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$D = \text{diag}(\lambda_n, n \in \mathbb{N})$

λ_n is not bounded

$$\exists x \in \ell^2 \Rightarrow Dx \notin \ell^2$$

we choose $x = (1, 1/4, 1/9, \dots, 1/n^2, \dots)$

$$\|x\|_2^2 < \infty \Rightarrow x \in \ell^2$$

$$\|Dx\|_2^2 = \sum_{n=1}^{\infty} (\lambda_n x_n)^2 = \sum_{n=1}^{\infty} \lambda_n^2 x_n^2 \rightarrow \text{this is divergent,}$$

because we multiply

x_n with a sequence that

is not bounded, it so
the sum of their product
~~this sum~~ will tend

to infinity



$$Dx \notin \ell^2$$