

# Integrating Plotly charts into Firefly visualization system

Tatiana Goldina  
IPAC/Caltech

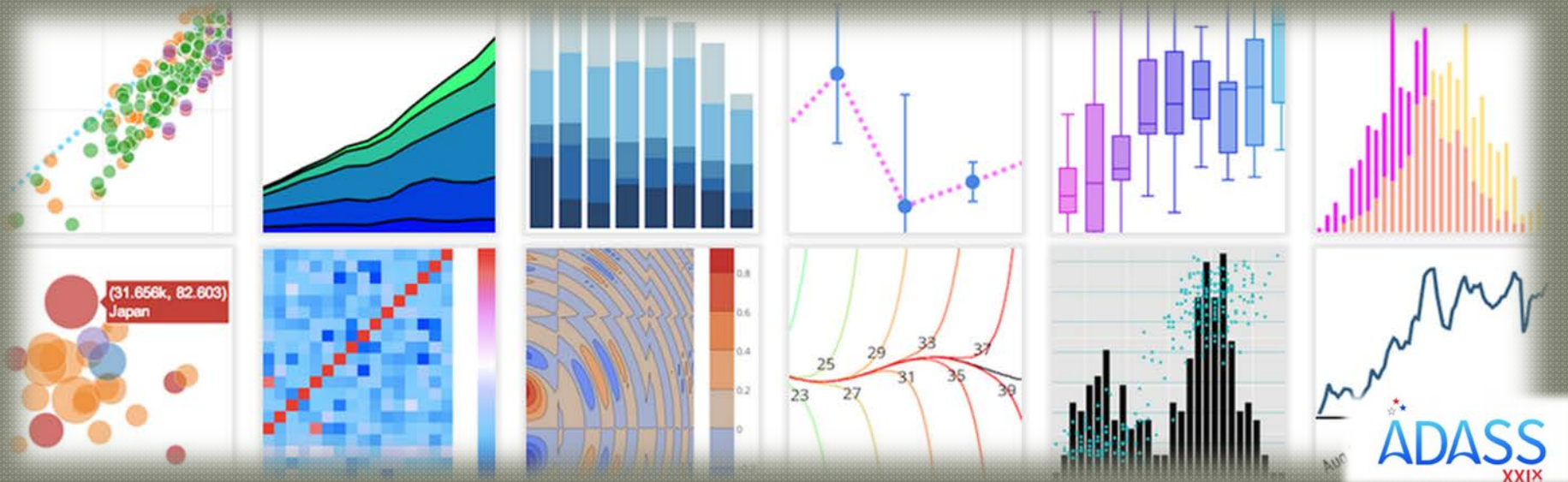


Image Credit: Plotly, Inc.

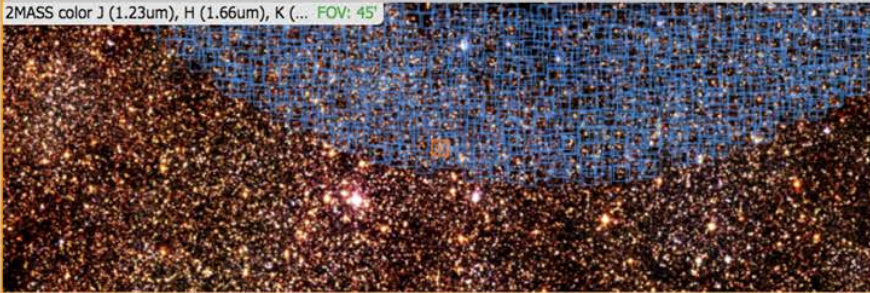
# Charts in Firefly



Coverage

Options: FITS HiPS Auto E<sub>q</sub> J2000 Change HiPS

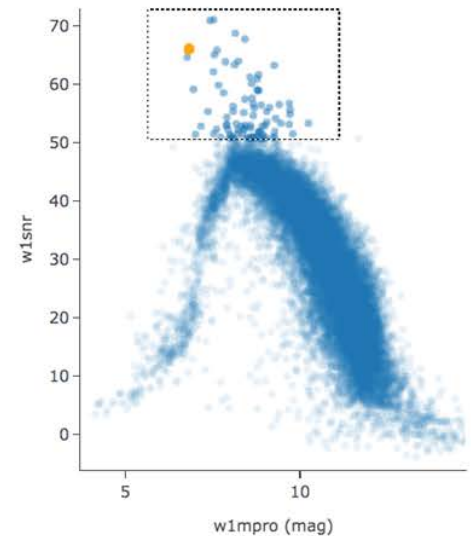
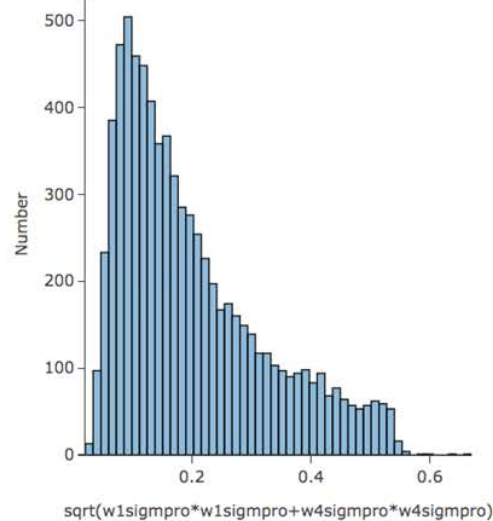
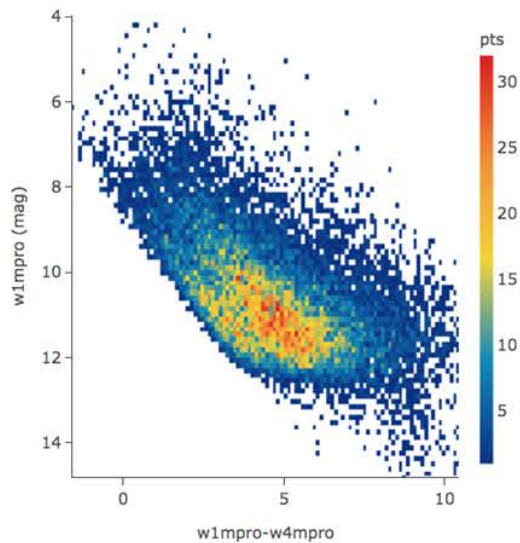
2MASS color J (1.23um), H (1.66um), K (... FOV: 45°



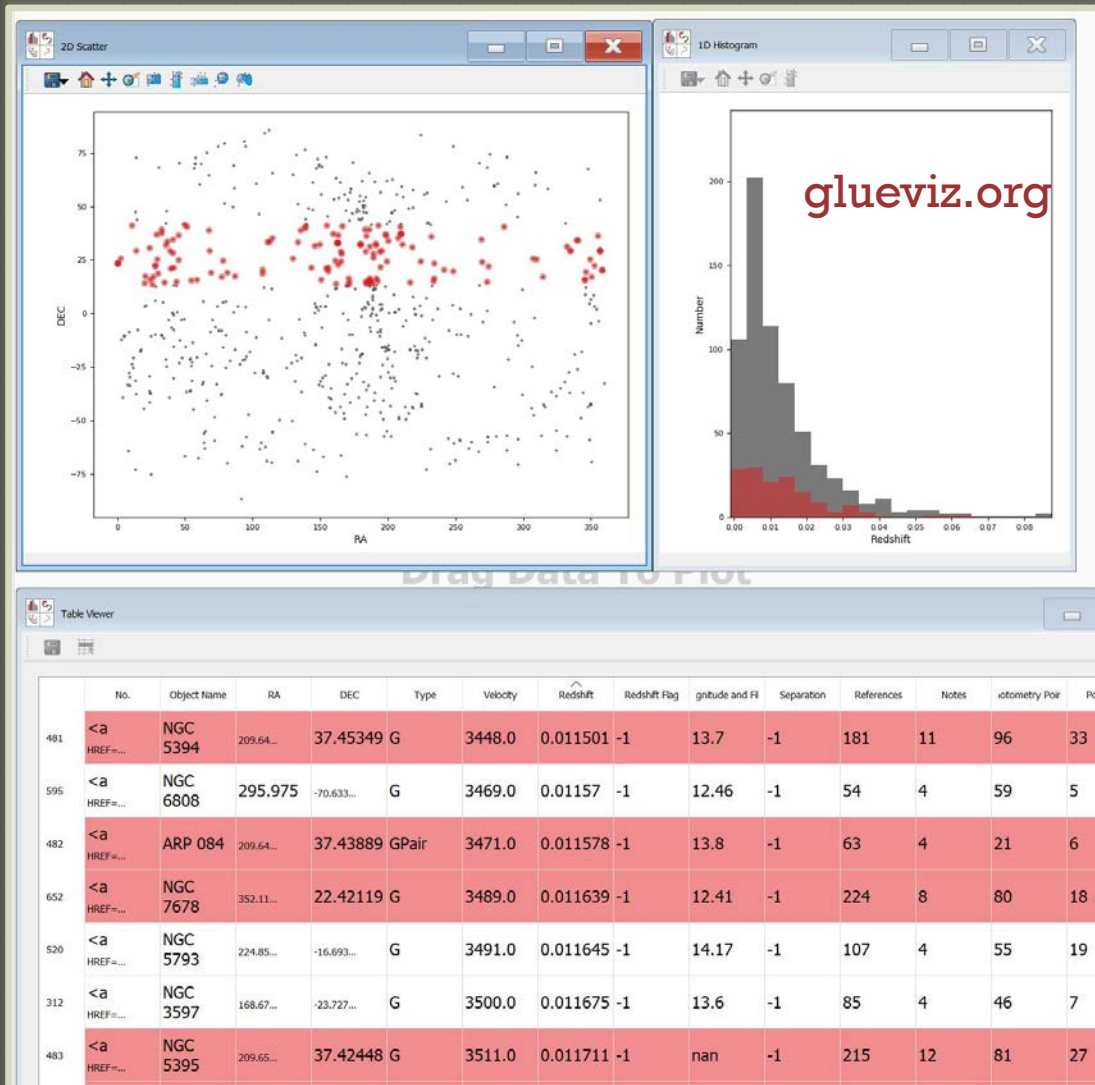
WISE-allwise\_p3as\_psd (Cone...

166 of 179 (16,501 - 16,600 of 17,817)

	designation	ra	dec	clon	clat	si <sub>ra</sub>	si <sub>dec</sub>
<input type="checkbox"/>	J182047.06-135032.5	275.1901173	-13.8423824	18h20m47.07s	-13d05m32.58s	0.1243	0.1442
<input type="checkbox"/>	J182024.66-140526.6	275.1027840	-14.0907466	18h20m24.67s	-14d05m26.69s	0.0628	0.0630
<input type="checkbox"/>	J182006.66-141013.5	275.0277859	-14.1704439	18h20m06.67s	-14d10m13.60s	0.0812	0.0813
<input type="checkbox"/>	J182039.63-135843.4	275.1651254	-13.9787392	18h20m39.63s	-13d58m43.46s	0.0913	0.0975
<input type="checkbox"/>	J181910.42-141651.9	274.7934528	-14.2810963	18h19m10.43s	-14d16m51.95s	0.0228	0.0280
<input type="checkbox"/>	J181843.69-141721.1	274.6820701	-14.2892221	18h18m43.70s	-14d17m21.20s	0.1250	0.1934
<input type="checkbox"/>	J181713.15-140555.8	274.3048237	-14.0988571	18h17m13.16s	-14d05m55.89s	0.1062	0.1127
<input type="checkbox"/>	J181715.81-140645.0	274.3158897	-14.1125048	18h17m15.81s	-14d06m45.02s	0.0471	0.0456
<input type="checkbox"/>	J181650.63-135317.9	274.2109930	-13.8883269	18h16m50.64s	-13d53m17.98s	0.0803	0.0809
<input type="checkbox"/>	J181748.04-132327.0	274.4501678	-13.3908337	18h17m48.04s	-13d23m27.00s	0.1148	0.1262
<input type="checkbox"/>	J181650.96-135345.0	274.2123533	-13.8958596	18h16m50.96s	-13d53m45.09s	0.0456	0.0428
<input type="checkbox"/>	J181740.71-141240.0	274.4571626	-14.2078666	18h17m40.71s	-14d12m40.02s	0.0714	0.0877



# Other tools with connected views



## Brushing & Linking

propagating  
selections in any  
graph to all others

## Supporting tools

glueviz.org  
uwdata/falcon  
Bokeh  
Plotly Dash

...

Image Credit: glueviz.org



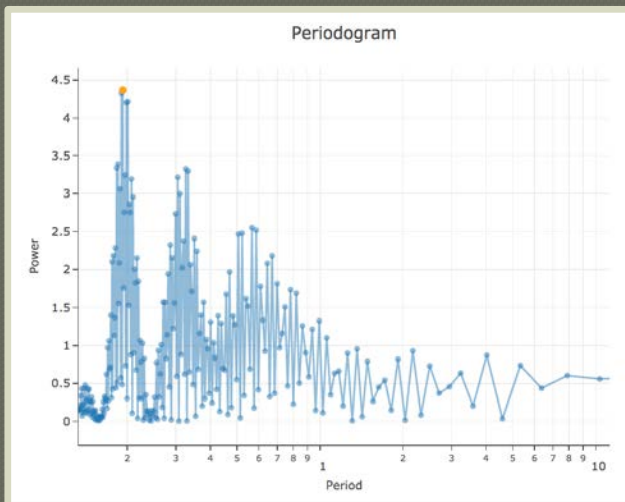
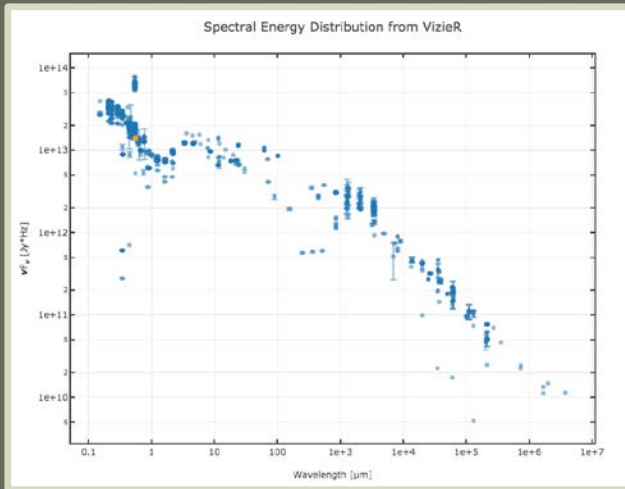
# Added Value of Integration

---

*Tools that tightly integrate data access, versioning, and management are preferred over those that put all of the data management steps purely outside of the Information Visualization system.*

*Dan Russell  
Google research scientist*

# Common charts



Must support

- Scatter charts; error/limits
- Line plots
- Histograms
- Density plots

Bonus: other charts

# Ideal chart tech requirements

---

- ◉ Visually attractive
- ◉ Interactive (dynamic tooltips, selections)
- ◉ Customizable (custom actions and looks)
- ◉ Responsive (no lag, no flicker)



- ◉ Executed in a browser (SVG, <CANVAS>, WebGL)
- ◉ Events monitoring and custom code hooks
- ◉ Easy mapping of our data to chart data
- ◉ Optimizations for iterative updates

# Firefly Chart API

---

Do not limit API users  
to common charts

Allow any chart or attribute supported  
by the charting library

How do we maintain and document  
these charts?

# Why Plotly?

---

- First scientific JS charting library on the web
- Open sourced 2015
- Declarative charts in JSON
- Language and platform independent
- Supported schema translations into

➤ JavaScript

➤ Python

➤ R

➤ MATLAB

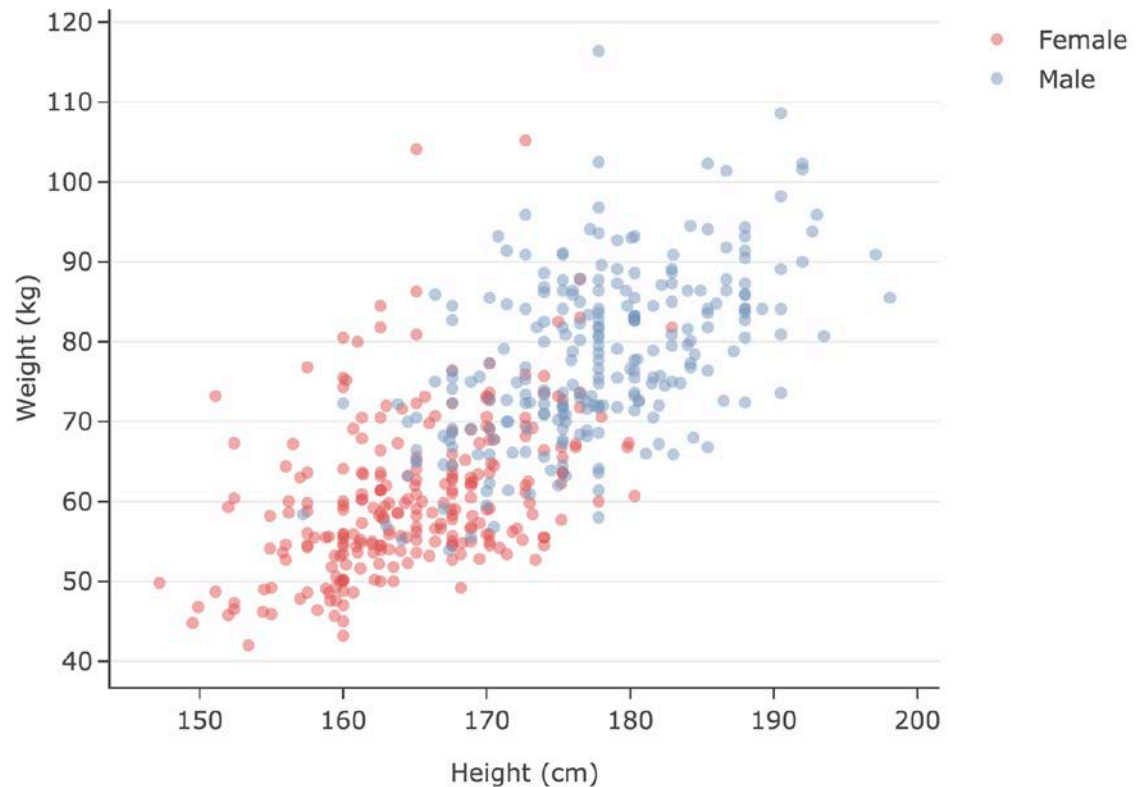




# Declarative Chart Example

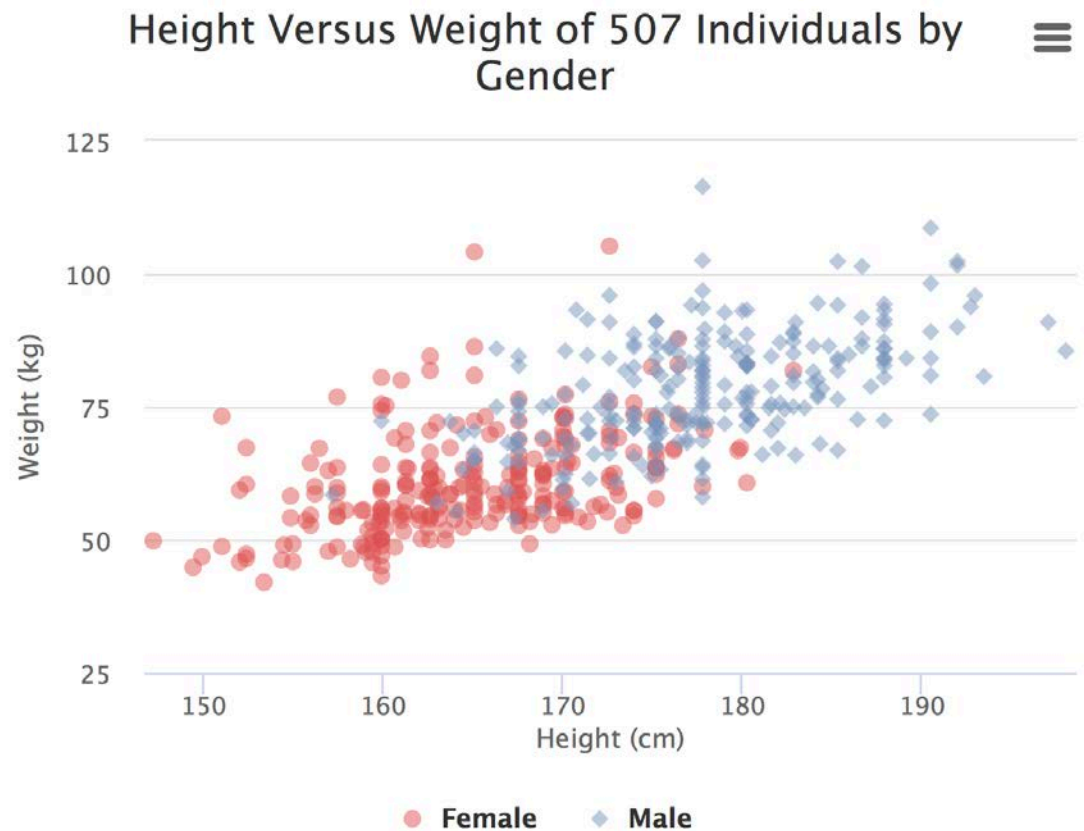
```
chart = {  
  data: [  
    {  
      name: 'Female',  
      mode: 'markers',  
      marker: {  
        color: 'rgb(223, 83, 83)',  
      },  
      x: [161.2, 167.5, 159.5, 158.5, 165.0, 162.0, 160.0, 163.0, 164.0, 166.0, 168.0, 169.0, 170.0, 171.0, 172.0, 173.0, 174.0, 175.0, 176.0, 177.0, 178.0, 179.0, 180.0, 181.0, 182.0, 183.0, 184.0, 185.0, 186.0, 187.0, 188.0, 189.0, 190.0, 191.0, 192.0, 193.0, 194.0, 195.0, 196.0, 197.0, 198.0, 199.0, 200.0],  
      y: [51.6, 59.0, 49.2, 63.0, 55.0, 60.0, 58.0, 62.0, 61.0, 64.0, 65.0, 66.0, 67.0, 68.0, 69.0, 70.0, 71.0, 72.0, 73.0, 74.0, 75.0, 76.0, 77.0, 78.0, 79.0, 80.0, 81.0, 82.0, 83.0, 84.0, 85.0, 86.0, 87.0, 88.0, 89.0, 90.0, 91.0, 92.0, 93.0, 94.0, 95.0, 96.0, 97.0, 98.0, 99.0, 100.0, 101.0, 102.0, 103.0, 104.0, 105.0, 106.0, 107.0, 108.0, 109.0, 110.0, 111.0, 112.0, 113.0, 114.0, 115.0, 116.0, 117.0, 118.0, 119.0, 120.0],  
    },  
    {  
      name: 'Male',  
      mode: 'markers',  
      marker: {  
        color: 'rgb(119, 152, 152)',  
      },  
      x: [174.0, 175.3, 193.5, 188.0, 176.0, 177.0, 178.0, 179.0, 180.0, 181.0, 182.0, 183.0, 184.0, 185.0, 186.0, 187.0, 188.0, 189.0, 190.0, 191.0, 192.0, 193.0, 194.0, 195.0, 196.0, 197.0, 198.0, 199.0, 200.0],  
      y: [65.6, 71.8, 80.7, 72.6, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0, 92.0, 94.0, 96.0, 98.0, 100.0, 102.0, 104.0, 106.0, 108.0, 110.0, 112.0, 114.0, 116.0, 118.0, 120.0],  
    },  
  ],  
  layout: {  
    title: 'Height Versus Weight of 507 Individuals by Gender',  
    xaxis: {title: 'Height (cm)'},  
    yaxis: {title: 'Weight (kg)'}  
  }  
};
```

Height Versus Weight of 507 Individuals by Gender



# Declarative Chart Example

```
{
  series: [{
    name: 'Female',
    color: 'rgba(223, 83, 83, .5)',
    data: [[161.2, 51.6], [167.5, 59.0],
  ], {
    name: 'Male',
    color: 'rgba(119, 152, 191, .5)',
    data: [[174.0, 65.6], [175.3, 71.8],
  ],
  chart: {
    type: 'scatter',
    zoomType: 'xy'
  },
  title: {
    text: 'Height Versus Weight of 507 In
  },
  xAxis: {
    title: {
      text: 'Height (cm)'
    },
  },
  yAxis: {
    title: {
      text: 'Weight (kg)'
    },
  },
}
```



# Declarative Chart Definitions

```
{
  series: [{
    name: 'Female',
    color: 'rgba(223, 83, 83, .5)',
    data: [[161.2, 51.6], [167.5, 59.0]],
  }, {
    name: 'Male',
    color: 'rgba(119, 152, 191, .5)',
    data: [[174.0, 65.6], [175.3, 71.8]],
  }],
  chart: {
    type: 'scatter',
    zoomType: 'xy'
  },
  title: {
    text: 'Height Versus Weight of 507 In
  },
  xAxis: {
    title: {
      text: 'Height (cm)'
    },
  },
  yAxis: {
    title: {
      text: 'Weight (kg)'
    },
  },
}
```

Highcharts

```
{
  data: [
    {
      name: 'Female',
      mode: 'markers',
      marker: {
        color: 'rgba(223, 83, 83, .5)'
      },
      x: [161.2, 167.5, 159.5, 157.0, 15
      y: [51.6, 59.0, 49.2, 63.0, 53.6,

    {
      name: 'Male',
      mode: 'markers',
      marker: {
        color: 'rgba(119, 152, 191, .5
      },
      x: [174.0, 175.3, 193.5, 186.5, 18
      y: [65.6, 71.8, 80.7, 72.6, 78.8,

  ],
  layout: {
    title: 'Height Versus Weight of 507 In
    xaxis: {title: 'Height (cm)'},
    yaxis: {title: 'Weight (kg)'}
  },
};
```

Plotly.js

# Declarative Charts Approach

---

Used by popular chart libraries:

Plotly, Highcharts, Vega-lite, many more

More than 1000 properties in each

Incompatible data models / vocabularies:

- Series in Highcharts
- Traces in Plotly
- Layers in Vega-Lite

Forces teams to choose one charting library and build on top of it



# Plotly Figure Hierarchy

DATA [ ]

TRACE { }

→ x, y, z [ ]

text [ ]

ERROR\_X, ERROR\_Y { }

→ array, arrayminus [ ]

MARKER { }

→ color ABC or [ ]

size 123 or [ ]

colorscale ABC or [ ]

symbol ABC

LAYOUT { }

showlegend True/False

autosize True/False

XAXIS, YAXIS { }

SCENE { }

XAXIS, YAXIS, ZAXIS { }

TITLE { }

LEGEND { }

ANNOTATIONS { }

Credit: [plotly\\_js\\_cheat\\_sheet.pdf](#)

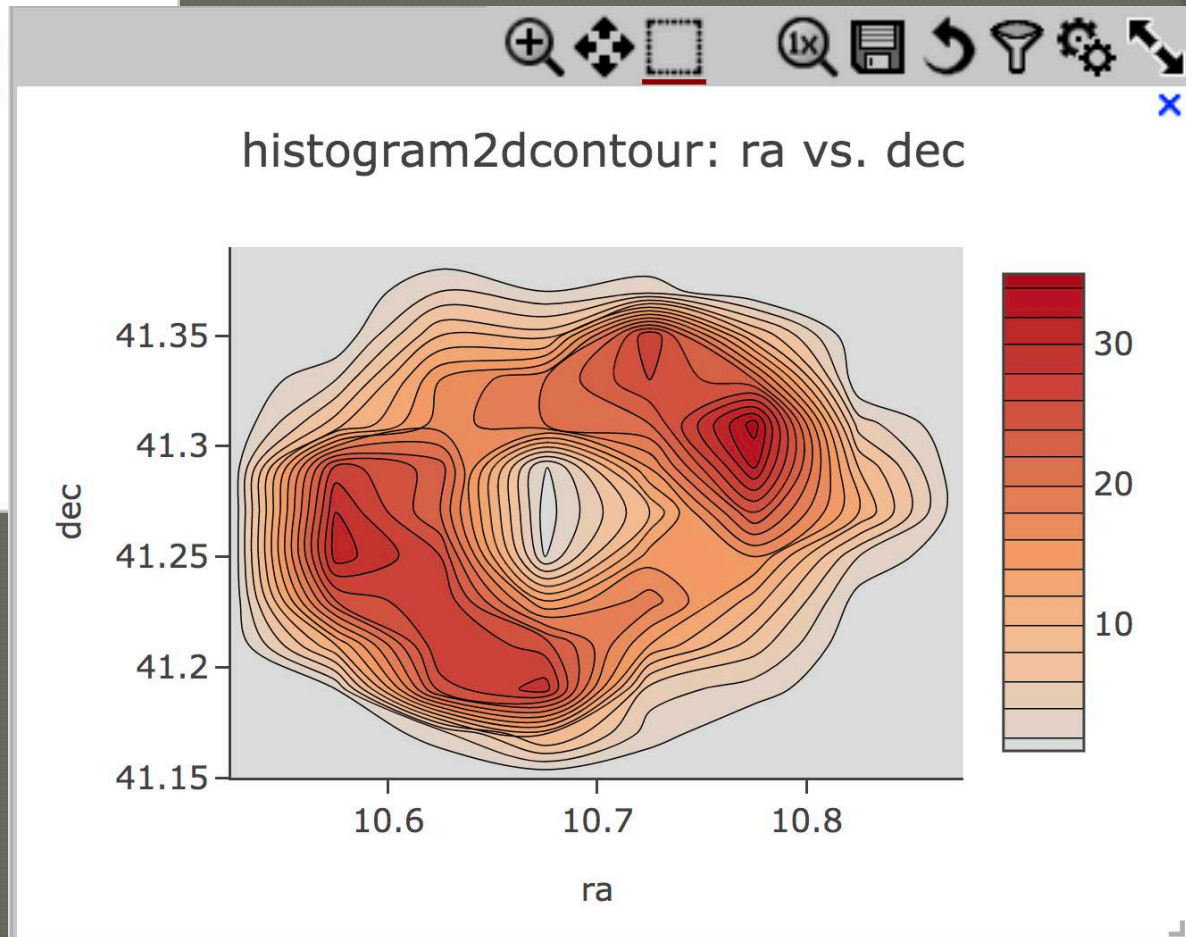
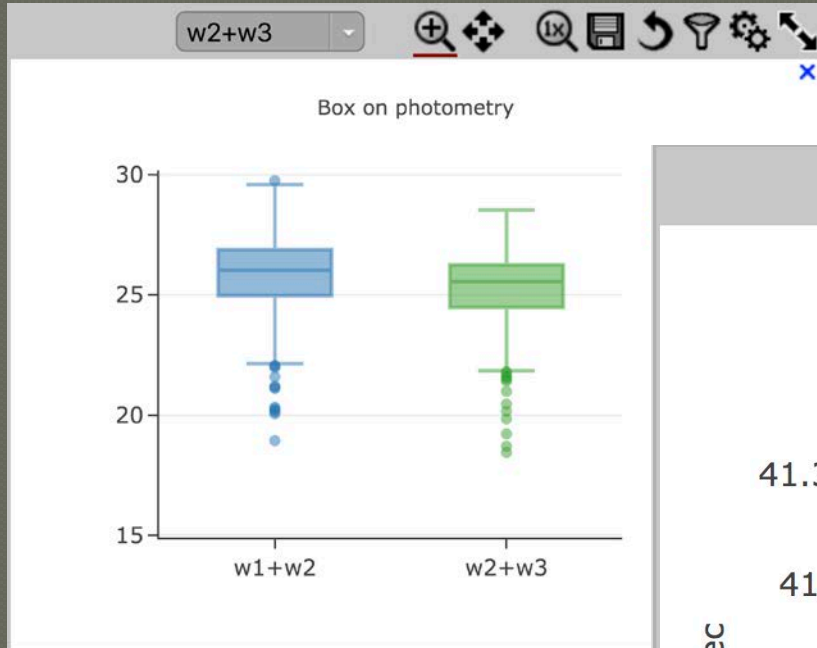
{ } = dictionary

[ ] = list

ABC = string

123 = number

# Sample charts



# Example – creating box chart

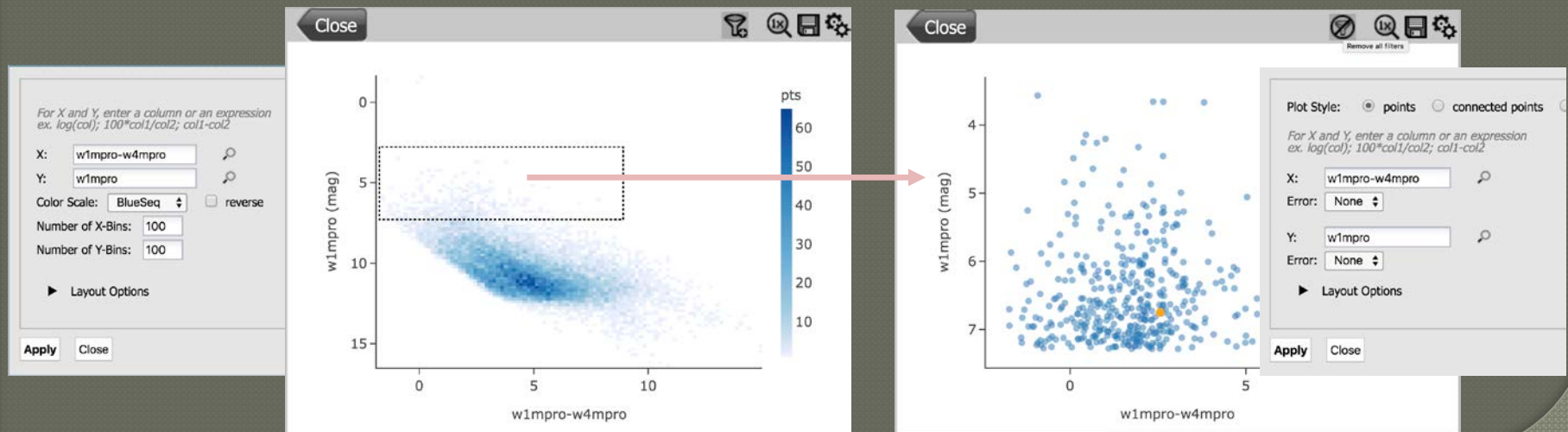
```
data = [  
  {  
    type: 'box',  
    name: 'w1+w2',  
    tbl_id: "wiseCatTbl",  
    y: "tables::w1mpro+w2mpro"  
  },  
  {  
    type: 'box',  
    name: 'w2+w3',  
    tbl_id: "wiseCatTbl",  
    y: "tables::w2mpro+w3mpro"  
  }  
];  
  
layout = {  
  title: 'Box on photometry',  
};  
  
firefly.getViewer().showChart({layout, data}, 'boxContainer');
```

**Table and column references**

**Plotly chart definition**

# Firefly Enhancements

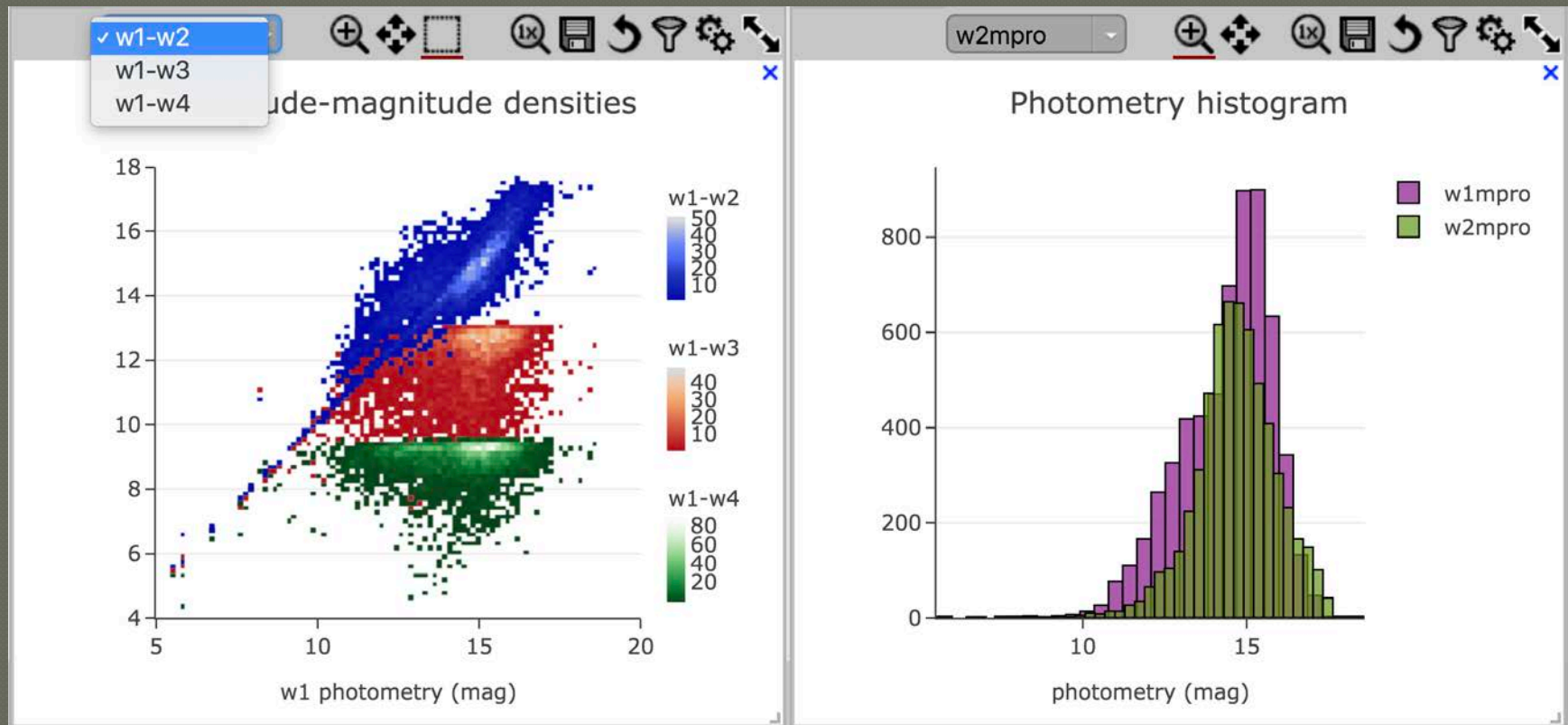
- Aggregating data on the server
- Upper/lower limits display
- Default chart: switching between heatmap and scatter based on the number of points
- UI for basic actions and chart modifications





# Firefly Enhancements

Multi-trace UI: add, remove, rearrange traces

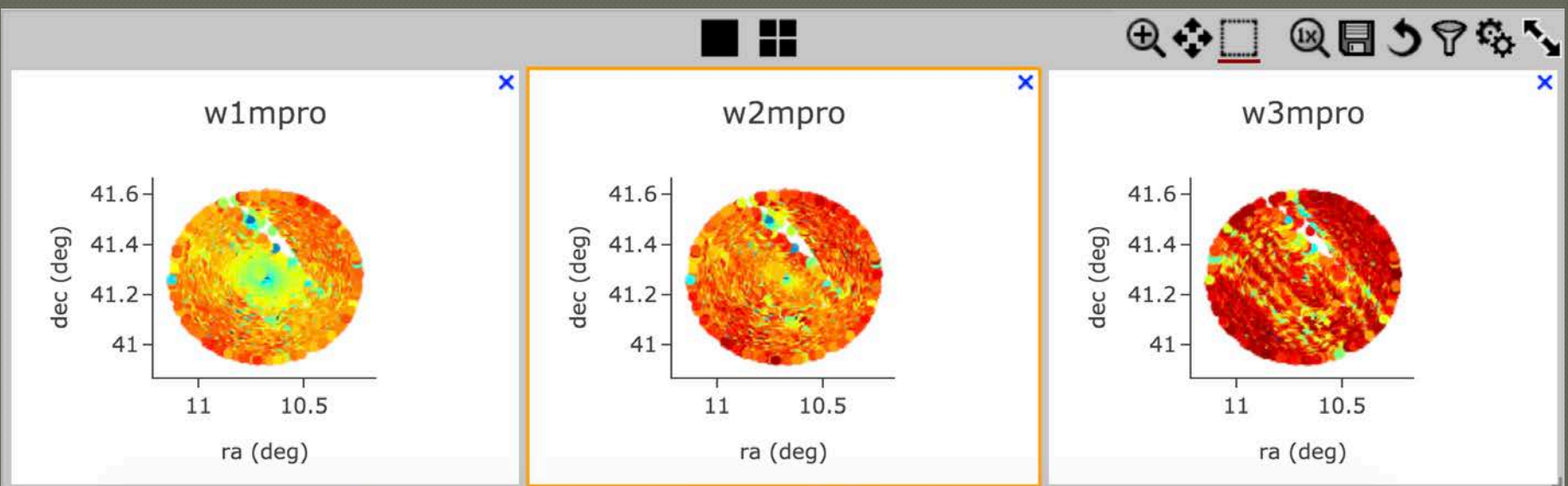


# Summary

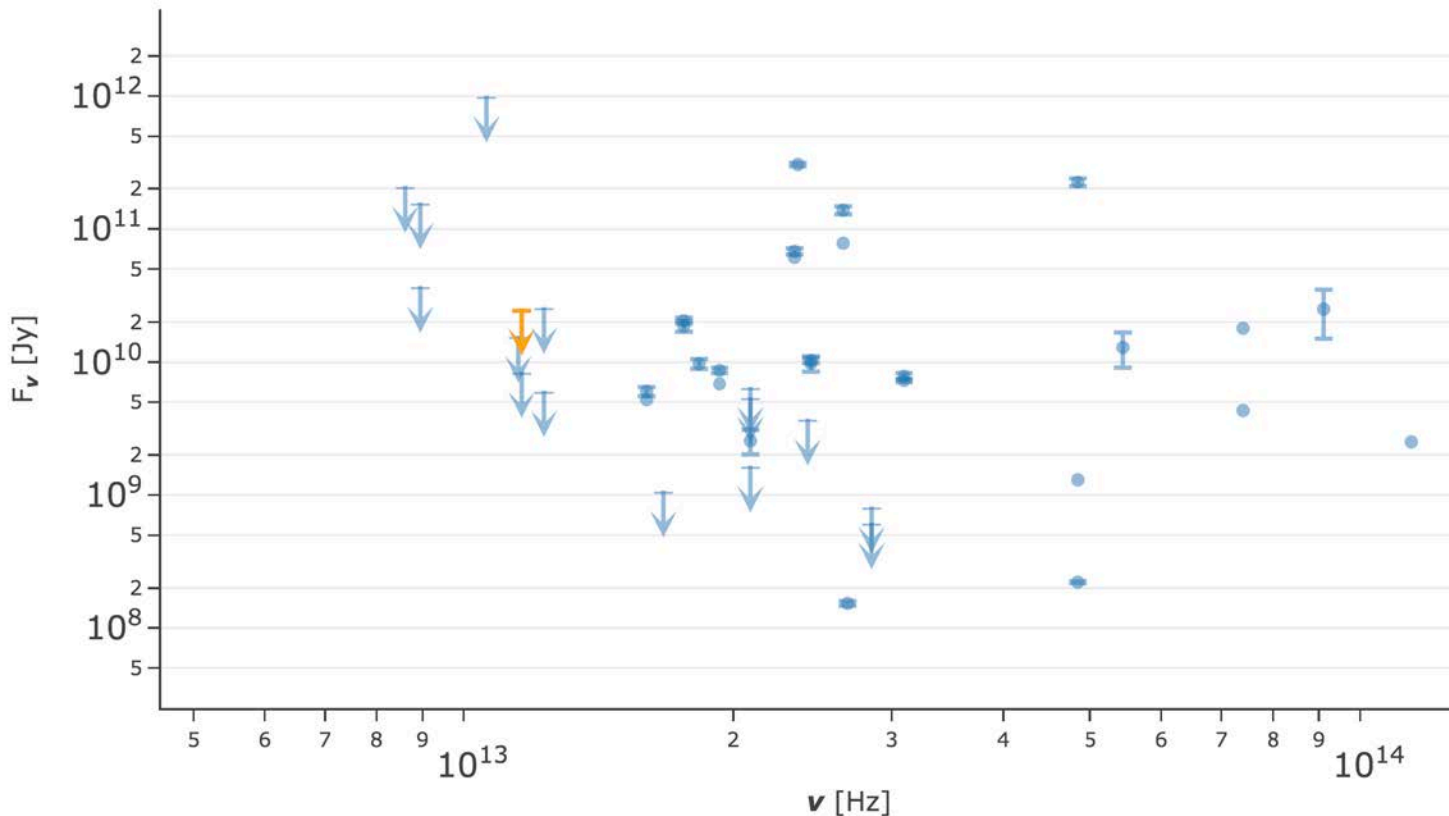
---

- Plotly proved to be a good choice to support our chart display and brushing and linking capabilities.
- Its declarative chart schema made our charting framework lightweight, flexible, and easy to extend.
- Any chart that Plotly supports can be used to visualize table data in Firefly API.
- Use <https://plot.ly/javascript/> for chart examples and attribute reference.

# Thank you!



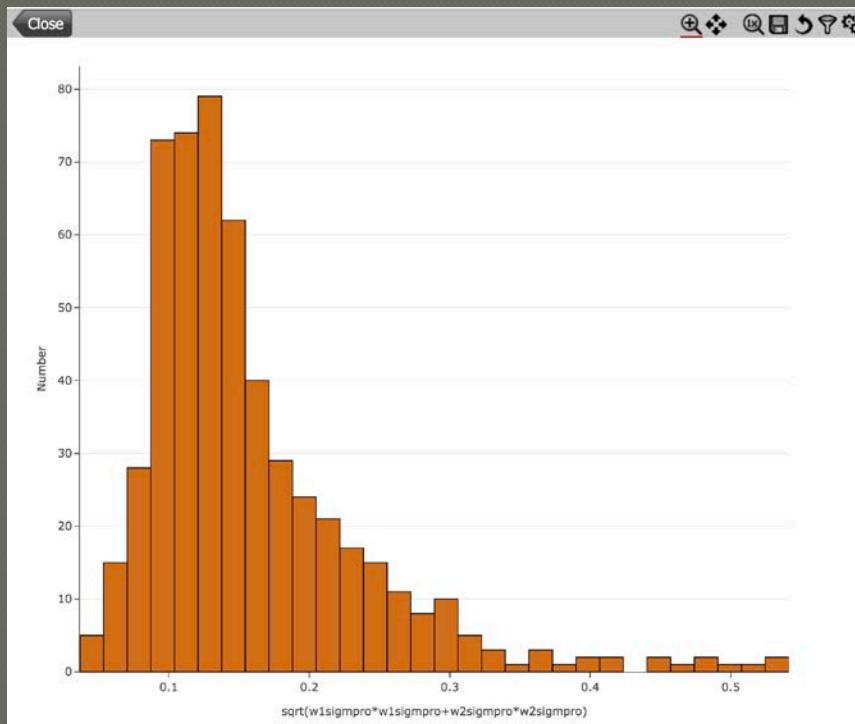
# Displaying Upper and Lower limits



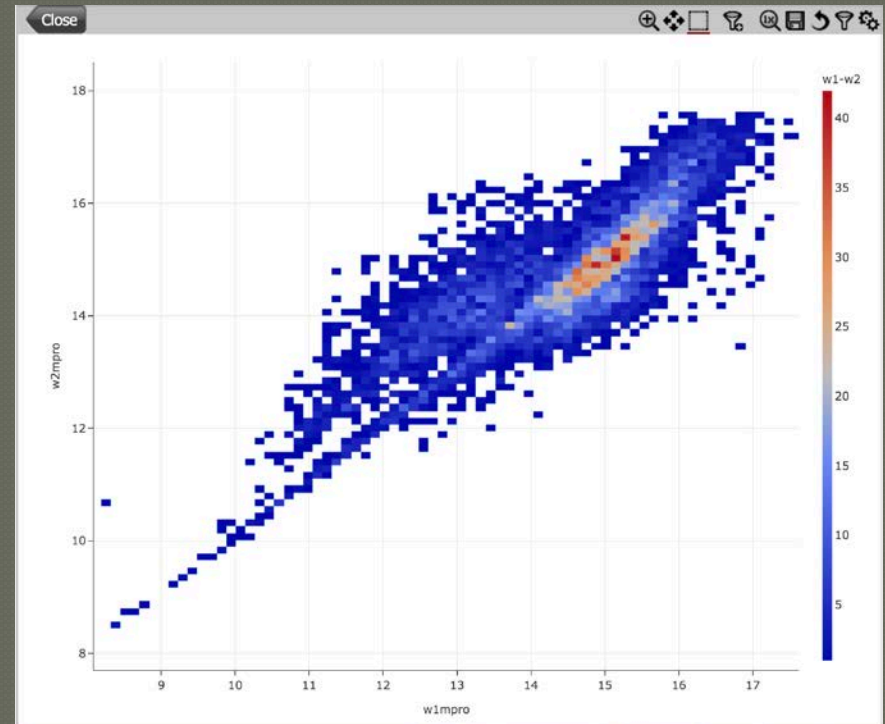


# Firefly Enhancements

## Aggregating data on the server



Firefly Histogram



Firefly Heatmap