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Finding 1

Several types of noise are present in the sensor data. Some sensors get “stuck” and repeat the same value rather than measure anything in the environment. All sensors experience salt-and-pepper noise, where one sensor reading would be several orders of magnitude larger than readings immediately before or after. It was necessary to scrub both types of noise in order to analyze the underlying data. All sensors also exhibited Gaussian-like fluctuations in their readings, which are visible in the below figure as “fuzzy caterpillars.”

Other anomalies were worth preserving. Several sensors show a “gradual spike,” where sensor readings rise significantly higher than background levels over the course of approximately a minute. Sensors can exhibit “plateaus,” where their radiation readings will jump from varying around one value to a different one. This is usually found in mobile sensors, though static sensor #11 also has this behavior. Many sensors also experience missing data, excluding the scrubbed noise mentioned before. The above figure has examples of all three anomalies.

We observed no direct change in radiation levels due to earthquakes. The primary shock of the earthquake occurred on April 8th at approximately 8:30AM, yet the first statistical anomaly does not occur until approximately 1:25PM. As of 6:00AM, the median clicks-per-minute over all sensors was 28.06; as of 4:00PM, it was 28.25. The 16th and 84th percentiles show equally slight increases, from 16.3 to 16.7 and 38.7 to 39.0, respectively, over the same timespan. In contrast, there is more variation in the median between 6:05AM (28.1) and 7:15AM (29.45).

The evidence for an overall increase is mixed; between 8:00AM on April 6th and midnight on April 11th, the median radiation level for all grid squares increased a negligible amount, from 28 to 30.5. After that time, there is a strong increase in radiation levels at the Always Safe plant, Downtown at 9:15PM, the mean cpm at (174500,140500), rises to 65 cpmin at roughly 1:45PM and by the end of the dataset has peaked at 78; in contrast, the Always Safe plant peaks at 325 cpm and by the end has fallen to 82.

April 10th sees the West Wilson Forest Highway anomaly reach a mean cpm of over 1,000, by far the highest on the map. Both the South Jade Bridge and Scenic Vista anomolies have readings twice as large as the nuclear plant, though by the end of the day the former will drop to the same as the plant.

After the cutoff date, Palace Hills, the Northern half of Southwest, and East Parton show a gradual increase in radiation levels. This may be due to employees of the nuclear plant commuting between the plant and their homes with mbl contamination on their cars.

Internal Design

Updating the Gaussian Inverse-Gamma conjugate prior required a sample variance calculation, which was impossible with a single observation. We instead held these observations until either a second observation arrived, or a set time had passed. In the latter case, the prior’s maximal likelihood mean was used to estimate the variance.

The exponential decay applied to the conjugate prior was adjusted so that an observation from twelve hours ago is worth approximately 37% of a current observation. Salt-and-pepper noise was detected by a windowed and modified Z-score, with the median substituted for the mean. If an observation was consistent with the mean, the observation was discarded.