Introduction to ARCHER and Cray MPI

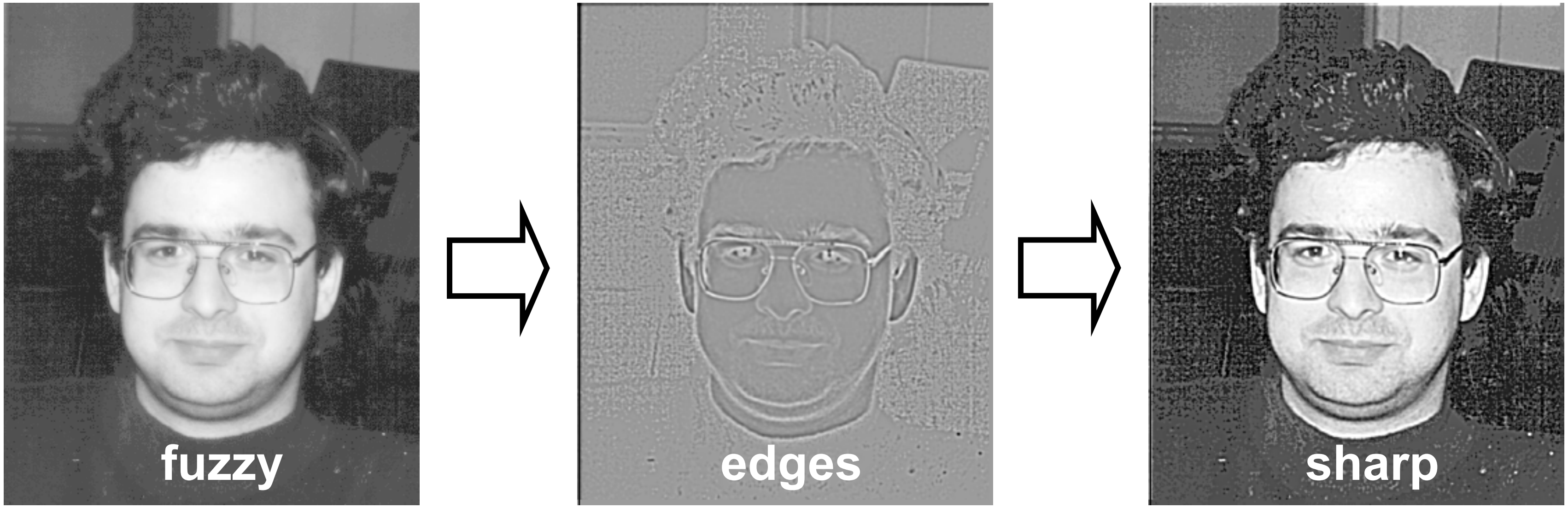
Running a Simple Parallel Program

Aims

- To familiarise yourself with running parallel programs
- To run a real parallel code (that does file I/O)
  - on different numbers of cores
  - measure the time taken
  - observe increase in performance
- Acknowledgements
  - algorithm, diagrams and images taken from:
  - *Hypermedia Image Processing Reference*, Bob Fisher, Simon Perkins, Ashley Walker and Erik Wolfart, Department of Artificial Intelligence, University of Edinburgh (1994)

Image sharpening

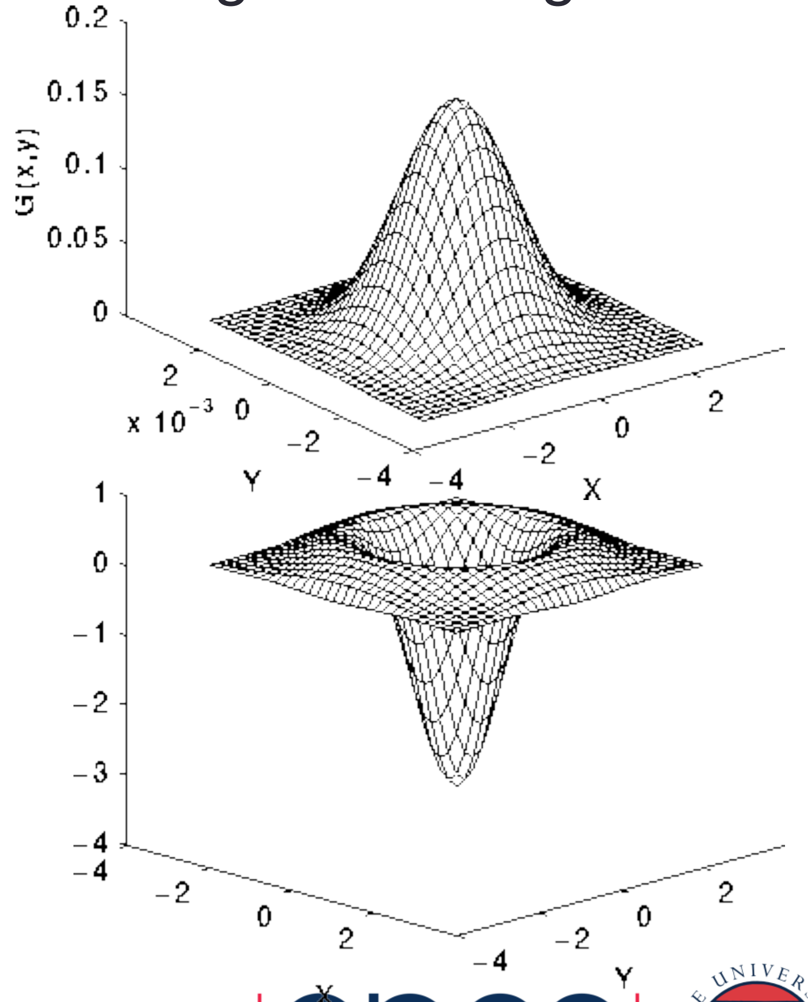
- Images can be fuzzy for two main reasons
  - random noise
  - blurring
- Aim to improve quality by
  - smoothing to remove noise
  - detecting edges
  - sharpening up the image with the edges



Technicalities

- Each pixel replaced by a weighted average of its neighbours
  - weighted by a 2D Gaussian
  - averaged over a square region

  - we will use:
    - Gaussian width of 1.4
    - a 17x17 square
  - then apply a Laplacian
    - this detects edges
    - a 2D second-derivative ∇^2



- Combine both operations
  - produces a single convolution filter

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Implementation

- For over every pixel in the image
  - loop over all pixels in the 17x17 square surrounding it
  - add in the value of the pixel weighted by a filter

$$edge(i,j) = \sum_{k,l=-8,8} image(i+k, j+l) \times filter(k,l)$$

- This gives the edges
  - add the edges back into the original image with some scaling factor
    - we use 1.0
  - rescale the sharpened image so pixels lie in the range 0 - 255

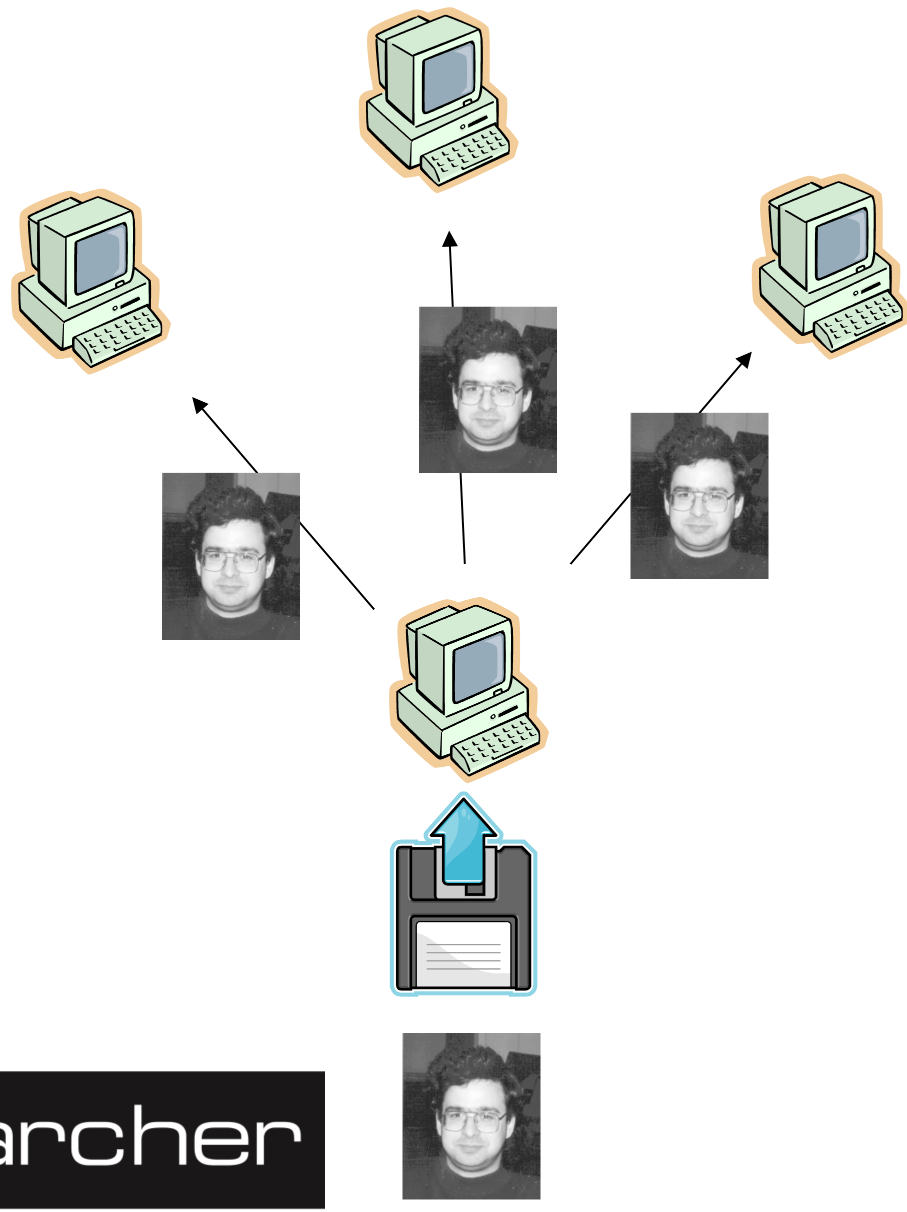
Parallelisation: Distributed Memory/MPI

- Each pixel can be processed independently
- A master process reads the image
- Broadcast the whole image to every processor
- Each processor computes edges for a subset of pixels:
  - scan the image line by line
  - with four processors, each processor computes every fourth pixel
- Combine the edges back onto a master process
  - add back into original image and rescale
  - save to disk
- Reports two times:
  - calculation time for just computing edges on each processor
  - overall time for the whole program

Parallelisation: Shared Memory/OpenMP

- Each pixel can be processed independently
- The master thread reads the image
- Store the image in shared memory
- Each thread/core computes edges for a subset of pixels:
  - scan the image line by line
  - with four cores, each thread computes every fourth pixel
- On the master thread only
  - add back into original image and rescale
  - save to disk
- Reports two times:
  - calculation time taken for just computing edges on each thread
  - overall time for the whole program

Parallelisation



1	2	3	4	1
2	3	4	1	2
3				

Compiling and Running

- We provide a tar file with code and sample images
  - one pair of codes uses MPI and Fortran/C
  - the other pair uses OpenMP and Fortran/C
- You should:
  - copy tar file it to your local account
  - unpack it
  - compile it
  - run it on the back end using appropriate batch scripts
  - view the input and output images using `eog` (Eye Of Gnome)
  - note the times for different numbers of processors
    - can you interpret them?
- See the exercise sheet for full details!

- Log on to ARCHER and compile and run a code.
- Password:
- Reservation ID:
- **http://tinyurl.com/archer230414/Exercises/P01_sharpen.pdf**
- If you are using Windows or do not have SSH installed you will need to obtain an SSH client. One such client is Putty, which can be obtained :
- http://the.earth.li/~sgtatham/putty/latest/x86/putty.exe
- http://sourceforge.net/projects/xming/