MULTIPOINT OPTIMISATION OF A RADIAL COMPRESSOR LOW SOLIDITY VANED DIFFUSER USING AN ARTIFICIAL NEURAL NETWORK, A GENETIC ALGORITHM, AND A 3-D NAVIER-STOKES SOLVER

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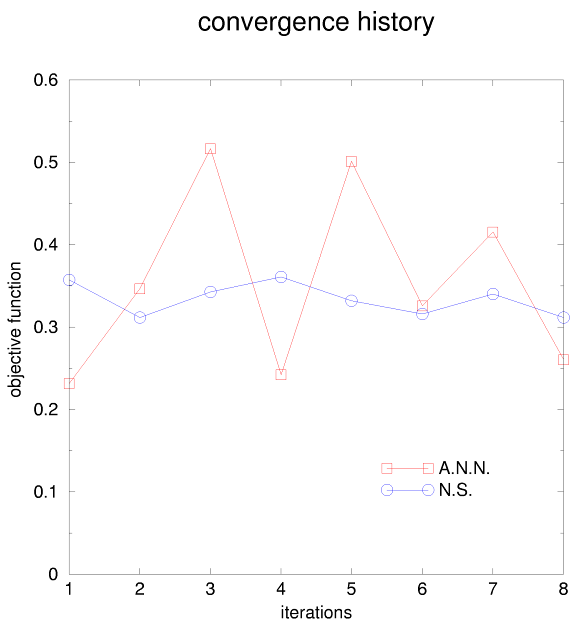
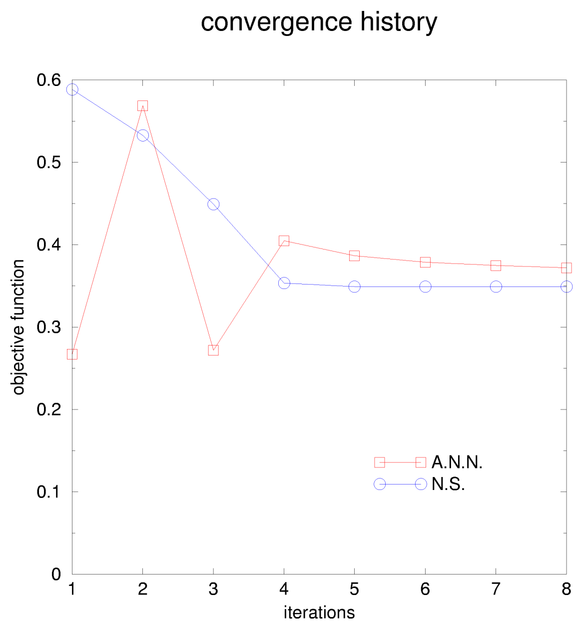
The radial compressor vaned diffusers are able to achieve high pressure recovery and high diffuser efficiency keeping a compact size of the compressor. On the other hand, vaneless diffusers allow a wider operation range and require a simpler manufacturing. Low solidity diffusers (LSD) try to combine the advantages of both without the disadvantages, LSD are characterized by a small number of blades and short vanes. They are able to make a high pressure recovery and high compressor efficiency for a wide flow range. In order to design a low solidity diffuser with a good efficiency in a wide flow range, the whole range of operation of the diffuser has to be investigated. To have a control of the behaviour of the flow also at 2 off-design points, in addition to the design point, a multi-point optimisation was made. The 2 off-design points are chosen very close to the extremes of the operation range coming out from a given existing radial compressor impeller matched with a vaneless diffuser. The optimisation is made by means of a fast approximate model, Artificial Neural Network (ANN) and verified by the Navier-Stokes solver (TRAF3D). The core of this knowledge-based design system is a Genetic Algorithm (GA) in combination with this fast approximate prediction model. The design system is driven by the knowledge acquired during previous designs of similar diffusers stored in a database, which is used for the training of the ANN to predict the performance of a given geometry.

Two optimisations were carried out, differing only in the initial number of geometries contained in the database (55 and 10), and consequentially in the ANN architecture. The two convergence histories are shown, from the first one it's possible to understand that the optimisation advances modestly after the fist iteration, because the ANN is already so well trained by the big sample number (55 geometries calculated at three different conditions). In the second optimisation (10 geometries) the first iteration is quite far from the optimum, and it takes some more iterations to teach the ANN better and arriving to a value of the objective function close to the one of the first optimisation.



I Optimisation (initial database = 55 geometries)



II Optimisation (initial database = 10 geometries)