A disjoint spatial splitting approach to daily soil moisture modeling in Utah

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Problem

In the state of Utah, there are 265 soil moisture sensing stations. Soil moisture will change nearly every day depending upon rainfall and climatic patterns. The following is one example measurement day of soil moisture:

The task at hand is to figure out an appropriate interpolation method so that a prediction of soil moisture can be found at any given latitude and longitude point in the state of Utah.

In a small region or field, soil moisture likely follows a second-order stationary spatial process. However, we do not know the exact boundaries of the regions where we could assume a stationary spatial process. These boundaries might change every day depending upon different soil attributes and daily rainfall patterns.

In this project, I explore a novel automatic region partitioning algorithm that defines boundaries of regions where a stationary spatial process can be assumed. Inside of those boundaries, traditional geostatistics methods like kriging can be used for interpolation. The automatic region partitioning algorithm utilizes multiple climatic covariates.

Data Collection and Processing

What does the direct data from the soil moisture stations look like?

```
head(example_soil_data)
```

```
##   Serial.Number     Station.Name Station.Id Network Elevation.meter. Latitude
## 1             1      Agua Canyon        907    SNTL         2712.720 37.52217
## 2             2    Bear River RS        992    SNTL         2675.230 40.88520
## 3             3      Beaver Dams        329    SNTL         2435.352 39.13683
## 4             4    Beaver Divide        330    SNTL         2523.744 40.61233
## 5             5  Ben Lomond Peak        332    SNTL         2343.607 41.37603
## 6             6 Ben Lomond Trail        333    SNTL         1820.266 41.38291
##   Longitude Wind.Speed.m.s. Air.Temperature.C.          Start.Date
## 1 -112.2712         -999999          8.7222222 2017-09-20 00:00:00
## 2 -110.8277         -999999         -0.1111111 2017-09-20 00:00:00
## 3 -111.5581         -999999          3.1111111 2017-09-20 00:00:00
## 4 -111.0978         -999999         -0.2777778 2017-09-20 00:00:00
## 5 -111.9441         -999999          2.8888889 2017-09-20 00:00:00
## 6 -111.9210         -999999          1.1111111 2017-09-20 00:00:00
##   Precipitation.for.1.day Precipitation.for.2.days Precipitation.for.3.days
## 1                    0.00                    0.00                    0.00
## 2                   17.78                   17.78                   17.78
```

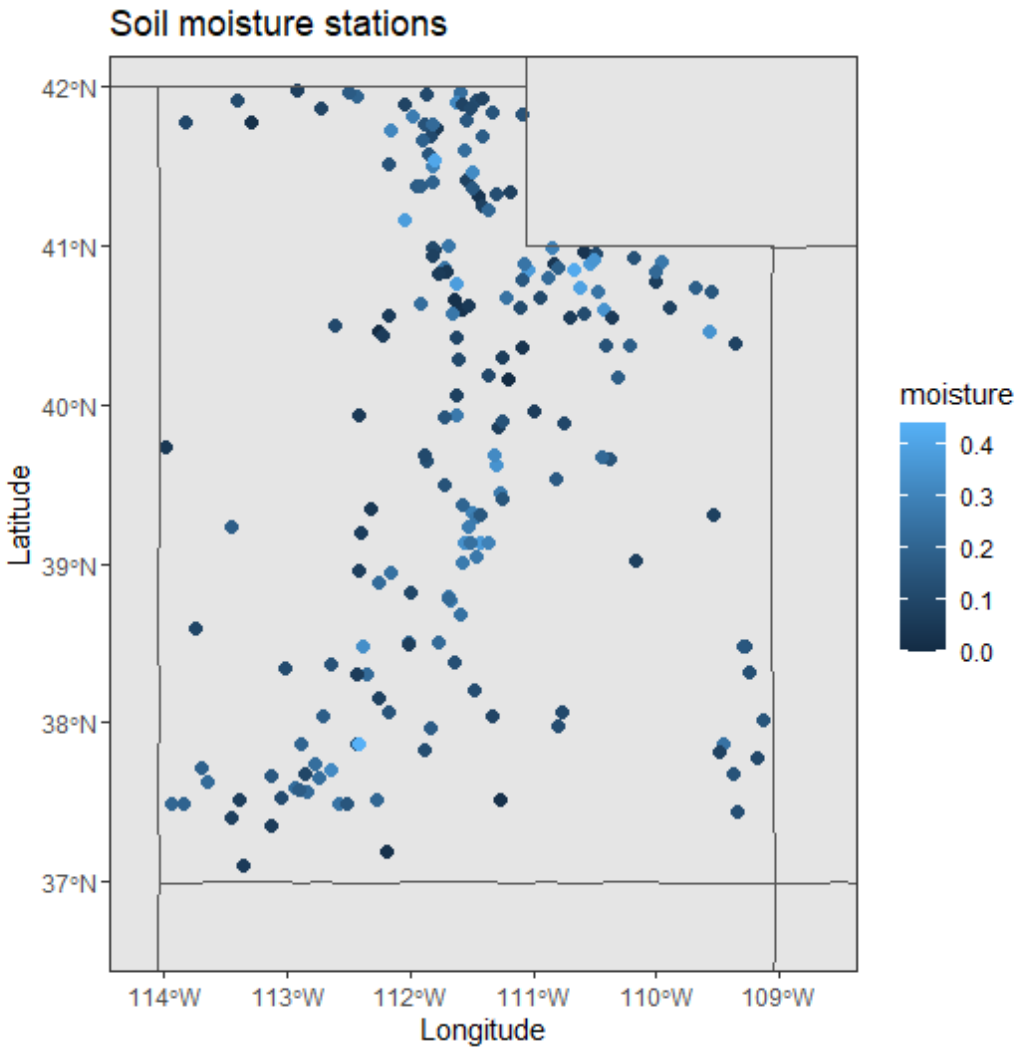

Figure 1: Soil moisture stations

```
## 3                    0.00                    0.00                    0.00
## 4                   15.24                   15.24                   15.24
## 5                    5.08                    7.62                    7.62
## 6                   15.24                   22.86                   22.86
##   Precipitation.for.4.days Precipitation.for.5.days  sm_2    sm_4  sm_8 sm_20
## 1                    0.00                    2.54 0.186 -999999 0.206 0.106
## 2                   20.32                   35.56 0.190 -999999 0.042 0.030
## 3                    0.00                   22.86 0.340 -999999 0.337 0.303
## 4                   15.24                   35.56 0.140 -999999 0.115 0.069
## 5                   12.70                   25.40 0.195 -999999 0.174 0.047
## 6                   22.86                   40.64 0.146 -999999 0.179 0.136
##     sm_40  st_2    st_4  st_8 st_20   st_40
## 1 -999999 11.67 -999999 13.89 13.33 -999999
## 2 -999999  6.11 -999999  6.11  8.33 -999999
## 3 -999999 10.00 -999999 11.67 12.22 -999999
## 4 -999999  5.00 -999999  8.89 11.11 -999999
## 5 -999999  4.44 -999999  8.33  8.89 -999999
## 6 -999999  8.33 -999999 10.00 11.11 -999999
```