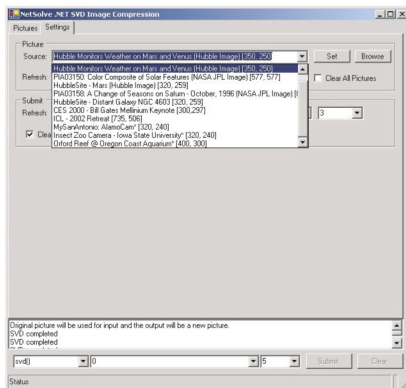


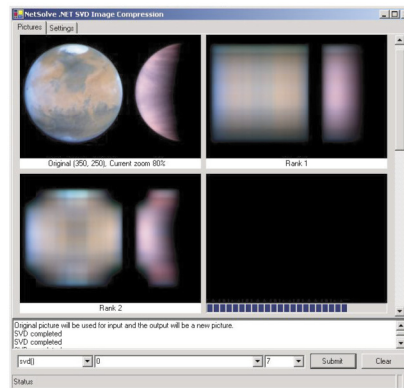
# NETSOLVE/.NET

@ <http://icl.cs.utk.edu/netsolve/>

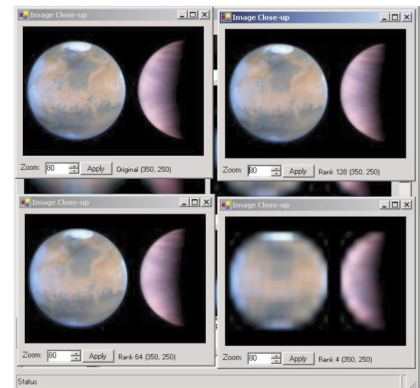
NetSolve/.NET exemplifies the efforts to bring powerful computational resources accessible through NetSolve to .NET users by exposing NetSolve functionalities as .NET web services.



Choosing the image



Processing the image



Comparing the results

## .NET

The NetSolve .NET SVD Image Compressor is built on Microsoft's .NET applications framework and uses NetSolve to solve complex SVD computations. The interaction of the SVD Image Compressor client and NetSolve is an excellent example of combining a .NET application with the power of scientific and grid computing.

## NETSOLVE .NET

Furthering the goal of NetSolve, the NetSolve .NET interface aims to incorporate scientific & grid computing into the world of .NET. Currently in prototype stages, the .NET interface communicates with NetSolve through a COM based dll. This type of design is a very limiting factor when creating web services and other unique .NET applications. Because of these limitations, future work will center around creating a completely managed dll with no legacy code.

## NETSOLVE

### FUTURE WORK

Create a native .NET interface to NetSolve

The purpose of NetSolve is to create the middleware necessary to provide a seamless bridge between the simple, standard programming interfaces and desktop Scientific Computing Environments (SCEs) that dominate the work of computational scientists and the rich supply of services supported by the emerging Grid architecture, so that the users of the former can easily access and reap the benefits (shared processing, storage, software, data resources, etc.) of using the latter.

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Singular Value Decomposition (SVD) is a useful mathematical tool for finding and removing information stored in matrix form based on its significance to the rest of the data. Image compression is one of many uses. The idea behind SVD is to take a matrix  $X$  and represent it as decomposition in the form  $U\Sigma V^T$ . The inner matrix  $\Sigma$  is a diagonal matrix of singular values, ranked from greatest to least.  $U$  and  $V$  are both orthogonal matrices containing the singular vectors. When a number of these smaller singular values are discarded the matrix loses precision, but should retain the same general shape and form.

Images are represented as matrices with values in the elements to describe the intensity of the color. Black and white images, which will be the primary focus for this document, will have values ranging from 0 (black) to 255 (white). Color images are actually a composite of matrices representing different colors; generally red, green, and blue. When the image is decomposed into the form  $U\Sigma V^T$  by SVD, the singular values are representative of the clarity of the image. When some of the values are discarded the image loses clarity, but this loss in precision is made up for by the reduction in space needed to store the image.

Currently, the prototype NetSolve web service implements *dgesvd* (a singular value decomposition routine from the LAPACK mathematical library) in a non-blocking fashion. Invoking the *dgesvd* web method creates a new thread and immediately returns. The *dgesvd* call ships the image as a .NET DIME attachment to the web service side. The web service then decomposes the image into 3 matrices representing red, green, and blue. Each of the matrices is then submitted to NetSolve using the *dgesvd* problem and solved. Image reconstruction is done as soon as the client receives enough information from the web service to reconstruct the requested image(s).

Providing a seamless bridge between users and the rich supply of services supported by the emerging Grid architecture is the goal of NetSolve. The NetSolve & .NET project furthers this goal by extending NetSolve into the world of .NET. The NetSolve .NET SVD Image Compressor has turned out to be an excellent example of what could be done using a native .NET interface to NetSolve. Exposing existing grid services to the vast array of .NET users is a tantalizing and feasible goal.

For more information about SVD and the NetSolve .NET project, contact the NetSolve team at [netsolve@cs.utk.edu](mailto:netsolve@cs.utk.edu)