

Graphics Programming Lecture 1

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Module Description

- ▶ An introduction to modern graphics programming and computer vision.
- ▶ Learning Outcomes:
 - ▶ On completion of this module the learner will be able to
 1. Programmatically create and manipulate image data.
 2. Programmatically create interactive and animated computer graphics.
 3. Use mathematics to reason about and model computer graphics.
 4. Analyse images using computer vision algorithms.
- ▶ Assessment
 - ▶ CA - 50%
 - ▶ Exam - 50%

Indicative Syllabus

- ▶ Graphics concepts
 - ▶ Pixels and Raster graphics.
 - ▶ Vector graphics.
 - ▶ Compression of graphics.
- ▶ Creating animated and interactive graphics
 - ▶ Animation frames.
 - ▶ User interaction with mouse and keyboard.
 - ▶ Mathematical modelling of visual objects.
 - ▶ Collision detection.
 - ▶ 3D modelling including wireframes, surfaces and rendering.
 - ▶ Matrix manipulations of visual objects.

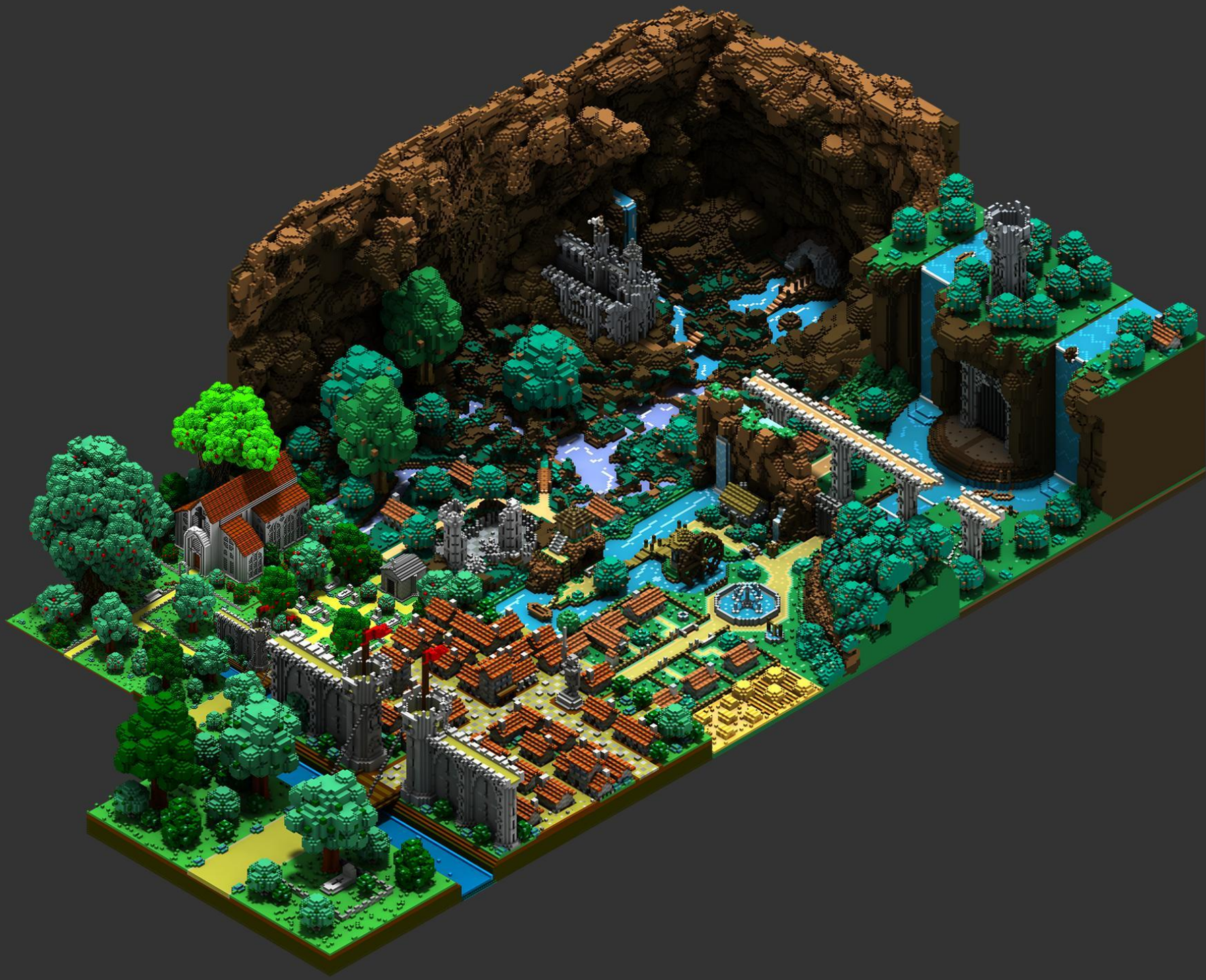
Indicative Syllabus (contd.)

- ▶ Computer vision
 - ▶ Regions of interest.
 - ▶ Colour manipulation.
 - ▶ Corner detection.
 - ▶ Face detection.
 - ▶ Facial feature detection.

Pixels and Raster graphics.

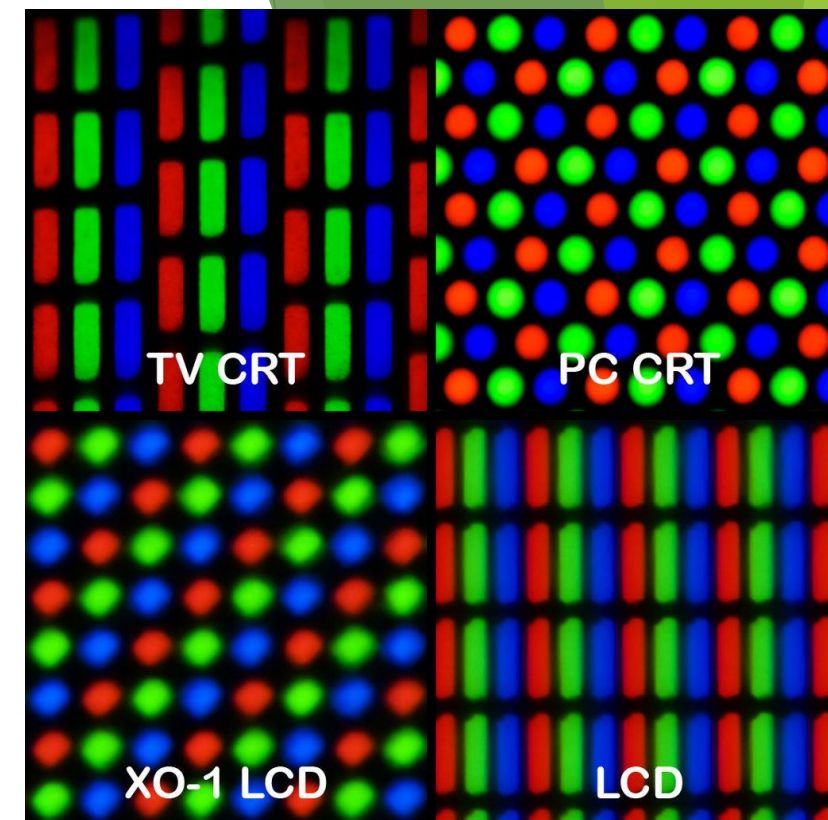
- ▶ A pixel is the smallest controllable element of a digital image
 - ▶ The address of a pixel corresponds to its physical coordinates.
 - ▶ Grayscale pixels are represented by 1-byte
 - ▶ Colour pixels are represented by 3-bytes (R,G,B)
 - ▶ Or sometimes CMYK (Cyan, Magenta, Yellow, Black)
 - ▶ Pixel - short for “Picture Element”
- ▶ Pixels in 3D space are known as voxels - “Volume Element”
 - ▶ Used in visualisation of computer games medical and scientific data (e.g. MRI)
- ▶ Geographic information systems (GIS) encode geographic data in the pixel values





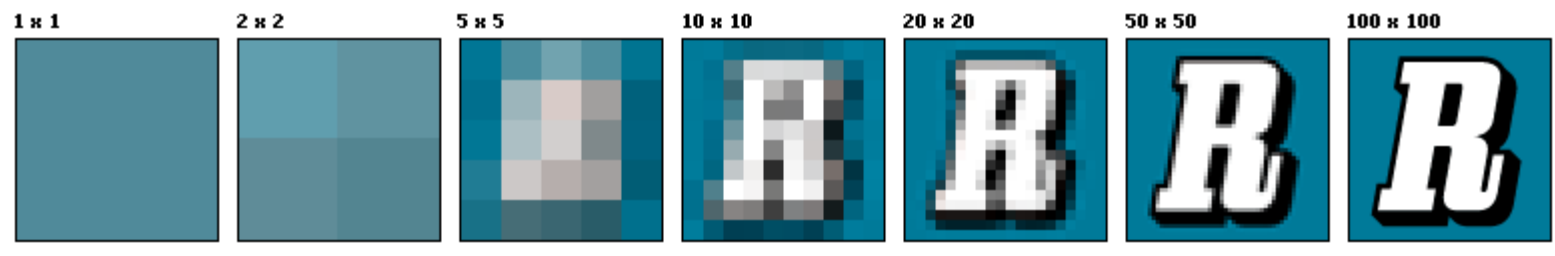
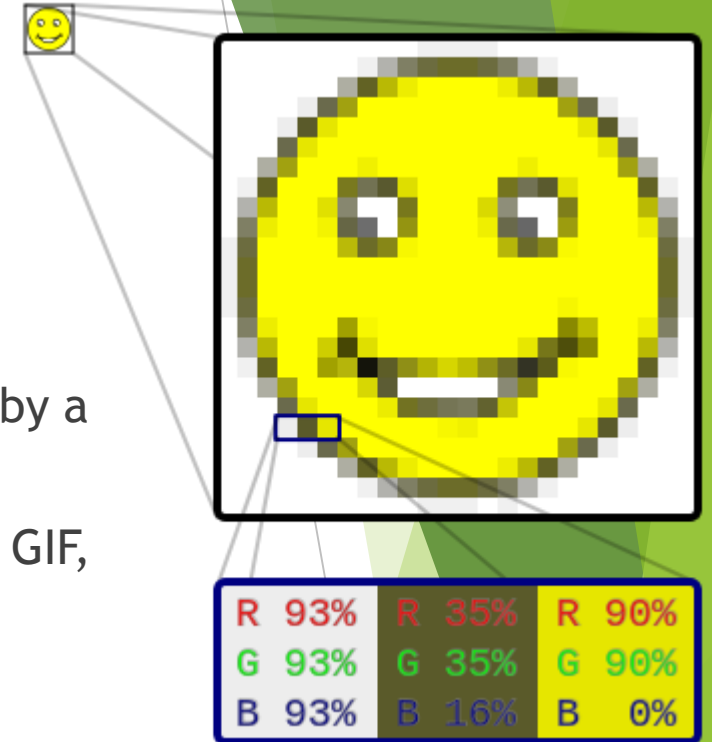
Pixels and Raster graphics.

- ▶ Bits per pixel
 - ▶ 1 bit = 2 colours (Monochrome)
 - ▶ 1 byte = 256 colours (Grayscale or limited colour)
 - ▶ 3 bytes = 16,777,216 colours ("Truecolour")
- ▶ Subpixels
 - ▶ Digital displays are not capable of displaying different colour channels at the same site
 - ▶ Therefore, the pixel grid is divided into single-color regions that contribute to the displayed colour when viewed at a distance.



Pixels and Raster graphics.

- ▶ A raster graphics image is a 2d dot matrix data structure, represented by a grid of pixels
- ▶ Raster images are stored in image files with varying formats (e.g. BMP, GIF, JPEG, and PNG)
- ▶ Resolution:
 - ▶ Image resolution is the detail an image holds
 - ▶ Resolution of an image is often specified as NxM px or in megapixels
 - ▶ Raster graphics are resolution dependent, meaning they cannot scale up without loss of quality.



Pixels and Raster graphics.

- ▶ Resolution:
 - ▶ VHS - 333x480
 - ▶ Super Betamax - 420x480
 - ▶ DVD - 720x480
 - ▶ Blu-ray - 1280x720
 - ▶ HDTV - 1920x1080
 - ▶ 2K Digital Cinema - 2048x1080
 - ▶ IMAX - 10000x7000 (70 MPx)
- ▶ Screens now specified as DPI (Dots per inch)
 - ▶ XXHDPI: eXtra eXtra High density, ~320-480 dots per inch



Raster Compression Formats

▶ BMP (Bitmap)

- ▶ No compression
- ▶ Each pixel represented individually
- ▶ No need for decoding hardware/software
- ▶ Created by Microsoft

▶ JPEG

- ▶ Lossy compression (selectively discards data using Wavelet Transform)
- ▶ Can adjust degree of compression
- ▶ Used to display photographs and other continuous-tone images on the web.
- ▶ Does not support transparency
- ▶ Extension .jpg usually used

Raster Compression Formats



- ▶ GIF (Graphics Interchange Format)

- ✚ Lossless compression

- ▶ Good for images with few colours (only 256 colours or 8 bits/px)
 - ▶ Good for images with flat blocks of colour (e.g. logos or simple illustrations)
 - ▶ Supports transparency
 - ▶ PNG meant to be replacement
 - ▶ Animated GIFs

- ▶ PNG (Portable Network Graphics)

- ▶ Lossless compression
 - ▶ Interlacing
 - ▶ Supports transparency
 - ▶ TrueColor (24 bits/px)



Raster Compression Formats

- ▶ Rules of thumb:
 - ▶ For photographic type images, use JPG
 - ▶ For logos or images with blocks of flat colour and no gradients, use GIF or PNG8
 - ▶ For images using effects such as drop shadows or glows, which also require transparency, choose PNG24.

Vector Graphics

- ▶ Raster-based image editors revolve around editing pixels, unlike vector-based image editors which revolve around editing lines and shapes (vectors).
- ▶ Vector graphics is the use of polygons to represent images in computer graphics.
- ▶ Typical primitive objects
 - ▶ Lines, polylines and polygons
 - ▶ Bézier curves and bezigons
 - ▶ Circles and ellipses
 - ▶ Text fonts often are created from Bézier or quadratic curves



Vector Graphics

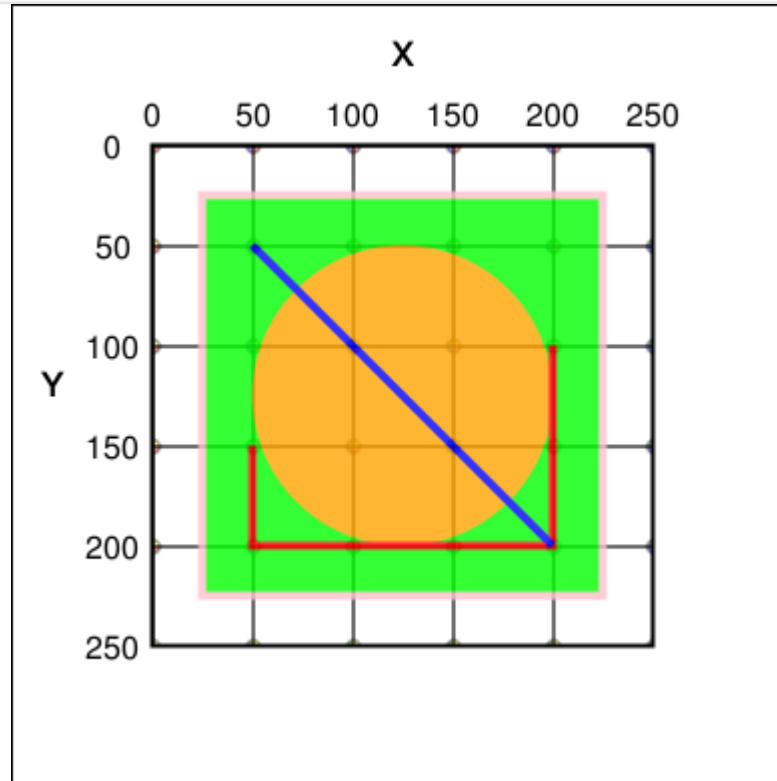


► SVG standard:

- The World Wide Web Consortium (W3C) standard for vector graphics is Scalable Vector Graphics (SVG) SVG is completely independent of the resolution of the rendering device (printer or monitor)
- SVG files are essentially printable text (XML) that describes both straight and curved paths, as well as other attributes
- E.g. Wikipedia prefers SVG for images such as simple maps, line illustrations, and flags, which generally are not like photographs or other continuous-tone images
- Rendering SVG requires conversion to raster format at a resolution appropriate for the current task
- SVG is also a format for animated graphics
- Supported natively by Chrome, Firefox, IE
- Adobe Illustrator and CorelDraw produce SCG files (for scaling purposes)

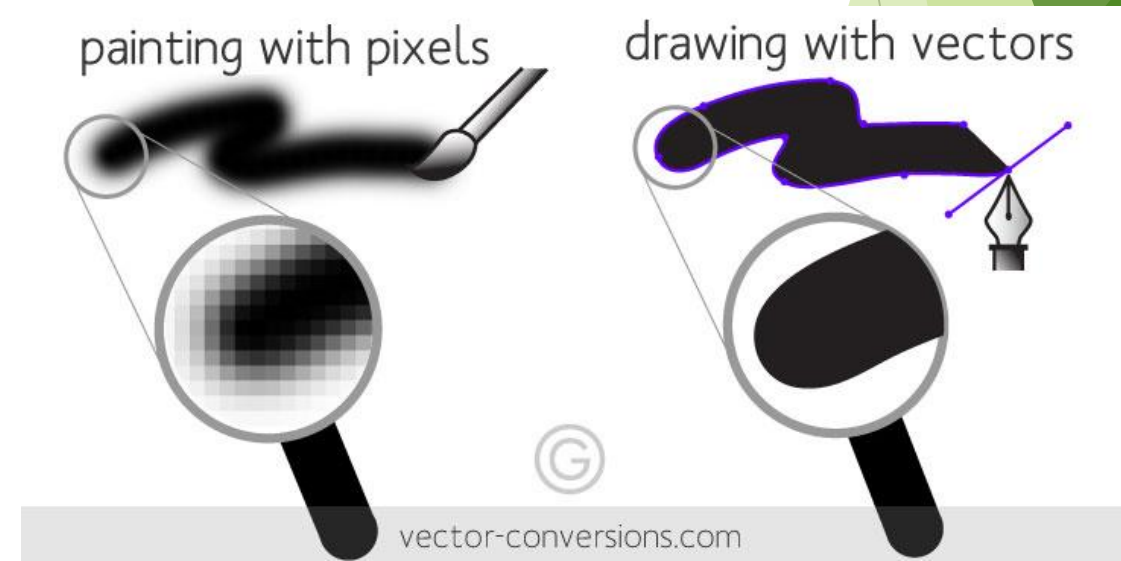
SVG XML

```
<svg xmlns="http://www.w3.org/2000/svg" version="1.1">  
  <rect x="25" y="25" width="200" height="200" fill="lime" stroke-width="4" stroke="pink" />  
  <circle cx="125" cy="125" r="75" fill="orange" />  
  <polyline points="50,150 50,200 200,200 200,100" stroke="red" stroke-width="4" fill="none" />  
  <line x1="50" y1="50" x2="200" y2="200" stroke="blue" stroke-width="4" />  
</svg>
```



Vector and Raster image comparisons

http://vector-conversions.com/vectorizing/raster_vs_vector.html



Vector Graphics



Vector Graphics

- ▶ Advantages over raster graphics:
 - ▶ Minimal information (smaller file size) compared to large raster images
 - ▶ The size of representation does not depend on the dimensions of the object
 - ▶ Correspondingly, one can infinitely zoom in on e.g., a circle arc, and it remains smooth.
 - ▶ The parameters of objects are stored and can be later modified. This means that moving, scaling, rotating, filling etc. doesn't degrade the quality of a drawing.
 - ▶ Dimensions are specified in device-independent units, which results in the best possible rasterization on raster devices.
 - ▶ From a 3-D perspective, rendering shadows is much more realistic with vector graphics

Typefaces and Fonts

- ▶ People mostly mean typeface when they say font.
 - ▶ Arial is a typeface.
 - ▶ Arial Bold 12pt is a font.
- ▶ Typeface is a family of fonts.
- ▶ Letters in a font are called glyphs
- ▶ Most fonts now represented by vectors
 - ▶ More processing power required to do this
 - ▶ TrueType (“.ttf”) files contain fonts
 - ▶ OpenType (“.otf”) is a more recent version
- ▶ Vector fonts are rasterised for visualisation

Arial

Arial Regular

Arial Italic

Arial Bold

Arial Bold Italic

Arial Black

Arial Narrow

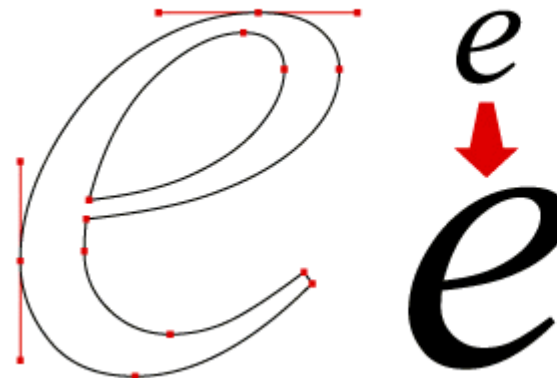
Arial Narrow Italic

Arial Narrow Bold

Arial Narrow Bold Italic

Arial Rounded MT Bold

VECTOR GRAPHICS



BITMAPMED (RASTER) GRAPHICS

