# WEEK 9 CHALLENGE

Introduction to OpenFoam Development

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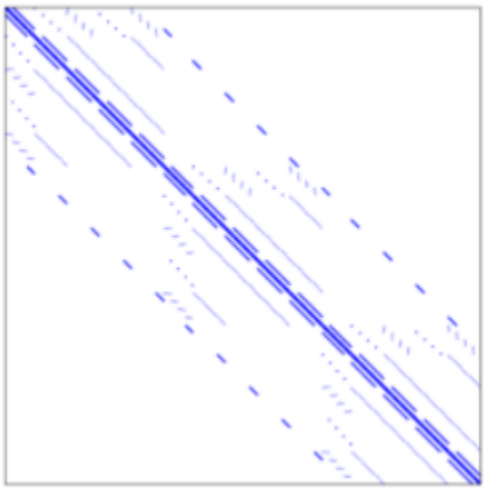
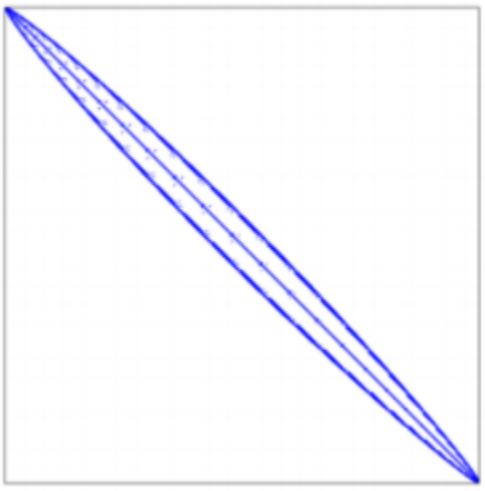
**Problem**:

1. The fvSolution file for solvers like pimpleFoam has entries like pFinal, where for every field var, there is a dictionary entry varFinal. What is the purpose of this?
2. These are images of the matrix fill of A in AU = B - what operation was done to obtain the matrix fill on the right





**Solution**:

1) Observe that solvers like pisoFoam and pimpleFoam are different from simpleFoam in the aspect that they have inner correctors instead of outer correctors. One advantage of having inner correctors is that you can treat the last step differently

   When we specify varFinal, we mention some Tol and RelTol values to be used for the last inner corrector loop. It is a general practice to keep lighter conditions for convergence in the initial loops and a very tight convergence later. This helps us ensure that the solution is correct without wasting a lot of computational resources on initial loops.

2) Observe and appreciate the fact that more the values are scattered away from the diagonal, the more unstable the system of linear solvers is. Also, if a small change is made to the input in the matrix on the left, there is a huge change in the output. This can be mathematically described as an “ill-conditioned matrix” or a system of linear equations with a high condition number.

As you may have correctly guessed, an ill-conditioned system is very difficult to solve and leads to a lot of errors while finding the answer numerically. Thus, we do a small trick to decrease the condition number of the matrix.

This trick is to use a preconditioner. In this method, we pre multiply the entire system with a matrix $P^{-1}$ so that the Matrix $P^{-1}A$ becomes a well conditioned system and we solve

$P^{-1}A\ x = P^{-1}B$

The details of preconditioning can be found here: pre-conditioning
Another useful reference, not used here: Preconditioning for linear systems

Thus, we have precondition the matrix on the left to make the matrix on the right.

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**THE END**

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