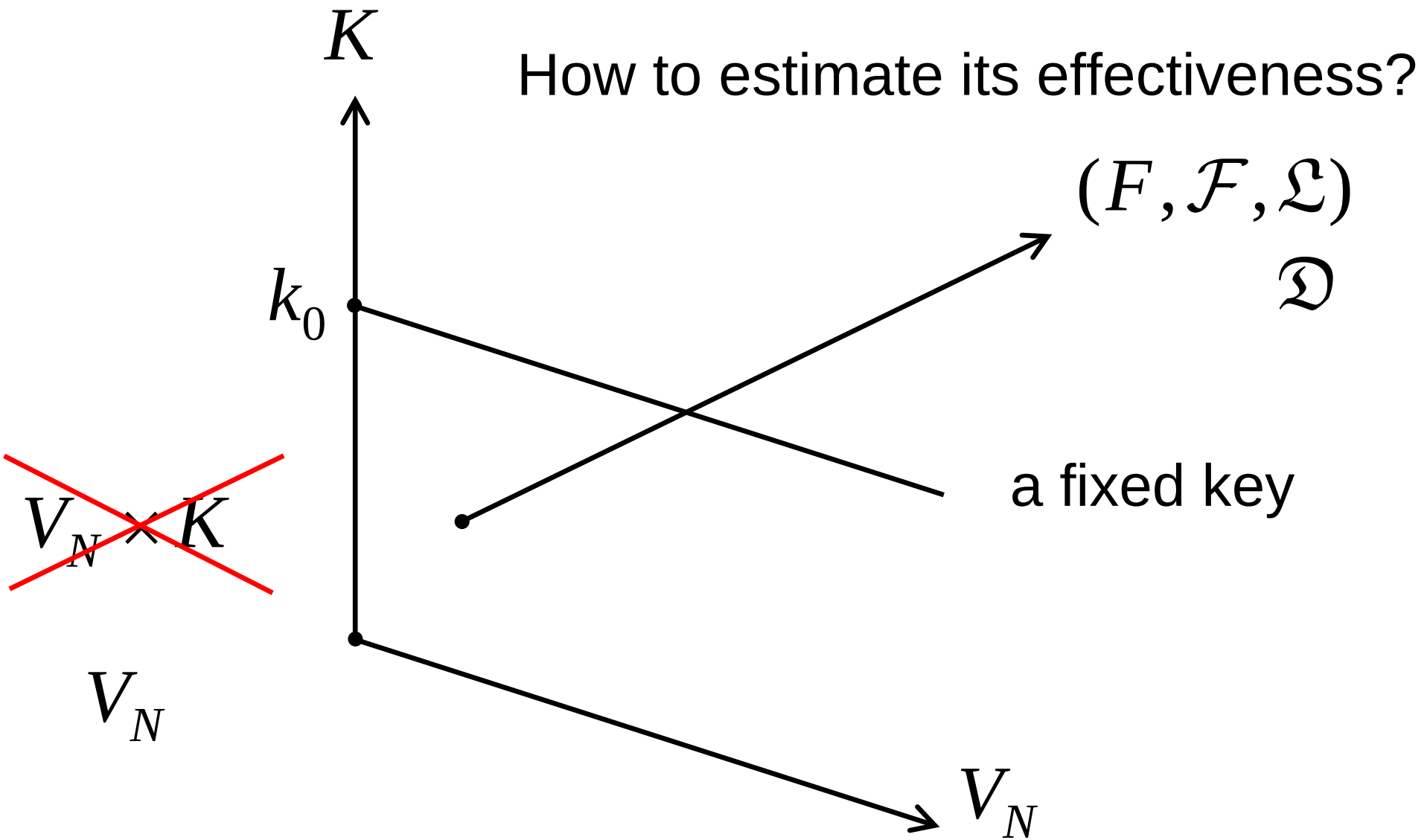

SOMETIMES due to $(F, \mathcal{F}, \mathfrak{L}, k_0)$.
$\mathfrak{D}$

THE DUALITY OF LINEAR AND DIFFERENTIAL CRYPTANALYSIS

$$C\begin{pmatrix} l'_1 \\ \vdots \\ l'_k \\ L'' \end{pmatrix} = \begin{pmatrix} L' \\ l''_1 \\ \vdots \\ l''_k \end{pmatrix}$$

$$(D', d''_1, ..., d''_k)C =$$
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$$(l'^T_1, ..., l'^T_k, L''^T)C^T = \\ = (L'^T, l''^T_1, ..., l''^T_k)$$

$$C^T\begin{pmatrix} D'^T \\ d''^T_1 \\ \vdots \\ d''^T_k \end{pmatrix} = \begin{pmatrix} d'^T_1 \\ \vdots \\ d'^T_k \\ D''^T \end{pmatrix}$$

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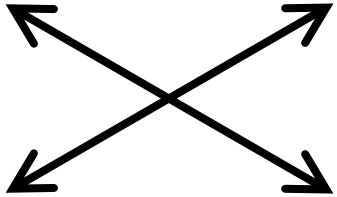

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2. Theorems 1, 2
3. Universal functional scheme
4. Methodology of experiments
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QUESTIONS?

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