SAND2015-7174C

# Slycat Ensemble Analysis & Visualization

## Workshop on Next-Generation Analytics for the Future Power Grid

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Patricia Crossno, Ph.D.

Sandia National Laboratories

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SANDXXXX

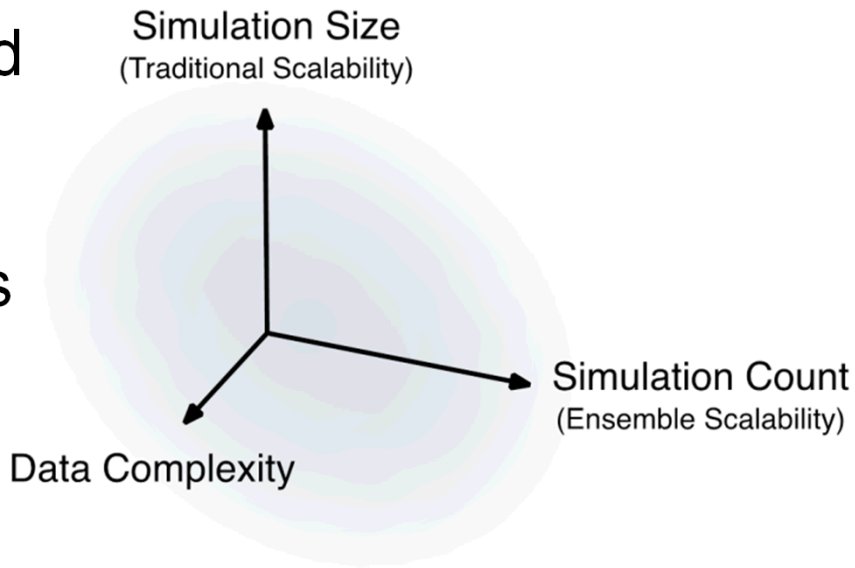
NNSA National Nuclear Security Administration

CCR Center for Computing Research

Sandia National Laboratories

# A Different Scaling Problem

We run thousands of related simulations to sample a shared problem space (an ensemble), but we lack scalable tools to analyze or visualize the results as a whole.



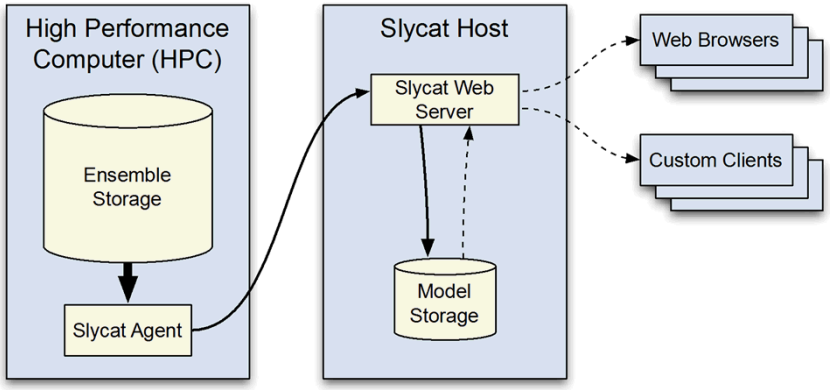

**Ensemble Challenges:**

- **Data Management:** How do we interactively explore remote ensemble data as it scales?
- **Interpretation:** How do we understand thousands of runs as a group?
- **Representations:** What visual abstractions can we use to reveal group behaviors?

# Slycat – Analysis as a Service

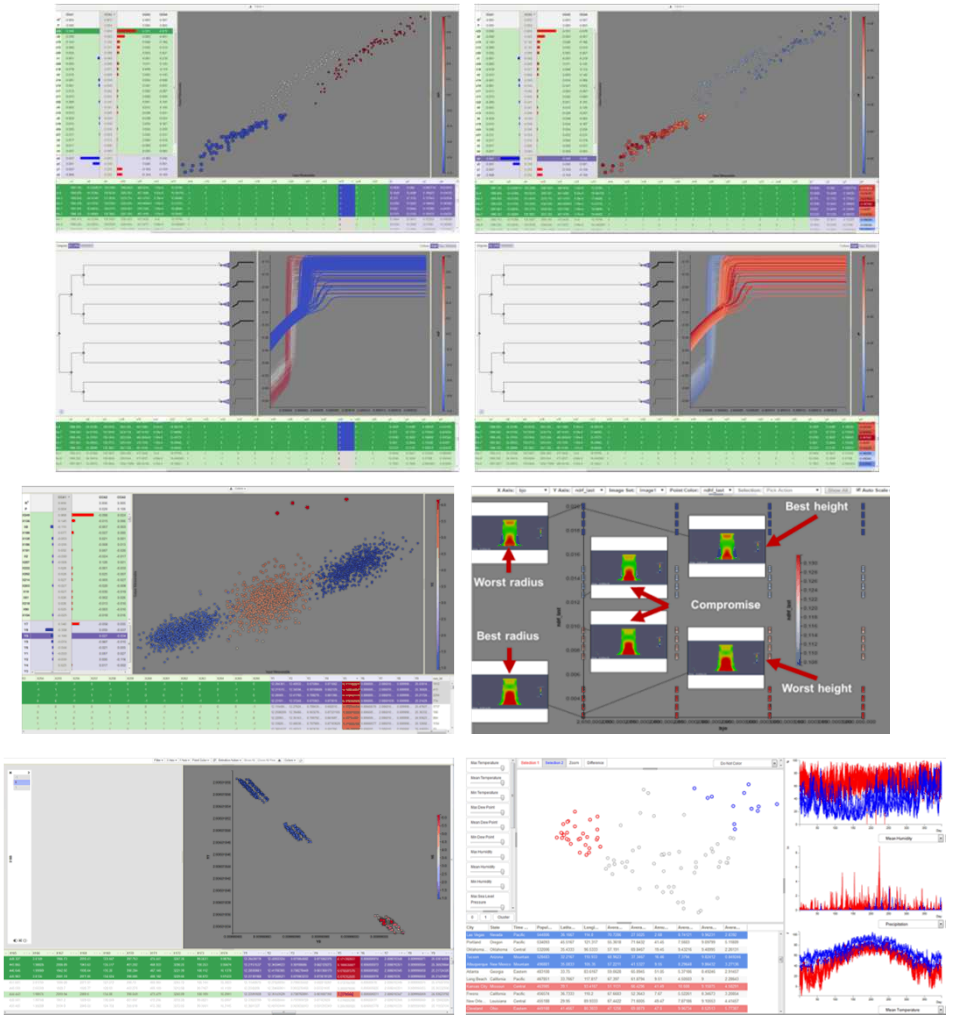
Slycat Server with Remote Desktop Delivery

- HPC-based agents operate on ensemble data in place
- Slycat server stores and manipulates analysis models
- Models are visualized remotely, interactively, and collaboratively
- Models support sensitivity analysis, anomaly detection, and parameter space exploration



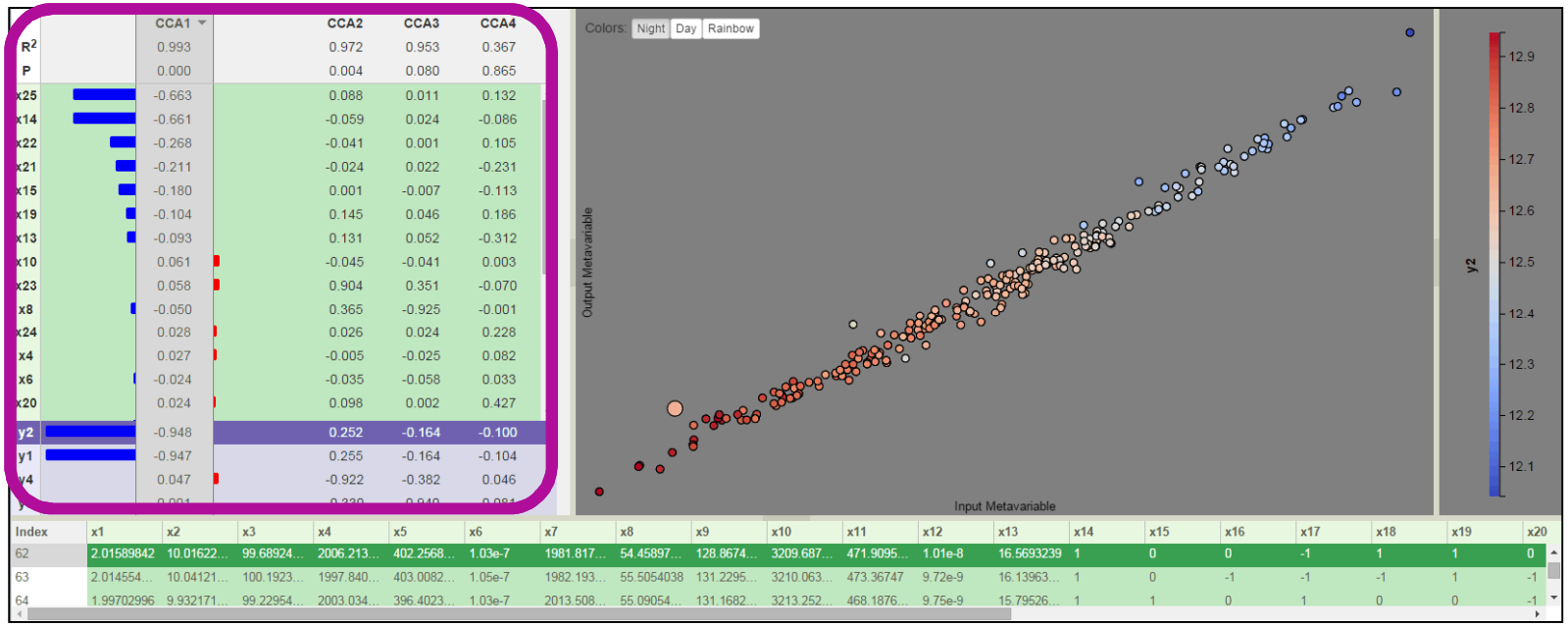
# Ensemble Use Cases

- Sensitivity Analysis
  - Model Understanding
  - Model Simplification
- Anomaly Detection
  - Unique Features
  - Debugging
- Parameter Space Exploration
  - Optimization
  - Solution Robustness
  - Result Clustering
- Ensemble Comparison



# Multiple Levels of Abstraction

- Ensemble summaries (correlations or similarities)



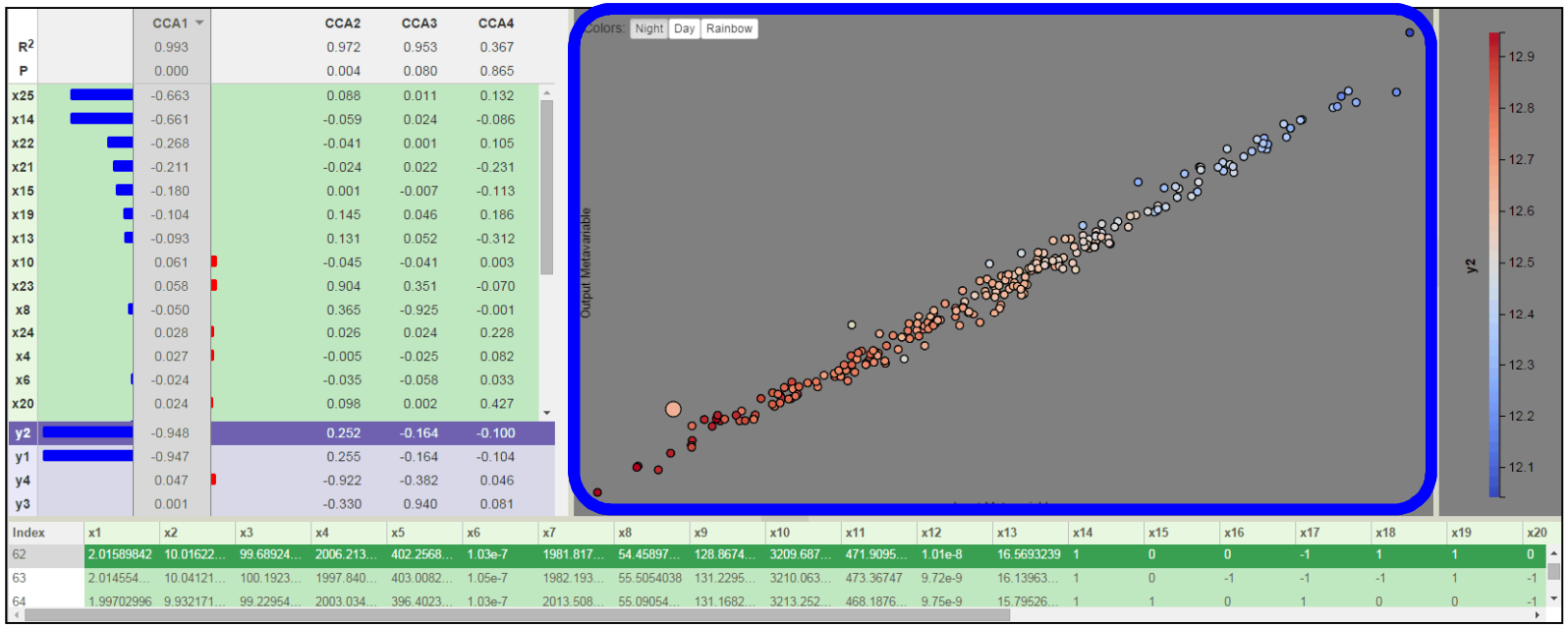
| | CCA1 | CCA2 | CCA3 | CCA4 |
|---|---|---|---|---|
| $R^2$ | 0.993 | 0.972 | 0.953 | 0.367 |
| P | 0.000 | 0.004 | 0.080 | 0.865 |
| x25 | -0.663 | 0.088 | 0.011 | 0.132 |
| x14 | -0.661 | -0.059 | 0.024 | -0.086 |
| x22 | -0.268 | -0.041 | 0.001 | 0.105 |
| x21 | -0.211 | -0.024 | 0.022 | -0.231 |
| x15 | -0.180 | 0.001 | -0.007 | -0.113 |
| x19 | -0.104 | 0.145 | 0.046 | 0.186 |
| x13 | -0.093 | 0.131 | 0.052 | -0.312 |
| x10 | 0.061 | -0.045 | -0.041 | 0.003 |
| x23 | 0.058 | 0.904 | 0.351 | -0.070 |
| x8 | -0.050 | 0.365 | -0.925 | -0.001 |
| x24 | 0.028 | 0.026 | 0.024 | 0.228 |
| x4 | 0.027 | -0.005 | -0.025 | 0.082 |
| x6 | -0.024 | -0.035 | -0.058 | 0.033 |
| x20 | 0.024 | 0.098 | 0.002 | 0.427 |
| y2 | -0.948 | 0.252 | -0.164 | -0.100 |
| y1 | -0.947 | 0.255 | -0.164 | -0.104 |
| y4 | 0.047 | -0.922 | -0.382 | 0.046 |



| Index | x1 | x2 | x3 | x4 | x5 | x6 | x7 | x8 | x9 | x10 | x11 | x12 | x13 | x14 | x15 | x16 | x17 | x18 | x19 | x20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 | 2.01589842 | 10.01622... | 99.68924... | 2006.213... | 402.2568... | 1.03e-7 | 1981.817... | 54.45897... | 128.8674... | 3209.687... | 471.9095... | 1.01e-8 | 16.5693239 | 1 | 0 | 0 | -1 | 1 | 1 | 0 |
| 63 | 2.014554... | 10.04121... | 100.1923... | 1997.840... | 403.0082... | 1.05e-7 | 1982.193... | 55.5054038 | 131.2295... | 3210.063... | 473.36747 | 9.72e-9 | 16.13963... | 1 | 0 | -1 | -1 | -1 | 1 | -1 |
| 64 | 1.99702996 | 9.932171... | 99.22954... | 2003.034... | 396.4023... | 1.03e-7 | 2013.508... | 55.09054... | 131.1682... | 3213.252... | 468.1876... | 9.75e-9 | 15.79526... | 1 | 1 | 0 | 1 | 0 | 0 | -1 |

# Multiple Levels of Abstraction

- Ensemble summaries (correlations or similarities)
- Individual runs relative to the group (distributions or behaviors)



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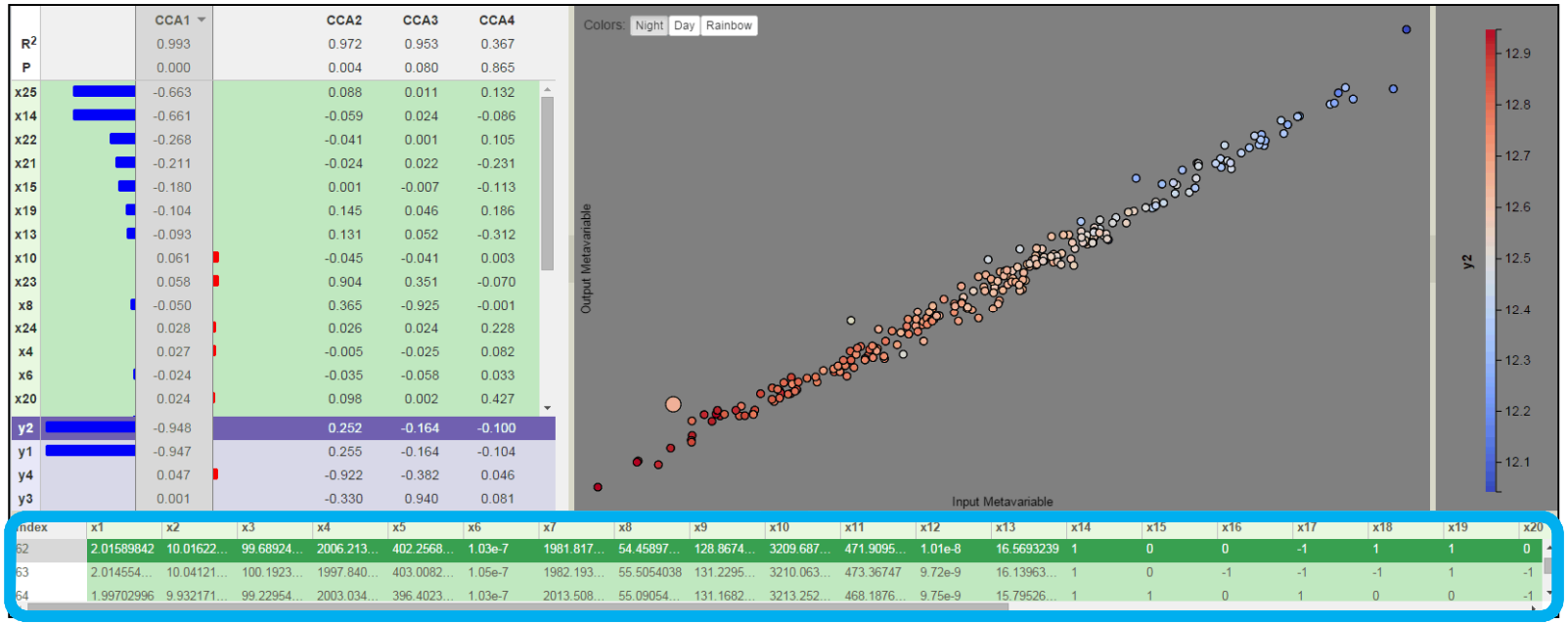
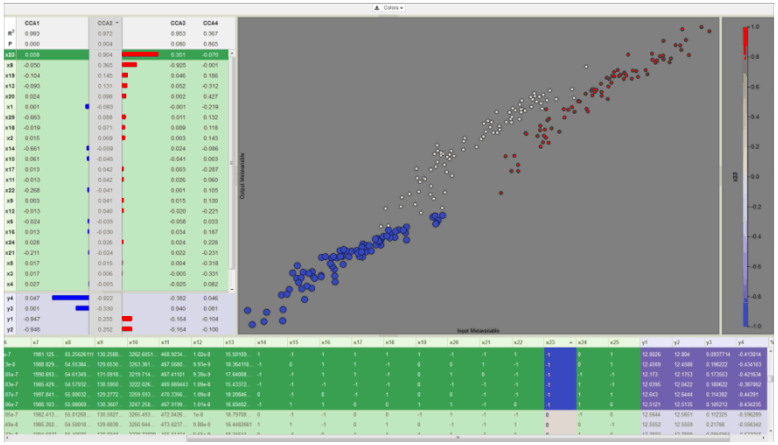
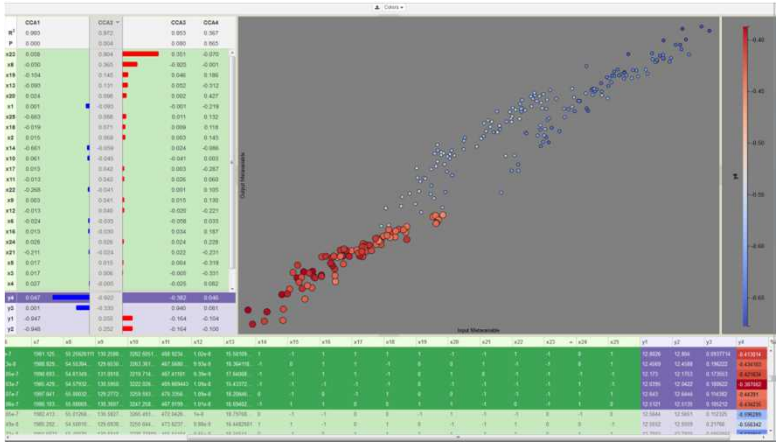
- Individual runs relative to the group (distributions or behaviors)
- Run-specific data (numeric values, images, or videos)



# Ensemble Use Cases: Sensitivity Analysis

- Understanding a user's model
- Validating a user's model
- Simplification of a user's model





Canonical Correlation Analysis:
All-to-all correlations

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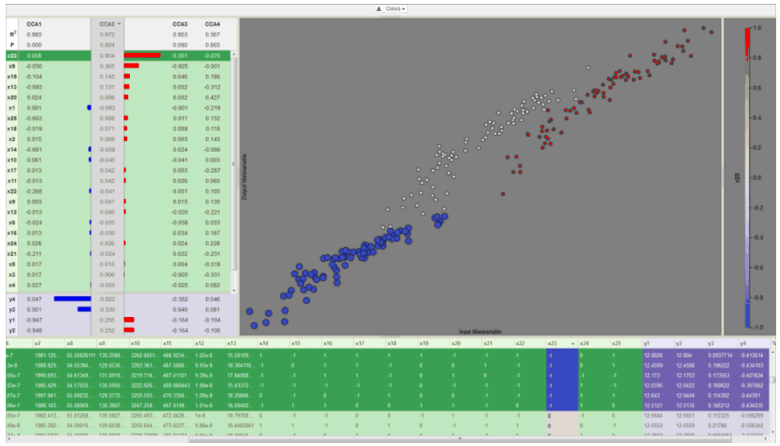

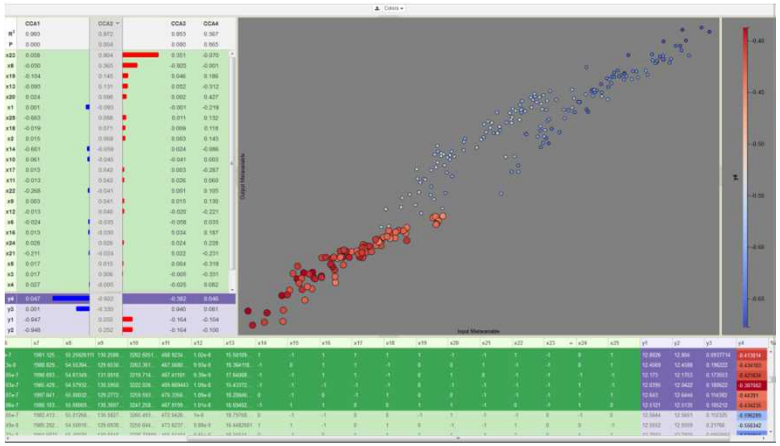

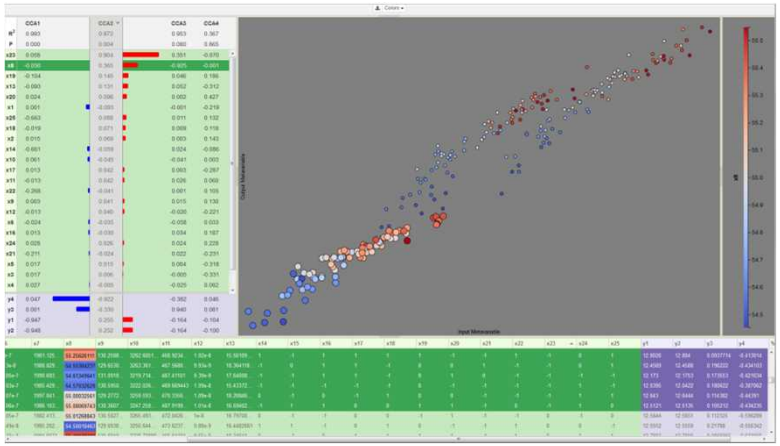

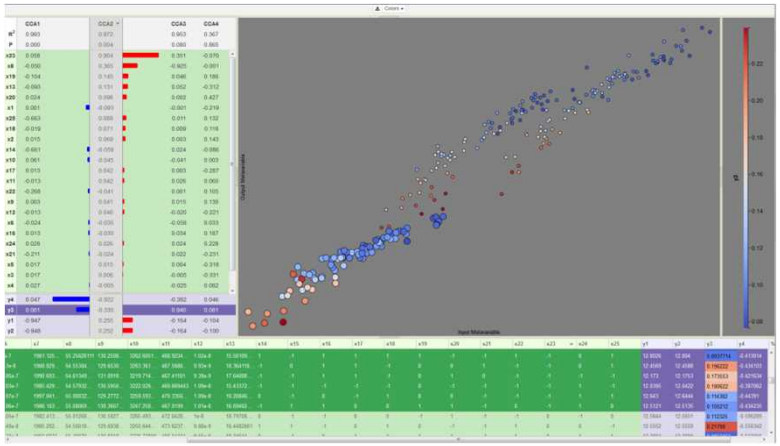

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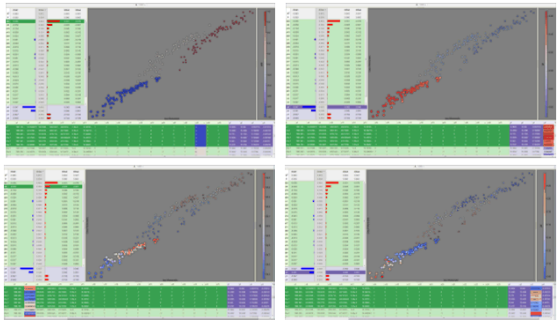

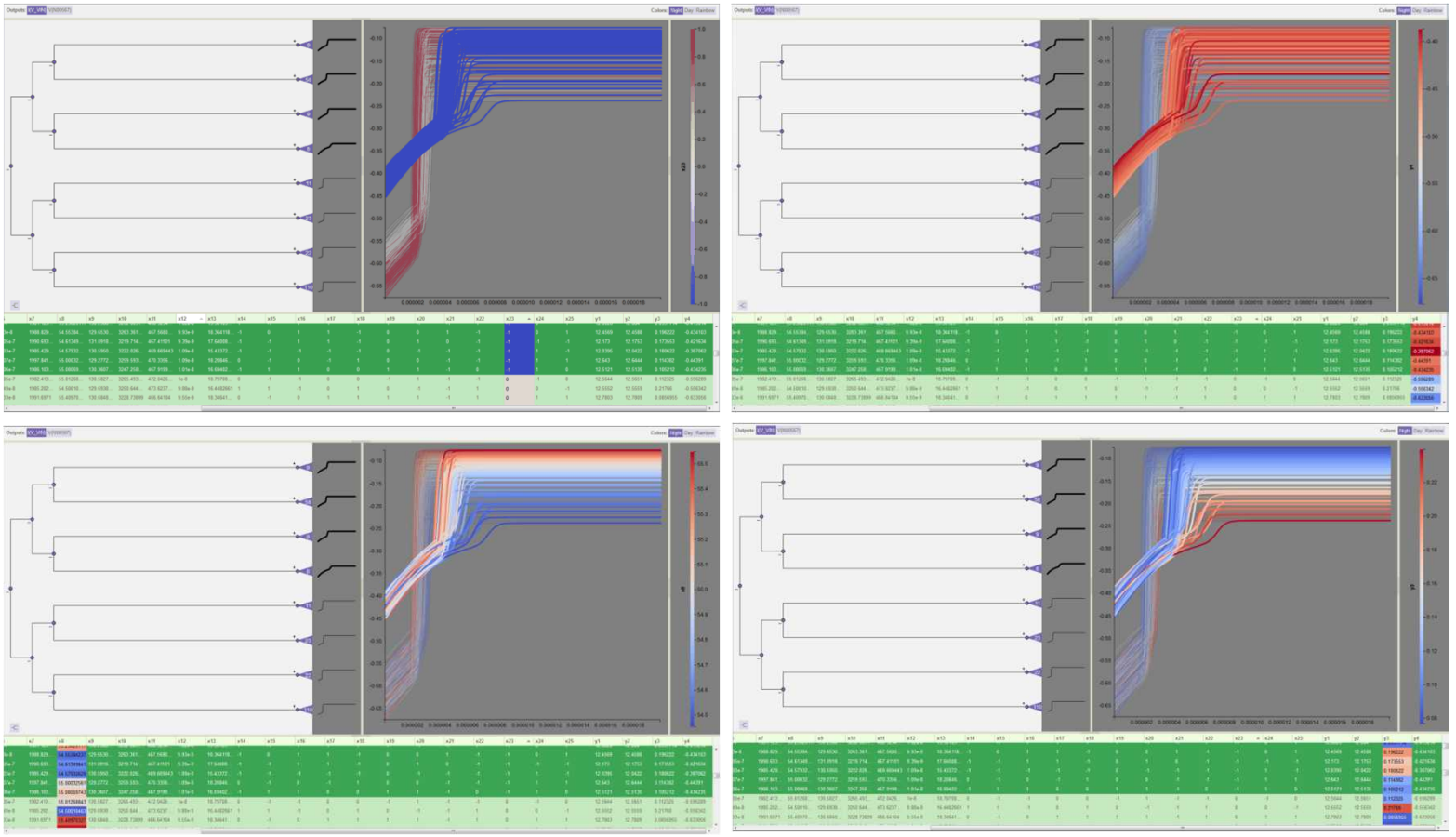

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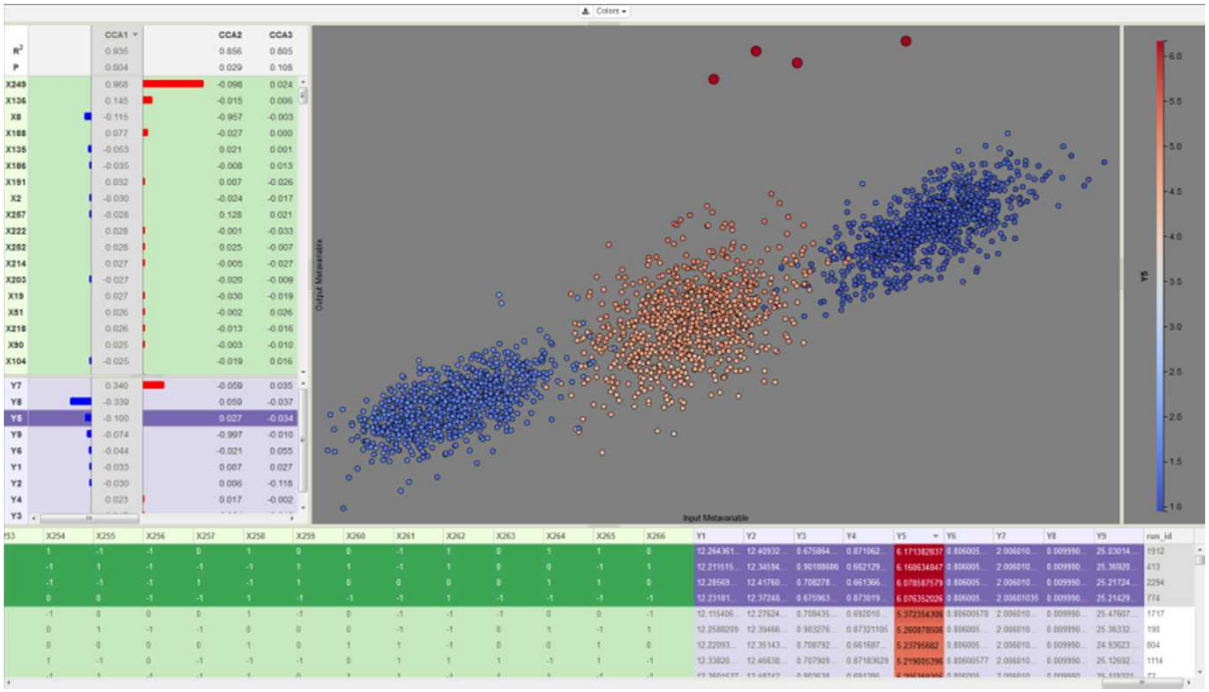


2641 runs each with 266 inputs, 9 outputs
Reduce input variables 266->21

# Ensemble Use Cases

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  - Unique Features
  - Bugs

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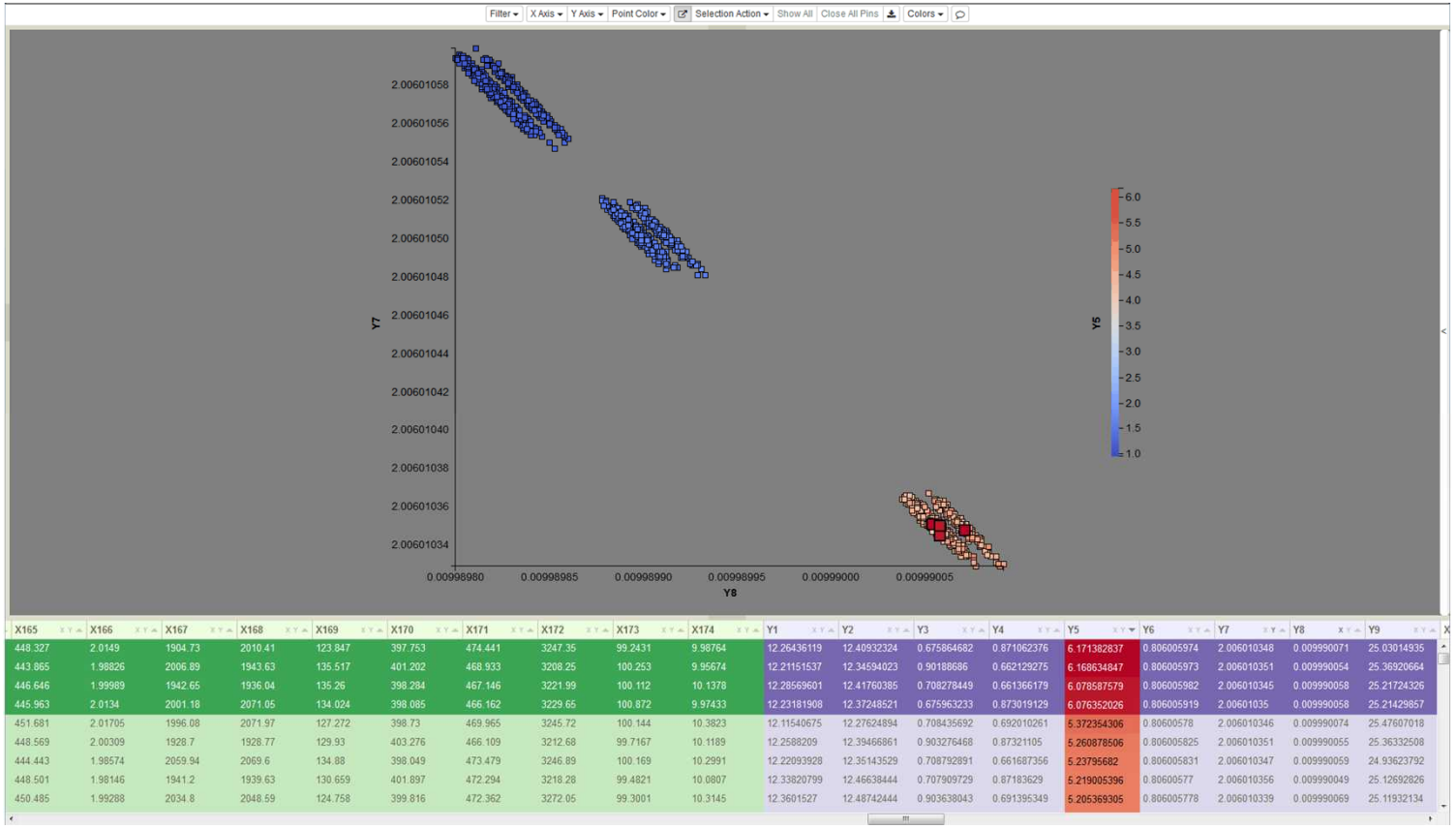


| X165 | X166 | X167 | X168 | X169 | X170 | X171 | X172 | X173 | X174 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y8 | Y9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 448.327 | 2.0149 | 1904.73 | 2010.41 | 123.847 | 397.753 | 474.441 | 3247.35 | 99.2431 | 9.98764 | 12.26436119 | 12.40932324 | 0.675864682 | 0.871062376 | 6.171382837 | 0.806005974 | 2.006010348 | 0.009990071 | 25.03014935 |
| 443.865 | 1.98826 | 2006.89 | 1943.63 | 135.517 | 401.202 | 468.933 | 3208.25 | 100.253 | 9.95674 | 12.21151537 | 12.34594023 | 0.90188686 | 0.662129275 | 6.168634847 | 0.806005973 | 2.006010351 | 0.009990054 | 25.36920664 |
| 446.646 | 1.99989 | 1942.65 | 1936.04 | 135.26 | 398.284 | 467.146 | 3221.99 | 100.112 | 10.1378 | 12.28569601 | 12.41760385 | 0.708278449 | 0.661366179 | 6.078587579 | 0.806005982 | 2.006010345 | 0.009990058 | 25.21724326 |
| 445.963 | 2.0134 | 2001.18 | 2071.05 | 134.024 | 398.085 | 466.162 | 3229.65 | 100.872 | 9.97433 | 12.23181908 | 12.37248521 | 0.675963233 | 0.873019129 | 6.076352026 | 0.806005919 | 2.00601035 | 0.009990058 | 25.21429857 |
| 451.681 | 2.01705 | 1996.08 | 2071.97 | 127.272 | 398.73 | 469.965 | 3245.72 | 100.144 | 10.3823 | 12.11540675 | 12.27624894 | 0.708435692 | 0.692010261 | 5.372354306 | 0.80600578 | 2.006010346 | 0.009990074 | 25.47607018 |
| 448.569 | 2.00309 | 1928.7 | 1928.77 | 129.93 | 403.276 | 466.109 | 3212.68 | 99.7167 | 10.1189 | 12.2588209 | 12.39466861 | 0.903276468 | 0.87321105 | 5.260878506 | 0.806005825 | 2.006010351 | 0.009990055 | 25.36332508 |
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.806005831 | 2.006010347 | 0.009990059 | 24.93623792 |
| 448.501 | 1.98146 | 1941.2 | 1939.63 | 130.659 | 401.897 | 472.294 | 3218.28 | 99.4821 | 10.0807 | 12.33820799 | 12.46638444 | 0.707909729 | 0.87183629 | 5.219005396 | 0.80600577 | 2.006010356 | 0.009990049 | 25.12692826 |
| 450.485 | 1.99288 | 2034.8 | 2048.59 | 124.758 | 399.816 | 472.362 | 3272.05 | 99.3001 | 10.3145 | 12.3601527 | 12.48742444 | 0.903638043 | 0.691395349 | 5.205369305 | 0.806005778 | 2.006010339 | 0.009990069 | 25.11932134 |

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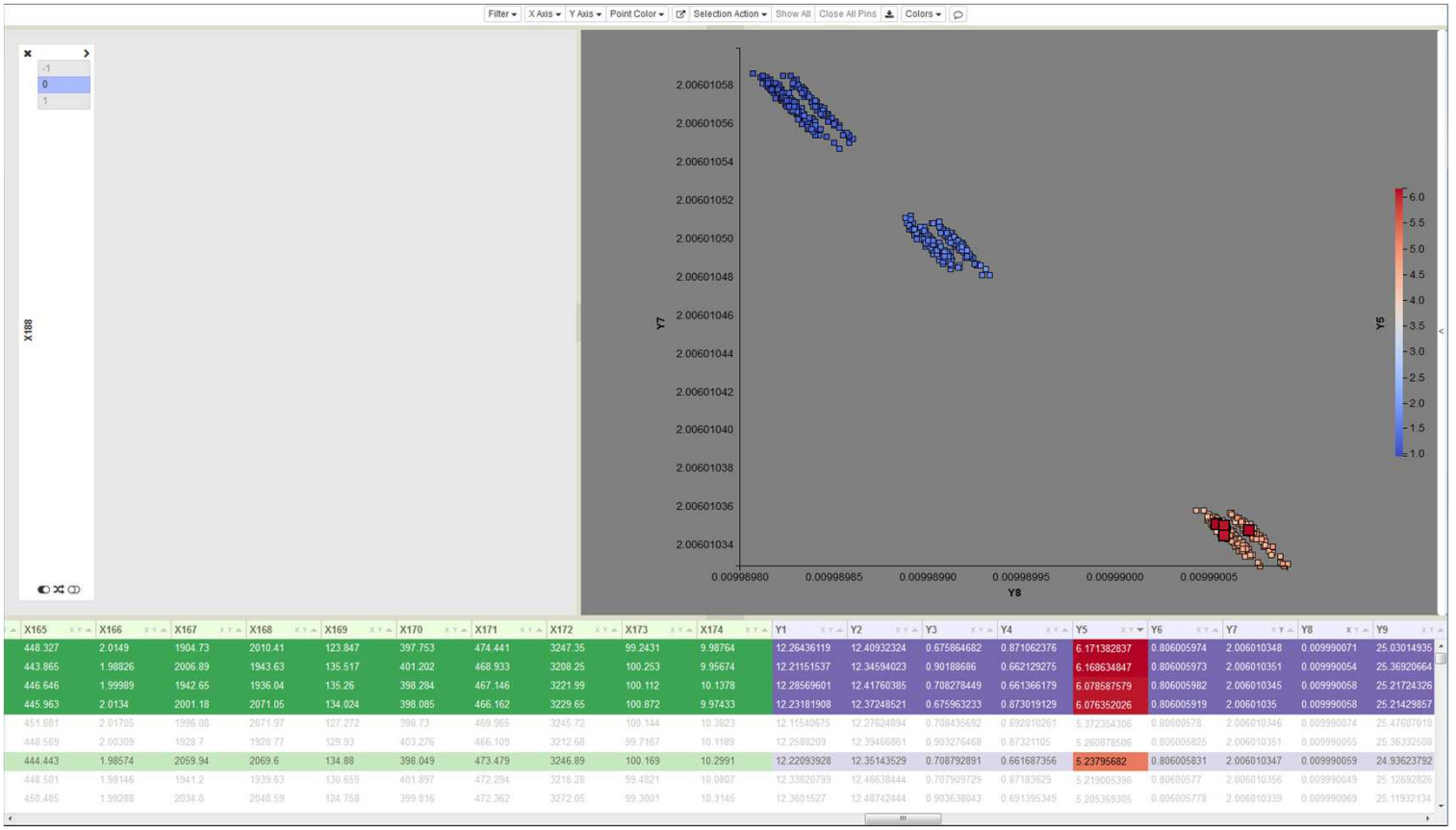


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| 451.681 | 2.01705 | 1996.08 | 2071.97 | 127.272 | 398.73 | 469.965 | 3245.72 | 100.144 | 10.3823 | 12.11540675 | 12.27624894 | 0.708435692 | 0.692010261 | 5.372354306 | 0.806005778 | 2.006010346 | 0.009990074 | 25.47607018 |
| 448.569 | 2.00309 | 1928.7 | 1928.77 | 129.93 | 403.276 | 466.109 | 3212.68 | 99.7167 | 10.1189 | 12.2588209 | 12.39466861 | 0.903276468 | 0.87321105 | 5.260878506 | 0.806005825 | 2.006010351 | 0.009990055 | 25.36332508 |
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.806005831 | 2.006010347 | 0.009990059 | 24.93623792 |
| 448.501 | 1.98146 | 1941.2 | 1939.63 | 130.659 | 401.897 | 472.294 | 3218.28 | 99.4821 | 10.0807 | 12.33820799 | 12.46638444 | 0.707909729 | 0.87183629 | 5.219005396 | 0.80600577 | 2.006010356 | 0.009990049 | 25.12692826 |
| 450.485 | 1.99288 | 2034.8 | 2048.59 | 124.758 | 399.816 | 472.362 | 3272.05 | 99.3001 | 10.3145 | 12.3691527 | 12.48742444 | 0.903638043 | 0.691395349 | 5.205369365 | 0.806005778 | 2.006010339 | 0.009990069 | 25.11932134 |

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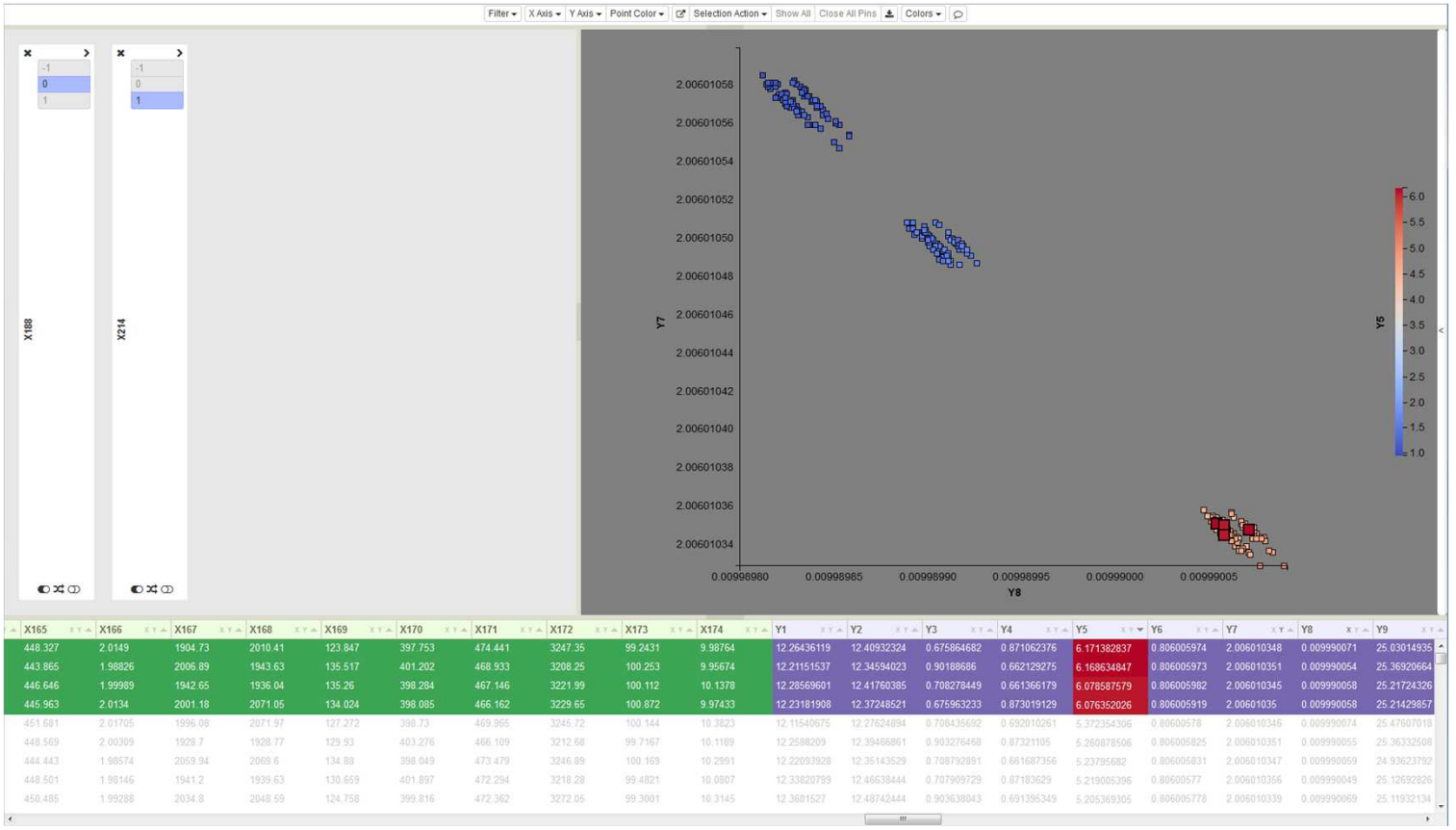


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| 448.569 | 2.00309 | 1928.7 | 1928.77 | 129.93 | 403.276 | 466.109 | 3212.68 | 99.7167 | 10.1189 | 12.2588209 | 12.39466861 | 0.903276468 | 0.87321105 | 5.260878506 | 0.806005825 | 2.006010351 | 0.009990055 | 25.36332508 |
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.806005831 | 2.006010347 | 0.009990059 | 24.93623792 |
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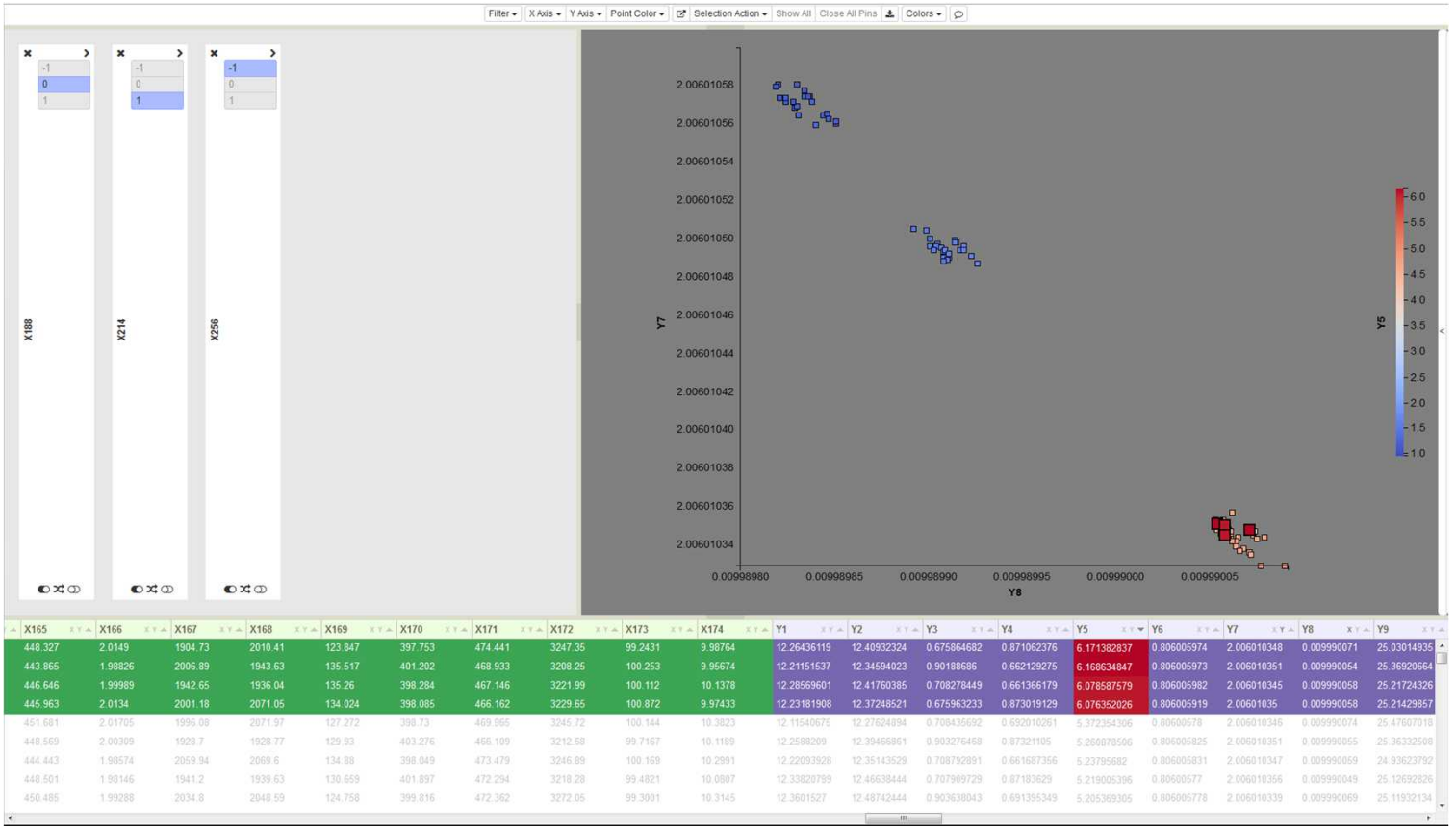


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| 451.681 | 2.01705 | 1996.08 | 2071.97 | 127.272 | 398.73 | 469.966 | 3245.72 | 100.144 | 10.3823 | 12.11540675 | 12.27624894 | 0.708435692 | 0.692010261 | 5.372354306 | 0.80600578 | 2.006010346 | 0.009990074 | 25.47607018 |
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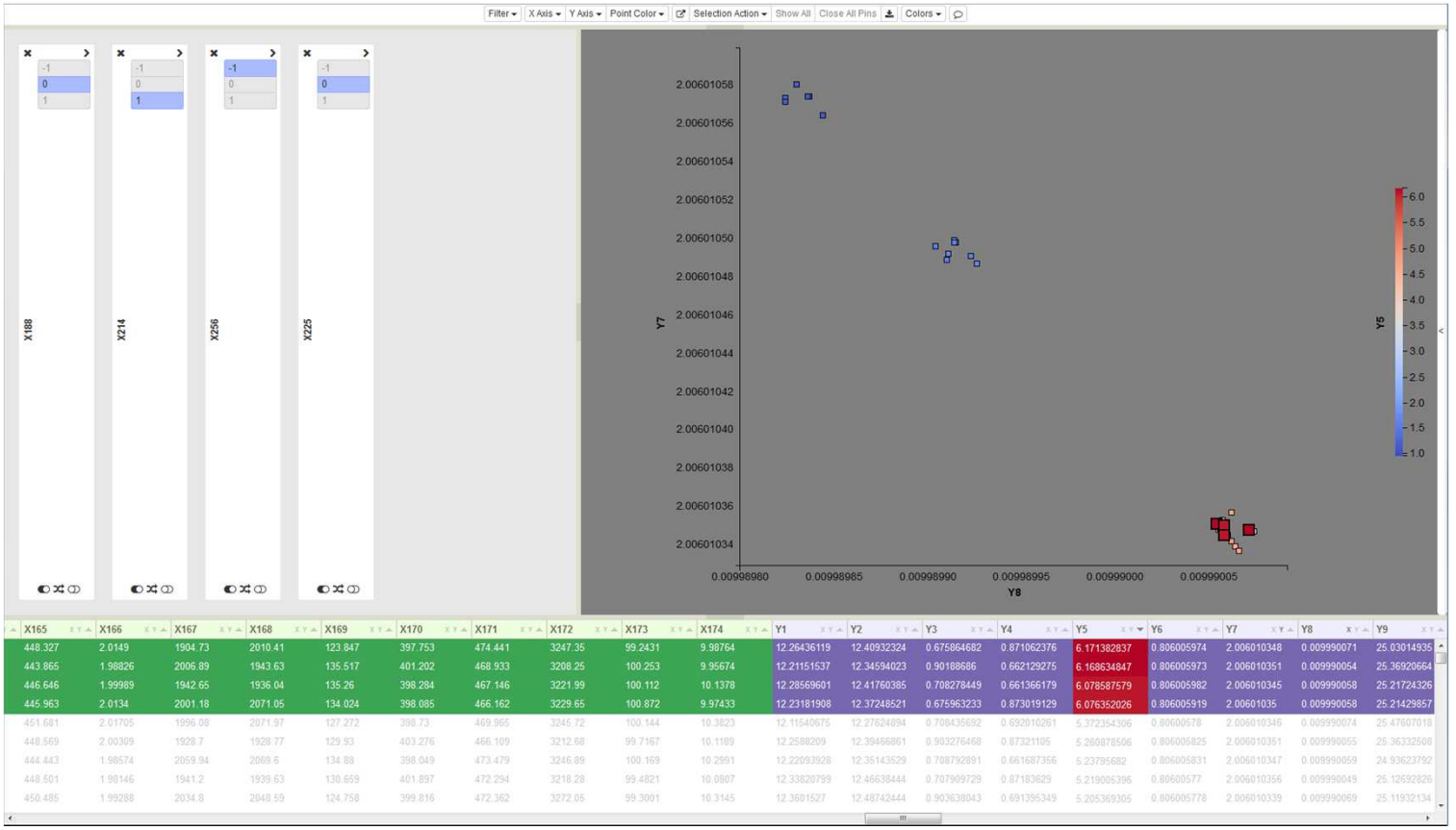
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.806005831 | 2.006010347 | 0.009990059 | 24.93623792 |
| 448.501 | 1.99146 | 1941.2 | 1939.63 | 130.659 | 401.897 | 472.294 | 3218.28 | 99.4821 | 10.0807 | 12.33820799 | 12.46638444 | 0.707909729 | 0.87183629 | 5.219005396 | 0.80600577 | 2.006010356 | 0.009990049 | 25.12692826 |
| 450.485 | 1.99288 | 2034.8 | 2048.59 | 124.758 | 399.816 | 472.362 | 3272.05 | 99.3061 | 10.3145 | 12.3601527 | 12.48742444 | 0.903638043 | 0.691395349 | 5.205369305 | 0.806006778 | 2.006010339 | 0.009990069 | 25.11932134 |

# Ensemble Use Cases

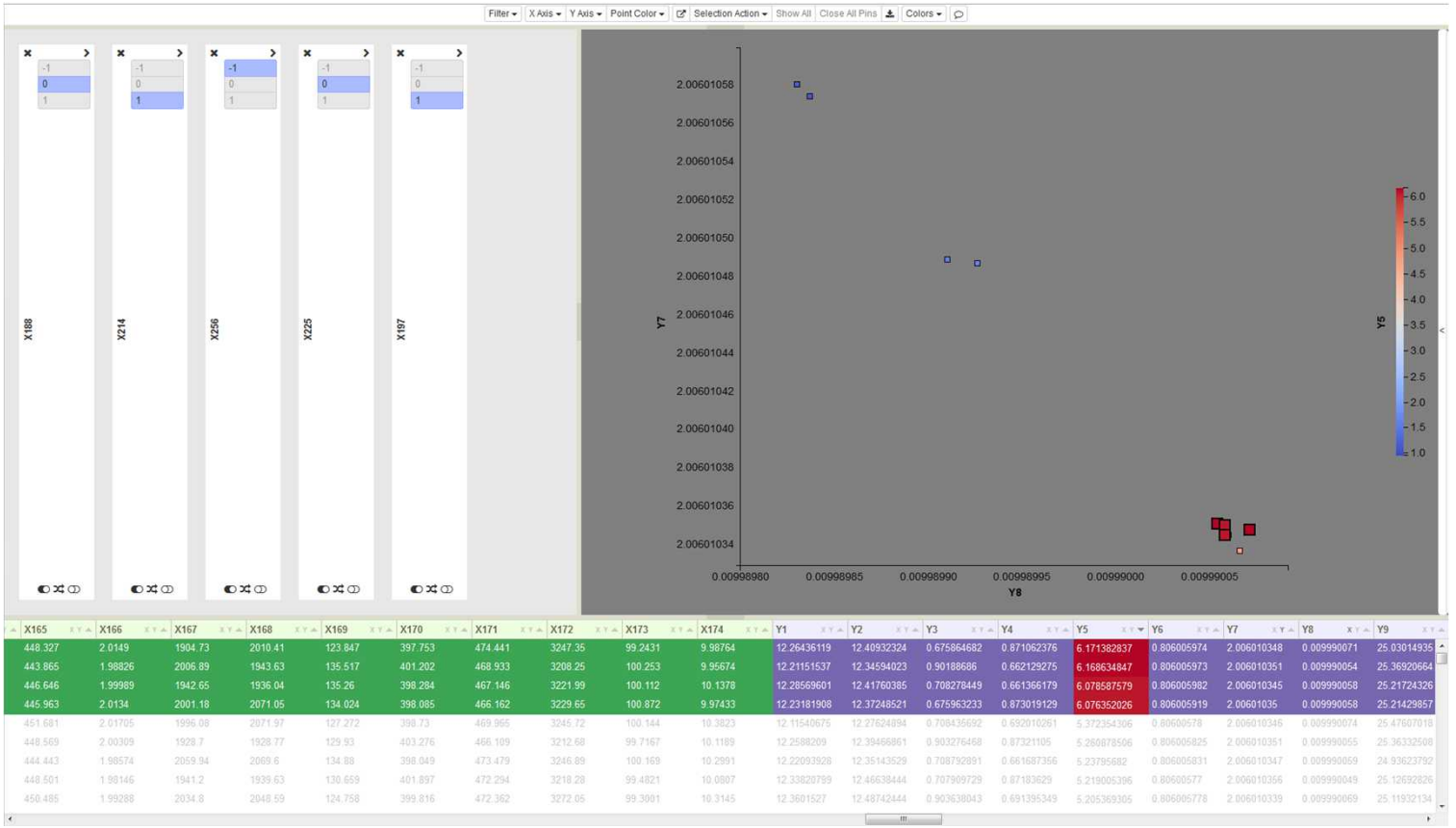
- Anomaly Detection
  - Unique Features
  - Bugs




| X165 | X166 | X167 | X168 | X169 | X170 | X171 | X172 | X173 | X174 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y8 | Y9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 448.327 | 2.0149 | 1904.73 | 2010.41 | 123.847 | 397.753 | 474.441 | 3247.35 | 99.2431 | 9.98764 | 12.26436119 | 12.40932324 | 0.675864682 | 0.871062376 | 6.171382837 | 0.806005974 | 2.006010348 | 0.009990071 | 25.03014935 |
| 443.865 | 1.98826 | 2006.89 | 1943.63 | 135.517 | 401.202 | 468.933 | 3208.25 | 100.253 | 9.95674 | 12.21151537 | 12.34594023 | 0.90188686 | 0.662129275 | 6.168634847 | 0.806005973 | 2.006010351 | 0.009990054 | 25.36920664 |
| 446.646 | 1.99989 | 1942.65 | 1936.04 | 135.26 | 398.284 | 467.146 | 3221.99 | 100.112 | 10.1378 | 12.28569601 | 12.41760385 | 0.708278449 | 0.661366179 | 6.078587579 | 0.806005982 | 2.006010345 | 0.009990058 | 25.21724326 |
| 445.963 | 2.0134 | 2001.18 | 2071.05 | 134.024 | 398.085 | 466.162 | 3229.65 | 100.872 | 9.97433 | 12.23181908 | 12.37248521 | 0.675963233 | 0.873019129 | 6.076352026 | 0.806005919 | 2.00601035 | 0.009990058 | 25.21429857 |
| 451.681 | 2.01705 | 1996.08 | 2071.97 | 127.272 | 398.73 | 469.965 | 3245.72 | 100.144 | 10.3823 | 12.11540675 | 12.27624894 | 0.706435692 | 0.692010261 | 5.372354306 | 0.80600578 | 2.006010346 | 0.009990074 | 25.47607018 |
| 448.569 | 2.00309 | 1928.7 | 1928.77 | 129.93 | 403.276 | 466.109 | 3212.68 | 99.7167 | 10.1189 | 12.2588209 | 12.39466861 | 0.903276468 | 0.87321105 | 5.260878506 | 0.806005825 | 2.006010351 | 0.009990055 | 25.36332508 |
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.80600583 | 2.006010347 | 0.009990059 | 24.93623792 |
| 448.501 | 1.99146 | 1941.2 | 1939.63 | 130.659 | 401.897 | 472.294 | 3218.28 | 99.4821 | 10.0807 | 12.33820739 | 12.46638444 | 0.707909729 | 0.87183629 | 5.219005396 | 0.80600577 | 2.006010356 | 0.009990049 | 25.12692826 |
| 450.485 | 1.99288 | 2034.8 | 2048.59 | 124.758 | 399.816 | 472.362 | 3272.05 | 99.3091 | 10.3145 | 12.3601527 | 12.48742444 | 0.903638043 | 0.691395349 | 5.205369305 | 0.806005778 | 2.006010339 | 0.009990069 | 25.11932134 |

# Ensemble Use Cases

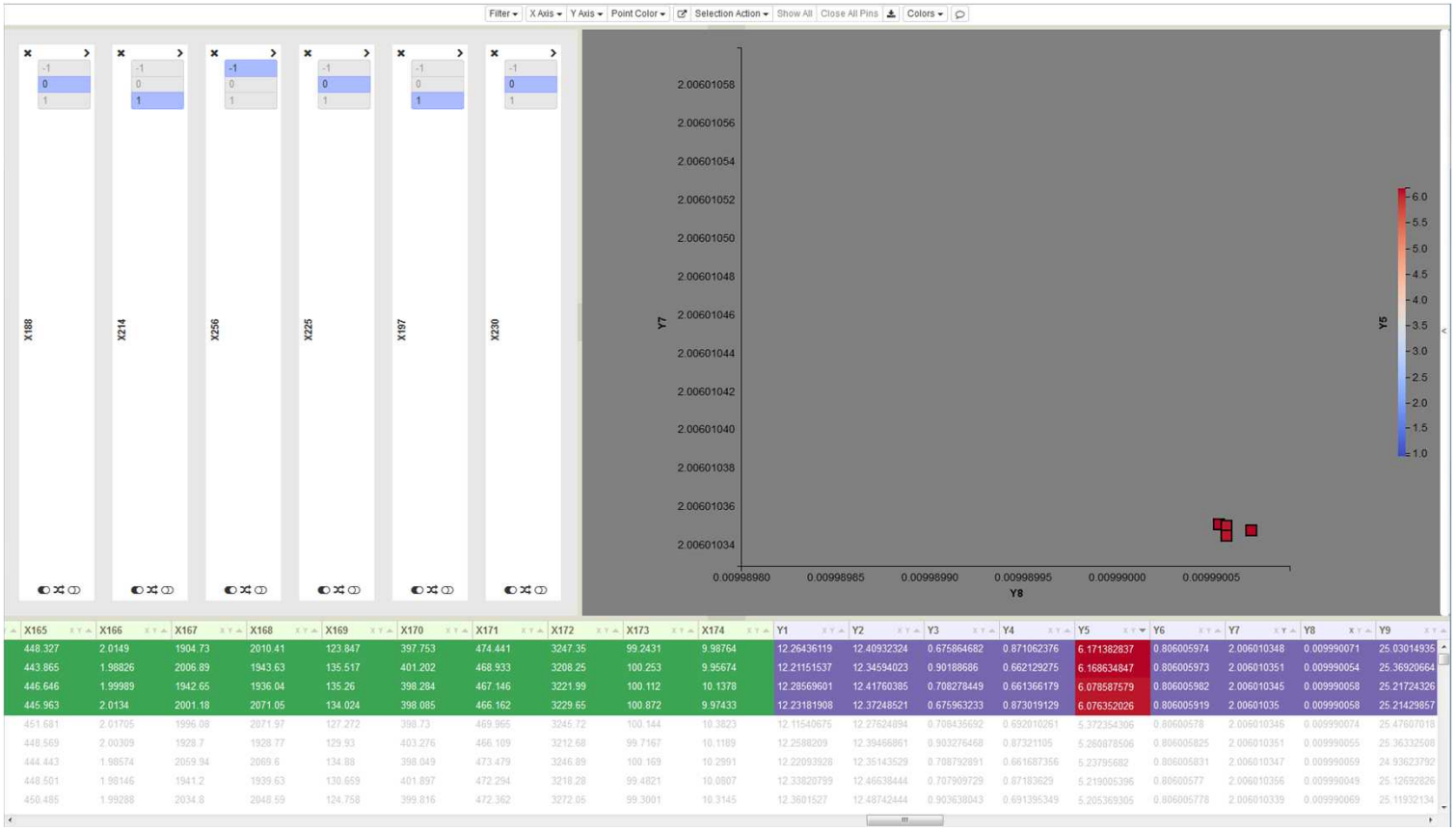
- Anomaly Detection
  - Unique Features
  - Bugs




| X165 | X166 | X167 | X168 | X169 | X170 | X171 | X172 | X173 | X174 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y8 | Y9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 448.327 | 2.0149 | 1904.73 | 2010.41 | 123.847 | 397.753 | 474.441 | 3247.35 | 99.2431 | 9.98764 | 12.26436119 | 12.40932324 | 0.675864682 | 0.871062376 | 6.171382837 | 0.806005974 | 2.006010348 | 0.009990071 | 25.03014935 |
| 443.865 | 1.98826 | 2006.89 | 1943.63 | 135.517 | 401.202 | 468.933 | 3208.25 | 100.253 | 9.95674 | 12.21151537 | 12.34594023 | 0.90188686 | 0.662129275 | 6.168634847 | 0.806005973 | 2.006010351 | 0.009990054 | 25.36920664 |
| 446.646 | 1.99989 | 1942.65 | 1936.04 | 135.26 | 398.284 | 467.146 | 3221.99 | 100.112 | 10.1378 | 12.28569601 | 12.41760385 | 0.708278449 | 0.661366179 | 6.078587579 | 0.806005982 | 2.006010345 | 0.009990058 | 25.21724326 |
| 445.963 | 2.0134 | 2001.18 | 2071.05 | 134.024 | 398.085 | 466.162 | 3229.65 | 100.872 | 9.97433 | 12.23181908 | 12.37248521 | 0.675963233 | 0.873019129 | 6.076352026 | 0.806005919 | 2.00601035 | 0.009990058 | 25.21429857 |
| 451.681 | 2.01705 | 1996.08 | 2071.97 | 127.272 | 398.73 | 469.965 | 3245.72 | 100.144 | 10.3823 | 12.11540675 | 12.27624894 | 0.708436692 | 0.692010261 | 5.372354306 | 0.80600578 | 2.006010345 | 0.009990074 | 25.47607018 |
| 448.569 | 2.00309 | 1928.7 | 1928.77 | 129.93 | 403.276 | 466.109 | 3212.68 | 99.7167 | 10.1189 | 12.2588209 | 12.39466861 | 0.903276468 | 0.87321105 | 5.260878506 | 0.806005825 | 2.006010351 | 0.009990055 | 25.36332508 |
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.806005831 | 2.006010347 | 0.009990059 | 24.93623792 |
| 448.501 | 1.99146 | 1941.2 | 1939.63 | 130.659 | 401.897 | 472.294 | 3218.28 | 99.4821 | 10.0807 | 12.33820799 | 12.46638444 | 0.707909729 | 0.87183629 | 5.219005396 | 0.80600577 | 2.006010356 | 0.009990049 | 25.12692826 |
| 450.485 | 1.99288 | 2034.8 | 2048.59 | 124.758 | 399.816 | 472.362 | 3272.05 | 99.3081 | 10.3145 | 12.3601527 | 12.48742444 | 0.903638043 | 0.691395349 | 5.205369305 | 0.806006778 | 2.006010339 | 0.009990069 | 25.11932134 |

# Ensemble Use Cases

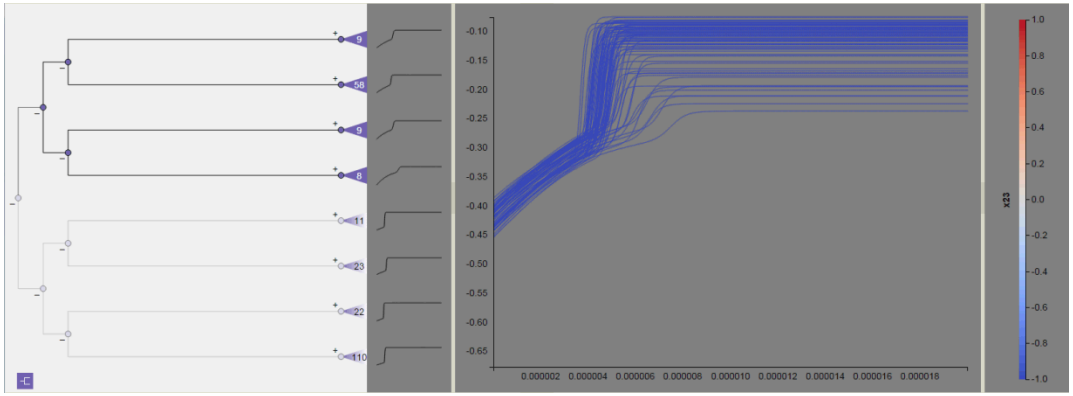
- Anomaly Detection
  - Unique Features
  - Bugs

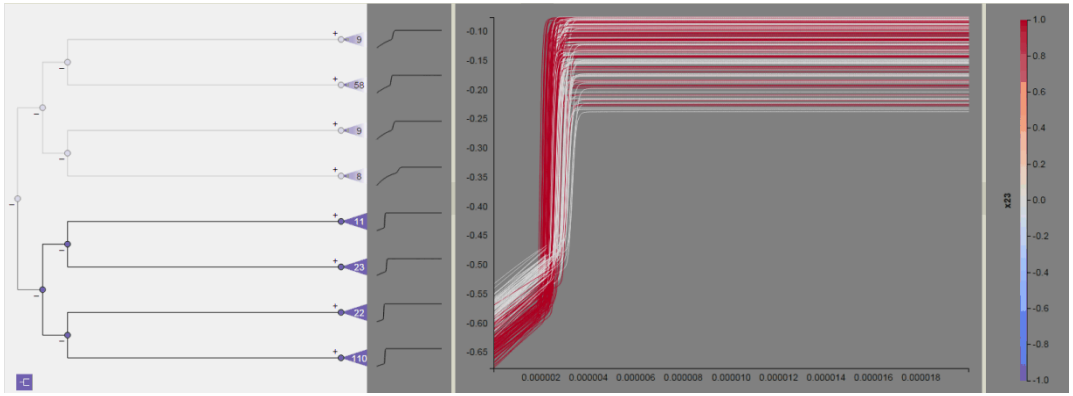



| X165 | X166 | X167 | X168 | X169 | X170 | X171 | X172 | X173 | X174 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 | Y8 | Y9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 448.327 | 2.0149 | 1904.73 | 2010.41 | 123.847 | 397.753 | 474.441 | 3247.35 | 99.2431 | 9.98764 | 12.26436119 | 12.40932324 | 0.675864682 | 0.871062376 | 6.171382837 | 0.806005974 | 2.006010348 | 0.009990071 | 25.03014935 |
| 443.865 | 1.98826 | 2006.89 | 1943.63 | 135.517 | 401.202 | 468.933 | 3208.25 | 100.253 | 9.95674 | 12.21151537 | 12.34594023 | 0.90188686 | 0.662129275 | 6.168634847 | 0.806005973 | 2.006010351 | 0.009990054 | 25.36920664 |
| 446.646 | 1.99989 | 1942.65 | 1936.04 | 135.26 | 398.284 | 467.146 | 3221.99 | 100.112 | 10.1378 | 12.28569601 | 12.41760385 | 0.708278449 | 0.661366179 | 6.078587579 | 0.806005982 | 2.006010345 | 0.009990058 | 25.21724326 |
| 445.963 | 2.0134 | 2001.18 | 2071.05 | 134.024 | 398.085 | 466.162 | 3229.65 | 100.872 | 9.97433 | 12.23181908 | 12.37248521 | 0.675963233 | 0.873019129 | 6.076352026 | 0.806005919 | 2.00601035 | 0.009990058 | 25.21429857 |
| 451.681 | 2.01705 | 1996.08 | 2071.97 | 127.272 | 398.73 | 469.965 | 3245.72 | 100.144 | 10.3823 | 12.11540675 | 12.27624894 | 0.706435692 | 0.692010261 | 5.372354306 | 0.80600578 | 2.006010346 | 0.009990074 | 25.47607018 |
| 448.569 | 2.00309 | 1928.7 | 1928.77 | 129.93 | 403.276 | 466.109 | 3212.68 | 99.7167 | 10.1189 | 12.2588209 | 12.39466861 | 0.903276468 | 0.87321105 | 5.260878506 | 0.806005825 | 2.006010351 | 0.009990055 | 25.36332508 |
| 444.443 | 1.98574 | 2059.94 | 2069.6 | 134.88 | 398.049 | 473.479 | 3246.89 | 100.169 | 10.2991 | 12.22093928 | 12.35143529 | 0.708792891 | 0.661687356 | 5.23795682 | 0.806005831 | 2.006010347 | 0.009990059 | 24.93623792 |
| 448.501 | 1.99146 | 1941.2 | 1939.63 | 130.659 | 401.897 | 472.294 | 3218.28 | 99.4821 | 10.0807 | 12.33820789 | 12.46638444 | 0.707909729 | 0.87183629 | 5.219005396 | 0.80600577 | 2.006010356 | 0.009990049 | 25.12692826 |
| 450.485 | 1.99288 | 2034.8 | 2048.59 | 124.758 | 399.816 | 472.362 | 3272.05 | 99.3001 | 10.3145 | 12.3691527 | 12.48742444 | 0.903638043 | 0.691395349 | 5.205369305 | 0.806005778 | 2.006010339 | 0.009990069 | 25.11932134 |

# Ensemble Use Cases

- Parameter Space Exploration
  - Results Clustering
  - Design Optimization
  - Model Tuning

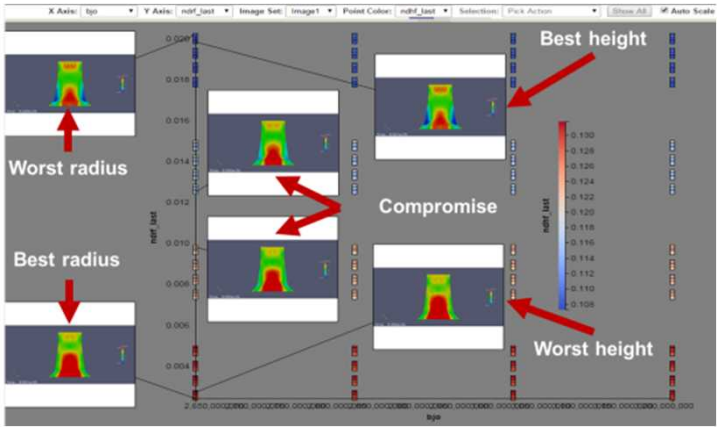


# Ensemble Use Cases

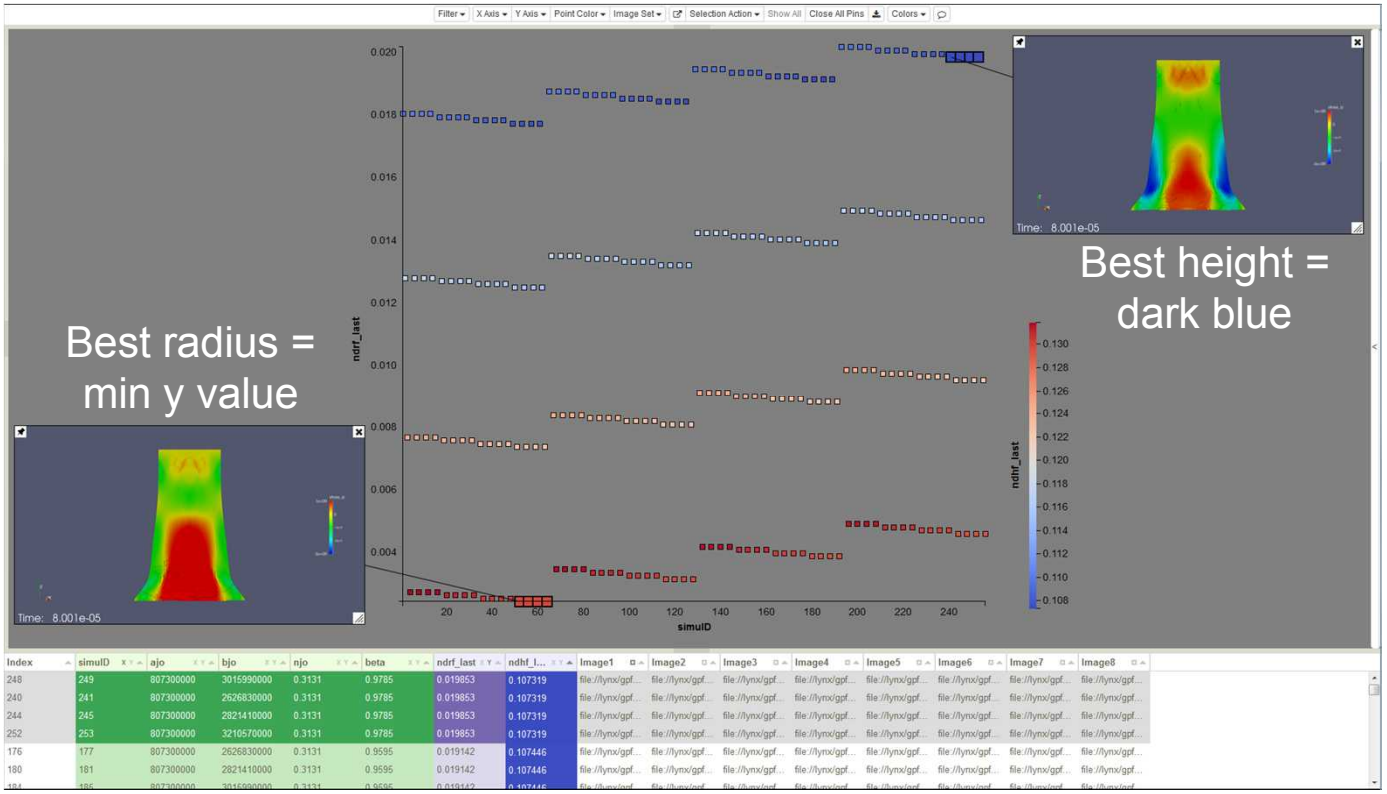
- Parameter Space Exploration
  - Results Clustering
  - Design Optimization
  - User Model Tuning

Taylor Anvil Demo



# Ensemble Use Cases

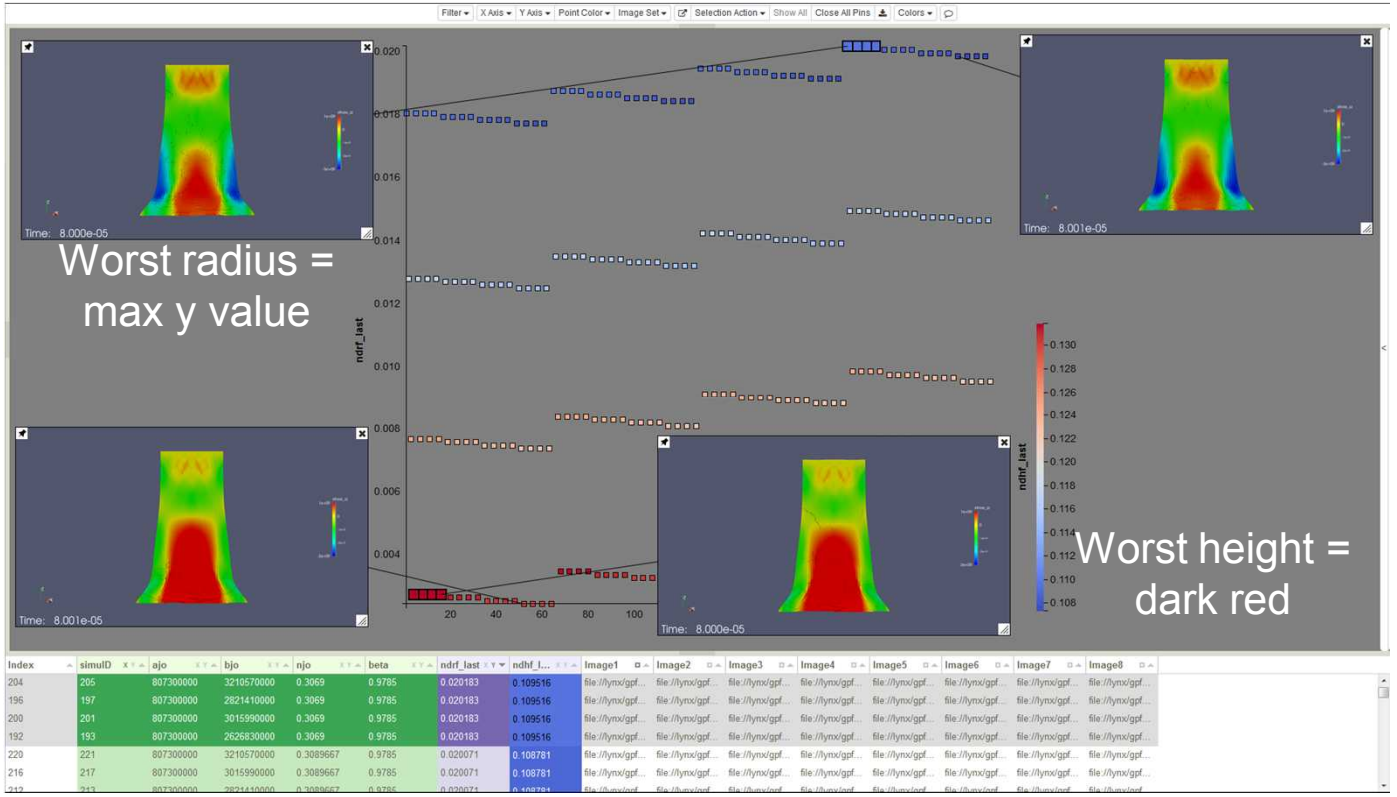
- Parameter Space Exploration
  - Results Clustering
  - Design Optimization
  - Model Tuning




| Index | simulD | ajo | bjo | njo | beta | ndrf_last | ndhf_l... | Image1 | Image2 | Image3 | Image4 | Image5 | Image6 | Image7 | Image8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 248 | 249 | 807300000 | 3015990000 | 0.3131 | 0.9785 | 0.019853 | 0.107319 | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... |
| 240 | 241 | 807300000 | 2626830000 | 0.3131 | 0.9785 | 0.019853 | 0.107319 | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... |
| 244 | 245 | 807300000 | 2821410000 | 0.3131 | 0.9785 | 0.019853 | 0.107319 | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... |
| 252 | 253 | 807300000 | 3210570000 | 0.3131 | 0.9785 | 0.019853 | 0.107319 | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... |
| 176 | 177 | 807300000 | 2626830000 | 0.3131 | 0.9595 | 0.019142 | 0.107446 | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... |
| 180 | 181 | 807300000 | 2821410000 | 0.3131 | 0.9595 | 0.019142 | 0.107446 | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... | file://lynx/gpf... |

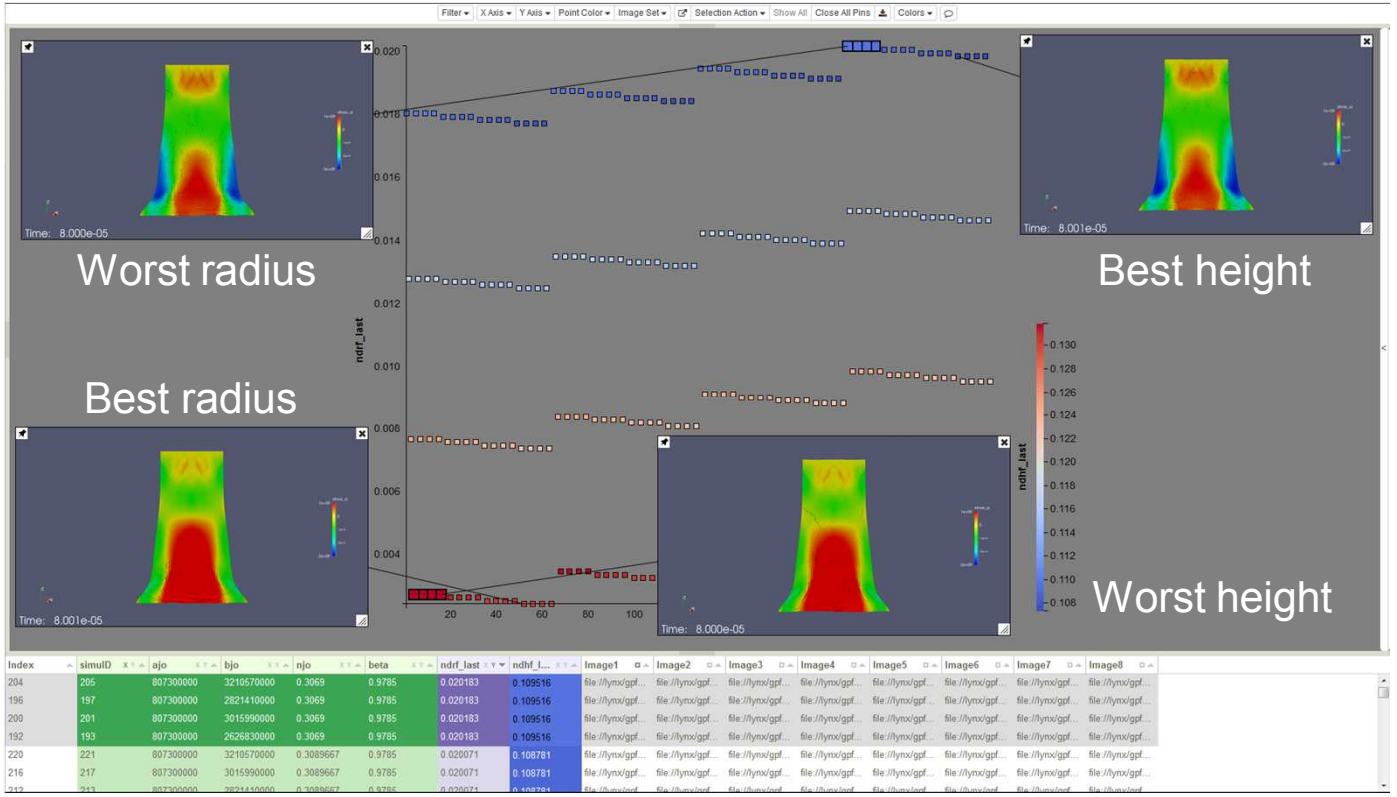
# Ensemble Use Cases

- Parameter Space Exploration
  - Results Clustering
  - Design Optimization
  - Model Tuning



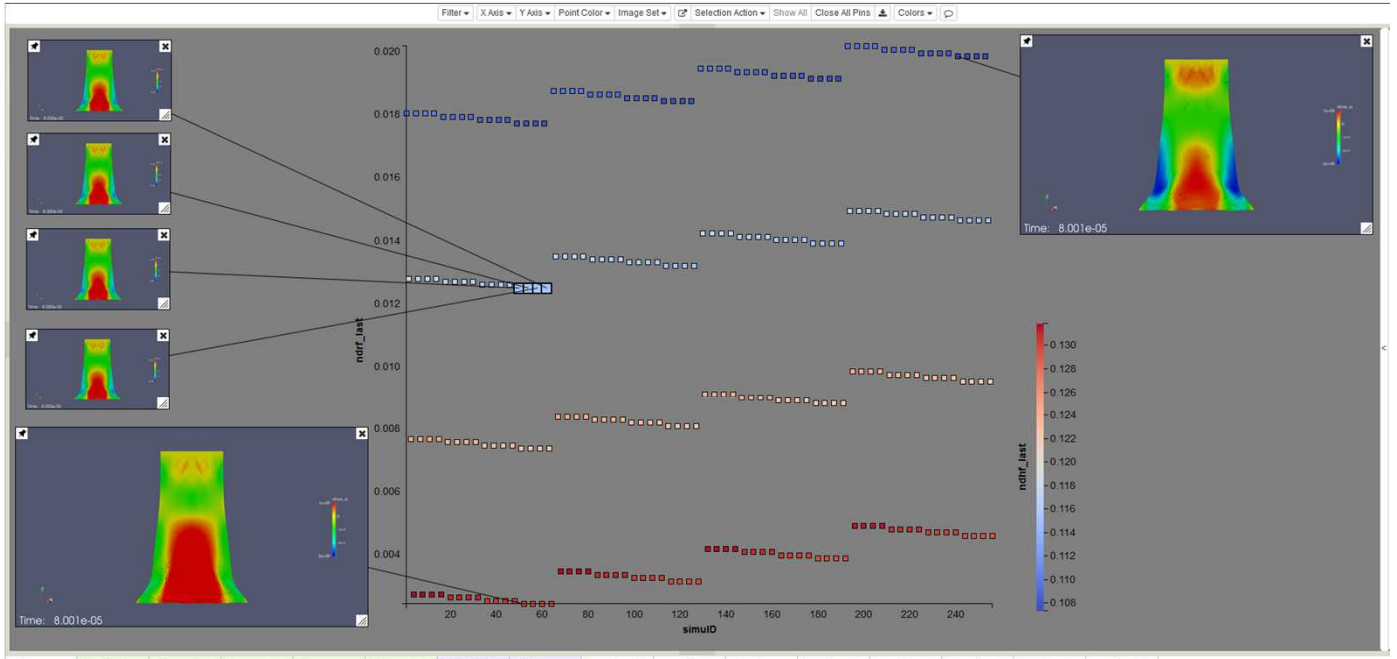
# Ensemble Use Cases

- Parameter Space Exploration
  - Results Clustering
  - Design Optimization
  - Model Tuning



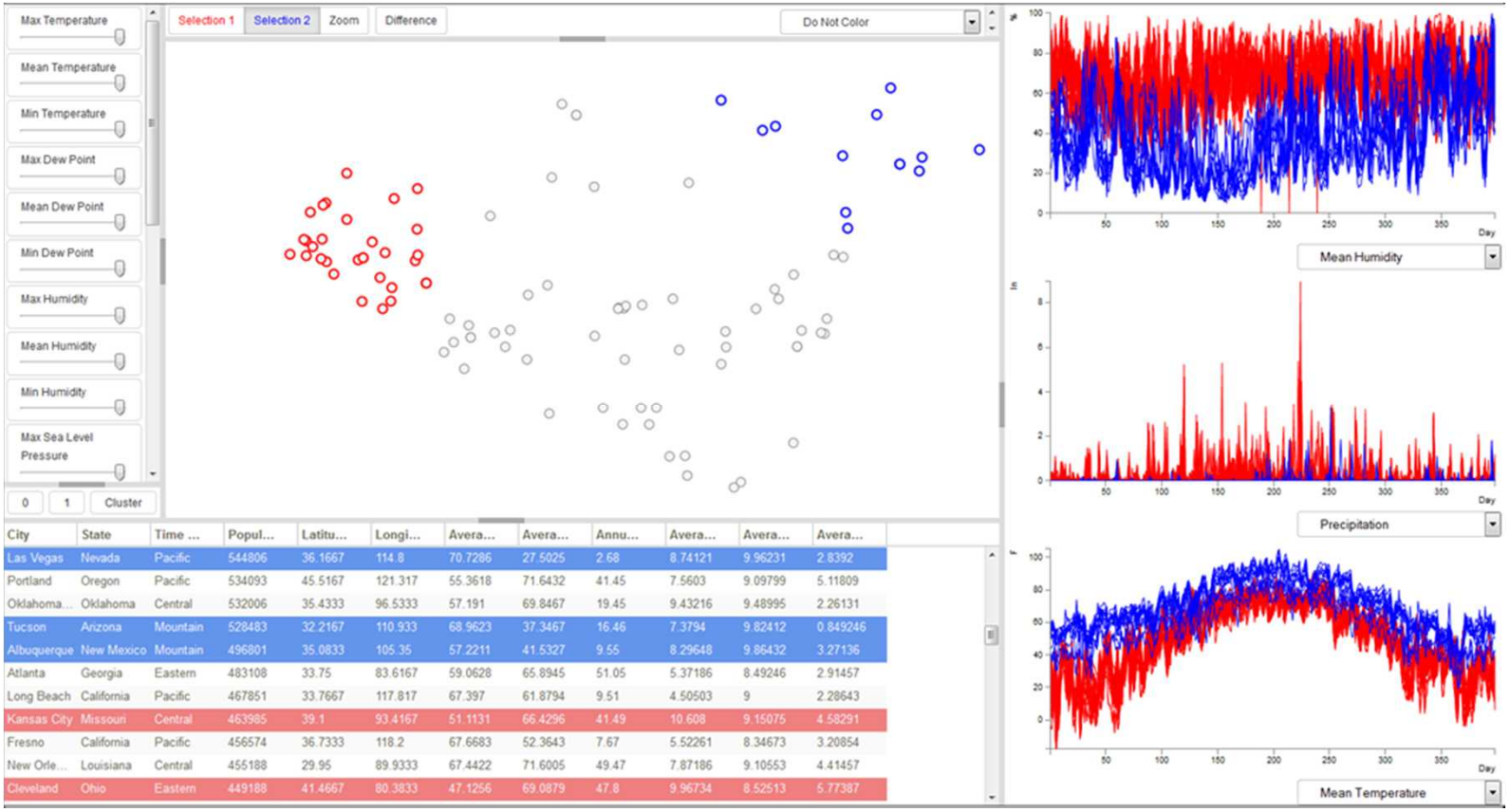
# Ensemble Use Cases

- Parameter Space Exploration
  - Results Clustering
  - Design Optimization
  - Model Tuning



# Slycat Models

- Dial-A-Cluster Plugin



# Slycat Provides

- Insights into previously unsuspected behaviors in simulation models (relationships, anomalies).
- On-demand remote exploration of terabytes of results without moving the data (reducing time/storage costs).
- Many-to-many correlations for sensitivity analysis.
- Ubiquitous web-based delivery for easy collaboration.
- Iterative Design Optimization: explore parameter space, rank & quantify result, export, resample refined space, generate refined ensemble