Linear Systems and
the LU Decomposition

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Chapter 3: Linear systems

\[ Ax = b, \]

where \( A \in \mathbb{R}^{m \times n}, \ x \in \mathbb{R}^n \) (unknown), and \( b \in \mathbb{R}^m \).

Applications (section 4.1):

- least squares
  data fitting, regression
- Tikhonov regularization
  image alignment, deconvolution
Applications

▶ Data fitting

![Graphs showing data fitting examples](image)

▶ Image alignment

![Image alignment explanation and examples](image)

▶ Deconvolution

![Deconvolution examples](image)
Outline of Chapter 3

1. Solvability of linear systems
2. Elementary matrix operations
   ▶ permutation
   ▶ row scaling
   ▶ elimination
3. Gaussian elimination
   ▶ Forward-elimination/substitution
   ▶ Back-elimination/substitution
4. LU factorization
5. The need of pivoting – mathematically
6. The need of pivoting – numerically*

* to be discussed after covering Chapter 2.