Comparison of HINFSTRUCT Matlab Robust Control Toolbox R2012a with HIFOO 3.5 with HANSO 2.1

Benchmarking

In the sequel, we consider benchmarking hinfstruct against hifoo. Our assessment is based on 234 test cases extracted from the *COMPl$_e$ib* benchmark library [4] and involves

- hinfstruct from the Matlab Robust Control Toolbox R2012a [5, 2], and
- hifoo 3.5 with hanso 2.1 [3].

Both hifoo and hinfstruct implements state-of-the-art nonsmooth programming techniques. hifoo is a two-stage technique where a smooth linesearch BFGS approach is followed by nonsmooth gradient sampling. This means gradients are randomized around the current iterate to refine or establish optimality in the second phase. hinfstruct on the other hand exploits extension sets of the Clarke sub-differential at each iteration and derive a tangent subproblem in the form of a nonsmooth convex QP approximation of the original problem. A search direction is then computed and a linesearch is carried out. Both techniques are endowed with local optimality certificates. In constrast to hifoo, hinfstruct relies on a single strategy all the way. hinfstruct is a deterministic technique and therefore does not use randomization except optionally for the starting point.

Individual information on the test cases can be found at [1] (earlier benchmark). Both codes are run in default mode with 3 starting points in each case. hifoo 3.5 runs the gradient sampling phase to enhance accuracy and to achieve an optimality certificate as hinfstruct does.

A comparative graphical view of the achieved objective values as well as execution times for both techniques is given in figure 1. The top plots in figure 1 shows the x-axis bar diagram of H_∞-norm ratios:

$$\log_2(H_\infty\text{-norm } \texttt{hinfstruct}/H_\infty\text{-norm } \texttt{hifoo})\,.$$

Note a left-half plane bar indicates advantage of hinfstruct over hifoo and conversely for right-half plane bars. A bar of unit length materializes improvement by a factor 2, a bar of length 2 a factor of 4, etc.

Similarly, the bottom plots of figure 1 displays cpu time ratios:

$$\log_{10}(\text{cpu time } \texttt{hinfstruct}/\text{cpu time } \texttt{hifoo})\,.$$

The bottom right diagram in figure 1 shows $\log_{10}$ of cpu time ratios for problems where `hinfstruct` and `hifoo` agree within 3% in the objective. Note a left-half plane bar indicates advantage of `hinfstruct` over `hifoo` and conversely for right-half plane bars. A bar of unit length materializes improvement by a factor 10, a bar of length 2 a factor of 100, etc.

Our testing demonstrates that `hinfstruct` is reliable and markedly fast and accurate on a variety of problems when compared to `hifoo`. It reveals therefore as an attractive practical tool for solving difficult synthesis problems.

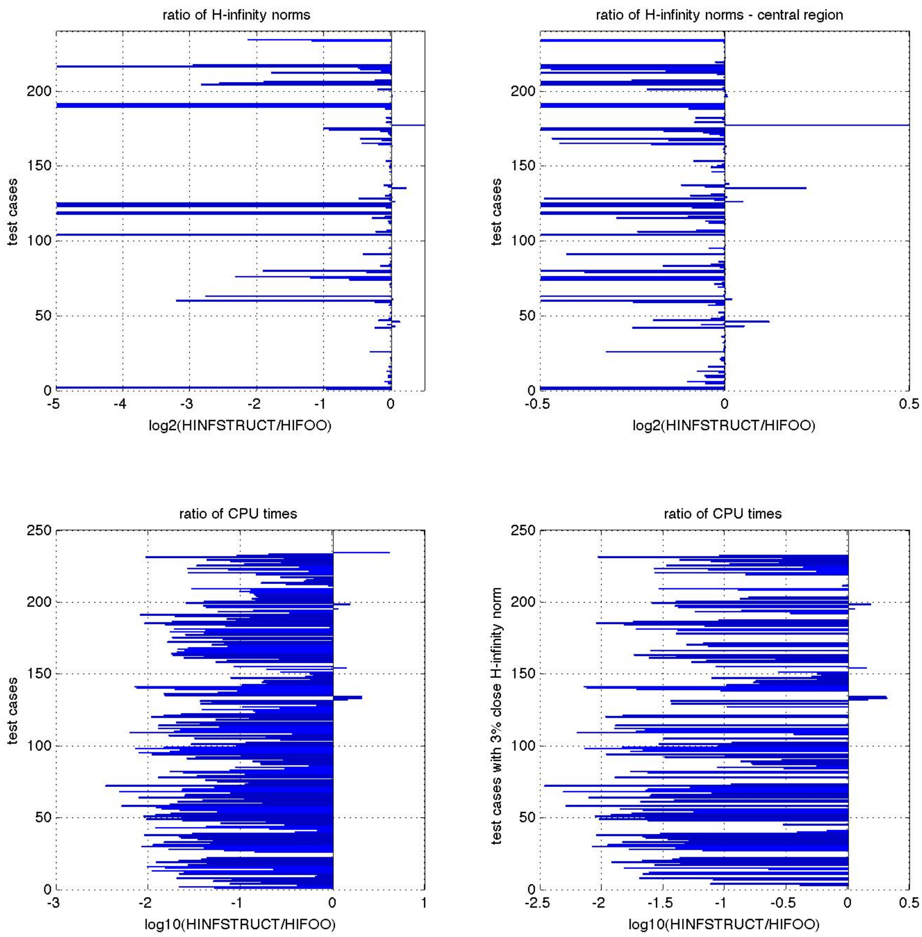

Figure 1: Achieved objectives (top) and cpu times (bottom)

top left:	$\log_2$ of H_∞-norm ratios
top right:	$\log_2$ of H_∞-norm ratios with magnification of central region
bottom left:	$\log_{10}$ of cpu time ratios
bottom right:	$\log_{10}$ of cpu time ratios for problems where `hinfstruct` and `hifoo` agree within 3% in the H_∞ norm.

References

[1] P. Apkarian. Internet pages. `http://pierre.apkarian.free.fr`, 2010.

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[4] F. Leibfritz. COMPL_eIB, COnstraint Matrix-optimization Problem LIbrary - a collection of test examples for nonlinear semidefinite programs, control system design and related problems. Technical report, Universität Trier, 2003.

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