What is a digital image?
Classifying aerial images

Aerial image of trees

Agricultural applications

Analysis of paper fibres

What is Computer Graphics (CG)?
- Creating and displaying graphics and images with the aid of a computer
- This can be almost anything, but usually starts with an abstract representation of numbers and ends with something that we can see

What can CG be used for?
- Visualization of data
  - Medicine, science, economics, ...
- Working tool
  - Graphical User Interfaces (GUIs), VR, ...
- Entertainment
  - Computer games, film, art, ...
- Part in telecommunication
  - Compression, decompression
  - ...
**Computer Graphics vs Image Analysis**

They are (almost) each others inverse

- In Computer Graphics, we start with some numbers and parameters and end with an image
- In Image Analysis, we start with an image and end with some numbers

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**What will we learn in this course?**

- How to draw images on a computer screen: points, polygons, objects
- How to create a 3D impression despite our restriction to flat screens
- How to move around in a virtual 3D world
- Some tools for modeling a 3D world
- A brief introduction to the OpenGL Application Programmer's Interface (API)

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**What we will not learn in this course**

- Esthetical aspects of CGX
- How to use 3D-studio, Lightwave, Renderman, ...
- How to render photo realistic images (off-line rendering)
- X, DirectX, SDL, Java3D, and all other APIs out there
- Older APIs: GKS, PHIGS, etc.
- Hardware stuff

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**The Display Pipeline**

The order may vary somewhat

- Modelling, create objects (this is not really a part of the pipeline)
- Transformations, move, scale, rotate...
- View transformation, put yourself in the origin of the world
- Clipping, cut away things outside the view volume
- Hidden surface removal - We do not see through things...
- Light and illumination, shadows perhaps
- Projection 3D to 2D
- Rasterization, put things onto our digital screen
- Texture, shading, image based HSR...
Images in a computer...

To draw images
- To write the right numbers at the right places in this large array (the screen buffer)
- This is often done by a function called `write_pixel(x, y, color)`
  - or (if possible) by directly writing in the array buffer[y][x]=color;

Triangles
- Using `write_pixel`, we can draw lines and we can draw polygons
- Tessellation:
  - cutting polygons into smaller polygons
- In fact, we need solely triangles
- Triangularisation:
  - cutting polygons into triangles
- Triangles are always flat, which is a nice property

Object in World
- We put our triangles together to form objects
- We put the objects in a 3D world
- We use a camera model to view the world

Transformations, etc.
- We use transformations to move around in the world, as well as to move objects around in the world
- We add light to get a nice 3D effect
- We remove things we cannot see

Fixing some more
- We may speedup things using maps of different types, e.g. textures
- Starting from polygons, it is tedious to build a world. We need modelling tools. Splines and fractals are two such tools
Visualization

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