Exercise Set 01: Loading, Plotting, and Reasoning About Data

BEE 4850/5850, Fall 2024

Name: Anthony Nicolaides

ID: ajn68

> **Due Date**
>
> Friday, 2/2/24, 9:00pm

Overview

Instructions

The goal of this exercise is for you to practice (or learn how to) load data from tabular data files, plot it, and do some basic reasoning about the data and relationships between variables.

Load Environment

The following code loads the environment and makes sure all needed packages are installed. This should be at the start of most Julia scripts.

In [ ]:
```
import Pkg
Pkg.activate(@__DIR__)
Pkg.instantiate()
```

```
  Activating project at `~/Documents/BEE5850/exercises/ex-week01`
```

The following packages are included in the environment (to help you find other similar packages in other languages). The code below loads these packages for use in the subsequent notebook (the desired functionality for each package is commented next to the package).

In [ ]:
```
using DataFrames # tabular data structure
using CSV # reads/writes .csv files
using Plots # plotting library
using StatsBase # statistical quantities like mean, median, etc
using StatsPlots # some additional statistical plotting tools
```

Problems

The goal of this exercise is for you to visualize and reason about the relationship between global mean surface temperature and global mean sea levels.

Problems 1 and 2 are both marked out of 5 points.

Problem 1

Load the data from the `data/` folder:

- Global mean temperature data from the HadCRUT 5.0.2.0 dataset (https://hadobs.metoffice.gov.uk/hadcrut5/data/HadCRUT.5.0.2.0/download.html) can be found in `data/HadCRUT.5.0.2.0.analysis.summary_series.global.annual.csv`. This data is averaged over the Northern and Southern Hemispheres and over the whole year.

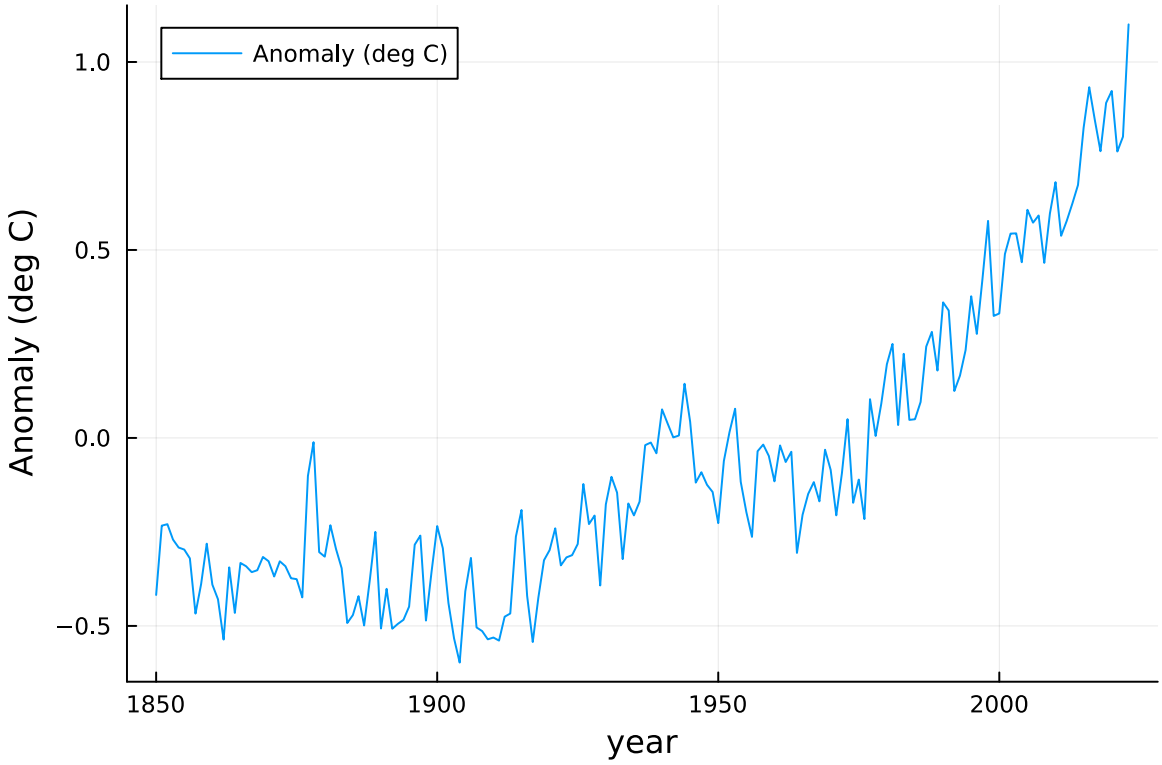
  > **Global Mean Temperature Anomalies**
  >
  > Global mean temperatures are typically represented as an *anomaly* from a certain reference or baseline period (in the case of HadCRUT5, the average surface temperature from 1961–1990). The climate change projections used by the Intergovernmental Panel on Climate Change typically use a "pre-industrial" baseline period from the 19th century, though specifics can also change.

- Global mean sea level anomalies (relative to the 1990 mean global sea level) are in `data/CSIRO_Recons_gmsl_yr_2015.csv`, courtesy of CSIRO (https://www.cmar.csiro.au/sealevel/sl_data_cmar.html).

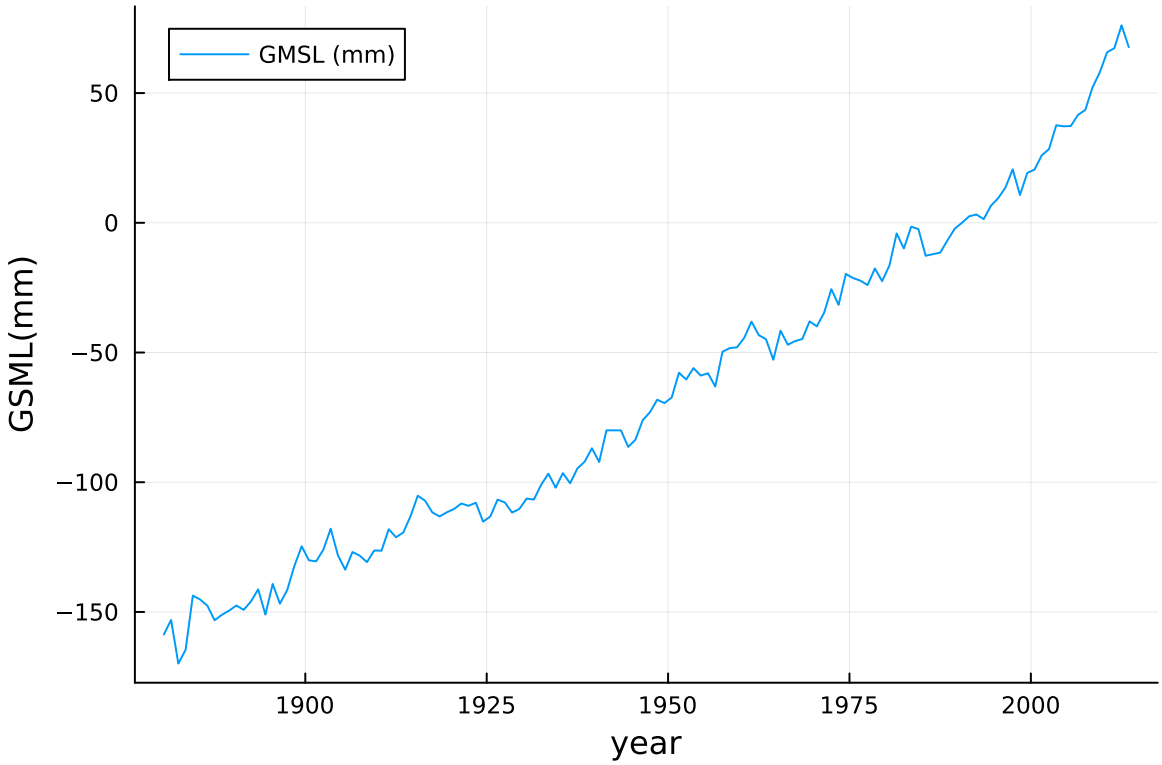
After loading the data, create a combined data structure (like a `DataFrame` in Julia or Python/Pandas, or a `data.frame` in R) with columns corresponding to the year, the estimated global mean temperature anomaly, and the estimated global mean sea level anomaly. Note that the years may need some adjustment to get them to match due to decimals. Then plot the two data series (not necessarily on the same axis; you can decide how to best present the data).

In [ ]:
```
data_temp = CSV.read("data/HadCRUT.5.0.2.0.analysis.summary_series.global.an
data_sea = CSV.read("data/CSIRO_Recons_gmsl_yr_2015.csv", DataFrame);
```

In [ ]:
```
plot(data_temp.Time, data_temp[!, "Anomaly (deg C)"],
    label="Anomaly (deg C)")
xlabel!("year")
ylabel!("Anomaly (deg C)")
```



In [ ]:
```
plot(data_sea.Time, data_sea[!, "GMSL (mm)"], label="GMSL (mm)")
xlabel!("year")
ylabel!("GSML(mm)")
```



Problem 2

What hypotheses can you draw about the relationship between global mean temperature and global mean sea level? Explain your reasoning for those hypotheses (they don't have to be mechanistically motivated and can be based on a statistical or visual analysis). Propose two different mathematical models (which could consist of one or multiple equations) which encode those hypotheses.

Based on the data, it seems that temperature and sea level have a positive correlation between each other because both has been increasing since the late 1800s. To find correlation between the two, you can use Pearson's coefficient to fit how the pre-exisitng data correlates with each other, as well as making an autoregressive model to see if the current trend continues.

It could also be that global mean temperature is causing the sea levels to rise, instead of them simply being correlated. This hypothesis cames from the reasoning that as the Earth gets hotter, more ice melts which cause sea levels to increase globally. A mathemathical model to test this hypothesis would be model fitting. For example, modeling global temperatures with an energy balance model and seeing how changes in temperature influences sea levels in the model.

References