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Schoonschip '91

Martinus J. G. Veltman and David N. Williams

Randall Laboratory of Physics
The University of Michigan
Ann Arbor, MI 48109-1120

ABSTRACT

The symbolic manipulation program Schoonschip is being made freely available for a number of computers with Motorola 680x0 cpu's. It can run on machines with relatively modest memory and disk resources, and is designed to run as fast as possible given the host constraints. Memory and disk utilization can be adapted to tune performance. Recently added capabilities include a system for efficient generation of diagrams, gamma algebra for continuous dimensions, algorithmic improvements for handling large problems, and an increase in the allowed number of `X` expressions.

1. History

The first working version of Schoonschip ran on an IBM 7094 in December, 1963. A basic problem in particle physics, namely, radiative corrections to photons interacting with a charged vector boson, was successfully completed. In 1966 Schoonschip was ported to the CDC 6600 series computers; and gradually, as hard disks and file storage became available, the distribution extended to encompass virtually all existing CDC machines. Even quite recently this version was used for a very complicated calculation of higher order effects in quantum chromodynamics in the USSR. Notable applications in quantum electrodynamics include works by Kinoshita and coauthors,[1] and Remiddi and coauthors,[2] among which we cite only a few. The early version of the Schoonschip manual by H. Strubbe[3] has been the standard reference for citations of Schoonschip itself.

In 1983, when microprocessors of sufficient capability became available, Schoonschip was ported to a computer built around the Motorola 68000 microprocessor, the Charles River Data Systems machine. The operating system was UNIX-like, and the port to any other machine containing a 68000 series processor and featuring a UNIX-type operating system became trivial.

2. Features

It is not likely that Schoonschip will ever have the popular constituency of programs like Maple and Mathematica. It does not have a graphics interface, and has much less built-in.* It can output formulas in Fortran format, but not in TeX or PostScript format. Although there is no reason why it cannot be used for general purposes, with a few exceptions its primary role so far has been that of a scientific instrument (especially in particle physics); and it demands a certain level of mathematical expertise for its effective use.

In this section, we review some of the features that are special to Schoonschip, or relatively new to it.

* There does exist the beginning of a mathematics and particle physics knowledge base of Schoonschip procedures, some of which is provided in the current distribution.

2.1 Speed

Schoonschip is written entirely in assembly language, which not only allows it to run fast, but also reduces its size compared to equivalent programs compiled in a higher level language.

2.2 Precision

Unlike some other symbolic manipulation programs, Schoonschip does not use "infinite" precision arithmetic. Its standard number is represented in floating point, with about 29 decimal digits for the mantissa and 4 decimal digits for the exponent. The precision for cancellation may be set by the user, with a default of about 25 decimal digits. The default output is in rational number format, within the current precision.

This approach has evolved after many years of trying different schemes, and seems about optimum for most scientific applications.

2.3 Noncommutative algebra

Schoonschip is efficient at noncommutative algebra, because one of its major data types, the function, is noncommutative by default.

2.4 Gamma algebra

The known gamma algebra algorithms are built-in, and provide for efficient and compact evaluation. The algorithms in recent versions have been extended to continuous dimensions.

2.5 Output format

The output format is fairly rigid, and not particularly adapted for direct use in scientific publications. The present version does, however, have a few new options which offer more control over the output format for formulas.

2.6 Substitution efficiency

Schoonschip pioneered the substitution concept in algebraic manipulation programs, and its speed and memory efficient approach is still not common;* indeed it seems incompatible with the Lisp heritage of several other programs.

2.7 Large problems

The handling of large problems has always been a major concern in the design of Schoonschip, and recent versions have incorporated new sorting algorithms and tuning facilities that offer order of magnitude improvements in speed and disk utilization. The number of `X` expressions allowed has been increased to about $1,000$ in the current release.

2.8 Conditionals

Recent versions of Schoonschip have a more familiar and flexible treatment of conditional statements, including

```
IF ...  ELSE ...  ENDIF
```

constructs.

2.9 Compatibility with earlier versions

Programs that worked with older M68000 and CDC versions of Schoonschip will run under Schoonschip '91 after minor, mainly cosmetic modifications, which are described in the manuals.

2.10 Compatibility among machines

All versions run alike on the various machines mentioned in the next section, except for differences in clock speed and host system efficiency; and Schoonschip programs developed on one machine will run on any of the others without change, beyond the usual translation of text file formats. Schoonschip programs are prepared with a normal text editor.

* As far as we know, Form, by J. Vermaseren, is the only other program that currently follows a similar approach.

2.11 Documentation

One of the text files in the free distribution is a comprehensive manual, which is keyed to a set of program examples that is also included. Apart from the free distribution, the authors of this article are publishing a reorganized, indexed, hardcopy version of the manual.

2.12 Examples

Nothing is more instructive than a working example. Therefore a large collection of programs, collected over the lifetime of Schoonschip, has been put together, notably including the very first program, executed in December, 1963.

3. Machine Requirements

At present, Schoonschip binary executable files are available for the following computers: Amiga, Atari, NeXT, and Sun 3. The Motorola 680x0 microprocessor is common to these machines.[⋆] It runs on the 68000, 68020, 68030, and 68040 microprocessors, and does not require a floating point coprocessor. The standard memory requirement is 1 Megabyte of contiguous RAM workspace, plus a little over 110 Kilobytes for the program.[†] Input and output file space is of course also needed. Typically, a rather large program might produce an output file of 400K, with temporary files totaling 1 Megabyte.

All of the machines listed below provide acceptable performance for real problems. At present, the NeXTstation, with its 25 MHz, 68040 cpu gives the best performance by a substantial margin. Second in performance are the machines with 25 MHz, 68030 cpu's, such as the Amiga 3000 and Mac II. As the 68040 cpu and higher clock speeds migrate to more machines, the situation will of course change. Very good performance has become relatively inexpensive.

[⋆] Schoonschip does not run, for example, on a Sun SparcStation or an IBM PC.

[†] The executable can be assembled to load with less workspace. Problems of moderate size run comfortably with less than 400K.

3.1 Amiga

The Amiga version has been tested on an Amiga 2000 (68000 cpu) with AmigaDOS 1.3, and on an Amiga 3000 (68030 cpu) with AmigaDOS 1.3 and 2.0. There is no reason to expect it to fail on an Amiga 500 or 1000, but it has not been tested on those machines.

3.2 Atari

The Atari version runs on an Atari ST1020 or Atari Mega. It will presumably run also on the new machine, containing a 68030 cpu and coprocessor, but that has not been tested.

3.3 Next

The NeXT version has been tested on a NeXTstation with a 68040 cpu and release 2.1 of the operating system.

3.4 Sun

The Sun version has been tested on a Sun 3/140 with a 68020 cpu and Sun UNIX 4.4 Release 3.3.

3.5 Macintosh

A working Macintosh II version exists, but it has not yet been upgraded to System 7. It replaces the Macintosh graphics interface with a complete CLI (*command line interface*) environment, which involves rather more than the other ports. A simpler version operating with the standard graphics interface will be released in the near future.

4. Availability

The Information Technology Division (ITD) of the University of Michigan is providing (for the time being at least) an anonymous ftp host for Schoonschip software, programs, and documentation, as well as other physics related computational material. Users with access to the internet can copy these files to their host machines by logging on with the ftp program available at many UNIX and VAX installations. The internet address is

```
archive.umich.edu
```

The software is currently in the directory `physics/schip`.

The transcript of an actual session run from a Sun follows, with a little editing:

```
> ftp archive.umich.edu
  Connected to archive.umich.edu.
  220 earth.rs.itd.umich.edu FTP server
    (Version 4.82 Wed Aug 14 23:53:47 EDT 1991) ready.
  Name (archive.umich.edu:williams):  ftp
  331 Guest login ok, send ident as password.
  Password:
  230 Guest login ok, access restrictions apply.
ftp> cd physics/schip
  250 CWD command successful.
ftp> dir
  200 PORT command successful.
  150 Opening data connection for /bin/ls (141.211.96.20,1274) (0 bytes).
  total 1212
  -rw-rw-rw-  1 9030     staff        1592 Aug  7 15:05 AmiAta.txt
  -rw-rw-rw-  1 9030     staff        1313 Aug  7 15:05 INDEX
  -rw-r--r--  1 9030     staff         587 Jul 17 19:24 Mac.txt
  -rw-r--r--  1 9030     staff         600 Jul 17 19:24 NextSun.txt
  -rw-rw-rw-  1 9030     staff        4608 Aug  5 15:03 README
  -rw-rw-rw-  1 9030     staff        2746 Aug  5 15:04 README.FTP
```

```
   -rw-rw-rw-  1 9030     staff      222076 Aug  6 13:32 SDocsAMI.LZH
   -rw-rw-rw-  1 9030     staff      226017 Aug  6 13:50 SDocsATA.LZH
   -rw-rw-rw-  1 9030     staff      100692 Aug  7 15:05 SchipAMI_M.LZH
   -rw-rw-rw-  1 9030     staff      100691 Aug  7 15:05 SchipAMI_S.LZH
   -rw-rw-rw-  1 9030     staff       82293 Aug  6 13:51 SchipATA.LZH
   -rw-rw-rw-  1 9030     staff      287582 Aug  6 14:17 SchipDocs.tar.Z
   -rw-rw-rw-  1 9030     staff      101291 Aug  6 14:12 SchipNXT.tar.Z
   -rw-rw-rw-  1 9030     staff      103313 Aug  6 14:07 SchipSUN.tar.Z
   226 Transfer complete.
   952 bytes received in 1.4 seconds (0.65 Kbytes/s)
ftp> binary
   200 Type set to I.
ftp> recv SchipATA.LZH
   200 PORT command successful.
   150 Opening data connection for SchipATA.LZH
    (141.211.96.20,1275) (82293 bytes).
   226 Transfer complete.
   local:  SchipATA.LZH remote:  SchipATA.LZH
   82293 bytes received in 1.9 seconds (41 Kbytes/s)
ftp> quit
   221 Goodbye.
```

The password supplied by the user is blanked out above. It can be essentially anything.

A few of the files in the above list are uncompressed text, and can be copied with the ftp `recv` command without setting the ftp binary (image) mode, namely, the files with a `.txt` extension, and the files `README` and `INDEX`. These files describe what the other files contain, and explain how to copy and decompress them.

The software itself, the manual, and a number of sample Schoonschip programs are in compressed formats, and must be copied in ftp binary mode, as in the session above.

Although copyrighted by M.J.V., the Schoonschip files at `archive.umich.edu` may be freely copied and redistributed, on a not-for-profit basis. Technically, they are "freeware."

Amiga and Atari users whose computers are not networked to the internet still have the problem of downloading the files after retrieval to a local machine which does have internet access. That is a common problem, with a number of solutions, among which Kermit over the telephone is ubiquitous although not entirely painless. An entirely acceptable solution is to get floppies from somebody who already has a copy.

5. Support

Every effort will be made to keep the program up to date, but we are not in a position to offer systematic support. A lot of examples have been provided, as well as some actual calculations. We invite users willing to make their Schoonschip calculations freely available to submit programs to the anonymous ftp host `archive.umich.edu`, which can serve as a central repository.

Problem reports and questions about availability of the software and documentation may be directed to either of us, and especially to D.N.W. at

`David.N.Williams@um.cc.umich.edu`
`DWilliams@UMiPhys.bitnet`
`7506.3124@CompuServe.com`

REFERENCES

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3. H. Strubbe, *Comp. Phys. Commun.* **8**, 1 (1974); **18**, 1 (1979).