



MITx CSE.0002x

Introduction to Computational Science and Engineering

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10.4.3 Gaussian elimination implementation

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This construction of Gaussain elimination can be generalized to N -by- N matrices, and results in the code below. Note that the code below is not utilizing NumPy's vectorization capability. As a result, it will be significantly slower than it could, especially in comparison to `np.linalg.solver`.

```
"""
Solve Ku = f by Gaussian elimination (no
pivoting)
"""

import numpy as np

def mysolve(K, f):
    """
    Args:
        K (numpy ndarray): square matrix
        f (numpy ndarray): right-hand side
vector

    Returns:
        numpy ndarray: u, solution to Ku=f
    """
    m,n = K.shape
    assert m == n, "Non-square matrix"

    u = np.zeros(n)

    # Extended matrix with the right-hand side
as last column
    A = np.zeros((n,n+1))
    A[:,0:n] = K
    A[:,n] = f
```

```
edX# Elimination of nonzero elements below
the diagonal
for i in range(n):
    assert A[i,i] != 0.0, "Zero pivot
detected"
    for j in range(i+1,n):
        Lji = A[j,i] / A[i,i]
        for k in range(i+1,n+1):
            A[j,k] = A[j,k] - Lji * A[i,k]
```

```
Legal# Back substitution
u[n-1] = A[n-1,n]/A[n-1,n-1]
for i in range(n-2,-1,-1):
    u[i] = A[i,n]
    for j in range(i+1,n):
        u[i] = u[i] - A[i,j]*u[j]
```

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$A = \begin{bmatrix} 0 & A_{11} & A_{12} & \dots & A_{1,n} \\ 0 & 0 & & & \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & A_{ii} & A_{i,j+1} & \dots & A_{i,n} \\ \vdots & \vdots & A_{j+1,i} & A_{j+1,j+1} & \dots & A_{j+1,n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \vdots & \vdots & \vdots & \vdots \end{bmatrix}$ by $A_{ji}/$
and subtract
for row
zero out

eliminated all of
the columns
below the