Computer Tools for Mathematicians

Euromath Center, Copenhagen

November 24, 1994

1 Introduction

The aim of this document is to give a survey of the computer tools that can help a mathematician in his daily work. The survey is based on the assumption that a suitable network of UNIX based workstations is available, although PC orMacintosh networks could probably do the job, too.

The main tasks of a mathematician, where a workstation can improve productivity dramatically, are

- Document preparation.
- Computing power.
- Communication.
- Information retrieval.

In order to prepare professional-looking documents (scientific papers, books, educational material, etc.) the mathematician must have access to a text formatting program which can handle mathematical symbols and formulas, a decent text editor (which could be an integrated part of the text formatting program), and a laser printer. A very popular combination among mathematicians (and other scientific communities) is TEX for typesetting, the emacs editor for text editing, i.e. for entering the text that is going to be formatted by TEX , and a PostScript laser printer. Both TEX , including the macro packages LATEX and AMS-TEX , and emacs are available as public domain software, i.e. they are free.

Computing power (number crunching etc.) is necessary if you want to use symbolic manipulators such as Maple, Mathematica, or others (see below), or if you are doing numerical analysis. A lot of public domain numerical libraries are available along with a few very good commercial products such as NAG and Matlab. Traditionally, many numerical libraries are written in

FORTRAN so you will need a FORTRAN compiler (most likely from the vendor of your workstations). You will under all circumstances also need a C compiler, but this usually comes with the workstations, or you can get the GNU C compiler which is public domain. The GNU project is described below.

Probably, the most popular use of computers among mathematicians is for sending and receiving electronic mail, e-mail in daily language. If you want to use e-mail your computer must be on a network. In practice, this means that your local network should be connected to the worldwide Internet (see below).

When you are on the Internet, you will realise that a huge amount of information is available for you. Of particular interest for mathematicians, we can mention electronic journals, mathematics related discussion groups, and free software. The amount of publicly available information is growing exponentially at the moment. You can also gain access to mathematical databases – we know of "Zentralblatt für Mathematik" and "Mathematical Reviews", but these databases you will have to pay for.

In order to help mathematicians benefit from modern information technology, the European Mathematical Trust (EMT) has directed the development of the*Euromath System* for which the first version is planned for release on May 15th, 1994. The overall Euromath objectives are (quoted from Euromath Policy Document, November 1989):

> "To provide European mathematicians with a shared, enriched, computing environment tailored to those tasks which arise frequently in their research work (such as exchanging information and ideas, interrogating databases, manipulating symbolic structures and editing complex documents). To stimulate and greatly enhance collaboration and exchange among individuals, not only with the obvious direct benefits but also with the indirect one of nurturing the rising self-consiousness of the European mathematical community."

2 Hard ware

It is difficult to give advice on which vendor to choose. The market changes constantly. If you are setting up a local network of workstations, you should choose the machines from the same vendor. This will make the network system administration much less painful than if you have a collection of machines from different vendors. The leading UNIX workstation suppliers for the academic community are Sun Microsystems, Digital, IBM, and Hewlett-Packard.

You will also need tape station(s) for extracting new software and for taking backup of data and system setup files (important!), a cdrom drive (most new software comes on cdrom), and laser printer(s).

3 The Internet

The Internet is a worldwide collection of several physical regional computer networks. For the user, however, the Internet appear as*one* huge network with millions of users, more being added every day. You should definitely get an Internet connection. There exists a lot of information about the Internet, much of it is available on the net itself. If you want a book about the Internet, you should get[1].

Being on the Internet allows you to communicate with collegues in the rest of the world through e-mail. If you have an account elsewhere, you can login to this account accross the Internet, and you can login to various kinds of information servers and download electronic documents and software.

There are a number of ways to retrieve publicly available information on theInternet. Some of the most popular are through

- gopher,
- anonymous ftp,
- world wide web,
- Usenet News,
- mailing lists,
- telnet.

Internet information retrieval is described below.

In order to work efficiently with your workstations, you need some basic applications. These include a mail program, a text editor, and compilers. Usually, you will receive such applications with the workstation, but often better applications exist, either as public domain or as commercial software. A very popular source of public domain software is the GNU project (GNU= *G*nu is *N*ot *U*NIX). GNU products include Emacs, a C compiler, and GNU make ("make" is a UNIX facility).

4 Information Retrieval

In this section we shall briefly describe the information retrieval methods that has already been mentioned above. A comprehensive guide to network resource tools can be obtained in electronic form from listserv@earncc.bitnet. Send an e-mail with the message get nettools memo, which returns an e-mail with a plain text document, or with the message get nettools ps which returns an e-mail with a postscript document [2].

4.1 Gopher

Gopher is a distributed document delivery service. You can browse through directories all over the world and search for keywords. When you find a file of interest, you simply save it. For mathematicians this might be papers from electronic journals, preprints, or software for computer algebra systems (both public domain and commercial packages such as Mathematica or Maple) or for numerical analysis. A good starting point is the Mathematics Subject Tree which is maintained on theEuromath Center's gopher server. The Mathematics Subject Tree contains links to several gopher servers around the world.

It is not necessary to run gopher servers or clients in order to use gopher, but if you want to take full advantage of gopher, you should install a gopher client on your system. The X windows program xgopher provides a particularly nice interface to gopher.

If you don't run a gopher client, you should telnet (see below) to a gopher server, e.g. the Euromath Center's gopher server: telnet gopher.euromath.dk and login as gopher. You then get a menu-driven interface to EmC's gopher.

If you have installed a gopher client, you run gopher with the command gopher ¡host¿ where host is optional. For example gopher euromath.dk.

4.2 Anonymous ftp

Anonymous ftp (*f*ile *t*ransfer *p*rotocol) is a way to download files from ftp servers where a number of files have been made publicly available. Gopher contains an interface to anonymous ftp so many files that are available through anonymous ftp are also available through gopher. It is possible to searchftp servers all over the world for specific files using the service "archie". As for gopher we recommend that you install an archie client, although you can use archie by telnetting to an archie server, e.g. telnet archie.sura.net and login as archie. The archie software is available through anonymous ftp. A particularly nice interface to archie is provided by the X windows program xarchie.

Typically, anonymous ftp is used to download major software packages, e.g. TEX , which you don't want to browse through before you get it. The use of anonymous ftp is perhaps best illustrated through an example:

```
% ftp euromath.dk
Connected to euromath.dk.
220 danmat FTP server (Version wu-2.1c(1) Wed Nov 10 17:39:03 MET 1993) ready.
Name (euromath.dk:henrik): anonymous
331 Guest login ok, send your complete e-mail address as password.
Password:
230 Guest login ok, access restrictions apply.
ftp> ls
200 PORT command successful.
150 Opening ASCII mode data connection for file list.
README
bin
etc
incoming
pub
226 Transfer complete.
33 bytes received in 0.031 seconds (1 kbytes/s)
ftp> get README -
200 PORT command successful.
150 Opening ASCII mode data connection for README (234 bytes).
Welcome to anonymous ftp on euromath.dk.

This site is maintained as a service for Nordic mathematical institutes
and EUROMATH subscribers.

If you have any problems during your session here please send a message
to emc@euromath.dk.
226 Transfer complete.
remote: README
241 bytes received in 0.02 seconds (12 Kbytes/s)
ftp> cd pub
250 CWD command successful.
ftp> ls
200 PORT command successful.
150 Opening ASCII mode data connection for file list.
misc
euromath
README
bin
```

```
cost
etc
incoming
226 Transfer complete.
50 bytes received in 0.035 seconds (1.4 Kbytes/s)
ftp>
```

So you login as anonymous and give your e-mail address as password. You can use the commands cd and ls to look through the directories and download files with the commandget. In the example above we used get README -; the - tells ftp to write to standard output rather than saving to a file. Before you use anonymous ftp, you should learn more about ftp, e.g. by reading the manual page for ftp.

4.3 World Wide Web

The World Wide Web (WWW) is a distributedhypertext document service. It was developed at CERN and the particular information that may be of interest to mathematicians is actually mainly directed toward physicists. Apart from CERN itself, an interesting starting point is Los Alamos National Laboratories where there is a succesful preprint archive. In order to take full advantage of WWW you should install the program xmosaic which runs under X Windows.xmosaic is available by anonymous ftp from ftp.ncsa.uiuc.edu.

A WWW document is identified by a Uniform Resource Locator (URL). For example, the welcoming document for the Center for Nonlinear Studies at Los Alamos is identified by the URL *http://cnls.lanl.gov*. HTTP in the beginning of the URL stands for HyperText Transport Protocol. You can also specify other protocols, e.g. if you want to connect to the Euromath Center's gopher server, you would use the URL *gopher://gopher.euromath.dk*.

4.4 Usenet News

Usenet is not a physical network, it is a collection of a huge number of newsgroups. These newsgroups are typically discussion forums where people ask questions that are then answered (with the answer sent to the particular newsgroup) by other people. The subjects of the newsgroups vary from culture and science to entertainment and hobbies. There are also a few newsgroups for mathematics, namedsci.math, sci.math.num-analysis, sci.math.research, sci.math.stat, sci.math.symbolic.

You don't need to have a machine connected to the Usenet in order to read Usenet news as some sites make the news available in other ways, e.g. on their gopher server. However, this is not an optimal way to read news. We recommend that you get one of your own machines connected to the Usenet.

In that case you will also need a newsreader program, e.g. *xrn* or you can use *gnus* which is integrated into *emacs*.

4.5 Mailing Lists

Mailing lists are normally discussion forums like Usenet newsgroups, but they are physically administered from one machine through some kind of list server program. In order to follow the discussion, you subscribe to a mailing list and will then receive everything that is sent to it. Mailing lists are often moderated which means that the person who administers the list will prevent things he doesn't think belong to the list from appearing. Information about active mailing lists is frequently posted in Usenet news.

Mathematicians also have their mailing lists, e.g. for algebraic geometry, number theory, and numerical analysis. Also, there exists a mailing list dedicated to Mathematicaproblems. The way you subscribe to a mailing list depends on the list server program, typically you send an e-mail with the message subscribe list name yourname.

Check the newsgroups news.announce.newusers and news.lists in order to find out which lists exist and how you subscribe to them.

4.6 Telnet

Telnet is a protocol that allows the user to remote login over the Internet. You use telnet to connect to some database-like services, e.g. e-math of the American Mathematical Society (AMS). Login and password are both e-math:

```
% telnet e-math.ams.org
Trying 130.44.1.100...
Connected to E-MATH.AMS.COM.
Escape character is '^]'.


ULTRIX V4.3 (Rev. 44) (e-math)

login: e-math
Password:

Possible e-MATH terminal types: vt100, vt200, vt300, vt400,
    vt50, vt52, xterms, sun, adm3, ampex

TERM = (vt100)
```

```
Ultrix Worksystem V2.1 (Rev. 14) System #3: Tue Sep 12 17:55:04 EDT 1989

        This is the American Mathematical Society's e-MATH
   system for electronic communication and information delivery

        Unauthorized access to this node is strictly prohibited.

                    MMM          MMM    AAAAAA    TTTTTTTTTTTTT  HH        HH
                    MMMM        MMMM   AAAAAAAA   TTTTTTTTTTTTT  HH        HH
                    MM MM      MM MM  AA      AA       TTT       HH        HH
    eeeeee          MM  MM    MM  MM  AA      AA       TTT       HH        HH
   e      e   ____  MM   MM MM    MM  AAAAAAAAAA       TTT       HHHHHHHHHHHH
   e      e   ____  MM    MMM     MM  AAAAAAAAAA       TTT       HHHHHHHHHHHH
   eeeeeee          MM     M      MM  AA      AA       TTT       HH        HH
   e                MM            MM  AA      AA       TTT       HH        HH
   e      e         MM            MM  AA      AA       TTT       HH        HH
    eeeeee          MM            MM  AA      AA       TTT       HH        HH


                         PRESS q for MAIN  MENU

                PRESS RETURN for Release Notes and Hints



                                e-MATH SERVICES

 [0] EXIT                                 [8] SUGGESTION BOX

 [1] DIRECTORY INFORMATION (CML)          [9] MATH REVIEWS AUTHOR LOOKUP

 [2] PROFESSIONAL OPPORTUNITIES           [10] E-MATH GOPHER

 [3] SOFTWARE                             [11] HELP

 [4] MATHDOC DOCUMENT DELIVERY

 [5] MATH REVIEWS CLASSIFICATION SCHEME

 [6] MATH REVIEWS SUBMISSION

 [7] WELCOME MESSAGE
```

4.7 Math Information Service

The Euromath Center is in the process of setting up a regional electronic information service for mathematicians. In the Danish version it will be possible to find information from each mathematical institute at Danish Universities about:

- Staff
- Postdocs
- Research students
- Visitors
- Seminars
- PhD courses
- Publications (bibliographies)
- Preprints (full text)
- Vacant positions

Each institute must maintain local information; the Euromath Center administers the service. The service should be available for every one on theInternet, you don't need any windowing system. Also, it should be easy for the institutes to maintain their informations.

It has (almost) been decided to use World Wide Web to distribute the information. This allows the user to browse through the information. We will also provide a search function.

More technically speaking, the Euromath Center will download all information (except preprints) each night, create a search index, and let all use of the information service take place on one machine, but the information will still be organised according to which institute it belongs to. There will also be an organisation according to subject independent of institute.

A system along the same lines will be proposed for EmNet/fSU.

5 Tex

The typesetting system TEX is a must for a mathematical institute. The software is public domain and can be downloaded by anonymous ftp from several sites on the Internet: ftp.uni-stuttgart.de, ftp.tex.ac.uk, pip.shsu.edu.

You will rarely use TEX alone. Usually, one uses one of the macro packages, LATEX , AMS-TEX , or AMS-LATEX which makes TEX quite easy to use. Also, you will often need to specify additional em style files in order to satisfy specific requirements for the presentation of your documents, e.g. if you are submitting a paper to a particular journal. An increasing number of journals accept submission of TEX files instead of paper copies.

A number of books about TEX are available. The classical texts are [4], [5], and [6].

6 Symbolic Manipulation

Quite a few packages for symbolic manipulations (computer algebra systems) are available. The best general purpose packages are commercial; prices depend on machine type and number of licenses. There are also specialised packages – which are often public domain or at least relatively inexpensive – for group theory, algebra, number theory, tensor analysis, and differential equations.

A list of symbolic manipulation packages is kept on the machine math.berkeley.edu and is available by gopher or anonymous ftp. A brief extract of this list is given here:

```
GENERAL PURPOSE
===============

Axiom::
        Type:      Commercial
        Machines:  SUN Sparc, IBM RS 6000's and other IBM mainframe platforms.
        Contact:   USA:                          Rest of the world:
                   ryan@nag.com                  valerie@nag.co.uk
                   NAG Inc                       NAG Ltd
                   1400 Opus Place, Suite 200    Wilkinson House
                   Downers Grove, Il 60515-5702  Jordan Hill Rd.
                   Phone: 708-971-2337           Oxford OX2 8DR
                   Fax:   708-971-2706           United Kingdom
                                                Phone:  865-51-1245
                                                 Fax:   865-31-0139
                   or
```

```
                axiom@watson.ibm.com
        Version:   1.1
        Comments:  General purpose.

Derive::
        Type:      Commercial
        Machines:  Runs on PC's and HP 95's.
        Contact:   Soft Warehouse Inc. 3660 Waialae Ave, Suite 304
                   Honolulu Hi 96816-3236 Phone: 808-734-5801
        Version:   2.53
        Comments:  Very robust, gets problems that other larger programs fail
on. Low cost. Runs on the tiny palmtop HP 95 and on meager
                   like PC XT.

Maple::
        Type:      Commercial
        Machines:  Unix workstations (DEC, HP, IBM, MIPS, Sun, SGI, Apollo),
                   PC-386 (DOS & Unix), Mac, Amiga, Atari, AT&T 3B2, Gould,
                   Convex, NCR, Pyramid, Sequent, Unisys and Cray's.
        Contact:   Waterloo Maple Software, 450 Phillip Street,
                   Waterloo, Ontario, Canada     N2L 5J2
                   info@maplesoft.on.ca
                   Phone: 519-747-2373 and 800-267-6583
        Version:   5 release 2.
        Comments:  General purpose , source available for most routines and
                   graphics support. A demo of the program for PC-DOS can be
                   obtained from anonymous FTP at

wuarchive.wustl.edu:/edu/math/msdos/modern.algebra/maplev.zip
                   Student version available for MAC and PC's.

Mathematica::
        Type:      Commercial
        Machines:  Macintosh (System 6.07 or later and A/UX), MS-DOS 386 and
                   higher, Microsoft Windows, Unix workstations (Sun 4, HP,
                   DEC, IBM Risc, Sony, Silicon Graphics, 386-Unix) NeXT,
                   CONVEX & MIPS. Under preparation: Windows NT, DEC Alpha,
                   PowerPC, NEXTSTEP Intel 486 and OS/2.
                   Contact:   Wolfram Research, Inc.
                   100 Trade Center Drive, Champaign IL 61820-7237
                   info@wri.com, Phone: 1-800-441-MATH  & 217-398-0700
                   Fax: 217-398-0747
```

```
                   Version:   2.1
        Comments:  General purpose, Notebook interface on Next, Mac,
                   nice graphics. Packages include: MathTensor for Tensors
                   and NCAlgebra for Non-Commutative Algebra  & Combinatorica
                   for Graph Theory. Student version available for MAC
andPC's.

GROUP THEORY
============

GAP::
      Type:      Anonymous FTP (free, but not PD; basically GNU copyleft)
        Machines:  All Unix workstations, ATARI ST, IBM PC (DOS and OS/2)
                   and MAC (with Mac Programmers Workshop) and DEC VMS.
        Contact:   gap@samson.math.rwth-aachen.de
        Version:   3.3
        Comments:  Group theory calculations. Available from the FTP sites:
                   samson.math.rwth-aachen.de, math.ucla.edu,
dimacs.rutgers.edu &&
                   wuarchive.wustl.edu & pell.anu.edu.au.  Very samall kernel
                   and most of the program written in the GAP language (like
                   Maple), very complete documentation and extensive Group
                   Theory library. The MAC version is available from
                   ccu.umanitoba.ca:/pub/mac/MacGAP31.sea.hqx
&
ALGEBRA & NUMBER THEORY
=======================

PARI::
        Type:      Anonymous FTP
        Machines:  Most  Unix workstations, Mac and NeXT
        Contact:   pari@mizar.greco-prog.fr
        Version:   1.35
        Comments:  Number theoretical computations, source available, key
                   routines are in assembler, ASCII and Xwindows  graphics.
                   PC-DOS version available from anonymous FTP at
                   wuarchive.wustl.edu:/edu/math/msdos/modern.algebra/pari386
                   or  math.ucla.edu (128.97.64.16) in the directory
/pub/pari.
```

As you are probably aware Mathematica and Maple are the two dominating systems. You will probably want at least one of them.

7 Numerical Analysis

Matlab is a very popular package for matrix calculations. Numerical analysis is mostly carried out using various Fortran and C libraries. Netlib is a fine collection of public domain numerical libraries. There is access by gopher on the host netlib2.cs.utk.edu.

The Numerical Algorithms Group (NAG) in Oxford, UK sell an excellent numerical Fortran library. They, too, have a gopher which is on the host nags2.nag.co.uk.

"Numerical Recipes" [3] is a very popular book with a great number of very well documented program examples which are also available on diskettes in Fortran, C, orPascal.

8 Mathematical Databases

We know about FIZMATH (gives access to Zentralblatt für Mathematik), AMSMATH (gives access to Mathematical Reviews), and INSPEC (Physics Abstracts, Electrical and Electronics Abstracts, and Computer and Control Abstracts). You must pay for the use of these services. Research libraries often provide access to search their book titles over a network.

8.1 Electronic Journals

1. Electronic Journal of Combinatorics

   http://math34.gatech.edu:8080/Journal/journal....html

2. Electronic Journal of Differential Equations

   http://ejde.math.swt.edu/

3. Electronic Transactions on Numerical Analysis

   http://etna.mcs.kent.edu/

4. New York Journal of Mathematics

   http://nyjm.albany.edu:8000/nyjm.html

5. Ulam Quaterly

   ftp://ftp.math.ufl.edu/pub/ulam/

8.2 General

1. The American Mathematical Society

   http://e-math.ams.org/

2. Society for Industrial and Applied Mathematics

   gopher://gopher.siam.org/11/

3. EINet Galaxy Mathematics Node

   http://galaxy.einet.net/galaxy/Science/Mathematics.html

4. WWW Virtual Library Mathematics Node

   http://euclid.math.fsu.edu/Science/math.html

5. Euromath Gopher Server

   gopher://laurel.euromath.dk/11/

6. The Mathematics Archives

   http://archives.math.utk.edu/

7. There is a WEB server about the activity of the French research community in computer algebra

   http://medicis.polytechnique.fr/

8. Mathematics topics, sources and services from Penn.

   http://www.math.upenn.edu/MathSources.html

8.3 Mathematical Departments

1. Penn State University, Department of Mathematics

   http://www.math.psu.edu

2. Penn State Erie, The Behrend College

   http://euler.bd.psu.edu

3. Brigham Young University Department of Mathematics

   http://www.math.byu.edu

4. Florida State University Mathematics Department

   http://euclid.math.fsu.edu

5. Northwestern University Department of Mathematics
   http://www.math.nwu.edu
6. Oklahoma State University, Mathematics Department
   http://math.okstate.edu:8001/
7. Rutgers University Mathematics Department
   http://www.math.rutgers.edu
8. Yale University Mathematics Department
   http://www.yale.edu/HTML/YaleMath-Info.html
9. United States Military Academy Math Dept Overview
   http://euler.math.usma.edu/MathSci.html
10. Trinity College, Dublin, Department of Mathematics
    http://www.maths.tcd.ie/
11. University of Durham, Department of Mathematics
    http://gauss.dur.ac.uk:8000/
12. T U Delft Department of Technical Mathematics and Informatics
    http://www.twi.tudelft.nl/
13. T U Eindhoven Department of Mathematics and Computer Science
    http://www.win.tue.nl/
14. University of East Anglia, School of Mathematics
    http://www.mth.uea.ac.uk/welcome.html
15. Ecole Normale Supérieure, Département de Mathématiques
    gopher://snekkar.ens.fr/11/
16. Lake Forest College Math/CS
    gopher://davinci.lfc.edu/11/
17. SUNY at Albany, Department of Mathematics and Statistics
    gopher://gopher.math.albany.edu:70/hh
18. University of California Berkeley Math Department
    gopher://math.berkeley.edu/11/

19. The University of Michigan

    http://www.math.lsa.umich.edu/

20. University of South Alabama, Dept. of Math. and Stat./Geometric Group Theory

    gopher://mathstat.usouthal.edu/11/

21. University of South Carolina, Mathematics Department

    gopher://bigcheese.math.scarolina.edu/11/

22. University of Texas, Math Department

    gopher://henri.ma.utexas.edu/11/

23. University of Tennessee, Knoxville, Department of Mathematics

    http://mathsun1.math.utk.edu:80/

24. University of Heidelberg, Institute of Pure Math

    gopher://vogon.mathi.uni-heidelberg.de/11/

25. Weizmann Institute, Department of Mathematics

    http://eris.wisdom.weizmann.ac.il/

26. Mathematics II; University of Bayreuth

    http://btm2xd.mat.uni-bayreuth.de

27. Institut de Recherche Mathematique Avancee, Strasbourg

    http://galois.u-strasbg.fr/home.html

28. School of Mathematics, Leeds

    http://www.amsta.leeds.ac.uk/

8.4 Other

1. University of Minnesota Geometry Center

   http://www.geom.umn.edu/

2. UMass Center for Geometry Analysis Numerics and Graphics

   http://www.gang.umass.edu

3. CTI Centre for Mathematics and Statistics

   http://www.bham.ac.uk/ctimath/

4. The Centre for Experimental and Constructive Mathematics
   http://www.cecm.sfu.ca/homepage.html
5. Centre International de Recontres Mathématiques
   http://cirm.univ-mrs.fr
6. Center for Scientific Computing, Mathematical Topics
   http://www.csc.fi/math_topics/General.html
7. CNAM Fractals Page
   http://www.cnam.fr/fractals.html
8. Computer Algebra Netherland (CAN)
   gopher://gopher.can.nl/11/
9. NSF Science and Technology Information System (STIS)
   gopher://stis.nsf.gov/11/
10. Netlib at Univ of Tenn and Oak Ridge National Lab
    ftp://netlib2.cs.utk.edu/
11. MathWorks Home Page (Producers of MATLAB)
    http://www.mathworks.com/homepage.html
12. Swarthmore's Geometry Forum
    http://www.forum.swartmore.edu/
13. Mathematisches Institut, Bonn
    http://rhein.iam.uni-bonn.de:1025/
14. Durham Pure Maths Page
    http://fourier.dur.ac.uk:8000/pure/pure.html
15. Ecole Normale Superieure, Paris Mathimatiques et Informatique(DMI)
    http://www.ens.fr/
16. Georgia Tech's Applied Chaos Laboratory
    http://nextworld.cc.gatech.edu:8001/Matt/acl/aclhome.html
17. Pennsylvania State University's list of Mathematics Information Servers.
    http://www.math.psu.edu/OtherMath.html

18. Salzburg Institut fur Mathematik
http://www.mat.sbg.ac.at/

19. Los Alamos National Laboratory
http://cnls-www.lanl.gov

20. Center for Nonlinear Studies (CNLS) and their Nonlinear Science e-Print Archive http://xyz.lanl.gov/

21. National Academy of Science
http://www.nas.edu/

22. ICM Berlin 1998 Preliminary WWW Server
http://icm98.zib-berlin.de/

23. MathSearch – search a collection of mathematical Web material
http://ms.maths.usyd.edu.au:8000/MathSearch.html

24. GAMS : Guide to Available Mathematical Software
http://gams.nist.gov/

9 Concluding Remarks

As is probably clear, we recommend that you get on the Internet as soon as possible. This document only provides a brief starter aimed primarily at mathematicians. You should definitely get hold of books about the Internet, e.g. [1].

The next step is to download and install public domain software: Begin with TEX , LATEX , and AMS-LATEX . Many people like emacs so you should get this as well.

As mathematicians you should also get Mathematica or Maple, or both.

And finally, it is a fulltime job administrating a local UNIX network. Employ someone to do it!

References

[1] E. Kroll, *The Whole Internet: User's Guide & Catalog*, O037777777664Reilly & Associates, Sebastopol, CA (1992). : ,

[2] EARN, *Guide to Network Resource Tools*, version 2.0 (September 1993). : ,

[3] W. H. Press, B. P. Flannery, S. A. Teukolsky, and W. T. Vetterling, *Numerical Recipes*, Cambridge University Press, Cambridge (1989). : ,

[4] D. E. Knuth, *The TEX book*, Addison Wesley, Reading, MA (1986). : ,

[5] L. Lamport, LATEX *: A Document Preparation System*, Addison Wesley, Reading, MA (1986). : ,

[6] M. D. Spivak, *The Joy of TEX* , AMS, Providence (1986). : ,

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