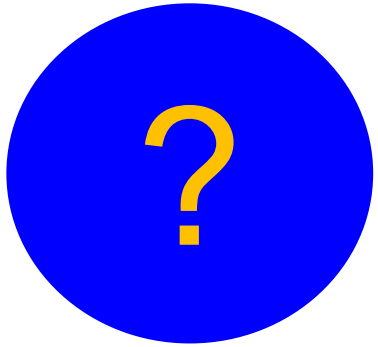

University of
Nottingham
UK | CHINA | MALAYSIA
COMP-2032
Introduction to
Image Processing
Lecture 1
Introductory

# Learning Outcomes

**WHAT**

- Image Processing
- Module Content




**IDENTIFY**

Digital Images

University of Nottingham
UK | CHINA | MALAYSIA

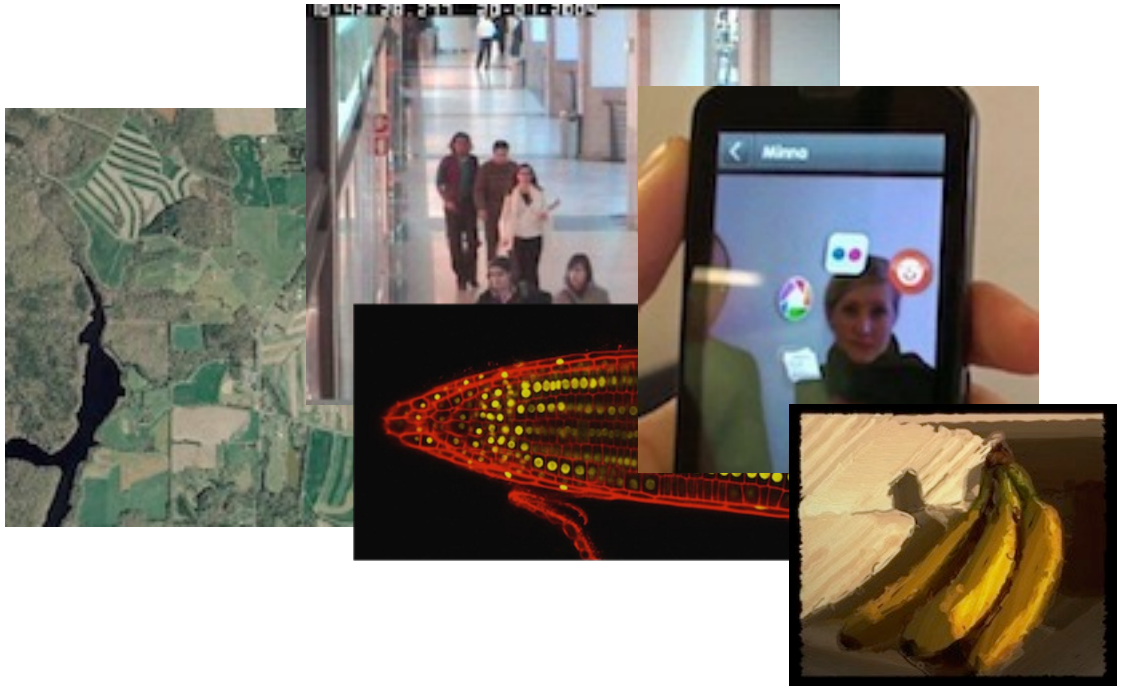
# What is Image Processing?

Let’s Debunk!

# Image Processing

Collection of topics & techniques related to the use of computers to perform the following actions on digital images

- *Acquire*
- *Store*
- *Manipulate*
- *Model*
- *Analyse/Interpret*
- *Display*



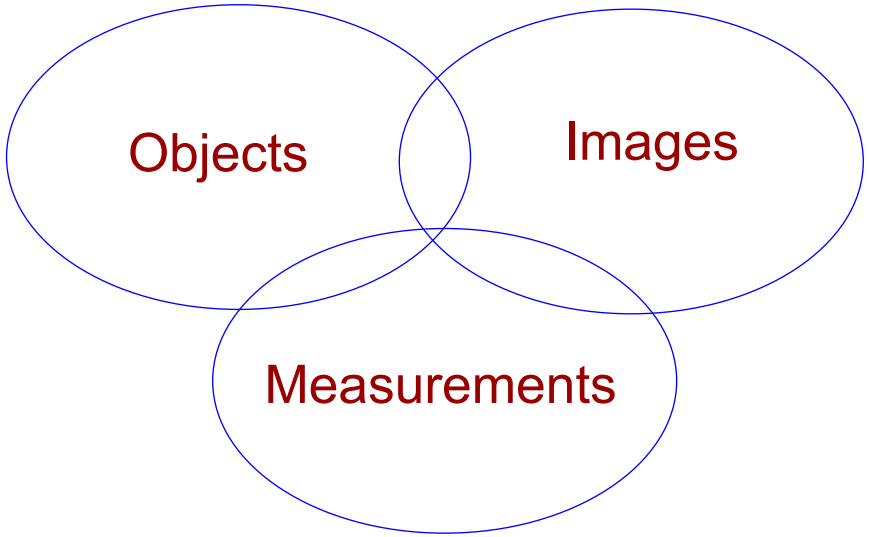
Generic techniques that are applied to images from most sources

ACK: Prof. Tony Pridmore, UNUK

# Know Your Limitations

**4** Terms are often used together and some are sometimes confused

1. *Image Processing*
2. *Image Analysis*
3. *Computer Vision*
4. *Computer Graphics*




- All share representations, underlying mathematics & some algorithms
- Their goals are very different

This is an Image Processing module with a little Image Analysis

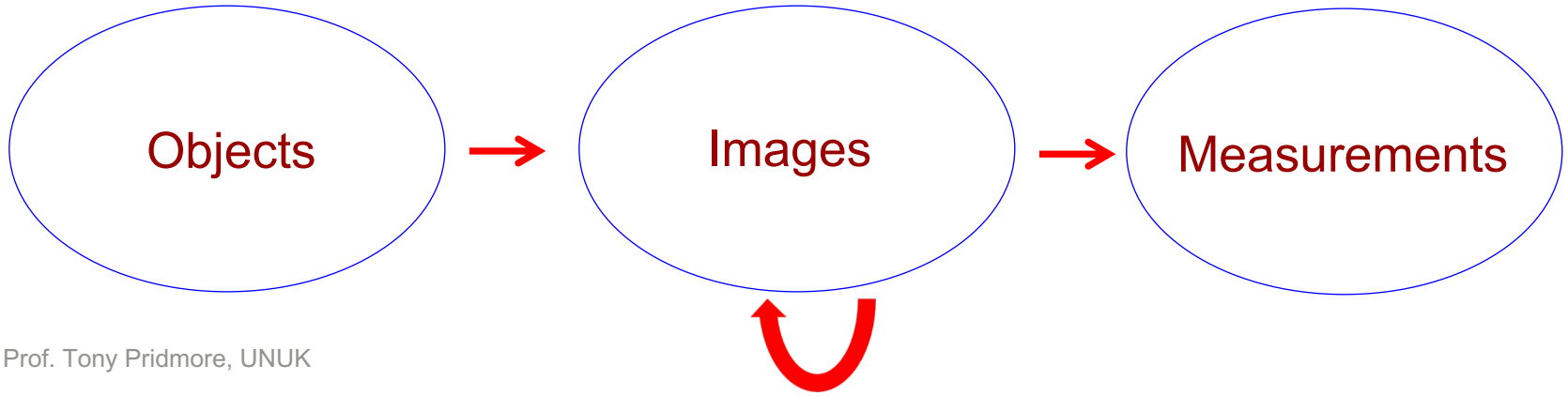
ACK: Prof. Tony Pridmore, UNUK

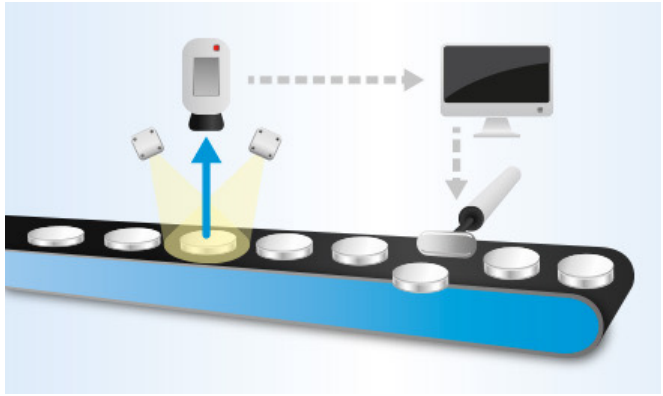
# Image Analysis

**What is the difference?**

- Concerned with making quantitative measurements on images:

  - Image acquisition is constrained so that image measurements are a proxy for some real world value
  - Sits between image processing and computer vision



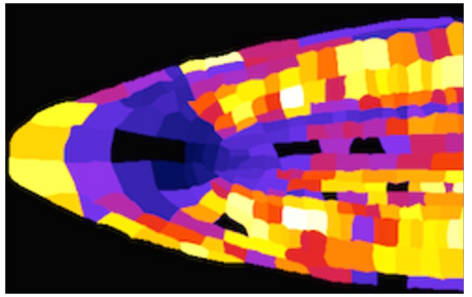



ACK: Prof. Tony Pridmore, UNUK

# Image Analysis

- Solutions are application specific
- Uses generic operations where possible, but takes an engineering more than scientific approach
- Many application areas:

  - Medical
  - Scientific
  - Industrial
    - Food, textiles, manufacturing….

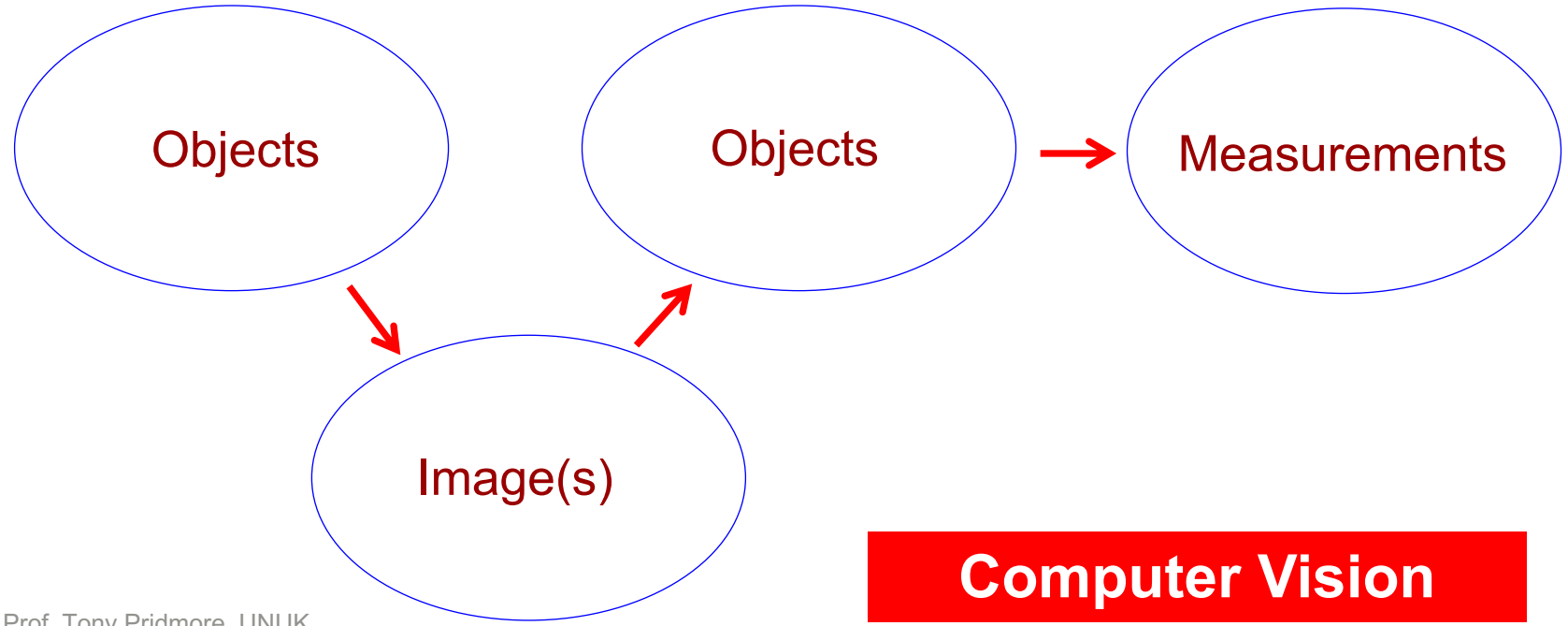


ACK: Prof. Tony Pridmore, UNUK

# It's NOT Computer Vision

Aims to invert image formation & recover information about the viewed world: 3D shape, motion, identity…

**What is the difference?**




**Computer Vision**

ACK: Prof. Tony Pridmore, UNUK

# It's NOT Computer Graphics

Focus is on creating images from object models

**What is the difference?**

- Lighting and shading modelling
- Volume modelling
- Curve and surface modelling
- Visibility modelling
- Texture synthesis
- Character animation
- Modelling terrain, liquids, fire/smoke, cloth, hair/fur, feature, skin etc.

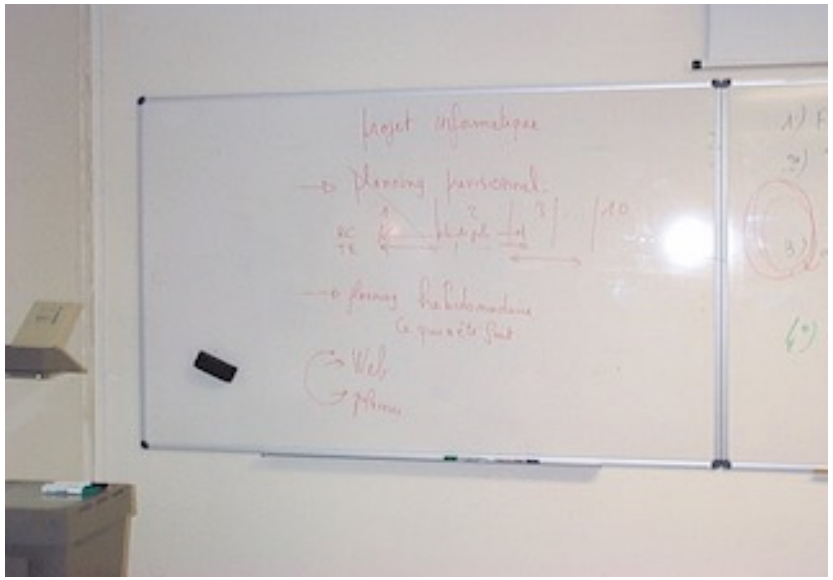
**Computer Graphics**

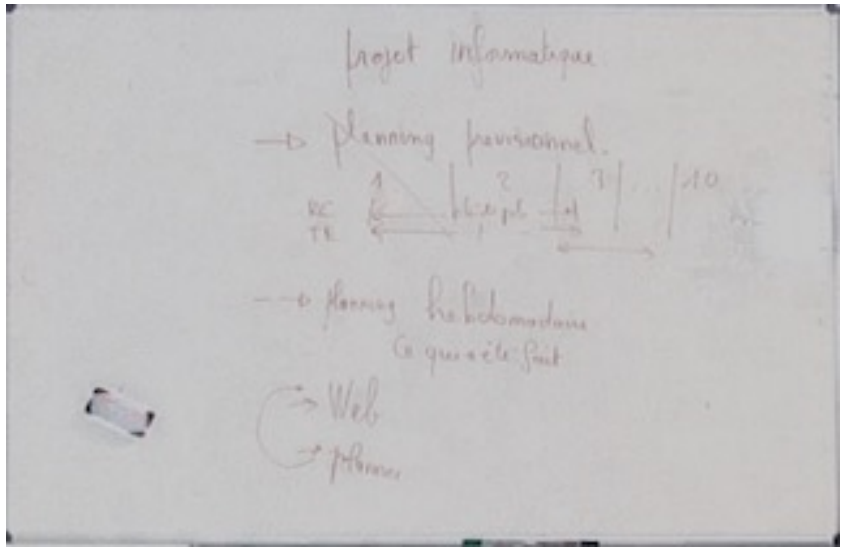

ACK: Prof. Tony Pridmore, UNUK

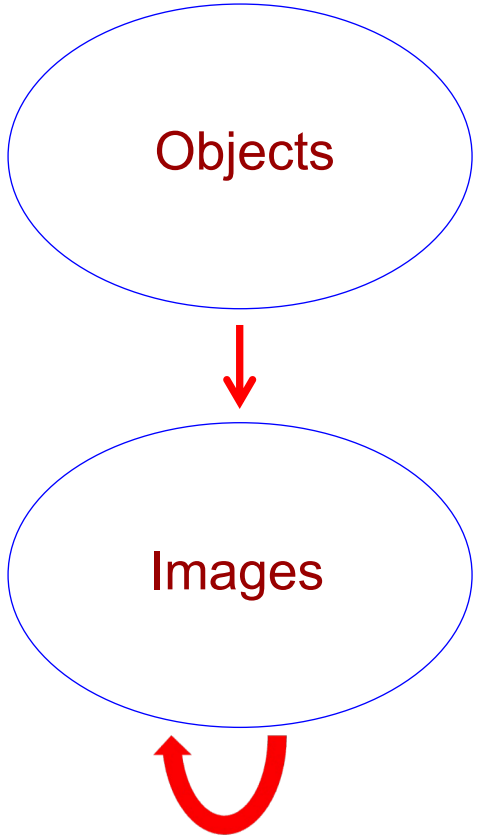
# Image Processing

**REMEMBER**

- Image(s) in, image(s) out
- Key information more easily seen/extracted
- More aesthetically pleasing

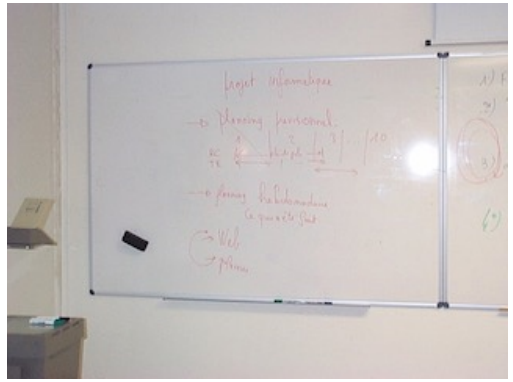




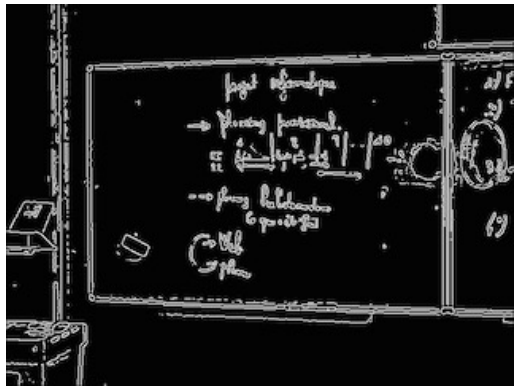



ACK: Prof. Tony Pridmore, UNUK

# It's a toolkit

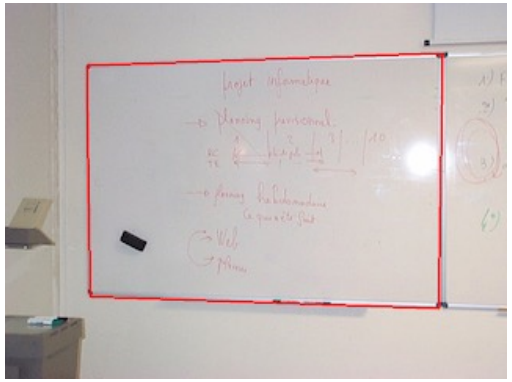


Input Image

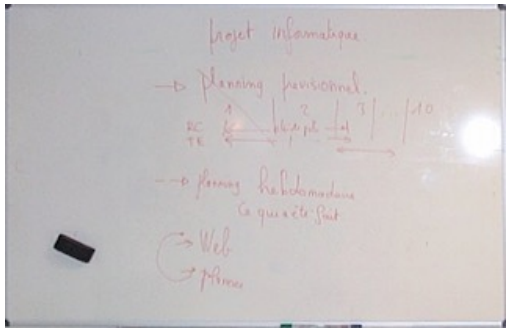


Edge detection

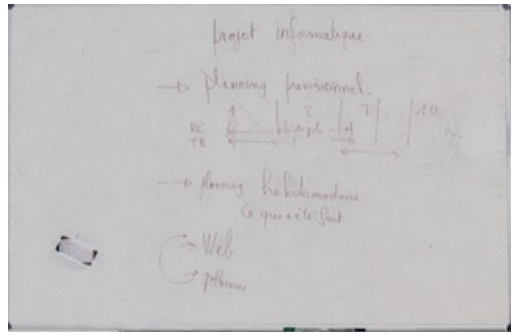
Line finding



Distortion correction

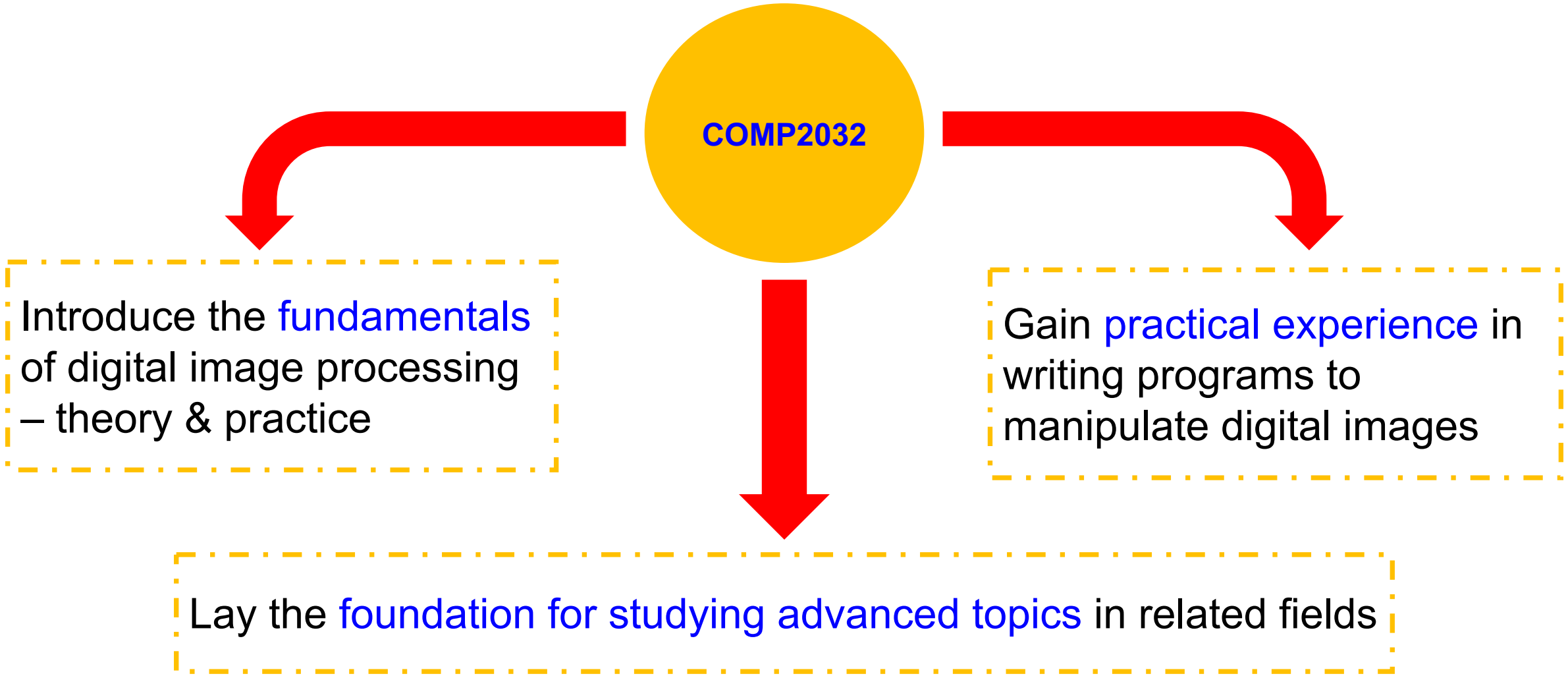


Illumination correction



ACK: Prof. Tony Pridmore, UNUK

# Primary Aims




ACK: Prof. Tony Pridmore, UNUK

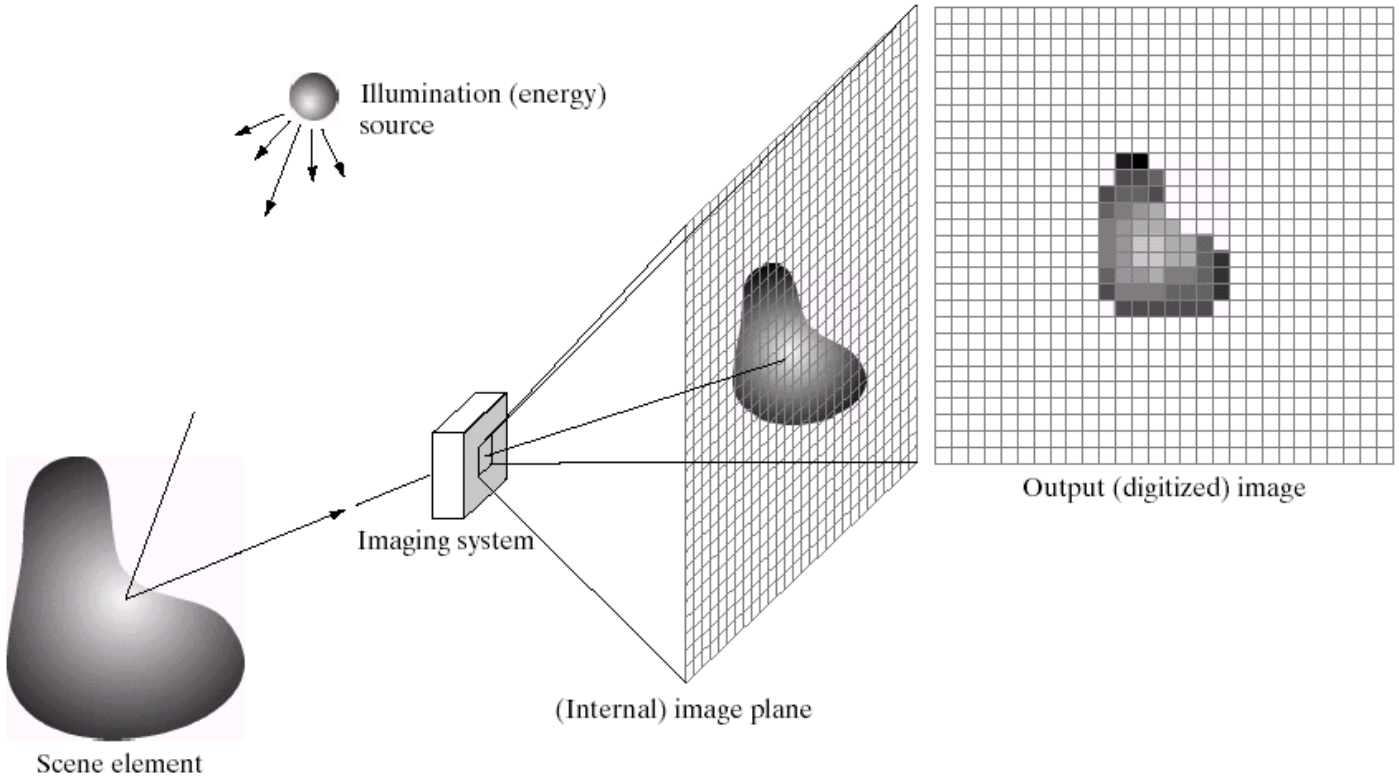
# Break

University of Nottingham
UK | CHINA | MALAYSIA

# Module Content

More SECRETs Revealed!

**Image Formation** | **Acquisition** | **Colour Representation**




ACK: Prof. Tony Pridmore, UNUK

# Digital Images

A common, low-level representation of the viewed world

```
123 33 234 45
67 90 12 134 34
56 89 54 67 98
111 56 67 90 65
34 ....
```

Pixel values represent the brightness and colour of the viewed objects, but give no indication of what object, e.g., books, monitors, these numbers refer to – hence low-level

ACK: Prof. Tony Pridmore, UNUK

Redundancy & image compression – efficiently represent image data for storage (*minimise disk space*) & communication (*minimise network bandwidth*)

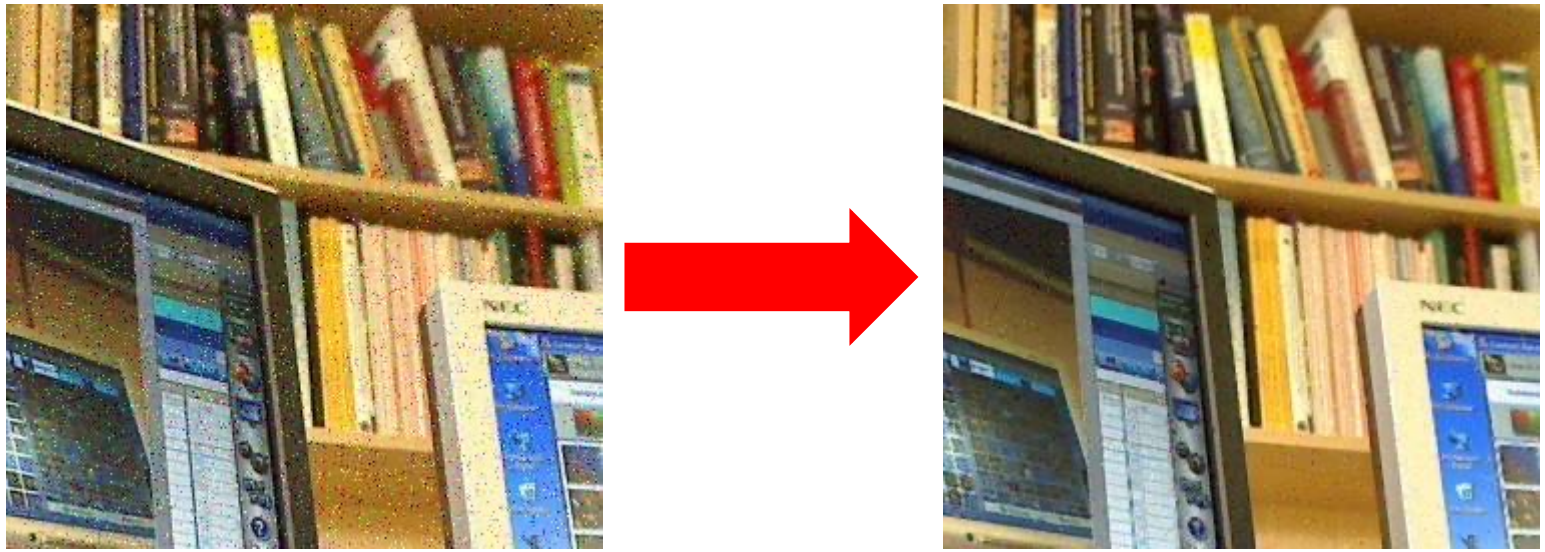
245,760 bytes

69,632 bytes

5,951 bytes

ACK: Prof. Tony Pridmore, UNUK

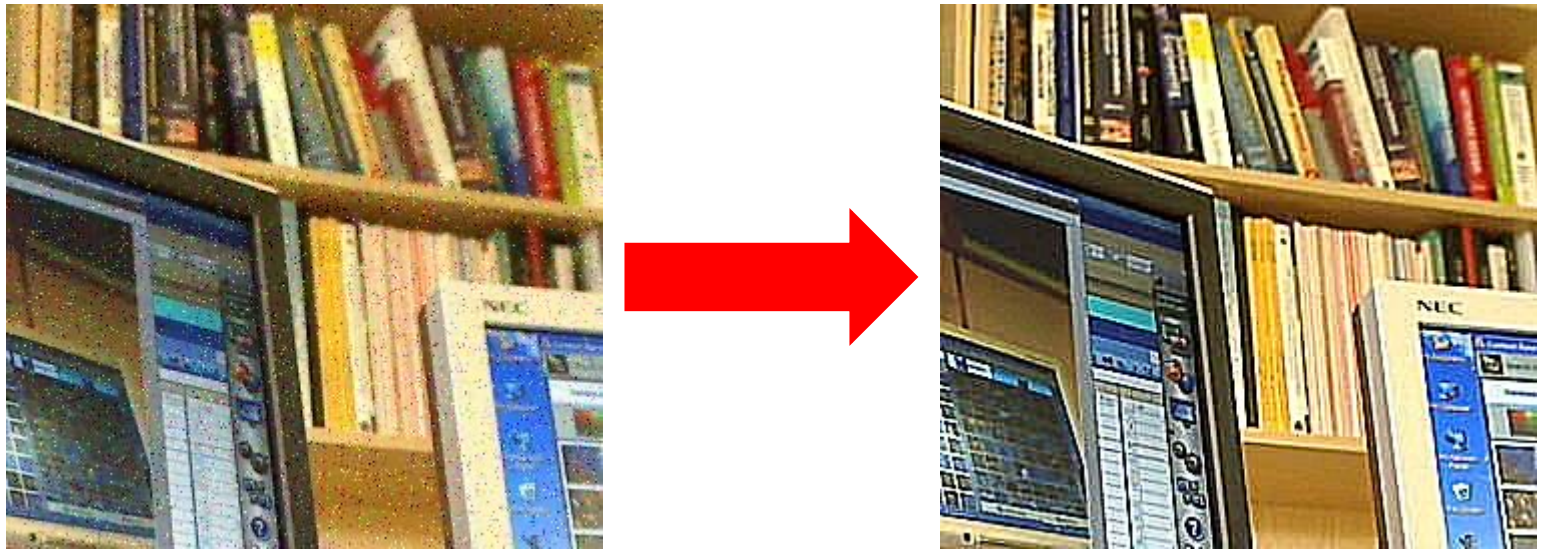
Image manipulation – noise removal, smoothing, sharpening, contrast enhancement, changing the appearance of an image, etc.



Noise reduction

ACK: Prof. Tony Pridmore, UNUK

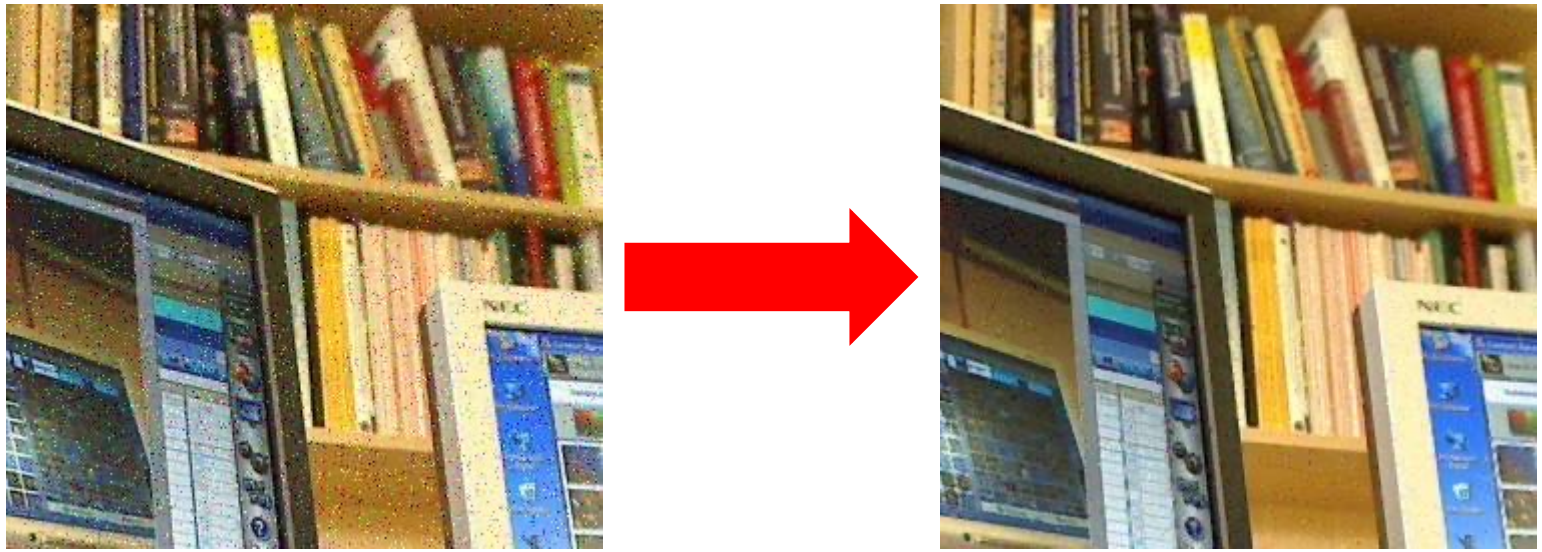
Image manipulation – noise removal, smoothing, sharpening, contrast enhancement, changing the appearance of an image, etc.



Sharpening

ACK: Prof. Tony Pridmore, UNUK

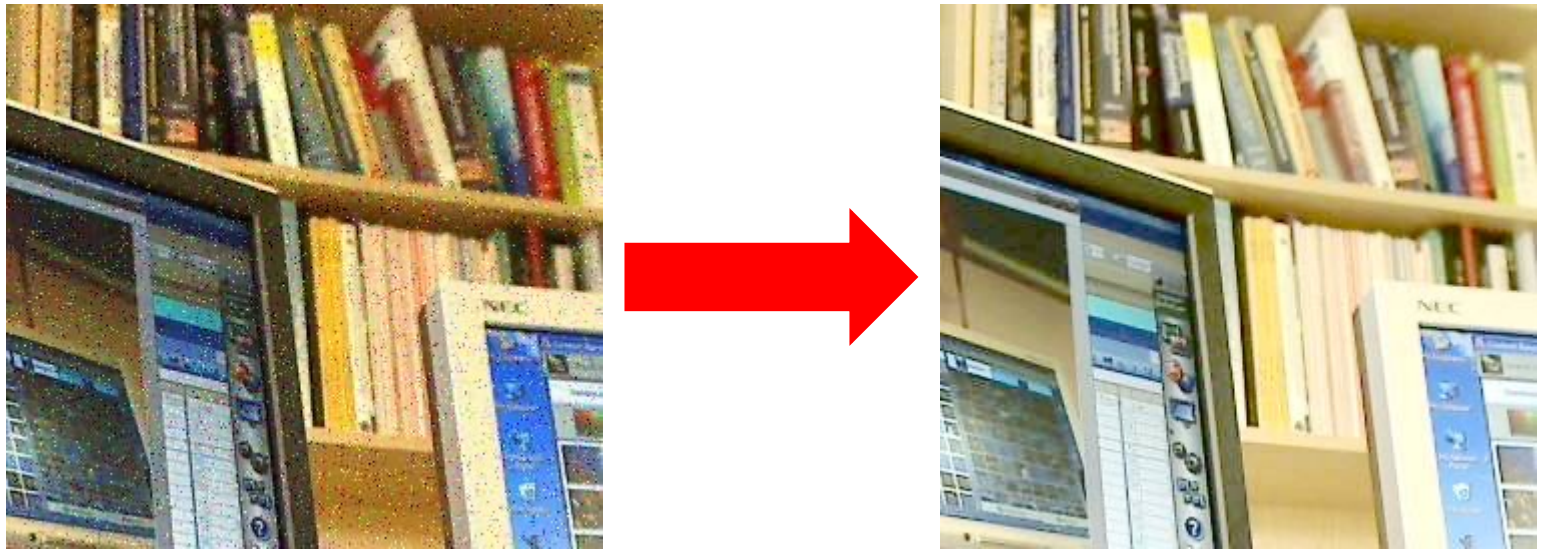
Image manipulation – noise removal, smoothing, sharpening, contrast enhancement, changing the appearance of an image, etc.



Smoothing

ACK: Prof. Tony Pridmore, UNUK

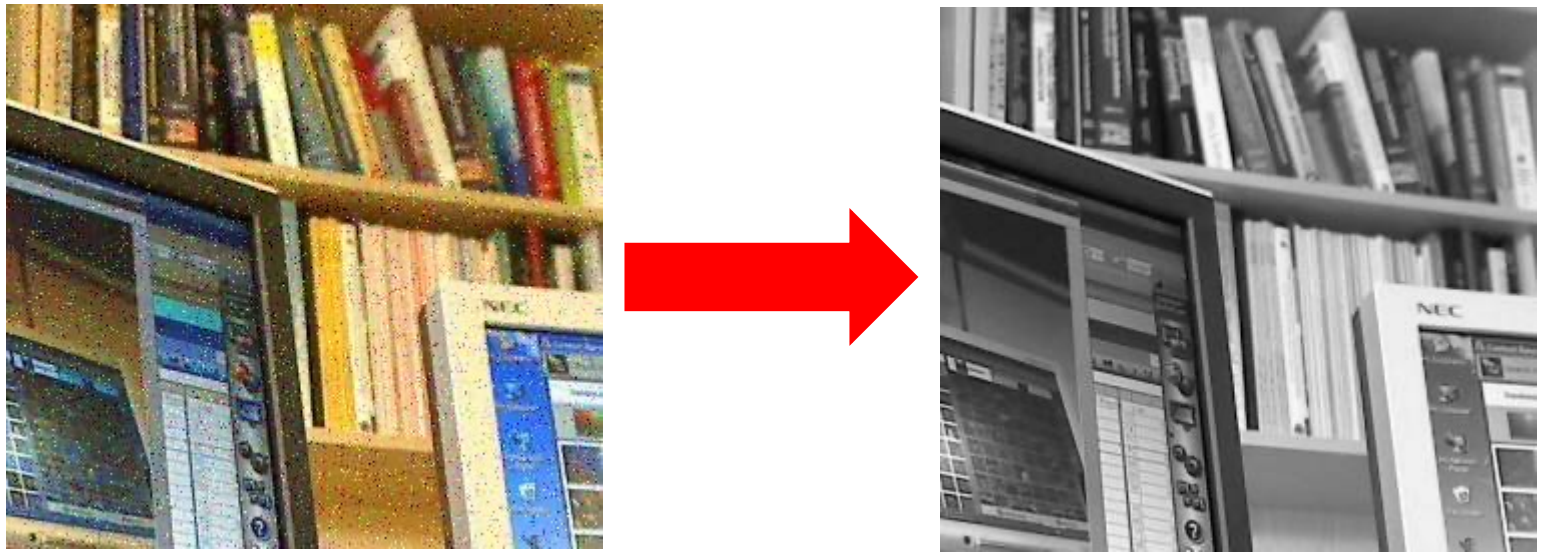
Image manipulation – noise removal, smoothing, sharpening, contrast enhancement, changing the appearance of an image, etc.



Contrast Enhancement

ACK: Prof. Tony Pridmore, UNUK

Image manipulation – noise removal, smoothing, sharpening, contrast enhancement, changing the appearance of an image, etc.

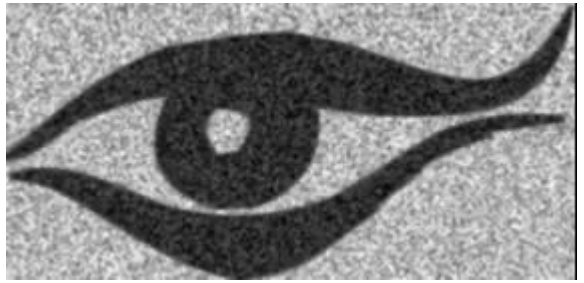


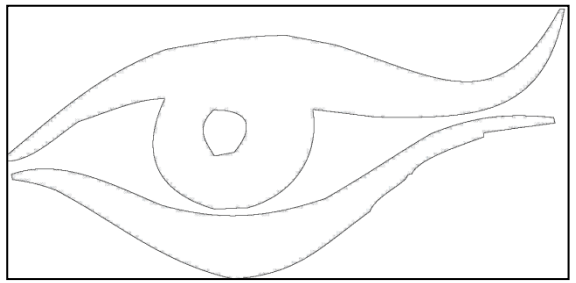
Changing image appearance

ACK: Prof. Tony Pridmore, UNUK

**Edge detection**

**Image segmentation**





- Underlying theory
- Some useful algorithms

A step towards image analysis & computer vision

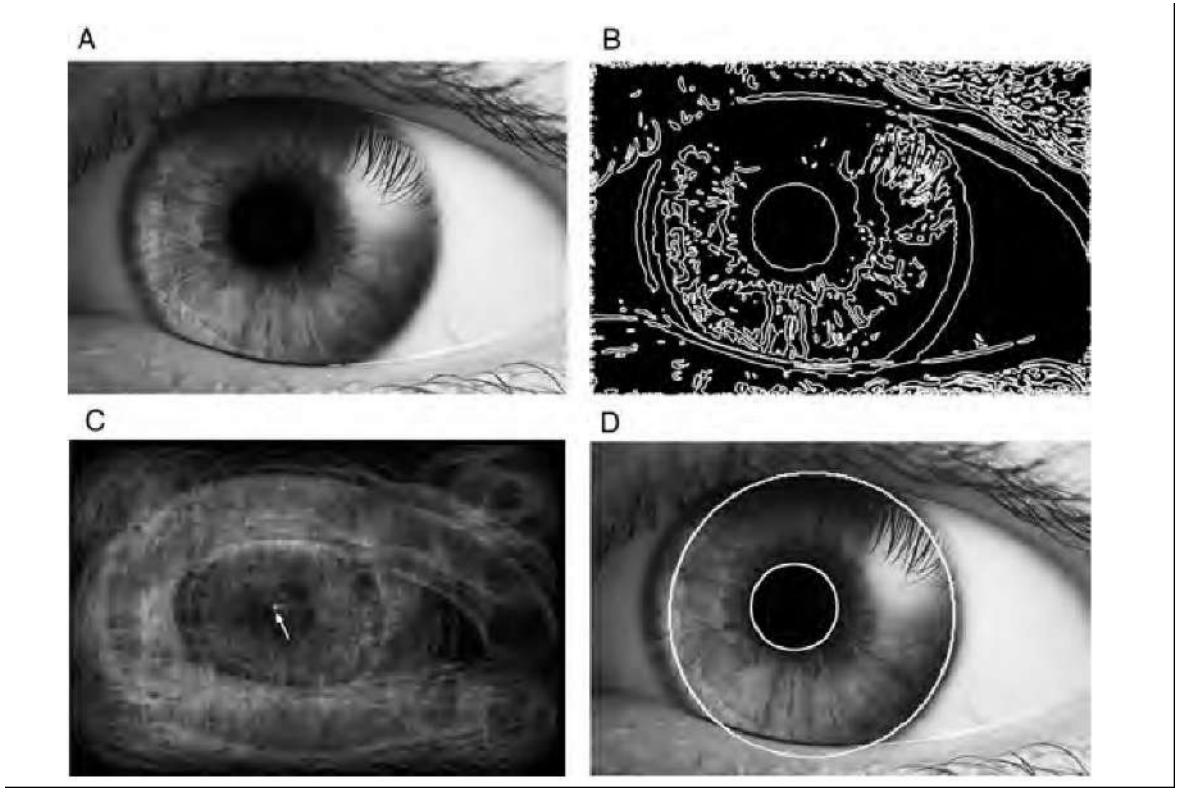
ACK: Prof. Tony Pridmore, UNUK

## Superpixels

- An increasingly popular intermediate representation
- Fewer data points = less work

ACK: Prof. Tony Pridmore, UNUK

# Finding geometric objects



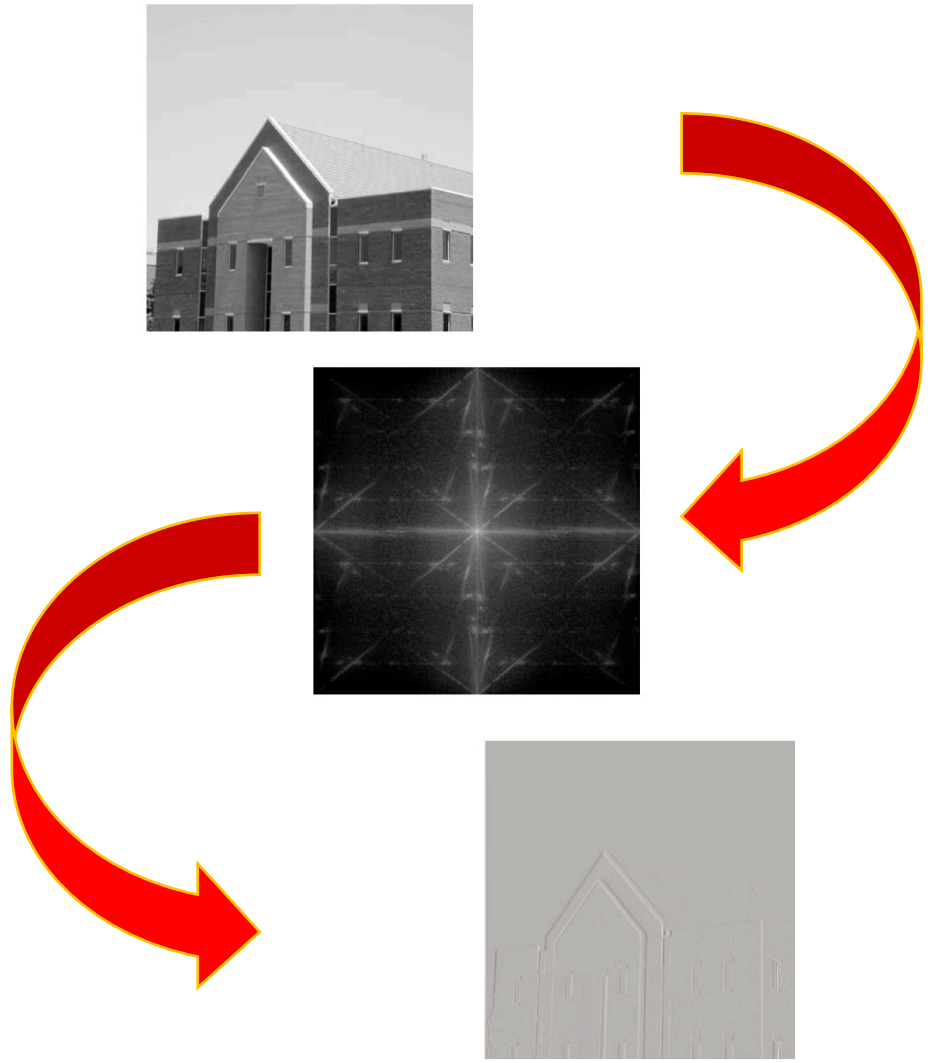

The Hough Transform

ACK: Prof. Tony Pridmore, UNUK

# COMP 2032

- **Focus** on spatial domain methods (*operating directly on the image*)
  - Point operations
  - Area operations

- **Overview** of frequency domain methods (*One Lecture*)
  - Compute the power spectrum of the image
  - Process the power spectrum
  - Reconstruct a new image from the modified power spectrum



ACK: Prof. Tony Pridmore, UNUK

Geometric operations – manipulate the array structure underlying image, not just the pixel values

Rotation, translation, scaling and affine transformations

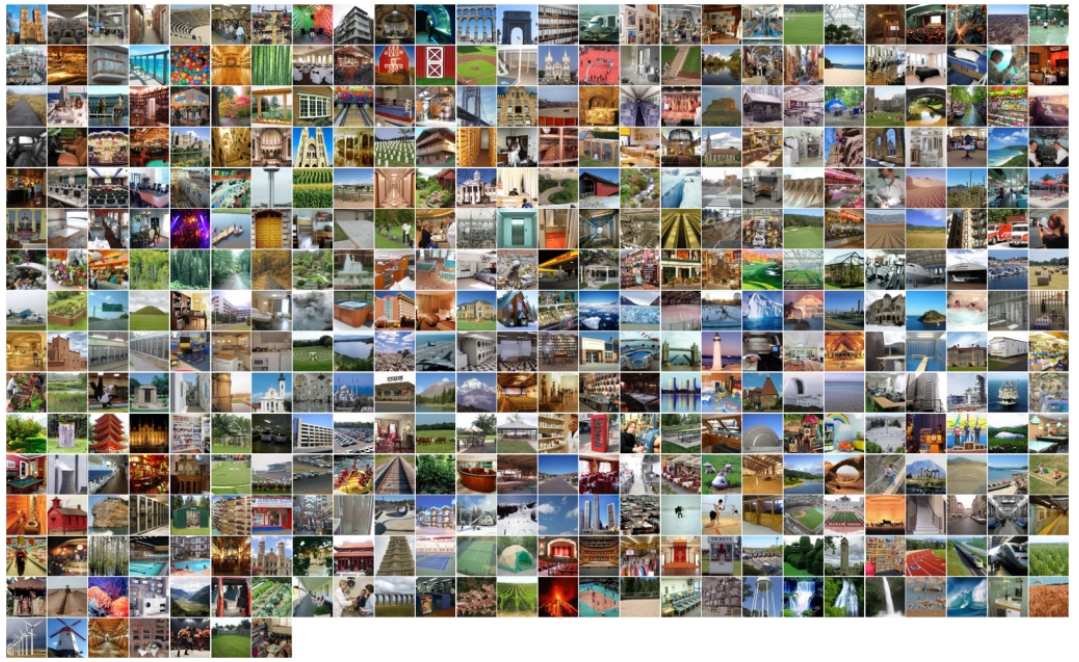
ACK: Prof. Tony Pridmore, UNUK

# Some Applications

Content-based Image Retrieval

Show me all the image like this:

In here:



ACK: Prof. Tony Pridmore, UNUK

# Some Applications

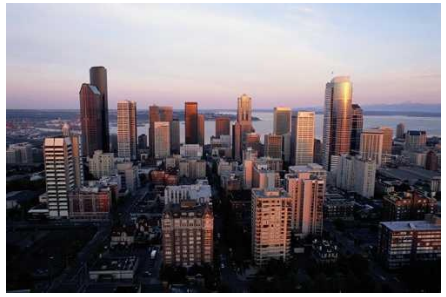
## Painterly Rendering

- Process images to give a painted feel
- Aims to reproduce a particular artist or movement's style, e.g., **Impressionism**

ACK: Prof. Tony Pridmore, UNUK

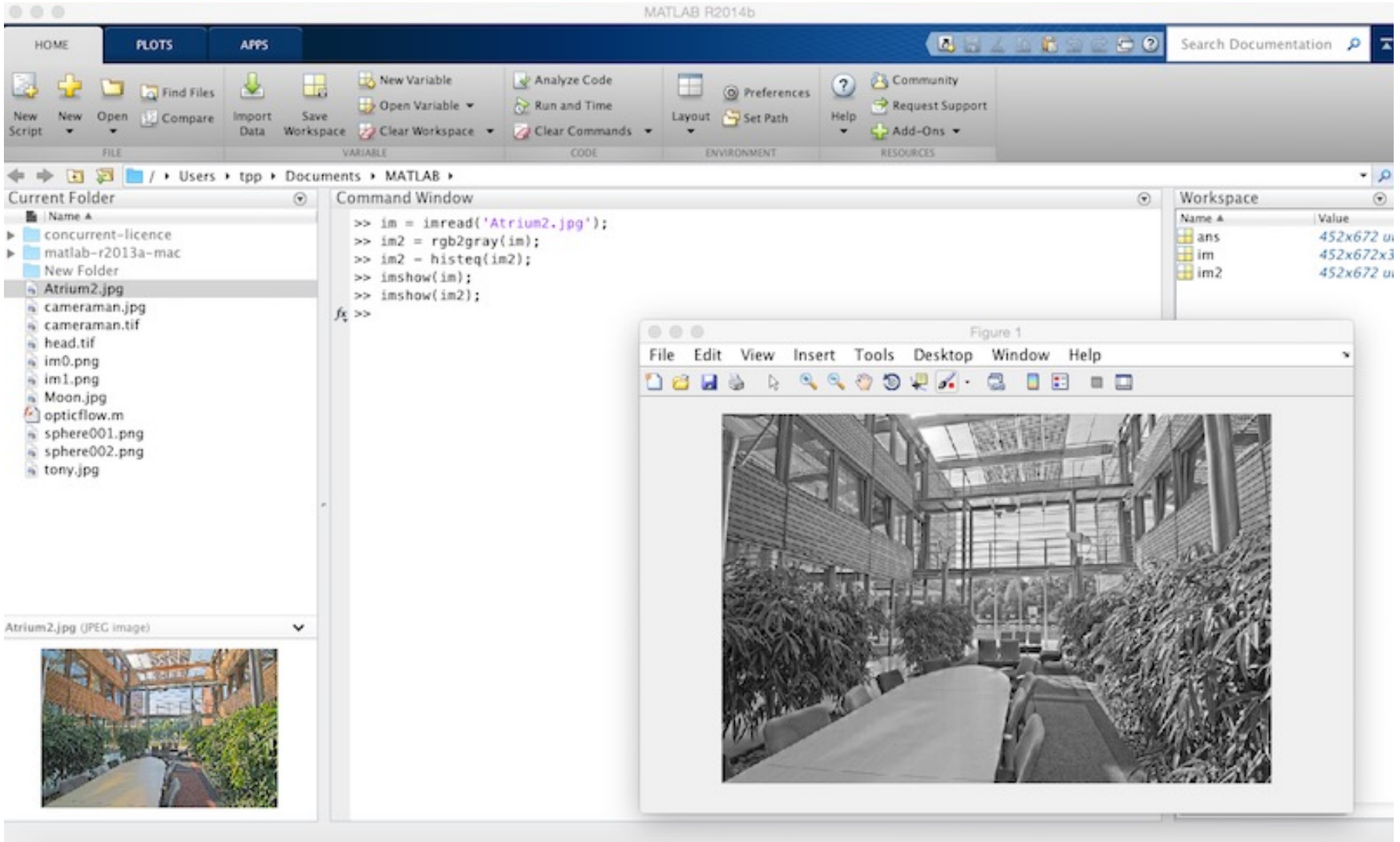
# Some Applications

Interactive Tools & Compositing



ACK: Prof. Tony Pridmore, UNUK

# MATLAB IP Toolbox




ACK: Prof. Tony Pridmore, UNUK

University of Nottingham
UK | CHINA | MALAYSIA

# Assessment

Very IMPORTANT

# COMP2032 - Assessment

- **2000** word report + programming
  - MATLAB application
  - Explanation & evaluation of results

Coursework

- 1 hour exam
  - Answer **ALL 3** questions

Exam

# Summary

1

- Image Processing
- Module Content

2

Digital Images


University of
Nottingham
UK | CHINA | MALAYSIA
Questions


University of
Nottingham
UK | CHINA | MALAYSIA
NEXT:
Digital Images +
Point Processing