Milestone overview

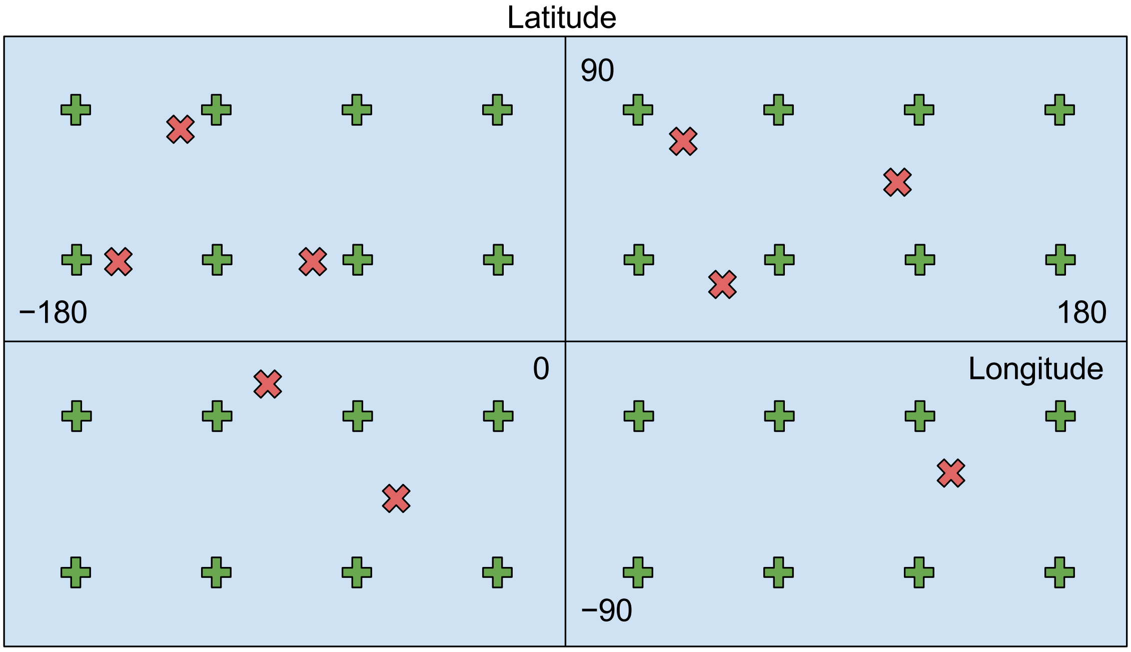
One of the primary goals of this project is to be able to visualize the evolution of the climate. If you tried to visualize the temperatures of different years in the previous milestone, you might have noticed that it is actually quite hard to really measure how the temperatures have evolved since 1975.

That's why we propose to visualize the *deviations* of the temperatures over the years, rather than just the temperatures themselves. The goal of this milestone is to compute such deviations. You will have to complete the file **Manipulation.scala**. But first, remember to update the grading milestone number:

```
val milestone: Int = 4
```

Computing deviations means comparing a value to a previous value which serves as a reference, or a "normal" temperature. You will first compute the average temperatures all over the world between 1975 and 1990. This will constitute your reference temperatures, which we refer to as "normals". You will then compare the yearly average temperatures, for each year between 1991 and 2015, to the normals.

In order to make things faster, you will first spatially interpolate your scattered data into a regular **grid**:



The above figure illustrates the grid points (in green) and the actual data points (in red). You will have to guess the temperature at the green locations based on the known temperatures at the red locations.

Once you will have such a grid for each year, you will easily be able to compute average (coordinate wise) over years and deviations.

You can monitor your progress by submitting your work at any time during the development of this milestone. Your submission token and the list of your graded submissions is available on this page.

Grid generation

To describe a grid point's location, we'll use integer latitude and longitude values. This way, every grid point (in green above) is the intersection of a circle of latitude and a line of longitude. Since this is a new coordinate system, we're introducing another case class, quite similar to **Location** but with integer coordinates:

```
case class GridLocation(lat: Int, lon: Int)
```

The latitude can be any integer between -89 and 90, and the longitude can be any integer between -180 and 179. The top-left corner has coordinates (90, -180), and the bottom-right corner has coordinates (-89, 179).

The grid associates every grid location with a temperature. You are free to internally represent the grid as you want (e.g. using a **class Grid**), but to interoperate with the grading system you will have to convert it to a function of type **GridLocation => Temperature**, which returns the temperature at the given grid location.

You will have to implement the following helper method:

```
def makeGrid(temperatures: Iterable[(Location, Temperature)]): GridLocation =>
  Temperature
```

It takes as parameter the temperatures associated with their location and returns the corresponding grid.

There are two approaches here:

- Pre-calculate all temperatures and return a getter function
- Calculate values when requested, using memoization to avoid recalculations

When we generate the map, we'll have to get the temperature of every point on the grid *at least once*. With this information in mind, think about which approach is more suitable and chose the best one for you.

Average and deviation computation

You will have to implement the following two methods:

```
def average(temperaturess: Iterable[Iterable[(Location, Temperature)]]):
  GridLocation => Temperature
```

This method takes a sequence of temperature data over several years (each “temperature data” for one year being a sequence of pairs of average yearly temperature and location), and returns a grid containing the average temperature over the given years at each location.

```
def deviation(
  temperatures: Iterable[(Location, Temperature)],
  normals: GridLocation => Temperature
): GridLocation => Temperature
```

This method takes temperature data and a grid containing normal temperatures, and returns a grid containing temperature deviations from the normals.

Mark as completed