TDWG Newsletter

International Working Group on Taxonomic Databases for Plant Sciences

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An Introduction to Computer Images

by Mike J. Dallwitz [1]

Pixels and Resolution

A "pixel" (picture element) is the smallest component of a computer image. When an image is being manipulated by the computer, a pixel is regarded as a dot of a single colour (although when the image is displayed, each pixel may be made up of even smaller dots). An image is made up of pixels located on a rectangular grid. The resolution of the image may be defined as the number of points in the grid, e.g. 640x480 (640 pixels wide by 480 pixels high); or as the spacing of the grid points, e.g. 75dpi (75 dots per inch). When discussing the internal storage and processing of images, it is better to specify the number of grid points. The grid spacing is meaningful only when the image is outside the computer, that is, when it is being scanned or displayed.

Vector images

"Vector" images store mathematical descriptions of shapes. For example, a straight line could be represented as the coordinates of its start and finish; a circle as the coordinates of its centre, and its radius; and a text symbol as the coordinates of a set of points around its outline. The colour and thickness of lines can be specified, and closed curves can be filled with simple patterns. However, vectors cannot easily represent complex "continuous-tone" images, such as a typical photograph.

Vector images are easy to modify. Each object in the image retains a separate identity, and can be altered, moved, or deleted, and placed over or under other objects. The mathematical objects are converted to pixels only when the image is to be displayed. Thus, output quality can be improved almost indefinitely by using high-resolution output devices such as laser printers or typesetters. Even on computer displays of comparatively low resolution, fine detail can be seen by zooming in on a part of the image.

These properties make vector images very suitable for drawings containing lines and simple shading. Programs for creating and editing vector drawings have been successfully used for biological illustration by several organizations.

Bitmap images

"Bitmap" ("raster") images store the colour value of each pixel. They are therefore suitable for storing photographic images, which can be converted to bitmap form by means of a scanner (see below). The resolution at which an image is scanned sets a permanent limit on the amount of detail that can be seen.

Bitmap images tend to be difficult to modify. All of the pixels are independent - they are not explicitly grouped into larger structures or objects. Editing programs may attempt to identify objects by looking for boundaries between regions of different colour or brightness, but this is not always possible. If an object is moved or deleted, it is difficult or impossible to correctly fill in the area thus exposed, unless it is uniform or almost uniform.

"Unmapped" ("true-colour" or "grey-scale") images store the colour value for each pixel directly. Unmapped colour images usually use 3 bytes for each pixel, 1 for each of the primary colours (1 byte = 8 bits). This allows 256 intensity levels for each primary colour, and therefore 16777216 different colours. (Some formats use only 5 bits per primary colour, giving 32 intensity levels and 32768 different

TDWG 8 & IOPI 2 IN MEXICO

TDWG and IOPI (International Organization for Plant Information) will held their annual meeting at the Instituto de Ecología in Xalapa, Mexico on November 3-13 1992.

In conjunction with the meetings a three days symposium will be held on "Management of Biological Diversity and Conservation Data". Workshops will be organized on special technical interests.

Timetable

November 3-5	IOPI 2
November 6	Excursion
November 7-9	TDWG 8
November 10-12	Symposium
November 13	Workshops

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Subgroup News

The subgroups - currently working on the production of standards - are listed below. Please write to the contact person directly for any information/contribution on the subgroup's activities.

Accessions

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Descriptors for Plants

Contact: Dr R. Pankhurst, Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, UK

Habitats

Contact: Dr J. M. Lock, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK

Phytogeography

Contact: Mme H. Falaise, Laboratoire de Phanérogamie, Muséum National d'Histoire Naturelle, 16 rue Buffon, 75005 Paris, France

Threats (New!)

This new subgroup was proposed at TDWG7 in Canberra to examine the status of information on threats to plants in the wild. The subgroup hopes to produce a system for classification of these threats in order to facilitate information exchange among the holders of such data.

Contact: M. J. O'Neal, Center for Plant Conservation, P.O. Box 299, St. Louis, MO 63166-0299, USA
or K. S. Walter, World Conservation Monitoring Centre, 219c Huntingdon Road, Cambridge CB3 0DL, UK

Uses (Economic Botany)

Contact: Mrs F. Cook or J. M. Lock, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK

colours. This is rather unsatisfactory, as the eye can readily discern the difference between adjacent levels.) Grey-scale images (i.e. continuous-tone 'black-and-white' photographs) require 1 byte per pixel, and true black-and-white images require only 1 bit per pixel.

"Mapped" ("paletted") images store colour values indirectly. The colours in a mapped image are restricted to a numbered set of colours, called the "palette". Each colour in the palette is defined by three numbers giving the intensities of the primary colours. The colour of a pixel is defined by specifying the number of its colour in the palette. The advantage of this scheme is a reduction in the amount of memory required to store the image. (For example, an image using a palette of 256 3-byte colours requires 1 byte per pixel, plus 768 bytes for the palette.) The disadvantage is that it may not be possible to represent the colours with sufficient accuracy. A typical colour image may contain several thousand different colours. A process called "colour reduction" is used to choose a palette for an image, and to replace each colour by the closest colour from the palette. A palette of 256 colours can give reasonably good results for most images, but a careful examination of a mapped image will usually reveal colour "contours", where the jump from one palette element to another takes place. This effect is particularly noticeable in large areas of gradually changing colour, such as a sky.

Image formats and compression

There is a large number of formats for storing digital images. Most were developed for use with a particular program, but some of these formats have become de facto standards, and are used by many programs. A few formats were developed specifically for interchanging files between different programs and computers.

Most bitmap formats have provision for reducing the file size by "compressing" the image data. The amount of compression depends on both the compression method and the nature of the image. Most compression methods work well on images that have large areas of uniform colour. For example, a simple line drawing could usually be compressed to less than 1/10th of its original size.

The following are some of the formats most commonly used:

CGM (Computer Graphics Metafile). A vector format for file interchange.

GIF (CompuServe Graphics Interchange Format). A mapped bitmap format developed for file interchange. Gives good compression.

JPEG (Joint Photographic Experts Group). A bitmap format for unmapped images, developed as a standard by ISO and CCITT (Wallace 1991). The main feature of this format is extremely good compression of continuous-tone images. Some information is lost in the compression, and there is a trade off between amount of compression (which may be specified by the user) and image quality. For most images, 20:1 compression may be achieved without noticeable degradation. (By comparison, the GIF format gives about 2:1 compression with continuous-tone images. Because GIF images are mapped, they effectively have an additional compression of 3:1 (for colour images), but information is lost in the colour reduction, as explained above.) Compressing and decompressing JPEG images with general-purpose computers is slow. However, special hardware is available which can decompress an image in a fraction of a second.

PCX. A mapped bitmap format developed by Zsoft for their paint programs.

Targa. A bitmap format developed by Truevision for use with their Targa graphics cards. Usually used for unmapped images, but mapped images are also supported.

TIFF (Tagged Image File Format). A very flexible bitmap format, supporting mapped and unmapped images. Widely used on Macintosh computers and for desktop publishing, and becoming more popular on IBM-compatible PC's.

Creating and editing images

Bitmap images can be produced from existing drawings or photographs by "scanners", which measure the brightness and/or colour of the original at each point of a grid. 'Flatbed' scanners scan large, usually opaque, material, such as the page of a book. The maximum resolution is usually 300-600dpi. "Slide" scanners scan small transparencies, such as 35mm slides or negatives. The maximum resolution is usually between 1000 and 6000 pixels along the longer dimension of a 35mm slide. Grey-scale ('black-and-white') scanners should be capable of distinguishing 256 grey levels if continuous-tone photographs are to be scanned (16 levels are enough for line drawings). Colour scanners should distinguish 256 levels for each primary colour.

Bitmap images are edited with 'paint' programs, such as Adobe Photoshop (Mac) or Aldus Photostyler (IBM PC). Paint programs usually have provision for scaling, and conversion between different formats, but these facilities may be rather limited. Image Alchemy (Handmade Software, 15951 Los Gatos Blvd, Suite 17, Los Gatos, CA 95032, USA) is a comprehensive program for format conversion (including JPEG), colour reduction, and scaling of bitmap images on IBM PC's and Sun computers. A shareware version of Image Alchemy, and some others shareware or free programs for viewing and processing bitmap images on IBM PC's, are available on Internet, in the directory /delta/graphics of the anonymous FTP area at spider.ento.csiro.au.

Vector images are created and edited with 'draw' programs, such as Aldus Freehand (Mac), Micrografx Designer (IBM PC), or CorelDraw (IBM PC). These programs often allow the use of a bitmap image as a guide for producing a vector image. A bitmap image containing well-defined edges, such as a scan of a line drawing, can be traced automatically to produce a first draft of the vector image. Bitmap images produced from continuous-tone photographs can be traced manually. The programs can also convert vector images to bitmap images.

Hardware for displaying images

Most IBM and Macintosh PC's store images in mapped form on the graphics card, and can therefore display at most 256 colours simultaneously. Graphics cards capable of displaying unmapped colour images are available, but have been expensive until recently.

The standard IBM VGA card has a highest resolution of 640x480 pixels and has 256kB of memory. It is limited to 16 simultaneous colours at the highest resolution (256 colours would require 307200 (=640x480) bytes of memory). It can display line drawings quite well, but is inadequate for continuous-tone images. The latter require a 'super' VGA card with at least 512kB of memory. Super VGA cards with 1MB of memory, and capable of displaying 256 colours at a resolution of 1024x768 or 32768 colours at 800x600 are now available quite cheaply. Super VGA cards require a multisync monitor. Many monitors display 1024x768 images in an 'interlaced' mode, which tends to cause flickering. Non-interlaced monitors are preferable, but are more expensive. Another potential problem is a change in the size, position, or proportions of the display area when the resolution is changed. A few monitors (including most NEC monitors) overcome this problem by storing separate adjustment values for each resolution.

Recommendations for storing scanned images

Images should be scanned and stored in such a way that they will be able to take advantage of improvements in display hardware. The resolution of the master copies should be as high as possible (preferably at least 1024x768). Lower-resolution versions can easily be made for display on currently available hardware. Line drawings can be stored compactly as GIF files with 16 grey levels. Using 16 grey levels gives smoother lines than 2 levels (black and white). (Using 256 grey levels does not give a noticeably better result, and produces larger files.) Continuous-tone colour and grey-scale images should be stored in JPEG format. They can be converted to other formats (including mapped formats) as necessary.

Reference: Wallace, G. K. (1991). The JPEG still picture compression standard. *Comm. ACM* 34: 30-44.

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Standards Editors' Report

TDWG Publication Series

Camera-ready copy for the TDWG geography standard was sent to Bob Kiger at the Hunt Institute in Pittsburgh on April 13. The publication includes 70 pages of text and tables and 17 maps and is available now. Members of TDWG receive one free copy of each standard published by TDWG. Additional copies may be purchased from the Hunt Institute at the price of $US18 plus shipping (see below).

Progress is being made on two other TDWG publications. The editors are expecting to have that standard published before the Xalapa meeting. Peter Rooney and Kerry Walter are collaborating on the final editing of the POSS standard.

Other Standards Endorsed by TDWG

Two other standards for botanical data that have been adopted by TDWG will be available this year. The Hunt Institute has published the supplement to B-P-H. This does not replace the original volume, but is an addition to it. The Royal Botanic Gardens, Kew have published "Authors of Plant Names" in June. The complete citations and ordering information follows:

Standard forms of names of authors of plant names.

Brummitt, R. K. and C. E. Powell, Eds. 1992. Authors of Plant Names. Kew: Royal Botanic Gardens. 731 p. [For information contact: Mail Order Dept. Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB (England).]

Titles and Abbreviations for periodicals.

Bridson, G. D. R. and E. R. Smith. 1991. Botanico -Periodicum- Huntianum /Supplementum Pittsburgh, Hunt Institute for Botanical Documentation. 1068 pp. [Order from: Hunt Institute, Carnegie Mellon University, Pittsburgh, PA 15213, U.S.A. $US95 plus shipping and insurance. Orders from individuals and dealers must be prepaid in $US by check, money order, Visa, Master Card or American Express; pro-forma invoice on request.

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Forum

During the 1991 general meeting of TDWG in Canberra, Australia, it became clear that some of TDGW's subgroups activities would not result in the production of so-called standards. These subgroups would merely offer a forum for discussion and may produce reports, recommandations, surveys, etc. This section lists the currently active "forums", their area of interest and the contact person.

Computer Images

Following an introductory talk by Mike Dallwitz about computer images (see report page 1), it was decided that a forum on this subject would be very useful to the community. The forum will discuss existing formats, experiences and, if useful, make recommandations for the use of a particular standard: software or hardware.

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Data Dictionary

Since the subgroups (and the published standards) all use dictionaries of terms, it is necessary to check the overall integrity and coherence of the local dictionaries.

Contact: R. Russell, Smithsonian Institution, Washington DC 20560, USA
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Data Models

In order to provide the community with existing data models for taxonomic databases, this group is collating the published/available data models.

Contact: Mrs Ch. McMahon, Missouri Botanical Garden, P.O. Box 299, St. Louis, MO 63166-0299, USA
Email: mcmahon@mobot.org

Geographic Information System

This group will investigate existing standards and make recommendations on the field of GIS (Geographic Information System).

Contact: B. Loader, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK

Types & Lectotypification Data

The idea of this forum is to discuss the compilation and dissemination of type and lectotypification information, rather than producing a world-wide specimen register. The latter goal will be realized when a critical mass of regional data has been accumulated. The importance of standards for type specimen data will become obvious when attempts are made to combine data from various local projects.

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