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Ul'yanov-type inequality for bounded convex sets in R^d

For $\Omega \in R^d$, a convex bounded set with non-empty interior, the moduli of smoothness $\omega^r(f,t)_{L_q(\Omega)}$ and the norm $\|f\|_{L_q(\Omega)}$ are estimated by an Ul'yanov-type expression involving $\omega^r(f,t)_{L_p(\Omega)}$ where $0 < p < q \le \infty$. The main result for $q < \infty$ is given by

$$\omega^r(f,t)_q \le C\left\{\int_0^t u^{-q\theta}\omega^r(f,u)_p^q\frac{du}{u}\right\}^{1/q}, \quad 0 < t \le \operatorname{diam}\Omega, \quad \theta = \frac{d}{p} - \frac{d}{q}.$$

A corresponding estimate of $\|f\|_{L_q(\Omega)}$ is, in fact, an embedding theorem involving Besov spaces with a range of q more general than known today. The power q achieved is optimal.