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Subject: IDL FAQ

Posted by [sterner](#) on Fri, 15 Nov 1996 08:00:00 GMT

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The IDL FAQ is posted on or about the 20th of each month  
Only the plain text version of the FAQ is posted to the news group.  
It's a bit early this month to make up for the times it was a bit late.

Version 3.16 of the IDL FAQ is included below.

Changes in version 3.16:

- . Added an explicit reference to Chris Chase's ftp directory on fermi in G07
- . Added Research Systems ftp site in G07
- . Added a pointer to the WWW site list under the ftp site question (G07)
- . Added a pointer to the ftp site list under the WWW site question (G13)

The HTML version of the IDL FAQ is available at:

[ftp://fermi.jhuapl.edu/www/s1r/idl/idl\\_faq/idl\\_faq.html](ftp://fermi.jhuapl.edu/www/s1r/idl/idl_faq/idl_faq.html)

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WWW Home page: <ftp://fermi.jhuapl.edu/www/s1r/people/res/res.html>

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## IDL (Interactive Data Language) FAQ

Frequently Asked Questions about the  
Interactive Data Language (IDL).

Archive-name: idl-faq  
Last-modified: 1996 Nov 15  
Version: 3.16

Latest IDL FAQ: See Appendix A02.  
FAQ maintainer: Ray Sterner  
Email: [sterner@tesla.jhuapl.edu](mailto:sterner@tesla.jhuapl.edu)

Changes in version 3.16:

- . Added an explicit reference to Chris Chase's ftp directory on fermi in G07
- . Added Research Systems ftp site in G07
- . Added a pointer to the WWW site list under the ftp site question (G07)

. Added a pointer to the ftp site list under the WWW site question (G13)

Previous changes may be found in Appendix A04.

## Introduction

This is a list of Frequently Asked Questions about the Interactive Data Language or IDL. These questions pop up fairly regularly in the newsgroup comp.lang.idl-pvwave. This list is an attempt to cut down on net traffic regarding commonly asked questions. Users are encouraged to read through this list before posting a query to the newsgroup.

As of 1994 Oct 27 Ray Sterner has been maintaining the IDL FAQ. Mike Schienle was handling this previously, and Patrick Ryan before him; much of the material and many of the comments here were compiled by them.

### A Note from the editor about PV~WAVE:

I do not have any direct experience with PV~WAVE. As such, I will try to minimize comments which appear to favor one package or the other. I will, however, welcome concise descriptions of technical and functional differences between the two packages.

## Contents

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## GENERAL QUESTIONS:

G01. What is IDL?

IDL is the Interactive Data Language. It is a product of Research Systems, Inc. (RSI).

The following is quoted from the README file at [rsinc.com/pub/idl/README](http://rsinc.com/pub/idl/README). As such, it describes IDL's capabilities in an understandably subjective manner. ;-)

IDL, Interactive Data analysis Language, is a complete package for the interactive reduction, analysis, and visualization of scientific data and images. Optimized for the workstation environment, IDL integrates a responsive array oriented language with numerous data analysis methods and an extensive variety of two and three dimensional displays into a powerful tool for researchers.

IDL supports an extensive data import capability, publication quality hard copy output, and user-defined Motif graphical user interfaces.

Users can create complex visualizations in hours instead of weeks with the aid of IDL's high level capabilities and interactive environment.

IDL is useful in physics, astronomy, image and signal processing, mapping, medical imaging, statistics, and other technical disciplines requiring visualization of large amounts of data.

Here is a short history of RSI:  
[attributed to [ali@rsinc.com](mailto:ali@rsinc.com) (Ali Bahrami)]

IDL is a product of Research Systems, Inc., founded in 1977 by David Stern. The origins of IDL were developed at the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado. David was one of the people involved in efforts to make computers easier to use for the physicists at the Lab. The first program in the evolutionary chain to IDL was named Rufus (named after Dave's dog). Rufus was a very simple vector oriented calculator that ran on the PDP-12. It accepted 2 letter codes that specified (1) An arithmetic operation (2) The input registers to serve as operands, and (3) the destination register. The next version was the Mars Mariner Spectrum Editor (MMED) which was a version of Rufus that ran on the PDP-8.

The next program in this line was named SOL, and it also ran on the PDP-8. Unlike its predecessors, SOL was a real computer language with a real syntax (no more 2 letter codes). It was an APL influenced array oriented language with some primitive graphics capabilities. The resemblance to IDL was there, but very faintly.

In 1977, Dave left LASP to start Research Systems Inc. (RSI) with the intention of building on the ideas contained in SOL. The initial result of this endeavor was PDP-11 IDL, which was much more capable than SOL. Graphics was usually done on Tektronix terminals and outboard raster graphics displays. I used this version at LASP in 1981 on a PDP11/34 under RSX-11M in 1981 (I worked as a student at LASP from 1981 to 1987). I didn't use it for very long though, because 1981 was the year that Dave released the VAX/VMS version of IDL. This version, which was written in VAX-11 MACRO and FORTRAN, took advantage of the VAX virtual memory and 32-bit address space, and was a huge step beyond the PDP-11 version. It used essentially the same sort of graphics hardware as the PDP-11.

In 1987, Dave decided that Unix workstations were the direction in which IDL should progress, but porting the current VAX IDL to Unix didn't make much sense because of its MACRO and FORTRAN implementation. I had just finished my Masters degree and was looking for work. Dave hired me and together we wrote the current version of IDL for Unix on the Sun 3 taking advantage of the re-write to extend and improve the language. Since then, we've ported it to many Unix machines and moved it back to VMS. RSI has many other employees now, but our focus is still the continued development of IDL. Recently, IDL was ported to PC class systems running Microsoft Windows.

G02. Where can I contact them?

Their address is:

Research Systems, Inc.  
2995 Wilderness Place  
Boulder, CO 80301  
(303) 786-9900 (Voice)  
(303) 786-9909 (Fax)

Email:

[info@rsinc.com](mailto:info@rsinc.com) or [support@rsinc.com](mailto:support@rsinc.com)

World Wide Web

<http://www.rsinc.com/>

Research Systems' Inc., International Distributor Offices

Austria, Germany, Lichtenstein, Luxembourg,  
Switzerland, The Netherlands

CREASO, GmbH

Talhof Str. 30

D82205 Gilching

Germany

Telephone: 49 8105 25055

Fax: 49 8105 25623

Contact: Bernhard Kortmann

email: 100137.2421@compuserve.com

Brazil

SulSoft

Rua Dom Pedro II, 1220 cj 515

90550-141 Porto Alegre - RS

Brazil

Telephone/Fax 55 51 337 38 91

Contact: Michael Steinmayer

email: mis@inf.ufrgs.br

China, Hong Kong

3- Link Systems Pte Ltd.

Room 801 Stone Plaza

No 2 Haidian Street

Beijing 100080 PR China

Telephone: 8610-261-0161

Fax: 8610-261-0163

Contact: Qunli Ren

email: linkbj@ox1.ios.ac.cn

Singapore

3- Link Systems Pte Ltd.

140 Robinson Road

#05-03 Chow House

Singapore 068907

Telephone: 65 227-8671

Fax: 65 227-8679

Contact: Harry Lee

email: zdlee@singnet.com.sg

France, Belgium

Fast Parallel Solutions France

1 Place Gustave Eiffel

Silic 267

94578 Rungis Cedex, France  
Telephone: 33 1 46 87 25 22  
Fax: 33 1 46 87 71 38  
Contact: Louis Tauziet  
email: 100347.1577@compuserve.com

#### Italy

Alliant Computer Systems SRL  
Centro Direzionale Colleoni  
Palazzo Taurus  
Ingresso 3  
20041 Agrate Brianza MI, Italy  
Telephone: 39 39 6091766  
Fax: 39 39 6091779  
Contact: Chris Stuart & Alberto Meroni  
email: chris@specialnet.cmt.it

#### Japan

Adam Net Ltd.  
Yushimadai Bldg. 2-31-27  
Yushima, Bunkyo-ku  
Tokyo, 113, Japan  
Telephone: 81 35802 2251  
Fax: 81 35802 2249  
Contact: Osamu Nakano  
email: nakano@adamnet.co.jp

#### Korea

Intersys  
373-1 KuSung-Dong  
YuSung-Gu  
Tae Jun 305-701  
Korea  
Telephone: 82 42 869 4746  
Fax: 82 42 862 9239  
Contact: Jong-Sik Yoon  
email: jsyoon@intersys.kaist.ac.kr

#### Spain

Estudio Atlas  
Parque Tecnológico de Alava  
C/Tecnológico 11,40  
01510 Minano (Alava)  
Spain  
Telephone: 34 45 298 080  
Fax: 34 45 298 084  
Contact: Montserrat Bacaicoa  
email: estuds01@sarenet.es

## Taiwan

Concentrate Corporation  
5th Fl., No. 8, Lane 259  
Fu Kang Road  
Shihlin, Taipei  
Taiwan  
Telephone: 886 2 883 7752  
Fax: 886 2 881 7946  
Contact: Peter Kang  
email: [conce@ms2.hinet.net](mailto:conce@ms2.hinet.net)

## United Kingdom

Floating Point Systems UK Ltd.  
Ash Court  
23 Rose Street  
Wokingham  
Berks RG11 1XS  
United Kingdom  
Telephone: 44 1734 776333  
Fax: 44 1734 776433  
Contact: Doug Wilson  
email: [doug@floating.demon.co.uk](mailto:doug@floating.demon.co.uk)

## G03. How do I get IDL?

RSI's distribution scheme is unique in that all of the binaries and IDL code needed are available via anonymous ftp. IDL binaries and code are available at these sites:

[gateway.rsinc.com](ftp://gateway.rsinc.com) (192.5.156.17)  
pub/idl  
[boulder.colorado.edu](ftp://boulder.colorado.edu) (128.138.240.1)  
pub/idl  
[ftp.Germany.EU.net](ftp://ftp.Germany.EU.net) (192.76.144.75)  
shop/CreaSo/IDL

The README file describes which files are needed, how to unpack them, and how to install them.

If you install IDL without a valid license, you will get IDL's 7 minute demo mode. This mode is designed for users who are considering buying the package.

To actually get IDL running for good, you must pay for a license from RSI



and follow their instructions. You will be asked to fill out a form with information unique to your machine. RSI will create a license key which the license manager program (Imgrd) reads to validate your license.

As of release 3.1, upgrades to IDL are no longer free. For details about upgrades and support contracts, contact RSI.

G04. What is the current version of IDL?

IDL 4.0.1 is the current version. It was released August 1995.

G05. On what systems does IDL run?

The information below is from the IDL 4.0.1 Online Help, under the topics "What's New in IDL 4.0.1?", "Platforms Supported in this Release":

IDL supports the following OS versions (including later version

- \* VAX VMS 5.5-2 with Motif 1.2.
- \* Alpha AXP VMS Version 6.1
- \* Risc Ultrix 4.4 with Motif 1.2. This is the final release for Ultrix.
- \* OSF/1 (Digital Unix) Version 3.2
- \* IBM RS/6000 AIX Version 3.2
- \* Sun Solaris Version 2.3
- \* SunOS Version 4.1.3
- \* Silicon Graphics Inc. IRIX Version 5.2
- \* Hewlett Packard Corporation HP/UX Version 9.01
- \* Linux: IDL for Linux was built under Linux 1.2.8 using Slackware version 2.2. We also ship a statically compiled version that should work with older kernels.
- \* Intel x86 Microsoft Windows NT Version 3.5, Microsoft Windows Version 3.1
- \* Apple Macintosh and PowerMacintosh MacOS System 7.0.1 or higher

Platform added since the release of IDL 4.0.1

- \* Alpha AXP Microsoft Windows NT Version 3.51

The following hardware/operating system combinations are no longer supported. The last release of these versions have been archived, and no future development for them will be done:

- Sun 386i (last release: 2.0.4).
- HP 9000 series 300 and 400 (last release: 3.1.0)
- VAX Ultrix (last release: 2.2.2)
- Sun 3 (last release: 3.1.0)
- MIPS running Risc/OS 4.52B (last release: 3.1.0)

G06. What is PV~WAVE and how is it related to IDL?

Around the time that the Unix version of IDL first became available (1988), Precision Visuals Inc. (PVI) entered into an agreement with RSI under which they enhanced and resold IDL under the name PV~WAVE. In September of 1990, they exercised an option in that agreement that resulted in the following:

- They received a copy of the IDL source code as it existed in September 1990 in return for a one-time payment to RSI.
- The connection between RSI and PVI was severed.

IDL and PV~WAVE are now on separate development tracks. Each company enhances, supports, and maintains its own product.

PVI has since merged with IMSL and is now Visual Numerics, Inc. (VNI).

G07. Are there anonymous FTP sites for IDL?

The sites below contain public domain IDL code. See also the list of World Wide Web sites under G13.

JHU/APL/S1R IDL library  
fermi.jhuapl.edu [128.244.147.18]  
/pub/idl

Chris Chase's Emacs related IDL tools sites  
fermi.jhuapl.edu [128.244.147.18]  
/pub/idl\_emacs

Research Systems, Inc. Emacs/Xemacs related IDL tools  
rsinc.com [192.5.156.17]  
/pub/user\_contrib/emacs

NASA IDL Astronomy User's Library  
(VAX) uit.gsfc.nasa.gov [128.183.57.27]  
Username: idluser  
Password: (Contact landsman@stars.gsfc.nasa.gov for password)  
(Unix) idlastro.gsfc.nasa.gov [128.183.57.82]  
/

IUE RDAF library  
iuesn1.gsfc.nasa.gov [128.183.57.16]

cetus.colorado.edu [128.138.238.151]  
/pub

ICUR Spectral Analysis Software  
ftp.astro.psu.edu [128.118.147.28]  
/pub/neffftp/icur

IDL ROSAT software  
legacy.gsfc.nasa.gov [128.183.8.233]  
rosat/software/idl

IDLmeteo library  
ftp.sma.ch (141.249.3.33)  
/pub/idlmeteo

ESRG library  
eos.crseo.ucsb.edu [128.111.228.1]  
/pub/idl

G08. How can I get help?

RSI has excellent telephone and email support. You can contact them at:

Voice: (303) 786-9900  
Fax: (303) 786-9909

Email:

(Internet)  
info@rsinc.com # general questions  
support@rsinc.com # technical support

(SPAN)  
ORION::IDL

Keep in mind, however, that RSI's technical support is for their paying customers, i.e. those with current support contracts.

G09. Why are there two newsgroups for IDL?

Unfortunately, there are two very different packages with the abbreviation "IDL". The newsgroup comp.lang.idl is for the Interface Definition Language. The newsgroup for discussing issues related to RSI's IDL and VNI's PV-WAVE and IMSL/IDL is comp.lang.idl-pvwave.

G10. Does anyone at RSI read this group? Is anyone there listening?

[ This question was included at the request of RSI. The answer was provided by Ali Bahrami. -pat ]

Yes, many of us do. We're naturally curious what people think of our product. We make notes about what people like and dislike and this influences our decisions.

However, you usually won't get a direct response from us from a posting to this group. There are many reasons for this. Here are a couple of the more important ones:

[] We believe that this group should belong solely to the user community, and should be free of vendor bias and marketing. It should be noted that both RSI and Visual Numerics (formerly PVI) have shown great restraint in this matter, and that this group is largely left to the actual users. (Long term readers will recall some notable exceptions to this, but in general it is true.)

It could be argued that as long as the topic stays technical, vendor postings are OK. The problem with this is that one persons technical posting is another's blatant product plug, and the line between them is not always obvious.

[] We provide support for our customers via the phone and email. If you would like an answer from us, you should call us directly. We have no objection to you sharing the information you get in this manner with the newsgroup as long as you quote us accurately and separate fact from conjecture.

In other words, you should view this newsgroup as a way to share questions and information with other users, not as a way to contact the vendor.

G11. When is the next version of IDL due out?

IDL 4.0 was released in June 1995.

IDL 4.01 was released in late August 1995 and includes over 140 corrections and enhancements to IDL 4.0.

IDL 5.0, the next major version of IDL, will be released during 1996.

G12. Are there training courses available for IDL?

[ This question included at the request of RSI. ]

RSI offers a number of IDL training courses for beginning, intermediate, and advanced IDL users. IDL courses are scheduled monthly at RSI's training facility in Boulder. On-site IDL courses are also available. Contact RSI at 303-786-9900 and ask for "training" or send e-mail to [training@rsinc.com](mailto:training@rsinc.com) for complete scheduling and price information.

G13. Is there a World Wide Web server for IDL or IDL based projects?

See also the list of ftp sites under G07.

RSI has WWW pages on IDL in general:

<http://www.rsinc.com/>

Pete Riley's IDL Home Page at the Lunar and Planetary Lab:

<http://xlr8.lpl.arizona.edu/idl.html>

Wayne Landsman's IDL Astronomy Library World Wide Web home page:

<http://idlastro.gsfc.nasa.gov/homepage.html>

The JHU/APL/S1R IDL library WWW page:

<http://fermi.jhuapl.edu/s1r/idl/idl.html>

University of Darmstadt, Germany, IDL page (in German):

[http://wwwpc.hrz.th-darmstadt.de/prog/grafik/idl-4\\_0.htm](http://wwwpc.hrz.th-darmstadt.de/prog/grafik/idl-4_0.htm)

Gary Kushner's IDL data acquisition web page: <====<<< Does anyone know what happened to this link?

<http://casa.Colorado.EDU:80/casa/personnel/staff/kushner/idl -iii.html>

R. Sterner's Color Shaded Relief Maps made by IDL:

<http://fermi.jhuapl.edu/states/states.html>

E. Loren Buhle, Jr. Ph.D. made a page on AVS IN MEDICAL TREATMENT PLANNING which also discusses IDL:

[http://archive.xrt.upenn.edu/0h/buhle/manuscripts/avs94\\_pape r.html](http://archive.xrt.upenn.edu/0h/buhle/manuscripts/avs94_pape r.html)

Liam Gumley has several IDL related web pages:

Frame Tools | Image Mapping Tool | HDF SDS Tool | Underground Guide to IDL

<http://cimss.ssec.wisc.edu/~gumley/index.html>

G14. How can I find if a routine to do what I want already exists?

One of the most useful tools to find an available routine is Pete Riley's

Searchable List of all IDL Routines.

This list is available from Pete's IDL page at  
<http://xlr8.lpl.arizona.edu/idl.html>.

If you would like to add your IDL library to Pete's list contact him at  
[uk2@lpl.arizona.edu](mailto:uk2@lpl.arizona.edu).

## TECHNICAL QUESTIONS:

Note for Sun users:

There is a mini FAQ for Sun IDL in `$IDL_DIR/notes`, and the following questions are answered in the file `sun.doc`:

1. IDL complains about missing fonts when creating widgets.
2. IDL complains about missing bitmap files when creating widgets.
3. How to make IDL work with OpenWindows version 3.0.
4. 3-D appearance for OpenLook IDLwidgets.
5. Why does one of the widgets appear red?
6. Why does pressing the left button while pointing at a pulldown menu button cause the menu to pop up with the pushpin in? Older versions of IDL didn't to that.
7. The font used by the list widget is much larger than it used to be, and I don't like the result on my program.
8. Why do I get "Cannot allocate colormap entry" errors, and why do they kill IDL?
9. I've changed my `.Xdefaults` file, but nothing different happened. Why?

T01. Why doesn't polycontour fill open contours??

This problem is described in the POLYCONTOUR manual page.

## RESTRICTIONS:

This routine will NOT draw open contours. To eliminate open contours in your dataset, surround the original array with a 1-element border on all sides. The border should be set to a value less than or equal to the minimum data array value.

For example, if A is an (N,M) array enter:

```
B = REPLICATE(MIN(A), N+2, M+2) ;Make background
B(1,1) = A ;Insert original data
CONTOUR, B, PATH=Filename ... ;Create the contour file.
```

[ This problem was fixed in IDL 3.1. ]

The following is from Ray Sterner at Johns Hopkins University:  
Here is a very simple algorithm that might be a useful addition to the section of the FAQ on filled contours. It is for evenly spaced contours only.

Z is an array to be contoured,  
CI is the desired contour interval,  
C0 is the desired starting color index,  
D is the desired step between colors.

```
T = fix(Z/CI)
M = T - smooth(T,3)
F = (C0 + T*D)*(1-M)
```

is an array with filled contours with the contours plotted with color 0. For contours of a different color simply add M\*CC where CC is the desired contour color index.

T02. How do I increase the number of commands stored in the history buffer?

The system variable !EDIT\_INPUT controls command recall. By default, it is set to 1, causing the last 20 commands to be saved. If it is 0, no commands are saved. To save more than 20 commands, just put !EDIT\_INPUT=50 (or other large number) in your startup file.

It is important to realize that IDL looks at the value of !EDIT\_INPUT the first time it reads anything from the keyboard, and the size of the history buffer is fixed after that. Hence, the command must be in a startup file because entering it at the keyboard is too late.

T03. How do I get IDL to call routines in language X, running under system Y?

Jeff Valenti has written a sizable document about calling external FORTRAN routines from IDL. You can find it at [eos.crseo.ucsb.edu:/pub/idl/idl-fortran.Z](http://eos.crseo.ucsb.edu:/pub/idl/idl-fortran.Z).

T04. Why does XPALETTE edit my color table incorrectly?

Here is the answer from RSI support:

The color applications such as xpalette and xloadct use a common block called "colors" to keep track of the color vectors. When you call tvlct, your vectors are loaded into the colormap, but they are not put into the colors common block.

When xpalette starts, it checks to see if the colors have been defined in the common block and uses them if they have. Otherwise it sets them to the standard black and white colormap, in which r,g,b are each linear ramps. (The colors are as you expect because there is only one colormap.)

Admittedly, this is not the most desirable situation. You would like your colors which you loaded with TVLCT to be recognized by xpalette. We modified xpalette (and xloadct) to use the current colormap when they start up by getting the current vectors with TVLCT.

Another alternative would be to use the following lines to define the common block prior to calling your current version of xpalette.

[ assume here that you have a routine called "restore" which reads colors from a file somewhere and creates vectors r, g, and b. -pat ]

```
IDL> restore, file='ryan.sav', r, g, b ;get the vectors from somewhere
IDL> tvlct, r, g, b
IDL> common colors,r_orig,g_orig,b_orig,r_curr,g_curr,b_curr
IDL> r_orig = r & r_curr = r
IDL> g_orig = g & g_curr = g
IDL> b_orig = b & b_curr = b
IDL> xpalette
```

T05. Is there on-line help for IDL?

Try ?.



T06. I run IDL under X in SunOS 4.x, and after I logout, the screen becomes completely blank. Typing in login names and passwords blindly logs you in again with the correct colors. How to prevent this?

[Note: This is only a problem under OpenWindows2. -pat ]

Add the following to your .Xdefaults:

```
Idl*colors: -5
```

which reserves some colors for the colormap so that IDL does not exhaust all the available colors. (For a nice summary of Sun IDL interactions with OpenWindows, see \$IDL\_DIR/notes/sun.doc)

Another solution is to put a call to clear\_colormap in your .login file to be executed after OpenWindows start up.

T07. Sometimes my variables seem to disappear. Why is this?

Quoting the IDL User's Guide, page 10-8:

IDL users may find that all their variables have seemingly disappeared after an error occurs inside a procedure or function. The misunderstood subtlety is that after the error occurs, IDL's context is inside the called procedure, not in the main level. Typing RETALL or RETURN will make the lost variables reappear.

RETALL is best suited for use when an error is detected in a procedure and it is desired to return immediately to the main program level despite nested procedure calls. RETALL issues RETURN commands until the main program level is reached.

The HELP command can be used to see the current call stack (i.e., which program unit IDL is in and which program unit called it).

T08. Are there any editors that support IDL programming?

Yes. For Emacs:

Chris Chase (chase@jackson.jhuapl.edu) has written idl.el, a major mode for editing IDL code. He has also written idl-shell.el for running IDL as an inferior process under emacs. URLs for these files are:

<ftp://eos.crseo.ucsb.edu/pub/idl/>

[ftp://fermi.jhuapl.edu/pub/idl\\_emacs/](ftp://fermi.jhuapl.edu/pub/idl_emacs/)  
Get the files: `idl.el` and `idl-shell.el`

VNI has available a PV~WAVE major mode. Given the (remaining) strong similarity between PV~WAVE and IDL, it has many of the features that one would like in such a mode. URLs for this file are:

<ftp://ftp.pvi.com/PVI/emacs/>  
<ftp://eos.crseo.ucsb.edu/pub/idl/>  
Get the file `wave-mode.shar`

From John E. Davis, [davis@space.mit.edu](mailto:davis@space.mit.edu):

Also available is JED, an extensible programmer's editor that is available for Unix, VMS, OS/2, MSDOS, and MS Windows. The size of the executable is only slightly larger than vi. The extension language resembles C. It provides emacs, EDT, wordstar, and brief editor emulations (Many claim that JED's EDT emulation is the best around). It is the only freely available editor that can perform color syntax highlighting on ordinary character-cell color terminals (e.g., MS-Kermit, etc.) as well as under XWindows (Xjed). Currently supported programming modes include: C, FORTRAN, (La)TeX and BiBTeX, DCL, IDL, NROFF, SH, HTML, and SLANG. Other extensions include mail, rmail, compile, as well as the ability to read GNU info files. It is available from

<ftp://space.mit.edu/pub/davis/jed/>

See Appendix A02 for details on using URLs.

T09. How do I get 3-D widgets under OpenLook 3.0?

This subject is discussed on page 53 of the OpenWindows Version 3 User's Guide Release Manual.

OpenWindows 3.0 added 3-D appearance for widgets. In order for the 3-D look to work, it must be enabled and the background color must be a medium tone color such as "grey" or "wheat". Add the following resources to your `~/.Xdefaults` file:

For plain IDL:

```
Idl*threeD: TRUE
```

Idl\*background: PeachPuff2

For IMSL/IDL:

Imslidl\*threeD: TRUE

Imslidl\*background: PeachPuff2

T10. Why does one of the widgets appear red under OpenWindows?

This subject is discussed on page 53 of the OpenWindows Version 3 User's Guide Release Manual.

The OLIT widget toolkit, which is used by IDL, added the concept of "mouseless focus" under version 3.0. The red widget indicates where the current mouseless focus is. Use the arrow keys to traverse the widgets, and the spacebar to make a selection.

T11. Where are all the IDL routines and userlib procedures?

The basic routines are not accessible, for obvious reasons. The userlib, statlib and widget procedures are in \$IDL\_DIR/lib/. The procedure XDL also displays the full pathname. The system variable !path also contains the directory names for all accessible IDL procedures.

T12. Does anybody know how to put multiple image plots on one page in PostScript?

Because PostScript has scalable pixels, you must specify the xsize and ysize parameters, as well as the position parameter, in TV or TVSCL. I don't know about PV-Wave, but the following works in IDL:

```
; Display four images in a 2x2 grid
; Assume data(x,y,4) = array containing the 4 images

set_plot, 'ps'           ;request PostScript output
device, ...              ;modify page size, orientation, etc. as desired
ximsize = 0.5*!d.x_size ;define output image size
yimsize = 0.5*!d.y_size ;note: 0.5 assumes 2x2 grid
for i=0,3 do begin      ;display the 4 images, using i as position index
    tv, data(*,*,i), i, xsize=ximsize, ysize=yimsize
endfor
```

T13. Does case matter in IDL?

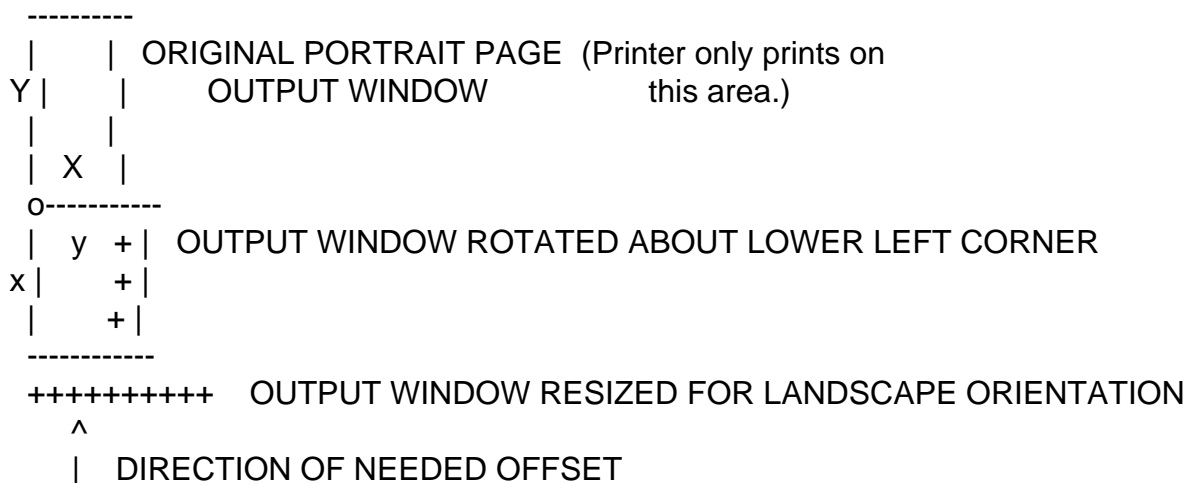
No.

Compiled routines are case insensitive. The only catch is that, on Unix systems, when executing a script via the .RUN command, the file name argument must exactly match the file name as it appears on the disk. Once the routines in the script are compiled, their names can be written in any case. This is not a problem in operating systems such as VMS that do not distinguish case for file names. This is usually not a problem under Unix either since, by convention, most people use lower case file names.

T14. How do I set up IDL to get precise control over plot window and text positioning with either portrait or landscape page orientation on a PostScript or HP-GL printer?

(This answer only applies to PostScript and HP-GL printers -- other printers may differ in having the X and Y offsets measured from the upper left corner of the portrait page instead of the lower left corner.)

IDL uses portrait page orientation as a default. (The x axis is along the shorter dimension of the paper.) In portrait orientation the lower left corner of the page is the origin for the XOFFSET and YOFFSET page offsetting keywords of the DEVICE command that determine the origin (lower left corner) of the output window. (Normally one uses XOFFSET=0 and YOFFSET=0 for portrait orientation.) Size of the output window is determined by the XSIZE and YSIZE keywords of the DEVICE command. The origin for graph positioning variables !P.POSITION and !P.REGION is the output window origin. X and Y coordinates for portrait page orientation are shown on the sketch below as upper case X and Y.



If device,/landscape is specified, then the output window is rotated 90 deg. clockwise about the lower left corner of the page. In this condition nothing

will be plotted on the page, since the rotation has carried the output window entirely off the paper as shown in the sketch above. To correct this mismatch, the rotated output window must be offset. XOFFSET AND YOFFSET are still measured in the X and Y coordinates of the portrait page, but now represent the position of the lower left corner of the rotated (and resized) output window (marked by an o above) with respect to the lower left corner of the portrait (actual) page. Hence, one generally uses XOFFSET=0 and YOFFSET=long\_dimension\_of\_page for landscape orientation.

In landscape orientation, the coordinates for graph positioning variables !P.POSITION and !P.REGION are the lower case x and y coordinates shown in the sketch above and having origin marked by the letter o. Position of output window origin o on the page is, of course, affected by the setting of XOFFSET and YOFFSET, as explained before. The XSIZE and YSIZE (output window size) keywords of the DEVICE command are also measured in the x and y directions when in landscape orientation. The resizing of the landscape page generally means interchanging the values of XSIZE and YSIZE appropriate for the portrait page.

Example of settings for a portrait page:

```
XPAGE=8.5 & YPAGE=11. & XOFFS=0. & YOFFS=0. ;Inches  
DEVICE,/INCHES,XSIZE=XPAGE,YSIZE=YPAGE,XOFFSET=XOFFS,YOFFSET =YOFFS
```

Example of settings for a landscape page:

```
XPAGE=11. & YPAGE=8.5 & XOFFS=0. & YOFFS=XPAGE ;Inches  
DEVICE,/LANDSCAPE,/INCHES,XSIZE=XPAGE,YSIZE=YPAGE,XOFFSET=XOFFS, $  
YOFFSET=YOFFS
```

Example of setting position and size of a plot window:

```
X0=1.374 & Y0=1.283 & XLEN=3.622 & YLEN=6.157 ;Inches  
!P.POSITION=[X0/XPAGE,Y0/YPAGE,(X0+XLEN)/XPAGE,(Y0+YLEN)/YPAGE]
```

Example of setting position and orientation of a text string:

```
x0=.35 & y0=.37 ;Inches  
xyouts,x0/xpage,y0/ypage,!stime,orient=90,/normal ;Date, time
```

T15. I get the error message "Code Area Full". What do I do?

IDL sets aside a certain amount of memory area for compiling programs. The current code and area sizes can be seen with the HELP command, e.g.

```
IDL> help
```

% At \$MAIN\$ .

Code area used: 0% (0/16384), Symbol area used: 0% (2/4096)

These sizes can be increased with the .SIZE command. Quoting the IDL User's Manual, page 2-11:

These sizes represent a compromise between an unlimited program space and conservation of memory. User procedures and functions are compiled in this large program area. After successful compilation, a new memory area of the required size is allocated to contain the newly compiled program unit.

Resizing the code and data areas erases the currently compiled main program and all main program variables. For example, to extend the code and data areas to 30000 and 5000 bytes respectively:

```
.SIZE 30000 5000
```

Getting "Code Area Full" is often an indication that the routine is large, and would benefit by decomposition into sub-procedures/functions. It's better to avoid use of .SIZE because your code will always work on other systems where the users don't use a large .SIZE setting.

T16. Sometimes I get the following error message:

```
% Unable to allocate memory: to make array.  
not enough core
```

RSI support replies:

The circumstances described happen when memory becomes fragmented. Unfortunately, there is nothing you can do except use less memory in your application, or get more for the system to work with.

T17. How can I set the cursor to a crosshair on my display?

Ray Sterner of Johns Hopkins University has written a procedure for managing this called `crossi`. It is in the `usr.tar` file of the JHU/APL IDL library mentioned in question G07.

Joel Parker has written a procedure called `rdplot` which manages this using an XOR graphics function and provides additional functionality. It is located in the NASA IDL Astronomy User's Library mentioned in question G07.

T18. How can I vectorize an equation of two different arrays?

From the user community:

I have two different arrays, (8) of float and (300,8) of float. I want to vectorize the equation and therefore I need to use both arrays in the same equation. For example :

```
newarray=cos(small_array)*sin(large_array)
```

where I want the data in small\_array to be used over and over 300 times in this calculation.

From Dan Carr (dan@rsinc.com):

```
IDL> arr1 = Findgen(8)
IDL> arr2 = Findgen(300, 8)
IDL> newarr = (Replicate(1.0, 300) #
Cos(arr1)) * Sin(arr2)
```

From Dave Landers (landers@tsunami.dseg.ti.com)

to convert an array1(M) to array2(n,M) :

```
array2 = array1( Lindgen(n,M) / n )
or array2 = replicate(1,n) # array1
```

to convert an array1(M) to array2(M,n) :

```
array2 = array1( Lindgen(M,n) MOD M )
or array2 = array1 # replicate(1,n)
```

From Chris Chase (chase@grant.jhuapl.edu)

Instead of using matrix multiply, one can use REBIN:

To make array1(M) to array2(M,n):

```
array2 = rebin(array1,M,n,/samp)
```

To make array1(M) to array2(n,M):

```
array2 = rebin(reform(array1,1,M),M,n,/samp)
```

Note: use of /overwrite in REFORM avoids copying array1, but changes array1.

REBIN is a little faster than the matrix multiply method. The additional advantage of REBIN is that it will work with higher dimensions, e.g. to make array1(M,N) into array2(M,N,L):

```
array2 = rebin(array1,M,N,L,/samp)
```

T19. How can I get IDL and MacX to work without crashing?

Using MacX v1.2 and IDL cause the Mac to crash quite often. This happens especially during allocation of color resources or display windows. You can get around the problem by downgrading to MacX v1.1.7 (apparently Apple will supply this if you can prove to them that you rightfully own v1.2). Another solution is to purchase White Pine's eXodus software. Rumors are that eXodus is an overall better product than MacX. White Pine can be contacted at:

White Pine Software  
40 Simon St. Suite 201 Nashua, NH 03060-3043  
phone: 603-886-9050 Fax: 603-886-9051

T20. How can I determine if a variable is defined?

It is often useful to determine if an IDL variable is defined. This is easily done using the `n_elements` function which returns 0 if the given variable is undefined. This is especially useful for setting defaults for keyword parameters. Here are several examples:

```
if n_elements(start) eq 0 then start=0
```

```
if n_elements(dir) eq 0 then cd, current=dir
```

T21. Why should `KEYWORD_SET` not be used to check if a variable is defined?

From Bill Thompson:

The IDL function `KEYWORD_SET()` is only designed to be used with logical variables, i.e. those which can be either True (usually signalled with the value 1) or False (0). It has the property that if a variable is undefined, then it returns False, so people often make the mistake of using it to test whether a variable is defined or not.

To test whether a variable is defined or not, use `N_ELEMENTS()` instead. This will return 0 if a variable is undefined, or some positive number otherwise. Only use `KEYWORD_SET` for truly Boolean (True/False) variables.

T22. What is the undocumented routine `TVRDC`?

From a `comp.lang.idl-pvwave` post by William Thompson:

The reason that `TVRDC` is undocumented is because it's not needed any



more. It doesn't do anything that CURSOR doesn't do. TVRDC is only retained for compatibility with older programs.

In the old days, before X-windows, CURSOR was used to read coordinates off of line graphics terminals, and TVRDC was used to read coordinates off of image display devices. With the advent of IDL 2.0, the distinctions between different kinds of graphics devices were mostly removed, and both of these functions were merged into CURSOR.

T23. How can IDL be used to generate dynamic GIFs for display on the World Wide Web?

By Jason Mathews, NASA/ Goddard Space Flight Center:

Common Gateway Interface (CGI) Perl scripts are invoked via submitting a HTML form , which execute IDL in batch mode, runs a IDL routine to make a plot of the selected parameters, and writes the results to a GIF. The perl program output is displayed on the WWW browser as a HTML document with an inline GIF image.

The IDL program must use the 'Z' device and write the output results to a GIF file as in the example below:

```
SET_PLOT, 'Z'           ; Select the Z buffer output device
PLOT, x, y, ...         ; Draw the plot
image = TVRD()         ; Copy the device contents into an image
WRITE_GIF, 'filename.gif', image ; Write image to a GIF file
EXIT                   ; Exit IDL routine
```

Examples of various perl programs that use IDL on the web and the corresponding HTML forms are available via the following URL:  
<http://coney.gsfc.nasa.gov/Mathews/misc/idl-www.html>

Some example WWW-based Data Browsing and Retrieval Systems using IDL:

NSSDC OMNIWeb: <http://nssdc.gsfc.nasa.gov/omniweb/ow.html>  
NSSDC COHOWeb: <http://nssdc.gsfc.nasa.gov/cohoweb/cw.html>  
WWW/IDL Interface Demo:  
[http://www.gsfc.nasa.gov/idl/idl\\_web.html](http://www.gsfc.nasa.gov/idl/idl_web.html)

T24. How can IDL be used to save an IDL window in a specified graphics format file (GIF, TIFF, ...)?

By Mark Rivers, CARS, Univ. of Chicago (slightly edited)

```
IDL> plot,x,y,title='This is my plot' ; Make a plot (or display an image).
IDL> image = tvrd() ; Read image into an array.
IDL> tvlct, r, g, b, /get ; Read color table.
IDL> write_gif, file, image, r, g, b ; Save in a GIF image file.
```

This sequence should work on any windowing display (X, Windows, Mac). For better speed and more flexibility, first issue the command `SET_PLOT, 'Z'` to write to the Z-buffer pseudo-device. You can set its resolution, and its write and readback performance is very fast.

[Additional notes by editor] The screen image may be saved in other graphics formats by using the correct write routine. Some of the routines of interest are:

`write_gif`, `tiff_write`, `write_jpeg`, `write_bmp`, ...

Note the different name pattern for `tiff_write`, check the manuals for the calling syntax for each routine.

There are also corresponding routines to read the images back into IDL.

Which format is best? GIF images are compressed so take less space than uncompressed images. JPEG images are also compressed but with a lossy compression, that is, the image when read back into IDL is not identical to the image written. However JPEG images can look very good and also often can be more highly compressed than GIF. Some images may be larger (much larger) using JPEG as compared to GIF, try both and compare. GIF images are widely used on the World Wide Web, JPEG is also supported by some web browsers. TIFF may be needed for publishing purposes.

T25. Why don't my desktop PC applications recognize the preview portion of IDL EPSI files?

By Troy Klein, Johns Hopkins Applied Physics Lab

Quoting the IDL version 4.0 online help for the `PREVIEW` keyword, "Set this keyword to add a 'device independent screen preview' to the PostScript output file, in encapsulated PostScript interchange format (EPSI). Use this keyword only with encapsulated output. Many, but certainly not all, desktop publishing and word processing programs will display this screen preview when the file is imported into a document."

The EPSI format is not compatible with some of the more popular Windows and Macintosh applications. Windows applications expect the preview image to be in TIFF format and Macintosh applications expect the preview image to be in PICT format and in the resource fork of the EPS file. I have found the EPSI file to be compatible with Framemaker for UNIX/X windows.

There are two workarounds available for Mac users and two for Windows users, all are similar. If you are using IDL on a UNIX machine, there is a package available (as of 8/2/95) on the popular University of Michigan Mac shareware/freeware archive (use the mirror site at <ftp://mirrors.aol.com>) titled "ps2epsmac", which uses Ghostscript and NetPBM on a UNIX machine to interpret the postscript and create a new EPS file in Macbinary format with the PICT preview. There are several Mac programs available ( StuffitExpander, Fetch, etc.) to interpret the Macbinary file. I have had great success in using this method to import IDL EPS files into Word, Powerpoint, and MacDraw Pro. There is a similar package at the archive titled "ps2epsplus" which does the same thing, but all on a Mac.

For UNIX IDL users trying to import IDL EPS files into Windows applications, there is a package called "ps2epsf" which can be located using an Archie search. This package essentially does the same thing as the UNIX/Mac package but produces an EPS file with a TIFF preview. The second solution for Windows users is the Windows application GSview (which can also be found with archie). Version 1.2 claims to be capable of adding preview images to EPS files.

T26. How can I fix widgets that broke with IDL version 4.x.x?

In IDL version 4, the sizing and layout of IDL's Motif widgets changed in several ways. This can cause problems. Widget changes are discussed in a file available from RSI at

<ftp://boulder.colorado.edu/pub/rsi/idl/notes/widgets.txt>.

T27. Why is memory not released back to the operating system after an array is deleted?

By Eric Korpela of Berkeley

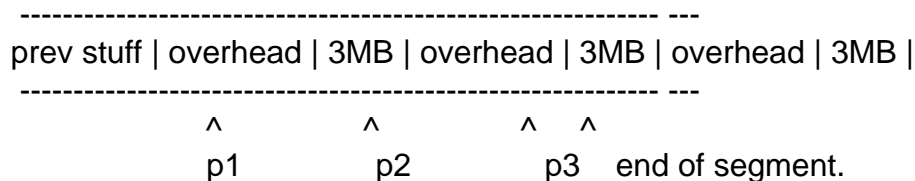
This is a result of IDL being written in C and using the C library functions (malloc and free) for memory allocation. In most C libraries, memory that is freed is NOT returned to the operating system. The C program retains this memory and will reuse it for future calls to malloc (assuming that the new allocation will fit in the freed block).

Another way of considering it is in terms of how memory allocation is done under UNIX. New memory is allocated using brk() or sbrk() which control the size of the data segment. These routines are called by malloc().

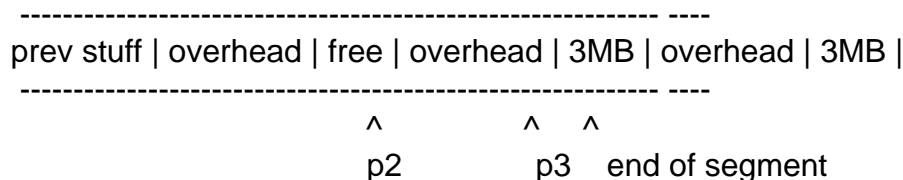
Suppose you allocate 3 1 MB regions of memory under C.

```
char *p1=(char *)malloc(3*1024*1024);
char *p2=(char *)malloc(3*1024*1024);
char *p3=(char *)malloc(3*1024*1024);
```

Here's what your data segment would look like assuming malloc had to call sbrk().



Now we free(p1).



Notice that the free memory is still in the data segment. If free had called brk to reduce the size of the segment, the 3MB pointed to by p3 would be outside the data segment! SIGSEGV city! If free had moved the allocated memory to lower addresses so the segment size could be reduced without losing data, then p2 and p3 would point to invalid addresses, and we'd be forced to use handles rather than pointers and call GetPointerFromHandle() every time we wanted to access the memory. Ick! Just like Windows!

T28. Why do color bars in PostScript not look as good as on the screen?

By default IDL uses 4 bits per pixel when displaying images in PostScript. This gives only 16 possible gray shades or colors as may be seen by the following example commands:

```
a = rebin(bindgen(256),256,50) ; Create a color bar.
set_plot,'ps' ; Set PostScript mode.
device,/color ; Specify color PostScript.
loadct,4 ; Load a color table.
tv,a,0,0,xs=12.8,ys=2.5,/centimeters ; Display bar.
device,/close ; Close PostScript file (idl.ps).
$gs idl.ps ; Send to a color PS printer or use
; a PostScript viewer to see results.
```

Replace first call to device above by:

device,/color,bits\_per\_pixel=8

This simple change may fix a number of problems with color PostScript. By the way, you will need to use /inches or /centimeters on a tv or tvscl command to get the desired results. This applies to both the position and sizes of the image. By default these are in pixels and PostScript has a lot of pixels as may be seen by doing help,/structure,!d after set\_plot,'ps'. Also try help,/device for other useful info when in PS mode.

## APPENDIX

### A01. Disclaimer:

I do not work for RSI and I am in no way answerable to them. Questions and answers in this document are culled from the user community. No warranty, express or implied exists regarding this document. Permission to copy all or part of this work is granted, provided that the copies are not made or distributed for resale.

### A02. Obtaining the latest IDL FAQ

The current IDL FAQ may be accessed at [fermi.jhuapl.edu](http://fermi.jhuapl.edu) [128.244.147.18] in directory [www/s1r/idl/idl\\_faq](http://www/s1r/idl/idl_faq)

HTML version: [idl\\_faq.html](#) (compressed: [idl\\_faq.html.Z](#))

Plain Text: [idl\\_faq.txt](#) (compressed: [idl\\_faq.txt.Z](#))

The URL (Uniform Resource Locator) for this file is:

[ftp://fermi.jhuapl.edu/www/s1r/idl/idl\\_faq/idl\\_faq.html](ftp://fermi.jhuapl.edu/www/s1r/idl/idl_faq/idl_faq.html)

#### How to interpret the URL

Using a WWW (World Wide Web) Browser, for example mosaic:

mosaic [ftp://fermi.jhuapl.edu/www/s1r/idl/idl\\_faq/idl\\_faq.html](ftp://fermi.jhuapl.edu/www/s1r/idl/idl_faq/idl_faq.html)

Save the file using the Save as ... option.

Using anonymous ftp:

ftp [fermi.jhuapl.edu](http://fermi.jhuapl.edu)

Login: anonymous

Password: enter your email address

cd [www/s1r/idl/idl\\_faq](http://www/s1r/idl/idl_faq)

get file

bye

## Additions and Corrections

Send additions and corrections to:

Ray Sterner  
sterner@tesla.jhuapl.edu

## A03. Many thanks to the following for their contributions

black@breeze.rsre.mod.uk (John Black)  
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## Previous IDL FAQ maintainers:

Patrick Ryan: founded the IDL FAQ  
Mike Schienle: from 12/01/93 to 10/27/94

## A04. IDL FAQ Versions History

### Changes in version 3.16:

- . Added an explicit reference to Chris Chase's ftp directory on fermi in G07
- . Added Research Systems ftp site in G07
- . Added a pointer to the WWW site list under the ftp site question (G07)
- . Added a pointer to the ftp site list under the WWW site question (G13)

### Changes in version 3.15:

- . Slightly modified Liam Gumley's web site address and the description in G13
- . Minor rewording for the VNI section of T08

### Changes in version 3.14:

- . Added a new web site in G13

### Changes in version 3.13:

- . Added a note to a non-working link in G13
- . Added additional info from Chris Chase in T18.

### Changes in version 3.12:

- . Updated answers to G0, G05, and G11 with information from RSI.
- . Added a new IDL web page to G13, submitted by Norbert Hahn. It is located at the University of Darmstadt, Germany, and is in German.
- . Added a new question on color PostScript (T28).

### Changes in version 3.11:

- . Fixed the missing end of question T02.
- . Added a new question on why memory is not released when an array is deleted (T27).

### Changes in version 3.10:

- . Updated RSI's home page in G13.
- . Made a few minor changes in the URLs that point to fermi (the home site of the IDL FAQ).
- . Fixed the broken link to Gary Kushner's IDL data acquisition web page in G13.

### Changes in version 3.9:

- . New question on how to find IDL routines (G14).
- . New question on widgets breaking with IDL version 4 (T26).
- . Minor change to G04.

### Changes in version 3.8:

- . New question on Encapsulated Postscript Previews (T25).

- . Generalized question T08 to non-emacs editors that support IDL programming (first is JED from MIT).
- . Minor addition to G11 When is the next version of IDL due out?

#### Changes since version 3.7:

- . New question on screen save to a graphics format image (T24).

#### Changes since version 3.6:

- . New question on using IDL to make WWW images (T23).
- . IDL 4.0 release dates added (G04, G11).

#### Changes since version 3.5:

- . Added question T22: What is the undocumented routine TVRDC?
- . Added question T21: Why should KEYWORD\_SET not be used to check if a variable is defined?

#### Changes since version 3.4:

- . Added Pete Riley's IDL Home Page at LPL (G13).
- . Added RSI's International Distributor Offices (G02).

#### Changes since version 3.3:

- . Added Gary Kushner's IDL data acquisition WWW page (G13).
- . Dropped Hal Mueller's U.S. map page (was out of service) (G13).
- . Added R. Sterner's Color Shaded Relief Maps WWW page (G13).
- . Added a new question on detecting undefined variables (T20).
- . Added a hyperlink to the directory in question T03.

#### Changes since version 3.2:

- . Updated IDL release dates.
- . Added Wayne Landsman's IDL Astronomy Library WWW page.
- . Added JHU/APL/S1R IDL Library WWW page.

#### Changes since version 3.1:

- . Made it easier to find where to get the latest FAQ.
- . Retroactively changed last version to 3.0, the first HTML version.

#### Changes since version 3.0:

- . New FAQ maintainer.
- . First HTML version.
- . Added an Appendix for some previous material.

#### Changes since version 2.8:

- . Added Power Macintosh to systems which IDL runs on.
- . Updated "Training" contact information.

#### Changes since version 2.7:

- . Updated information regarding next release dates.



- . Changed reference to openwin3.doc to sun.doc.

#### Changes since version 2.6:

- . New question T19 added regarding MacX and IDL.
- . Updated information regarding current IDL versions.
- . Reference to current IDL version changed from 3.5.1 to 3.6.1.

#### Changes since version 2.5:

- . T18 responses corrected.

#### Changes since version 2.4:

- . New question T18 added regarding vectorizing an equation.
- . Address change for FAQ maintainer.
- . Address change for FAQ location.

#### Changes since version 2.3:

- . New question T17 added regarding cross-hair cursor.
- . Additional info for NASA ftp site.
- . Additional information provided for question T01 regarding contours.
- . Question G09 referred to the "other" IDL as Interface Description Language, rather than the correct Interface Definition Language.

#### Changes since version 2.2:

- . Question G13 regarding IDL World Wide Web info added.
- . JHU/APL IDL library name changed from nansen to fermi. Nansen will still work for some time.
- . Release dates for upcoming versions of IDL revised.

#### Changes since version 2.1:

- . Due to resource problems, the lumpi.informatik.uni-dortmund.de site is no longer carrying IDL binaries. However, the distribution is now available from ftp.Germany.EU.net (192.76.144.75).
- . Reference to current IDL version changed from 3.5 to 3.5.1.
- . Mention of compressed version of FAQ included.
- . Added ESRG to list of FTP sites.

The End

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