

Homework 3

Nick Snyder

1.

Medicine: Medical Imaging, Image Enhancement, Computer-Aided Diagnosis, Image Registration, Endoscopy/Microscopy

Astronomy: Telescope Image Enhancement, Object Detection, Image Stitching, Deblurring, Comet/Asteroid Tracking.

Sports: Player Tracking, Biomechanics, Referee Decision Support, Performance Analysis, Virtual Environments/Stadiums

Music: Music Score Recognition, Audio Visualization, Automatic Music Transcription, Music Video Effects, Gesture-Controlled Instruments

Agriculture: Crop Monitoring, Weed Detection, Irrigation Management, Livestock Tracking, Disease Detection

Travel: Tourism Promotion, Augmented Reality, Navigation, Language Translation, Image-Based Search

2.

```
imshow('text.png')
```

The term watershed
refers to a ridge that ...

... divides areas
drained by different
river systems.

```
imfinfo('text.png')
```

```
ans = struct with fields:  
    Filename: 'C:\Program Files\MATLAB\R2022a\toolbox\images\imdata\text.png'  
    FileModDate: '13-Oct-2002 08:48:21'  
    FileSize: 1322
```

```
    Format: 'png'
FormatVersion: []
    Width: 256
    Height: 256
    BitDepth: 1
    ColorType: 'grayscale'
FormatSignature: [137 80 78 71 13 10 26 10]
    Colormap: []
    Histogram: []
    InterlaceType: 'none'
    Transparency: 'none'
SimpleTransparencyData: []
    BackgroundColor: []
RenderingIntent: []
    Chromaticities: []
        Gamma: []
    XResolution: []
    YResolution: []
ResolutionUnit: []
    XOffset: []
    YOffset: []
    OffsetUnit: []
SignificantBits: []
ImageModTime: '19 Jun 2002 14:04:02 +0000'
    Title: []
    Author: []
    Description: []
    Copyright: 'Copyright The MathWorks, Inc.'
CreationTime: []
    Software: []
Disclaimer: []
    Warning: []
    Source: []
    Comment: []
OtherText: []
```

Type:

Height:

Width:

Total:

Description:

```
% imshow('')
% imfinfo('')
```

Type: True Color

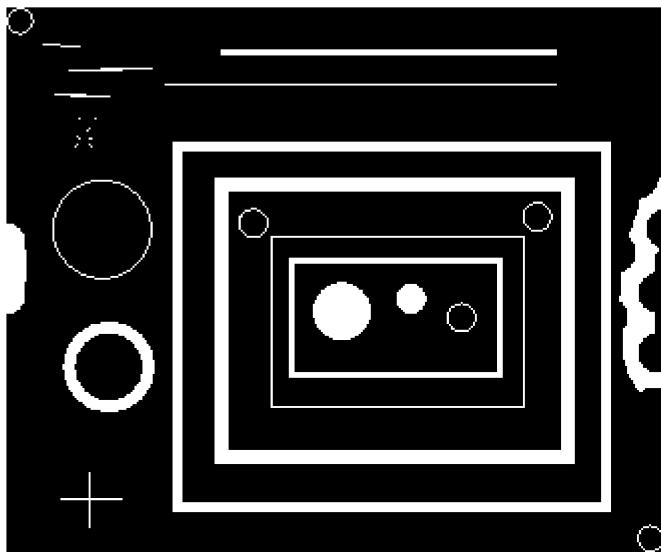
Height: 2336

Width: 3504

Total: 4950495

Description: An old abandoned car parked in dirt

```
imshow('blobs.png')
```



```
imfinfo('blobs.png')
```

```
ans = struct with fields:
    Filename: 'C:\Program Files\MATLAB\R2022a\toolbox\images\imdata\blobs.png'
    FileModDate: '18-Nov-2002 16:13:30'
    FileSize: 1094
    Format: 'png'
    FormatVersion: []
    Width: 329
    Height: 272
    BitDepth: 1
    ColorType: 'grayscale'
    FormatSignature: [137 80 78 71 13 10 26 10]
    Colormap: []
    Histogram: []
    InterlaceType: 'none'
    Transparency: 'none'
    SimpleTransparencyData: []
    BackgroundColor: []
    RenderingIntent: []
    Chromaticities: []
        Gamma: []
    XResolution: []
    YResolution: []
    ResolutionUnit: []
        XOffset: []
        YOffset: []
    OffsetUnit: []
    SignificantBits: []
    ImageModTime: '13 Nov 2002 20:21:22 +0000'
        Title: []
        Author: []
    Description: []
        Copyright: 'Copyright The Mathworks, Inc.'
    CreationTime: []
    Software: []
    Disclaimer: []
```

```
Warning: []
Source: []
Comment: []
OtherText: []
```

Type: Grayscale

Height: 272

Width: 329

Total: 1094

Description: Seemingly random shapes

```
imshow('kobi.png')
```



```
imfinfo('kobi.png')
```

```
ans = struct with fields:
    Filename: 'C:\Program Files\MATLAB\R2022a\toolbox\images\imdata\kobi.png'
    FileModDate: '10-Apr-2015 08:04:28'
    FileSize: 2446773
    Format: 'png'
```

```
FormatVersion: []
    Width: 1632
    Height: 1224
    BitDepth: 24
    ColorType: 'truecolor'
FormatSignature: [137 80 78 71 13 10 26 10]
    Colormap: []
    Histogram: []
InterlaceType: 'none'
Transparency: 'none'
SimpleTransparencyData: []
BackgroundColor: []
RenderingIntent: []
Chromaticities: []
    Gamma: []
    XResolution: []
    YResolution: []
ResolutionUnit: []
    XOffset: []
    YOffset: []
    OffsetUnit: []
SignificantBits: []
ImageModTime: '10 Apr 2015 12:04:28 +0000'
    Title: []
    Author: []
Description: 'Kobi: Labrador Retreiver, age 4 years.'
    Copyright: 'Alex Taylor'
CreationTime: []
    Software: []
Disclaimer: []
    Warning: []
    Source: []
    Comment: []
OtherText: []
```

Type: True Color

Height: 1224

Width: 1632

Total: 2446773

Description: Obiedent dog

```
imshow('m83.tif')
```



```
imfinfo('m83.tif')
```

```
ans = struct with fields:
    Filename: 'C:\Program Files\MATLAB\R2022a\toolbox\images\imdata\m83.tif'
    FileModDate: '13-Apr-2015 09:23:13'
    FileSize: 150389
    Format: 'tif'
    FormatVersion: []
        Width: 400
        Height: 378
        BitDepth: 8
        ColorType: 'indexed'
    FormatSignature: [73 73 42 0]
        ByteOrder: 'little-endian'
    NewSubFileType: 0
        BitsPerSample: 8
        Compression: 'PackBits'
    PhotometricInterpretation: 'RGB Palette'
        StripOffsets: [8 7599 15124 22669 30307 37990 45778 53544 61449 69365 77318 85292 93254 101142 1090
    SamplesPerPixel: 1
        RowsPerStrip: 20
    StripByteCounts: [7591 7525 7545 7638 7683 7788 7766 7905 7916 7953 7974 7962 7888 7889 7768 7777 767
        XResolution: 72
        YResolution: 72
    ResolutionUnit: 'Inch'
        Colormap: [256x3 double]
    PlanarConfiguration: 'Chunky'
        TileWidth: []
        TileLength: []
```

```

    TileOffsets: []
    TileByteCounts: []
    Orientation: 1
    FillOrder: 1
    GrayResponseUnit: 0.0100
    MaxSampleValue: 255
    MinSampleValue: 0
    Thresholding: 1
    Offset: 148392
ImageDescription: 'M83 spiral galaxy astronomical image courtesy of Anglo-Australian Observatory, photo'

```

Type: Indexed

Height: 378

Width: 400

Total: 150389

Description: Spiral Galaxy

3.

```

r = imread('rice256.tif');
imfinfo('rice256.tif')

ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\rice256.tif'
    FileModDate: '26-Feb-2024 21:32:13'
    FileSize: 3914
    Format: 'png'
    FormatVersion: []
        Width: 512
        Height: 512
        BitDepth: 1
        ColorType: 'grayscale'
    FormatsSignature: [137 80 78 71 13 10 26 10]
        Colormap: []
        Histogram: []
    InterlaceType: 'none'
    Transparency: 'none'
SimpleTransparencyData: []
BackgroundColor: []
RenderingIntent: []
Chromaticities: []
    Gamma: []
    XResolution: []
    YResolution: []
ResolutionUnit: []
    XOffset: []
    YOffset: []
    OffsetUnit: []
SignificantBits: []
    ImageModTime: '27 Feb 2024 02:32:13 +0000'
        Title: []
        Author: []
    Description: []
    Copyright: []
CreationTime: []
    Software: []
Disclaimer: []

```

```

    Warning: []
    Source: []
    Comment: []
    OtherText: []

imwrite(r, 'rice256.jpg', 'jpg');
imfinfo('rice256.jpg')

ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\rice256.jpg'
    FileModDate: '26-Feb-2024 23:20:51'
    FileSize: 25989
    Format: 'jpg'
    FormatVersion: ''
    Width: 512
    Height: 512
    BitDepth: 8
    ColorType: 'grayscale'
    FormatSignature: ''
    NumberOfSamples: 1
    CodingMethod: 'Huffman'
    CodingProcess: 'Sequential'
    Comment: {}

imwrite(b, 'rice256.png', 'png');
imfinfo('rice256.png')

ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\rice256.png'
    FileModDate: '26-Feb-2024 23:20:51'
    FileSize: 3914
    Format: 'png'
    FormatVersion: []
    Width: 512
    Height: 512
    BitDepth: 1
    ColorType: 'grayscale'
    FormatSignature: [137 80 78 71 13 10 26 10]
    Colormap: []
    Histogram: []
    InterlaceType: 'none'
    Transparency: 'none'
    SimpleTransparencyData: []
    BackgroundColor: []
    RenderingIntent: []
    Chromaticities: []
        Gamma: []
    XResolution: []
    YResolution: []
    ResolutionUnit: []
        XOffset: []
        YOffset: []
    OffsetUnit: []
    SignificantBits: []
    ImageModTime: '27 Feb 2024 04:20:51 +0000'
        Title: []
        Author: []
    Description: []
    Copyright: []
    CreationTime: []
    Software: []
    Disclaimer: []

```

```

Warning: []
Source: []
Comment: []
OtherText: []

imwrite(b, 'rice256.bmp', 'bmp');
imfinfo('rice256.bmp')

ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\rice256.bmp'
    FileModDate: '26-Feb-2024 23:20:51'
    FileSize: 32830
    Format: 'bmp'
    FormatVersion: 'Version 3 (Microsoft Windows 3.x)'
    Width: 512
    Height: 512
    BitDepth: 1
    ColorType: 'indexed'
    FormatSignature: 'BM'
    NumColormapEntries: 2
        Colormap: [2x3 double]
        RedMask: []
        GreenMask: []
        BlueMask: []
    ImageDataOffset: 62
    BitmapHeaderSize: 40
        NumPlanes: 1
    CompressionType: 'none'
        BitmapSize: 32768
    HorzResolution: 0
    VertResolution: 0
    NumColorsUsed: 2
    NumImportantColors: 0

```

The sizes are as ordered: 3914 (.tif), 25985 (.jpg), 3914 (.png), 32830 (.bmp)

4.

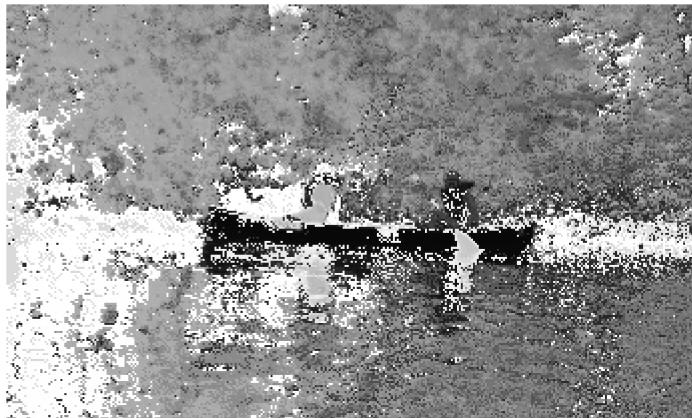
Binary

Indexed Color

```

c = imread('canoe.tif');
imshow(c)

```



```
imfinfo('canoe.tif')
```

```
ans = struct with fields:
    Filename: 'C:\Program Files\MATLAB\R2022a\toolbox\images\imdata\canoe.tif'
    FileModDate: '13-Apr-2015 09:23:12'
    FileSize: 71548
    Format: 'tif'
    FormatVersion: []
        Width: 346
        Height: 207
        BitDepth: 8
        ColorType: 'indexed'
    FormatSignature: [73 73 42 0]
        ByteOrder: 'little-endian'
    NewSubFileType: 0
    BitsPerSample: 8
        Compression: 'PackBits'
    PhotometricInterpretation: 'RGB Palette'
        StripOffsets: [8 7986 15905 23749 31644 38954 45750 53036 60499]
    SamplesPerPixel: 1
        RowsPerStrip: 23
    StripByteCounts: [7978 7919 7844 7895 7310 6796 7286 7463 7410]
        XResolution: 72
        YResolution: 72
    ResolutionUnit: 'Inch'
        Colormap: [256x3 double]
    PlanarConfiguration: 'Chunky'
        TileWidth: []
        TileLength: []
        TileOffsets: []
    TileByteCounts: []
    Orientation: 1
        FillOrder: 1
    GrayResponseUnit: 0.0100
    MaxSampleValue: 255
    MinSampleValue: 0
        Thresholding: 1
        Offset: 69708
    ImageDescription: 'Copyright The MathWorks, Inc.'
```

```
imwrite(c, 'canoe.jpg', 'jpg');
```

```
imfinfo('canoe.jpg')
```

```
ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\canoe.jpg'
    FileModDate: '26-Feb-2024 23:37:27'
    FileSize: 28774
    Format: 'jpg'
    FormatVersion: ''
    Width: 346
    Height: 207
    BitDepth: 8
    ColorType: 'grayscale'
    FormatSignature: ''
    NumberOfSamples: 1
    CodingMethod: 'Huffman'
    CodingProcess: 'Sequential'
    Comment: {}
```

```
imwrite(c, 'canoe.png', 'png');
imfinfo('canoe.png')
```

```
ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\canoe.png'
    FileModDate: '26-Feb-2024 23:37:27'
    FileSize: 54429
    Format: 'png'
    FormatVersion: []
    Width: 346
    Height: 207
    BitDepth: 8
    ColorType: 'grayscale'
    FormatSignature: [137 80 78 71 13 10 26 10]
    Colormap: []
    Histogram: []
    InterlaceType: 'none'
    Transparency: 'none'
    SimpleTransparencyData: []
    BackgroundColor: []
    RenderingIntent: []
    Chromaticities: []
        Gamma: []
    XResolution: []
    YResolution: []
    ResolutionUnit: []
        XOffset: []
        YOffset: []
    OffsetUnit: []
    SignificantBits: []
    ImageModTime: '27 Feb 2024 04:37:27 +0000'
        Title: []
        Author: []
        Description: []
        Copyright: []
    CreationTime: []
        Software: []
        Disclaimer: []
        Warning: []
        Source: []
        Comment: []
    OtherText: []
```

```
imwrite(c, 'canoe.bmp', 'bmp');
imfinfo('canoe.bmp')
```

```
ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\canoe.bmp'
    FileModDate: '26-Feb-2024 23:37:27'
    FileSize: 73114
    Format: 'bmp'
    FormatVersion: 'Version 3 (Microsoft Windows 3.x)'
    Width: 346
    Height: 207
    BitDepth: 8
    ColorType: 'indexed'
    FormatSignature: 'BM'
    NumColormapEntries: 256
        Colormap: [256x3 double]
        RedMask: []
        GreenMask: []
        BlueMask: []
    ImageDataOffset: 1078
    BitmapHeaderSize: 40
        NumPlanes: 1
    CompressionType: 'none'
        BitmapSize: 72036
    HorzResolution: 0
    VertResolution: 0
    NumColorsUsed: 256
    NumImportantColors: 0
```

True Color

```
a = imread('autumn.tif');
imshow('autumn.tif')
```



```
imfinfo('autumn.tif')
```

```
ans = struct with fields:
    Filename: 'C:\Program Files\MATLAB\R2022a\toolbox\images\imdata\autumn.tif'
    FileModDate: '13-Apr-2015 09:23:12'
    FileSize: 214108
    Format: 'tif'
    FormatVersion: []
    Width: 345
```

```
imwrite(a, 'autumn.jpg', 'jpg');  
imfinfo('autumn.jpg')
```

```
ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\autumn.jpg'
    FileModDate: '26-Feb-2024 23:37:27'
    FileSize: 12736
    Format: 'jpg'
    FormatVersion: ''
        Width: 345
        Height: 206
        BitDepth: 24
    ColorType: 'truecolor'
    FormatSignature: ''
    NumberOfSamples: 3
        CodingMethod: 'Huffman'
        CodingProcess: 'Sequential'
        Comment: {}
```

```
imwrite(a, 'autumn.png', 'png');  
imfinfo('autumn.png')
```

```
ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\autumn.png'
    FileModDate: '26-Feb-2024 23:37:27'
    FileSize: 118786
    Format: 'png'
    FormatVersion: []
    Width: 345
    Height: 206
    BitDepth: 24
```

```

    ColorType: 'truecolor'
FormatSignature: [137 80 78 71 13 10 26 10]
    Colormap: []
    Histogram: []
InterlaceType: 'none'
Transparency: 'none'
SimpleTransparencyData: []
    BackgroundColor: []
RenderingIntent: []
    Chromaticities: []
        Gamma: []
    XResolution: []
    YResolution: []
ResolutionUnit: []
    XOffset: []
    YOffset: []
    OffsetUnit: []
SignificantBits: []
ImageModTime: '27 Feb 2024 04:37:27 +0000'
    Title: []
    Author: []
Description: []
    Copyright: []
CreationTime: []
    Software: []
Disclaimer: []
    Warning: []
    Source: []
    Comment: []
OtherText: []

```

```

imwrite(a, 'autumn.bmp', 'bmp');
imfinfo('autumn.bmp')

```

```

ans = struct with fields:
    Filename: 'C:\Users\no_kn\Documents\unh\coursework\ece717\hw3\autumn.bmp'
    FileModDate: '26-Feb-2024 23:37:27'
    FileSize: 213470
    Format: 'bmp'
    FormatVersion: 'Version 3 (Microsoft Windows 3.x)'
        Width: 345
        Height: 206
        BitDepth: 24
        ColorType: 'truecolor'
    FormatSignature: 'BM'
    NumColormapEntries: 0
        Colormap: []
        RedMask: []
        GreenMask: []
        BlueMask: []
    ImageDataOffset: 54
    BitmapHeaderSize: 40
        NumPlanes: 1
    CompressionType: 'none'
        BitmapSize: 213416
    HorzResolution: 0
    VertResolution: 0
    NumColorsUsed: 0
NumImportantColors: 0

```

```
% A. 2 x 2, 2 * 2 = 4, 2^4 = 16. 16 possible images
% B.

B = zeros(2, 2);
for i = 0:1
    for j = 0:1
        for k = 0:1
            for l = 0:1
                B = [i j; k l]
            end
        end
    end
end
```

```
B = 2x2
 0  0
 0  0
B = 2x2
 0  0
 0  1
B = 2x2
 0  0
 1  0
B = 2x2
 0  0
 1  1
B = 2x2
 0  1
 0  0
B = 2x2
 0  1
 0  1
B = 2x2
 0  1
 1  0
B = 2x2
 0  1
 1  1
B = 2x2
 1  0
 0  0
B = 2x2
 1  0
 0  1
B = 2x2
 1  0
 1  0
B = 2x2
 1  0
 1  1
B = 2x2
 1  1
 0  0
B = 2x2
 1  1
 0  1
B = 2x2
 1  1
 1  0
B = 2x2
 1  1
```

1 1

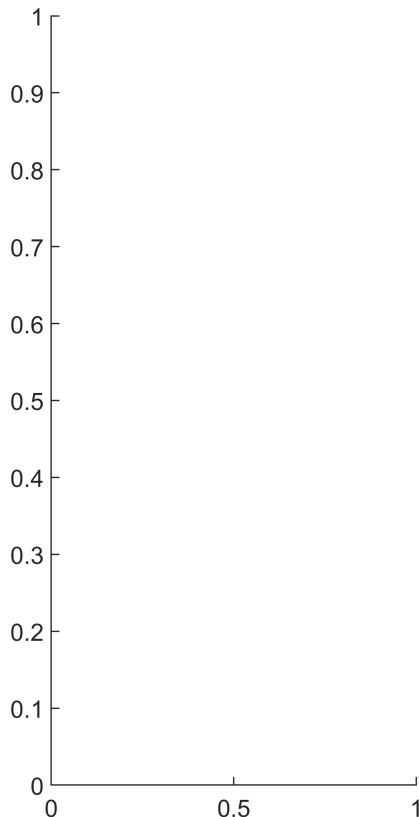
6.

A. $8 \times 8, 8^8 = 64, 2^{64} = 18,446,744,073,709,551,616$. 18,446,744,073,709,551,616 possible images

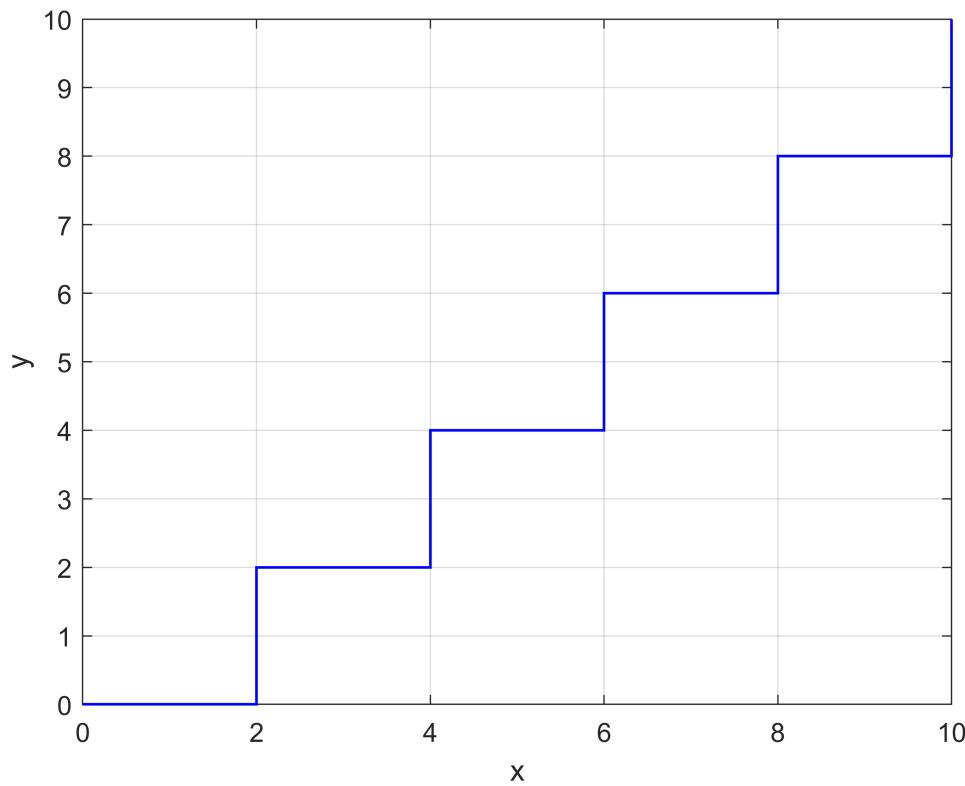
B. 18,446,744,073,709,551,616 images, 10 seconds per image, $18446744073709551616 * 10 = 184467440737095516160$ seconds = 5,845,420,460,906 years

7.

```
tiledlayout(1, 2);
nexttile;
```



```
% Generate example data
x = linspace(0, 10, 6);
y1 = x;
% Create a staircase plot
figure;
stairs(x, y1, 'b-', 'LineWidth', 1);
xlabel('x');
ylabel('y');
grid on;
```



8.

```
tiledlayout(1, 3);

nexttile;
for K1 = 0:10
    Ii = linspace(0, 10, 100);
    Io = K1 * log10(K2 + K3 * Ii);
    plot(Ii, Io, 'b-', 'LineWidth', 2);
    axis([0 10 0 25])
    xlabel('Input (I_i)');
    ylabel('Output (I_o)');
    title('0 <= K1 <= 10');
    grid on;
    hold on;
end

nexttile;
for K2 = 0:10
    Ii = linspace(0, 10, 100);
    Io = K1 * log10(K2 + K3 * Ii);
    plot(Ii, Io, 'b-', 'LineWidth', 2);
    axis([0 10 0 25])
    xlabel('Input (I_i)');
    ylabel('Output (I_o)');

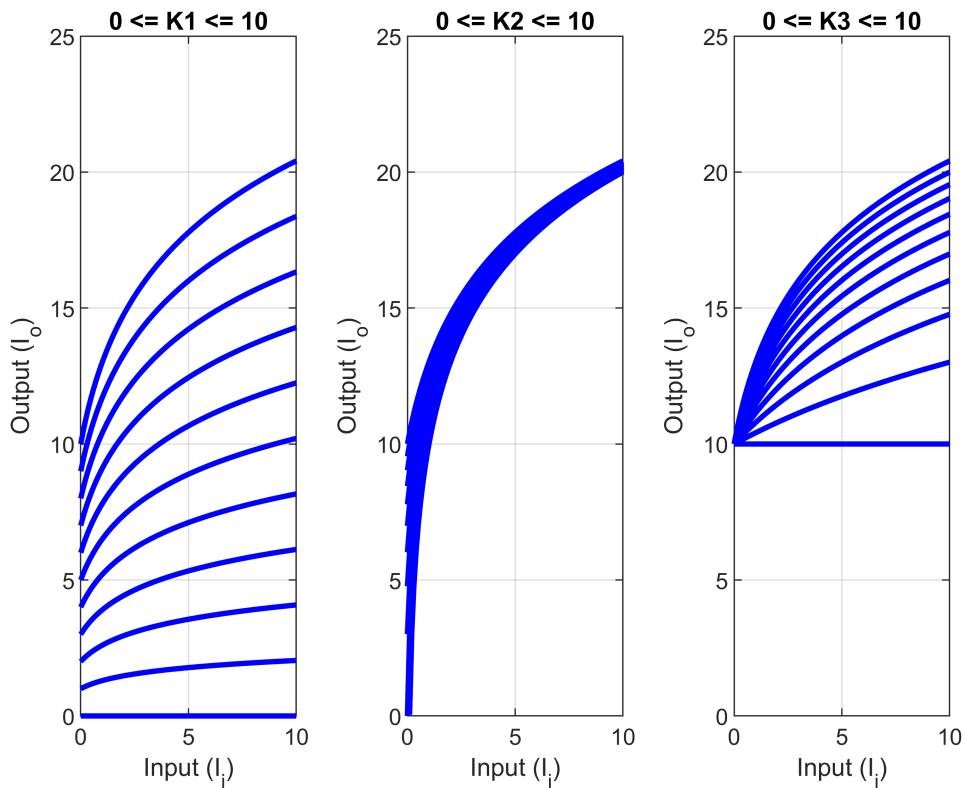
```

```

title('0 <= K2 <= 10');
grid on;
hold on;
end

nexttile;
for K3 = 0:10
    Ii = linspace(0, 10, 100);
    Io = K1 * log10(K2 + K3 * Ii);
    plot(Ii, Io, 'b-', 'LineWidth', 2);
    axis([0 10 0 25])
    xlabel('Input (I_i)');
    ylabel('Output (I_o)');
    title('0 <= K3 <= 10');
    grid on;
    hold on;
end

```



Each constant scales the function in different ways. I don't have any units so I'm not sure what

9.

```

r = imread('rice256.tif');
num_levels = 8

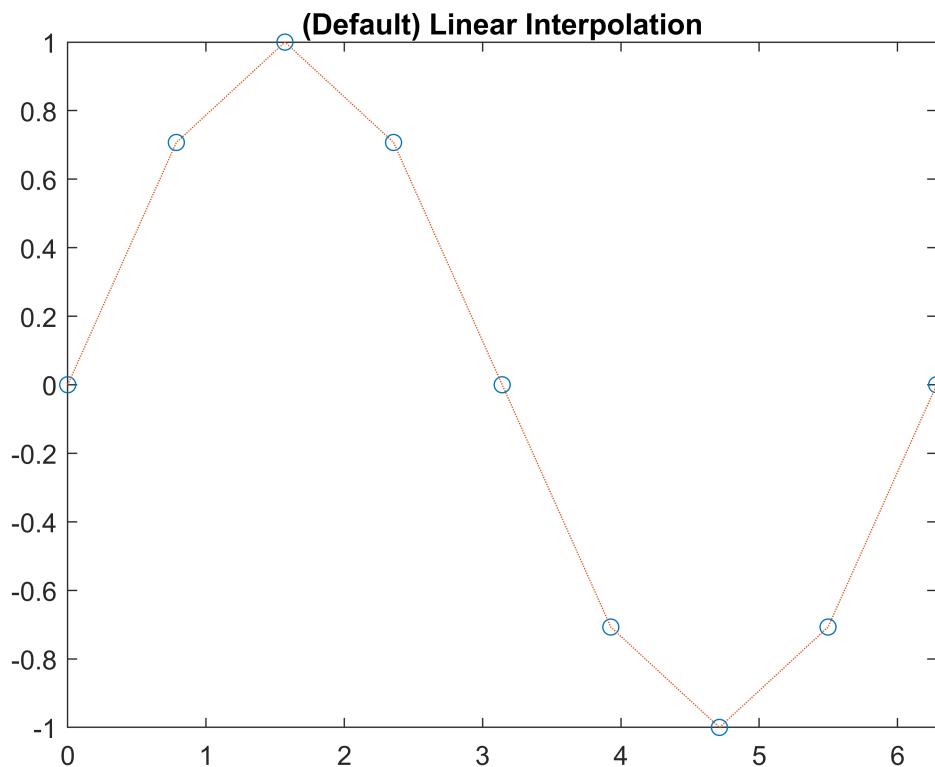
```

```
num_levels = 8
```

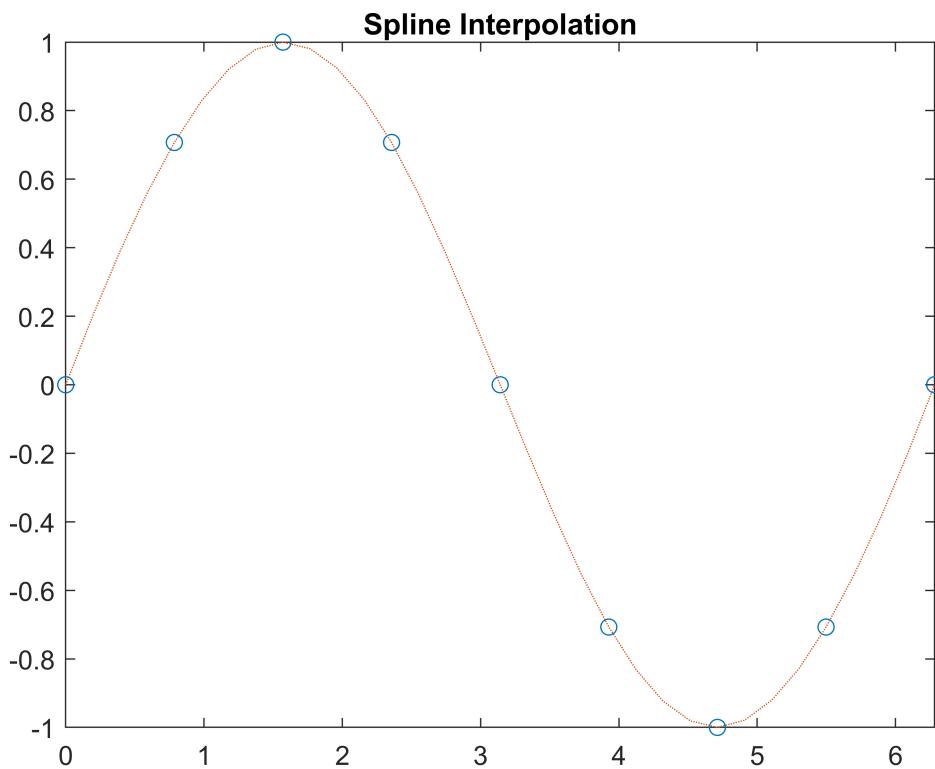
10.

```
% Define the sample points and corresponding values
x = 0:pi/4:2*pi;
v = sin(x);
xq = 0:pi/16:2*pi;

% Linear
vq1 = interp1(x, v, xq);
figure;
plot(x, v, 'o', xq, vq1, ':');
xlim([0 2*pi]);
title('(Default) Linear Interpolation');
```

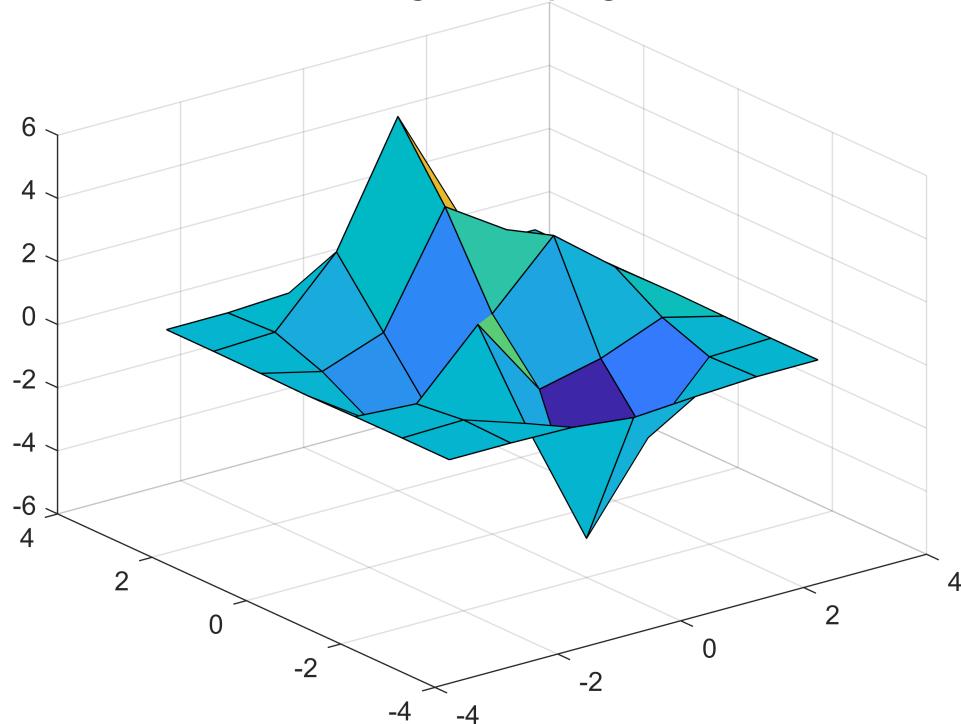


```
% Spline
vq2 = interp1(x, v, xq, 'spline');
figure;
plot(x, v, 'o', xq, vq2, ':');
xlim([0 2*pi]);
title('Spline Interpolation');
```



```
% original
[X,Y] = meshgrid(-3:3);
V = peaks(X,Y);
figure
surf(X,Y,V)
title('Original Sampling');
```

Original Sampling



```
% Redo with tighter grid
[Xq,Yq] = meshgrid(-3:0.25:3);
Vq = interp2(X,Y,V,Xq,Yq, 'cubic');
figure
surf(Xq,Yq,Vq);
title('Cubic Interpolation Over Finer Grid');
```

Cubic Interpolation Over Finer Grid

