



an NSF-sponsored research network for
Sustainable Climate
Risk Management



Visualizing Data with OpenMORDM

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What is OpenMORDM?

- A **free** and **open source** visualization framework written in R
- Supports 3D and 2D visualization of datasets
- Analytics: sensitivity analysis, PRIM, CART, etc.
- Accessible via your web browser!

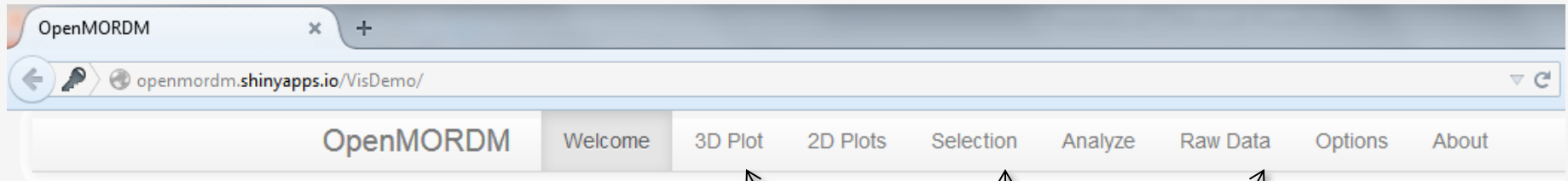


Demo

- Open your web browser to:
<http://openmordm.shinyapps.io/VisDemo/>
- Login with the username / password provided by SCRiM
- Best to use latest version of Firefox or Chrome

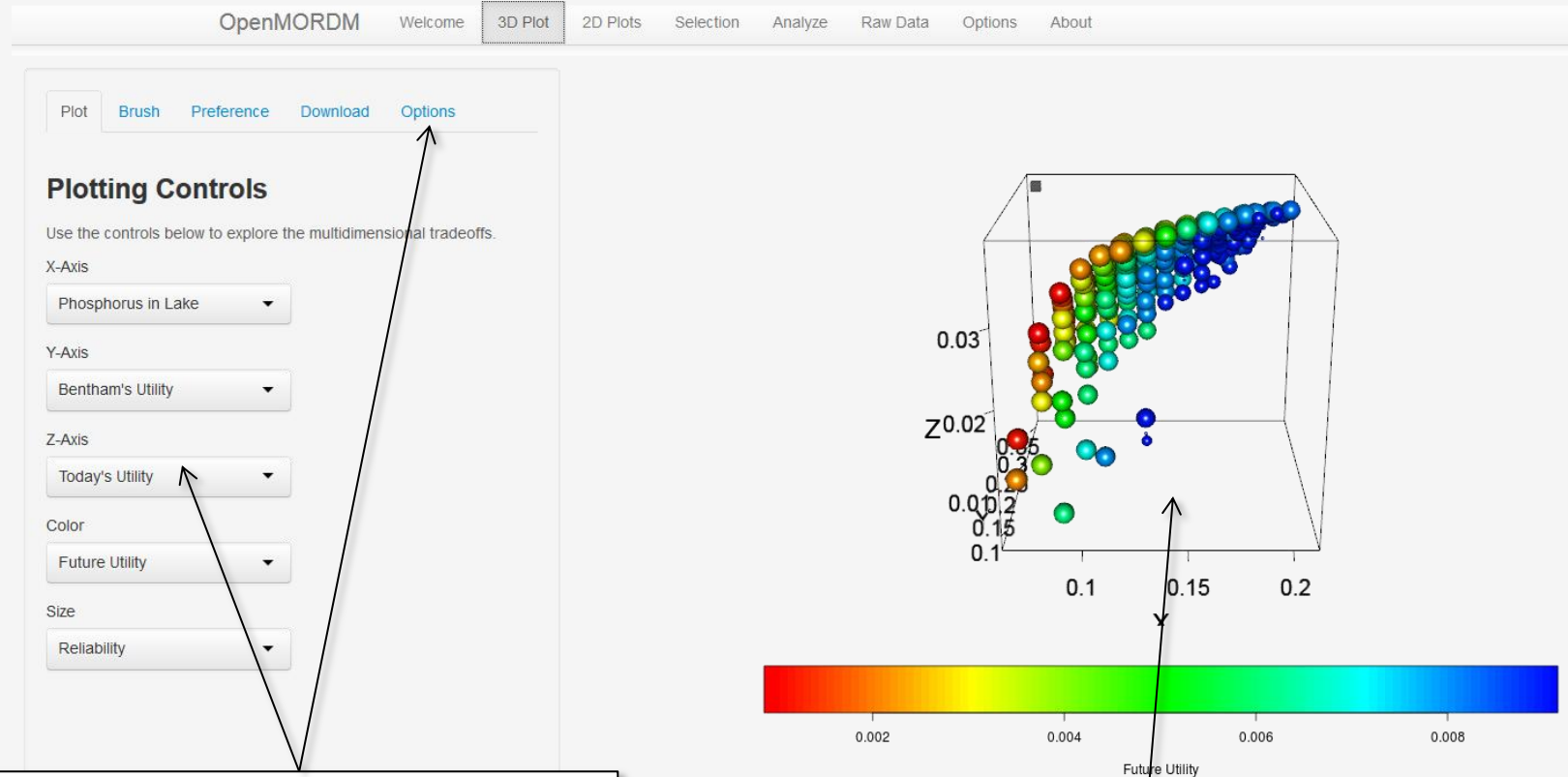
This is a beta version. If the application stops responding, refresh the page in your browser.

Navigation



Click the tabs at the top of the page to access the different views.

3D View

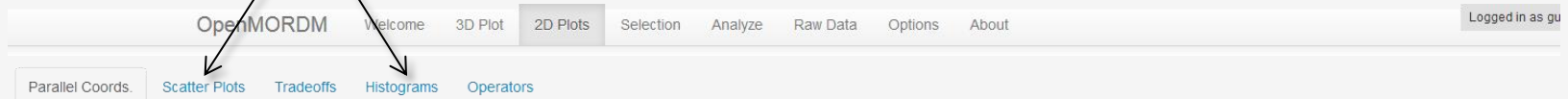


Adjust plotting options

Click and drag with mouse to rotate, use mouse wheel to zoom

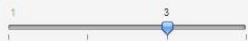
2D Views

Click tabs to access all 2D views



Plotting Options

Line Width



Transparency




Label Size



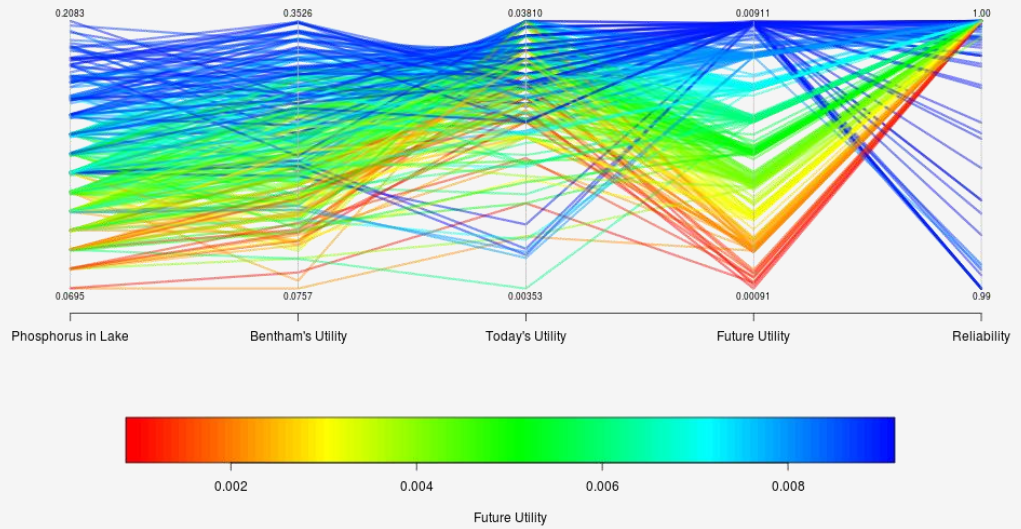
Download

 PNG Image

 SVG Image

 EPS File

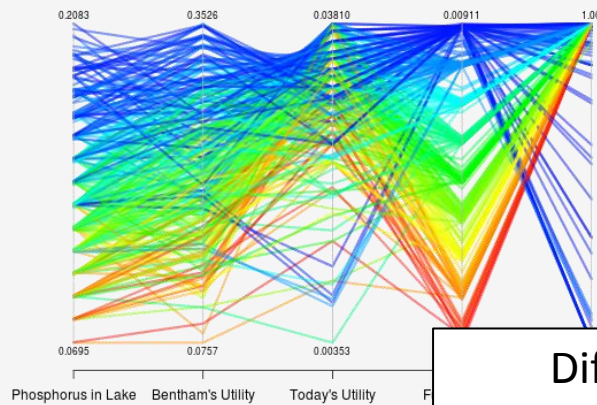
Note: EPS export does not support transparency. Transparent lines will not appear.



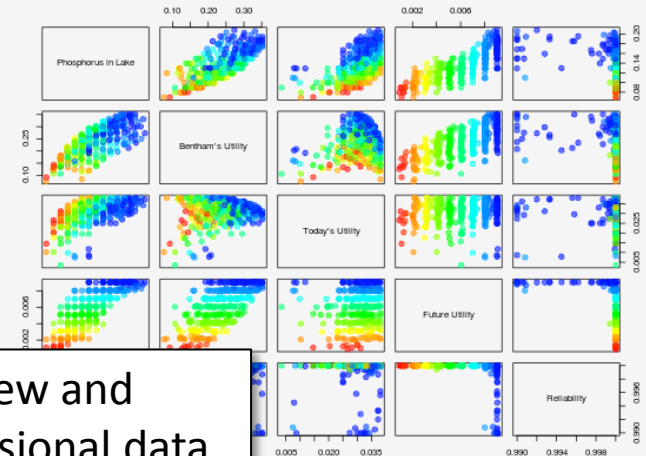
Download high-def image

2D Views (Continued)

Parallel Coordinates

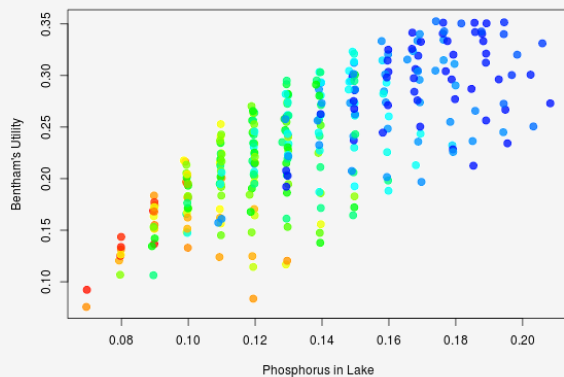


Scatter (Multiattribute) Plot

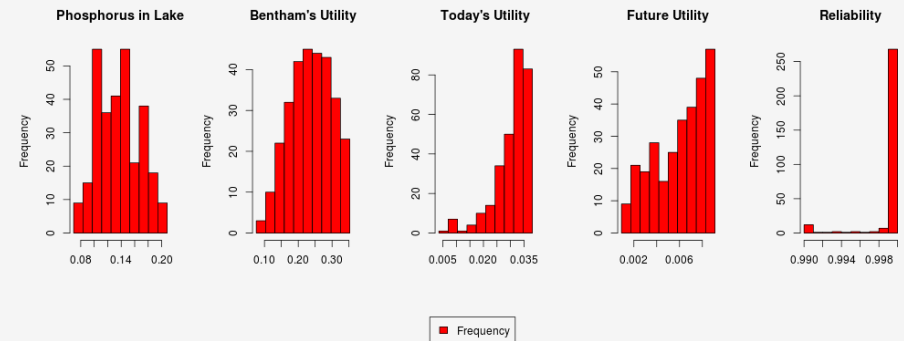


Different ways to view and understand high-dimensional data

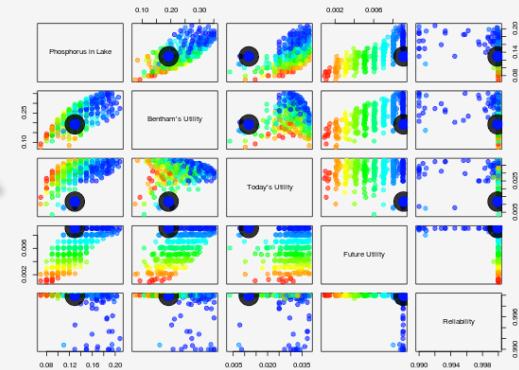
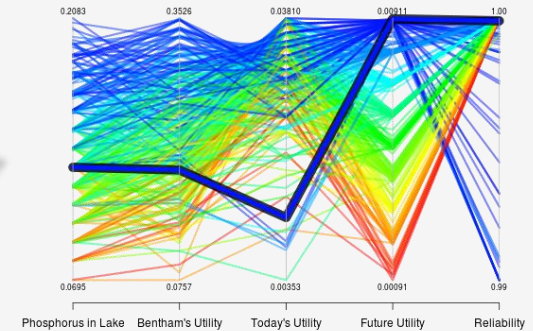
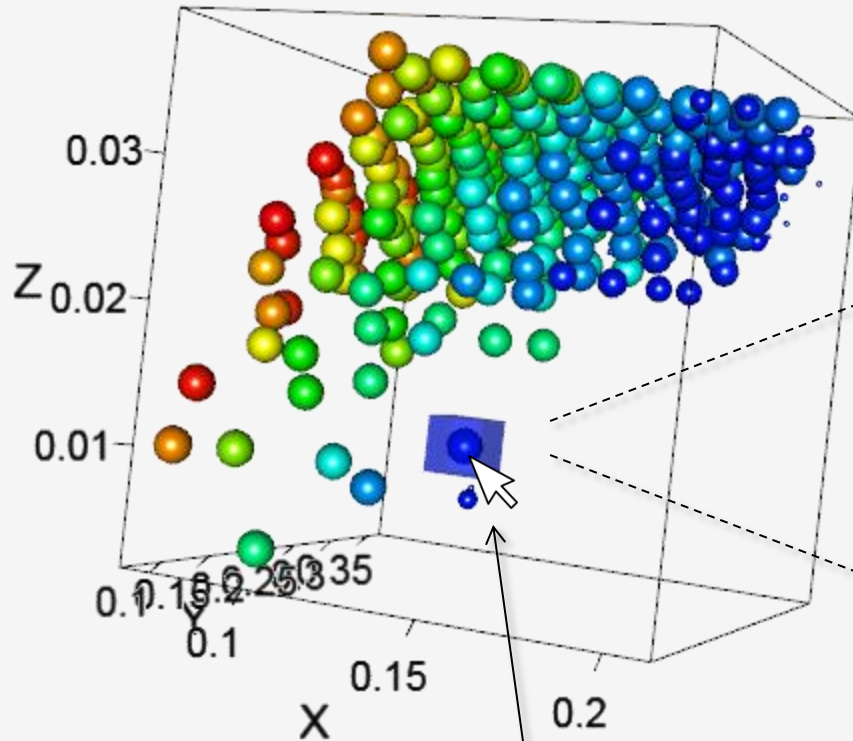
Tradeoff Between Two Objectives



Histogram



Selecting Points



Click a point in the 3D view to highlight the point in all plots

Viewing Details

OpenMORDM

Welcome

3D Plot

2D Plots

Selection

Analyze

Raw Data


Options

About


Logged in as

You can provide a custom Shiny interface that will display details for the currently selected point. In this example, the figure to the right shows the pollution control strategy for the lake problem.

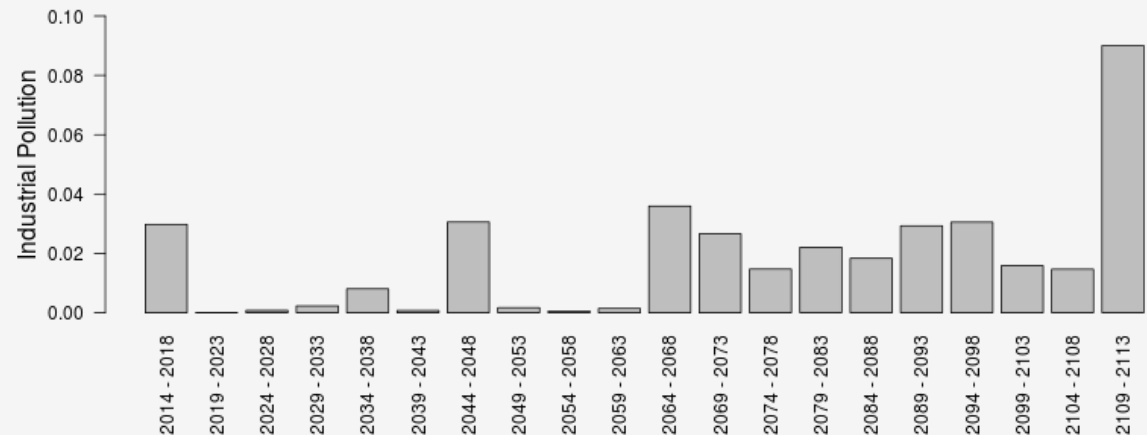
Download

 PNG Image

 SVG Image

 EPS File

Pollution Control Strategy for the Selected Solution



When a point is selected, switch to the Selection tab to view details of that point. In this example, we are looking at the pollution control strategy for the lake problem.

Analysis

The Analyze tab provides a number of routines to analyze multivariate data



The screenshot shows the OpenMORDM web application interface. The top navigation bar includes links for OpenMORDM, Welcome, 3D Plot, 2D Plots, Selection, **Analyze**, Raw Data, Options, and About. A user is logged in as a guest. Below the navigation bar, there are four tabs: Correlations, Sensitivity, PRIM, and CART. The Correlations tab is active, displaying 'Correlation Options' with checkboxes for 'Show all correlations' and 'Only show correlations between objectives'. A 'Download' section offers PNG Image, SVG Image, and EPS File formats. A note at the bottom states: 'Note: Use the Options tab to select which variables/objectives are shown in the correlogram.' To the right, a 'Summary' section shows correlation counts: Highly Correlated (9), Inversely Correlated (0), Weakly Correlated (181), and Uncorrelated (110). Below this, 'High Correlations' lists variables and their correlations with 'Future Utility' and 'Bentham's Utility'. Finally, 'Inverse Correlations' are listed as 'None'.

OpenMORDM Welcome 3D Plot 2D Plots Selection **Analyze** Raw Data Options About Logged in as guest [Lo](#)

Correlations **Sensitivity** PRIM CART

Correlation Options

☐ Show all correlations

☐ Only show correlations between objectives

Download

[PNG Image](#) [SVG Image](#) [EPS File](#)

Note: Use the Options tab to select which variables/objectives are shown in the correlogram.

Summary:

Highly Correlated: 9

Inversely Correlated: 0

Weakly Correlated: 181

Uncorrelated: 110

High Correlations:

Var1 <-> Today's Utility (1)

Var20 <-> Future Utility (0.91)

Var17 <-> Future Utility (0.84)

Var11 <-> Future Utility (0.83)

Phosphorus in Lake <-> Future Utility (0.82)

Var15 <-> Future Utility (0.79)

Var14 <-> Future Utility (0.79)

Var4 <-> Bentham's Utility (0.77)

Var12 <-> Future Utility (0.75)

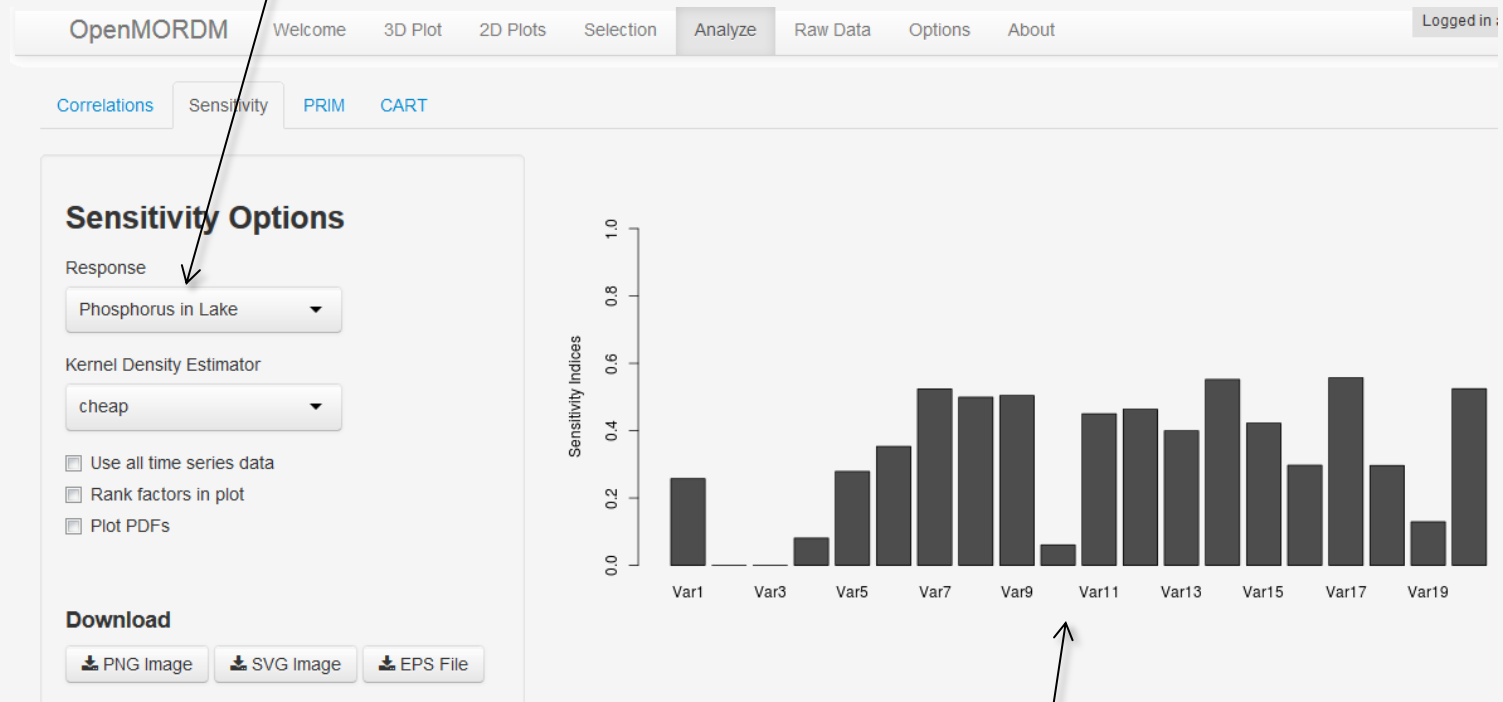
Inverse Correlations:

None

Click these tabs to access each method

Sensitivity Analysis

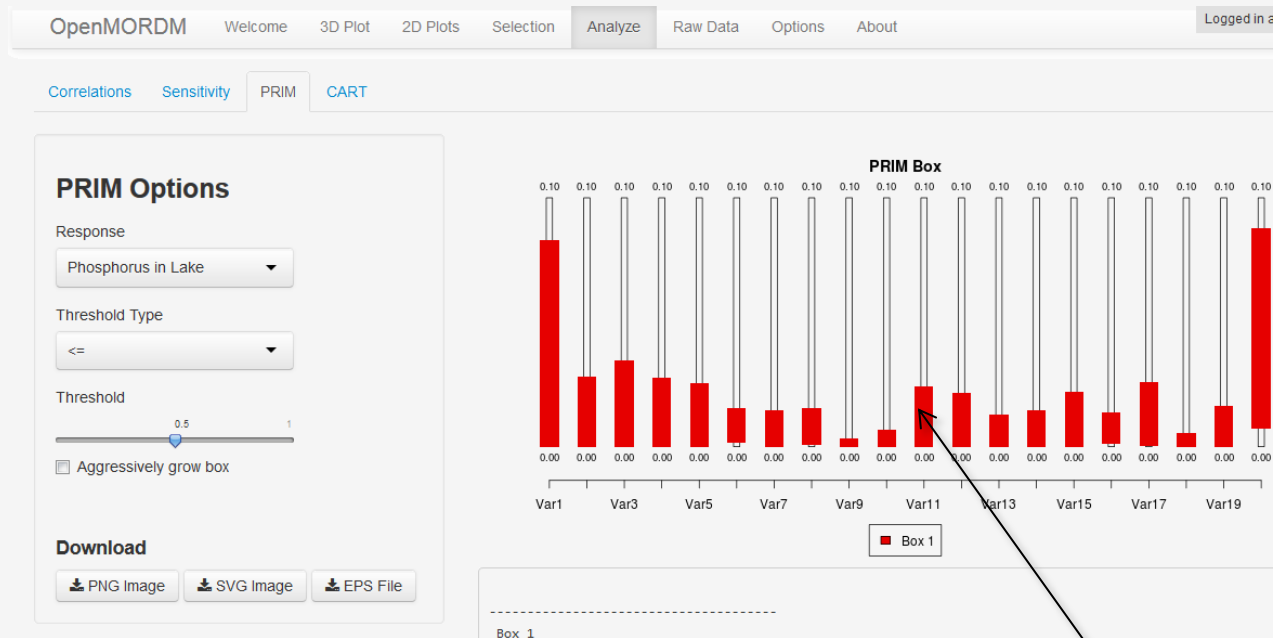
Select the response (the objective) of interest...



...to view the sensitivity of that response to each input variable

PRIM

Use the Patient Rule Induction Method (PRIM) to discover the ranges of inputs that cause a response to be less than or greater than a given threshold.

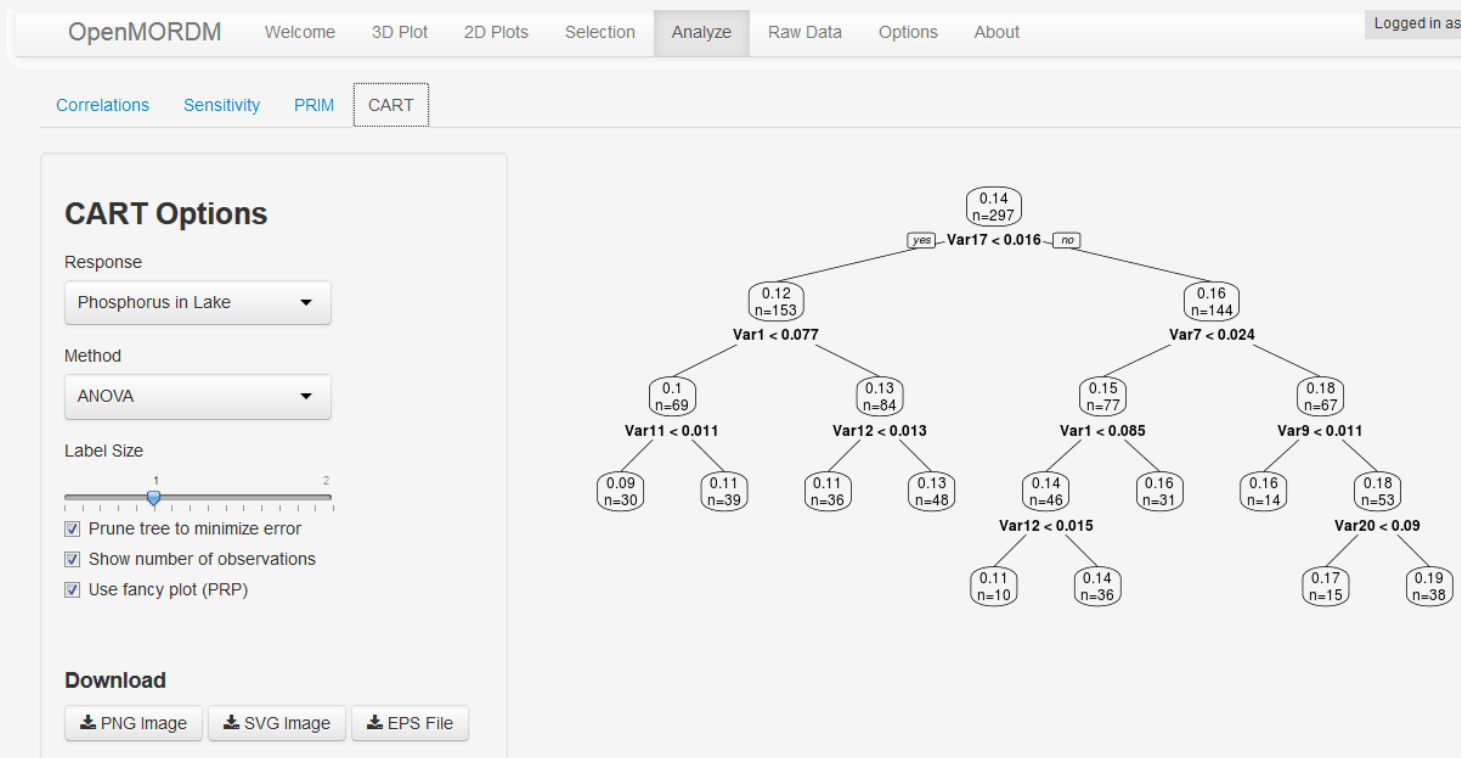


Friedman, J.H. and Fisher, N.I. (1999). "Bump-hunting for high dimensional data", Statistics and Computing, 9, 123–143.

Inputs contained within these red boxes have a high likelihood of satisfying our conditions.

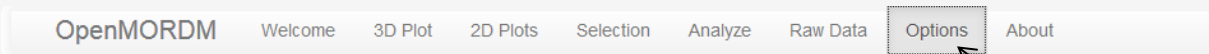
CART

Similar in use to PRIM, Classification and Regression Trees (CART) determine how to partition the data into similar subsets, identifying the key input variables.





Customization



Visible Decision Variables / Objectives

By default, all decision variables and objectives are plotted. Unselect any fields below to remove from plots.

Visible Decision Variables

☐ Var1 ☐ Var2 ☐ Var3 ☐ Var4 ☐ Var5 ☐ Var6 ☐ Var7 ☐ Var8 ☐ Var9 ☐ Var10 ☐ Var11 ☐ Var12 ☐ Var13 ☐ Var14
☐ Var18 ☐ Var19 ☐ Var20

All

None

Visible Objectives

☒ Phosphorus in Lake ☒ Bentham's Utility ☒ Today's Utility ☒ Future Utility ☒ Reliability

All

None

Color Scheme

Set the color scheme used in all figures. * indicates a color scheme suitable for colorblind individuals with deficient or anomalous red-green vision.

Color Scheme

Rainbow (Red to Blue) ▼

☐ Reverse color map

☐ Black background

Selection

Enable/disable selection and control plotting options.

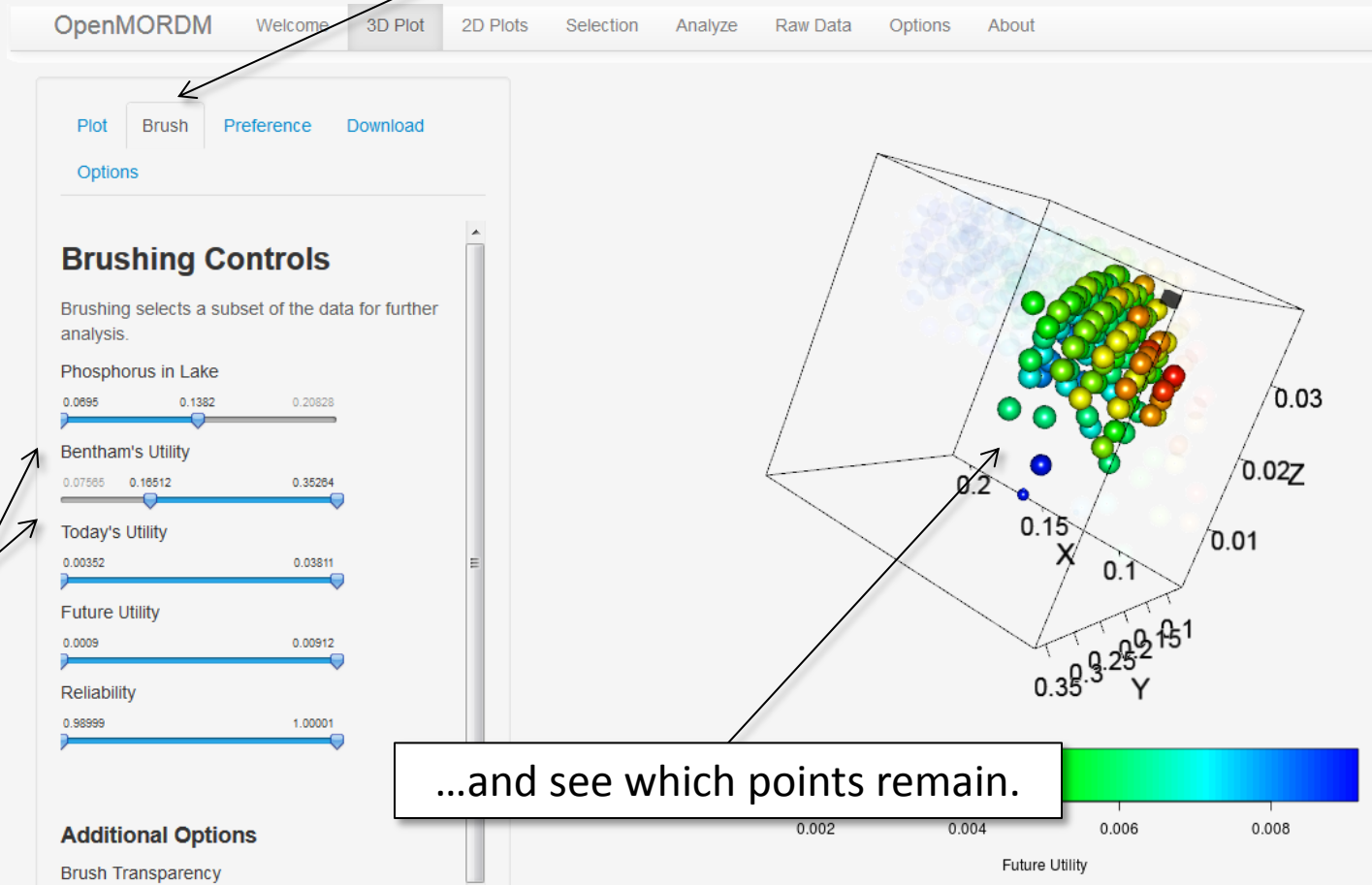
☒ Selection enabled

Scale Selected Solutions

Customize the tool (which fields are plotted, color schemes, etc.) using the Options tab

Advanced: Brushing

Brushing lets you identify a subset of the data for analysis.

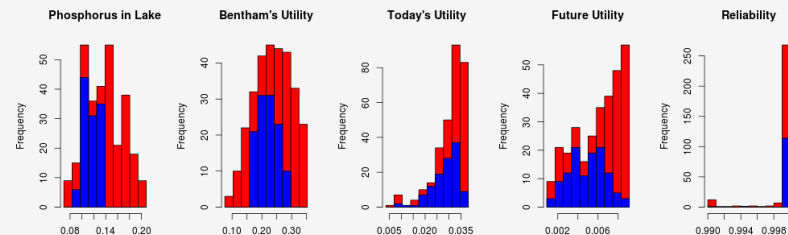
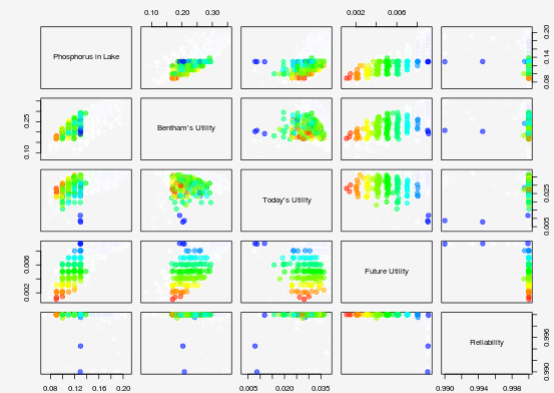
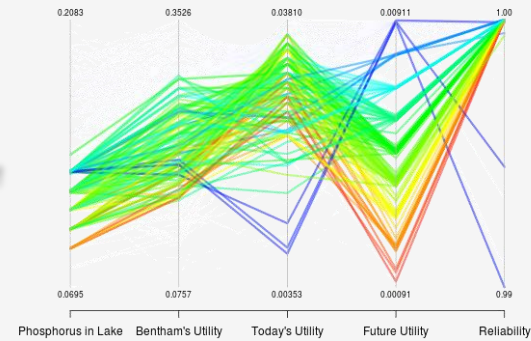


Use these sliders to specify the lower/upper bounds...

...and see which points remain.

Advanced: Brushing

The 2D plots update automatically to show the brushed set



Advanced: Brushing

Additionally, the analysis methods include a “Brushed Set” response to analyze the difference between the solutions in the brushed set and those removed.

OpenMORDM
Welcome
3D Plot
2D Plots
Selection
Analyze
Raw Data
Options
About

Correlations
Sensitivity
PRIM
CART

CART Options

Response

Brushed Set
Phosphorus in Lake
Bentham's Utility
Today's Utility
Future Utility
Reliability
Brushed Set
Preference

☒ Use fancy plot (PRP)

Download

PNG Image
 SVG Image
 EPS File

```

graph TD
    Root["Removed  
181 116"] -- yes --> L1["Removed  
123 21"]
    Root -- no --> R1["Survived  
58 95"]
    R1 -- Var4 < 0.011 --> L2["Removed  
46 22"]
    R1 -- Var4 < 0.011 --> R2["Survived  
12 73"]

```

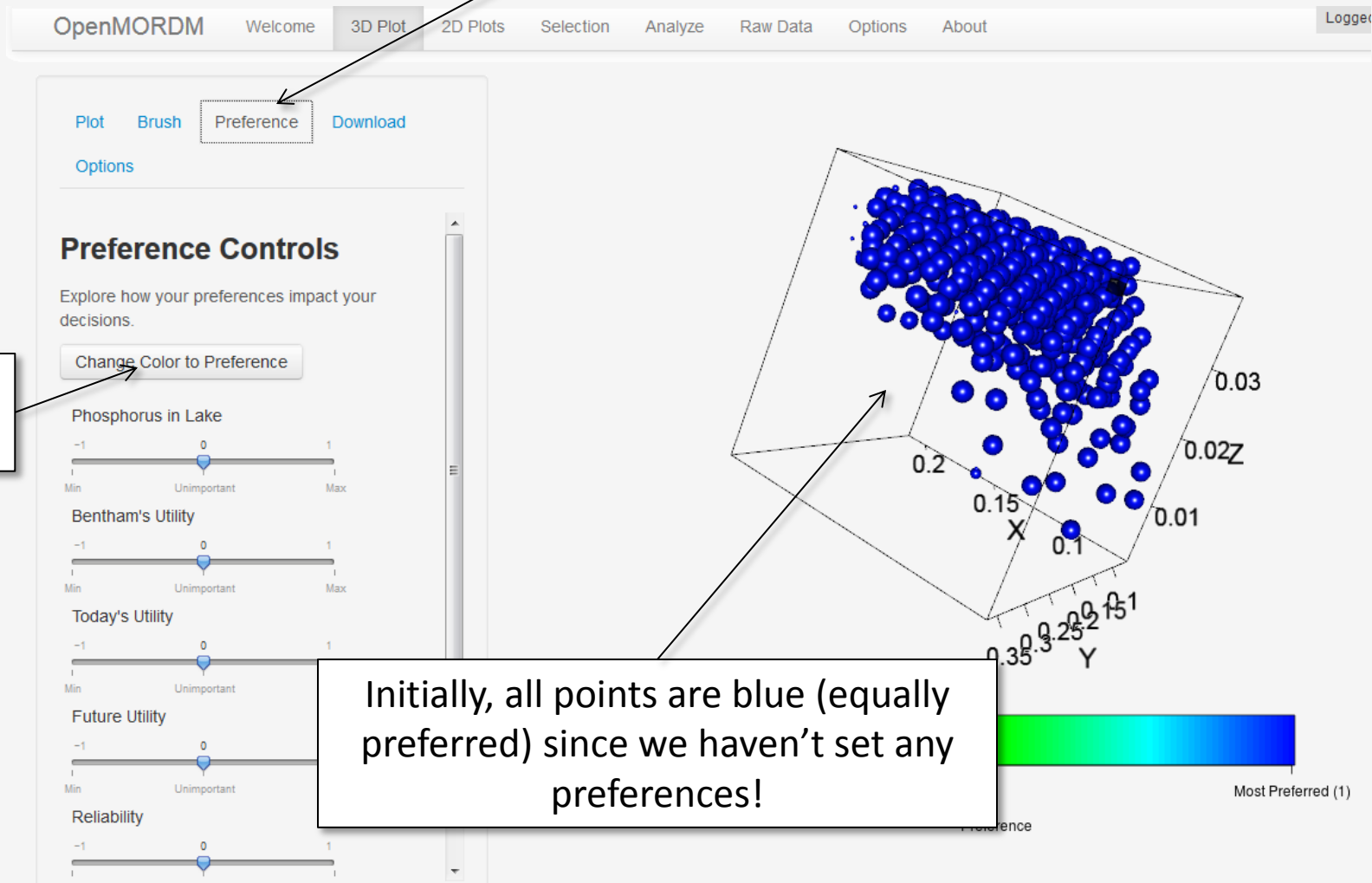
Var17 >= 0.016

Var4 < 0.011

In this example, CART shows that only two inputs are needed to classify our brushed set!

Advanced: Preferences

Specify preferences to color points by their relative importance



Click to color by preference

Initially, all points are blue (equally preferred) since we haven't set any preferences!

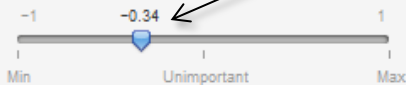
Advanced: Preferences

Preference Controls

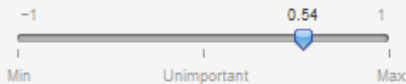
Explore how your preferences impact your decisions.

Change Color to Preference

Phosphorus in Lake



Bentham's Utility



Today's Utility



Future Utility

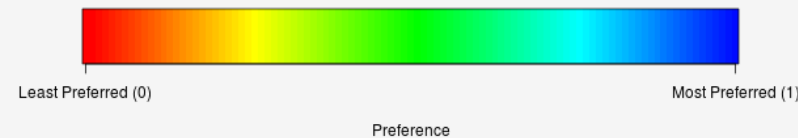
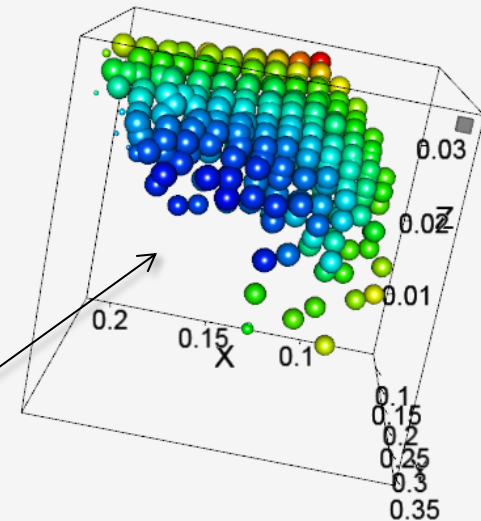


Reliability

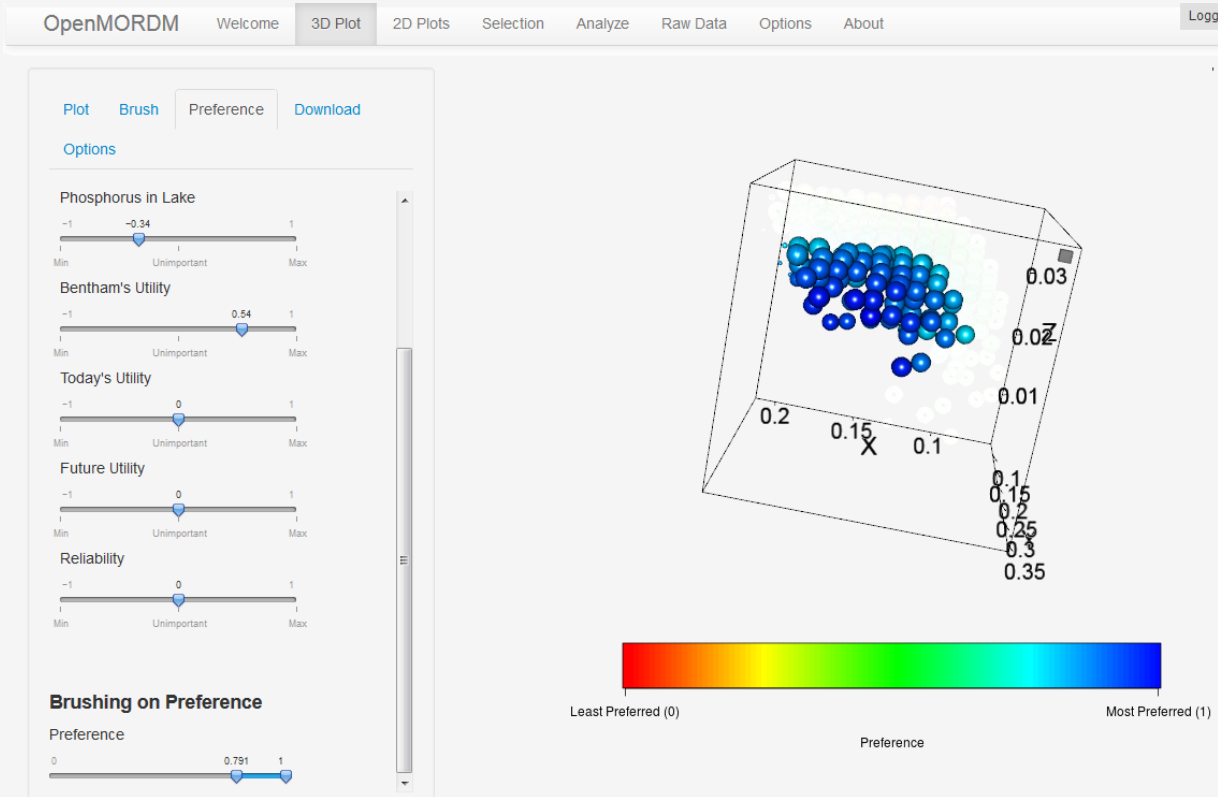


Adjust these sliders to set your preferences. Slide left to minimize, right to maximize. The further to the left/right increases the importance of that objective.

Your preferred points (blue is most preferred).



Advanced: Preferences



Finally, you can brush on your preferences and run the analyses on your brushed set.

Conclusion

- OpenMORDM aims to be a free and accessible visualization toolkit
- Please send comments and suggestions to:
Dr. Klaus Keller (SCRiM PI) - kzk10@ems.psu.edu
Dr. David Hadka (OpenMORDM developer) – dmh309@psu.edu