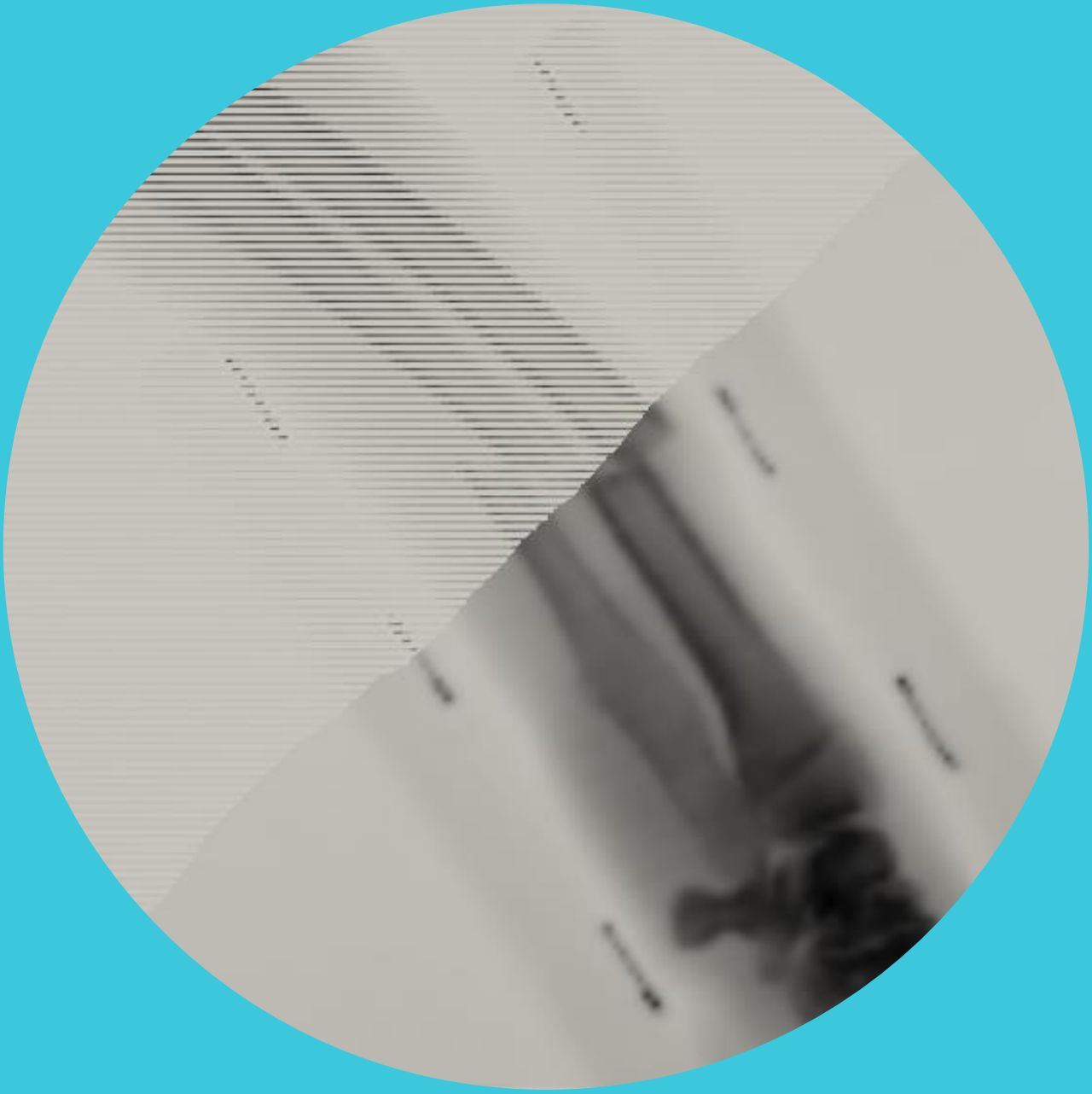


Broken Bones and 1's and 0's

Key Stage 4 Programme

Pupil Name	
Handbook Designed by	Dr. Gary Poole

Timetable and Assignment Submission

Timetable – Tutorials

Tutorial Number	Date	Title	Location
1		What's in an Image?	
2		What Makes a Medical Image Special?	
3		Core Interpolation Techniques	
4		How to Adapt or Improve a Technique	
5		Critical Review of a Technique – Final Assignment	
6 (Feedback)		Feedback Tutorial	

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1	Analyse the features of the 6 images.	
Tutorial 2	Fill in the missing pixels.	
Tutorial 3	Practice interpolation techniques.	
Tutorial 4	Independent research.	
Tutorial 5	Final assignment.	

The Brilliant Club KS4 Programme – Pupil Feedback Report

Assignment Feedback – Marking and Grade Descriptors

Grade	Marks	What this means
1st	70+	Performing to an excellent standard at A-level
2:1	60-69	Performing to a good standard at A-level
2:2	50-59	Performing to an excellent standard at GCSE
3rd	40-49	Performing to a good standard at GCSE
Working towards a pass	0-39	Performing below a good standard at GCSE
Did not submit	DNS	No assignment received by The Brilliant Club

Assignment Submission – Lateness and Plagiarism

Lateness	
Submission after midnight on 19/2/2018 Submission after midnight on 23/2/2018	10 marks deducted 100 Marks Deducted (Fail)
Plagiarism	
Some plagiarism *(inc. poor referencing)*	10 marks deducted
Moderate plagiarism *(inc. some copy-paste)*	20 marks deducted
Extreme plagiarism *(collusion or extreme copy-paste)*	Automatic fail

Name of PhD Tutor	Dr. Gary Poole		
Title of Assignment	Critical Evaluation of an Image Interpolation Technique		
Name of Pupil			
Name of School	Reach Academy Feltham		
ORIGINAL MARK / 100		FINAL MARK / 100	
DEDUCTED MARKS		FINAL GRADE	
If marks have been deducted (e.g. late submission, plagiarism) the PhD tutor should give an explanation in this section:			
Learning Feedback Comment 1 -			
Learning Feedback Comment 2 –			

Learning Feedback Comment 3 –	
Resilience Comment	

Contents

Course Rationale P6

Mark Scheme P7

Tutorial 1 P11

- Lecture 1 P12
- Matching Activity P13
- Top Secret! P15
- **Independent Practice** P17

Tutorial 2 P18

- **Medical Images** P19
- Presentation P21
- Lecture 2 P23
- **Independent Task** P24

Tutorial 3 P25

- Partner Homework Review P26
- Independent Practice P28
- WIP P30

Tutorial 4 P31

- Independent Research Session P32

Tutorial 5 P33

- Final Assignment P34

Tutorial 6 P36

- Reflection on feedback P37

Appendices P38

- Referencing correctly P38
- **Virtual Learning Environment** P40

Course Rationale

Digital imaging technology and applications are all around us in the modern world. One of the most important topics in this field is called Computerised Tomography (CT) or simply Tomography. Common in many imaging applications, not least in medical imaging, CT applications have given rise to active areas of research for many decades and there are thousands of scientists and groups both in research and industry that dedicate themselves to this rich and diverse topic.

Magnetic Resonance Imaging (MRI) provides medical practicioners with images needed for diagnosis and surgical assessments in various diseases, injuries and conditions across the board; there is a world of Mathematics, Physics, Computer Science and Engineering going on under the hood to get a good quality image into the medic's hands.

In our first tutorials we will discover what makes a digital image and how to identify mathematical features in an image which then allow us to not only classify images into various classes, but also provide us with some criteria to assist us in designing part of the techniques needed in the applications those images will arise later in the course.

Pupils will then learn some fundamental interpolation algorithms that can be used to repair missing data in incomplete images and explore and evaluate the algorithms based on their effectiveness within particular classes of images. Pupils will learn how this can be used to select suitable algorithms for different applications.

In the final assignment the pupils will compare and evaluate the techniques discussed throughout the course on their use for a given set of damaged images and will also be encouraged to research or adapt their own techniques that could be used and provide a critical analysis of the efficacy of those techniques. Combining their knowledge the will be expected to recommend a full technique for inpainting of a medical image.

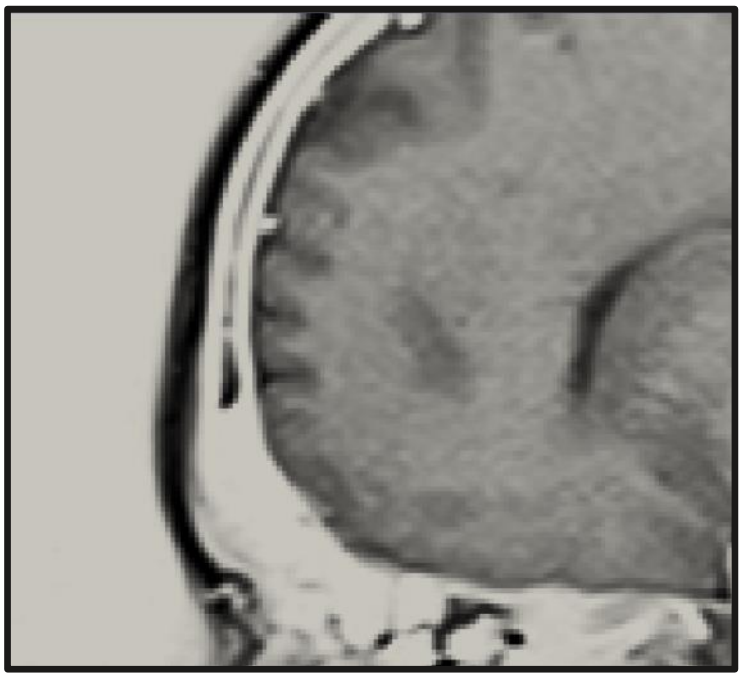
Mark Scheme Table

	Skills	1st (70-100)	2:1 (60-69)	2:2 (50-59)
Subject knowledge	Knowledge and Understanding	○ All content included is relevant to the general topic and to the specific question/title ○ Good understanding of all the relevant topics. ○ Scientific terms are defined and used accurately throughout ○ Clear justification on how the content included is related to the specific issues that are the focus of the assignment	○ Most of the content included is relevant to the general topic and to the specific question/title ○ Good understanding of most the relevant topics ○ Scientific terms are used accurately but not always clearly defined. ○ Adequate justification on how the content included is related to the specific issues that are the focus of the assignment	○ Some of the content included is relevant to the general topic and to the specific question/title ○ Good understanding on some of the relevant topics but occasional confusion on others. ○ Scientific terms are used mostly accurately with occasional confusion and often not defined. ○ Some justification on how the content included is related to the specific issues that are the focus of the assignment
Critical thinking	Research and Evidence (if used in final assignment)	○ Inclusion of rich sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas ○ Use evidence/calculations to support claims/assertions /ideas, consistently clearly and convincingly ○ Evidence of further reading beyond materials provided which were used in an appropriate context ○ Data is effectively analysed and appropriate assumptions/conclusions are reached	○ Inclusion of adequate sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas ○ Use evidence/calculations to support claims/assertions/ideas, mostly clearly and convincingly ○ Evidence of further reading beyond materials provided ○ Data is analysed and the assumptions/conclusions that are reached are mostly appropriate	○ Inclusion of some sources of research findings, data, quotations or other sourced material as evidence for the claims/ ideas ○ Use evidence/calculations to support claims/assertions/ideas, at times clearly and convincingly ○ Limited evidence of further reading beyond materials provided ○ There is an attempt to analyse data is and draw assumptions/conclusions
	Developing an Argument	○ A point of view or position in relation to the title or question is	○ A point of view or position in relation to the title or question is	○ A point of view or position in relation to the title or question is

		consistently clear o Argument/proof exceptionally well-developed and well-justified o A position is clearly established in relation to the question, and is developed effectively and consistently throughout the essay o Makes links effectively between subjects that have not previously been associated o Uses concepts from the tutorials in an unfamiliar context, and does so accurately and confidently. o Content is analysed effectively to support the argument	adequately clear o Argument/proof clear and well-developed and position justified o A position is established in relation to the question, and is well-developed in most of the essay o Some evidence of linking subjects that have not previously been associated o Use some concepts from the tutorials in an unfamiliar context, but not always accurate o Analysis of content to support the argument	somewhat clear o Argument/proof clear but not well-developed o A position is established in relation to the question, and is well-developed in parts of the essay o Limited evidence of linking subjects that have not previously been associated o Limited use of concepts from the tutorials in other contexts o Some analysis of content to support the argument
	Critical Evaluation	o Moved beyond description to an assessment of the value or significance of what is described o Evaluative points are consistently explicit/systematic/reasoned/justified o Effective critiques on the reliability of sources provided	o Mostly description but some assessment of the value or significance of what is described o Evaluative points are mostly explicit/systematic/reasoned/justified o Some evidence of critiques on the reliability of sources provided	o Only description with minimal assessment of the value or significance of what is described o Evaluative points are at times explicit/systematic/reasoned/justified o Limited evidence of critiques on the reliability of sources provided
Written communication	Structure and Presentation	o Ideas are presented in paragraphs and arranged in a logical structure that is appropriate for the assignment o The introduction clearly outlines how the essay/report will deal with the issues o The conclusion summarises all the main points clearly and concisely	o Ideas are presented in paragraphs and arranged in a structure that is mostly appropriate for the assignment o The introduction adequately describes how the essay/report will deal with the issues o The conclusion summarises most of the main points clearly o Calculations,	o Ideas are presented in paragraphs and arranged in a structure o The introduction mentions how the essay/report will deal with the issues o The conclusion summarises some of the main points clearly o Calculations, formulas and methods are not always structured, clear to follow

		○ All calculations, formulas and methods are clearly structured, clear to follow and correct ○ Tables and graphs are effectively constructed including appropriate headings, units and scales. ○ All sources are referenced correctly in an agreed format	formulas and methods are mostly structured, clear to follow and correct ○ Most tables and graphs are well constructed ○ Most sources are referenced correctly in an agreed format	and correct. ○ Some tables and graphs are well constructed but contains some errors ○ Some sources are referenced correctly in the agreed format with occasional errors
	Language and Style	○ No spelling, grammar or punctuation errors ○ Units and significant figures are presented accurately throughout ○ Writing style consistently clear, appropriate for scientific documents and easy to follow ○ Accurate and consistent use of technical language and vocabulary	○ Minimal spelling, grammar or punctuation errors ○ Units and significant figures are presented accurately throughout ○ Writing style mostly clear, appropriate for scientific documents and easy to follow ○ Some attempts of using technical language and vocab alary, but not always accurate	○ Some spelling, grammar or punctuation errors ○ Units and significant figures are presented accurately throughout with occasional errors ○ Writing style moderately clear, appropriate for scientific documents and easy to follow ○ Use of simple language and vocabulary effectively but struggles to use technical language

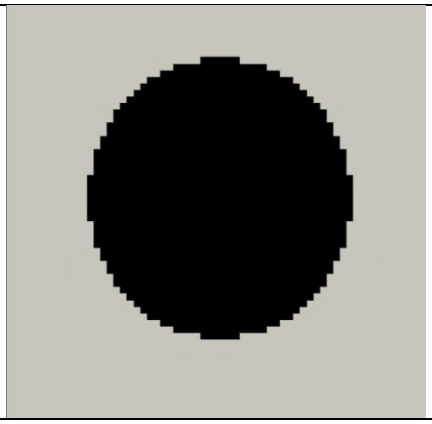
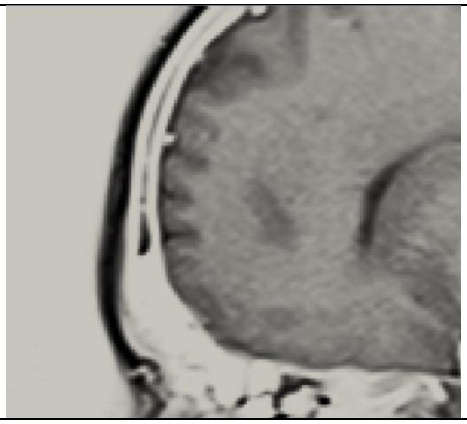
Tutorial 1 – What's in an Image?



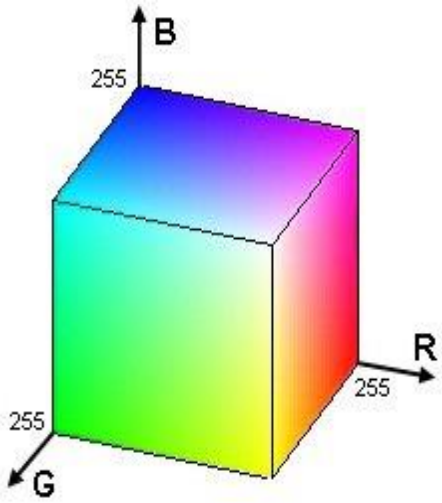
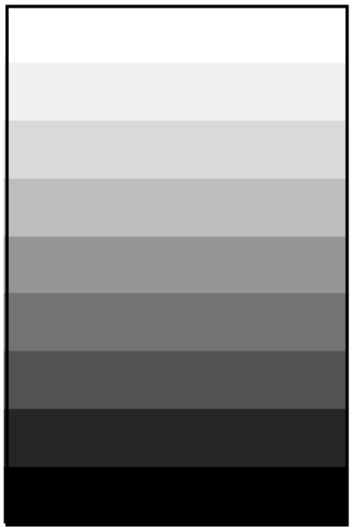
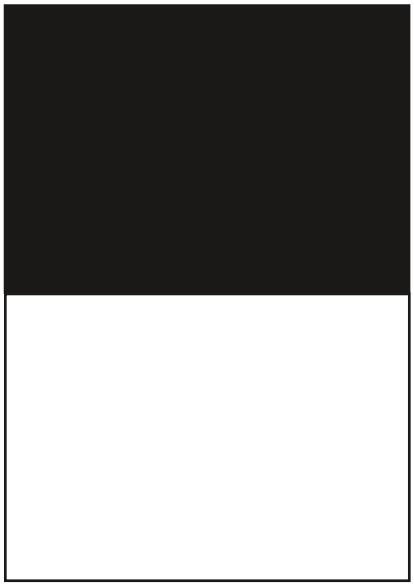
Word	Definition	Examples
Digital Image		
Resolution		
Pixel Value		
Colour Spectrum		
Edge		
Local Features		
Global Features		

Lecture 1: What is a Digital Image?

Colour Spectra – Matching Activity

[0, 1, ..., 255]	[0, 1, ..., 255] x [0, 1, ..., 255] x [0, 1, ..., 255]	{0,1}

Notes:

Classifying Images – "Top Secret!" Activity

I have two secret images on my laptop. In your pairs, decide which one of you gets to see the first image and which one will be responsible for drawing.

When I start the timer, your nominated person gets 20 seconds to look at the first secret image. That person must then describe the secret image to their partner; you have 3 minutes to produce the most accurate reproduction possible in the space below.

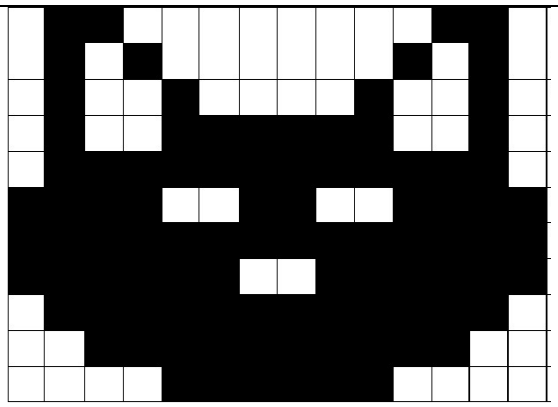
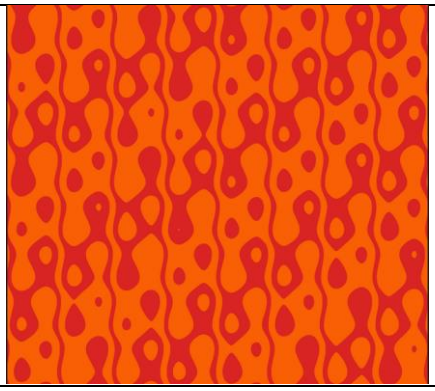
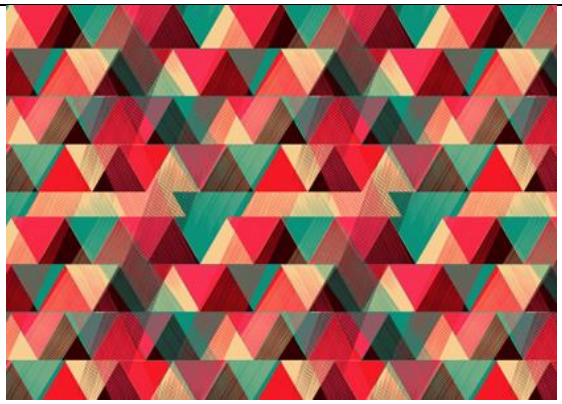
You will then swap roles and repeat the same process for the second image. The best drawings *may* win themselves a prize.

Notes:

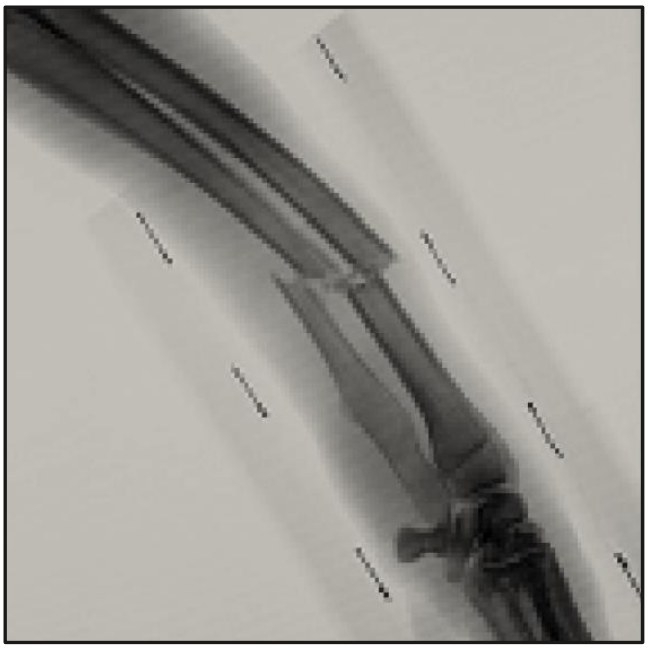
Independent Task (Complete for Homework):

Using the key words and concepts from today, briefly describe the key features of the following images.

Be sure to include their colour spectrum, any distinct recognisable global features and then any local details you feel may be relevant.

Tutorial 2 – What makes a Medical Image Special?



Word	Definition	Examples
Medical Image		
Tissue		
Background		
Discontinuity		
Noise		
Computerised Tomography		
MRI		

Starter Activity: Think – Pair – Share

Inspect the image below. Using what you learned in the previous tutorial, identify the key features of this image.

Extension: Intuitively, this image is of a medical nature; in your opinion, what are the features of the image that could identify it as such?

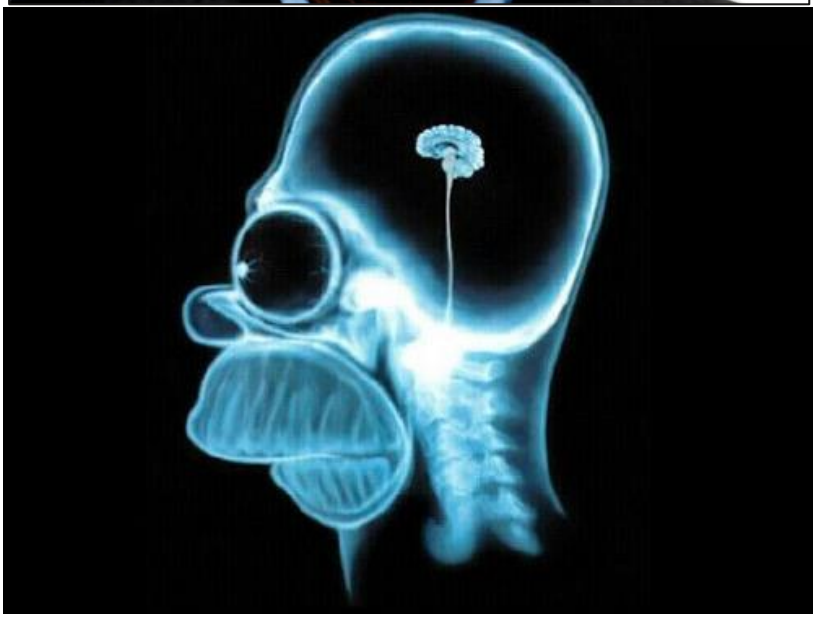
Label the image with all of the features we identify as a group.

Make notes on the opposite page from the discussion to aid you in your later tasks.

Notes:

Independent Task: Presentation

You will be assigned one of the images below. You will then be given time to prepare a short (2-3 minutes) presentation discussing the key features of the image and whether or not those features classify it as a medical image. Be prepared to answer questions.



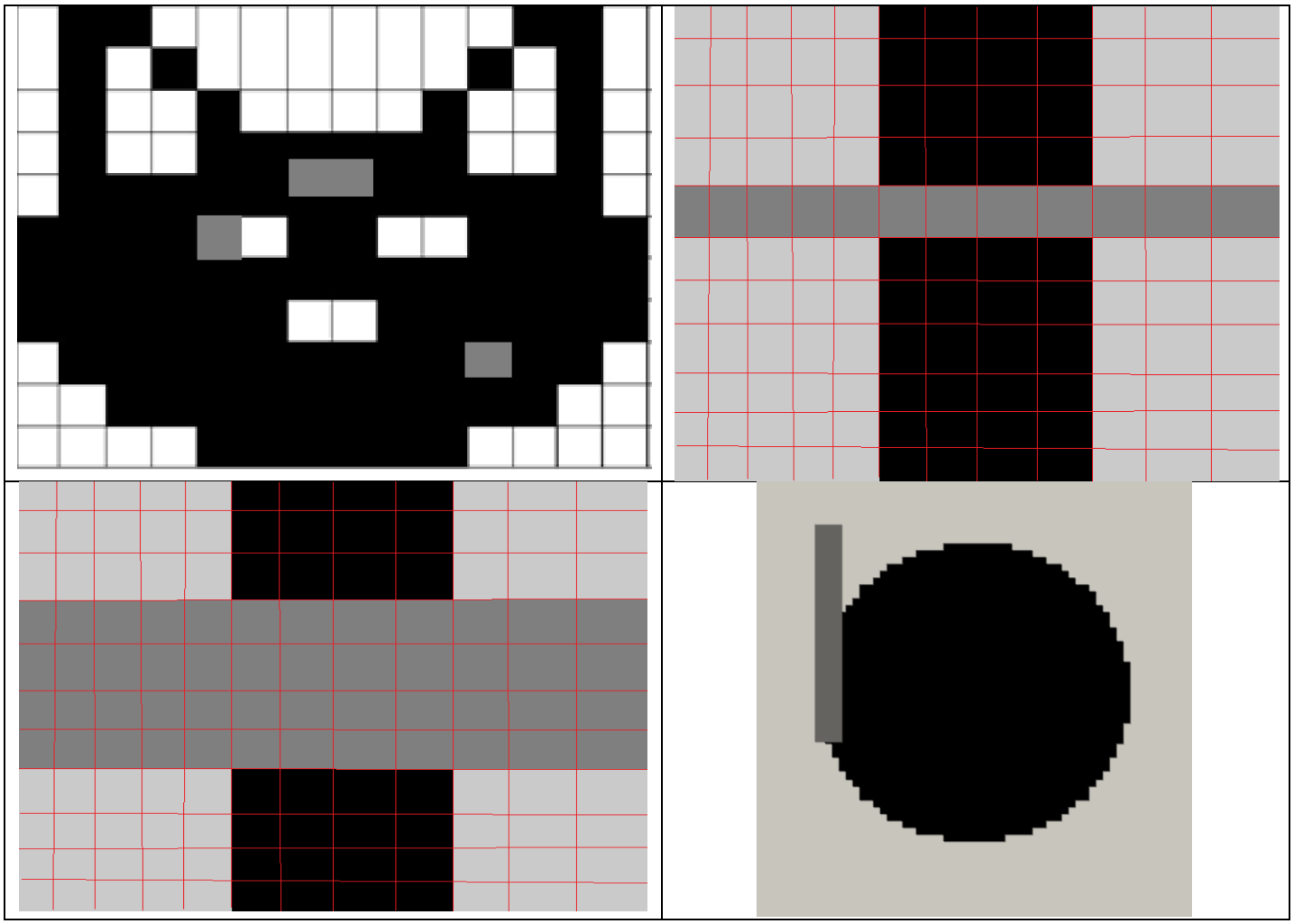
Presentation Notes:

Independent Task (Complete for Homework):

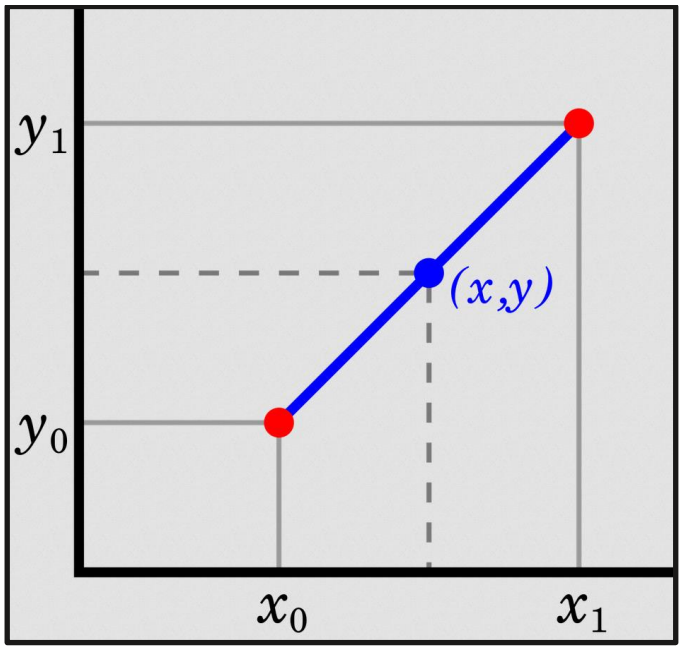
Look at the damaged images below; some of the pixel grids have been explicitly drawn to aid you in recognising the features in the image.

Using your intuition, decide how you would fill in the 'missing pixels' (the bold grey squares) with a colour that you feel is appropriate.

In the space below, write some notes on how you decided to fill in the pixels and be prepared to discuss next session.



Tutorial 3 – Core Interpolation Techniques



Word	Definition	Examples
Interpolation		
Neighbourhood		
Averaging		
Linear		
Damaged Pixel		
Contour		
Failed Interpolation		

Starter Activity: Partner Task

Review your independent task/homework from last session. With your partner, find one image where your pixels mostly agree and one where they don't agree.

Try to generalise the principles that you both used to get the same results; make use of your keywords from previous sessions and remember to think about the features in the image and how that affects your decisions.

For the pixels where you don't agree, try to establish why. There is not necessarily a correct answer depending on your individual way of thinking; what rule/process did you each use and why did this give a different result?

Be prepared to discuss with the rest of the group.

Lecture 3: Interpolation

Independent Task: Putting it into Practice

Below is a selection of pixel values for some digital images. The unknown, or damaged, pixels are left blank.

Use the techniques from today's lecture to fill in the blanks on the right and then complete the colourised image in the box on the left (hope you're good with a pencil!) for the first 3 grids. For the final grid, use a combination of techniques to fully interpolate the image.

		1	1	1	1	1	1	1
		2	2	2		1		1
1		1	1	1		1	2	1
	3					1	2	3
3	2	2	2	2		1	1	3
	3	1		2			2	3
		3	2	3	3	3	1	

Technique:_____

Calculations:

		1	1	1	1	1	1	1
		2	2	2		1		1
1		1	1	1		1	2	1
	3					1	2	3
3	2	2	2	2		1	1	3
	3	1		2			2	3
		3	2	3	3	3	1	

Technique:_____

Calculations:

		1	1	1	1	1	1	1
		2	2	2		1		1
1		1	1	1		1	2	1
	3					1	2	3
3	2	2	2	2		1	1	3
	3	1		2			2	3
		3	2	3	3	3	1	

Technique:_____

Calculations:

		1	1	1	1	1	1	1
		2	2	2		1		1
1		1	1	1		1	2	1
	3					1	2	3
3	2	2	2	2		1	1	3
	3	1		2			2	3
		3	2	3	3	3	1	

Techniques:

Calculations:

Relevant Calculations:

(The key words for tutorial have been deliberately left blank for you to add any you feel that arise during the session.)

Word	Definition	Examples

Independent Research Session

A range of materials and discussion will be provided describing ways you can alter or improve the four techniques we looked at in the previous tutorial.

Choose your favourite of the three techniques and use the materials and ideas provided to do some further research on its use and how it can be adapted.

By the end of the session you need to produce a quick reference sheet of your own detailing the original algorithm and the adaptations discussed in the provided material.

Extension: What other adaptations to your chosen technique could you make? Can you think of any examples that would immediately be useless, interesting or perhaps effective but exceptionally complicated? Add these to your reference.

Extra Practice Examples

Use the extra copies of our previous example to aid your thinking in the adaptation of the techniques if feel it is helpful. Make sure to note the main differences between the outcomes for the adapted technique and whether or not any decision making was easier or harder to make.

		1	1	1	1	1	1	1
		2	2	2		1		1
1		1	1	1		1	2	1
	3					1	2	3
3	2	2	2	2		1	1	3
	3	1		2			2	3
		3	2	3	3	3	1	

Technique:_____

Calculations:

		1	1	1	1	1	1	1
		2	2	2		1		1
1		1	1	1		1	2	1
	3					1	2	3
3	2	2	2	2		1	1	3
	3	1		2			2	3
		3	2	3	3	3	1	

Technique:_____

Calculations:

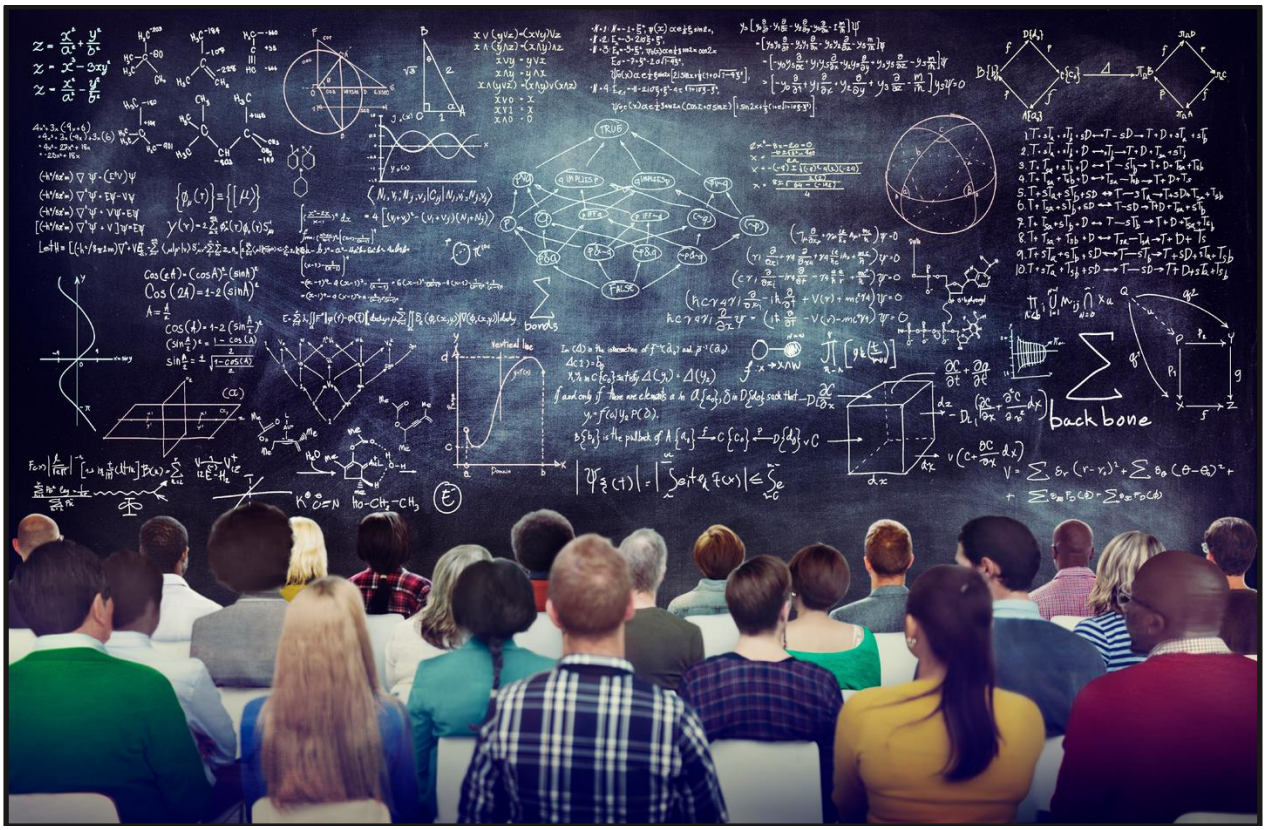
Blank Examples

Use the grids below to create your own examples to test the practicality of your chosen adapted technique. You can choose a different scaling for these examples if you wish, perhaps choosing 1-5 if you're good at shading with a pencil!

Technique:_____	Calculations:

Technique:_____	Calculations:

Tutorial 5 – Review Session, Example Critical Evaluation of Interpolation Techniques, Final Assignment



Start Activity: Pictionary

For our starter today we are going to play Pictionary! Split into two teams; Keywords and concepts from this course will be given. After five rounds, the team with the lowest total time wins!

Final Assignment

By the end of this tutorial you will have been given all of the content and tools needed to complete the final assignment for this course.

Throughout the course we have discussed interpolation techniques and their use in repairing damaged pixels in incomplete digital images. In today's tutorial we will cover explicitly how to assess the efficacy of a particular technique for a particular image or a particular class of images with certain features.

For your final assignment you have three choices of rubrik, along with three choices of question to respond to. You must complete either:

1. A 1'500 to 2'000 word essay;
2. A 20 minute presentation, which will be delivered to Mathematics teachers;
3. A conference poster (I will provide the format and guidelines for you if you wish to do this).

Your chosen format must have content in response to one of the three following challenges:

1. Compare and contrast two or more of the interpolation techniques we have studied in this course; compare their efficacy for a particular class of images.
2. Research another technique we have not covered or suggest a new technique of your own that is applicable to a particular class of image and argue its efficacy.
3. Compare a particular technique's efficacy across multiple classes of images and evaluate its use; suggest improvements or variations that should be made to the technique to make it more applicable to the individual classes.

Pay heed to the following guidance:

- You are predominantly being assessed on your ability to evaluate the use of the techniques; the mathematical complexity of the techniques themselves contributes to only a small portion of your grade;
- If you choose to suggest your own variations or introduce a new technique, you will not be assessed on the quality of the technique itself but on your ability to argue its efficacy and for providing a balanced, critical overview of its use;
- If you choose to give a presentation, you will be assessed on both the content and delivery of the presentation. You will be asked to provide printed presentation slides with the notes you used for your talk.

You will need to complete a draft outline of your chosen assignment by the next tutorial, during which you will receive guidance and feedback to make sure you are on the right track and to provide you with some more ideas to extend your work.

You will then have 2 weeks to complete the assignment for assessment. Feel free to seek additional help during that time, but remember that the earlier you seek feedback, the larger impact it will have on your work since you will have more time to respond and adapt.

If you have any questions, do not hesitate to contact me.

Good luck!

Lecture 5: Example Critical Evaluation of a Technique

Tutorial 6 – Feedback Tutorial

What is the Purpose of Tutorial 6?

- To receive feedback on final assignments.
- To share examples of best practice with the other pupils in your group.
- To write targets for improvement in school lessons.
- To reflect on the programme including what was enjoyed and what was challenging.

Final assignment feedback

What I did well…	What I could have improved on…
•	•
•	•
•	•

My target for future work is…

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?
•   •   •

What did you find challenging about the programme?	How did you overcome these challenges?
• • •	• • •

Appendix 1 – Referencing correctly

When you get to university, you will need to include references in the assignments that you write, so we would like you to start getting into the habit of referencing in your Brilliant Club assignment. This is really important, because it will help you to avoid plagiarism. Plagiarism is when you take someone else's work or ideas and pass them off as your own. Whether plagiarism is deliberate or accidental, the consequences can be severe. In order to avoid losing marks in your final assignment, or even failing, you must be careful to reference your sources correctly.

What is a reference?

A reference is just a note in your assignment which says if you have referred to or been influenced by another source such as book, website or article. For example, if you use the internet to research a particular subject, and you want to include a specific piece of information from this website, you will need to reference it.

Why should I reference?

Referencing is important in your work for the following reasons:

- It gives credit to the authors of any sources you have referred to or been influenced by.
- It supports the arguments you make in your assignments.
- It demonstrates the variety of sources you have used.
- It helps to prevent you losing marks, or failing, due to plagiarism.

When should I use a reference?

You should use a reference when you:

- Quote directly from another source.
- Summarise or rephrase another piece of work.
- Include a specific statistic or fact from a source.

How do I reference?

There are a number of different ways of referencing, and these often vary depending on what subject you are studying. The most important to thing is to be consistent. This means that you need to stick to the same system throughout your whole assignment. Here is a basic system of referencing that you can use, which consists of the following two parts:

1. **A marker in your assignment**: After you have used a reference in your assignment (you have read something and included it in your work as a quote, or re-written it your own words) you should mark this is in your text with a number, e.g. [1]. The next time you use a reference you should use the next number, e.g. [2].
2. **Bibliography**: This is just a list of the references you have used in your assignment. In the bibliography, you list your references by the numbers you have used, and include as much information as you have about the reference. The list below gives what should be included for different sources.

    a. **Websites** – Author (if possible), title of the web page, website address, [date you accessed it, in square brackets].

    E.g. Dan Snow, 'How did so many soldiers survive the trenches?', http://www.bbc.co.uk/guides/z3kgjxs#zg2dtfr [11 July 2014].

    b. **Books** – Author, date published, title of book (in italics), pages where the information came from.

    E.g. S. Dubner and S. Levitt, (2006) *Freakonomics*, 7-9.

    c. **Articles** – Author, 'title of the article' (with quotation marks), *where the article comes from* (newspaper, journal etc.), date of the article.

    E.g. Maev Kennedy, 'The lights to go out across the UK to mark First World War's centenary', Guardian, 10 July 2014.

Appendix 2 – Using the VLE

VLE username	
VLE password	

Please remember the following key details…

- You are able log into the VLE either through the link on our website (www.thebrilliantclub.org) or going directly to the VLE site at (https://portal.thebrilliantclub.org/sign-in).
- Please update your profile with your full name and email address- this will allow you to retrieve forgotten passwords or usernames
- If you forget your log-in details you can request them to be emailed to you by clicking the link on the VLE home page. (If you are still having problems you can email: schools@thebrilliantclub.org)

What is the VLE?

The VLE is a virtual learning environment for all pupils on Uni Pathways it is used for:

- messaging your tutor
- submitting homework
- submitting your final assignment
- accessing resources for your tutorials
- finding out more information about university and careers

How should I use the VLE?

The VLE is a professional academic environment in which pupils are able to message their PhD Tutor. Here are a few things to consider:

- Ensure you keep a professional tone in the messages you send to your tutors.
- Ensure you always reply to your tutors in a timely manner.
- Thank your tutor for the effort they are putting in to give you your feedback etc.
- Submit all homework to your tutor on time.

IMPORTANT: Final assignment

- When you submit your final assignment, please remember that you need to do so through the 'My Activities' tab and not as an attachment to a message.

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UNI PATHWAYS

Course Title

Key Stage 4 Programme

researchersinschools.org