MGNet: a multigrid and domain decomposition network[*]

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Abstract

MGNet provides a mechanism for exchanging information and computer programs related to multigrid and/or domain decomposition methods.

Key words. multigrid, domain decomposition, parallel computing

AMS(MOS) subject classification. 65N20, 65P05, 65W05.

1 Introduction

The Multigrid Network started in April, 1991 as a means of exchanging ideas for people in the field. With the addition in the summer of 1991 of an anonymous ftp site at the computer science department of Yale University, the concept was expanded to include easy access to old digests, freely distributable codes, unpublished papers, bibliographic information, and a common exchange point for subscribing members.

To become a subscriber of MGNet, send an electronic mail message with your name and preferred e–mail address to

$$mgnet - requests@cs.yale.edu$$

Please use an Internet style e–mail address if possible. Bitnet and uucp addresses will be accepted if an Internet address is not available.

The repository must be accessed using the ftp program from the Internet. Unlike $netlib$, there is no e–mail interface to the files stored at Yale. In fact, sending e–mail to MGNet requesting files only results in the message being delivered to my mailbox. There is 400 megabytes allocated to MGNet currently (out of the 1,200 that we can use in a pinch), so there is no shortage of space for papers, codes, or whatever.

Unless stated otherwise, everything in this repository is "use at your own risk." There are no warranties implied or expressed, not even that anything does what it claims to do or will even install on anything. You are somewhat on your own in case of difficulties. I have provided an author list and a way to contact them, but I do not guarantee that this will work, either.

If you plan on putting this software on a machine someplace that by law imposes warranties or liabilities on the author or distributor, then you are not welcome to any software from MGNet unless the authors of each package you place on such a machine explicitly agree to this. I am sorry to impose this restriction, but this is freely distributed material.

2 Communicating with Others

To post a message to the MGNet digest, send electronic mail to

$$mgnet@cs.yale.edu$$

and I will put it in the next issue if your message is appropriate. I will also send you a confirmation of receipt.

I am very tolerant when it comes to the content of messages. I would like to see the following items in particular:

- Technical discussions

- Meeting and course information relevant to multigrid or domain decomposition.

- Abstracts for codes, papers, and books

- People movement

I have even offered to set up a curriculeam vitae directory, if I am asked politely, for people who are seeking another employer.

Some topics that will not be included in digests include the following:

- Tirades on any subject

- Software patent discussions

- Meeting or course announcements devoid of relevance to multigrid or domain decomposition (e.g., regional meetings of the ...).

3   Accessing the Repository

A wealth of software, reports, and old digests is stored here. Feel free to copy anything you like from the subdirectories here subject to the restriction mentioned at the end of the introduction. The file mgnet/INDEX.mgnet explains what is in the entire repository. Always look at the README.mgnet file in any directory. It will tell you how to unpack files, what they contain, and any conditions for use.

What is stored in the MGNet repository changes monthly. To see what is currently stored there, ftp to host *casper.cs.yale.edu* (128.36.12.1). In the following script, what is in **boldface** is what you would type; the normal text is how your computer will prompt you.

> % **ftp casper.cs.yale.edu**
> User: **anonymous**
> Password: **a**
> ftp> **cd mgnet**
> ftp> **dir**

Ftp is a program that should be on your computer; do not send an e-mail message with this in it.

If this is your first visit to MGNet's repository, please get a copy of the files README.mgnet and INDEX.mgnet:

> ftp> get **README.mgnet**
> ftp> get **INDEX.mgnet**

These files contain suggestions and a directory of what is actually stored in the repository. There are phone numbers in the README.mgnet file in case of emergency.

I keep the following *single line* entry in the *.netrc* file in my home directory:

> *machine casper.cs.yale.edu login anonymous*
> *password bells@noisy.watson.ibm.com*

Then when I issue the ftp command, I can skip the user and password part of the above.

Once you know where things are stored, you can change directory to whatever you like. Software packages have their own directories as do old digests, papers, and bibliography references. Each directory should have a README.mgnet file that has pertinent information. I create these files, not the authors who have submitted things (though I do read their abstracts).

To save space, most things have been tar'ed and compress'ed (standard UNIX utilities). Files ending in *.Z* have been compress'ed. Hence, you will need uncompress (or zcat) and tar to unpack these packages. Some packages may be in a shell archive format before being compress'ed. In this case, you will not need tar, but you will need the standard sh program on UNIX. The rule of thumb will be, I must be able to unpack a submission on my workstation before I will store it in the MGNet area.

For example, suppose you had downloaded a file *f77.tar.Z* to your computer. To unpack this,

> zcat *f77.tar.Z* | tar xvf −

Here, zcat uncompress'es the file and pipes its output to the tar command which ultimately unpacks the files.

To place something in the repository, either e-mail it to me or deposit it directly at Yale. For example, suppose you want to put paper.dvi (the output of some flavor of TeX) and paper.abs (a title and abstract file in plain ascii) in the repository, try the following from a UNIX machine:

> % **ftp casper.cs.yale.edu**
> User: **anonymous**
> Password: **a**
> ftp> **cd mgnet/incoming**
> ftp> **mkdir your_name**
> ftp> **cd your_name**
> ftp> **hash**
> ftp> **put paper.abs**
> ftp> **binary**
> ftp> **put paper.dvi**
> ftp> **quit**

Finally, send an e-mail message explaining what you just did to *mgnet − requests@cs.yale.edu*. An even better approach is to send e-mail there first explaining what you intend to do, wait until I respond, and then transfer your package to the incoming area. The latter approach guarantees that I will unload your contribution in a timely fashion.

The *mgnet/incoming* directory is world writable. This has caused problems in the past. Besides people putting offensive material there, legitimate files have been tampered with before I could move them to places that are not world writable.

Thus, the final e–mail message in the delivery is very important.

No software will be accepted if it comes with a collection of weird user requirements or conditions. An example of this is if you require users to send money after they have used it for more some period of time. I prefer public domain items, but I will accept copyrighted material as long as nobody will get sued.

Suggestions are always welcome. If you are interested in shadowing this repository, please send me electronic mail so I can include you in a private mailing list for shadow owners.

Finally, this is an electronic medium, not a paper one. I will only mail paper copies under extreme circumstances. I am sorry about that, but paper copies require a lot of extra work and cost more.

4 Contents of the Repository

The repository is divided into a number of areas:

bib The slowly growing BibTeX database for multigrid.

digests The complete collection of digests.

incoming Where new things are dropped off by subscribers.

papers A directory tree of research reports.

... The software packages.

4.1 mgnet/bib

This directory contains bibliographic references for multigrid. So far, only papers and books are referenced. Unpublished research reports have not been added nor has a domain decomposition database been started.

This is being constructed through donations of bibliography databases. If you have a publication that is not listed here, please e–mail relevant information to $mgnet - requests@casper.cs.yale.edu$.

Currently, only BibTeX style entries are here. Complete entries are encouraged. By this, I mean that a journal article should have the authors, journal, volume, issue number, year, and pages. Books should have the publisher, location, and book authors if it is in an edited book (e.g., a proceedings).

4.2 mgnet/papers

This contains directories with not yet published in a journal or book papers. These are mostly multigrid or domain decomposition oriented papers. However, some have been considered by the authors merely of interest to multigrid readers.

Directories that have appeared so far include

- Arbesmeier–Ruede
- Douglas
- Douglas–Douglas
- Douglas–Mandel
- Hanisch
- Mack–Kalkreuter–Palma–Speh
- Ruede
- SmithJ

Papers on such topics as abstract multigrid theory, adaptive multigrid methodology, C++ efforts and multigrid, domain decomposition preconditioning of p–method finite element methods, effective field theories, multigrid preconditioning, and parallel computing.

4.3 mgnet/...

These are the software packages. These include

boxmg Victor Bandy's modifications to Joel Dendy's black box multigrid codes. This is Fortran-77 code. This might be public domain software, but it might be owned by the US Department of Energy (DOE). Check with both authors.

gmd The GMD multigrid solvers AMG, MG00, and MG01. This is Fortran-77 code. This is not public domain software.

jmandel Jan Mandel's Balancing Domain Decomposition code. This is Fortran-77 code. This is copyrighted by Jan Mandel and Solvers International, Inc., 1992.

madpack2 Version 2 of Craig Douglas' multigrid package. This is an abstract solver. It is PDE, domain, and discretization independent. It only handles linear problems, however. This has C, Fortran-77, and extended Ratfor versions of the code. This is definitely public domain software.

madpack4 Version 4 of Craig Douglas' multigrid package. This contains an abstract solver (DAMG) and a 2D/3D Poisson solver (DPMG). DAMG has 4 multigrid schemes, 11 solvers and 5 preconditioners (and can be different per level), handles non PDE problems, any PDE that can be discretized, and optionally will call back your own change level, smoother, or preconditioner subroutines, can

be restarted after adding levels (coarser or finer), and might feed your cat when you are on vacation. DPMG is tailored for 3 different machine architectures, has a variety of projection and interpolation operators, handles uniform or tensor product grids and not completely trivial boundary conditions. This requires version 2, release 1 (or later) of IBM's ESSL. Updates will eliminate this requirement. This is Fortran-77 code. This is copyrighted by International Business Machines, 1992. It was released for unlimited public distribution on July 20, 1992 and is also available via anonymous ftp from IBM's Internet ftp server, software.watson.ibm.com.

mgd9v Paul M. de Zeuww's blackbox multigrid solver designed for linear systems resulting from the 9-point discretization of a general linear second-order elliptic partial differential equation in two dimensions. This is Fortran-77 code. This is not public domain software.

pltmg Version 6.1 of Randy Bank's piecewise linear triangle multigrid package. It solves two dimensional problems, has a graphics interface, and does adaptive gridding. This is Fortran-77 with a little C code. This might be public domain software.

wesseling MGLAB.FOR is a tutorial multigrid program. It solves elliptic boundary values in one dimension. The user may choose various multigrid cycles, transfer operators, smoothing methods, and nested iteration end defect correction. Cell-centered and vertex-centered discretization and multigrid is included. Documentation is included in the program. The program is written in portable FORTRAN-77, and has run on MS-DOS PC's and Unix mainframes. The methods used are fully described in the following book: An Introduction to Multigrid Methods, Wiley, Chichester, 1992 by P. Wesseling.

5 Conclusions

In summary, MGNet offers its subscribers and Internet members the following:

- An e–mail newsletter that is sent to subscribers about once a month. This is a function of the number of contributions and my schedule.

- Unpublished papers from many sources (with an easy method for contributing your own research reports).

- Numerous software packages implementing multigrid or domain decomposition algorithms.

- Bibliography references in a clean BibTeX format.

- Ftp access for Internet users to entire repository.

MGNet: a multigrid and domain decomposition network. ACM SIGNUM Newsletter, 27:2-8, 1992. [11] C. C. Douglas. Implementing abstract multigrid or multilevel methods. Technical Report YALEU /DCS /TR-952, Department of Computer Science, Yale University, New Haven, 1993. In the Proceedings of the Sixth Copper Mountain Conference on Multigrid Methods, N. D. Melson (ed.), NASA CP 3224, Langley, VA, 1993, pp. 127-141. [12] C. C. Douglas and J. Douglas. Â Then the convergence analysis for domain decomposition methods applies to the frequency decomposition multi-grid method and yields. 48. Wolfgang Hackbusch. robust convergence. Since the convergence analysis for Schwarz-type iterations is.