

#### WEIGHTED NORMS

# Why

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## **Definition**

**Proposition 1.** Let W be a positive semidefinite n by n matrix. Then  $g: \mathbb{R}^n \to \mathbb{R}$  defined by  $g(x) = \sqrt{x^\top W x}$  is a norm on  $\mathbb{R}^n$ .

#### Notation

Let  $W \in \mathbb{R}^{n \times n}$ , positive semidefinite. Then we denote the norm corresponding to W by  $\|\cdot\|_W$ . So then, the norm of a vector  $x \in \mathbb{R}^n$  is  $\|x\|_w$ . Notice that  $\|x\|_W = \|W^{1/2}x\|_2$ .

## Visualization

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We can compare the Euclidean norm on  $\mathsf{R}^2$  with the weighted norm given by

$$W = \begin{pmatrix} 2 & 1 \\ 1 & 4 \end{pmatrix}$$

<sup>&</sup>lt;sup>1</sup>Future editions will include this.

 $<sup>^2</sup>$ Future editions will visualize these norms as function on  $\mathsf{R}^2$ , via contour plots.

