

**INFORMATION TECHNOLOGY/ARTIFICIAL INTELLIGENCE**

**PROJECT: Artificial Intelligence for EM Problem Set (Soil and Groundwater) – Sensor Data Analysis and Visualization from the Wells at the SRS F-Area using Machine Learning / Deep Learning**

**CLIENT: U.S. Department of Energy**  
**SITE: LBNL, SRNL**  
**PRINCIPAL INVESTIGATOR: Dr. Leonel Lagos**

**Description:**

The traditional method of groundwater monitoring for contaminant transport dynamics based on periodic collection and analysis of samples is not suitable for forecasting and proactive measurement to ensure regulatory compliance. Department of Energy - Office of Environmental Management (DOE-EM) has taken the initiative to develop a new paradigm for long term monitoring of groundwater, which can be automated and suitable for applying Artificial Intelligence.

The overall objective of this project is to determine the most optimal well locations to place Aqua TROLL 500 sensors in the Savannah River Site (SRS) F-Area. The well locations should be chosen with the aim of capturing the overall contamination and groundwater movement.

**Objectives:**

- Data Exploration and Pre-processing such as Time series exploration, Resampling, and Interpolation.
- Spatial Estimation.
- Optimization algorithm implementation.
- Majority Voting.

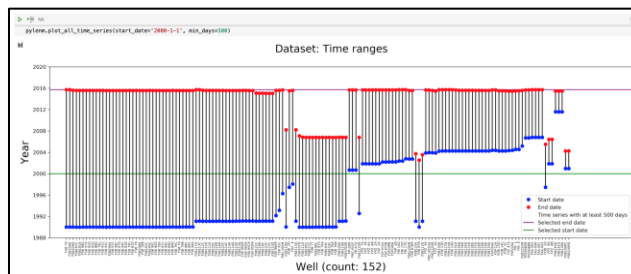
**Benefits:**

- Identification of a subset of wells that captures the overall plume dynamic in order of contribution.
- Capacity to handle multivariate information (multiple analytes and timeframes) through majority voting.
- Development of a spatial estimation method that is independent from the optimization and

therefore interchangeable to suit the needs of the data.

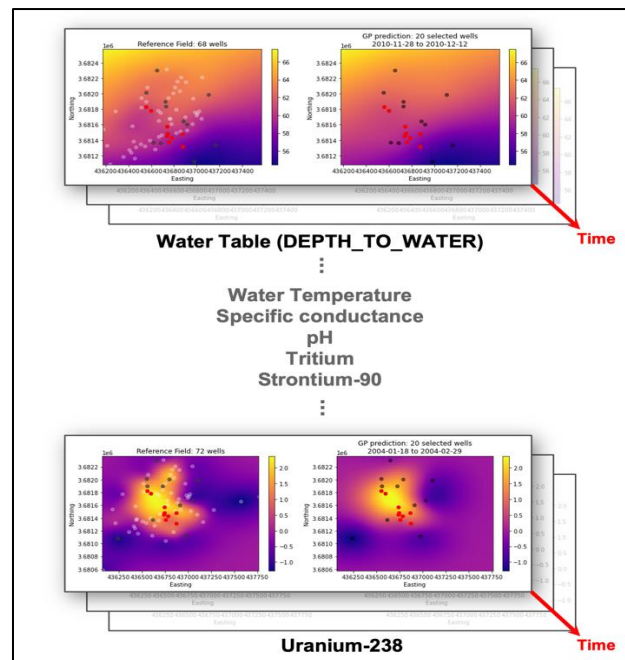
**Accomplishments:**

- Developed a suite of preprocessing and visualization tools to understand the pattern of the data for processing.



**Time series exploration with at least 500 days of data**

- Identified key analytes for the sensor placement optimization by finding the correlation between in-situ sensors and contaminant.



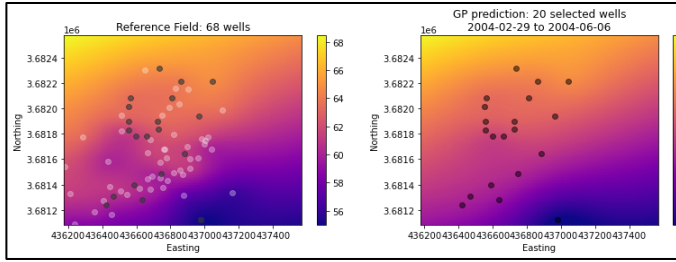
**Optimization process through aggregation of time series buckets for each analyte**

**ABOUT**

Since 1995, the Applied Research Center at Florida International University has provided critical support to the Department of Energy's Office of Environmental Management mission of accelerated risk reduction and cleanup of the environmental legacy of the nation's nuclear weapons program. ARC's research performed under the DOE-FIU Cooperative Agreement (Contract#DE-EM0005213) can be classified as fundamental/basic, proof of principle, prototyping and laboratory experimentation.

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- Developed a spatial estimation pipeline to optimize its parameters based on the given input.



**Selection algorithm applied to water table data**

- Selection of 13 well locations by LBNL that appeared in the recommended top 20 and another two that appeared in the top 22 to install new Aqua TROLL 500 sensors.
- Developed and deployed an open-source python package called pyLEnM to analyze contaminated groundwater datasets including sensor placement optimization tools.

Rank	well name	W preset Run (Count)	W preset Run (%)
Preset	FSB126D	32	100.00%
Preset	FSB130D	32	100.00%
Preset	FSB 97D	32	100.00%
Preset	FSB 79	32	100.00%
Preset	FSB 95DR	32	100.00%
Preset	FPZ 6A	32	100.00%
Preset	FPZ 4A	28	87.50%
Preset	FSP-12A	28	87.50%
Preset	FSB131D	24	75.00%
<b>1</b>	<b>FSB 92D</b>	<b>18</b>	<b>56.25%</b>
<b>2</b>	<b>FSB108D</b>	<b>16</b>	<b>50.00%</b>
<b>3</b>	<b>FSB116D</b>	<b>16</b>	<b>50.00%</b>
<b>4</b>	<b>FSB124D</b>	<b>15</b>	<b>46.88%</b>
<b>5</b>	<b>FSB 91D</b>	<b>14</b>	<b>43.75%</b>
<b>6</b>	<b>FSB 93D</b>	<b>13</b>	<b>40.63%</b>
<b>7</b>	<b>FSB 94DR</b>	<b>13</b>	<b>40.63%</b>
<b>8</b>	<b>FSB 87D</b>	<b>12</b>	<b>37.50%</b>
<b>9</b>	<b>FSB132D</b>	<b>12</b>	<b>37.50%</b>
<b>10</b>	<b>FSB 99D</b>	<b>12</b>	<b>37.50%</b>
<b>11</b>	<b>FSB138D</b>	<b>12</b>	<b>37.50%</b>
<b>12</b>	<b>FOB 14D</b>	<b>12</b>	<b>37.50%</b>
<b>13</b>	<b>FSB123D</b>	<b>12</b>	<b>37.50%</b>
<b>14</b>	<b>FSB134D</b>	<b>11</b>	<b>34.38%</b>
<b>15</b>	<b>FBI 17D</b>	<b>10</b>	<b>31.25%</b>
<b>16</b>	<b>FOB 13D</b>	<b>10</b>	<b>31.25%</b>
<b>17</b>	<b>FSB129D</b>	<b>9</b>	<b>28.13%</b>
<b>18</b>	<b>FEX 4</b>	<b>8</b>	<b>25.00%</b>
<b>19</b>	<b>FSB112DR</b>	<b>8</b>	<b>25.00%</b>
<b>20</b>	<b>FSB118D</b>	<b>8</b>	<b>25.00%</b>
<b>21</b>	<b>FSB 78</b>	<b>8</b>	<b>25.00%</b>
<b>22</b>	<b>FSB120D</b>	<b>8</b>	<b>25.00%</b>
<b>23</b>	<b>FSB122D</b>	<b>8</b>	<b>25.00%</b>
<b>24</b>	<b>FSB 88D</b>	<b>8</b>	<b>25.00%</b>
<b>25</b>	<b>FSB115D</b>	<b>8</b>	<b>25.00%</b>
<b>26</b>	<b>FSB109D</b>	<b>8</b>	<b>25.00%</b>
<b>27</b>	<b>FSB135D</b>	<b>7</b>	<b>21.88%</b>
<b>28</b>	<b>FSB 98D</b>	<b>7</b>	<b>21.88%</b>
<b>29</b>	<b>FSB125DR</b>	<b>7</b>	<b>21.88%</b>
<b>30</b>	<b>FSB104D</b>	<b>6</b>	<b>18.75%</b>
<b>31</b>	<b>FSB117D</b>	<b>6</b>	<b>18.75%</b>
<b>32</b>	<b>FBI 15D</b>	<b>6</b>	<b>18.75%</b>
<b>33</b>	<b>FSB114D</b>	<b>6</b>	<b>18.75%</b>
<b>34</b>	<b>FSB128D</b>	<b>4</b>	<b>12.50%</b>
<b>35</b>	<b>FSB136D</b>	<b>4</b>	<b>12.50%</b>
<b>36</b>	<b>FSB137D</b>	<b>4</b>	<b>12.50%</b>
<b>37</b>	<b>FSB133D</b>	<b>4</b>	<b>12.50%</b>
<b>38</b>	<b>FSB127D</b>	<b>4</b>	<b>12.50%</b>
<b>39</b>	<b>FSB 76</b>	<b>4</b>	<b>12.50%</b>
<b>40</b>	<b>FBI 14D</b>	<b>4</b>	<b>12.50%</b>
<b>41</b>	<b>FSB 90D</b>	<b>4</b>	<b>12.50%</b>
<b>42</b>	<b>FSB 89D</b>	<b>2</b>	<b>6.25%</b>
<b>43</b>	<b>FOB 15D</b>	<b>#N/A</b>	<b>#N/A</b>
<b>44</b>	<b>FIB 1</b>	<b>#N/A</b>	<b>#N/A</b>
<b>45</b>	<b>FIB 8</b>	<b>#N/A</b>	<b>#N/A</b>
<b>46</b>	<b>FOB 2D</b>	<b>#N/A</b>	<b>#N/A</b>

**Well selection results to install Aqua TROLL 500 sensors**