GK-12 Lesson Plan

Teacher:
Period: **Class:**
Date(s):

SETTING THE STAGE	
Essential Question	How can we compress an image file?
Content Objective(s) (Student-friendly)	We will learn how a transform of a set of points into a series of cosines can compress an image and what effects this may have, if any.
Connection to previous or future lessons	This is the first lesson.
Critical Thinking Questions	Do we lose any data by performing this transform? What happens to an image when coefficients are removed? How is this represented in terms of the series of cosines?
Key Vocabulary	Discrete Cosine Transform, compression, jpg, transform
Materials Needed/Safety	DCT1.pdf
ACTIVE INSTRUCTION	
• Launch (Engage)	With modern day cameras the file sizes of pictures taken may be so large that saving hundreds or thousands of them costs far too much disk space. How can we compress an image so that it occupies less space?
• Investigation (Explore)	Explore what a picture looks like (Numbers on a grayscale). DCT illustration. DCT illustration with entropy encoding. Stop for questions. Show progression of an image as more coefficients are removed from the DCT.
TIME FOR REFLECTION	
• Summarization (Explain & Extend)	What happened to the picture as more coefficients were removed? How can this be explained in terms of the series of cosines?
• Assessment (Evaluate)	Their questions and responses to open questions during the presentation be enough of an evaluation.
• Homework	Five minutes researching the DCT.

*This template is available in electronic form.

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Teacher:

As this lesson plan was only an introduction it was fairly straightforward. The students had to do no computations and it was an open presentation where students could ask questions at any time. The students were highly engaged and very interested in picking apart the pictures and explaining what happened. As soon as they heard this was about making a jpeg they all became incredibly interested. One student made a connection between this and file format settings on a camera and a discussion on that was had. The connection between analog and digital was also very intriguing for them. Went as planned.

Discrete Cosine Transform

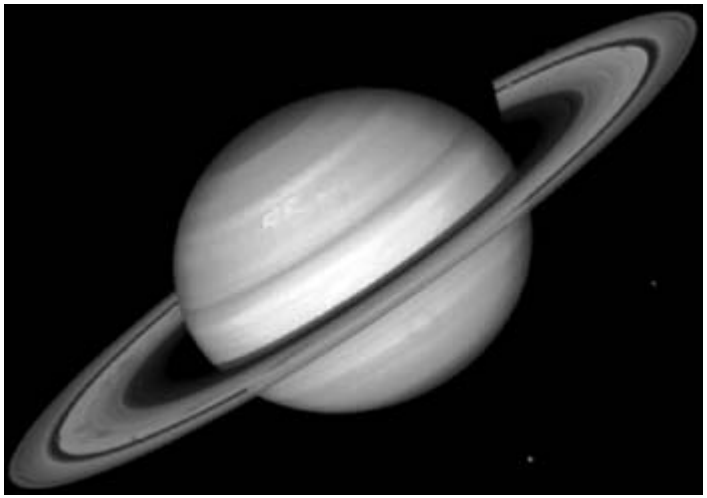
What is the Discrete Cosine Transform?

- Discrete – separate, countable, non-continuous
- Cosine – you know this
- Transform – Represents a set of data X in a different form without inherent loss

- Thus the DCT is a way to represent a series of points as a series of cosine waves

Motivation

- Say we have a picture:



- To represent this picture on this computer, each pixel must be represented by a number that contains the value of the gray scale for that pixel.

Motivation (Cont'd)

- iPhone 5 = 6 megapixel camera = 6291456 pixels (Roughly six million). That's a 3000x2000 pixel picture.

- Raw file size can be upwards of 9 MB.

- How can we reduce the information needed to contain the picture?

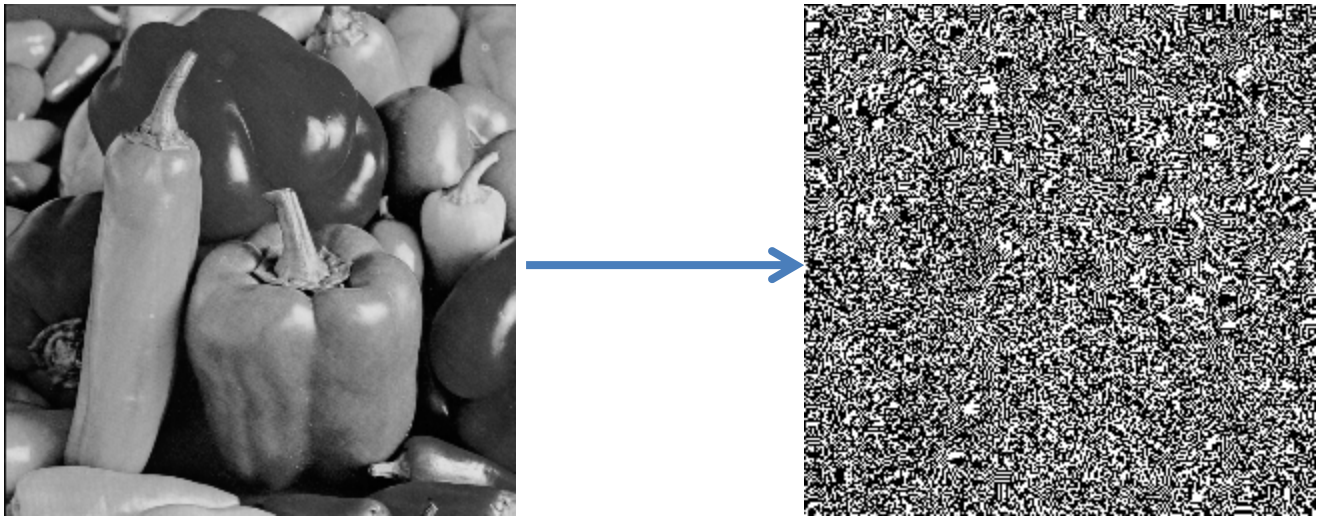
Continuous and Discrete

- What is the difference?

Picture Representation

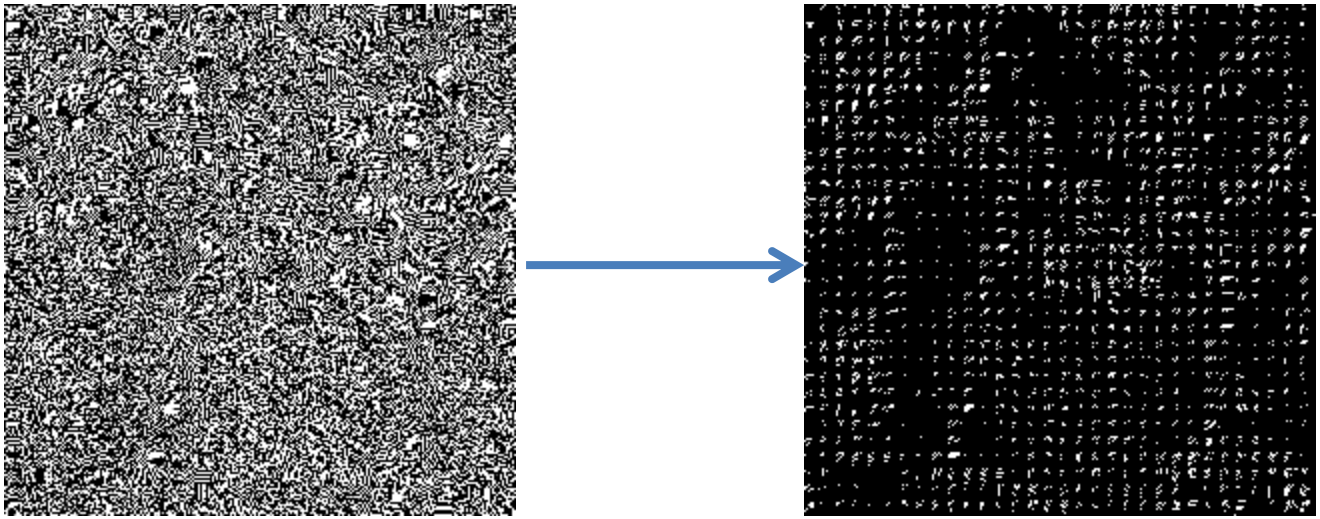
13	113	117	247	188	126	76	160
20	87	222	170	176	209	13	188
164	81	239	222	89	118	177	96
49	94	68	3	43	117	166	3
216	101	41	35	40	115	251	108
45	151	223	209	49	106	141	193
44	31	61	110	108	230	103	203
254	10	165	228	219	2	51	235

DCT Illustration



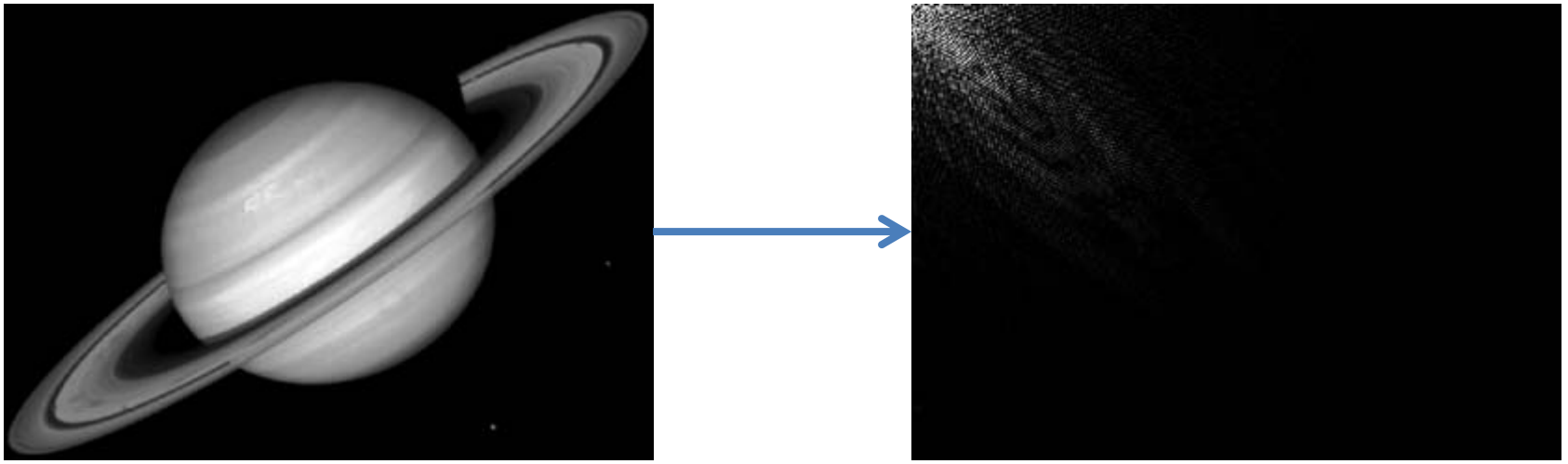
http://online.redwoods.cc.ca.us/instruct/darnold/laproj/fall98/pken/dct.pdf

DCT Illustration



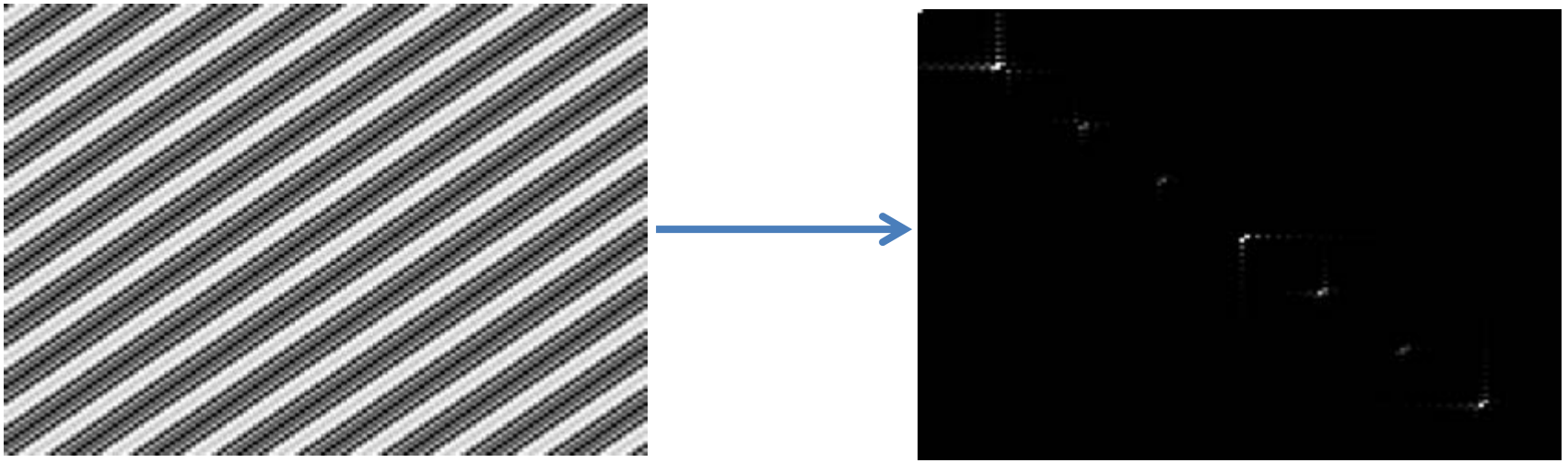
http://online.redwoods.cc.ca.us/instruct/darnold/laproj/fall98/pken/dct.pdf

DCT Illustration



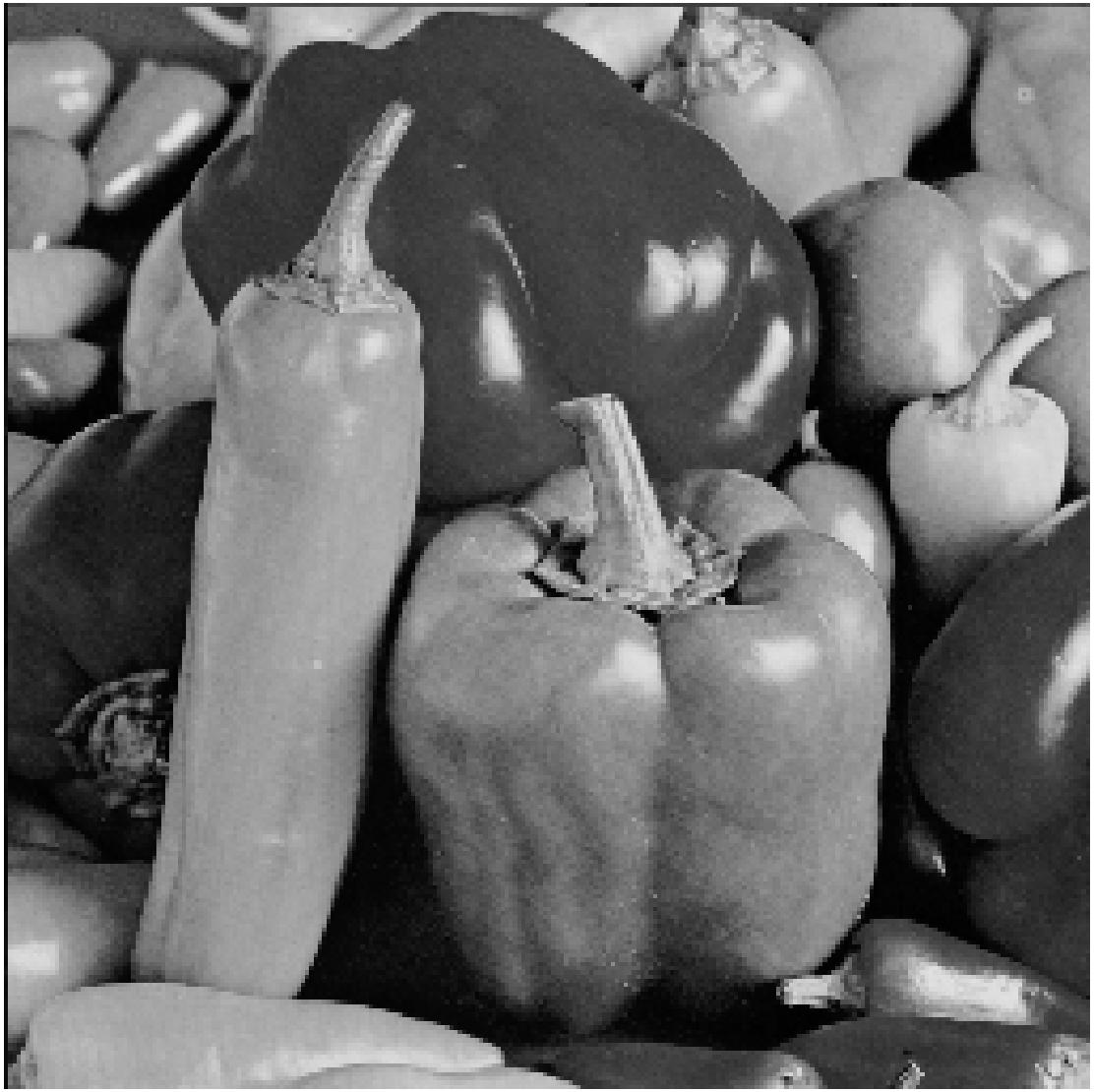
http://www.dcd.zju.edu.cn/~jun/Courses/Multimedia2011.../complementary/DCT_Theory%20and%20Application.pdf

DCT Illustration

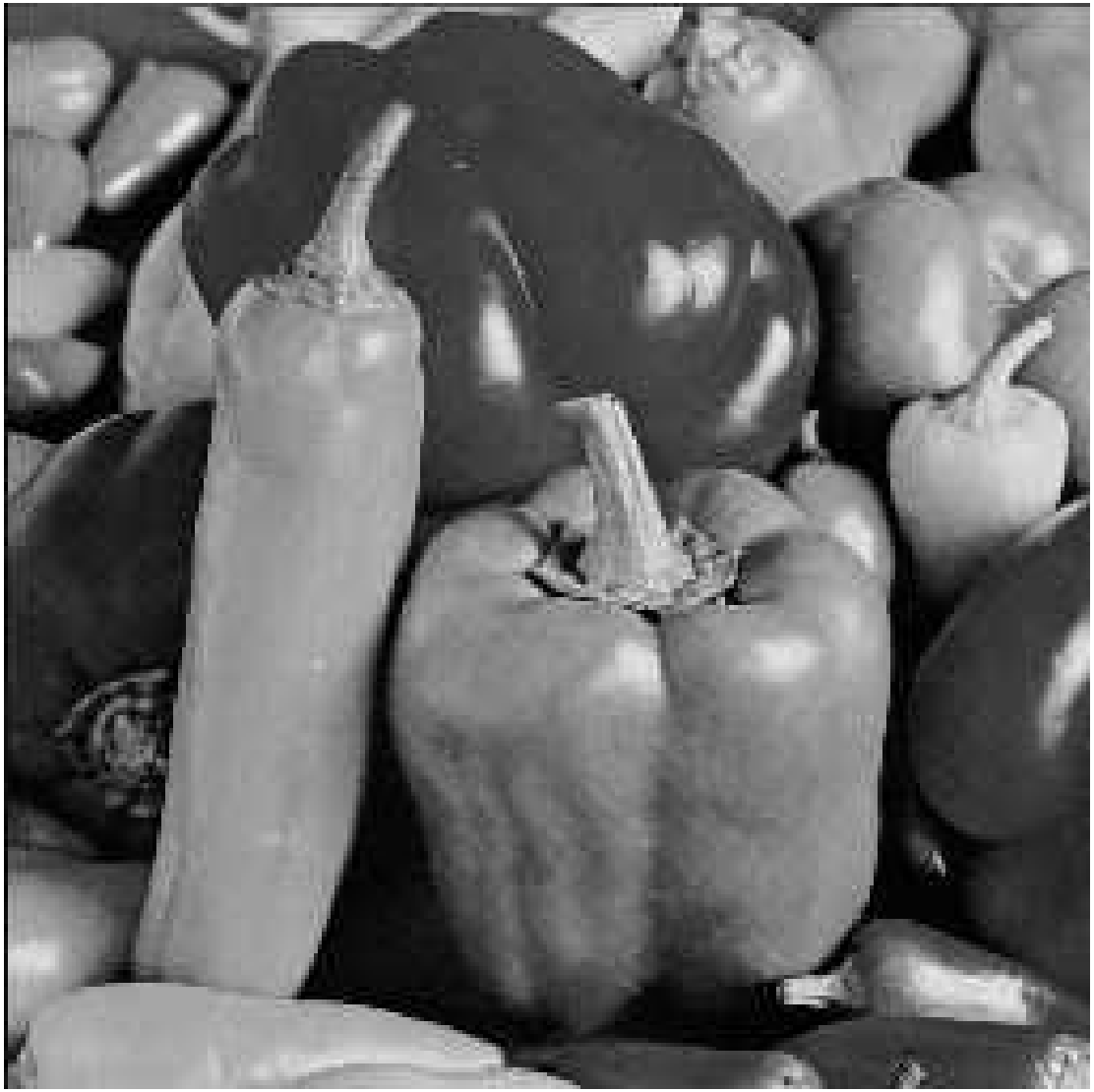


http://www.dcd.zju.edu.cn/~jun/Courses/Multimedia2011.../complementary/DCT_Theory%20and%20Application.pdf

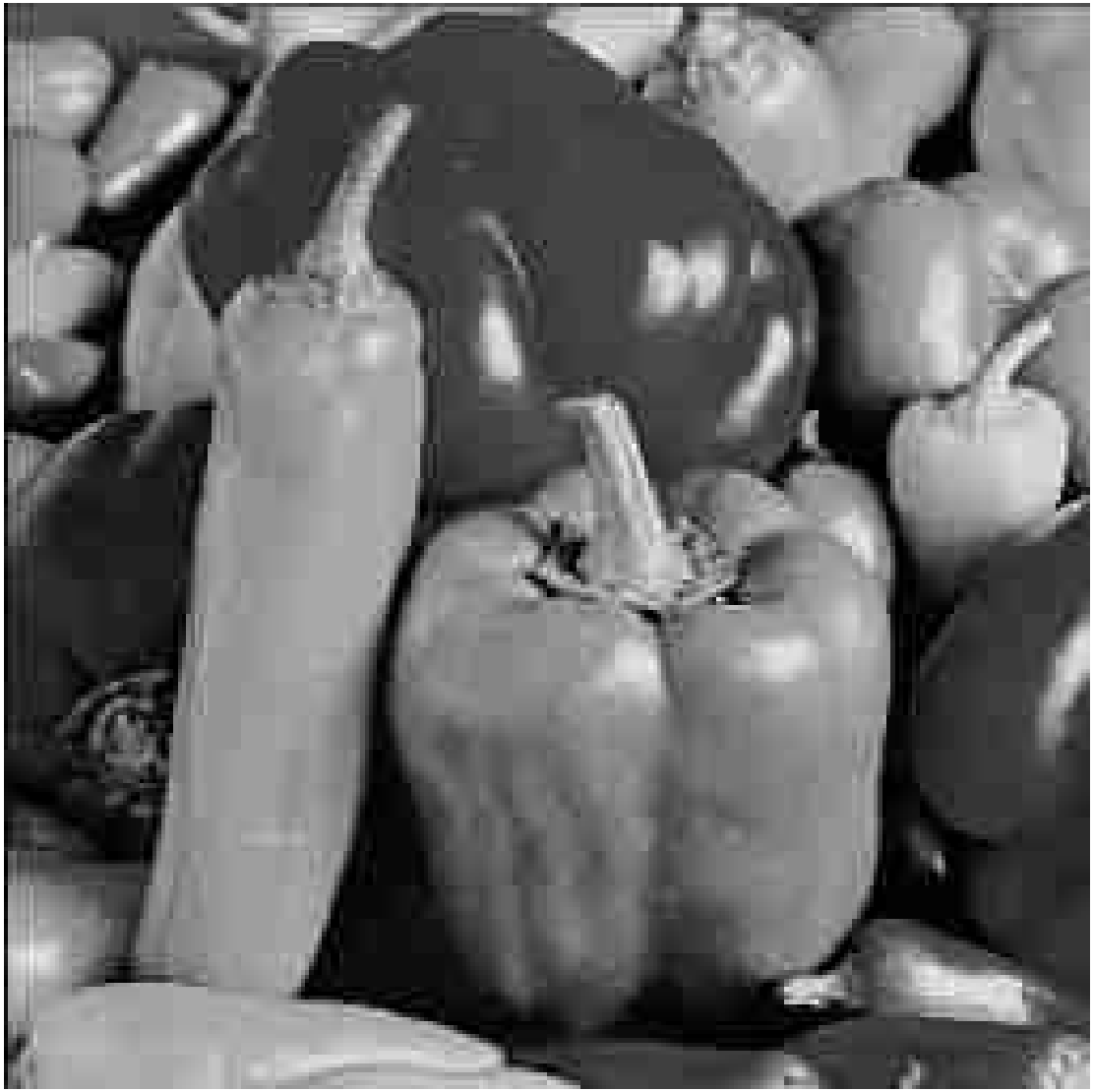
DCT Compression (Original)



DCT Compression (84% zeros)

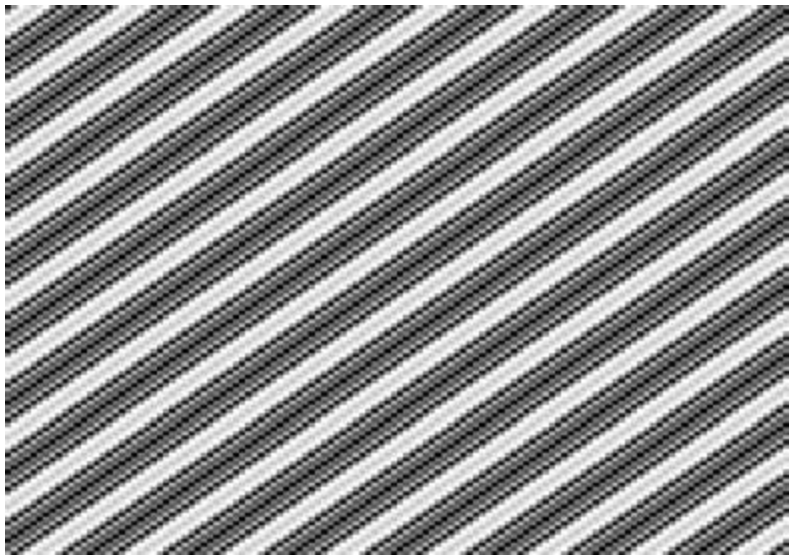


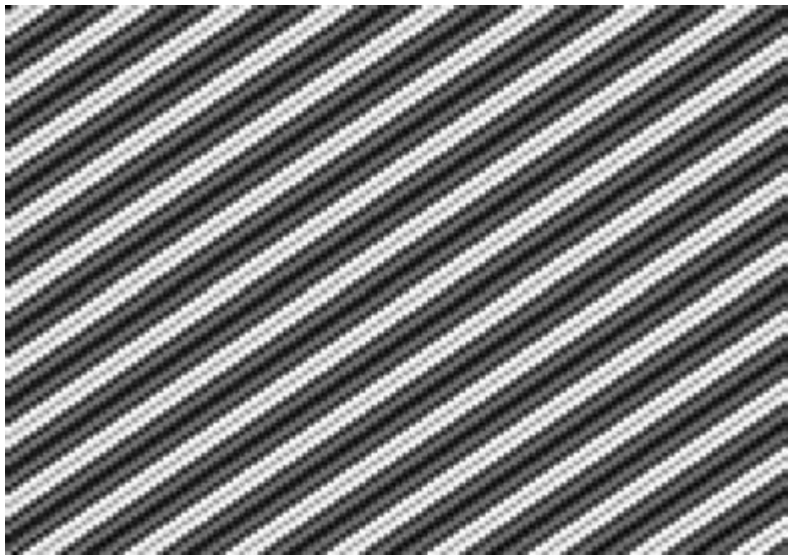
DCT Compression (91% zeros)

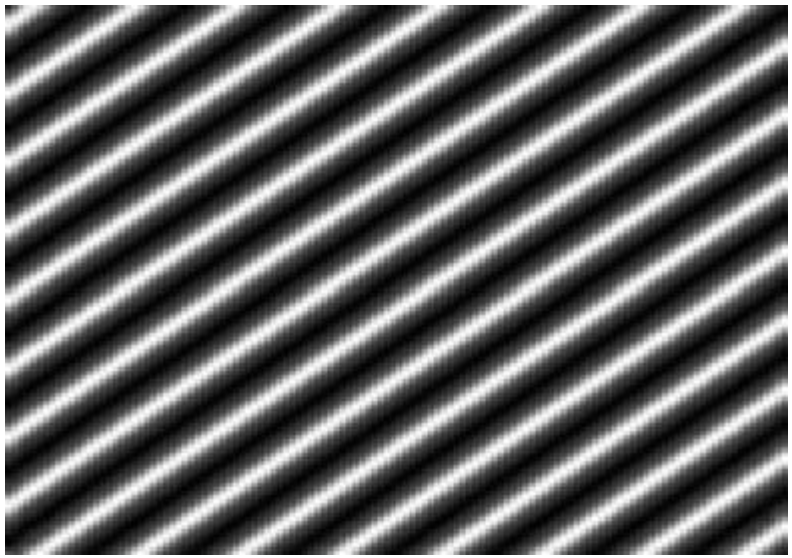


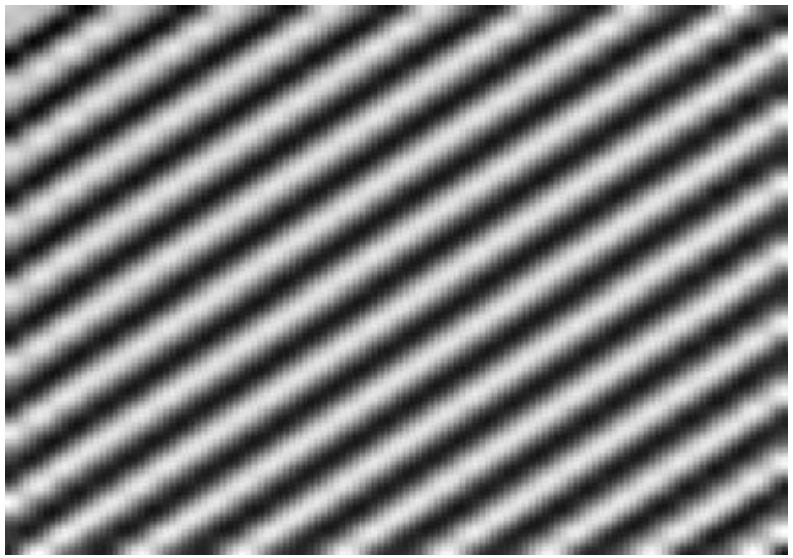
DCT Compression (94% zeros)

DCT Compression









Recap

- 1. Break image into values from 0-255 (Black to white)
- 2. Use DCT on 8x8 chunks at a time
- 3. Remove coefficients to save space (This will be covered more later)
- 4. Bam, .jpg! (…of sorts)

For Next Time

- How does the Discrete Cosine Transform work?
- Take five minutes, research it (Google is your friend. I recommend wikipedia), and see if you can understand the concept.
- Our final goal will be performing the DCT in Matlab or your graphing calculators to compress an actual image.