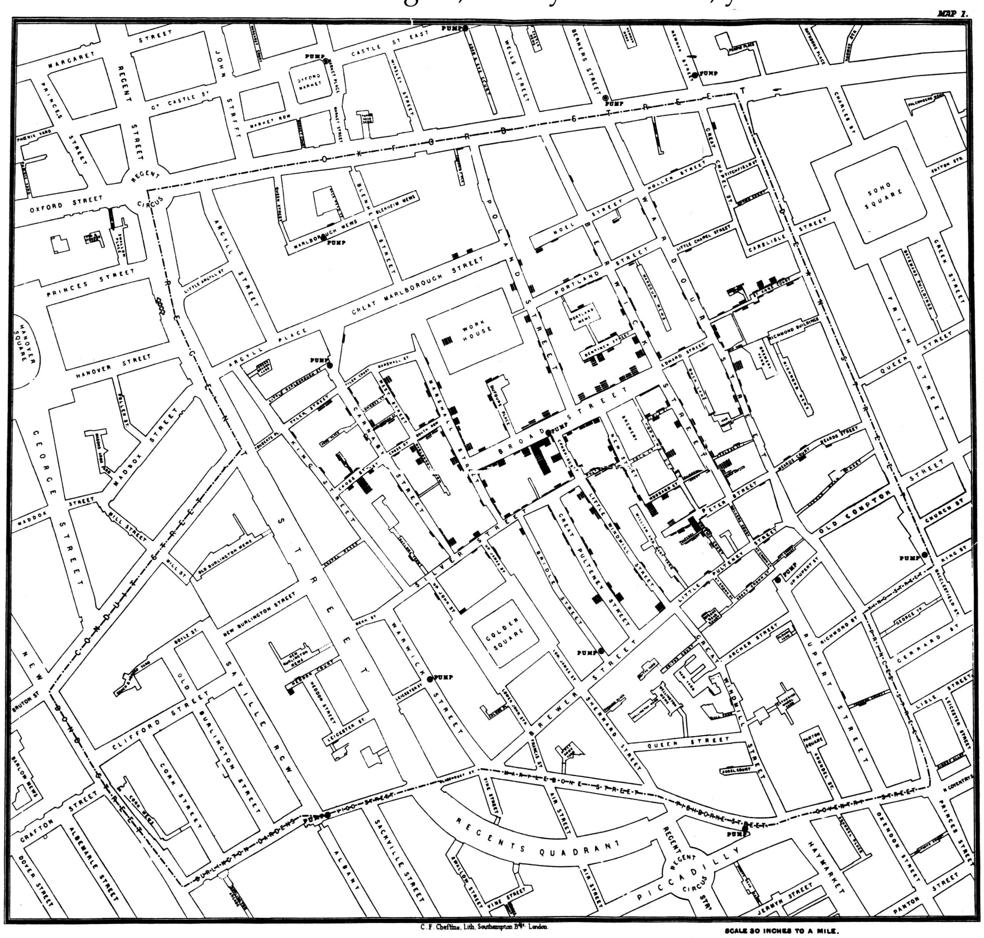
12.2 Dot Maps

May 9, 2019

1 12.2 Dot Maps

A **dot map** is a way to visualize the locations of events in space. In a dot map, points are added to a map to represent the geographic location of some event.

The most important dot map ever made is perhaps John Snow's map of the cholera cases during the 1854 London cholera outbreak. At the time, the cause of cholera was unknown. Snow's dot map showed that the cholera cases centered around a particular water pump, the Broad Street pump. (In the days before running water, residents had to fetch water from the local water pump.) Snow's dot map is shown below; each "dot" is a thin black box. Snow stacked the boxes when there were multiple people in one residence that contracted cholera. At this resolution, the data appear as black bars of different heights, but if you zoom in, you will see the individual "dots".



Snow followed up on his insight by interviewing residents near the Broad Street pump. He found that everyone who had contracted cholera had consumed water from the Broad Street pump; those who lived near the pump but did not contract cholera got their water from a different pump. Thus, one dot map gave John Snow the key insight he needed to identify the cause of cholera.

Let's look at how to make dot maps in Python. We will make a map of all earthquakes in the world on June 4, 2018. First, we read in the data.

In [1]:
```
import pandas as pd
pd.options.display.max_rows = 15

quakes = pd.read_csv("https://raw.githubusercontent.com/dlsun/data-science-book/"
                     "master/data/earthquakes.csv")
quakes
```

Out[1]:
```
                         time   latitude   longitude   depth   mag magType  \
0    2018-06-05T17:51:13.660Z  19.407833 -155.282837    1.19  1.88      ml
1    2018-06-05T17:46:26.600Z  35.378333 -117.858333    0.21  0.87      ml
2    2018-06-05T17:46:24.020Z  38.803665 -122.740837   12.37  0.62      md
3    2018-06-05T17:34:35.195Z  67.533300 -144.217500   10.30  1.20      ml
4    2018-06-05T17:20:31.020Z  19.324499 -155.251999    3.84  2.64      ml
5    2018-06-05T17:10:39.620Z  19.410000 -155.282165    0.70  1.99      md
6    2018-06-05T17:03:43.940Z  34.116333 -118.446833    6.65  1.35      ml
..                        ...        ...         ...     ...   ...     ...
534  2018-06-04T18:38:21.069Z  64.949100 -149.072300   16.60  1.70      ml
535  2018-06-04T18:37:04.330Z  19.400667 -155.256836    0.48  2.27      ml
536  2018-06-04T18:33:13.660Z  44.139333 -110.314333    6.28  0.91      md
537  2018-06-04T18:30:13.520Z  19.391666 -155.278503    0.69  1.70      ml
538  2018-06-04T18:24:37.410Z  -7.055000  123.203900  628.69  5.30     mww
539  2018-06-04T18:20:04.548Z  37.160100 -117.552900    9.60  0.70      ml
540  2018-06-04T18:10:35.980Z  46.873000 -112.521167   13.55  1.40      ml

      nst     gap      dmin     rms    ...                      updated  \
0    19.0   82.00  0.009850  0.1300    ...     2018-06-05T17:56:55.940Z
1    10.0   88.00  0.111100  0.1600    ...     2018-06-05T17:50:16.233Z
2    10.0  224.00  0.042770  0.1800    ...     2018-06-05T17:48:01.126Z
3     NaN     NaN       NaN  0.6800    ...     2018-06-05T17:38:03.433Z
4    15.0  113.00  0.047680  0.1000    ...     2018-06-05T17:26:16.040Z
5    15.0   68.00  0.007837  0.1400    ...     2018-06-05T17:13:44.990Z
6    21.0   78.00  0.012210  0.1800    ...     2018-06-05T17:07:27.705Z
..    ...     ...       ...     ...    ...                          ...
534   NaN     NaN       NaN  0.7500    ...     2018-06-04T18:45:18.271Z
535  18.0  102.00  0.009009  0.1100    ...     2018-06-04T18:42:46.190Z
536  10.0  162.00  0.253300  0.2100    ...     2018-06-04T20:51:17.600Z
537  14.0  128.00  0.005883  0.2900    ...     2018-06-04T18:36:05.750Z
538   NaN   43.00  1.839000  0.7000    ...     2018-06-05T17:40:41.040Z
539  13.0  164.33  0.104000  0.1146    ...     2018-06-04T18:48:15.218Z
540  12.0  103.00  0.124000  0.1000    ...     2018-06-04T19:31:52.880Z
```

```
                                       place       type horizontalError  \
0                5km WSW of Volcano, Hawaii  earthquake            0.21
1               20km W of Johannesburg, CA  earthquake            0.38
2                       3km SW of Cobb, CA  earthquake            3.04
3         86km SE of Arctic Village, Alaska  earthquake             NaN
4                 11km S of Volcano, Hawaii  earthquake            0.51
5                5km WSW of Volcano, Hawaii  earthquake            0.22
6                 4km S of Sherman Oaks, CA  earthquake            0.38
..                                      ...         ...             ...
534          41km N of North Nenana, Alaska  earthquake             NaN
535              3km SSW of Volcano, Hawaii  earthquake            0.19
536  54km SE of Old Faithful Geyser, Wyoming  earthquake            0.97
537               6km SW of Volcano, Hawaii  earthquake            0.76
538            165km NNE of Palue, Indonesia  earthquake            9.70
539          65km E of Big Pine, California  earthquake             NaN
540             15km SE of Lincoln, Montana  earthquake            0.37

    depthError  magError  magNst     status  locationSource magSource
0         0.28     0.250     9.0  automatic              hv        hv
1        31.61     0.107    13.0  automatic              ci        ci
2         6.68       NaN     1.0  automatic              nc        nc
3         0.30       NaN     NaN  automatic              ak        ak
4         1.87     0.520     3.0  automatic              hv        hv
5         0.23     0.140    12.0  automatic              hv        hv
6         0.55     0.272    28.0  automatic              ci        ci
..         ...       ...     ...        ...             ...       ...
534       0.10       NaN     NaN  automatic              ak        ak
535       0.27     0.440    11.0  automatic              hv        hv
536       3.12     0.115     4.0   reviewed              uu        uu
537       0.49     0.200     4.0  automatic              hv        hv
538       5.20     0.071    19.0   reviewed              us        us
539       2.20     0.230     9.0   reviewed              nn        nn
540       0.59     0.051     2.0   reviewed              mb        mb

[541 rows x 22 columns]
```

Now, we set up the basic map, just as we did in the previous section. To add the points to the map, we make a scatterplot, just like we learned in Chapter 3, but we have to specify the coordinate system we are using. (Longitude and latitude are not the only way to specify a geographic location.) If the coordinates are specified in latitude and longitude, it is best to use the `Geodetic` transform.

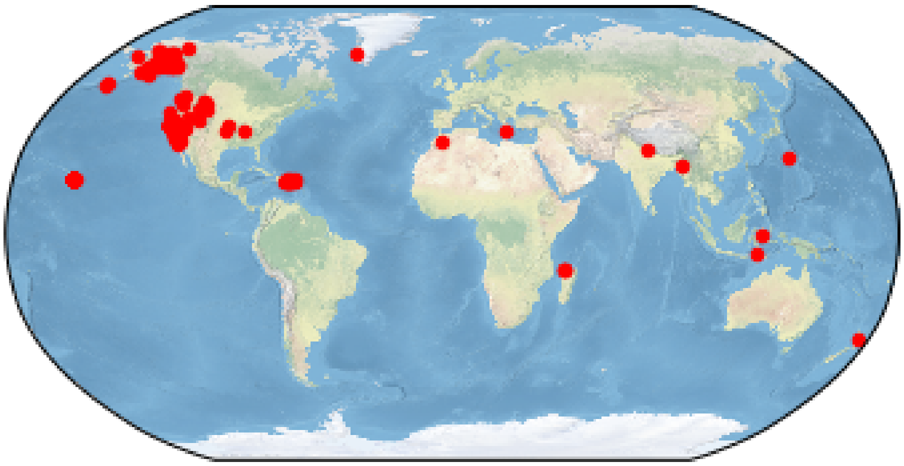
```
In [2]: import cartopy.crs as ccrs
        import matplotlib.pyplot as plt
        %matplotlib inline

        ax = plt.axes(projection=ccrs.Robinson())
```

```
ax.stock_img()

quakes.plot.scatter(ax=ax,
                    x="longitude", y="latitude",
                    c="red",
                    transform=ccrs.Geodetic())
```

Out[2]: <cartopy.mpl.geoaxes.GeoAxesSubplot at 0x7fae56e80eb8>



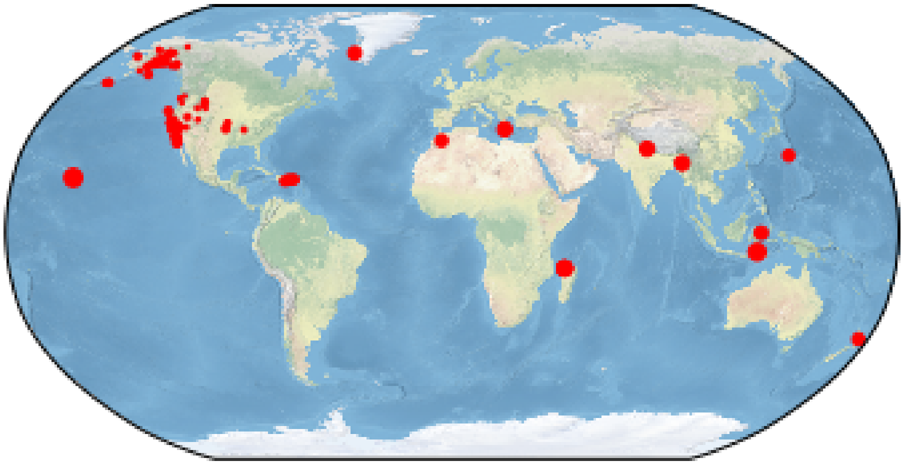
Just as before, we can use size to represent another dimension of the data. In the graphic below, we use size to represent the magnitude of each earthquake.

In [3]:
```
import numpy as np

ax = plt.axes(projection=ccrs.Robinson())
ax.stock_img()

ax.scatter(quakes["longitude"], quakes["latitude"],
           c="red", s=2 ** quakes["mag"],
           transform=ccrs.Geodetic())
```

Out[3]: <matplotlib.collections.PathCollection at 0x7fae417bb198>



2 Exercises

Exercise 1. The file `https://raw.githubusercontent.com/dlsun/data-science-book/master/data/ncaa-foot` contains information about the locations and capacity of NCAA football stadiums. Make a dot map that represents this data.

```
In [16]: ncaa = pd.read_csv("https://raw.githubusercontent.com/dlsun/data-science-book/master/c

         ax = plt.axes(projection=ccrs.Robinson())
         ax.stock_img()

         ax.set_extent([-125, -66.5, 10, 50])

         ncaa.plot.scatter(ax=ax,
                           x="longitude", y="latitude",
                           c="red",
                           transform=ccrs.Geodetic())

Out[16]: <cartopy.mpl.geoaxes.GeoAxesSubplot at 0x7fae2e87d5c0>
```