$$\int P(x)\,dx = \int P(\cancel{\phi}\, x(y)) \left|\frac{\partial x}{\partial y}\right| dy$$

convolution Thm for probability of $\cancel{z} = x_1 + x_2$

SAVE

$$P(y) = P(x(y)) \left|\frac{\partial x}{\partial y}\right|$$

now let $\underline{y} = \underline{\underline{A}}\,\underline{x}$ $\quad P(\underline{x}) = F(\underline{x})$

$$P(\underline{y}) = |\underline{\underline{A}}|^{-1} F(\underline{\underline{A}}^{-1} \underline{y})$$

let $\underline{y} = [y_1, y_2]^T$

$$P(y_1) = \int |\underline{\underline{A}}|^{-1} F(\underline{A}^{-1} \underline{y})\, dy_2$$

let $\underline{\underline{A}} = \begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$ so $|A| = 2$

$A^{-1} = \frac{1}{2}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$

$$P(y_1) = \cancel{\int F(x)\, dy_2}$$

$$= \int \tfrac{1}{2} F(\underline{\underline{A}}^{-1} y)\, dy_2 =$$

$$= \tfrac{1}{2} \int F\left(\frac{y_1 - y_2}{2}, \frac{y_1 + y_2}{2}\right) dy_2$$

let $F(x_1, x_2) = F_1(x_1) F_2(x_2)$

$$= \tfrac{1}{2} \int F_1\left(\frac{y_1 - y_2}{2}\right) F_2\left(\frac{y_1 + y_2}{2}\right) dy_2$$

let $z = (y_1 + y_2)/2$ $\quad dz = \frac{1}{2} dy_2$

$y_2 = 2z - y_1$

$$= \int F_1(y_1 - z)\, F_2(z)\, dz$$

$\frac{y_1 - y_2}{2} = \frac{y_1 - 2z + y_1}{2} = \frac{2y_1 - 2z}{2} = y_1 - z$