Hilbert Matrix

# Overview

The tasks for part one are completed using three java files: HilbertOps.java, LUFactorization.java, and QRFactorization.java. The two Factorization classes, LUFactorization and QRFactorization, contain the methods to factorize matrices. LUFactorization.java contains **lu\_fact()**, which returns an LUFactorization Object. QRFactorization.java contains **qr\_fact\_househ()**, and **qr\_fact\_givens()**, both of which return a QRFactorization Object.

The QRFactorization and LUFactorization Objects both encapsulate all of the pertinent information about their factorization, including the factor matrices and the error (||LU – A||, for example).

These Objects can be passed to the **solve\_lu\_b()** and the **solve\_qr\_b()** methods, respectively, to solve the equation Ax = b, given a b vector.

HilbertOps.java contains all of the helper methods used throughout this part of the project. The Ops class in the General package of the project also contains some helper methods used in this part, however they were placed in another package because they are universally useful throughout the project.

# Conventions

In code, a matrix is represented as an array of arrays of 64 bit, signed, floating-point numbers. Each individual array within the matrix represents a row of the matrix. Vectors are, at times, represented as simple arrays of 64 bit, signed, floating-point numbers, and are independent of an orientation. The transpose of a vector, when it is needed, is accomplished by the way the data is treated. The orientation of a vector is assumed to be the only orientation that would make the problem solvable.

1. **lu\_fact()** is implemented as a static method in the LUFactorization class. It returns and LUFactorization Object, which contains the L and U matrices, and the error ||LU – A||.
2. **qr\_fact\_househ()** and **qr\_fact\_givens()** are implemented in the QRFactorization class. They both return QRFactorization Objects, which contain the Q and R matrices, as well as the error ||QR – A||
3. **solve\_lu\_b()** and **solve\_qr\_b()** are both implemented in the