

Lab 8

Non-Linear Fitting Review and Animated Visualization

Handout – print version of Lecture on *Marine Modelling* March 4, 2019

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8.1

1 Outline

Outline

We will work through two examples:

- Review non-linear fitting
- Plot surface chlorophyll measured by satellite over time and create an animation

8.2

2 Non-Linear Least Squares Regression

Non-Linear Least Squares Regression

Same approach, but needs to be solved iteratively, i.e. search coefficient space by repeatedly calculating χ^2 .

There are many different techniques of searching for the minimum:

- Grid search
- Gradient descent/search
- Expansion methods

See, for example, Bevington and Robinson, Chapter 8.

8.3

Steepest Descent Gradient Search

This is vaguely analogous to rolling a marble on the χ^2 surface: it will roll down hill until it reaches the lowest point. Sometimes it will oscillate around the minimum.

Mathematical routines typically required:

- an initial guess of the coefficient values
- how small of a $\Delta\chi^2$ you consider convergence
- the name of an m-file that codes your model
- sometimes the maximum number of iterations
- sometimes the name of an m-file that calculates the model gradient

Note: It's always good to have a "good first guess".

Cautionary note: Be aware of local minima.

8.4

3 MODIS Surface Chlorophyll Data

MODIS Surface Chlorophyll Data

Data: Ocean colour satellite (MODIS) 8-day composite

Objective: Plot pseudocolour of image and coastline over 1-year of data, and use to create an animation



8.5

MODIS Surface Chlorophyll Data

```
% load chlorophyll data, resolved in lon/lat/time
load chl_mm2018
```

8.6

MODIS Surface Chlorophyll Data

```
% loop through third index - time dimension
for i=1:size(CHL,3)
    pcolor(LON,LAT,log10(CHL(:, :, i)))
    shading interp, caxis([log10(0.1),log10(20)])
    % function that plots new england coastline
    plotnewengland
```

8.7

MODIS Surface Chlorophyll Data

```
% loop through third index - time dimension
for i=1:size(CHL,3)
% plot chlorophyll on a log colorscale
    pcolor(LON,LAT,log10(CHL(:, :, i)))
    shading interp, caxis([log10(0.1),log10(20)])
    % function that plots new england coastline
    plotnewengland
    % set colormap to nice cmocean green map
    colormap(cmocean('algae',21))
    cb = colorbar; % create colorbar
```

8.8

MODIS Surface Chlorophyll Data

```
% loop through third index - time dimension
for i=1:size(CHL,3)
% plot chlorophyll on a log colorscale
    pcolor(LON,LAT,log10(CHL(:, :, i)))
    shading interp, caxis([log10(0.1),log10(20)])
% function that plots new england coastline
    plotnewengland
% set colormap to nice cmocean green map
    colormap(cmocean('algae',21))
    cb = colorbar; % create colorbar
% set ticks and tick labels for logscale
    set(cb,'ticks',[log10(0.1),log10(0.2),...
log10(0.5),log10(1),log10(2),log10(5),...
log10(10),log10(20)])
    set(cb,'ticklabels',{'0.1','0.2','0.5',...
'1','2','5','10','20'})
    title([sprintf('Chl (mg/m3)\n'),...
datestr(doy2date(JDAY(i),2012))])
```

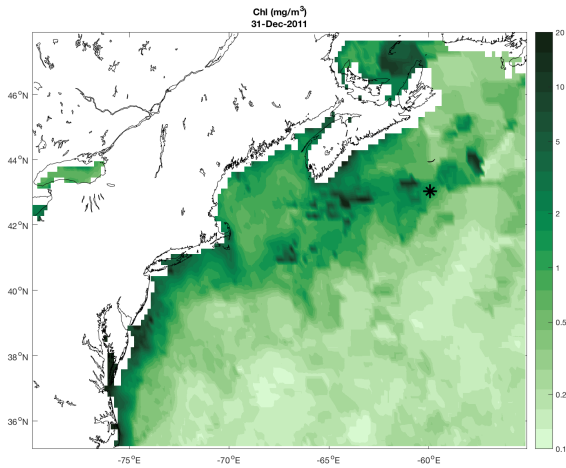
8.9

MODIS Surface Chlorophyll Data

```
for i=1:size(CHL,3)
% plot chlorophyll on a log colorscale
    pcolor(LON,LAT,log10(CHL(:, :, i)))
    shading interp, caxis([log10(0.1),log10(20)])
% function that plots new england coastline
    plotnewengland
% set colormap to nice cmocean green map
    colormap(cmocean('algae',21))
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log10(0.5),log10(1),log10(2),log10(5),...
log10(10),log10(20)])
    set(cb,'ticklabels',{'0.1','0.2','0.5',...
'1','2','5','10','20'})
    title([sprintf('Chl (mg/m3)\n'),...
datestr(doy2date(JDAY(i),2012))])
% pause for animation effect
    pause(0.2)
end
```

8.10

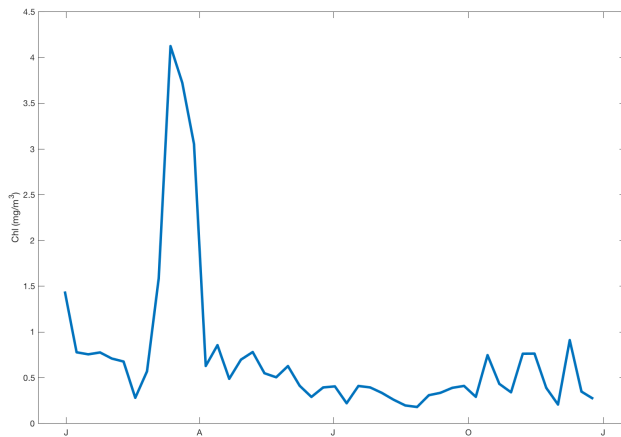
MODIS Surface Chlorophyll Data



8.11

MODIS Surface Chlorophyll Data

Timeseries shows spring bloom in North Atlantic



8.12

Creating videos/animations with MatLab

Open the script: `images2video.m` It can create a video from the files provided in a defined directory.

Explain the code ...

8.13