

ELEC 221: Signals and Systems

Climate Change and The Antarctic Sea Ice

Extent - Visual to Statistics

Submitted By: Atif Mahmud

TASK 1

Q0. Total Number of Frames = 3081

Frame Rate = 29.97 frames per second

```
%% MATLAB Code to Complete Q0

% Creating a VideoReader Object
vidObj = VideoReader('NASA.mp4');
get(vidObj);

% % Source: http://stackoverflow.com/questions/31932380/why-is-matlab-unable-
% to-determine-the-number-of-frames-in-a-video-file
% We need to read the last frame
data = read(vidObj, Inf);
numFrames = vidObj.NumberOfFrames;
```

MATLAB Code for Q0

Q1. Size of Data Array: <720 x 1280 x 3unit8>
Height of each frame: 720 pixels
Width of each frame: 1280 pixels
Bits per pixel: 24

```
%% Extracting all the frames onto my drive
% I will then use the ones I need
% Source: https://www.youtube.com/watch?v=AI-1ch6CHkI&t=295s
for img = 1:vidObj.NumberOfFrames;
    filename=strcat('frame_number', num2str(img), '.png');
    frame=read(vidObj, img);
    imwrite(frame, filename);
end
```

MATLAB Code for Writing the Frames Onto my Drive

TASK 2

Q2. 8 bits per pixel

Q3. To convert to grayscale, I used MATLAB's `rgb2gray()` function. The function works by removing hue (actual colour), and saturation (amount of grey) in the colour, but retaining the luminance. The luminance shows up as intensity in the grayscale image.

```
%% Converting from RGB to Grayscale and writing on drive  
% Source: https://www.mathworks.com/help/matlab/ref/rgb2gray.html  
for num= 1363:1703 %the frames we are interested in  
    file=strcat('frame_number', num2str(num), '.png');  
    RGB=imread(file);  
    gray_file=strcat('Gray_Scale ', 'frame_number', num2str(num), '.png');  
    gray_image=rgb2gray(RGB);  
    imwrite(gray_image, gray_file);  
end
```

MATLAB Code for Converting the Images to Grayscale



Figure 1: Displaying a frame using `imshow()`

My student number is 48660147, hence my date was April 18.

```
% Using imshow to display April 18 Photograph  
  
imshow('Gray_Scaleframe_number1416.png');
```

MATLAB Code for Fig 1.

Q4. Once we convert to grayscale, each pixel is represented as an *intensity*, in 8-bits, and not a combination of red, green, and blue. Thus, it is easier to convert to black-and-white using the algorithm explained in **Q5** once each pixel is represented as an intensity.

TASK 3

Q5. To convert from Grayscale to black-and-white, I used MATLAB's `im2bw()` function. What that function does is, upon analysis of an image using a certain value for intensity, converts everything below that level to black, and everything above that to white. The intensity is specified in the `level` input of the function. If no level is specified by the user, MATLAB uses a default of 0.5.

```
%% Changing from grayscale to black and white  
% Source: https://www.mathworks.com/help/images/ref/im2bw.html  
for num= 1363:1703 %the frames we are interested in  
    gray_file=strcat('Gray_Scale ', 'frame_number', num2str(num), '.png');  
    I=imread(gray_file);  
    blackwhite=im2bw(I); % No level specified; MATLAB uses 0.5  
    blackwhite_filename=strcat('Black_White', 'frame_number', num2str(num), '.png');  
    imwrite(blackwhite, blackwhite_filename);  
end
```

MATLAB code for Coverting the Images to Black and White

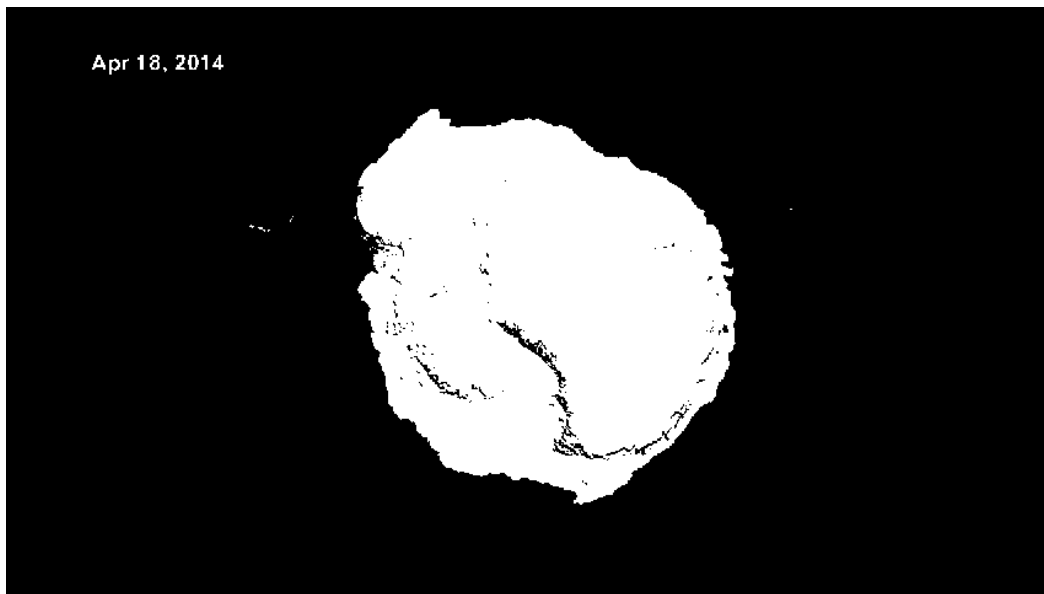


Fig 2. Displaying the same frame as Fig1 in black-and-white (using `imshow()`)

```
% Using imshow to display black and white April 18 photograph  
imshow('Black_Whiteframe_number1416.png');
```

MATLAB Code for Fig 2.

TASK 4

Q6. For every black-and-white .png image, I will specify a certain section (section occupied by the date stamp) of the image using a range of pixels in both horizontal (pixels 73 to 291) and vertical (pixels 28 to 94) direction. Then I will change those pixels to black, thus masking out the date stamp.

Source: <https://www.mathworks.com/matlabcentral/answers/86410-changing-values-of-pixels-in-an-image-pixel-by-pixel-thresholding>

```
%% Masking out the date stamp
% Source: https://www.mathworks.com/matlabcentral/answers/86410-changing-
%values-of-pixels-in-an-image-pixel-by-pixel-thresholdin
for number = 1363:1703; % the images we are working with
    blackwhite_filename=strcat('Black_White','frame_number',
num2str(number),'.png');
    my_image =imread(blackwhite_filename);
    for R=28:94
        for C=73:291
            my_image(R,C)=0;
        end
    end
    masked_BW_filename=strcat(num2str(number), '.png');
    imwrite(my_image, masked_BW_filename);
end
```

MATLAB code for Q6

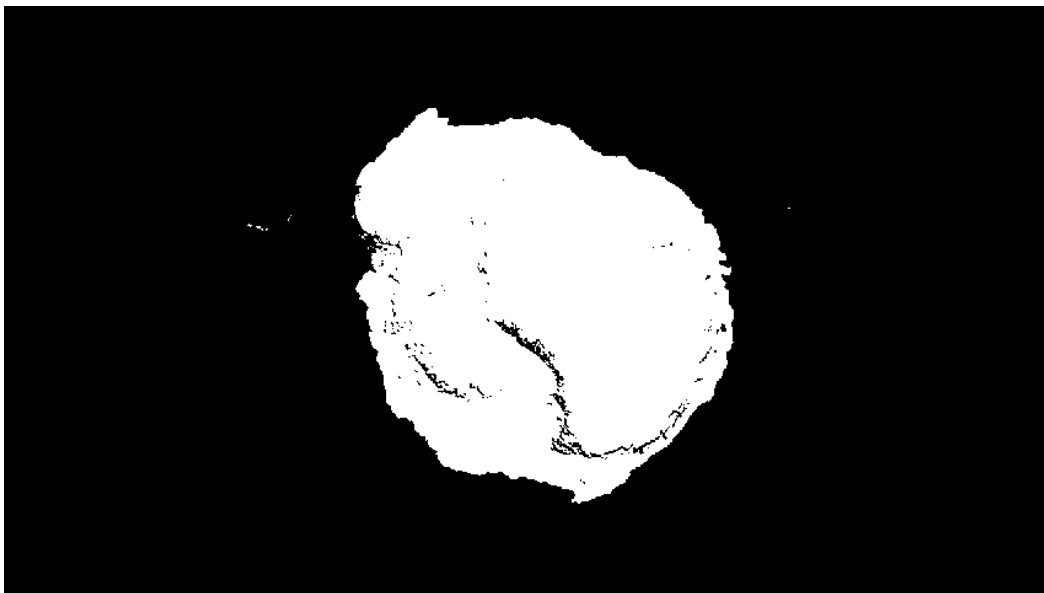


Fig 3. Displaying the same frame as Fig1 and Fig2 in black-and-white (using `imshow()`)

```
%% Using imshow to display MASKED black and white April 18 photograph  
  
imshow('1416.png');
```

MATLAB Code for Fig 3.

TASK 5

Q7. I used `N= special('gaussian', [12, 12], 15);`
I used it once per frame.

```
%% Gaussian Low-pass Filter  
% Source: `  
%https://www.mathworks.com/matlabcentral/newsreader/view\_thread/156894  
  
for number = 1363:1703; % the images we are working with  
    masked_BW_filename=strcat(num2str(number), '.png');  
    masked_image=imread(masked_BW_filename);  
    N = fspecial('gaussian', [12, 12], 15);  
    image=imfilter(masked_image,N);  
    filtered_name=strcat(num2str(number), 'filter', '.png');  
    imwrite(image,filtered_name);  
end
```

MATLAB Code for Filtering

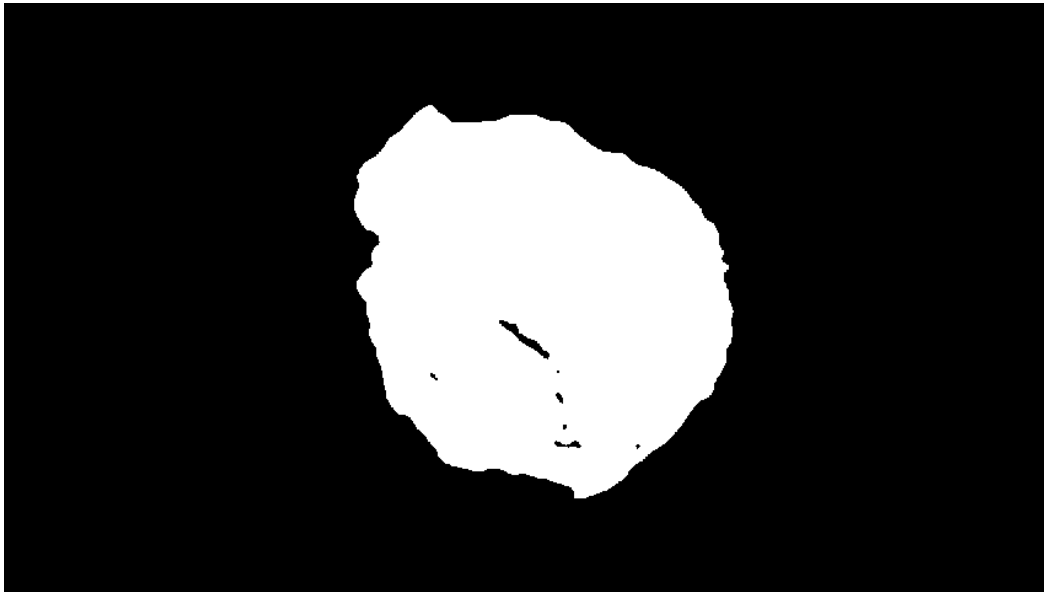
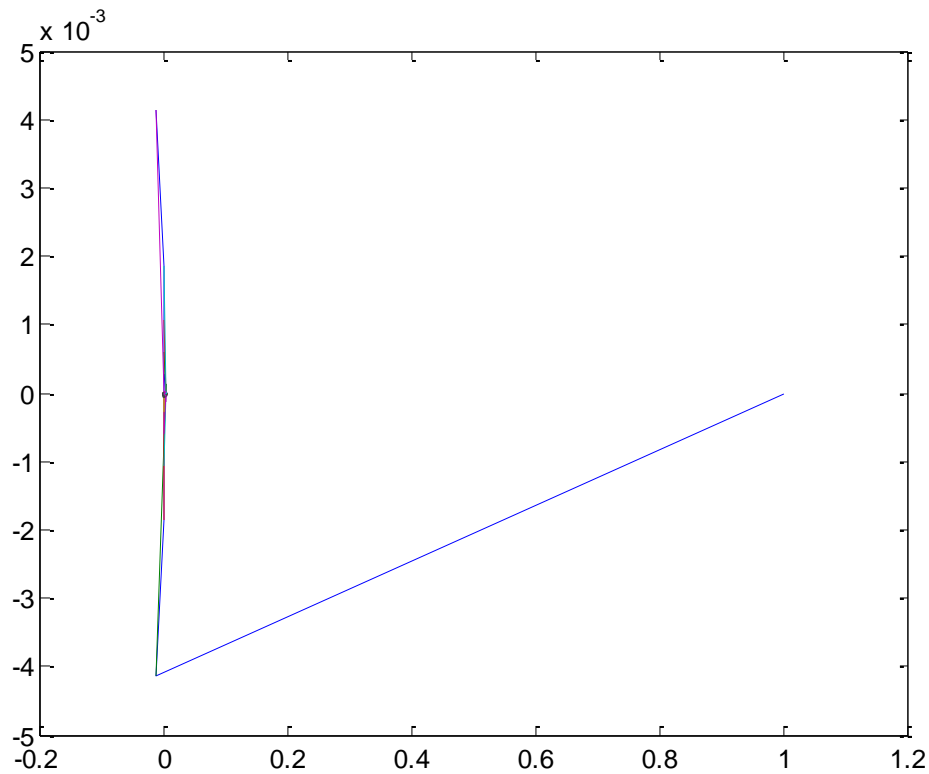


Fig 4. Displaying the same frame as Fig1 – Fig3 in black-and-white (after filtering) (using `imshow()`)

```
%% Using imshow to display FILTERED black and white April 18 photograph  
imshow('1416filter.png');
```

MATLAB Code for Fig 4.

Q8. The value of the 2-D DFT is <12 x 12>



Shown Above: Plot of the fft

```
%% Finding 2-D DFT of averaging filter  
N = fspecial('gaussian', [12, 12], 15);  
fft=fft2(N);
```

MATLAB code for Q8.

TASK 6

Please see the next page...

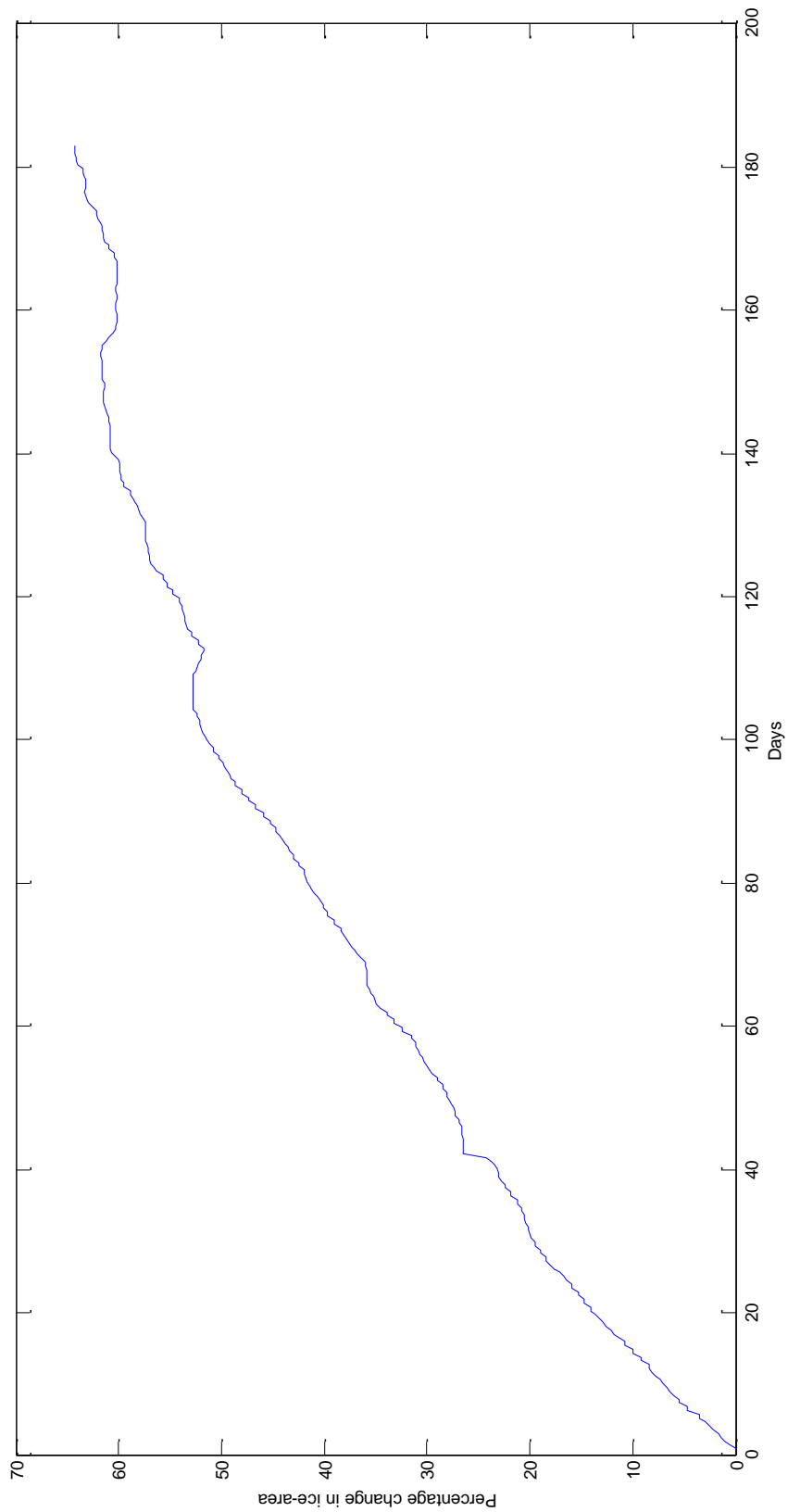


Figure 5: Plot of change in ice-area

```

%% Counting white pixels in Day 1
% Source: https://www.mathworks.com/matlabcentral/answers/12011-count-black-and-white-pixels-on-a-image

image_1=imread('1363filter.png');
whitepix_1=0;
blackpix_1=0;

for R=1:720
    for C=1:1280
        if image_1(R,C)==1;
            whitepix_1=whitepix_1+1;
        else
            blackpix_1=blackpix_1+1
        end
    end
end

area_1=whitepix_1;

% Caclulating the percentage change in ice by counting white pixels Source:
% https://www.mathworks.com/matlabcentral/answers/12011-count-black-and-white-pixels-on-a-image
for number = 1363:1703; % the images we are working with
    filtered_name=strcat(num2str(number),'filter', '.png');
    image_x=imread(filtered_name);
    whitepix=0;
    blackpix=0;
    day=number-1363+1;
    index=0;
    for R=1:720
        for C=1:1280
            if image_x(R,C)==1;
                whitepix=whitepix+1;
            else
                blackpix=blackpix+1;
            end
        end
    end
    area=whitepix
    ice_change_tag= ((area-area_1)/area_1)*100;

    % Source:
    % https://www.mathworks.com/matlabcentral/answers/113171-how-to-store-values-from-a-loop
    y_val(day)=ice_change_tag;

end

x=linspace(1,183,341);
figure
plot(x,y_val);

% Source:
% https://www.mathworks.com/help/matlab/creating\_plots/add-title-axis-labels-and-legend-to-graph.html
xlabel('Days');
ylabel('Percentage change in ice-area');

```

MATLAB Code For Figure 5

Q9. The ice area has quite steadily increased. By the end of this time period, the ice area has increased by about 60%

TASK 7

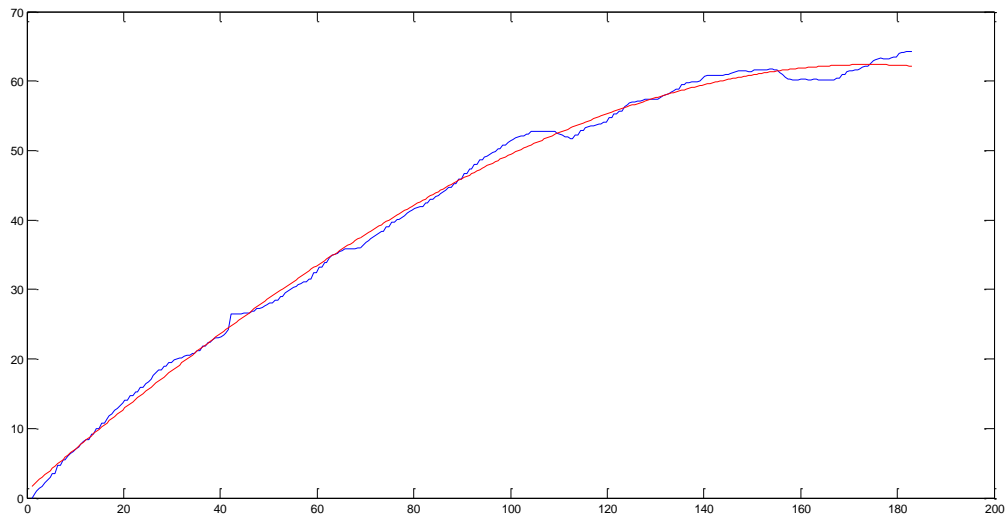


Fig 6: The plot and polynomial regression (I intentionally left it small)
(polynomial is in red)

Q10. I used a third order polynomial. The polynomial was:

$$-0.000003x^3 - 0.000871566168956669x^2 + 0.603560779036551x + 1.09784583678310$$

```
% Using polyfit to model ice change as polynomial regression

poly=polyfit(x,y_val,3); % n=3
val=polyval(poly,x);

% Source:
% https://www.mathworks.com/help/matlab/creating_plots/add-title-axis-labels-
and-legend-to-graph.html
figure
xlabel('Days');
ylabel('Percentage change in ice-area');

plot(x,y_val);
hold
% Source: https://www.mathworks.com/matlabcentral/newsreader/view_thread/2131
plot(x,val, 'Color', 'red');

exp=-3.29472397891272e-06;
```

MATLAB Code For TASK 7

Q11 September 30th is 11 days after September 19th. So in our case, it is $\text{Day}(183+11) = \text{Day } 194$

Thus, plugging into the polynomial regression we have in Q10, the ice coverage is 63.422% more than the start date.

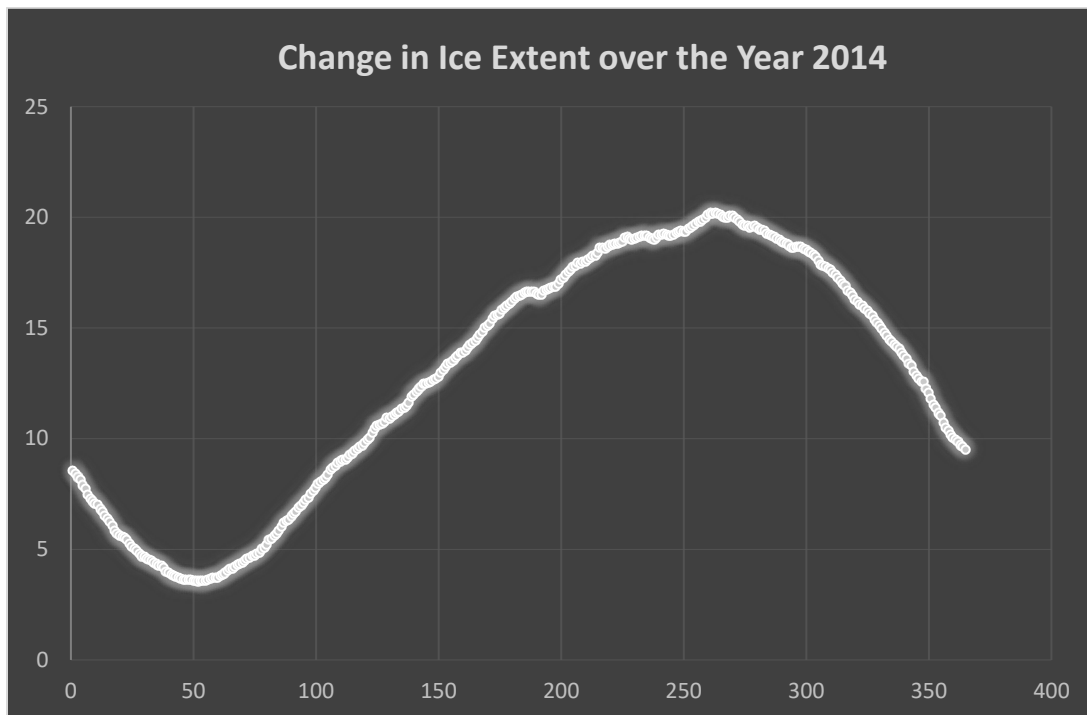
TASK 8

Fig: Plot showing change in Ice-extent over the year

- Q12.** Minimum Ice area: 3.548 million square kilometers, February 21
Maximum Icea area: 20.178 million square kilometers, September 18.

The ice area is low at the start and end of the year (summer in southern hemispere)

The ice area is high at the middle of year (winter in southern hemispere)

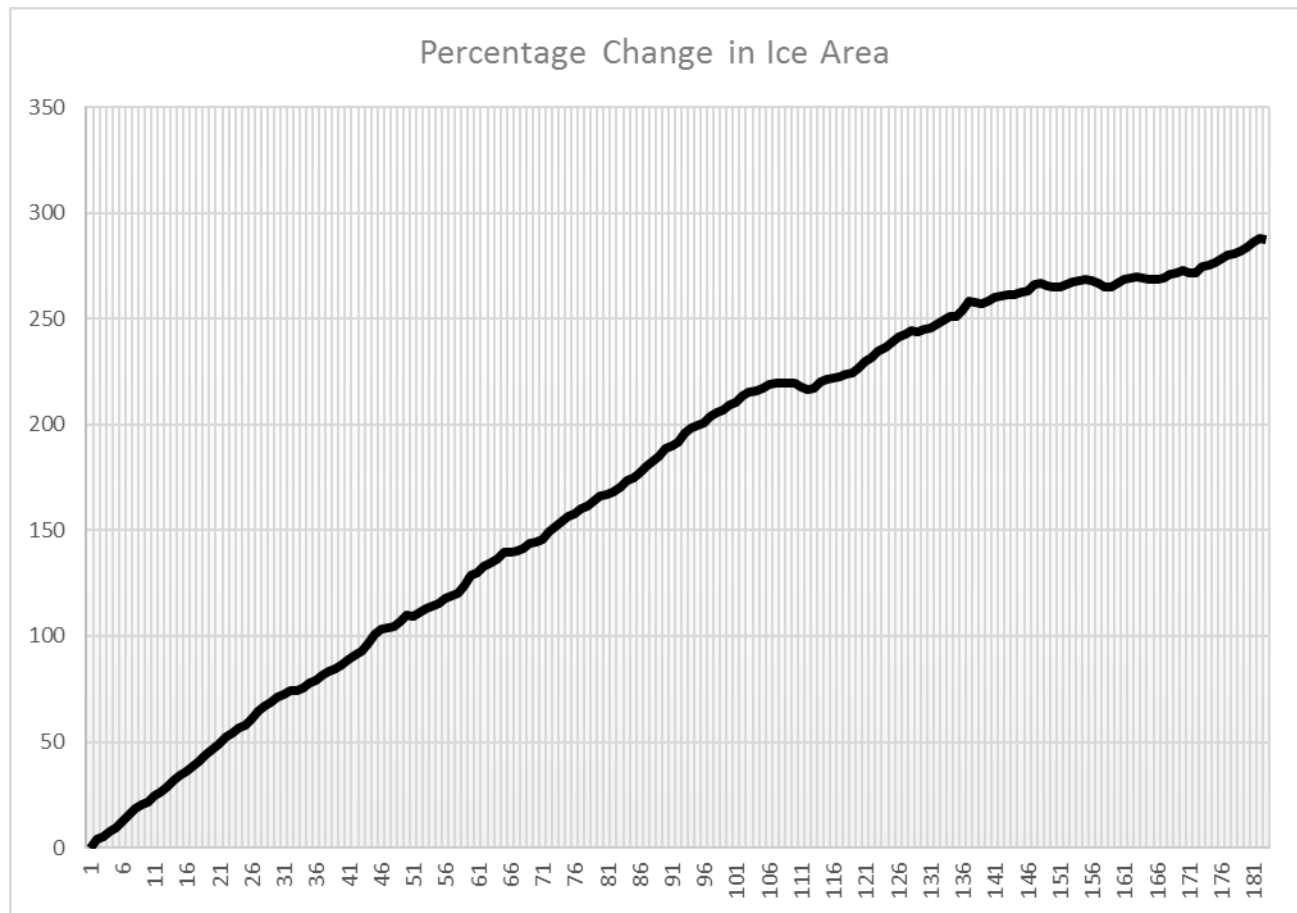


Fig 8. Percentage change in ice extent from Dataset

Q13. The results are not very compatible. The graphs look the same, but the final percentage change in ice area are vastly different. From counting pixels, we have an approximate 60% change, but from the dataset, we about 287.5%. The possible causes are

- Image size:** Considering that we are dealing with area the order of million square kilometres, it is very difficult to get an accurate estimate using a 720x1280 image, because of the scale.
- Imperfect Filter:** My low-pass filter may have been imperfect, and may have left some black pixels uncovered, and destroyed some white pixels at the edges .

Q14. Other techniques include using functions like `bwarea`, `regionprops`. Source:

<https://www.mathworks.com/help/images/pixel-values-and-image-statistics.html>

We can also use `imshowpair`. Source:

<https://www.mathworks.com/help/images/ref/imshowpair.html>

APPENDIX: The MATLAB Script

```
%% Creating a VideoReader Object
vidObj = VideoReader('NASA.mp4');
get(vidObj);

% Source: http://stackoverflow.com/questions/31932380/why-is-matlab-unable-to-determine-the-number-of-frames-in-a-video-file
% We need to read the last frame
data = read(vidObj, Inf);
numFrames = vidObj.NumberOfFrames;

%% Determining Height and Width of Frames
% Source: https://www.mathworks.com/help/matlab/import\_export/read-video-files.html
vidHeight = vidObj.Height;
vidWidth = vidObj.Width;

%% Extracting all the frames onto my drive
% I will then use the ones I need
% Source: https://www.youtube.com/watch?v=AI-1ch6CHkI&t=295s

for img = 1:vidObj.NumberOfFrames;
    filename=strcat('frame_number', num2str(img), '.png');
    frame=read(vidObj, img);
    imwrite(frame, filename);
end

%% Converting from RGB to Grayscale and writing on drive
% Source: https://www.mathworks.com/help/matlab/ref/rgb2gray.html

for num= 1363:1703 %the frames we are interested in
    file=strcat('frame_number', num2str(num), '.png');
    RGB=imread(file);
    gray_file=strcat('Gray_Scale ', 'frame_number', num2str(num), '.png');
    gray_image=rgb2gray(RGB);
    imwrite(gray_image, gray_file);
end

% Using imshow to display April 18 Photograph

imshow('Gray_Scaleframe_number1416.png');

%% To mask out date stamp, use pixels X= 81:292
%%Y = 41:100

%% Changing from grayscale to black and white
% Source: https://www.mathworks.com/help/images/ref/im2bw.html

for num= 1363:1703 %the frames we are interested in
    gray_file=strcat('Gray_Scale ', 'frame_number', num2str(num), '.png');
    I=imread(gray_file);
    blackwhite=im2bw(I); % No level specified; MATLAB uses 0.5
    blackwhite_filename=strcat('Black_White', 'frame_number', num2str(num), '.png');
    imwrite(blackwhite, blackwhite_filename);
end

%% Using imshow to display black and white April 18 photograph

imshow('Black_Whiteframe_number1416.png');

%% Masking out the date stamp
% Source: https://www.mathworks.com/matlabcentral/answers/86410-changing-values-of-pixels-in-an-image-pixel-by-pixel-thresholdin
for number = 1363:1703; % the images we are working with
    blackwhite_filename=strcat('Black_White', 'frame_number', num2str(number), '.png');
    my_image =imread(blackwhite_filename);
    for R=28:94
        for C=73:291
            my_image(R,C)=0;
        end
    end
    masked_BW_filename=strcat(num2str(number), '.png');
    imwrite(my_image, masked_BW_filename);
end

%% Using imshow to display MASKED black and white April 18 photograph

imshow('1416.png');
```

```

%% Gaussian Low-pass Filter
% Source: https://www.mathworks.com/matlabcentral/newsreader/view\_thread/15689

for number = 1363:1703; % the images we are working with
    masked_BW_filename=strcat(num2str(number), '.png');
    masked_image=imread(masked_BW_filename);
    N = fspecial('gaussian', [12, 12], 15);%
    image=imfilter(masked_image,N);
    filtered_name=strcat(num2str(number),'filter', '.png');
    imwrite(image,filtered_name);
end

Using imshow to display FILTERED black and white April 18 photograph
imshow('1416filter.png');

Finding 2-D DFT of averaging filter

fft=fft2(N);

%% Counting white pixels in Day 1
%Source: https://www.mathworks.com/matlabcentral/answers/12011-count-black-and-white-pixels-on-a-image

image_1=imread('1363filter.png');
whitepix_1=0;
blackpix_1=0;

for R=1:720
    for C=1:1280
        if image_1(R,C)==1;
            whitepix_1=whitepix_1+1;
        else
            blackpix_1=blackpix_1+1
        end
    end
end

area_1=whitepix_1;

% Calculating the percentage change in ice by counting white pixels Source:
% https://www.mathworks.com/matlabcentral/answers/12011-count-black-and-white-pixels-on-a-image
for number = 1363:1703; % the images we are working with
    filtered_name=strcat(num2str(number),'filter', '.png');
    image_x=imread(filtered_name);
    whitepix=0;
    blackpix=0;
    day=number-1363+1;
    index=0;
    for R=1:720
        for C=1:1280
            if image_x(R,C)==1;
                whitepix=whitepix+1;
            else
                blackpix=blackpix+1;
            end
        end
    end
    area=whitepix
    ice_change_tag= ((area-area_1)/area_1)*100;

    % Source:
    % https://www.mathworks.com/matlabcentral/answers/113171-how-to-store-values-from-a-loop
    y_val(day)=ice_change_tag;

end
x=linspace(1,183,341);
figure
plot(x,y_val);
%% Using polyfit to model ice change as polynomial regression
poly=polyfit(x,y_val,3); % n=3
val=polyval(poly,x);
% Source: https://www.mathworks.com/help/matlab/creating\_plots/add-title-axis-labels-and-legend-to-graph.html
figure
xlabel('Days');
ylabel('Percentage change in ice-area');
plot(x,y_val);
hold % Source: https://www.mathworks.com/matlabcentral/newsreader/view\_thread/2131
plot(x,val, 'Color', 'red');

```