Graphics File Formats

Graphics File Formats

Why have a range of graphics file formats?

What to look for when choosing a file format

A sample tour of different file formats, including

- bitmap-based formats
- vector-based formats
- metafiles
- proprietary formats

Graphics File Formats

Need to store and retrieve graphical data in an efficient and logical way

- Data stored according to specific format conventions
- Formats are immortal - technology evolves, new formats appear, but the old ones will still be there
- No one universal format - different formats for different purposes
- You (probably) won't need to access the formats in detail
  - there is usually library code to input/output/convert images for you
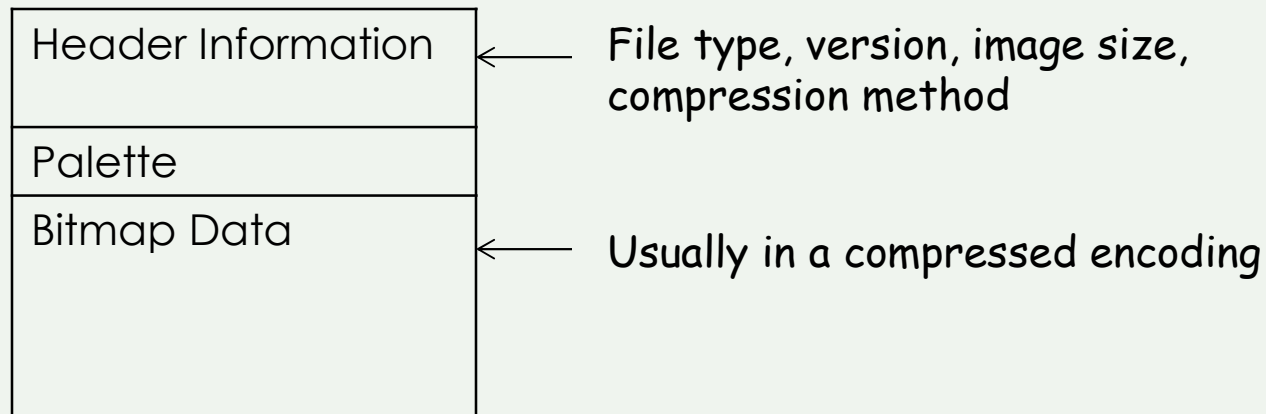- Useful to understand what is going on "behind the scenes", for making the best image format choices

What to Look For in File Formats

When choosing which is more appropriate for your purpose, some common factors to consider:

- *Lossy* or *lossless* compression?
- What is the compression ratio?
- Data format: 8-bit (binary) or 7-bit (text)?
- Is the image stored at a fixed resolution?
- How many images per file (static or animated)?
- Colour model? (usually RGB)
- ....amongst other things

Bitmaps

Simplified structure of a bitmap file:

Header Information
Palette
Bitmap Data

← File type, version, image size, compression method

← Usually in a compressed encoding

In practice there are many format variations

PBM, PGM, PPM

Family of portable bitmaps
- Designed to be as simple as possible
- Written in ASCII
  - 7 bit code
- No compression
- 1 image per file

Portable Bit Map (PBM)

For black/white images

```
P1
# feep.pbm
24 7
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 1 1 1 0 0 1 1 1 1 0 0 1 1 1 1 0 0 1 1 1 1 0
0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0
0 1 1 1 0 0 0 1 1 1 0 0 0 1 1 1 0 0 0 1 1 1 1 0
0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0
0 1 0 0 0 0 0 1 1 1 1 0 0 1 1 1 1 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```
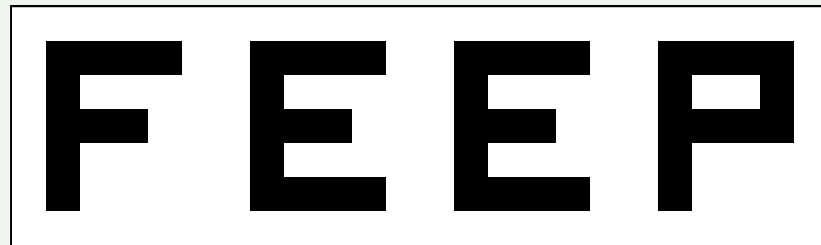
Portable Grey Map (PGM)

For grey scale images


```
P2
# feep.pgm
24 7
15
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  3  3  3  3  0  0  7  7  7  7  0  0 11 11 11 11  0  0 15 15 15 15  0
0  3  0  0  0  0  0  7  0  0  0  0  0 11  0  0  0  0  0 15  0  0 15  0
0  3  3  3  0  0  0  7  7  7  0  0  0 11 11 11  0  0  0 15 15 15 15  0
0  3  0  0  0  0  0  7  0  0  0  0  0 11  0  0  0  0  0 15  0  0  0  0
0  3  0  0  0  0  0  7  7  7  7  0  0 11 11 11 11  0  0 15  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```
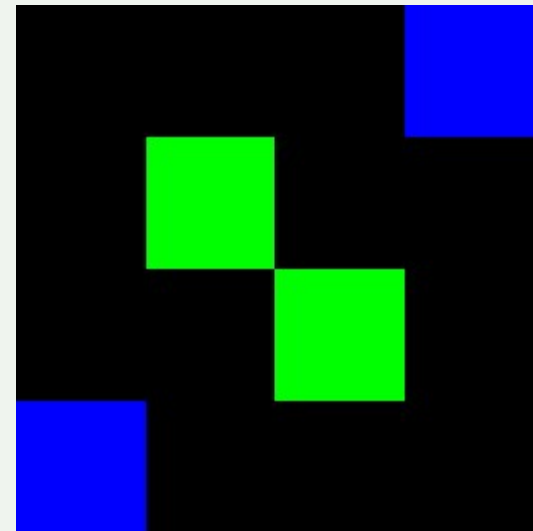
Portable Pixel Map (PPM)

For colour images

```
P3
# sq.ppm
4 4
15
  0   0   0     0   0   0     0   0   0     0   0  15
  0   0   0     0  15   0     0   0   0     0   0   0
  0   0   0     0   0   0     0  15   0     0   0   0
  0   0  15     0   0   0     0   0   0     0   0   0
```

BMP

Standard bitmap storage format for Microsoft Windows (also supported by some other non-Microsoft applications)

- Device-independent bitmaps (DIB) supporting different colour depths (bits-per-pixel)
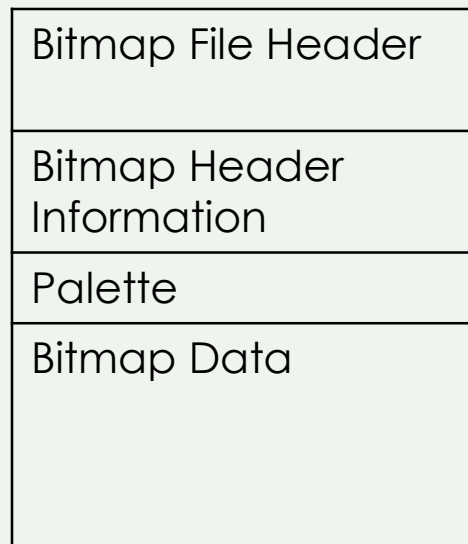
1 image per file with RLE (run-length encoding)

- therefore uses lossless compression
- original bitmap did not support compression

Huge file sizes

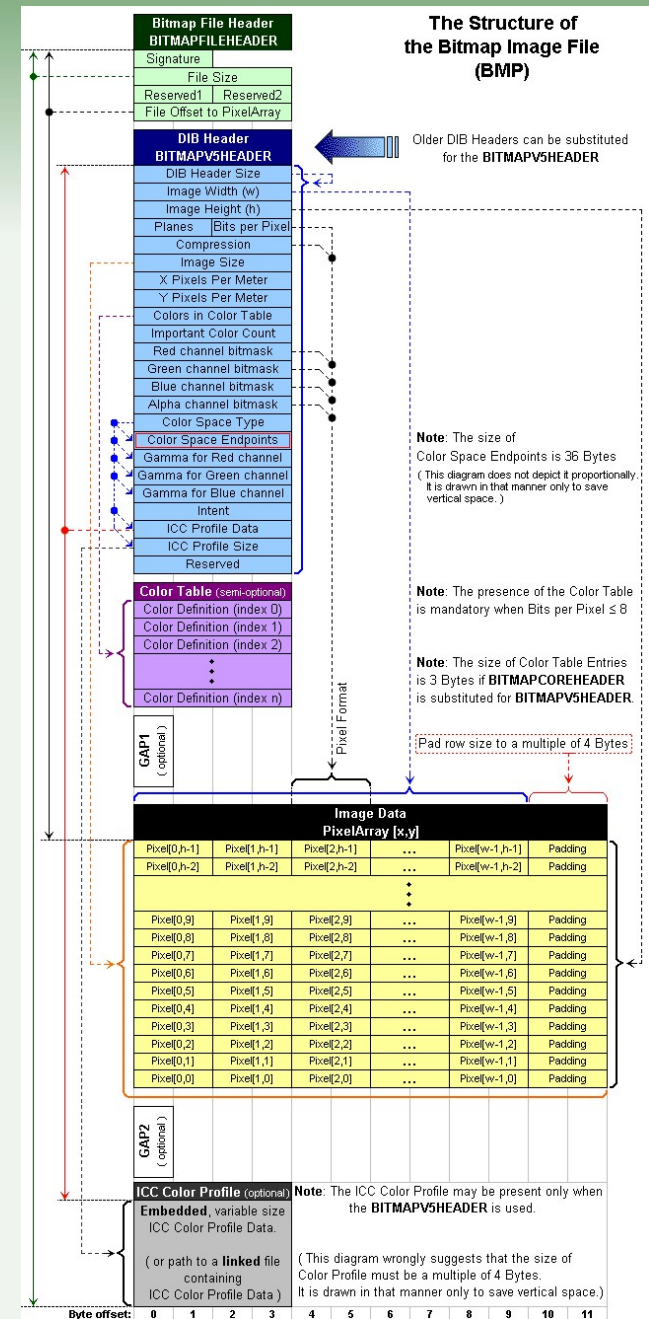- e.g. sample 470x682 photo stored as 40.3K JPG file is a 963K BMP file

BMP

Bitmap File Header	
Bitmap Header Information	
Palette	
Bitmap Data	

Type, size and layout

Dimensions, compression type, colour format

Equal to colours present in bitmap

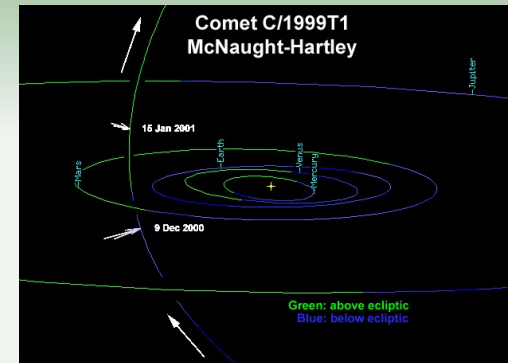Stored as scan lines, left to right from the *bottom* upward

The Structure of the Bitmap Image File (BMP)

(Wikipedia)

GIF

Graphics Interchange Format (1987 and 1989 versions)
- Uses a palette of up to 256 colours
  - not good for photographs, but great for text/diagrams
- Uses LZW compression of the bitmap data
  - caused copyright problems until 2004 (Unisys patent)
  - reasonably easy to read and decompress
- Supports multiple images
  - Simple animation
- 1989 version supports transparency and interlacing
  - At most one colour in the palette may be declared transparent

GIF

(Wikipedia)

Header Information Screen Descriptor Global Palette

←——— **Image width & height**

←——— **Palettes of up to 256 colours (24-bit)**

Image Descriptor Local Palette Bitmap Data

←——— **Can be repeated several times,**
e.g. animated GIF frames

←——— **8-bit indices into the colour palette**

GIF Terminator

Interlacing of Pixel Data

```
Row Number                              Interlace Pass

0   ----------------------------------------    1
1   ----------------------------------------                         4
2   ----------------------------------------                  3
3   ----------------------------------------                         4
4   ----------------------------------------          2
5   ----------------------------------------                         4
6   ----------------------------------------                  3
7   ----------------------------------------                         4
8   ----------------------------------------    1
9   ----------------------------------------                         4
10  ----------------------------------------                  3
11  ----------------------------------------                         4
12  ----------------------------------------          2
13  ----------------------------------------                         4
14  ----------------------------------------                  3
15  ----------------------------------------                         4
16  ----------------------------------------    1
17  ----------------------------------------                         4
18  ----------------------------------------                  3
19  ----------------------------------------                         4
```

Interlacing

PNG

Portable **N**etwork **G**raphics

- – informally known as "PNG Not GIF"
- – pronounced "ping"
- – Successor to GIF (lossless but free)
- – Not a restricted palette - up to 48-bit truecolour
- – Supports transparency, interlacing, but not animation
  - • animation available in a related format, MNG
- – Transparency through an alpha channel
  - • also supports anti-aliasing
- – Compression marginally better than GIFs, based on LZ77 (earlier than LZW)

JPEG File Interchange Format

JFIF - JPEG File Interchange Format
- There is no (single) JPEG format…
- JPEG refers to the compression algorithm used
- Basically a data stream with a few restrictions and identifying markers
- Colour stored in YCbCr colour model and decoded into RGB
- Allows storage of an associated thumbnail image

Tag Image File Format (TIFF)

Designed primarily for desktop publishing and related applications

- Bitmap images
- Compression (JPEG, RLE, LZW) or none
- Contains lots of tags in the file, identifying different types of content e.g. vector clipping regions
- Rationale behind using tags is that it is easier to incorporate new features in future versions of the format without confusing old software, or making old TIFF images useless
- Very complex since may contain multiple internal image formats

SVG - Scalable Vector Graphics

XML language for vector graphics in web pages:

```
<?xml version="1.0"?>
<svg xmlns="http://www.w3.org/2000/svg">
<g style="fill-opacity:0.7; stroke:black; stroke-width:0.1cm;">
<circle cx="6cm" cy="2cm" r="100" style="fill:red;"
transform="translate(0,50)" />
<circle cx="6cm" cy="2cm" r="100" style="fill:blue;"
transform="translate(70,150)" />
<circle cx="6cm" cy="2cm" r="100" style="fill:green;"
transform="translate(-70,150)"/>
</g>
</svg>
```

SVG Example
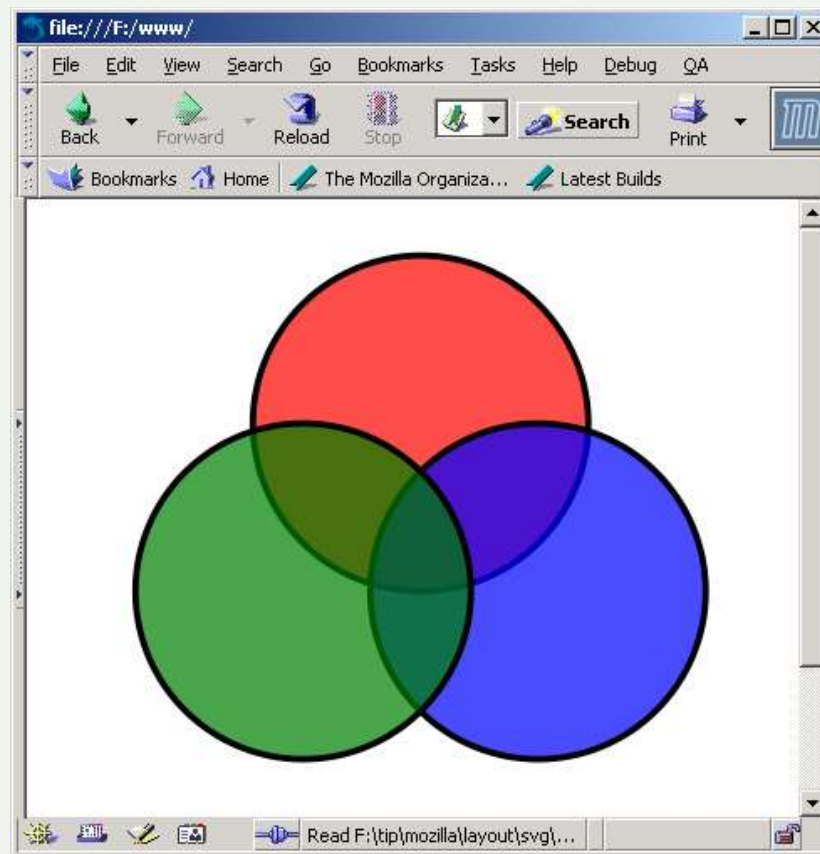
Computer Graphics Metafile (CGM)

Three different encodings
- One for minimal size/ease of transmission
- Binary encoded for speed of access
- Clear text encoding for human readability/editing

Primarily vector graphics, but also bitmap data
- An ISO standard

Popular for computer-aided design software

POVRay

POVRay is a 3D computer graphics ray-tracing rendering program

- it has its own proprietary 3D scene-based format, looks like program code
- example
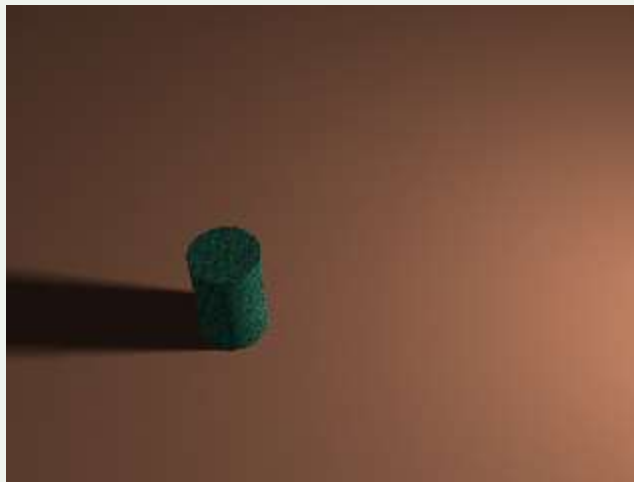
POVRay – File Format

```
global_settings { assumed_gamma 2.2 }

#include "colors.inc"
#include "shapes.inc"
#include "textures.inc"
#include "stones.inc"

camera {
   location <0, 45, -40>
   direction <0, 0, 1.5>
   look_at <0, 0, 0>
}

light_source {
   <30, 20, -10>
   color White
   area_light <4, 0, 0>, <0, 0, 4>, 9, 9
}
```

```
plane { y, 0
   pigment { Tan }
   finish {
       crand 0.015
       ambient 0.12
       diffuse 0.8
   }
}

cylinder {
   <0, -4, 0>, <0, 4, 0>, 2.5

   translate <-7, 4, -8>
 texture { T_Stone18 }
}
```

Extensible 3D Worlds - X3D

XML version of **V**irtual **R**eality **M**odelling **L**anguage (VRML)

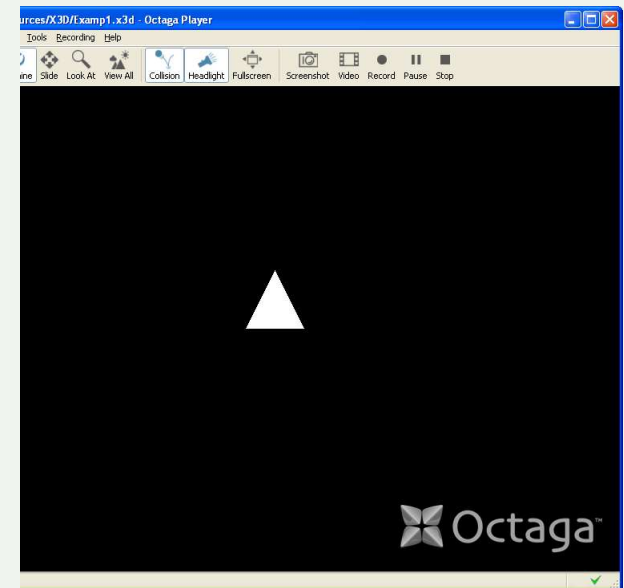– Interactive 3D worlds: browser plugins available
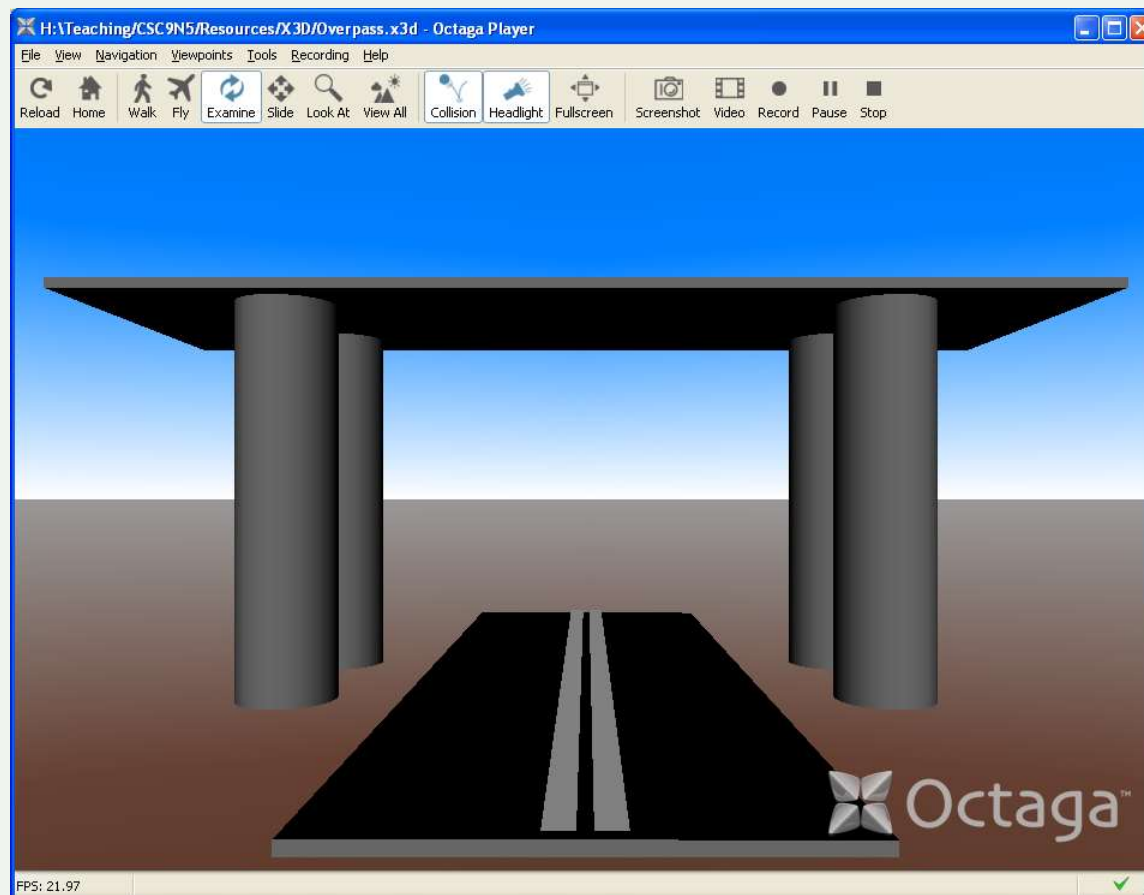
X3D Code Example

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.2//EN"
   "http://www.web3d.org/specifications/x3d-3.2.dtd">

<X3D profile="Interchange" version="3.2"
     xmlns:xsd="http://www.w3.org/2001/XMLSchema-
instance"

xsd:noNamespaceSchemaLocation="http://www.web3d.org/spe
cifications/x3d-3.2.xsd">
<Scene>
  <Shape>
    <IndexedFaceSet coordIndex="0 1 2">
      <Coordinate point="0 0 0 1 0 0 0.5 1 0"/>
    </IndexedFaceSet>
  </Shape>
</Scene>
</X3D>
```
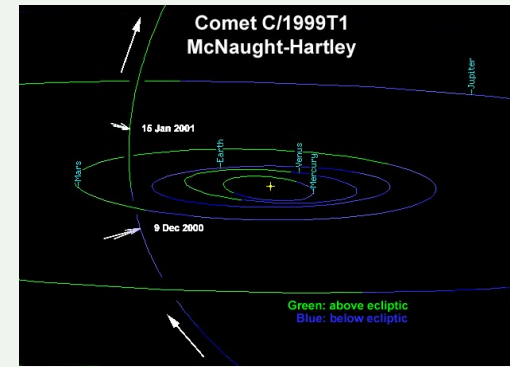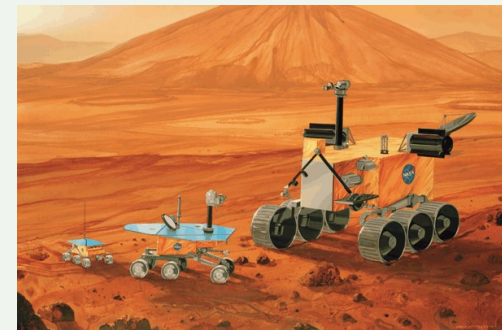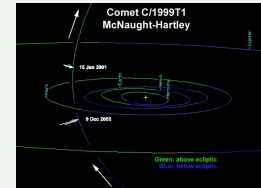
Comparison of Images

624 × 453 pixels

1024 × 768 pixels

600 x 401 pixels

Comparison Table

Raw Data	100%	100%	100%
PPM	407%	406%	406%
BMP (RLE)	100%	33%	33%
GIF	19%	18%	1%
PNG	32%	16%	1%
TIFF (LZW)	111%	18%	1%
JPEG	5%	5%	10%