

Eg. statica:

$$\textcircled{1} \quad m_1 g - c_1 z_1 + c_2 (z_2 - z_1) = 0$$

$$\textcircled{2} \quad m_2 g + c_2 (z_1 - z_2) - c_3 (z_2 - h) = 0$$

sistema da studiare:

$$A \rightarrow \begin{bmatrix} c_1 + c_2 & -c_2 \\ -c_2 & c_2 + c_3 \end{bmatrix} \begin{bmatrix} z_1 \\ z_2 \end{bmatrix} = \begin{bmatrix} m_1 g \\ m_2 g + c_3 h \end{bmatrix}$$

- parametri:  $c_1 = c_2 = c_3 = 100 \text{ N/m}$   
 $m_1 = m_2 = 1 \text{ kg}$   
 $g = 9,81 \text{ m/s}^2$ ;  $h = 5 \text{ m}$

- soluzione:  $z_1^* \approx 1,76 \text{ m}$ ;  $z_2^* \approx 3,43 \text{ m}$

- valore g noto solo con approssimazione:  $|\delta g| < 10^{-2}$

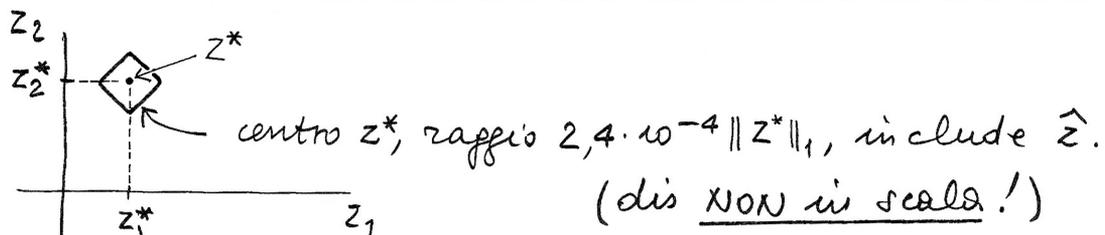
$\Rightarrow$  perturbaz dati:  $f = \begin{bmatrix} m_1 \delta g \\ m_2 \delta g \end{bmatrix}$ ,  $E = 0$ ,

$$\epsilon_b = \frac{\|f\|_1}{\|b\|_1} < \frac{2}{500} |\delta g| < 4 \cdot 10^{-5} \quad (= \alpha)$$

- $c_1(A) = 3 \Rightarrow \alpha c_1(A) < \frac{1}{10}$

- $\hat{z}$ : soluzione con  $\hat{g}$  t.c.  $|g - \hat{g}| < 10^{-2} \dots$

Teo condiz  $\Rightarrow$   $\frac{\|\hat{z} - z^*\|_1}{\|z^*\|_1} \leq 2 \alpha c_1(A) \approx 2,4 \cdot 10^{-4}$



- $\frac{\|z^*\|_1}{|z_1^*|} \approx 3$ ,  $\frac{\|z^*\|_1}{|z_2^*|} \approx 1,5 \Rightarrow$  Stime simili per la variaz relativa delle componenti della soluzione:

- valori delle  $c_k$  noti solo con approssimazione:  $|\delta c_k| < 1$

$$\Rightarrow \text{perturbazione dati: } E = \begin{bmatrix} \delta c_1 + \delta c_2 & -\delta c_2 \\ -\delta c_2 & \delta c_2 + \delta c_3 \end{bmatrix}, \quad f = \begin{bmatrix} 0 \\ h \delta c_3 \end{bmatrix}$$

$$\frac{\|E\|_1}{\|A\|_1} \leq \frac{3}{300} = \overline{10^{-2}}; \quad \frac{\|f\|_1}{\|b\|_1} \leq \frac{5}{500} |\delta c_3| < \overline{10^{-2}}$$

$$\Rightarrow \alpha = 10^{-2}$$

- $\alpha c_1(A) < \frac{1}{10}$

- $\hat{z}$  soluzione con  $\hat{c}_k$  t.c.  $|c_k - \hat{c}_k| < 1 \dots$

$$\text{Teo condiz} \Rightarrow \frac{\|\hat{z} - z^*\|_1}{\|z^*\|_1} \leq 2 \alpha c_1(A) = 6 \cdot 10^{-2}$$