

In summary: ①  $A = QR$ ,  $Q^T \vec{b} = \begin{pmatrix} \vec{c} \\ \vec{d} \end{pmatrix}$

②  $\vec{x} = R^{-1} \vec{c}$

③  $\|\vec{x}\|_2 = \|\vec{c}\|_2$

Ex.: (3) Same as ex. (2) but with QR

no slides

(Of course, we get the same result!)

(4) Same as ex. (2) & (3) but with the MATLAB

all-in-one solution:  $\vec{x} = A \backslash \vec{b}$

↖ backslash operator

## V.2 Non-linear Least-Squares

Let's now consider the case of overdetermined nonlinear systems of equations

$$\begin{aligned}
 f_1(x_1, \dots, x_n) &= b_1 \\
 f_2(x_1, \dots, x_n) &= b_2 \\
 &\vdots \\
 f_m(x_1, \dots, x_n) &= b_m
 \end{aligned}
 \quad \text{or short} \quad
 \begin{aligned}
 & \vec{f}: D \subset \mathbb{R}^n \rightarrow \mathbb{R}^m \\
 & \vec{f}(\vec{x}) = \vec{b} \quad \vec{b} = \begin{pmatrix} b_1 \\ \vdots \\ b_m \end{pmatrix} \in \mathbb{R}^m \\
 & \vec{x} = \begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} \in \mathbb{R}^n
 \end{aligned}$$

m (nonlinear) equations in n unknowns.

Usually  $m \gg n$  (many more measurements than parameters!)