

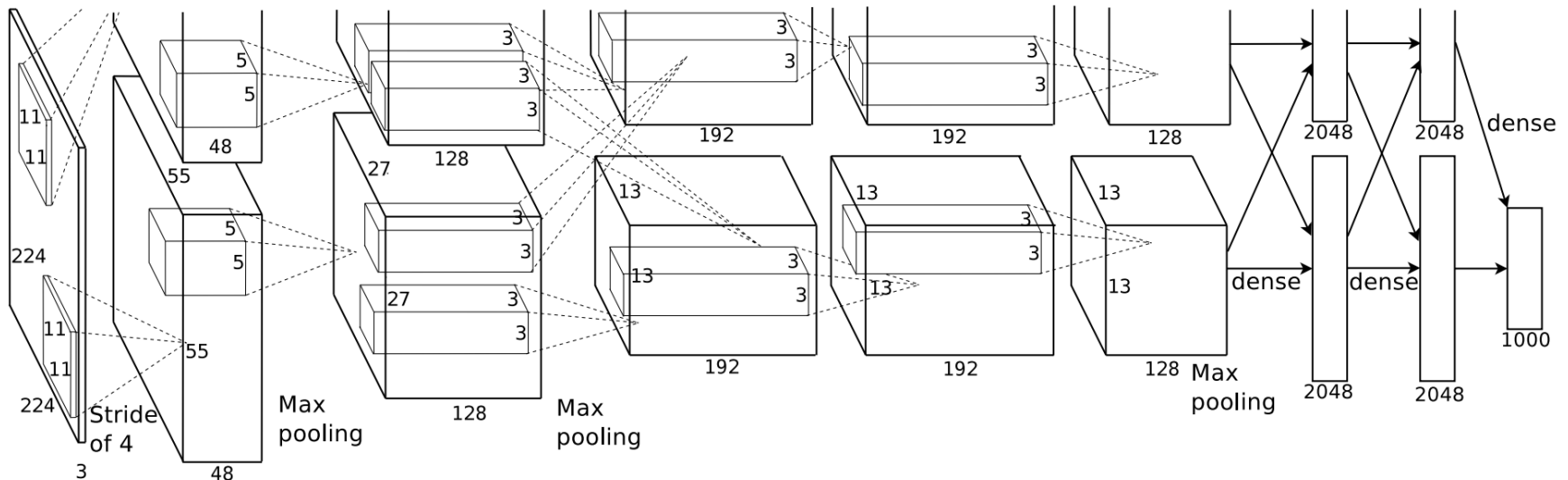
# Seein' In

## Interactive Visualization of the Convolutional Neural Network (CNN)

Tanner Schmidt

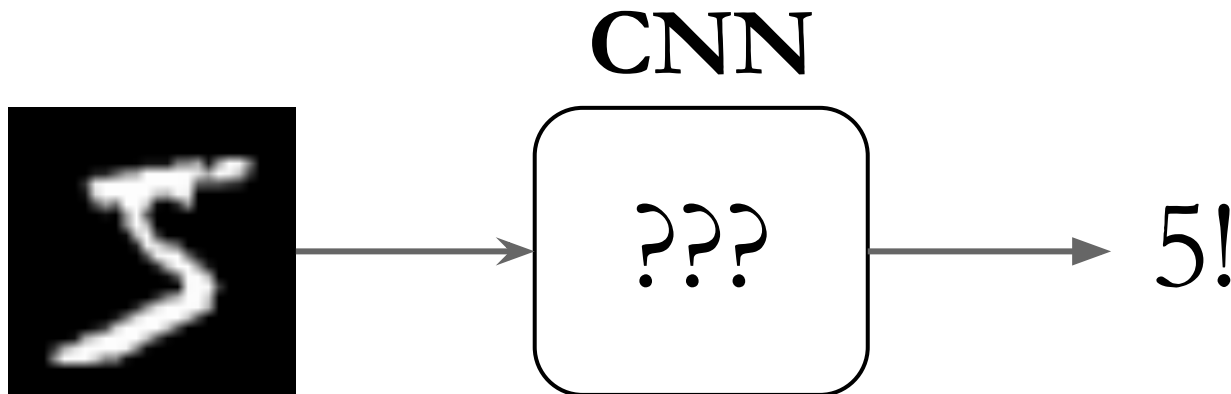
# Problem

- Convolutional neural networks have recently been wildly successful in computer vision
- They essentially apply an obscenely high-dimensional operator to an input image



# Problem

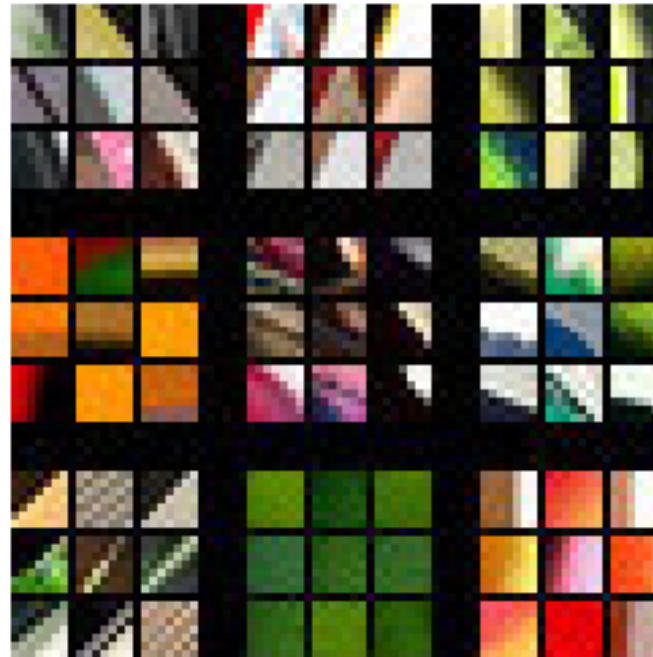
- Are CNNs a black box?
- Can we understand more about what they're doing?

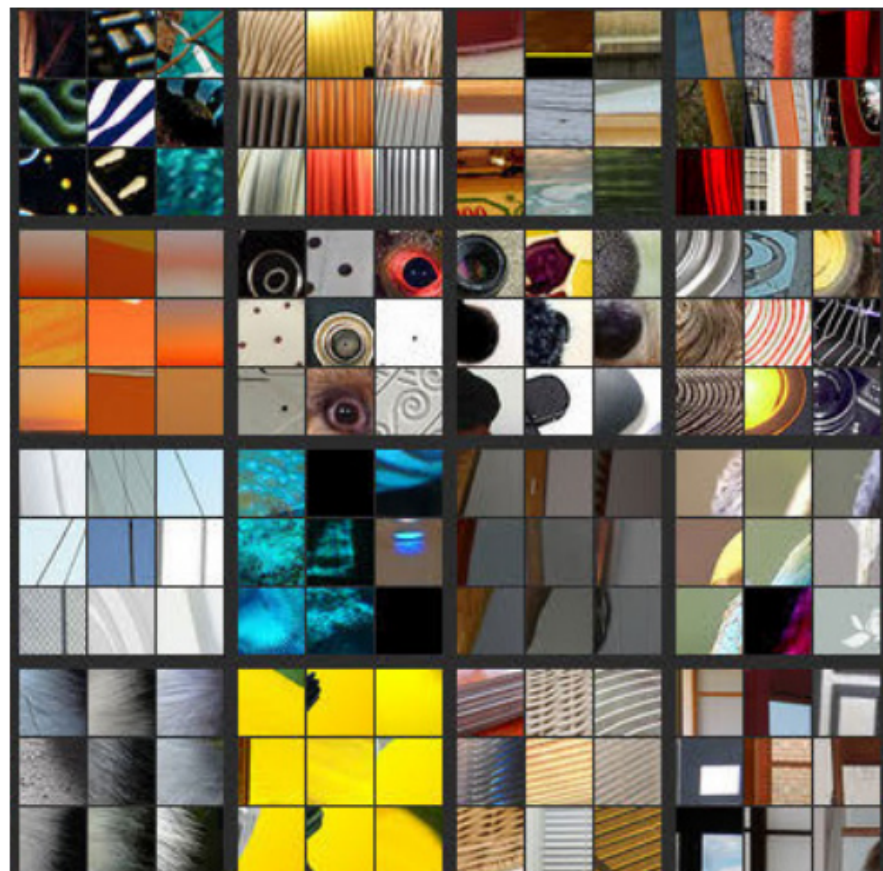
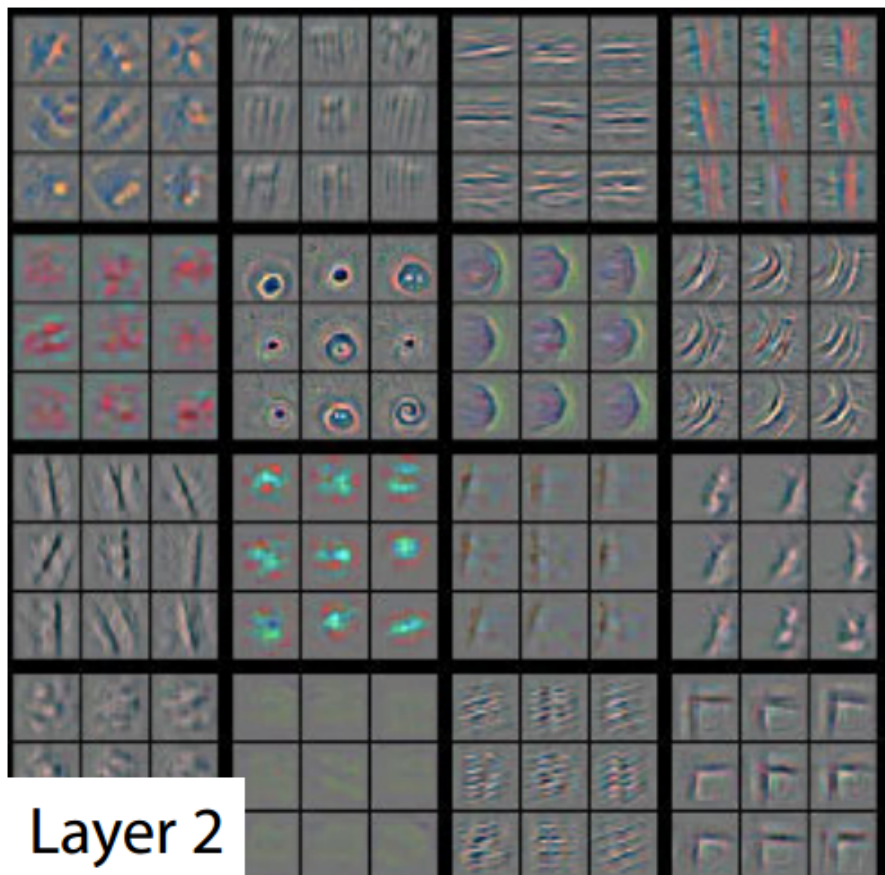


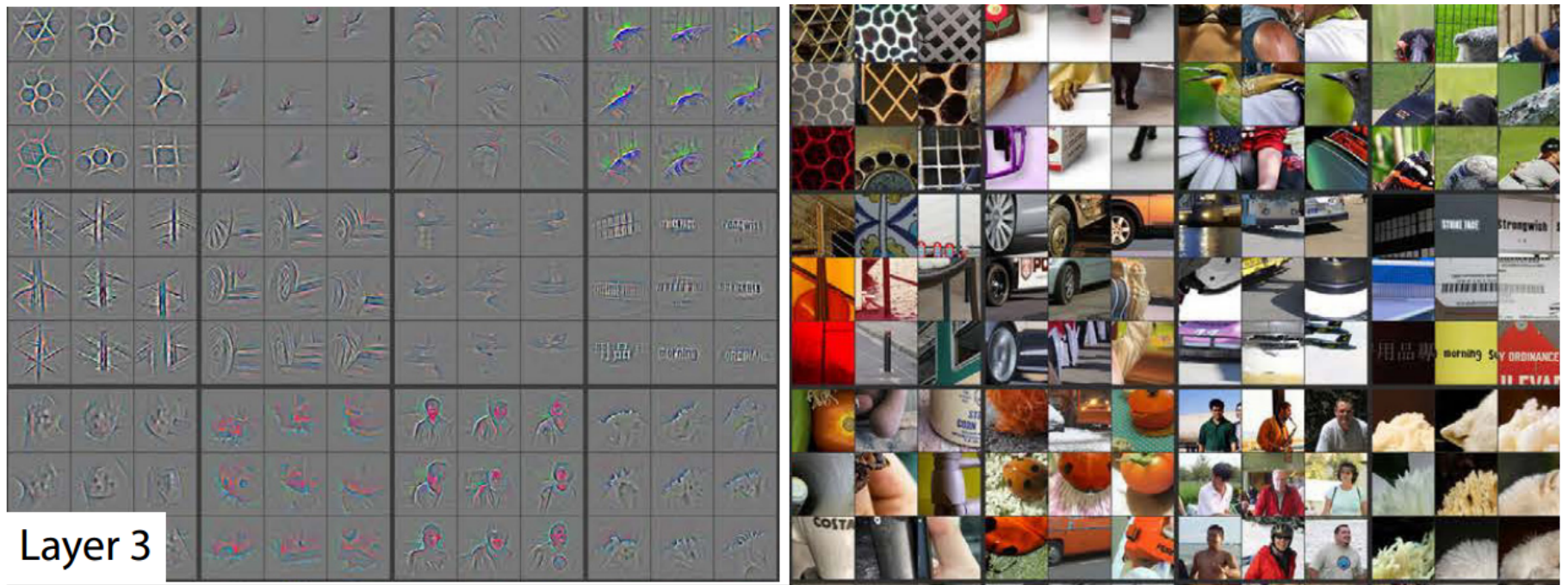
# Related Work

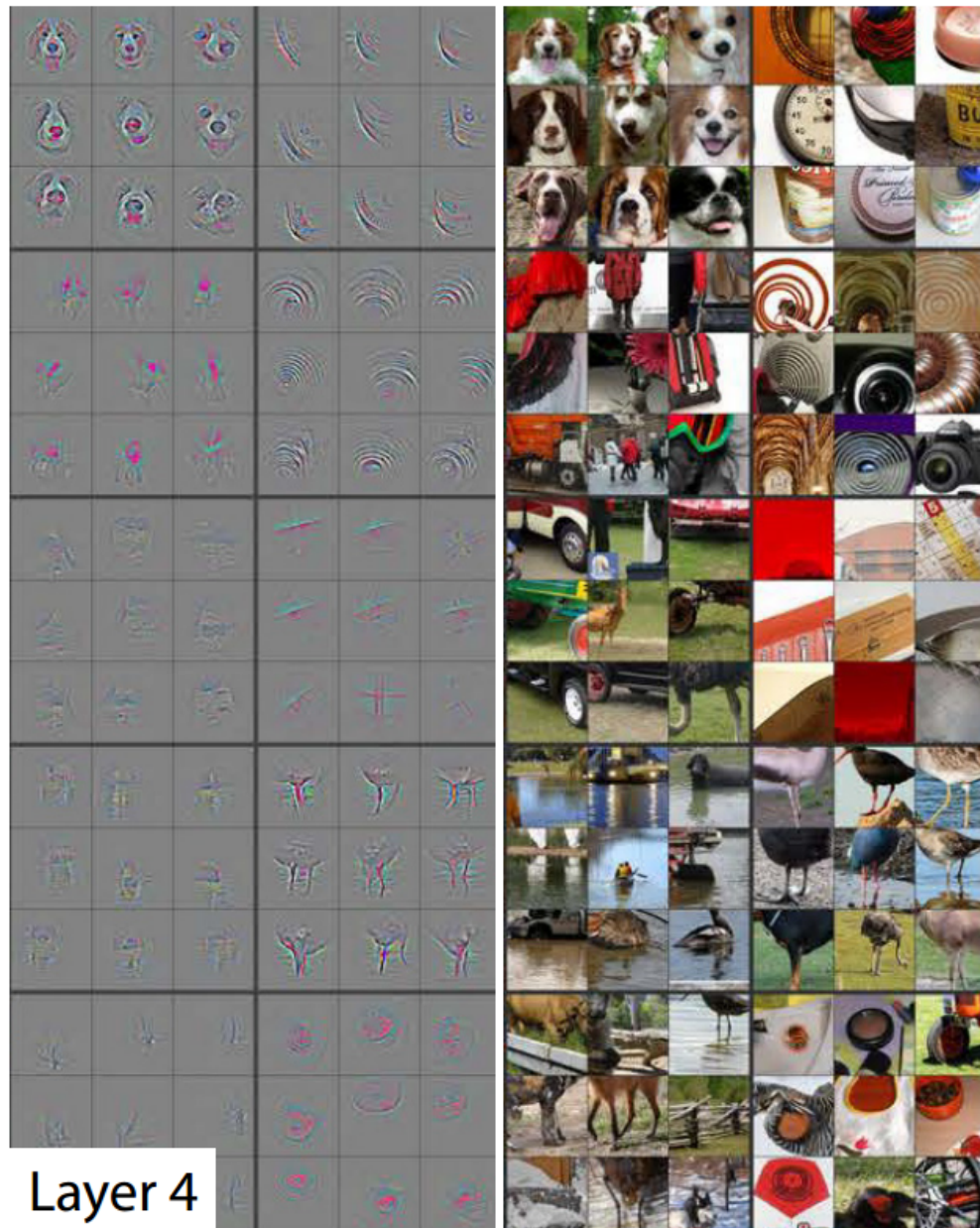


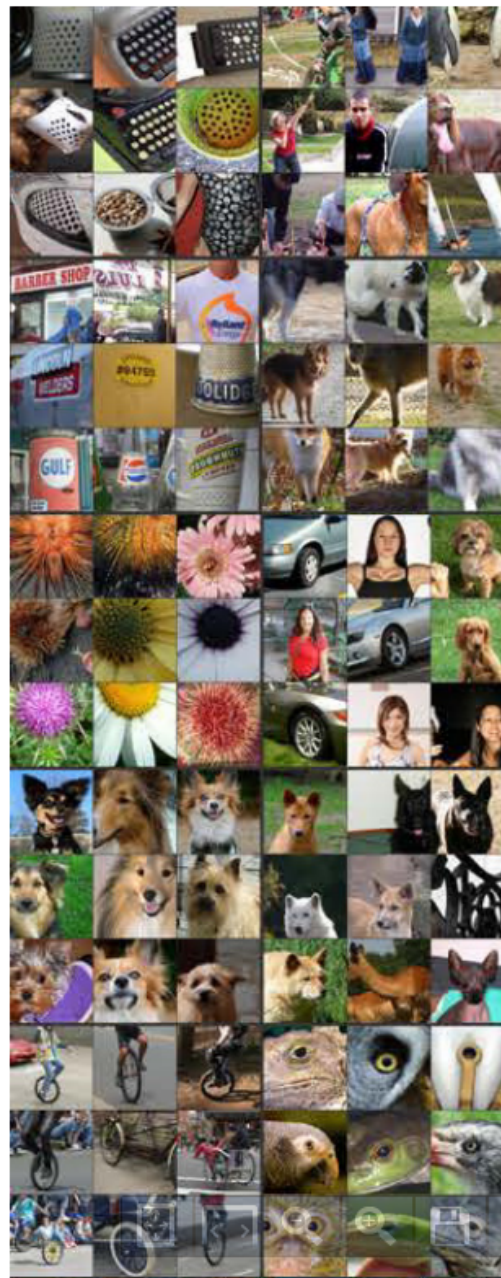
Layer 1












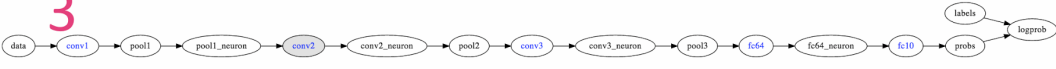


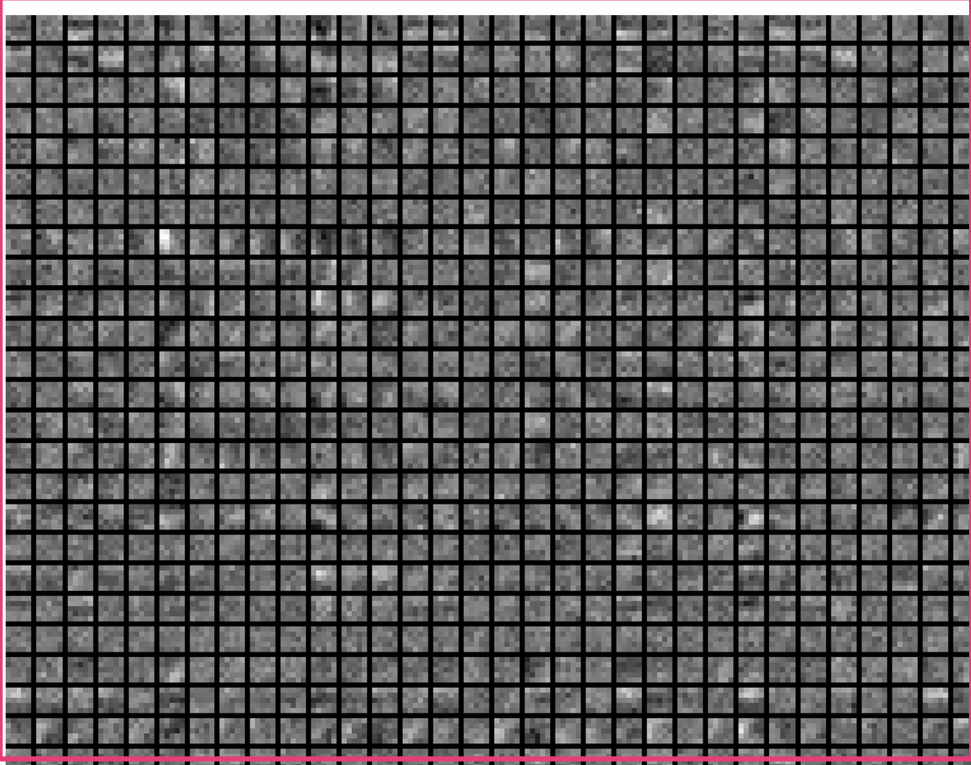
# Related Work: deepViz

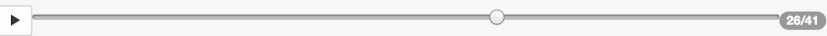
Deep Viz **Filters** Confusion Matrix Clustered Images Direct Compare **5** **6**

**1** Filter Info  
Selected filter: None

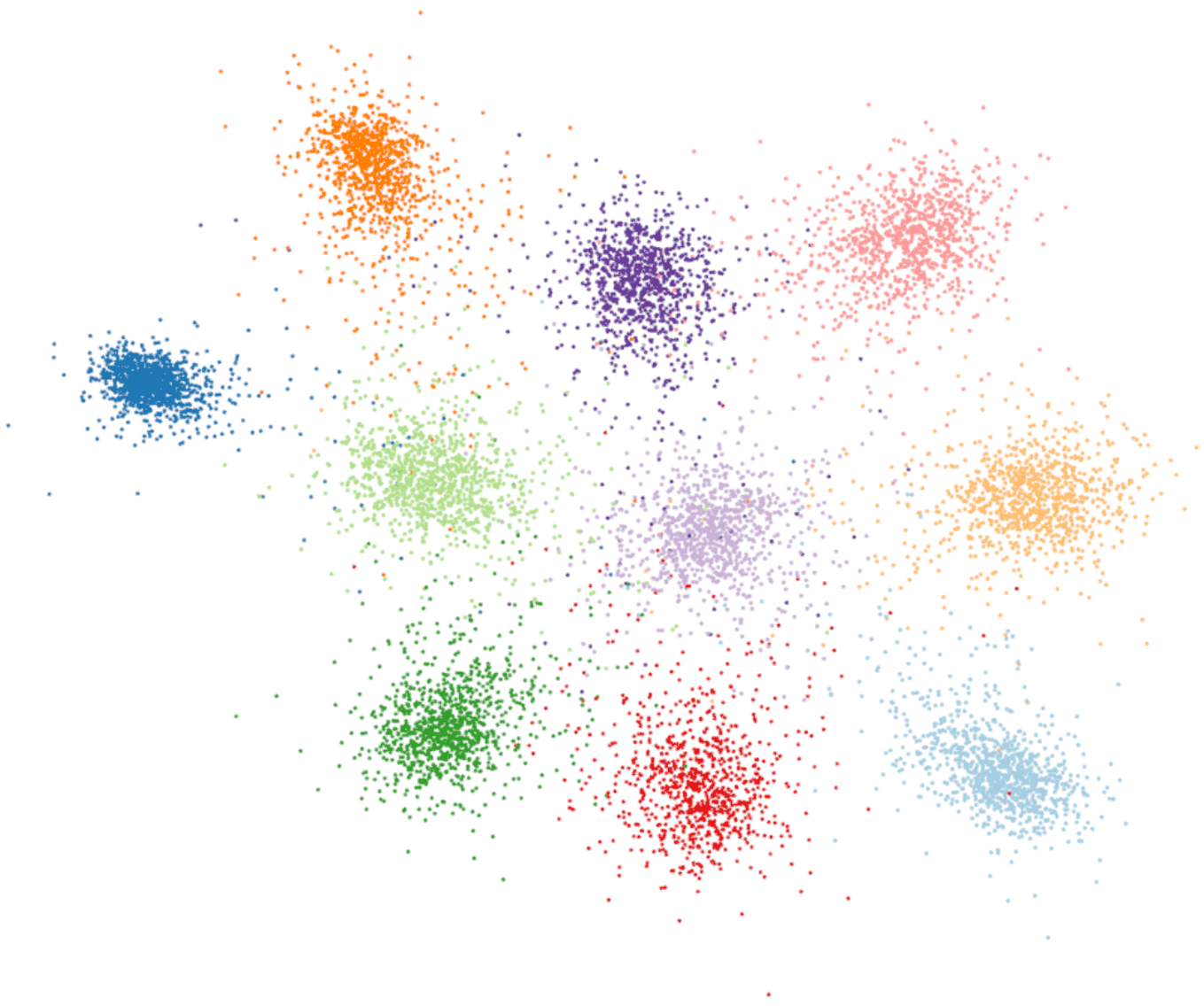
**2** Training Images   
plane  


**3** 

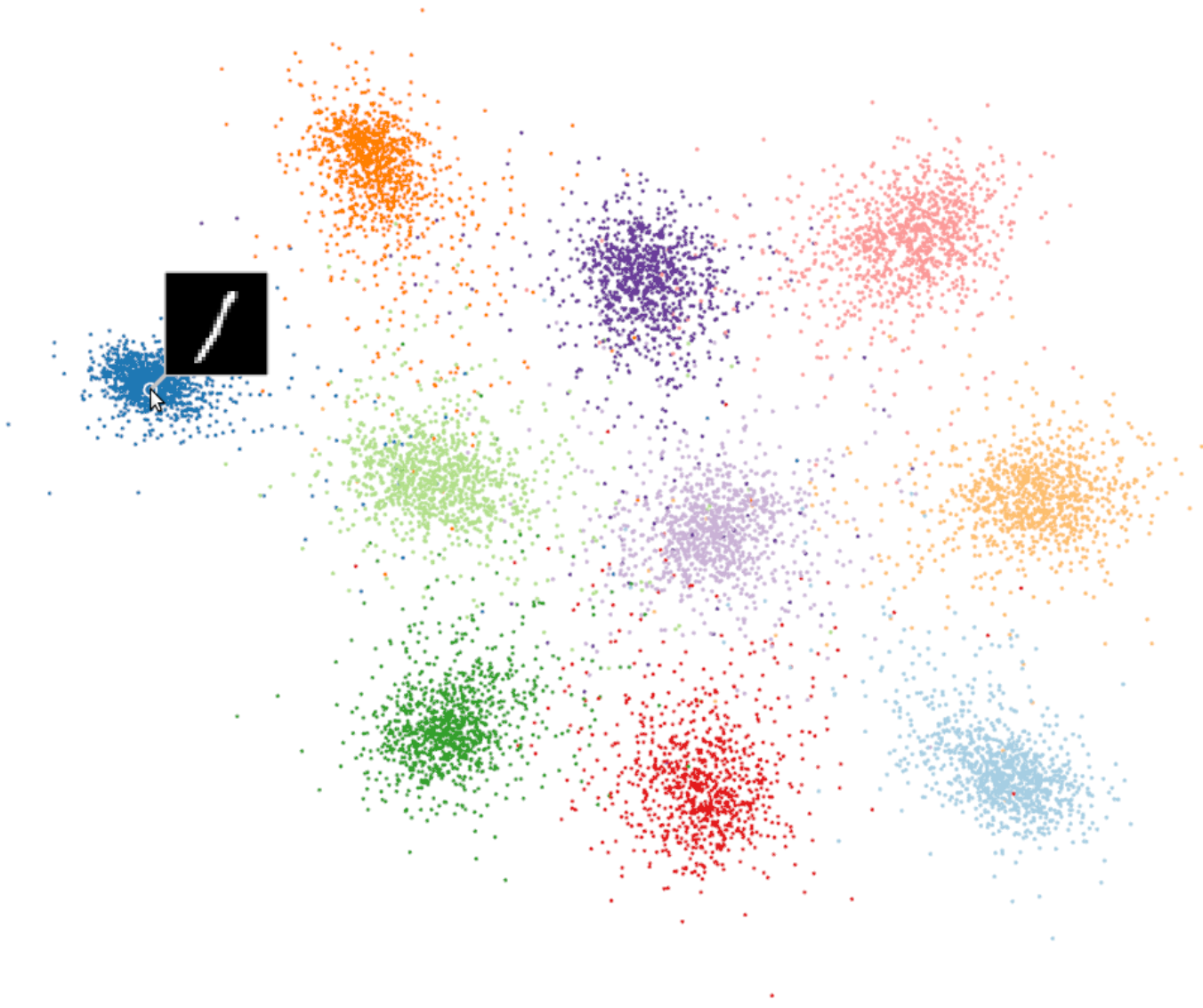
**4** 

**7**  28/41

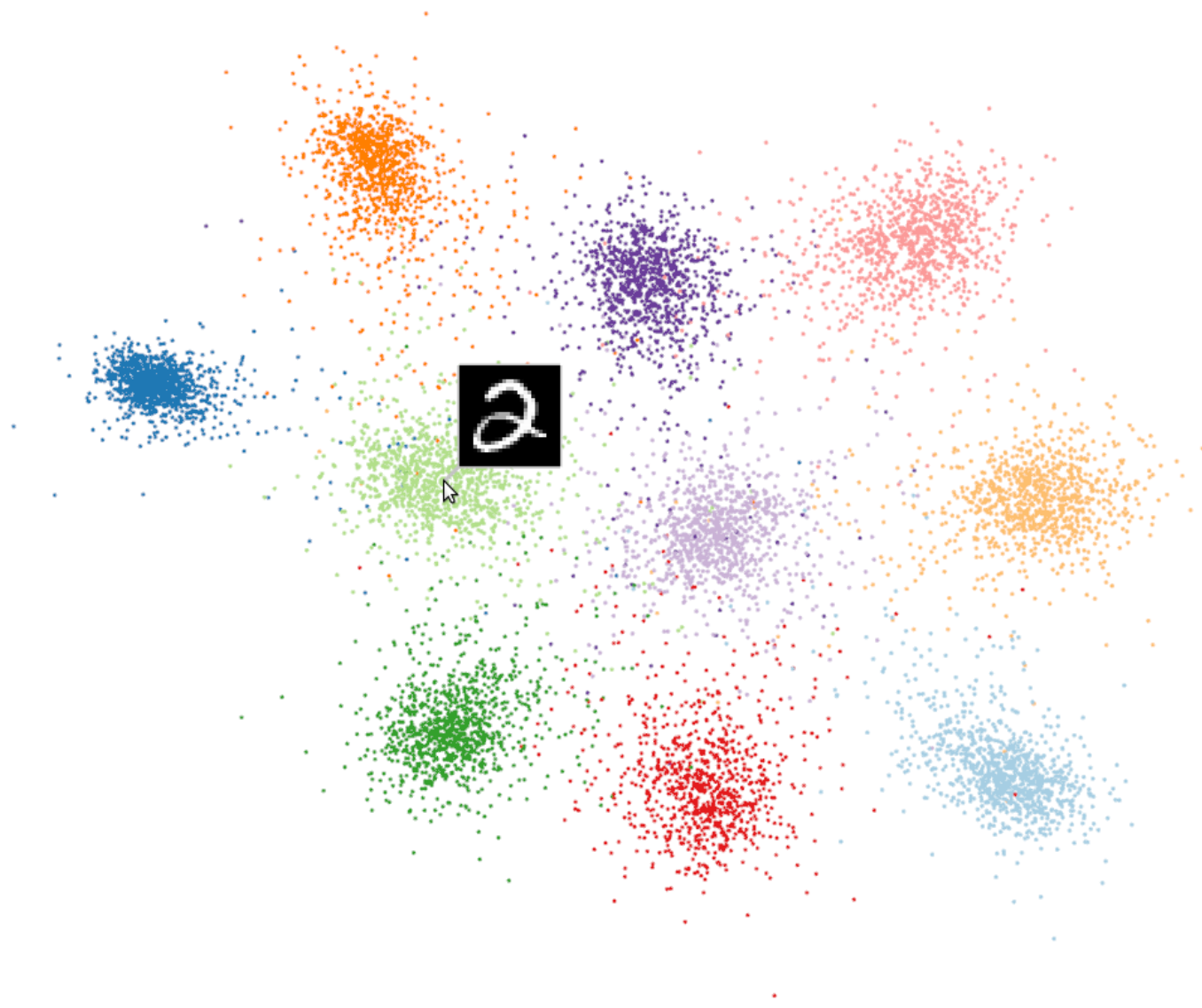
# Current Progress



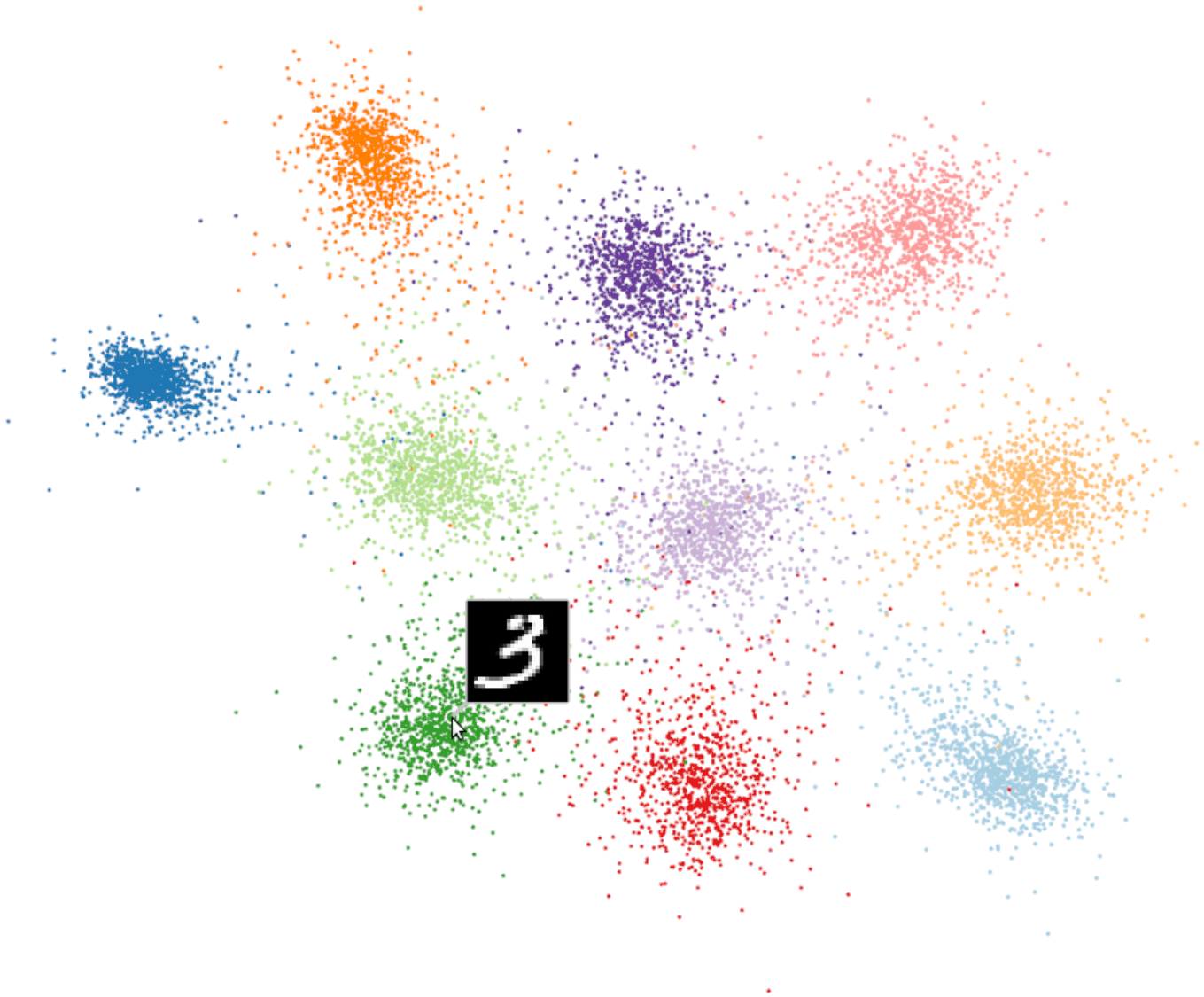
# Current Progress



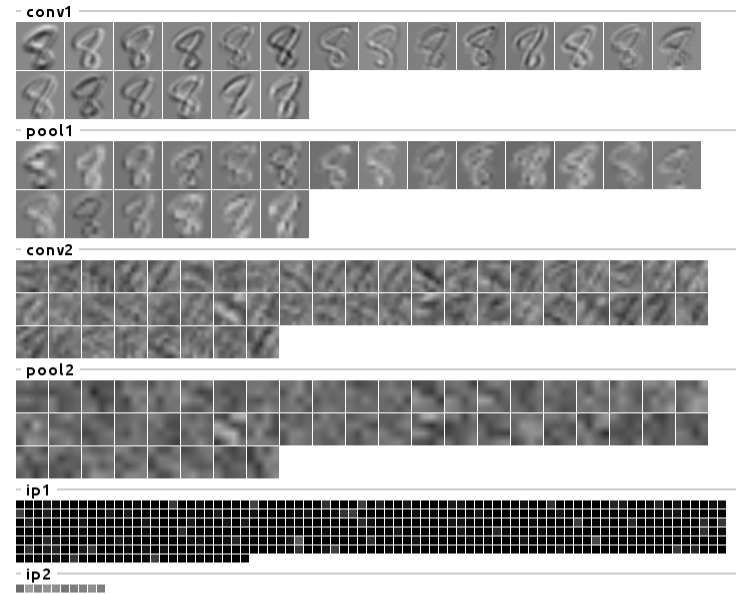
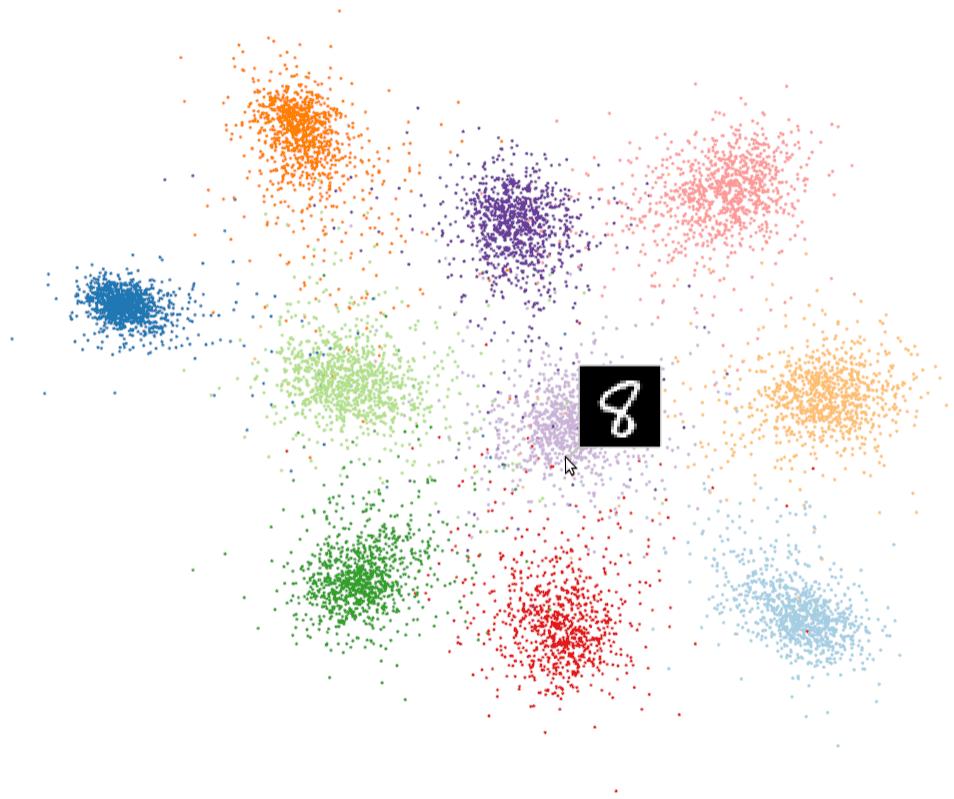
# Current Progress



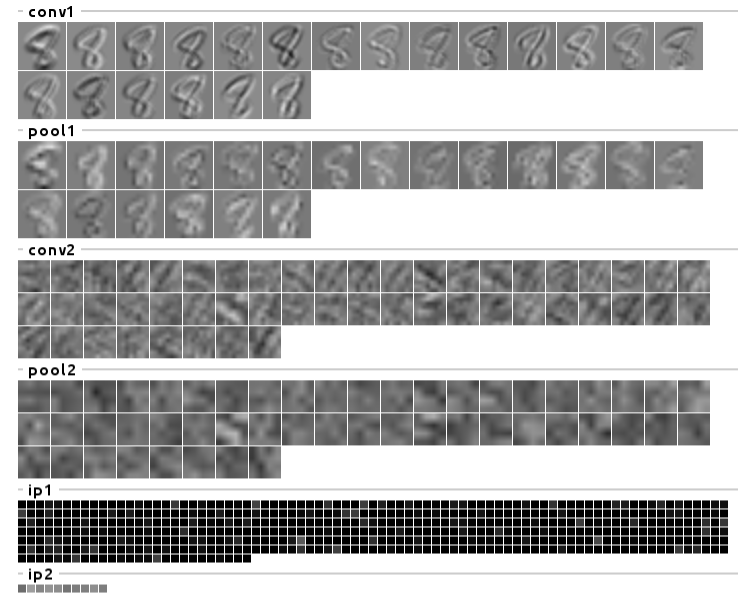
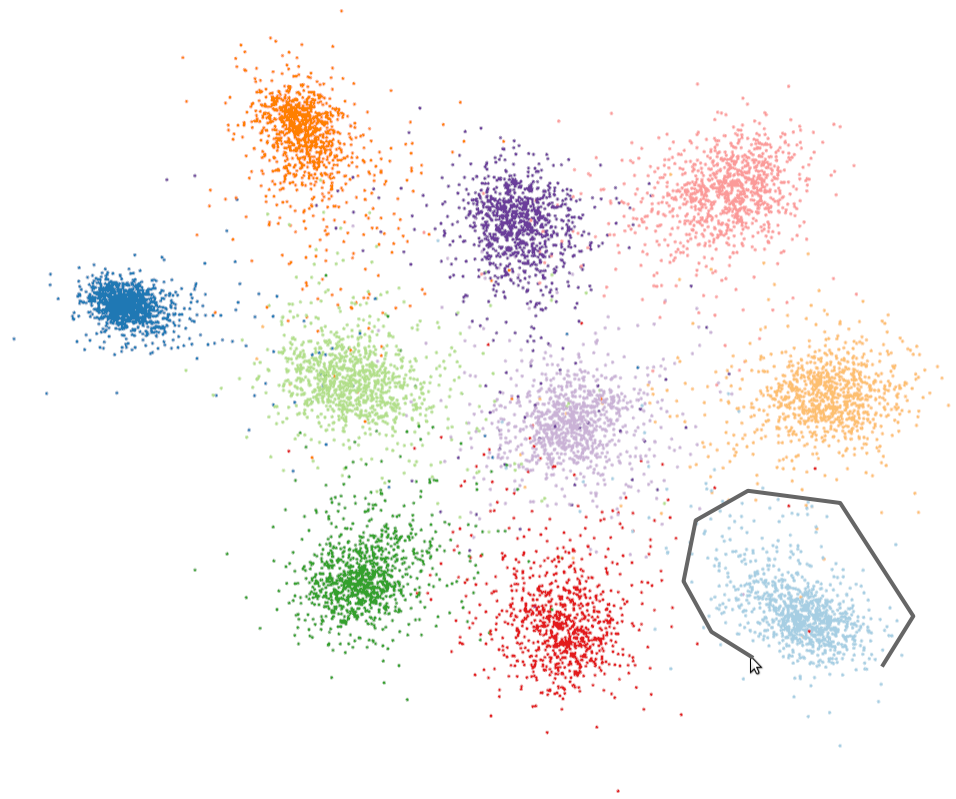
# Current Progress



# Current Progress



# Future Plans: Next Step



aggregate response

# Future Plans: Reasonable Ideas

- Show ‘embedding’ for intermediate layers
  - Small multiples?
  - Parallel coordinates?
  - Approximately distance-preserving projection from  $N$  dimensions to 2? (e.g. t-SNE)
- Back-project filter activation
  - Allow user to click pixel in feature map and show what led to activation, à la Zeiler et al.
- Video mode
  - Animations showing visually how filter responses are computed
  - Can be useful for teaching someone how CNNs operate

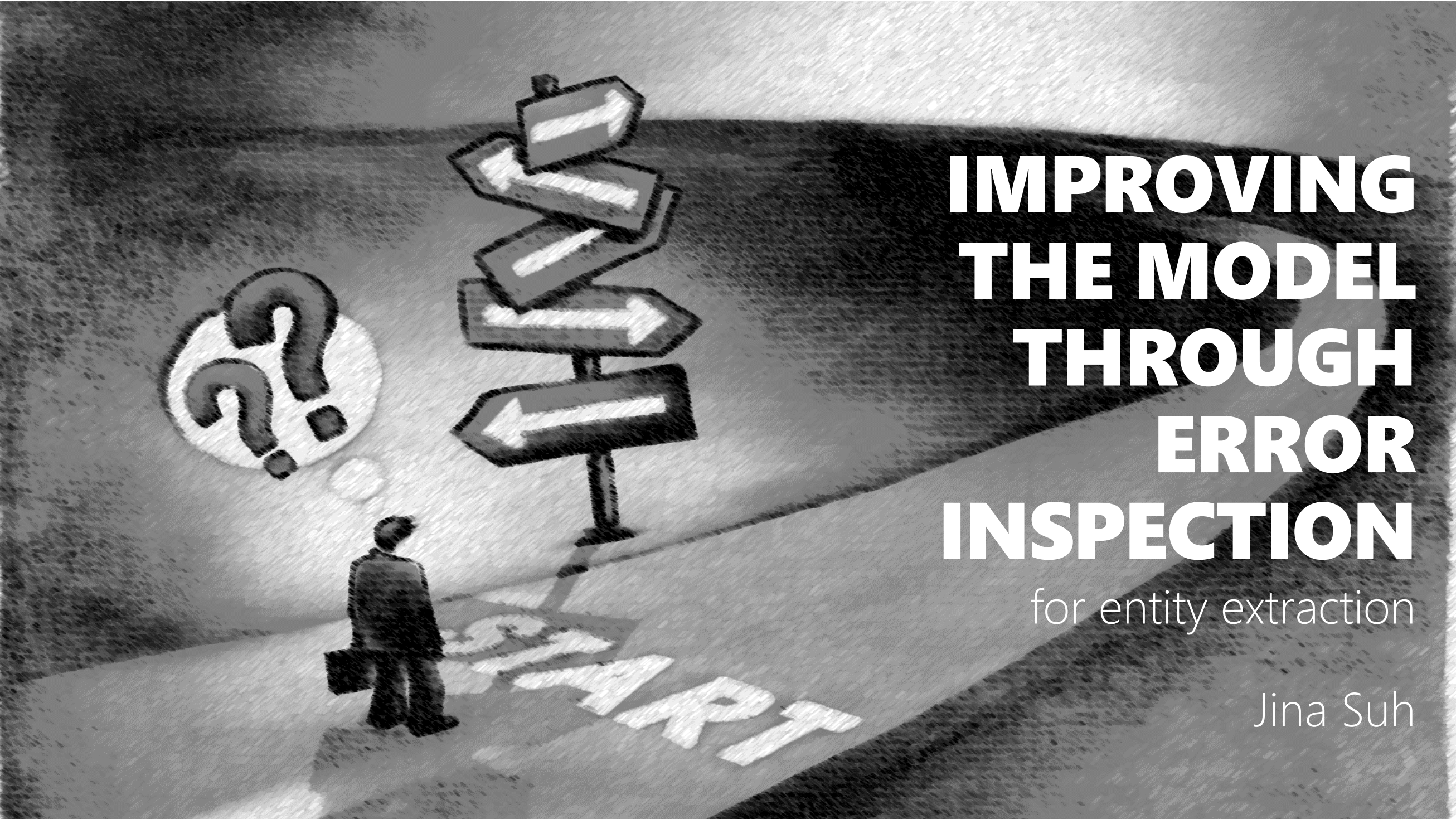


# Future Plans: Crazy Ideas

- Hallucination mode
  - Allow user to select point in embedding space and ‘hallucinate’ possible images that would land there
- Draw mode
  - Allow user to draw a new digit and push it through the network
  - Allow user to modify existing digits and see how their embedding changes

# Questions

- Which of visualization techniques that I just talked about seem most compelling?
- Are there other techniques I didn't mention which might also be compelling?
- Did anything I said in the past 3 minutes make any sense whatsoever?



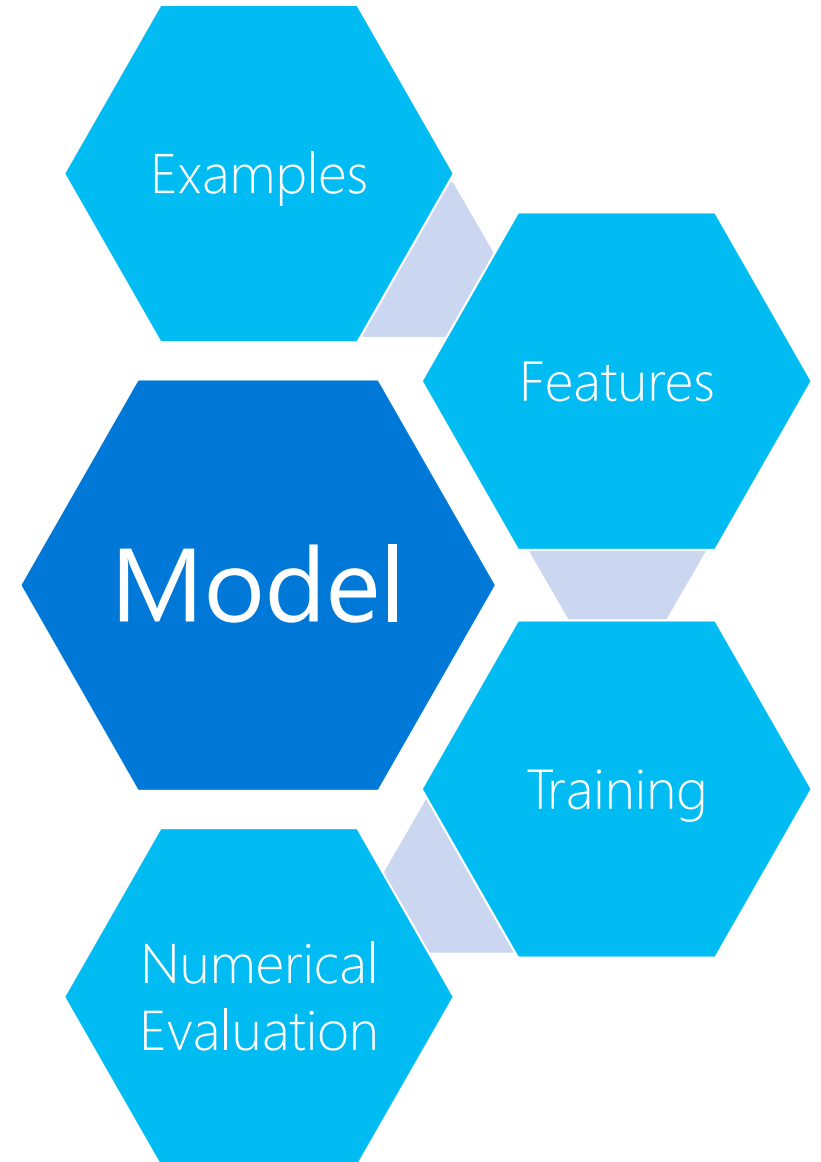
# IMPROVING THE MODEL THROUGH ERROR INSPECTION

for entity extraction

Jina Suh

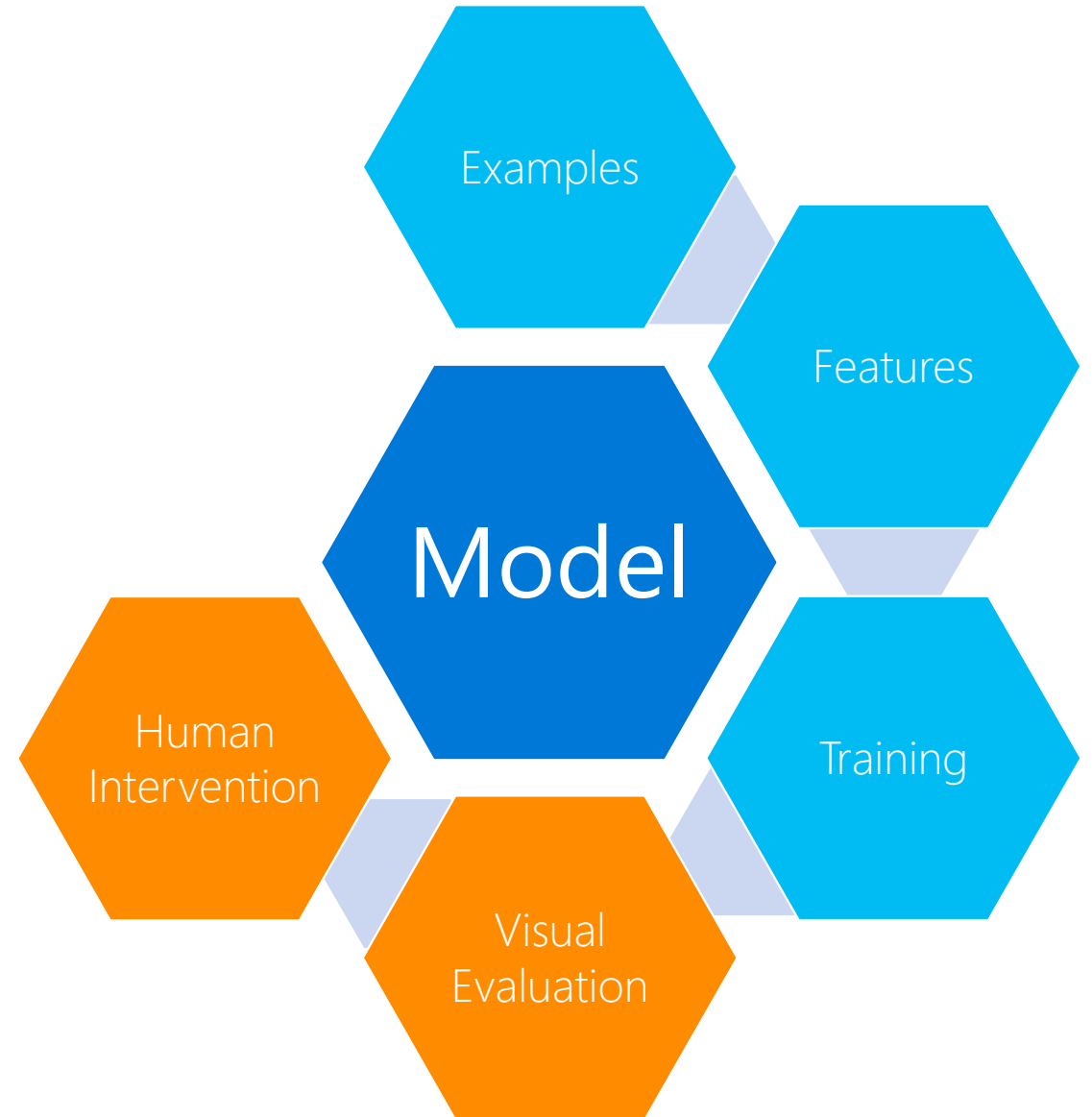
# CLASSICAL MACHINE LEARNING

- Restrictive
- Expensive
- Slow Training
- Difficult to Troubleshoot



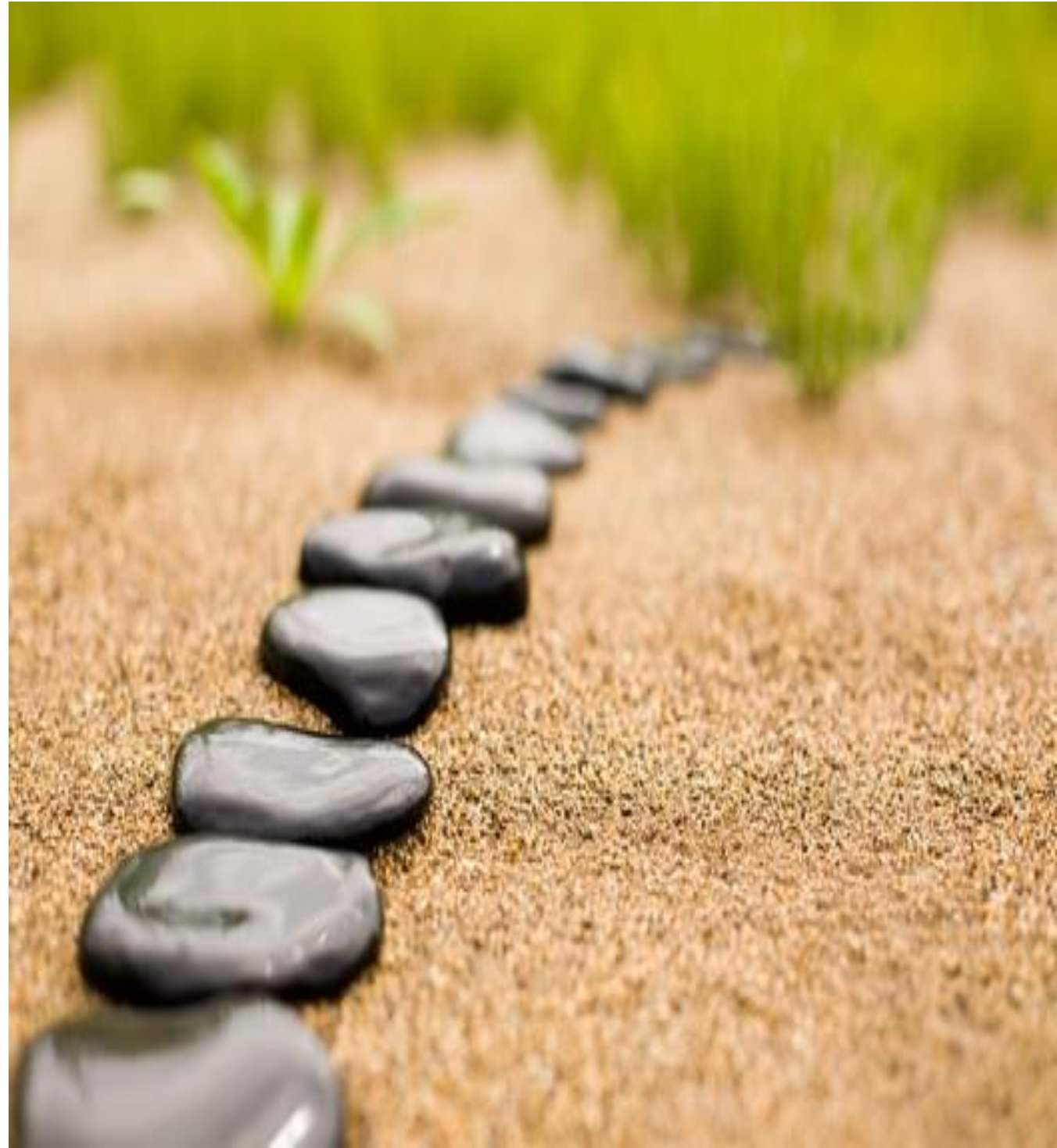
# INTERACTIVE MACHINE LEARNING

- Human in the Loop
- Iterative
- Fast Training
- Visual Evaluation
- Direct intervention



# HELPING HUMANS GUIDE THE MODEL

- Effective Labeling
- Effective Featuring
- Effective Evaluation



# HELPING HUMANS GUIDE THE MODEL

- Effective Labeling
- **Effective Featuring**
- **Effective Evaluation**



# ENTITY EXTRACTION

## Frequently requested contacts

[Office of Admissions](#) (Seattle undergraduate)

Box 355852  
1410 NE Campus Parkway  
Seattle WA 98195-5852

[Office of the Registrar](#)

225 Schmitz Hall  
Campus Box 355850  
Seattle, WA 98195-5850

[Human Resources/Employment](#)

[uw hires@uw.edu](mailto:uw hires@uw.edu)

206-543-2544

Generic address for forms: 1410 NE Campus Parkway Seattle, WA 98195

Street: 1410 NE Campus Parkway  
City: Seattle  
State: WA  
Zip: 98195



# DATA DOMAIN

- Open Directory Platform (ODP) web pages
- 2-300 "true" labels according to hierarchy
  - Address = Street + City + State + Zip
- Model predictions for addresses
- Individual token labels and predictions
- Individual token transition labels and predictions
- Uncertainty scores for model prediction

# HYPOTHESIS

By showing the error and the uncertainty in the model prediction, the users will be able to add, remove, or modify the features to improve the model performance.

Error Evaluation + Featuring → Better Model

# VISUALIZATION TASKS

- Step 1: Is my model performing at a satisfactory level?

# VISUALIZATION TASKS

- Step 1: Is my model performing at a satisfactory level?
- Step 2: Where is my model performing poorly?

# VISUALIZATION TASKS

- Step 1: Is my model performing at a satisfactory level?
- Step 2: Where is my model performing poorly?
- Step 3: Why is my model performing poorly?

# VISUALIZATION TASKS

- Step 1: Is my model performing at a satisfactory level?
- Step 2: Where is my model performing poorly?
- Step 3: Why is my model performing poorly?
- Step 4: This is how I would distinguish the examples.

# VISUALIZATION TASKS

- Step 1: Is my model performing at a satisfactory level?
- Step 2: Where is my model performing poorly?
- Step 3: Why is my model performing poorly?
- Step 4: This is how I would distinguish the examples.
- Step 5: Did my explanation fix the problem?

# VISUALIZATION TASKS



- Step 1: Is my model performing at a satisfactory level?
- Step 2: Where is my model performing poorly?
- Step 3: Why is my model performing poorly?
- Step 4: This is how I would wish the examples.
- Step 5: Did my explanation fix the problem?



# VISUALIZATION COMPONENTS

1. Performance  
Summary and Detail

2. Example Inspection

3. Featuring

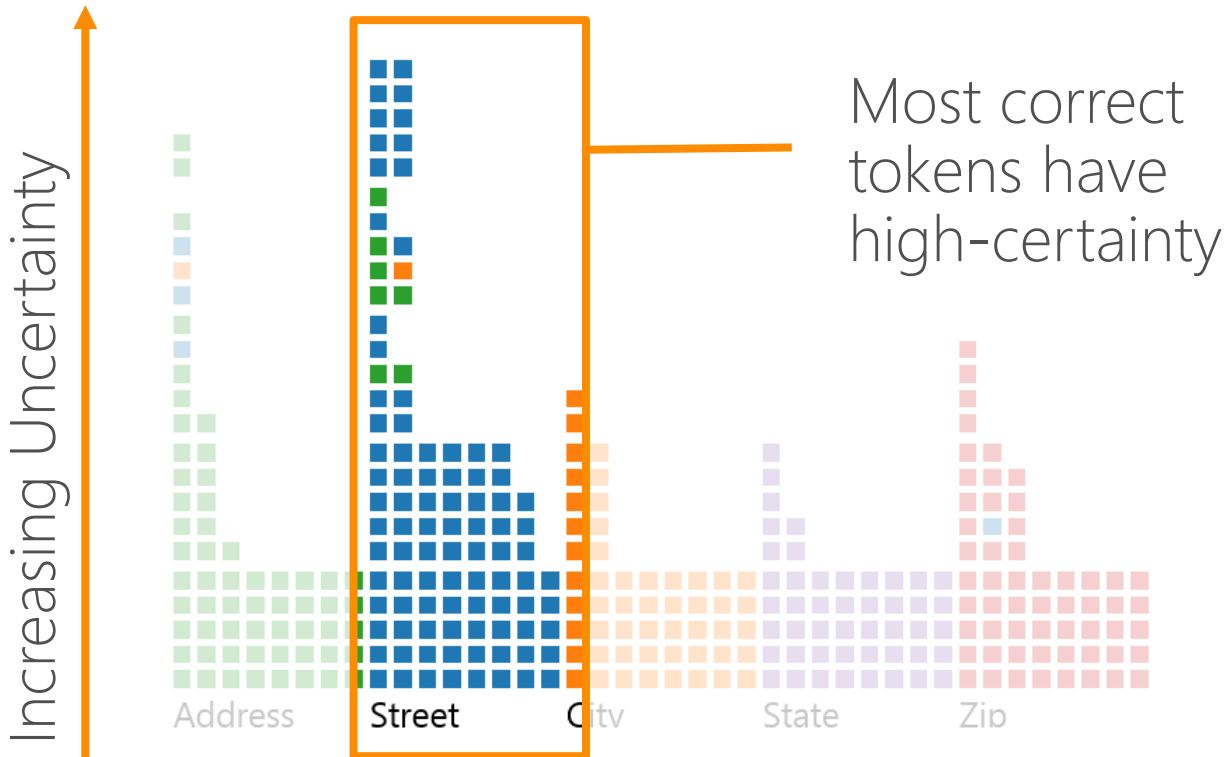
4. Training Status

# PERFORMANCE SUMMARY

Is my model performing at a satisfactory level?

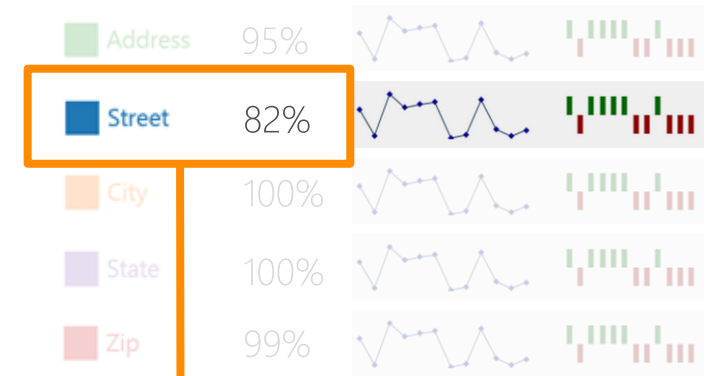
## VISUALIZATION COMPONENTS

1. Performance Summary and Detail		
-----------------------------------	--	--



Model Tracker

OR



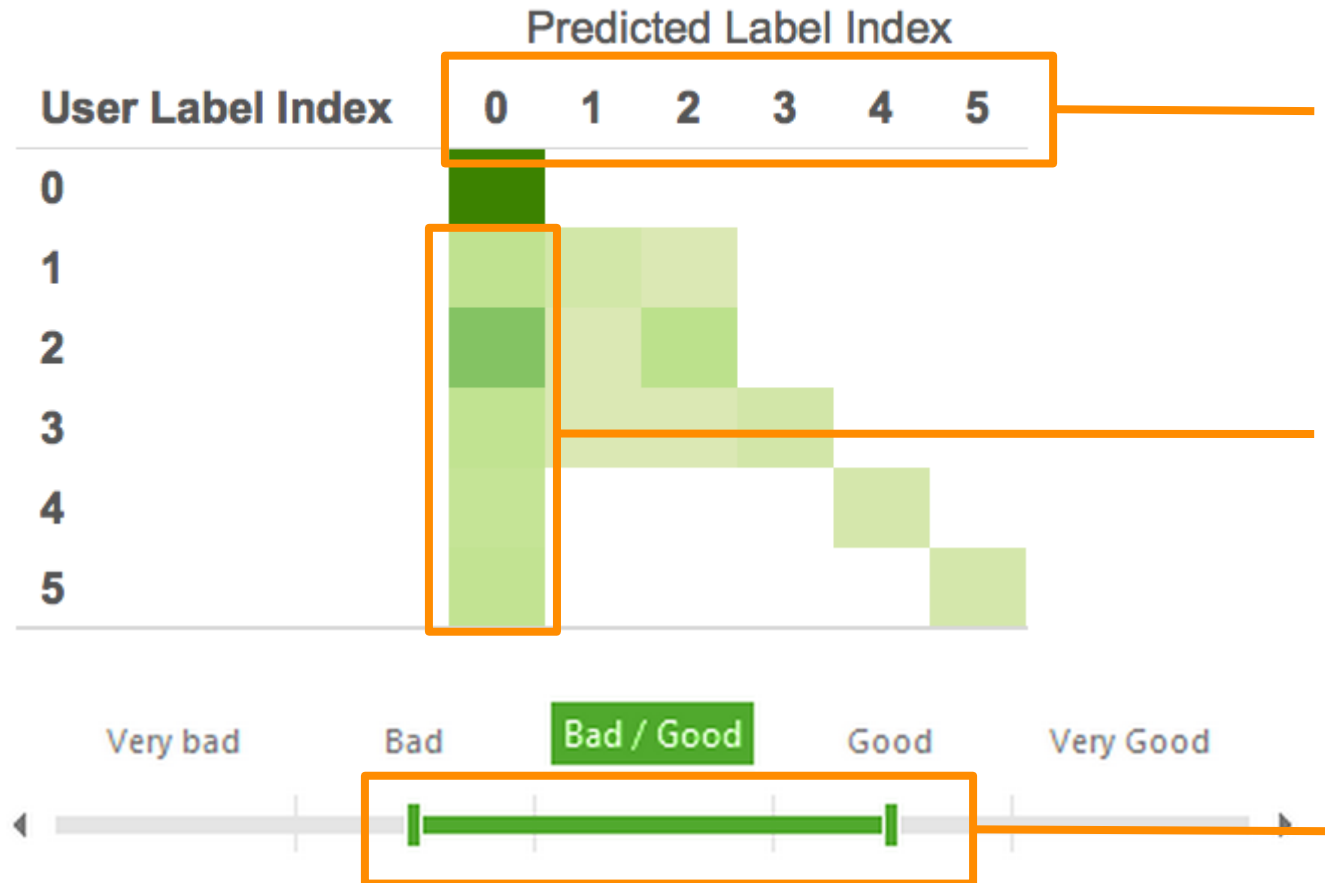
Street accuracy is below my acceptance threshold

Summary Accuracy

# PERFORMANCE DETAIL

Where is my model performing poorly?

1. Performance  
Summary and Detail



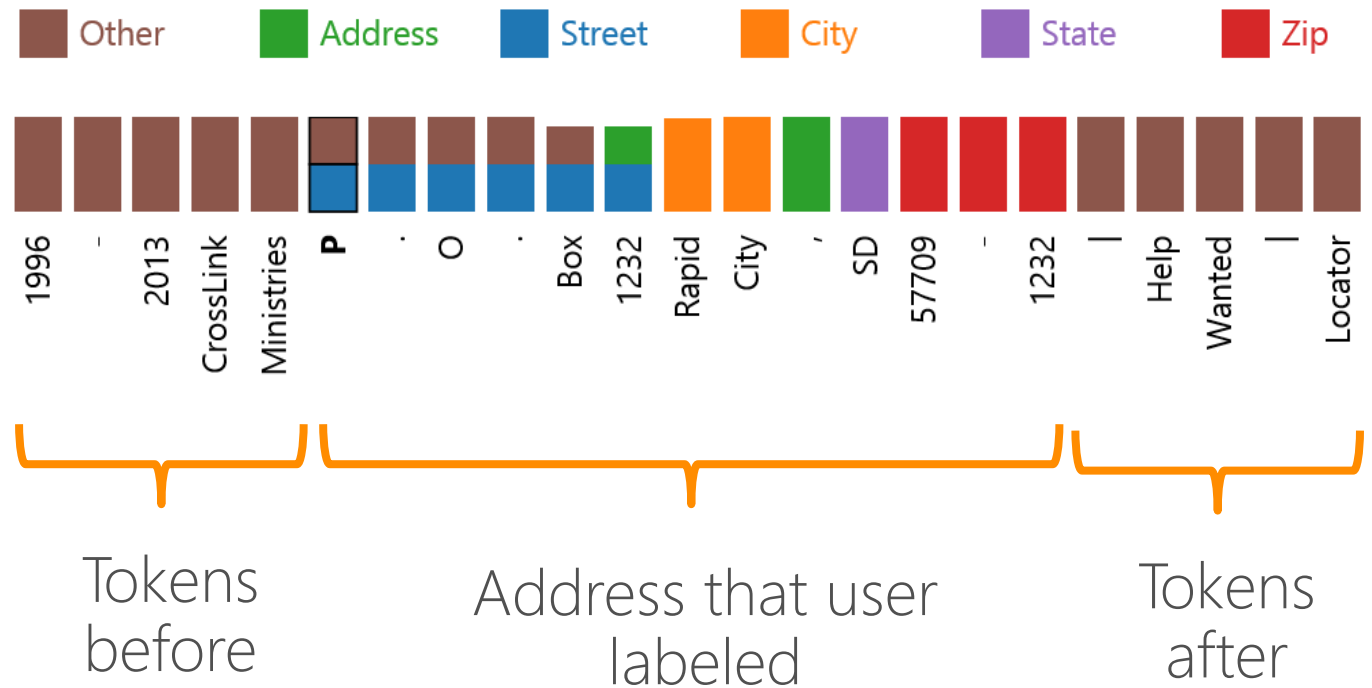
6 Token Tags (City, State, etc)  
25 Token Transition Tags (City -> State)

Off-Diagonal = Errors  
Click a box to retrieve examples

Filter on uncertainty score to focus on examples that the model is having trouble with.

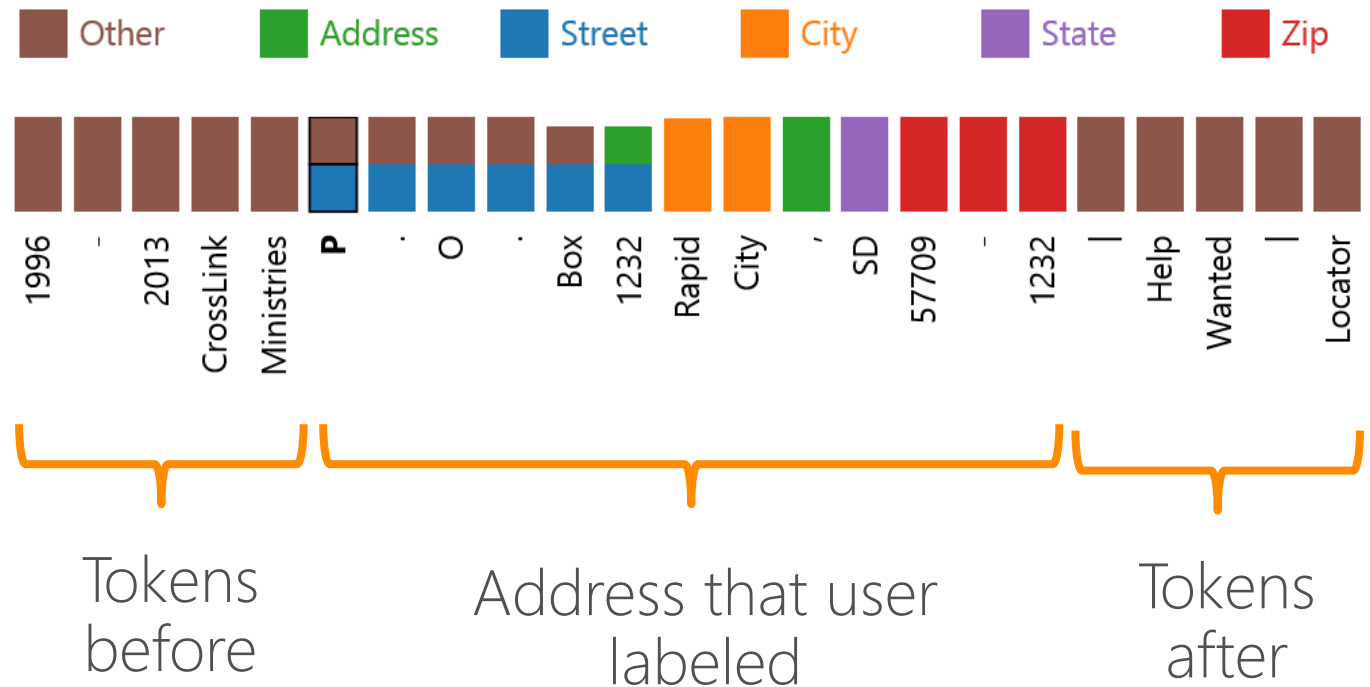
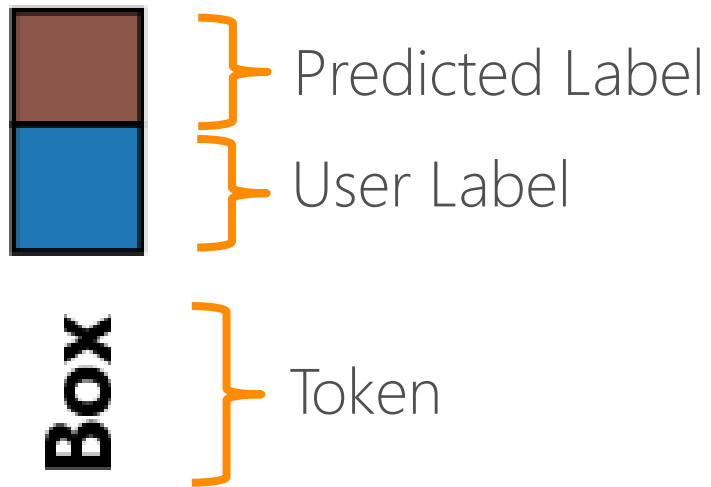
# EXAMPLE INSPECTION

Why is my model performing poorly?



# EXAMPLE INSPECTION

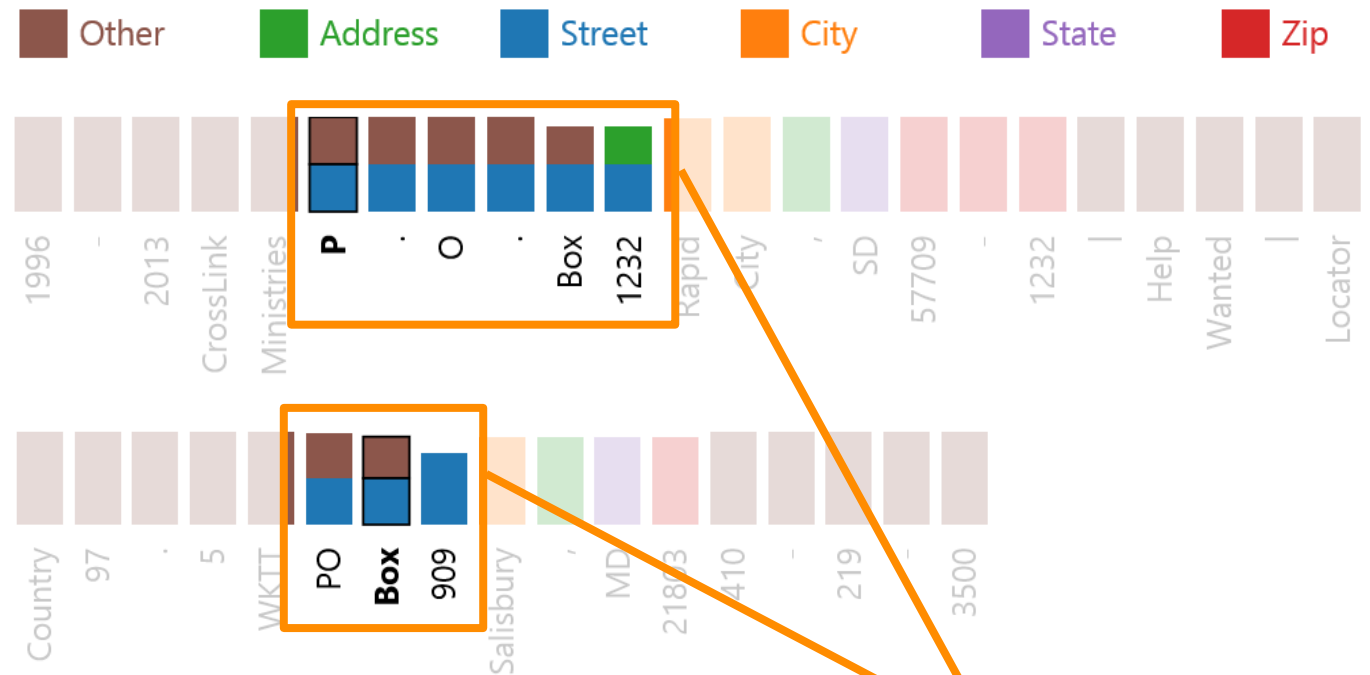
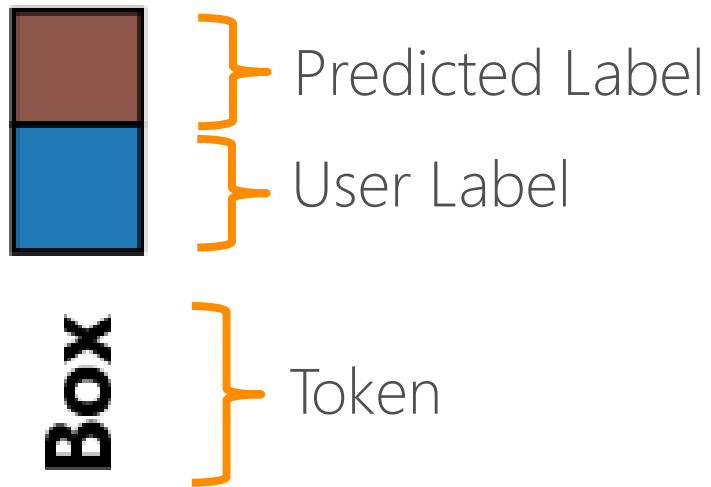
Why is my model performing poorly?



# EXAMPLE INSPECTION

2. Example Inspection

Why is my model performing poorly?



Model doesn't understand "PO Box"

# FEATURING

This is how I would distinguish the examples.

Address - PO Box

PO Box, P.O. Box, POBox, POB|

Weight  
One weight per feature

Create Cancel

Address - States

Semantic group of words

# VALIDATION

Did my explanation fix the problem?

- Fast training in the background (~3-10 seconds)
- Look back at the performance summary and detail
- Open research questions
  - Change indication (besides animation)
  - Local vs Global
  - Branch from last known good

		3. Featuring
	4. Training Status	



# VISUALIZATION QUESTIONS

- What is the best way to encode 2 dimensions (item count and uncertainty score) in each square of the matrix visualization?
- What is the best way to convey changes in the matrix visualization?
- For example inspection, should I optimize for readability of the prediction and the user label? OR should I optimize for detecting discrepancies between the label and the prediction?

# **A Visualization Tool for Human-in-the-loop Machine Learning**

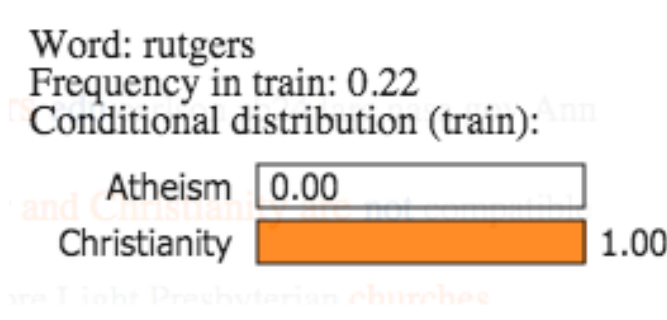
Brian Dolhansky and Marco Túlio Ribeiro  
CSE 512 Final Project Progress

# Problem description

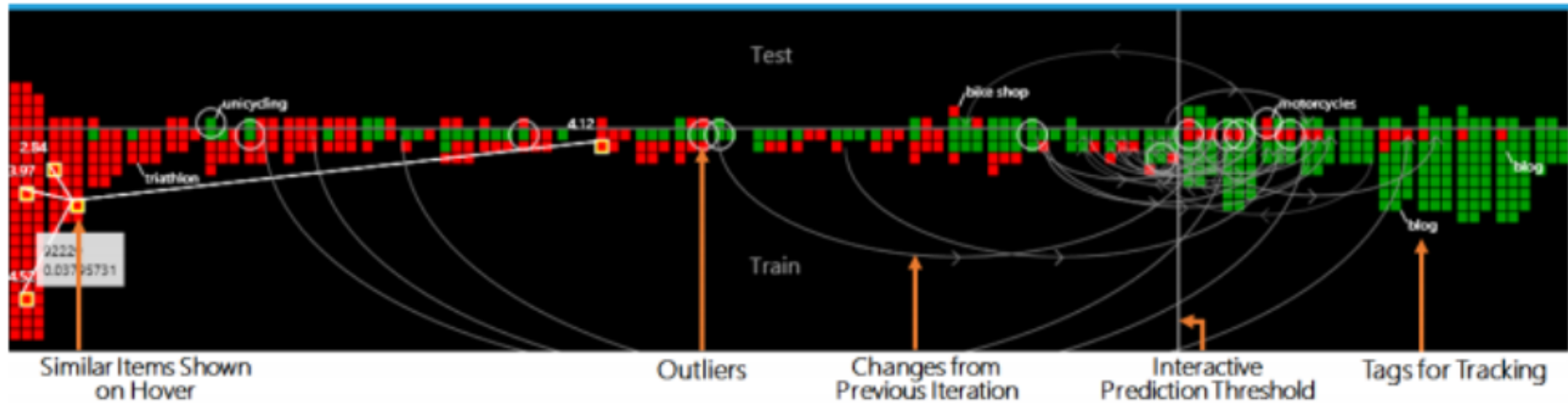
- Machine learning is hard to understand, and tweak
  - Hard to know how to improve
  - Hard to evaluate performance
  - Hard to provide feedback
- For understanding and evaluation:
  - Global understanding
  - Individual predictions
- Feedback: future work

# Example: 20 newsgroups

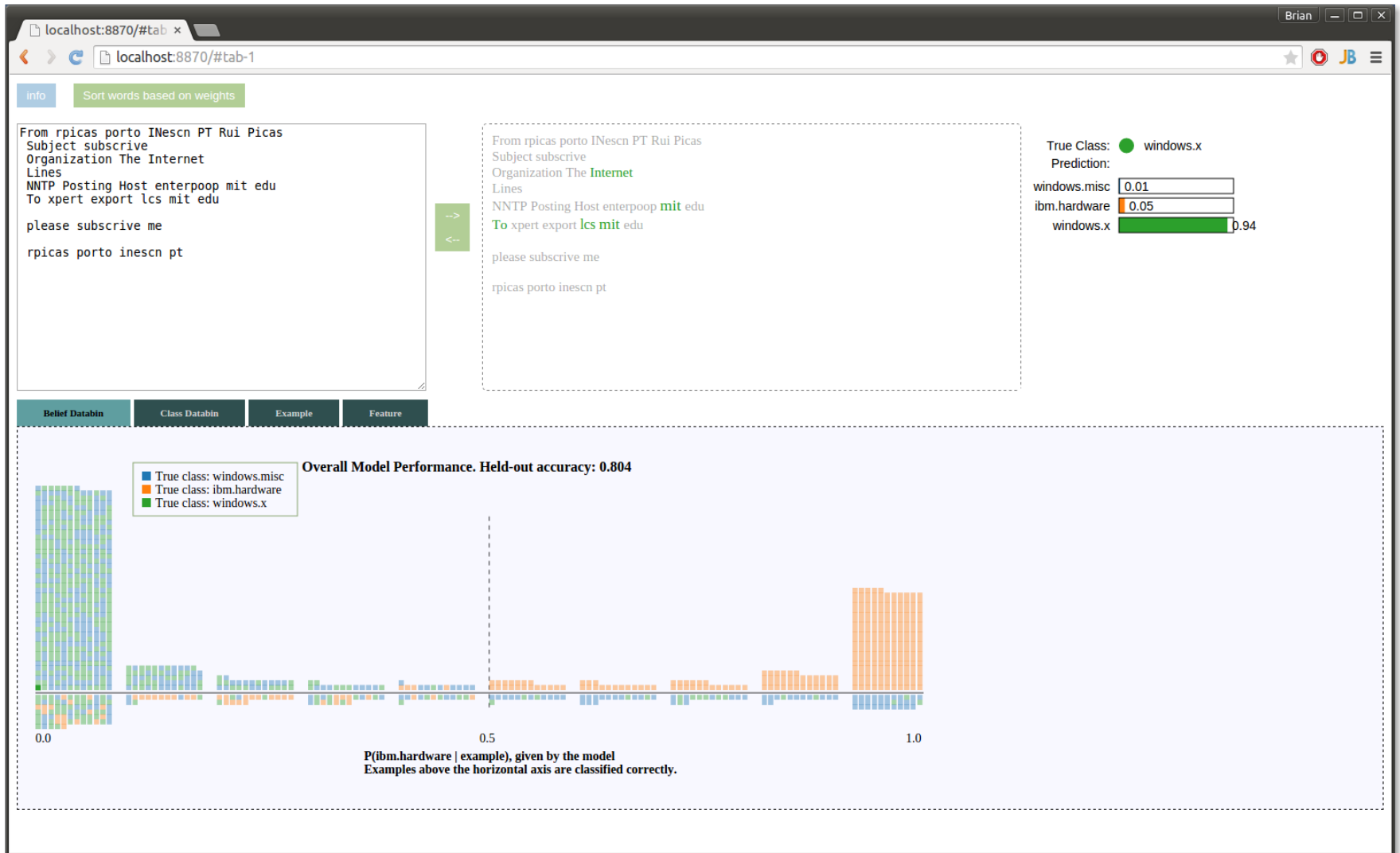
- Christianity vs Atheism: baseline accuracy 92.3%
- Example problem: headers



# Prior work - Modeltracker



# Current progress



# Current progress

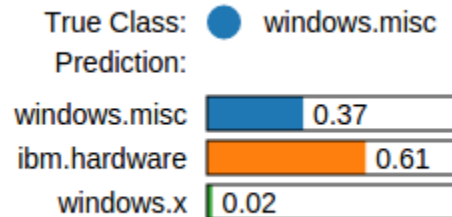
```
From sthong eniac seas upenn edu Steven Hong
Subject LOOKING FOR ORGANIZER
Distribution comp
Organization University of Pennsylvania Philadelphia PA
USA
Lines 18
Nntp Posting Host eniac seas upenn edu

Looking for ORGANIZER program for Windows
Currently have Lotus Organizer not bad but looking for
better
Should have calender scheduler
Should have to do list
Nice additions Address Phone Book
Diary
Please any suggestions Shareware Public or Copyrighted
Please EMAIL sthong eniac seas upenn edu
```



```
From sthong eniac seas upenn edu Steven Hong
Subject LOOKING FOR ORGANIZER
Distribution comp
Organization University of Pennsylvania Philadelphia PA USA
Lines 18
Nntp Posting Host eniac seas upenn edu

Looking for ORGANIZER program for Windows
Currently have Lotus Organizer not bad but looking for better
Should have calender scheduler
Should have to do list
Nice additions Address Phone Book
Diary
Please any suggestions Shareware Public or Copyrighted
```



# Current progress

Looking for ORGANIZER program for Windows  
Currently have Lotus Organizer not bad but looking for better  
Should have calender scheduler  
Should have to do list  
Nice additions Address Phone Book  
Diary  
Please any suggestions Shareware Public or Copyrighted  
Please EMAIL sthong eniac seas upenn edu

Steven Hong  
Email Address sthong eniac seas upenn edu  
University of Pennsylvania  
Engineering Class of 1996

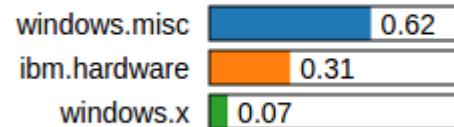


Looking for ORGANIZER program for Windows  
Currently have Lotus Organizer not bad but looking for better  
Should have calender scheduler  
Should have to do list  
Nice additions Address Phone Book  
Diary  
Please any suggestions Shareware Public or Copyrighted  
Please EMAIL sthong eniac seas upenn edu



True Class: ● windows.misc

Prediction:





Sort words based on weights

From root lyra scg hac com Dave Fisher  
 Subject Screen snapshot  
 Reply To fisher lyra hac com Dave Fisher  
 Organization Hughes Aircraft Co Carlsbad CA  
 Lines 10

Is there way can save snapshot of my screen to file under  
 Windows Similar to the way one can press CMD SHIFT on Mac

Please email rather than posting

Thanks Dave Fisher  
 fisher lyra hac com

-->  
--<

From root lyra scg hac **com** Dave Fisher  
 Subject Screen snapshot  
 Reply To fisher lyra hac **com** Dave Fisher  
 Organization Hughes Aircraft **Co** Carlsbad **CA**  
 Lines 10

Is there way can save snapshot of my screen to file under  
**Windows** Similar to the way one can press CMD SHIFT on Mac

Please email rather than posting

Thanks Dave Fisher  
 fisher lyra hac **COM**

True Class: ● windows.misc  
 Prediction:  
 windows.misc 0.66  
 ibm.hardware 0.04  
 windows.x 0.30

Belief Databin Class Databin Example Feature

Overall Model Performance. Held-out accuracy: 0.804



Sort words based on weights

From rpicas porto INescn PT Rui Picas  
 Subject subscribe  
 Organization The Internet  
 Lines  
 NNTP Posting Host enterpoop mit edu  
 To xpert export lcs mit edu  
 please subscribe me  
 rpicas porto inescn pt

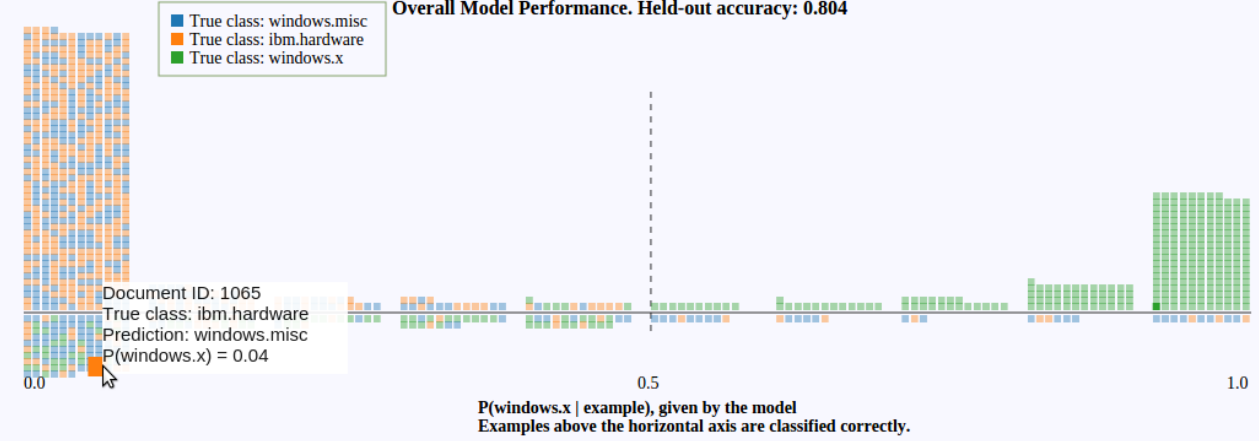


From rpicas porto INescn PT Rui Picas  
 Subject subscribe  
 Organization The **Internet**  
 Lines  
 NNTP Posting Host enterpoop **mit** edu  
**To** xpert export **lcs mit** edu  
 please subscribe me  
 rpicas porto inescn pt

True Class: ● windows.x  
 Prediction:  
 windows.misc   
 ibm.hardware   
 windows.x

Belief Databin   Class Databin   Example   Feature

Overall Model Performance. Held-out accuracy: 0.804



Belief Databin

Class Databin

Example

Feature

- True class: windows.misc
- True class: ibm.hardware
- True class: windows.x



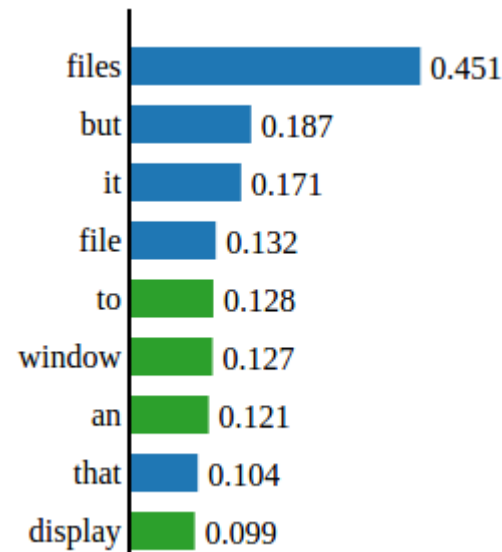
# Future work



Handling lots of data

Location	Federal Government	State/Local Government	Medical Professionals	Insurance Companies	Employers	Consumers
Jackson	3.6	3.0	5.7	1.8	3.6	7.8
Seattle	4.3	4.0	5.9	1.6	2.3	7.3
Denver	4.2	4.0	6.4	2.5	3.8	6.8
Providence	4.1	3.8	6.8	2.3	2.8	8.0
Miami	5.0	4.5	5.5	2.3	3.0	6.9
Indianapolis	4.9	3.9	6.1	2.2	3.3	7.6
Detroit	3.5	3.7	6.8	1.4	2.4	7.6
Phoenix	3.9	3.7	5.2	2.0	3.4	7.7
Des Moines	5.0	4.7	5.4	2.2	2.6	6.7
Philadelphia	4.4	4.4	6.0	1.5	3.1	6.7
Sacramento	3.8	3.8	6.4	2.5	2.9	7.4
Billings	5.1	4.7	6.0	2.4	4.0	6.3
New York	5.2	4.1	6.7	1.4	2.1	7.7
Tucson	3.9	3.4	6.2	2.6	3.2	6.6
Salt Lake City	4.6	4.7	4.9	2.6	3.1	6.8
Average	4.4	4.0	6.0	2.1	3.0	7.2

Handling different types of data



Better feature interaction/visualizations

# Discussion questions

1. As an ML novice/expert, would this tool be useful for debugging?
2. Does the “databin” visualization effectively convey what the model is doing?
3. How might you visualize large amounts of data?

# Visual Toolbox for Classification

Final Project Progress Report

CSE 512

Amit Meir and Yoni Fintzi

# Introduction

- Classification is one of the most common tasks in Statistics and ML.
- The data analyst must optimize performance while preserving interpretability, parsimony and scientific plausibility.
- Building a classifier is an iterative process involving:
  - Data exploration
  - Variable selection.
  - Model Assessment.

# Visual Toolbox for Classification

We propose to construct a tool that will allow the user to:

- Explore basic aspects of a data set visually.
- Generate new features in a guided manner.
- Fit and tune different classifiers to the data.
- Diagnose and compare the performance of different classifiers visually and qualitatively.



# Previous Work

- Seo and Shneiderman [2004] built a system for data exploration, where possible data views are ranked different criteria.
- Muhlbacher and Piringer [2013] constructed a tool for building regression models.
- Garg et al. [2008] built a classification tool based on Logic Programming.

new feature

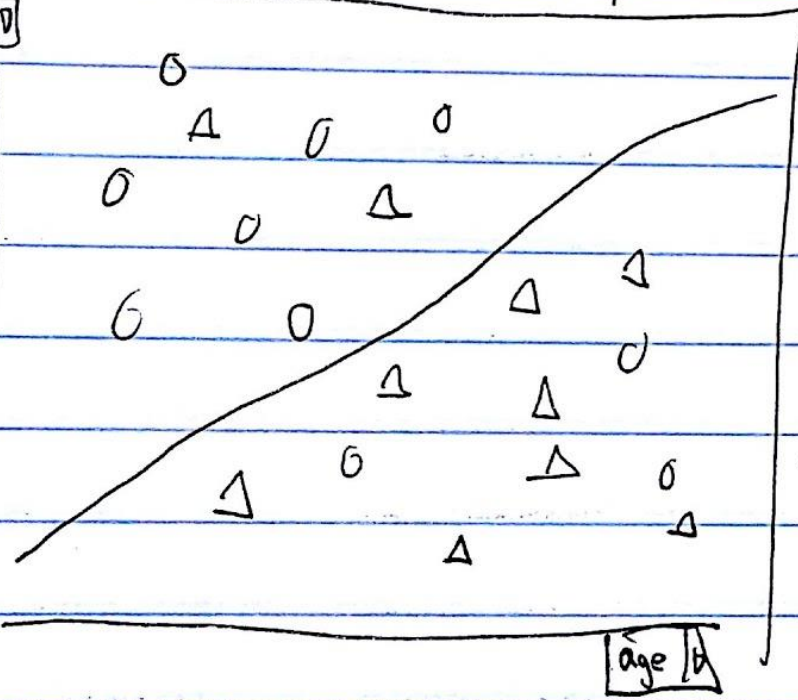
generation

Variables:

- income
- age
- education
- ponies
- cars
- Ebola

income

Facet



ROC

AUC 0.6



tuning Parameter



CV score

Ridge logistic

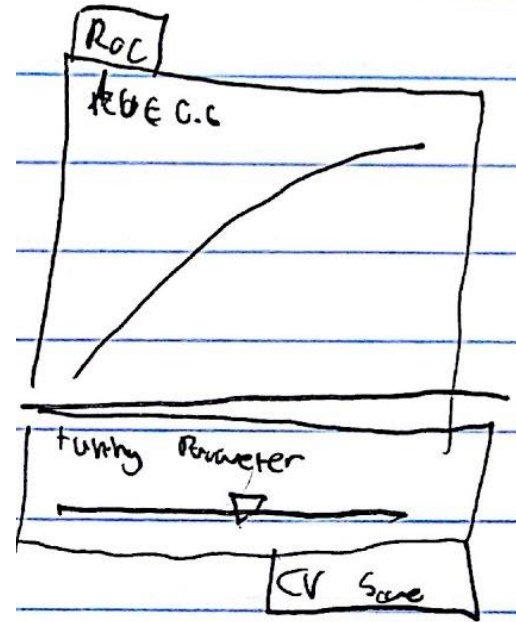
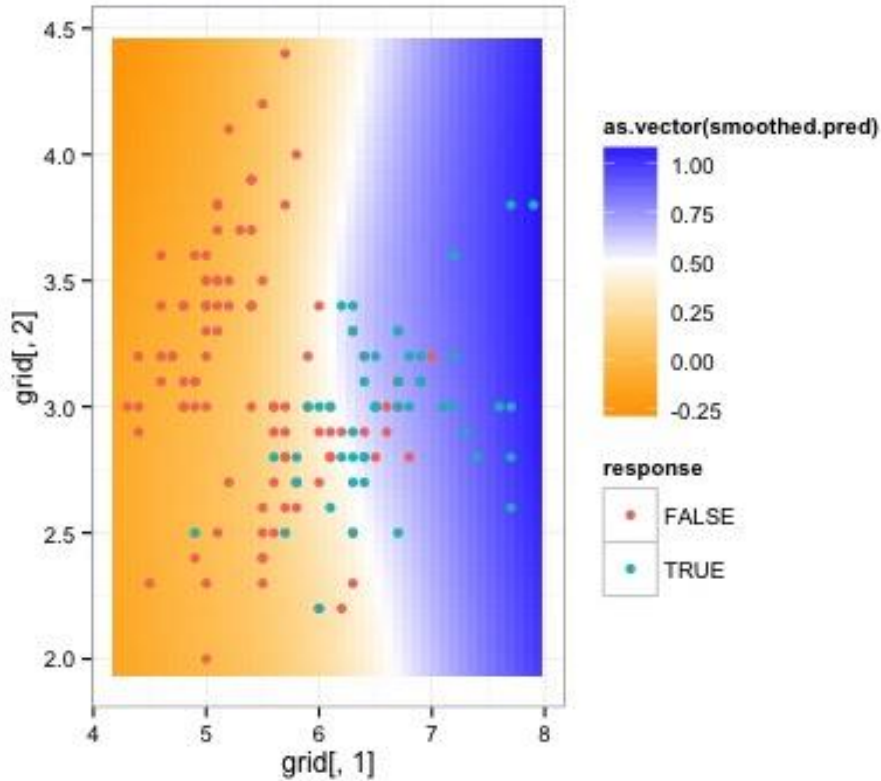
svm

Regression Trees

new feature  
generation

variables:

income  
age  
education  
ponies  
wings  
Ebola



Ridge logistic

SVM

Regression Trees

# Questions

- What operations should the tool support for constructing the model?
- Additional data views and operations to assist with evaluating the model?
- How can we make the tool intuitive for non-professionals?

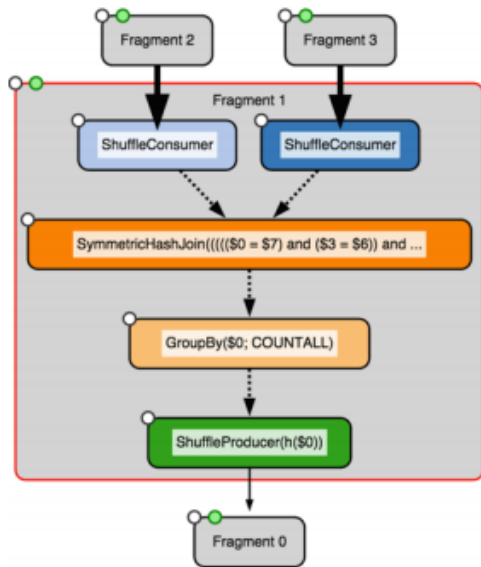
**Thank You!**

# **HYBRID**Perfopticon

Brandon Haynes & Shrainik Jain

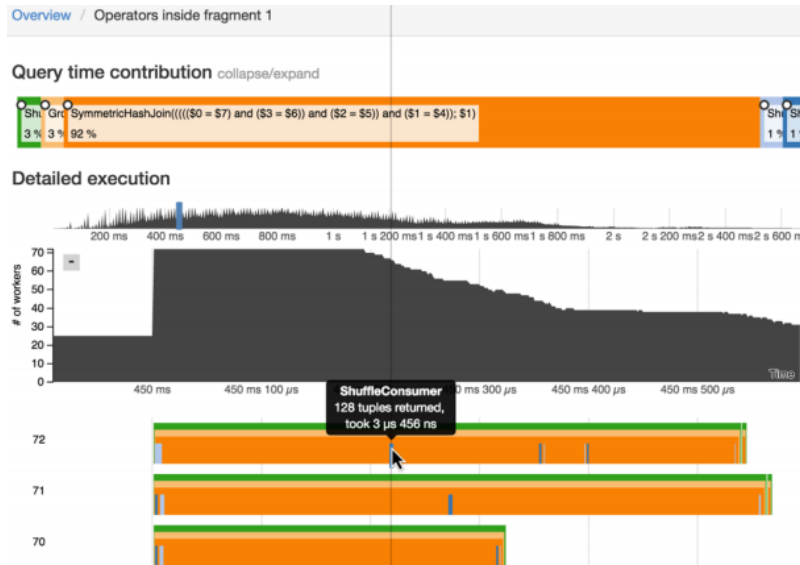
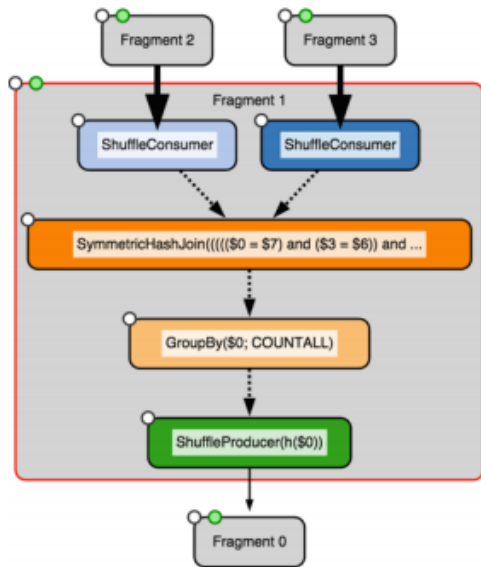
**We've seen Perfopticon before.**

# We've seen Perfoption before.





# We've seen Perfopticon before.



**What about multiple databases?**

# What about multiple databases?

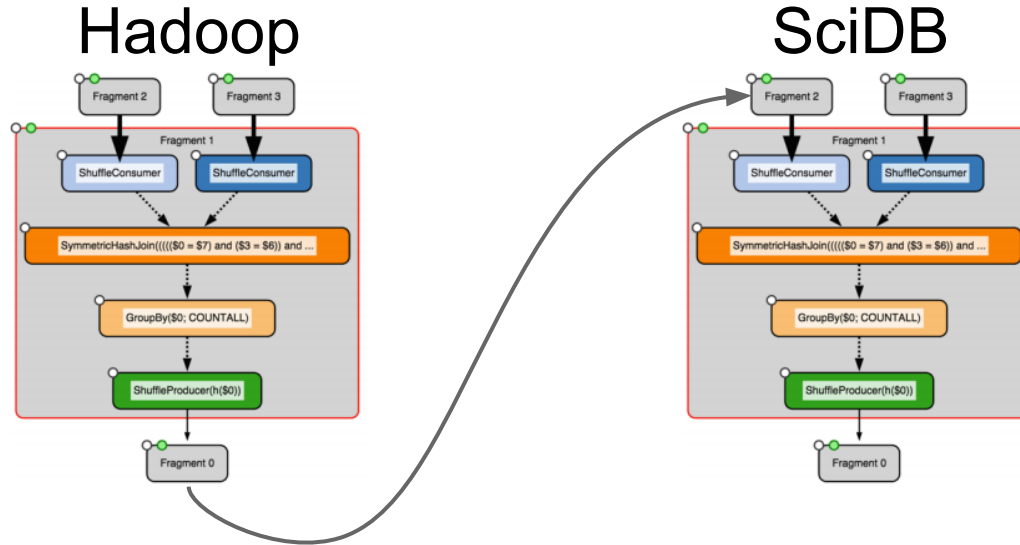
Hadoop

SciDB

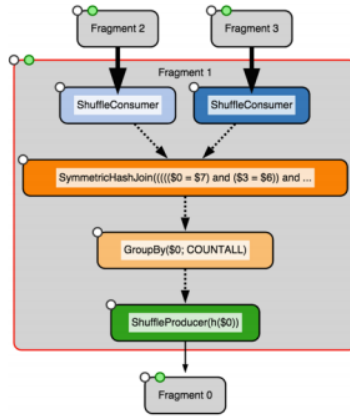
# What about multiple databases?

Hadoop  SciDB

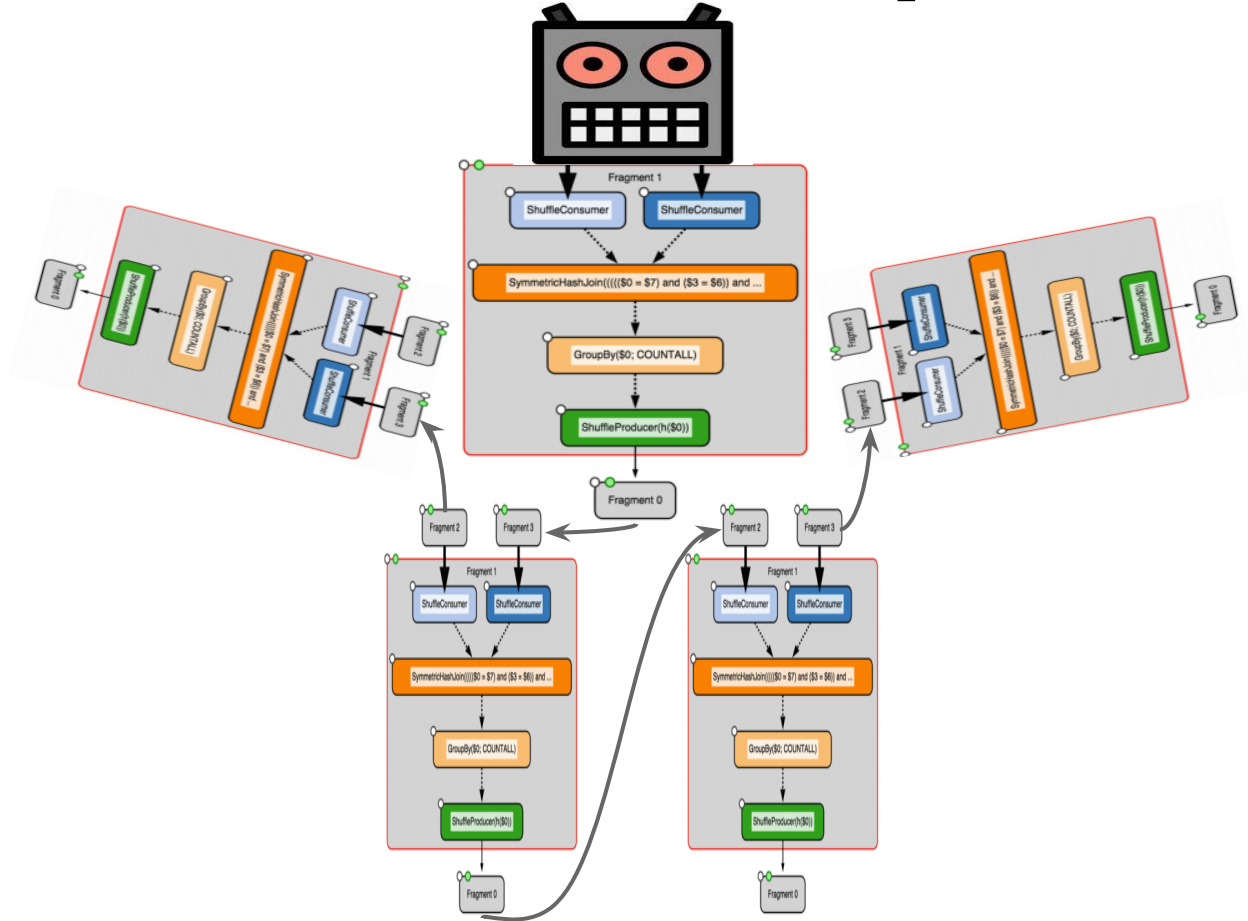
# What about multiple databases?



# Perfopticon



# HYBRIDPerfopticon



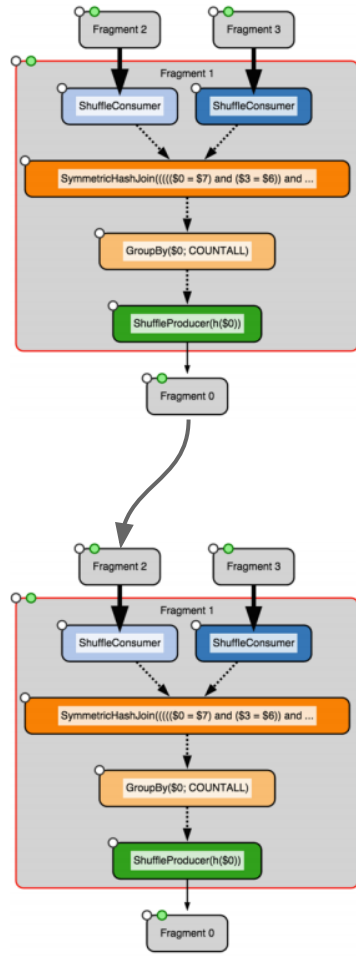
# We'll focus on:

1. Two database systems: Myria and SciDB
2. Visualizing plans occurring across these systems
3. Highlighting inter-database transfer, a common bottleneck
4. Communicating inter-operator cardinality and skew



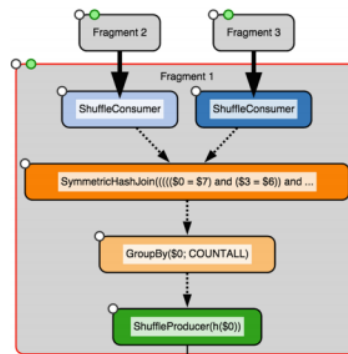
# **Some Challenges**

# 1. Which operators belong to with systems?

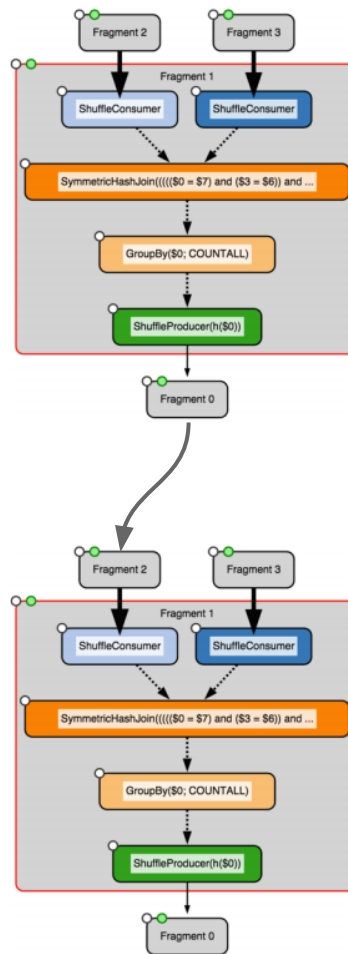


# 1. Which operators belong to which systems?

Myria

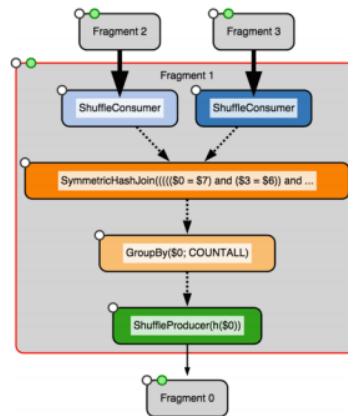


SciDB

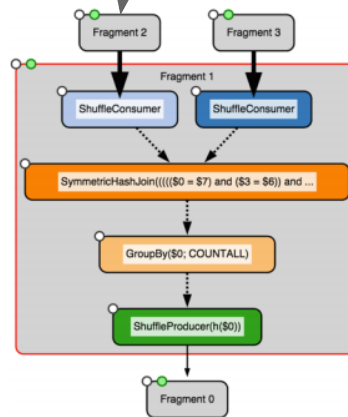


# 1. Which operators belong to which systems?

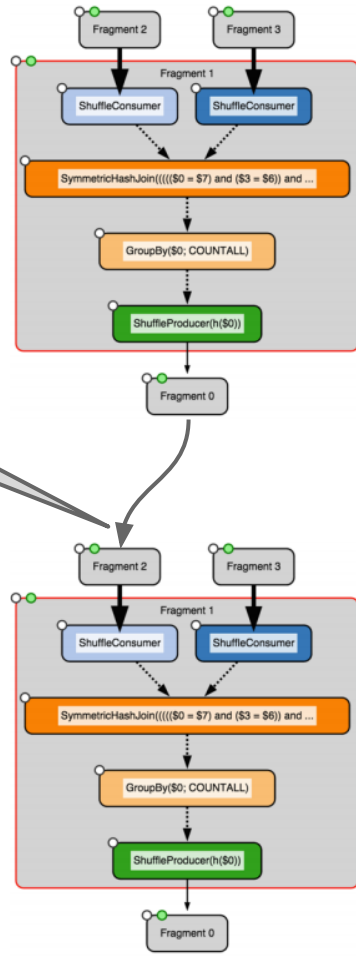
Myria



SciDB



# 2. Displaying shuffle skew



### 3. Instrumenting non-relational databases

```
redimension(  
  store(  
    regrid(  
      scan(transform),  
      1, 2,  
      avg(value), bin(value)),  
    result),  
  template,  
  count(id));
```


```
redimension(  
  store(  
    regrid(  
      scan(transform),  
      1, 2,  
      avg(value), bin(value)),  
    result),  
  template,  
  count(id));
```

# 3. Instrumenting non-relational databases

Operator types not found in relational systems  
(parallels often exist)

```
redimension(  
  store(  
    regrid(  
      scan(transform),  
      1, 2,  
      avg(value), bin(value)),  
    result),  
  template,  
  count(id));
```

```
redimension(  
  store(  
    regrid(  
      scan(transform),  
      1, 2,  
      avg(value), bin(value)),  
    result),  
  template,  
  count(id));
```



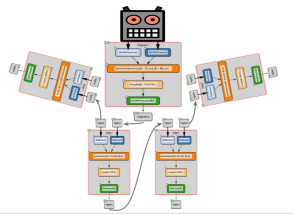
### 3. Instrumenting non-relational databases

Atomic unit is an array chunk, **not** a tuple

```
redimension(  
  store(  
    regrid(  
      scan(transform),  
      1, 2,  
      avg(value), bin(value)),  
    result),  
  template,  
  count(id));
```

```
redimension(  
  store(  
    regrid(  
      scan(transform),  
      1, 2,  
      avg(value), bin(value)),  
    result),  
  template,  
  count(id));
```





# Key Challenges

## Visualization:

1. Displaying plan/profiling data from multiple sources in real-time
2. Indicating skew
3. Aggregating and displaying SciDB queries as unified programs

## Systems:

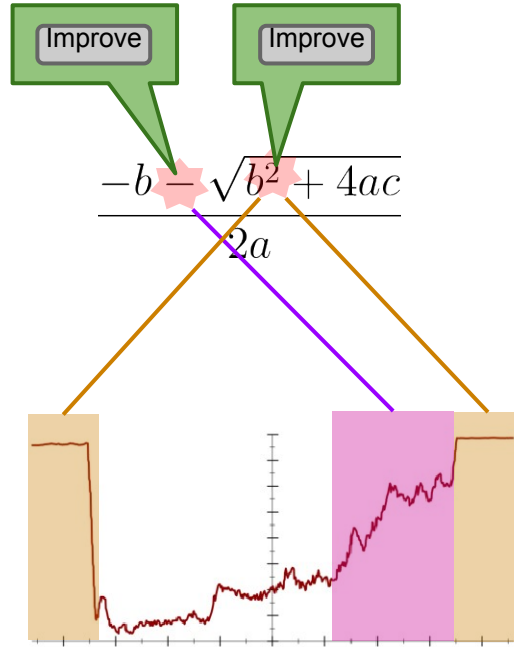
4. Instrumenting SciDB operators
5. Combining subgraphs into a unified plan
6. Exposing profiling data via HTTP
7. Quantifying SciDB transfer metrics

# **Herbie Interface Visualization**

# The Problem

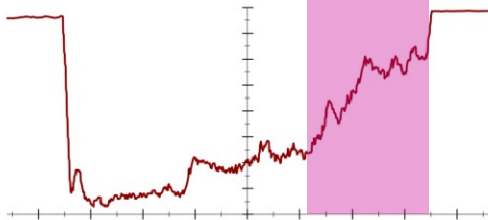
- Teach users how to identify and address floating point issues

# Design



# Design

$$\frac{-b + \sqrt{b^2 + 4ac}}{2a}$$

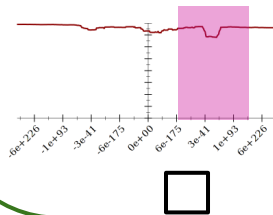


Apply the rule:

$$a - b \rightarrow \log \frac{e^a}{e^b}$$

to get:

$$\log \frac{e^{-b}}{e^{\sqrt{b^2 - 4ac}}}$$



Apply the rule:

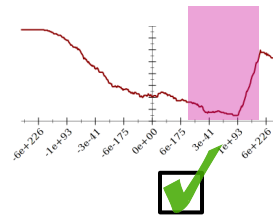
$$a - b \rightarrow \frac{a^2 - b^2}{a + b}$$

to get:

$$\frac{(-b)^2 - \sqrt{b^2 - 4ac}^2}{-b + \sqrt{b^2 - 4ac}} / 2a$$

and simplify to:

$$\frac{2c}{-b + \sqrt{b^2 - 4ac}}$$

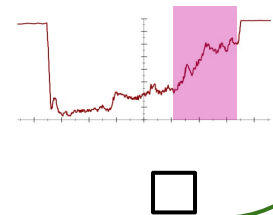


Apply the rule:

$$a \rightarrow 1 * a$$

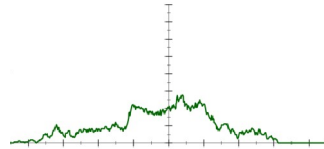
to get:

$$\frac{1 * (-b - \sqrt{b^2 - 4ac})}{2a}$$



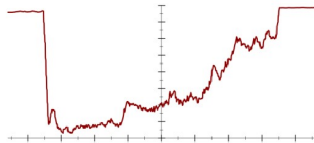
# Design

Current combination



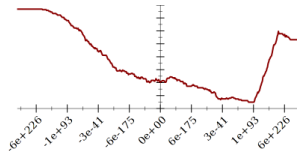
Choose

$$\frac{-b - \sqrt{b^2 + 4ac}}{2a}$$



Choose

$$\frac{2c}{-b + \sqrt{b^2 - 4ac}}$$



# Questions

- Does this seem like an intuitive way to navigate?
- Does this increase intuition about the accuracy of floating point expressions?

# **FlowViz**

**a Visualization Toolkit for Developing  
Visual Programming Languages**

Sonya Alexandrova and Alex Fiannaca



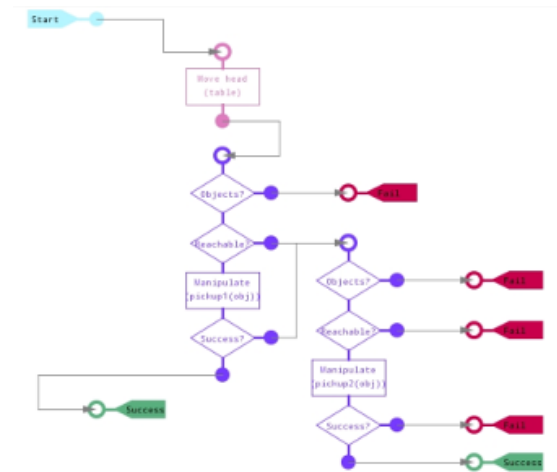
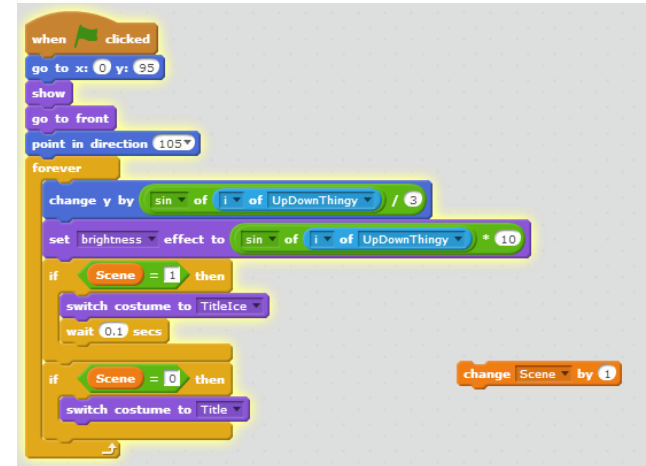
# Visual Programming Languages

Represented as flow charts:

- Nodes - “Code”
- Edges - Program Flow

Allows non-expert end users to code systems

VPLs share many properties but there are no unified tools for developing VPLs



# Our Project

Implement a visualization toolkit that provides an interface for developers to create new VPLs

- Declarative (JSON) configuration spec
- Intuitive Default Interactions
- Extensible
- Downloadable graph spec

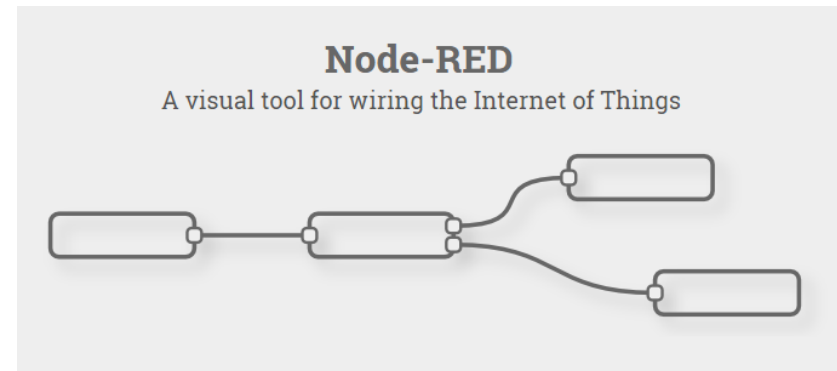
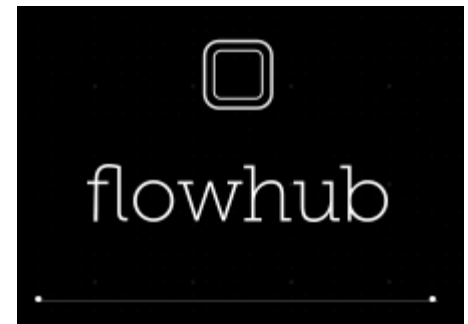
## Big picture:

Constraint-aware interactive graph visualization system!

# Current Systems

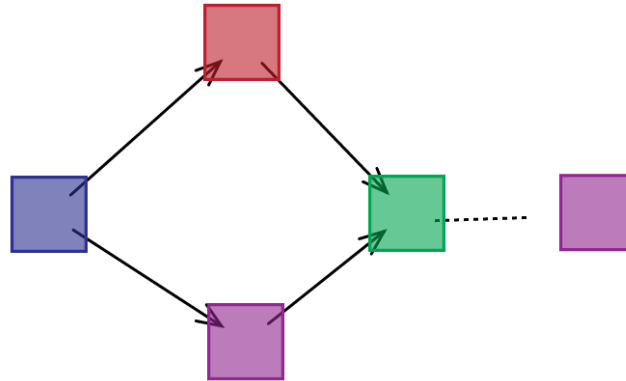
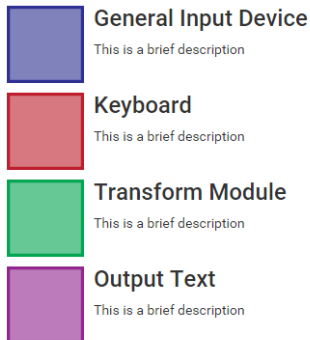
No toolkits exist for creating new VPLs

Existing tools are VPLs which allow developers and end users to write visual programs



# Current Project State

```
var App = new FlowViz.App('config.json', 'svg#InteractiveViz', {  
  
  ready: function() {  
    this.Legend.Create('div#LeftSidebar');  
  }  
  
});
```



```
{  
  "name": "MapAll",  
  "connectEvt": "dblclick",  
  "draggable": true,  
  "layout": "right",  
  "types": [{  
    "type": "InputDevice",  
    "name": "General Input Device",  
    "view": "<?xml version=\"1.0\" encoding=\"  
    \"desc\": \"This is a brief description\",  
    \"clickItems\": null,  
    \"callbacks\": null,  
    \"constraints\": {  
      \"incoming\": \"none\",  
      \"outgoing\": \"Transform.*\"  
    },  
    \"subtypes\": [{  
      ...  
    }  
  ]  
}
```

- Devs specify node types and display through config file
- Our system has an internal representation of the graph, and uses D3 and the svg stored in the config file to generate the visualization
- We have default add-on tools (e.g. a Legend generator)

# In Progress

Enforce constraints

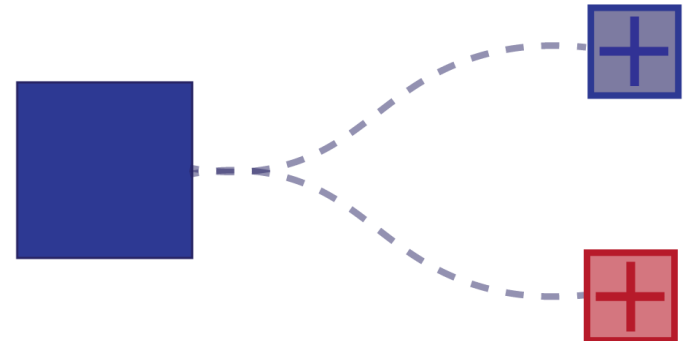
```
"constraints": {  
  "incoming": ["InputDevice.*", "Transform.*"],  
  "outgoing": ["Transform.*", "Action.*"]  
},
```

Enable interaction callbacks

Enable auto-completion

Enable node “options” interface

Enable edge “options” interface



A rounded rectangular dialog box with a light gray background and a dark gray border. The title "Node XYZ" is centered at the top. Below the title are three input fields, each preceded by the text "Some Property:". The first two are text input boxes, and the third is a slider control. A "Save" button is located at the bottom right of the dialog.

# Questions

1. Which features should we add?
2. Does it make sense for multiple edges between nodes to automatically bundle?
3. Are there constraints besides parent-child constraints that would be useful to include?

# Visualizing Changes from User Interaction

Jane Hoffswell

Vega is a declarative  
visualization language.



Vega Live Editor

localhost:8080/examples/editor/

Jane

Vega brush Visualization Renderer Canvas

```
{
  "width": 200,
  "height": 200,

  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}]
    }
  ],

  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}
```

Vega Live Editor

localhost:8080/examples/editor/

brush Format Parse Visualization

Renderer Canvas

```
{
  "width": 200,
  "height": 200,
  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}
      ]
    }
  ],
  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}
```

The visualization is a scatter plot with 'Sepal Width' on the x-axis (ranging from 2.0 to 4.0) and 'Petal Length' on the y-axis (ranging from 1 to 7). The data points are represented by semi-transparent grey circles. A brush interaction is active, indicated by a red box around the 'Parse' button in the interface. The brush is currently positioned over a cluster of points in the upper-left region of the plot, with its start point at approximately (2.2, 4.5) and its end point at approximately (3.0, 6.5).

But what happens when  
something goes wrong?

Vega Live Editor

localhost:8080/examples/editor/

Vega brush Visualization Renderer Canvas

```
{
  "width": 200,
  "height": 200,

  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}]
    }
  ],

  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}
```

Vega Live Editor

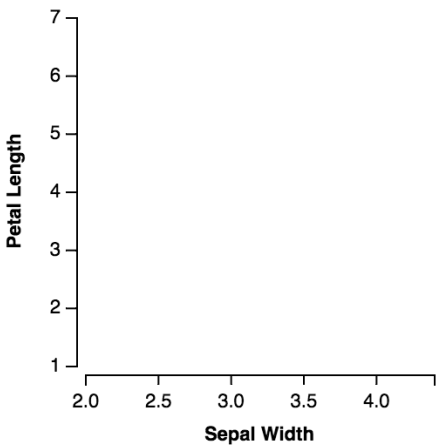
localhost:8080/examples/editor/

Vega brush Format Parse Visualization Renderer Canvas

```
{
  "width": 200,
  "height": 200,

  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}]
    }
  ],

  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}
```





Vega

brush

Format

Parse

Visualization

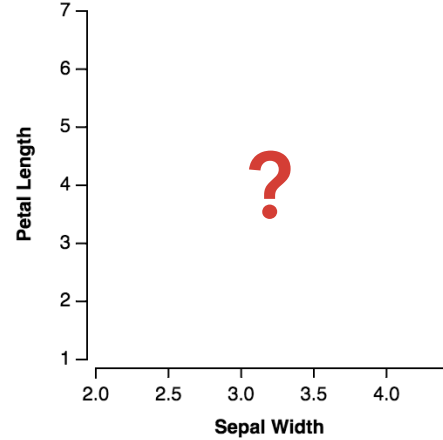
Renderer

Canvas

```
{
  "width": 200,
  "height": 200,

  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}
      ]
    }
  ],

  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}
```



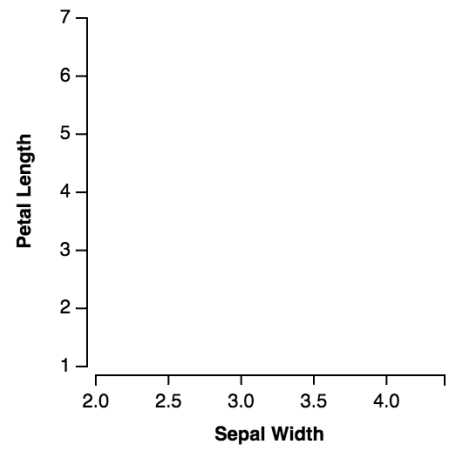
```

{
  "width": 200,
  "height": 200,

  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}
      ]
    }
  ],

  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],

```



Console Search Emulation Rendering

Clear console log. Stop frames. Preserve log

```

Object {def: Object, markType: group, interactive: true, items: Array[1], bounds: bounds...}
  bounds: bounds
  def: Object
  interactive: true
  items: Array[1]
    0: Item
      _id: 488
      _prev: undefined
      _scales: Object
      axes: Array[2]
      axisItems: Array[2]
      bounds: bounds
      bounds:prev: bounds
      datum: Object
      height: 200
      items: Array[2]
        0: Object
          bounds: bounds
          def: Object
          group: Item
          interactive: true
          items: Array[150]
            [0 .. 99]
              0: Item
              1: Item
              2: Item
              3: Item
              4: Item
              5: Item
              6: Item
              7: Item
              8: Item
              9: Item
              10: Item
              11: Item
              12: Item
              13: Item
              14: Item
              15: Item
              16: Item
              17: Item
              18: Item
              19: Item
              20: Item
              21: Item
              22: Item
              23: Item
              24: Item
              25: Item
              26: Item
              27: Item
              28: Item
              29: Item

```

How can we make the  
debugging process easier?



# Related Work: D3 vs. Vega

	Pro	Con
D3	flexibility & debug support	user responsible for some internal control flow
Vega	internal optimizations without user	limited debug support

# Visualizing Changes from User Interaction

Vega Live Editor Jane

localhost:8080/examples/editor/

Vega Visualisation Renderer Canvas

```

{
  "width": 200,
  "height": 200,
  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}
      ]
    }
  ],
  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}

```

The visualization is a scatter plot with 'Sepal Width' on the x-axis (ranging from 2.0 to 4.0) and 'Petal Length' on the y-axis (ranging from 1 to 7). A brush tool is active, highlighting a cluster of points in the upper-left region where Sepal Width is between 2.5 and 3.5 and Petal Length is between 4 and 7.

Scenegraph Show All

The scenegraph is a tree structure representing the visualization's components. The root node is a 'group' with ID 151. It branches into two 'group' nodes: 309 (left) and 308 (right). Node 309 contains a 'rule' node (307) and a 'rule' node (309). Node 308 contains a 'rule' node (308) and a 'rule' node (308). The 'rule' nodes further branch into 'text' and 'path' nodes, which are labeled with IDs such as 325, 324, 337, and 336.

Vega Live Editor Jane

localhost:8080/examples/editor/

Vega brush

```

{
  "width": 200,
  "height": 200,
  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}
      ]
    }
  ],
  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}

```

Visualization Renderer

Scenegraph

Vega Live Editor Jane

localhost:8080/examples/editor/

Vega brush

```

{
  "width": 200,
  "height": 200,
  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}
      ]
    }
  ],
  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}
      ]
    }
  ],
}

```

Visualization Renderer

Scenegraph

Vega Live Editor Jane

localhost:8080/examples/editor/

Vega brush

```

{
  "width": 200,
  "height": 200,
  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}]
    }
  ],
  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}]
    }
  ],

```

Visualization Renderer

Scenegraph

Vega Live Editor Jane

localhost:8080/examples/editor/

Vega brush

```

{
  "width": 200,
  "height": 200,
  "signals": [
    {
      "name": "brush_start",
      "init": {"x": 0, "y": 0},
      "streams": [{"type": "mousedown", "expr": "p"}]
    },
    {
      "name": "brush_end",
      "init": {"x": 0, "y": 0},
      "streams": [
        {"type": "mousedown, mouseup, [mousedown, mouseup] > mousemove", "expr": "p"}]
    }
  ],
  "predicates": [
    {
      "name": "xRange",
      "type": "in",
      "item": {"arg": "x"},
      "range": [{"signal": "brush_start.x"}, {"signal": "brush_end.x"}],
      "scale": {"arg": "xScale"}
    },
    {
      "name": "yRange",
      "type": "in",
      "item": {"arg": "y"},
      "range": [{"signal": "brush_start.y"}, {"signal": "brush_end.y"}],
      "scale": {"arg": "yScale"}
    },
    {
      "name": "inRange",
      "type": "&&",
      "operands": [
        {"predicate": "xRange"},
        {"predicate": "yRange"}]
    }
  ],

```

Visualization Renderer

Scenegraph

x	y	fill	fill opacit	petal length	sepal width
4	61	grey	0.5	1.4	3.5
32	8	grey	0.5	4.6	3.1
21	19	grey	0.5	2.8	5.2
4	33	grey	0.5	6.9	2.1



x	y	fill	fill opacit	petal length	sepal width
4	61	<b>orange</b>	0.5	1.4	3.5
32	8	<b>green</b>	0.5	4.6	3.1
21	19	grey	0.5	2.8	5.2
4	33	<b>orange</b>	0.5	6.9	2.1



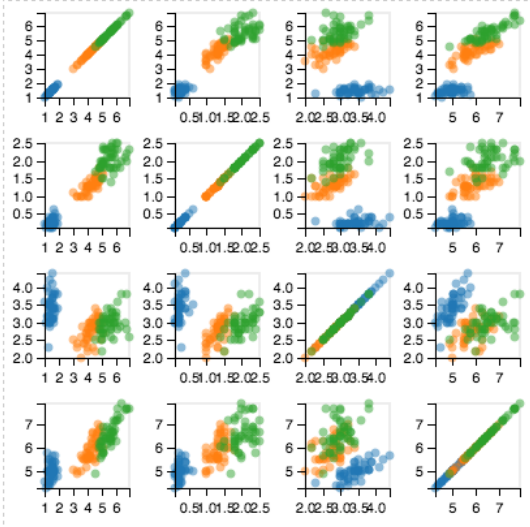
Vega scatter\_matrix Format Parse

Visualization Renderer Canvas

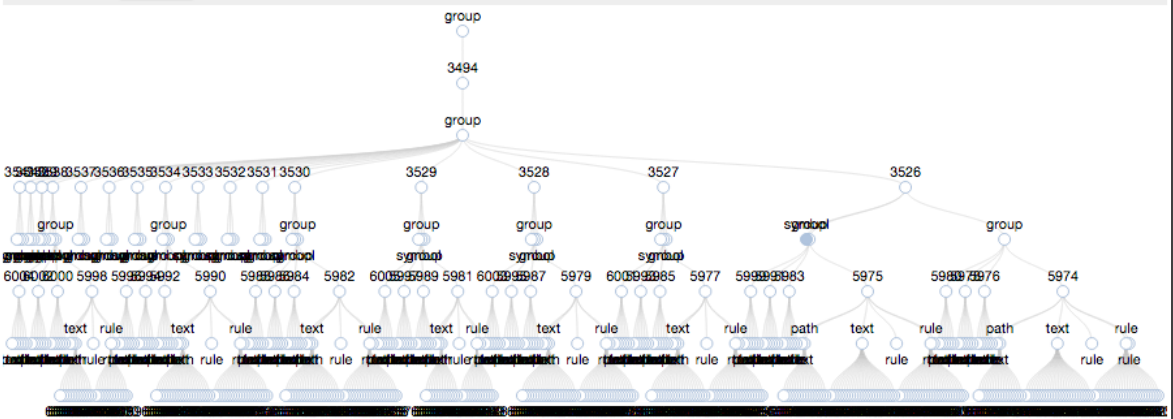
```

{
  "width": 400,
  "height": 400,
  "data": [
    {
      "name": "iris",
      "url": "data/iris.json"
    },
    {
      "name": "fields",
      "values": ["petalLength", "petalWidth", "sepalWidth", "sepalLength"]
    }
  ],
  "scales": [
    {
      "name": "gx",
      "type": "ordinal",
      "range": "width",
      "round": true,
      "domain": {"data": "fields", "field": "data"}
    },
    {
      "name": "gy",
      "type": "ordinal",
      "range": "height",
      "round": true,
      "domain": {"data": "fields", "field": "data"}
    },
    {
      "name": "c",
      "type": "ordinal",
      "domain": {"data": "iris", "field": "species"},
      "range": "category10"
    }
  ],
  "legends": [
    {
      "fill": "c",
      "title": "Species",
      "offset": 10,
      "properties": {
        "symbols": {
          "fillOpacity": {"value": 0.5},
          "stroke": {"value": "transparent"}
        }
      }
    }
  ],
  "marks": [
    {
      "type": "group",
      "from": {
        "data": "fields",
        "transform": [{"type": "cross"}]
      },
      "properties": {

```



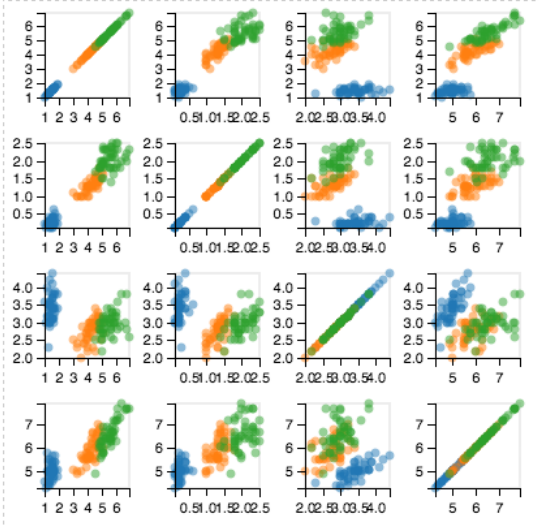
Scenegraph Show All



Vega scatter\_matrix Format Parse

Visualization Renderer Canvas

```
{
  "width": 400,
  "height": 400,
  "data": [
    {
      "name": "iris",
      "url": "data/iris.json"
    },
    {
      "name": "fields",
      "values": ["petalLength", "petalWidth", "sepalWidth", "sepalLength"]
    }
  ],
  "scales": [
    {
      "name": "gx",
      "type": "ordinal",
      "range": "width",
      "round": true,
      "domain": {"data": "fields", "field": "data"}
    },
    {
      "name": "gy",
      "type": "ordinal",
      "range": "height",
      "round": true,
      "domain": {"data": "fields", "field": "data"}
    },
    {
      "name": "c",
      "type": "ordinal",
      "domain": {"data": "iris", "field": "species"},
      "range": "category10"
    }
  ],
  "legends": [
    {
      "fill": "c",
      "title": "Species",
      "offset": 10,
      "properties": {
        "symbols": {
          "fillOpacity": {"value": 0.5},
          "stroke": {"value": "transparent"}
        }
      }
    }
  ],
  "marks": [
    {
      "type": "group",
      "from": {
        "data": "fields",
        "transform": [{"type": "cross"}]
      },
      "properties": {
```



Scenegraph Show All



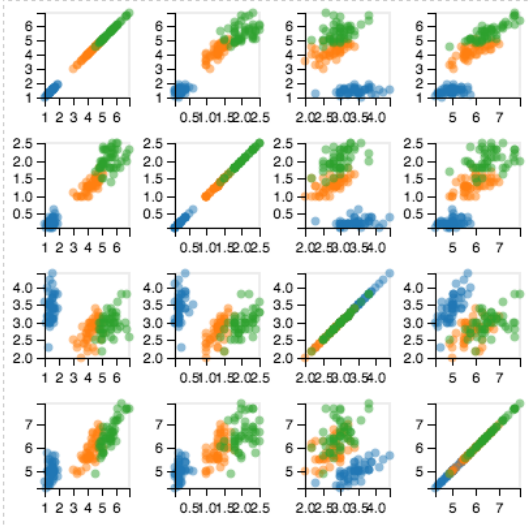
Vega scatter\_matrix Format Parse

Visualization Renderer Canvas

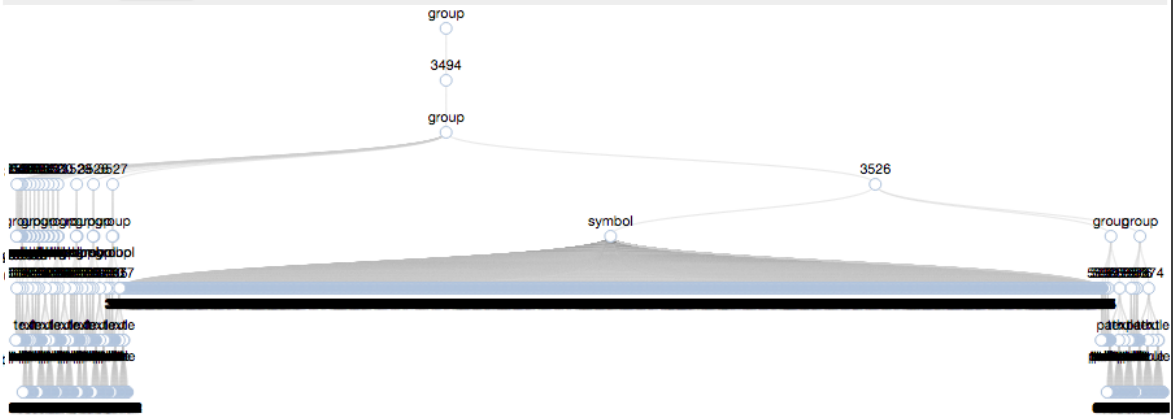
```

{
  "width": 400,
  "height": 400,
  "data": [
    {
      "name": "iris",
      "url": "data/iris.json"
    },
    {
      "name": "fields",
      "values": ["petalLength", "petalWidth", "sepalWidth", "sepalLength"]
    }
  ],
  "scales": [
    {
      "name": "gx",
      "type": "ordinal",
      "range": "width",
      "round": true,
      "domain": {"data": "fields", "field": "data"}
    },
    {
      "name": "gy",
      "type": "ordinal",
      "range": "height",
      "round": true,
      "domain": {"data": "fields", "field": "data"}
    },
    {
      "name": "c",
      "type": "ordinal",
      "domain": {"data": "iris", "field": "species"},
      "range": "category10"
    }
  ],
  "legends": [
    {
      "fill": "c",
      "title": "Species",
      "offset": 10,
      "properties": {
        "symbols": {
          "fillOpacity": {"value": 0.5},
          "stroke": {"value": "transparent"}
        }
      }
    }
  ],
  "marks": [
    {
      "type": "group",
      "from": {
        "data": "fields",
        "transform": [{"type": "cross"}]
      },
      "properties": {

```



Scenegraph Show All



# Please let me know if you have questions or feedback!!

- What strategies could be effective for **simplifying** the scenegraph?
- How should I **surface relevant internal information** associated with the nodes?
- What **automatic labels** should be shown?
- What **types of interactions/tasks** might a user want to perform?
- Is there a **better representation** for this data?

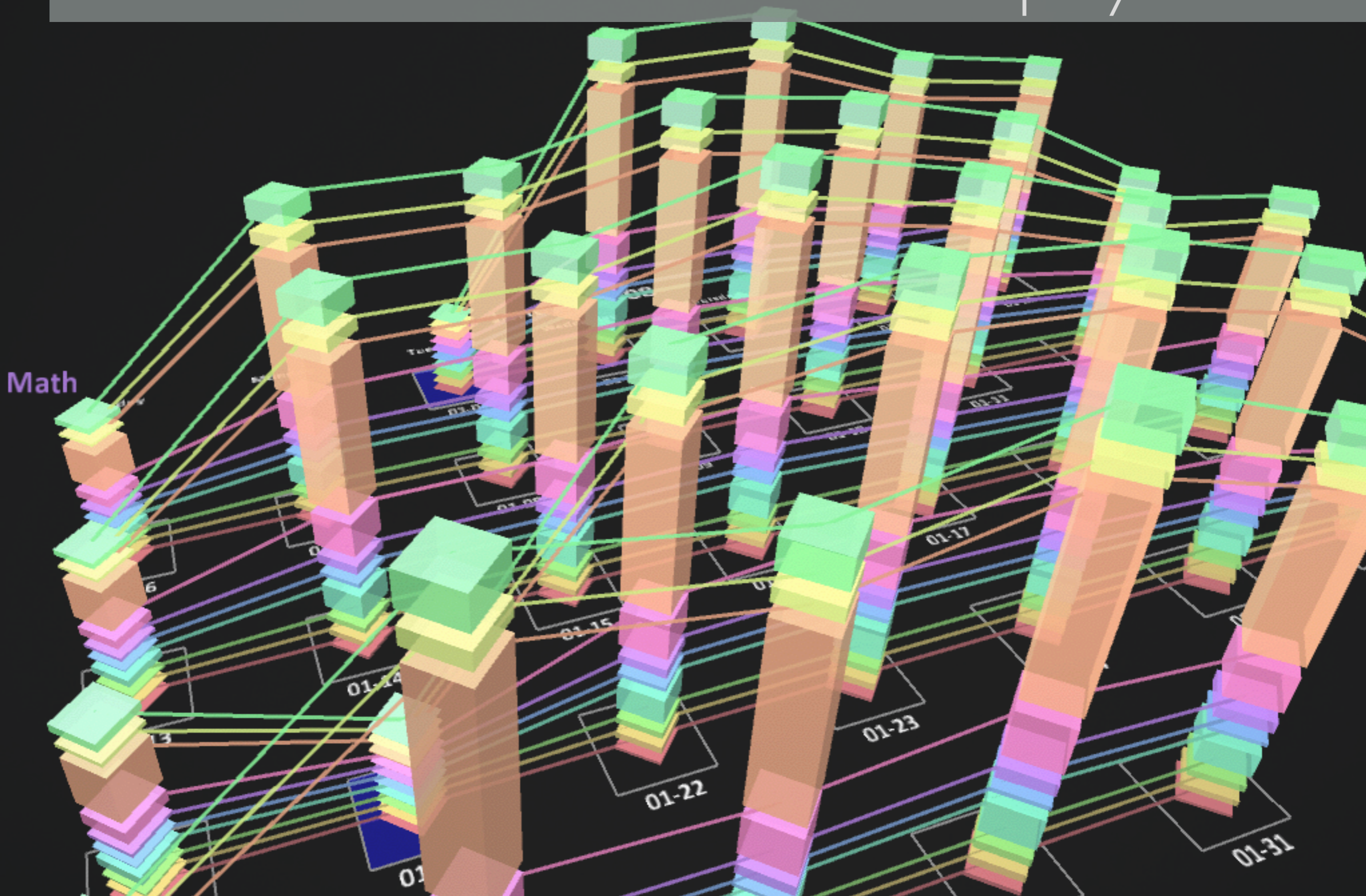
# VIRTUAL REALITY + DATA VIZ

Aditya Sankar

2D data visualization is limited by screen real estate



3D visualizations on 2D displays suck!







Virtual Reality is now inexpensive and accessible!

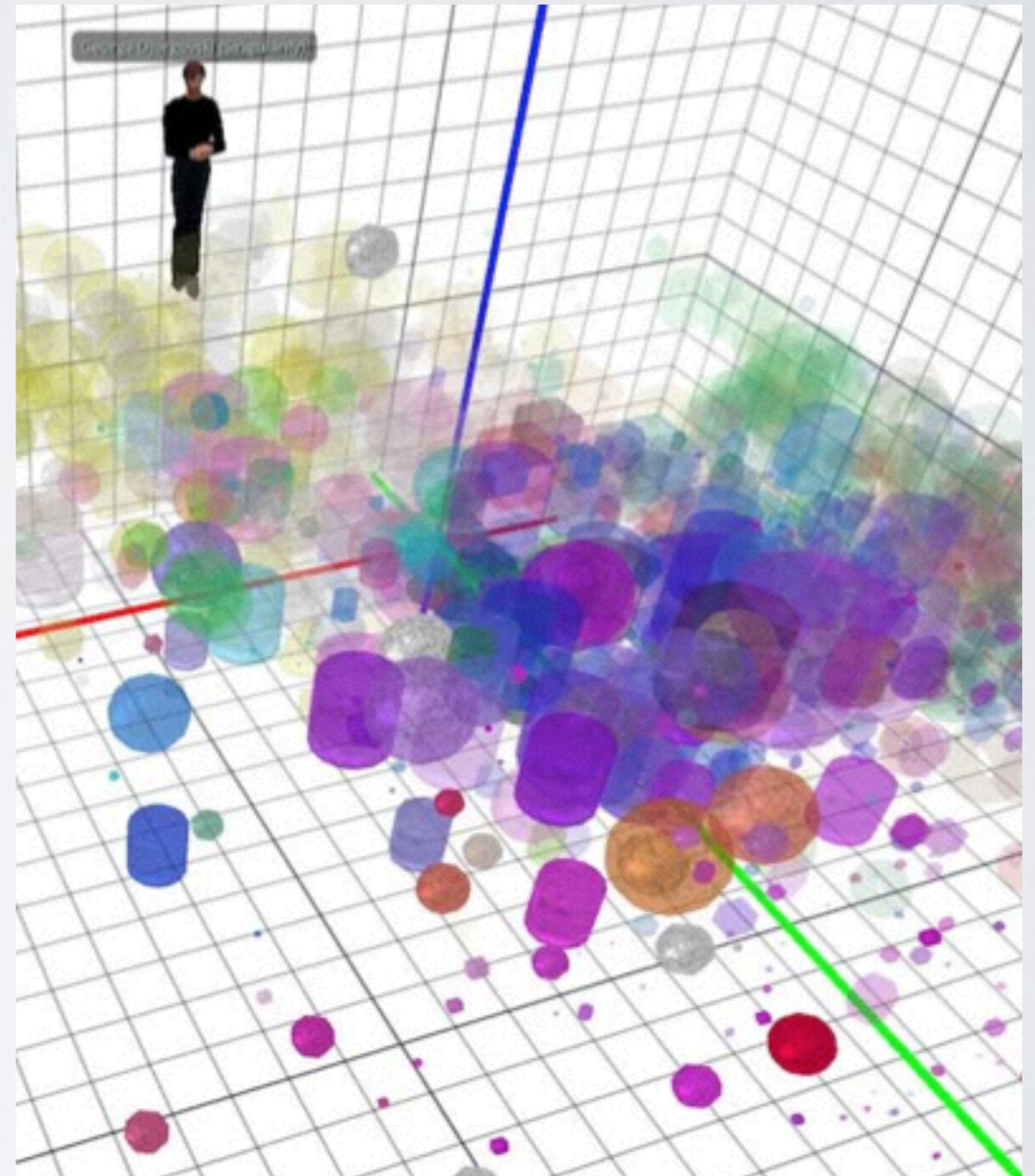
# RELATED WORK

- CAVE displays [1]
- Shown demonstrable improvement in data visualization tasks, especially with spatial and volumetric data
- Are prohibitively expensive!



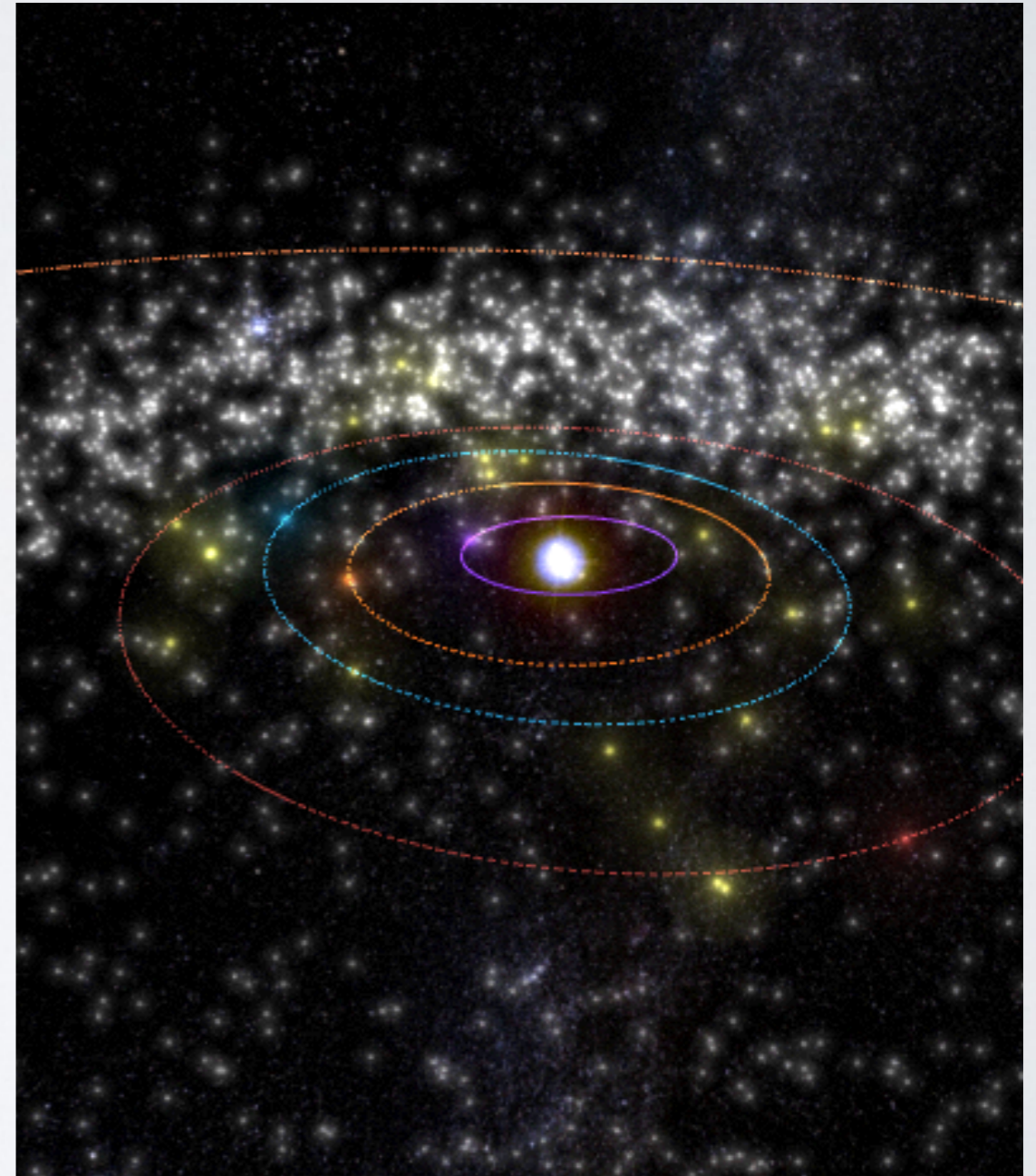
# VR + VIZ

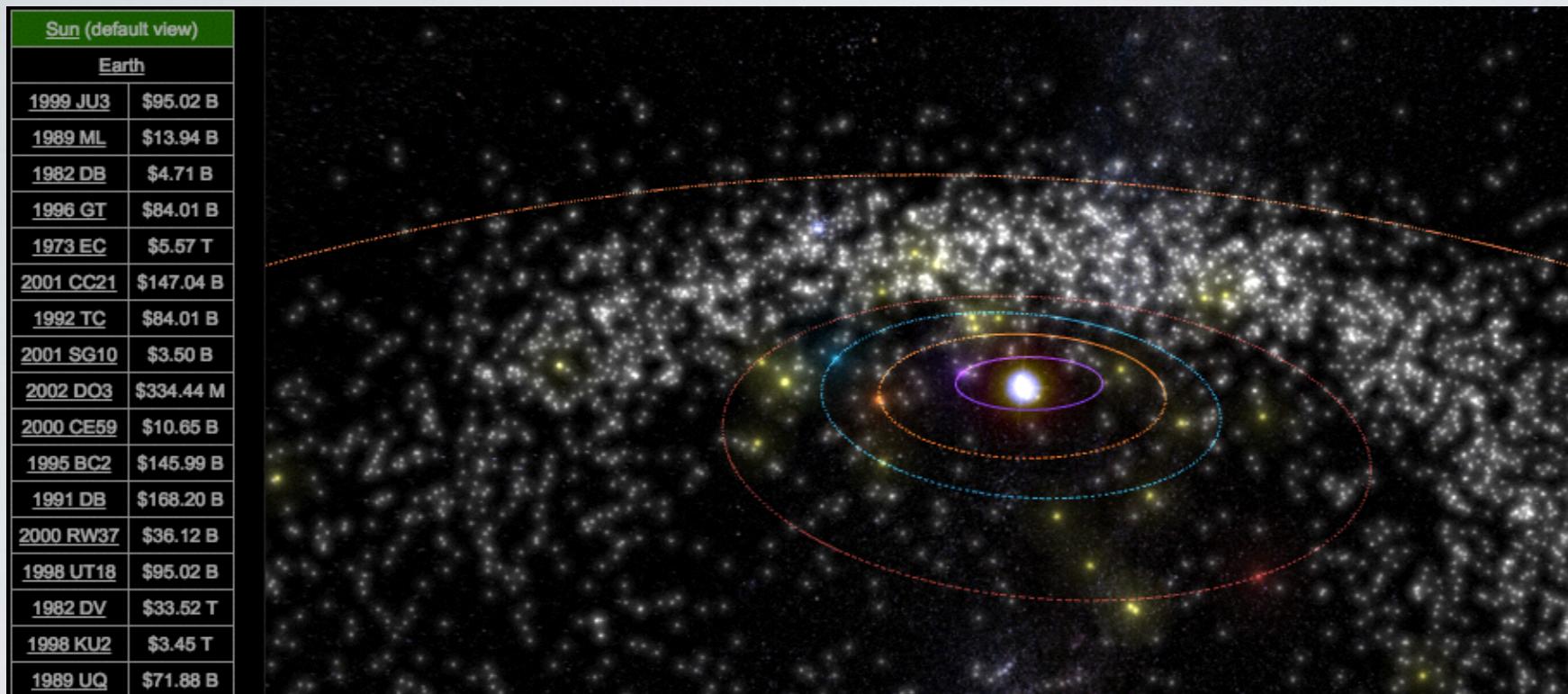
- Donalek et. al. [2] conduct closely related research
- Show benefits of VR
- Focus more on methods for down projecting high-dimensional “big data”



# ASTERANK

- Catalog of 600,000 asteroids based on:
  - Name, Mass, Estimated Value
  - Data sourced from NASA JPL and others
  - 3D to 2D web interface with point and click controls





# PROJECT PROPOSAL

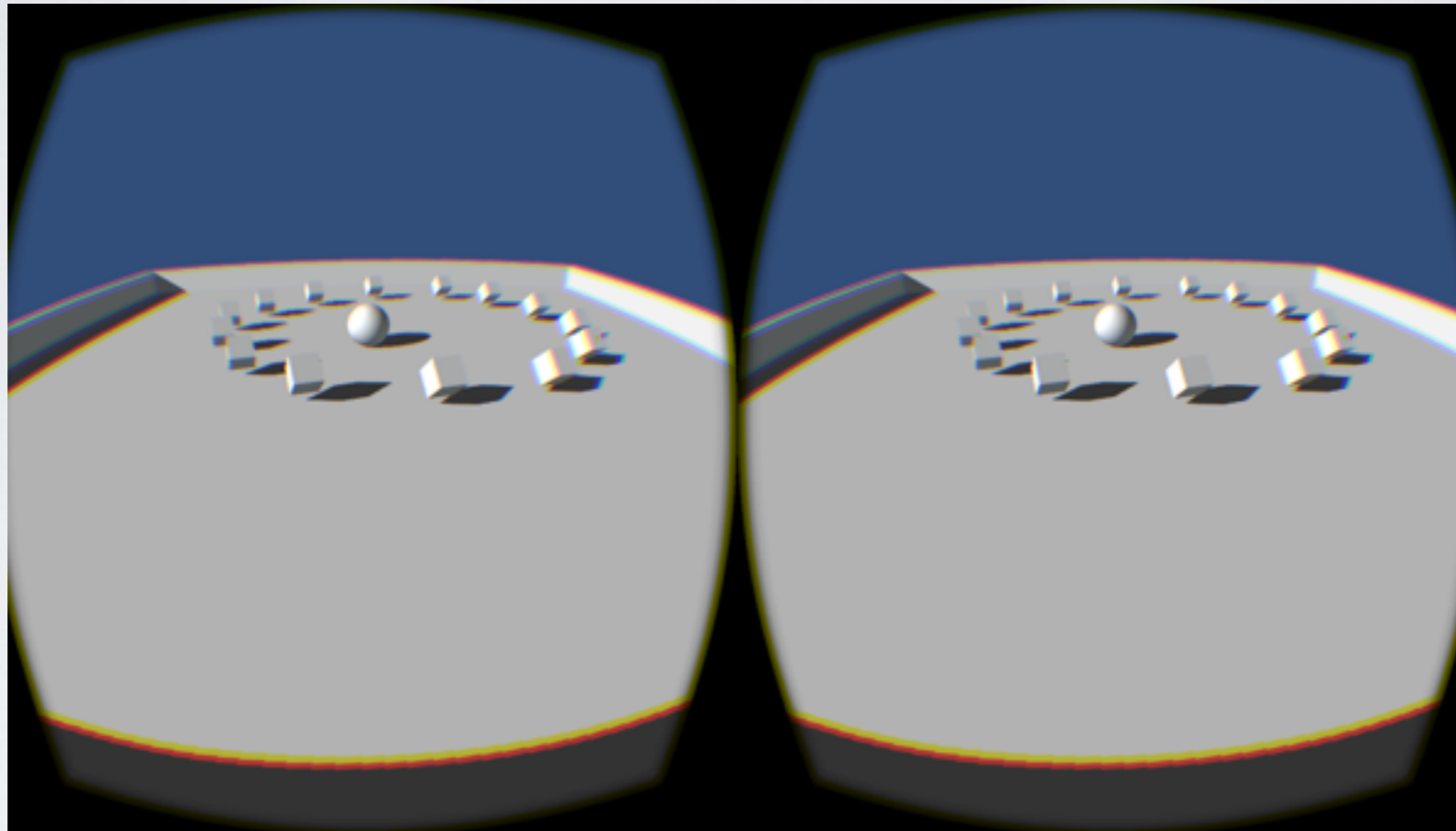
Visualize and interact with asteroid data using Oculus Rift

# INTERACTION

- Gaze to select & drill-down
- Focus + context using Lens
- Touch trackpad to translate / zoom



# CURRENT PROGRESS



- Set up Oculus dev environment
- Studied Asterank data format
- Built toy project in Unity
- Able to hook into API

# COMPLETION PLAN

- Currently working on solar system model in Unity
- Import asteroid data as particles in a physics simulation (gravity field, initial position, velocity)
- Implement and evaluate interaction techniques



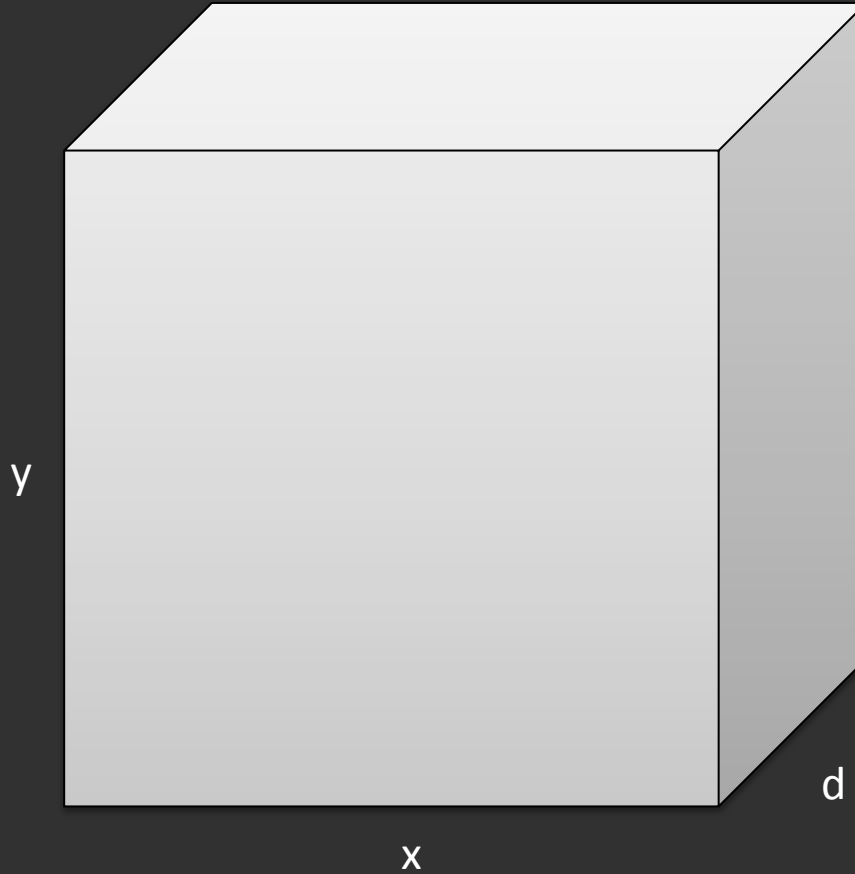
# FEEDBACK

- Other interaction techniques to explore?
- How can VR benefit abstract data viz?
- General comments; how else can VR be useful in Data Viz?

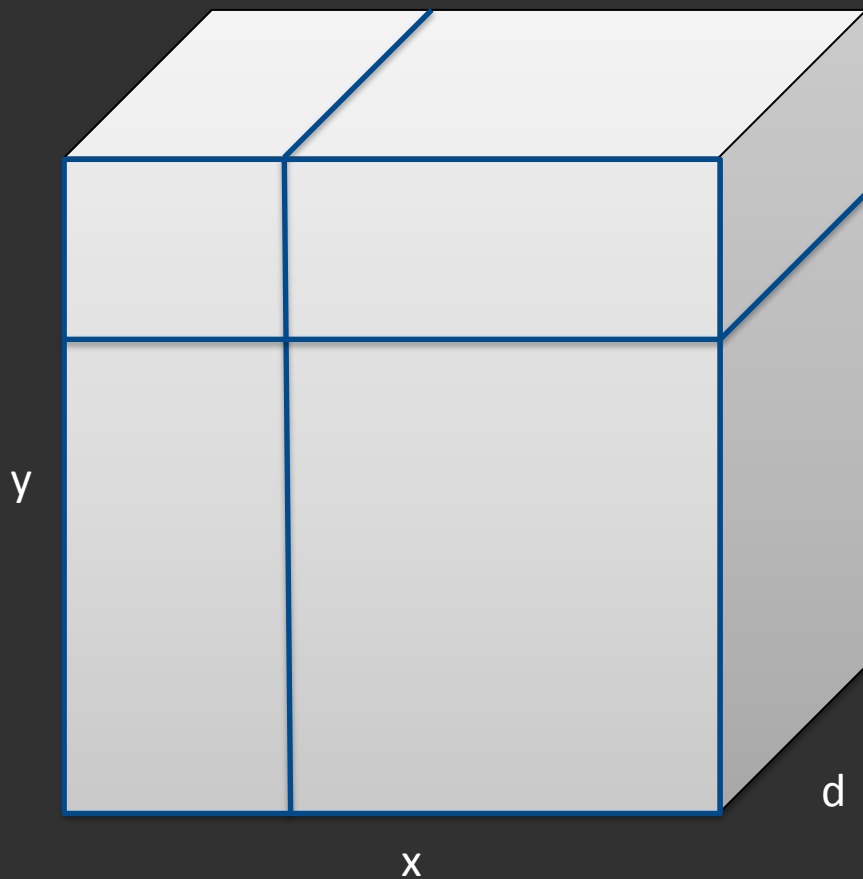
# Disparity Space Visualization

Juliet Fiss

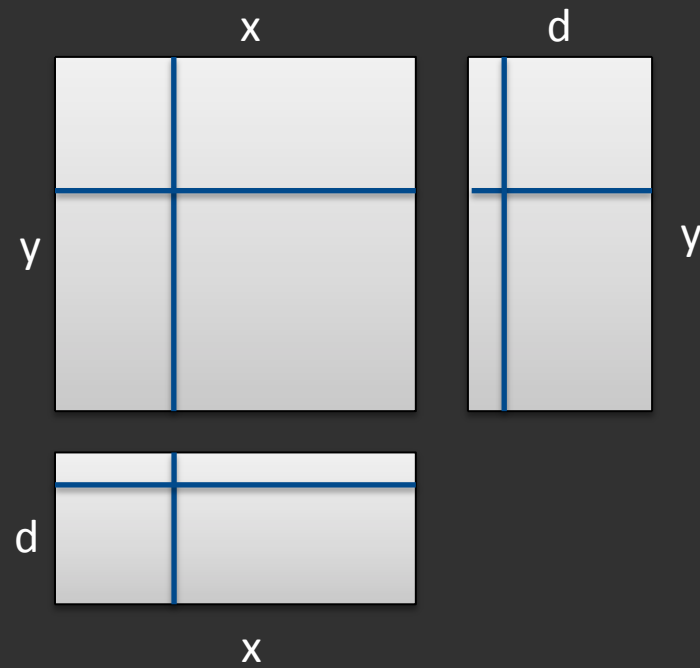
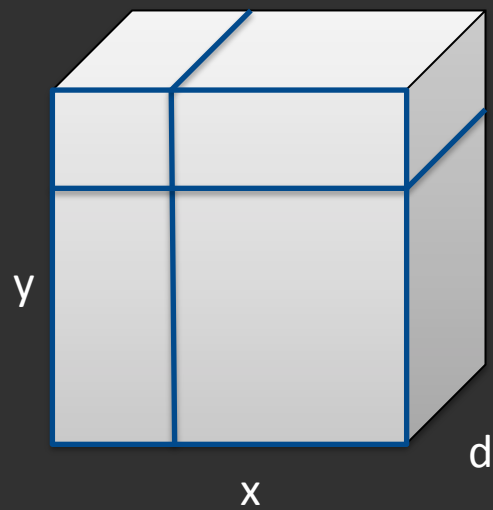
# Disparity Space



Selected (x, y, d)

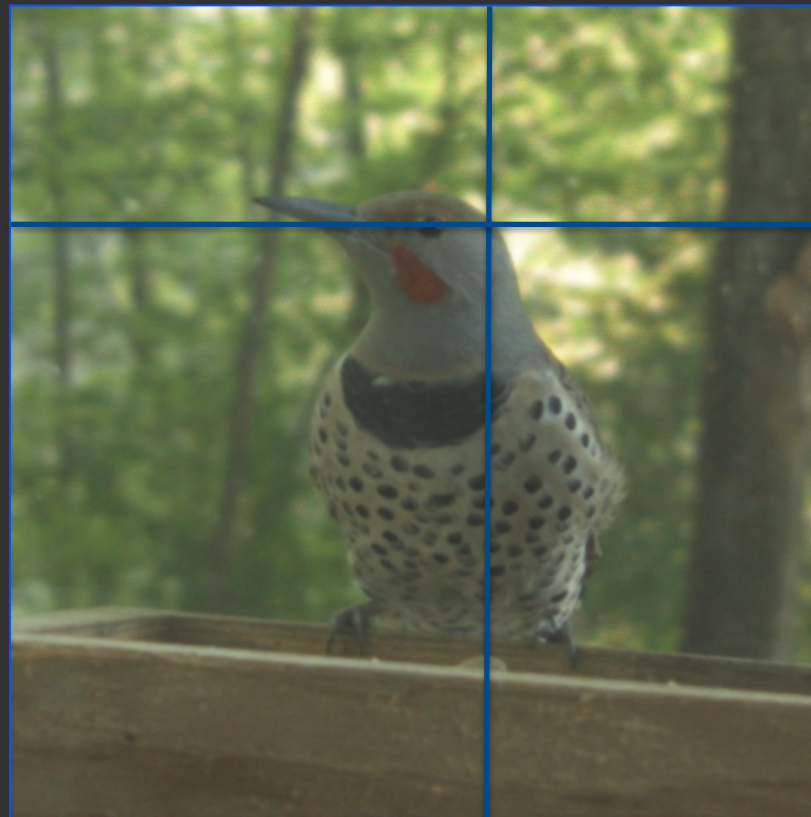


# Disparity Space Visualization



# Question #1

How to show selected (x, y, d) without obscuring image content?

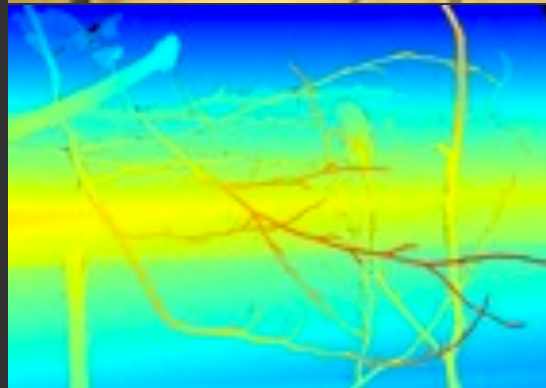
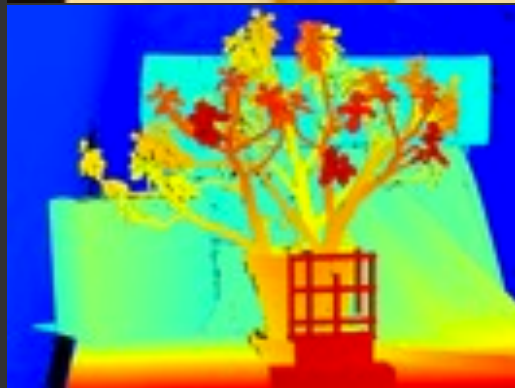


# Question #2: How to Encode Depth and Uncertainty?



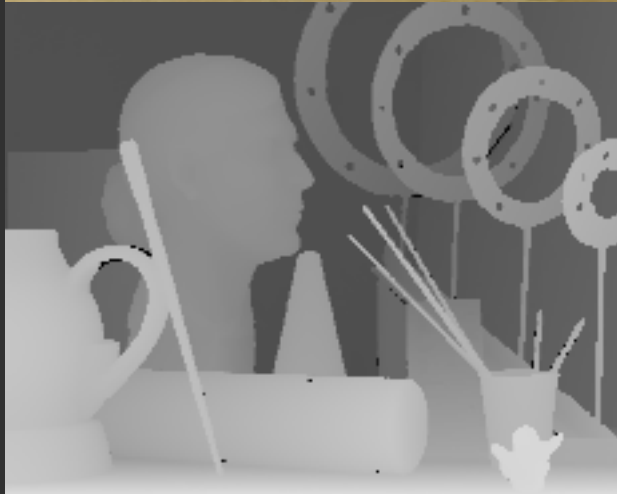
Standard: Hue = Depth, Luminance = Uncertainty

# Problem: Depth Scale Hard to Interpret

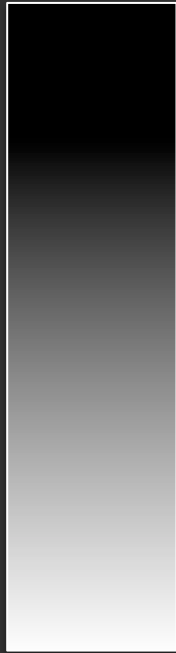




# Luminance = Depth & Uncertainty

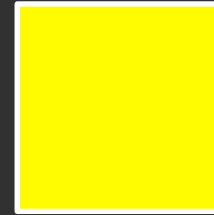
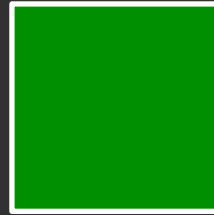


# Proposed Encoding



Luminance = Depth

Color = Uncertainty (low, medium, high)



# Video

- <http://homes.cs.washington.edu/~juliet/dsivis.html>

# **Visualizing Third-Party Content on Web Pages**

Ryan Russell, Adrian Sham, Lindsey Nguyen, Johnson Goh

# The problem

- Third-party tracking on the web is a privacy issue
- Many browser plug-ins can help users understand how much tracking is happening and by whom
- However, hard for user to identify **where** on a page third-party content actually is and by whom

# Example (Ghostery)

1. Where is this ad coming from?

2. Who should I block?

The screenshot shows a web browser displaying the homepage of The Seattle Times. The page features a navigation menu with categories like ENTERTAINMENT, LIFE, TRAVEL, OPINION, JOBS, and MARKETPLACE. A prominent advertisement for a red Toyota car is visible, with the text "AdChoices TOYOTA Let's Go Places" and a "VIEW DETAILS" button. Below the car ad, there is a photograph of a man and a woman with a baby, and a red banner for a "ToyotaTime Sales Event" with the text "Event ends...".

The Ghostery browser extension is overlaid on the right side of the browser window. The extension's interface shows a blue header with a ghost icon and the text "Ghostery found 64 trackers www.seattletimes.com". Below the header is a list of trackers with their names, categories, and toggle switches. The trackers listed are:

Tracker Name	Category	Toggle	Whitelist
Adap.tv	Advertising	On	On
Advertising.com	Advertising	On	On
Aggregate Knowledge	Beacons	On	On
AppNexus	Advertising	On	On
Audience Science	Beacons	On	On
BidSwitch	Advertising	On	On

At the bottom of the extension interface, there are three buttons: "Pause Blocking", "Whitelist Site", and a question mark icon.

# One page view

- Give the user the ability to quickly identify third party content
- Allow the user to mouse over a specific element to display more information



**ToyotaTime Sales Event**  
Event ends June 1st

**11 12 28 55**  
DAYS | HOURS | MINUTES | SECONDS

Limited Time Offers



AdChoices  
**TOYOTA**  
Let's Go Places  
VIEW DETAILS

Prototype shown with options. Production model will vary.

West Seattle couple bequeaths it all — \$847,215 — to Uncle Sam

First dinosaur bone found in state, 80 million years later

Updated 11:19 am

Thousands of teachers hit streets — and Dems walk out in Olympia

Q&A: How to see if your car is affected by Takata air-bag recall

Expensive bonsai stolen from Federal Way museum recovered Updated 11:06 am

Air Force launches hush-hush Boeing-built rocket into space Updated 10:46 am

State's jobless rate shrinks to 5.5 percent, close to U.S. average Updated 10:36 am



Family life: Anthony Johnson and wife Shaunte Nance-Johnson play with son Kaine-Carter Johnson. (Lindsey Wasson / The Seattle Times)

## After a stormy childhood, Tacoma's Anthony Johnson hopes for a bright future

Johnson played Division I basketball at Montana, walked down the red carpet at the ESPYs and briefly shared a court with Kobe Bryant. He also has spent long years sorting through his issues, which included a childhood beating that still affects his eyesight.

## ToyotaTime Sales Event

Event ends June 1st

### Limited Time Offers



LEARN MORE



Some vehicles prototypes. All models shown with options.





**ToyotaTime Sales Event**  
Event ends June 1st

11 12 28 56  
DAYS | HOURS | MINUTES | SECONDS

Limited Time Offers



AdChoices TOYOTA Let's Go Places

VIEW DETAILS

Prototype shown with options. Production model will vary.

West Seattle couple bequeaths it all — \$847,215 — to Uncle Sam

First dinosaur bone found in state, 80 million years later  
Updated 11:19 am

Thousands of teachers hit streets — and Dems walk out in Olympia

Q&A: How to see if your car is affected by Takata air-bag recall

Expensive bonsai stolen from Federal Way museum recovered  
Updated 11:06 am

Air Force launches hush-hush Boeing-built rocket into space  
Updated 10:46 am

State's jobless rate shrinks to 5.5 percent, close to U.S. average  
Updated 10:36 am




Family life: Anthony Johnson and wife Shaunte Nance-Johnson play with son Kaine-Carter Johnson. (Lindsey Wasson / The Seattle Times)

## After a stormy childhood, Tacoma's Anthony Johnson hopes for a bright future

Johnson played Division I basketball at Montana, walked down the red carpet at the ESPYs and briefly shared a court with Kobe Bryant. He also has spent long years sorting through his issues, which included a childhood beating that still affects his eyesight.

**ToyotaTime Sales Event**  
Event ends June 1st

Limited Time Offers



LEARN MORE

TOYOTA | Let's Go Places


Some vehicles prototypes. All models shown with options.



**ToyotaTime Sales Event**  
Event ends June 1st

11 12 28 56  
DAYS | HOURS | MINUTES | SECONDS

Limited Time Offers



**TOYOTA**  
Let's Go Places

VIEW DETAILS

Prototype shown with options. Production model will vary.

DoubleClick.net

West Seattle couple bequeaths it all — \$847,215 — to Uncle Sam

First dinosaur bone found in state, 80 million years later  
Updated 11:19 am

Thousands of teachers hit streets — and Dems walk out in Olympia

Q&A: How to see if your car is affected by Takata air-bag recall

Expensive bonsai stolen from Federal Way museum recovered  
Updated 11:06 am

Air Force launches hush-hush Boeing-built rocket into space  
Updated 10:46 am

State's jobless rate shrinks to 5.5 percent, close to U.S. average  
Updated 10:36 am




Family life: Anthony Johnson and wife Shaunte Nance-Johnson play with son Kaine-Carter Johnson. (Lindsey Wasson / The Seattle Times)

## After a stormy childhood, Tacoma's Anthony Johnson hopes for a bright future

Johnson played Division I basketball at Montana, walked down the red carpet at the ESPYs and briefly shared a court with Kobe Bryant. He also has spent long years sorting through his issues, which included a childhood beating that still affects his eyesight.

**ToyotaTime Sales Event**  
Event ends June 1st

Limited Time Offers



LEARN MORE

**TOYOTA** | Let's Go Places

Some vehicles prototypes. All models shown with options.



## ToyotaTime Sales Event

Event ends June 1st

11 12 28 56  
DAYS | HOURS | MINUTES | SECONDS

Limited Time Offers



AdChoices  
**TOYOTA**  
Let's Go Places

VIEW DETAILS

Prototype shown with options. Production model will vary.

West Seattle couple bequeaths it all — \$847,215 — to Uncle Sam

First dinosaur bone found in state, 80 million years later  
Updated 11:19 am

Thousands of teachers hit streets — and Dems walk out in Olympia

Q&A: How to see if your car is affected by Takata air-bag recall

Expensive bonsai stolen from Federal Way museum recovered  
Updated 11:06 am

Air Force launches hush-hush Boeing-built rocket into space  
Updated 10:46 am

State's jobless rate shrinks to 5.5 percent, close to U.S. average  
Updated 10:36 am



Family life: Anthony Johnson and wife Shaunte Nance-Johnson play with son Kaine-Carter Johnson. (Lindsey Wasson / The Seattle Times)

## After a stormy childhood, Tacoma's Anthony Johnson hopes for a bright future

Johnson played Division I basketball at Montana, walked down the red carpet at the ESPYs and briefly shared a court with Kobe Bryant. He also has spent long years sorting through his issues, which included a childhood beating that still affects his eyesight.

## ToyotaTime Sales Event

Event ends June 1st

### Limited Time Offers



LEARN MORE

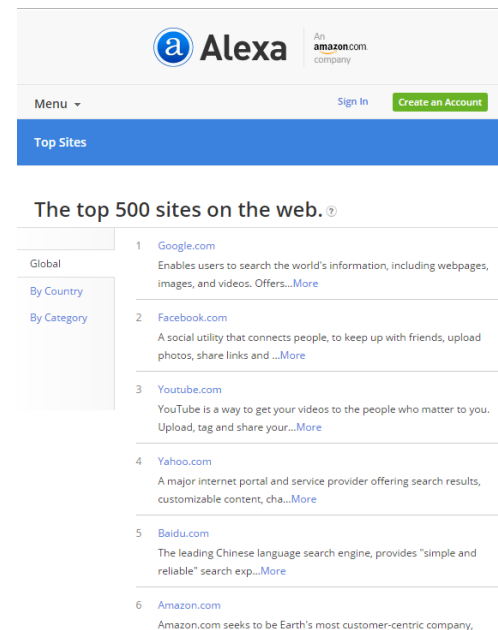
**TOYOTA** | Let's Go Places

Some vehicles prototypes. All models shown with options.

# Final Visualization

- Get top ~1000 sites of the world from Alexa
- Use chrome driver to visit all sites
- Gather data by using our previous extension
- Create final network graph using this data

Two possible options...



The screenshot shows the Alexa website interface. At the top, there is the Alexa logo and the text "amazon.com company". Below this, there is a navigation bar with "Menu", "Sign In", and "Create an Account" buttons. The main content area is titled "Top Sites" and features a section for "The top 500 sites on the web." with a dropdown menu for "Global". The list of top sites is as follows:

Rank	Site	Description
1	Google.com	Enables users to search the world's information, including webpages, images, and videos. Offers...More
2	Facebook.com	A social utility that connects people, to keep up with friends, upload photos, share links and ...More
3	Youtube.com	YouTube is a way to get your videos to the people who matter to you. Upload, tag and share your...More
4	Yahoo.com	A major internet portal and service provider offering search results, customizable content, cha...More
5	Baidu.com	The leading Chinese language search engine, provides "simple and reliable" search exp...More
6	Amazon.com	Amazon.com seeks to be Earth's most customer-centric company,

# Option 1: Graph

## something similar to Lightbeam

Lightbeam for Firefox

DATA GATHERED SINCE MAY 15, 2015

YOU HAVE VISITED 9 SITES

YOU HAVE CONNECTED WITH 112 THIRD PARTY SITES

TRACKING PROTECTION OFF

VISUALIZATION

- Graph
- List

DATA

- Save Data
- Reset Data
- Give Us Feedback
- mozilla.org/lightbeam

Weekly

GRAPH VIEW

Too crowded for sites that have lots of similar third party connections

Third party sites that are only connected to one first party site take up too much room

Sites like Facebook or Google are both first and third party sites but it is not shown

Hard to tell which lines connect to what. Hovering doesn't give more info

TOGGLE CONTROLS

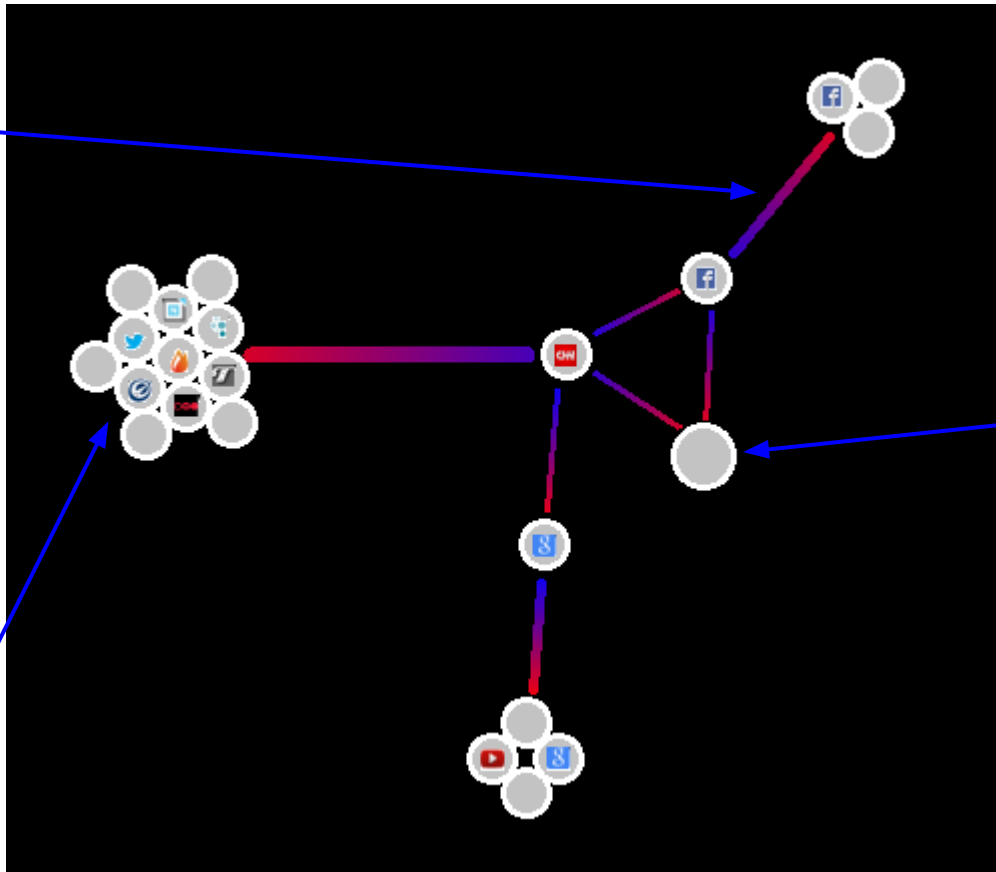
- Visited Sites
- Watched Sites
- Cookies
- Third Party Sites
- Blocked Sites
- Connections

FILTER

- Recent Site
- Last 10 Sites
- Daily
- Weekly

# Option 1: Graph

Gradient lines show connection from first party (blue) to third party (red)



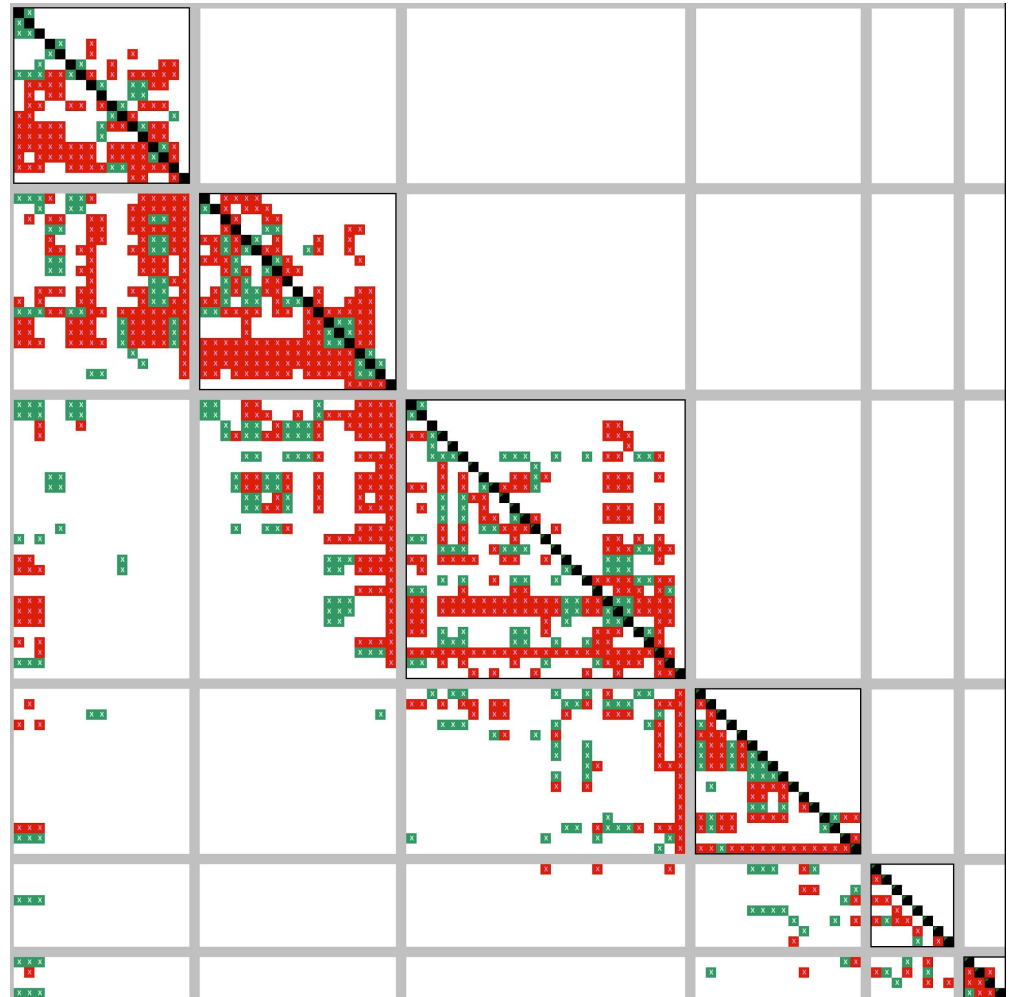
Third party sites with the same connections bundle together with the lines growing larger

Size of circle is dependent on number of sites it is a third party of. Sites contained on more sites will be larger.

The goal is to display sites that have access to the most sites. In this example the larger node is "doubleclick.net" which is a third party for both CNN and Facebook.

# Option 2: Matrix Diagram

- third party sites as rows
- first part sites as columns
- box colored by chosen other variable?
- problem: graph not dense enough?



# Questions

- Have we made it easier for users to discover the origin of third party content?
- Graph or Matrix view? What are the pros and cons for each?



# INSPIRATION

[LOGIN](#) [REGISTER](#)

[ABOUT](#)

[LOCATIONS](#)

[CHALLENGES](#)



[NEWS](#)

[AWARDS](#)

[PROJECTS](#)

**STREAM GAZER**  
2015 Challenge

[CREATE PROJECT SOLVING THIS CHALLENGE](#)

[DESCRIPTION](#) [PROJECTS](#) [HACKPAD](#)

The banner features a satellite-style image of a river delta with a semi-transparent dark overlay. The text "STREAM GAZER" and "2015 Challenge" is centered in white. A green button with white text "CREATE PROJECT SOLVING THIS CHALLENGE" is positioned below the title. At the bottom, three white links "DESCRIPTION", "PROJECTS", and "HACKPAD" are displayed.

## Hashtags:

[#earth](#), [#streamgazer](#), [#intermediate](#)

## Contact:


[streamgazer@spaceappschallenge.org](mailto:streamgazer@spaceappschallenge.org)

## Tags:

[Model](#), [Imagery](#), [Platform](#), [Data Visualization](#)

# DATA

15 min. volume measurements from 9,000+ sites back to 2007.  
Daily summaries at 100k's of sites dating back several decades.



**REST Web Services**

**HOME REST SERVICES SOAP SERVICES DOCUMENTATION EXAMPLES LINKS FAQ CONTACT US**

## USGS Statistics Web Service

You can use this service to retrieve daily, monthly or annual statistics for a USGS site and parameter.

To provide statistics, the site must serve time-series data, i.e. data is collected via an automated means and at regular intervals. To ensure your query is qualified with the argument `&hasDataTypeCd=dv`.

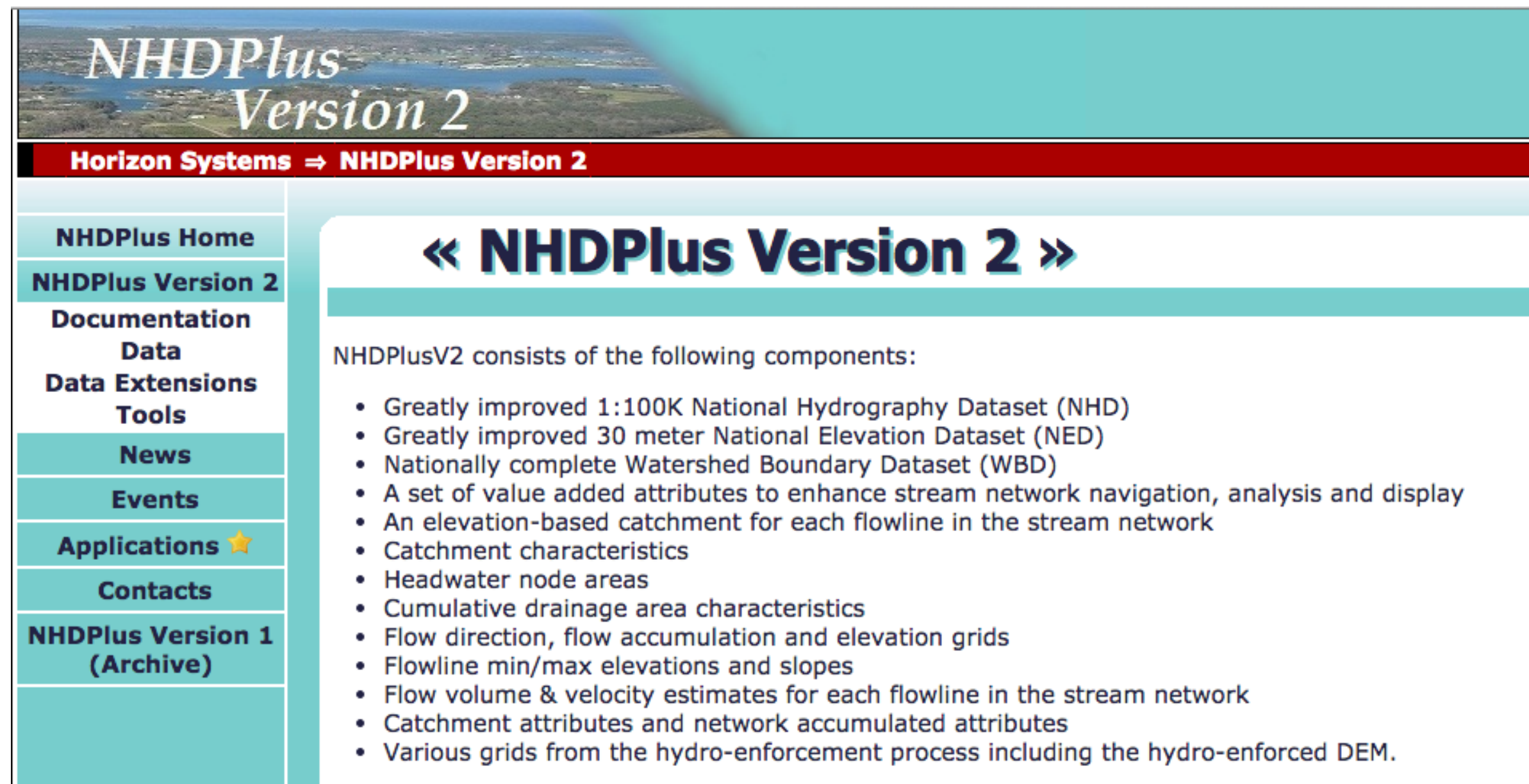
**The service serves statistics based on approved data only.** Recent data is considered provisional and is thus not approved. A value may be left blank depending on the service called.

Please join the [USGS Water Data for the Nation Notification List](#). This way you will receive an announcement when changes are made.

---

# DATA

## Comprehensive geospatial data



The screenshot shows the NHDPlus Version 2 website. At the top, there is a banner with the text "NHDPlus Version 2" over a landscape image. Below the banner is a red navigation bar with the text "Horizon Systems → NHDPlus Version 2". On the left side, there is a vertical menu with the following items: "NHDPlus Home", "NHDPlus Version 2", "Documentation", "Data", "Data Extensions", "Tools", "News", "Events", "Applications" (with a star icon), "Contacts", "NHDPlus Version 1 (Archive)", and an empty space at the bottom. The main content area features a large heading "« NHDPlus Version 2 »" and a sub-heading "NHDPlusV2 consists of the following components:". Below this, there is a bulleted list of 13 items describing the dataset's features and components.

**NHDPlus Version 2**

Horizon Systems → NHDPlus Version 2

**« NHDPlus Version 2 »**

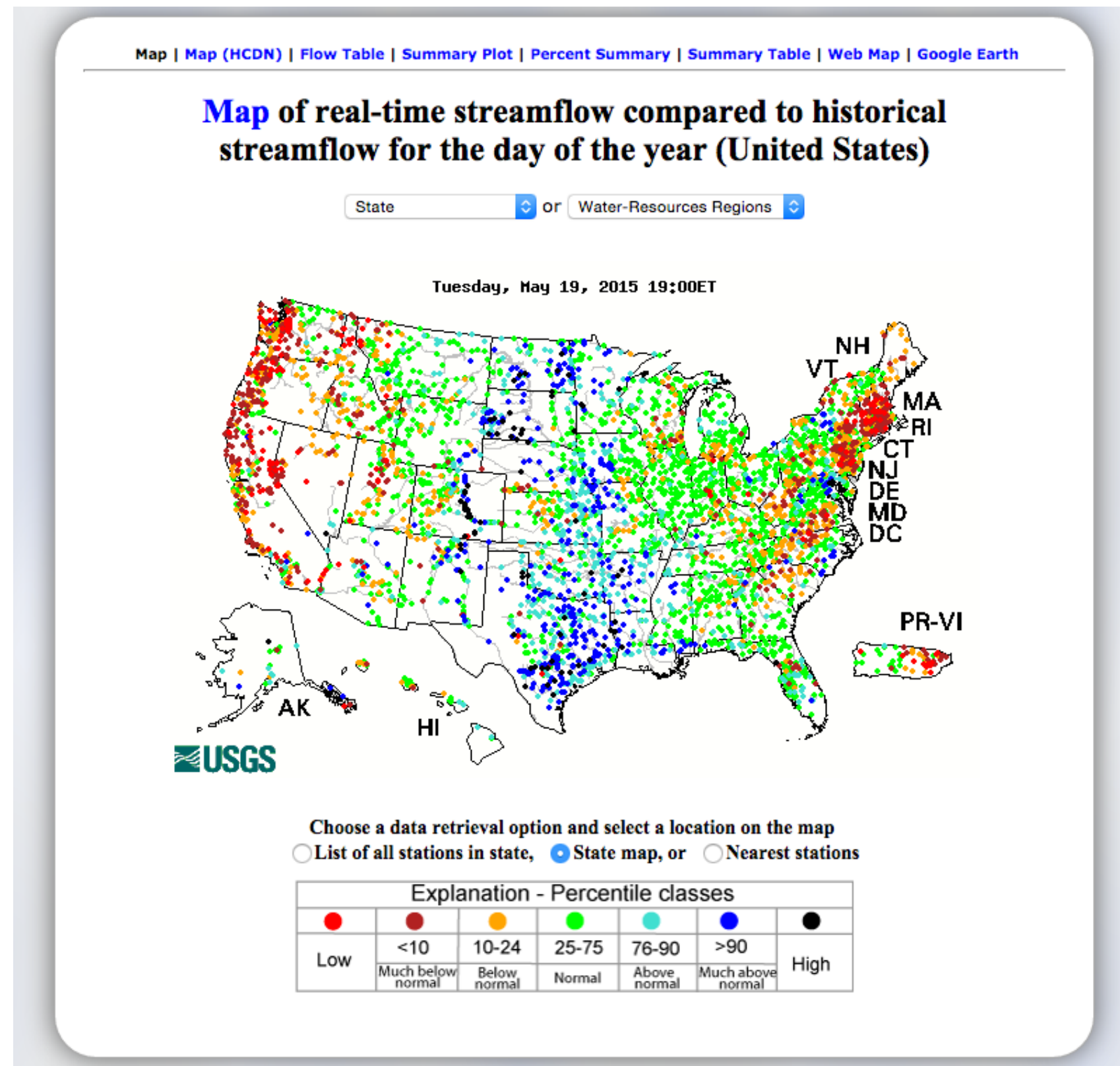
NHDPlusV2 consists of the following components:

- Greatly improved 1:100K National Hydrography Dataset (NHD)
- Greatly improved 30 meter National Elevation Dataset (NED)
- Nationally complete Watershed Boundary Dataset (WBD)
- A set of value added attributes to enhance stream network navigation, analysis and display
- An elevation-based catchment for each flowline in the stream network
- Catchment characteristics
- Headwater node areas
- Cumulative drainage area characteristics
- Flow direction, flow accumulation and elevation grids
- Flowline min/max elevations and slopes
- Flow volume & velocity estimates for each flowline in the stream network
- Catchment attributes and network accumulated attributes
- Various grids from the hydro-enforcement process including the hydro-enforced DEM.

So What?

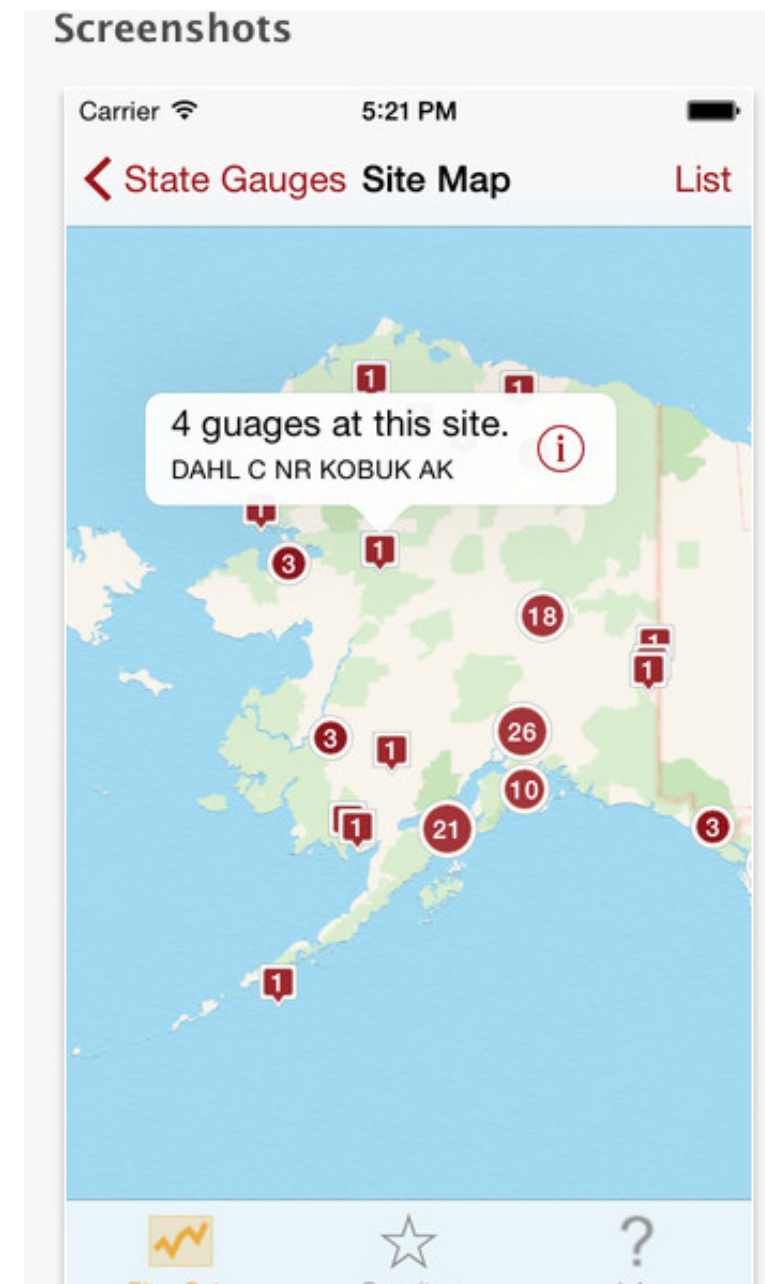
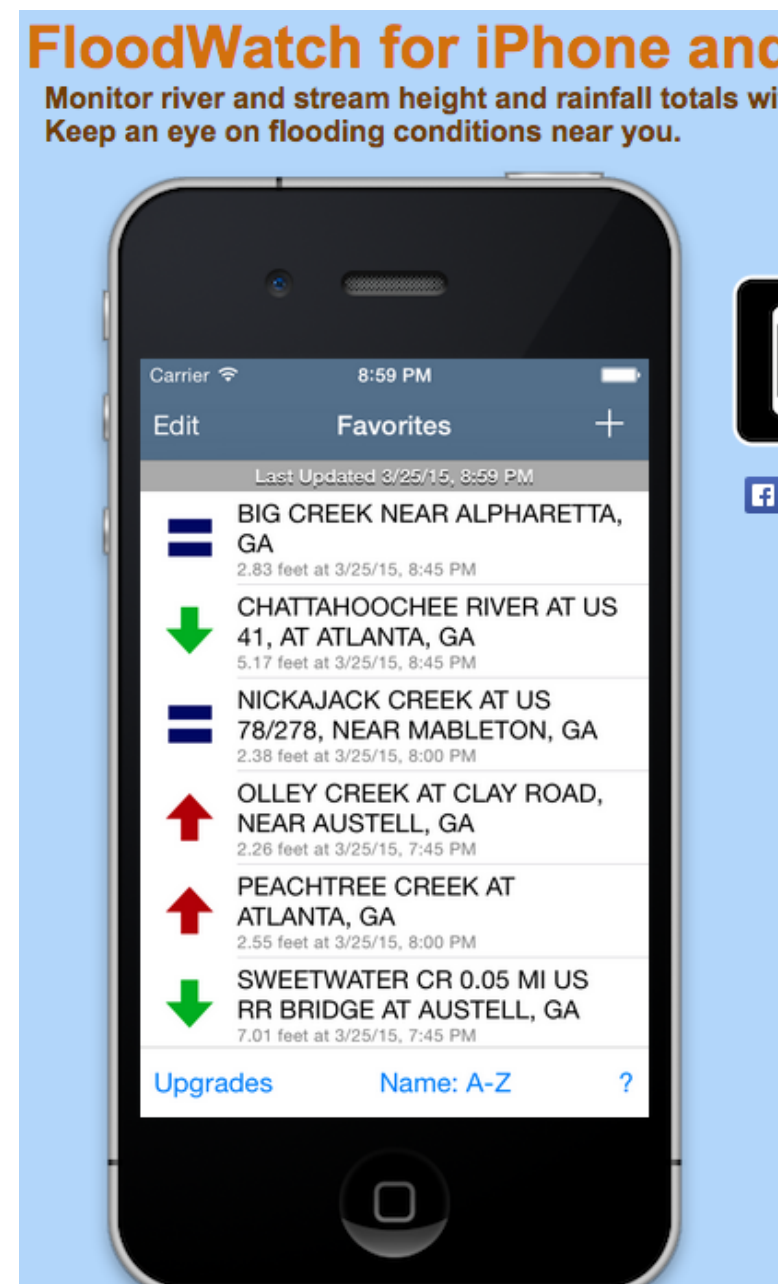
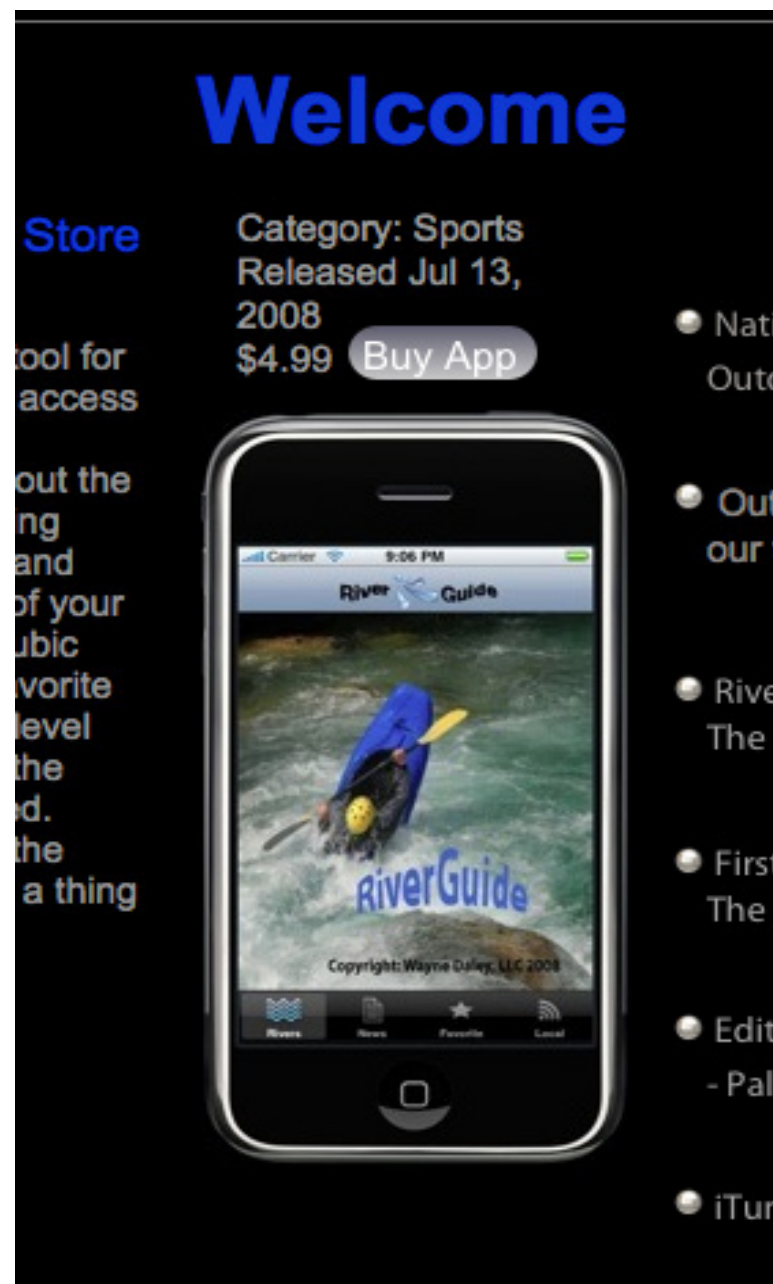
# EXISTING WORK

Existing visualizations leave room for improvement.



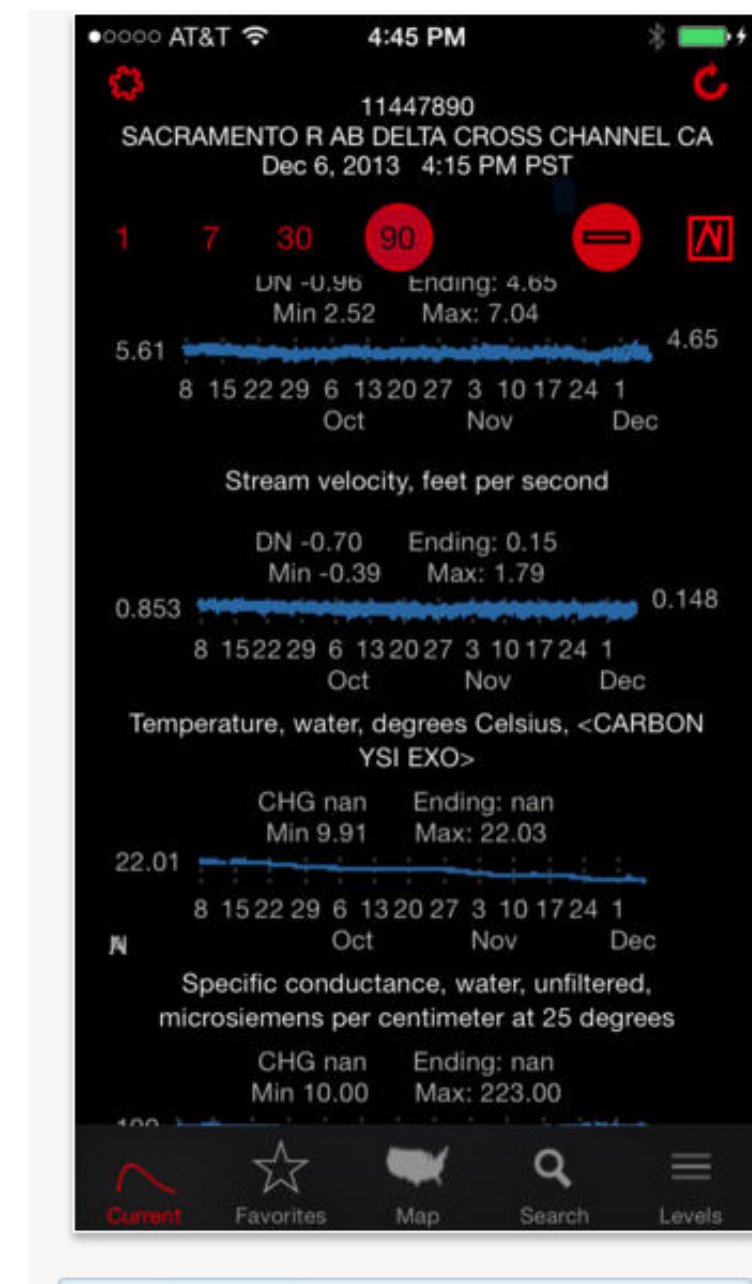
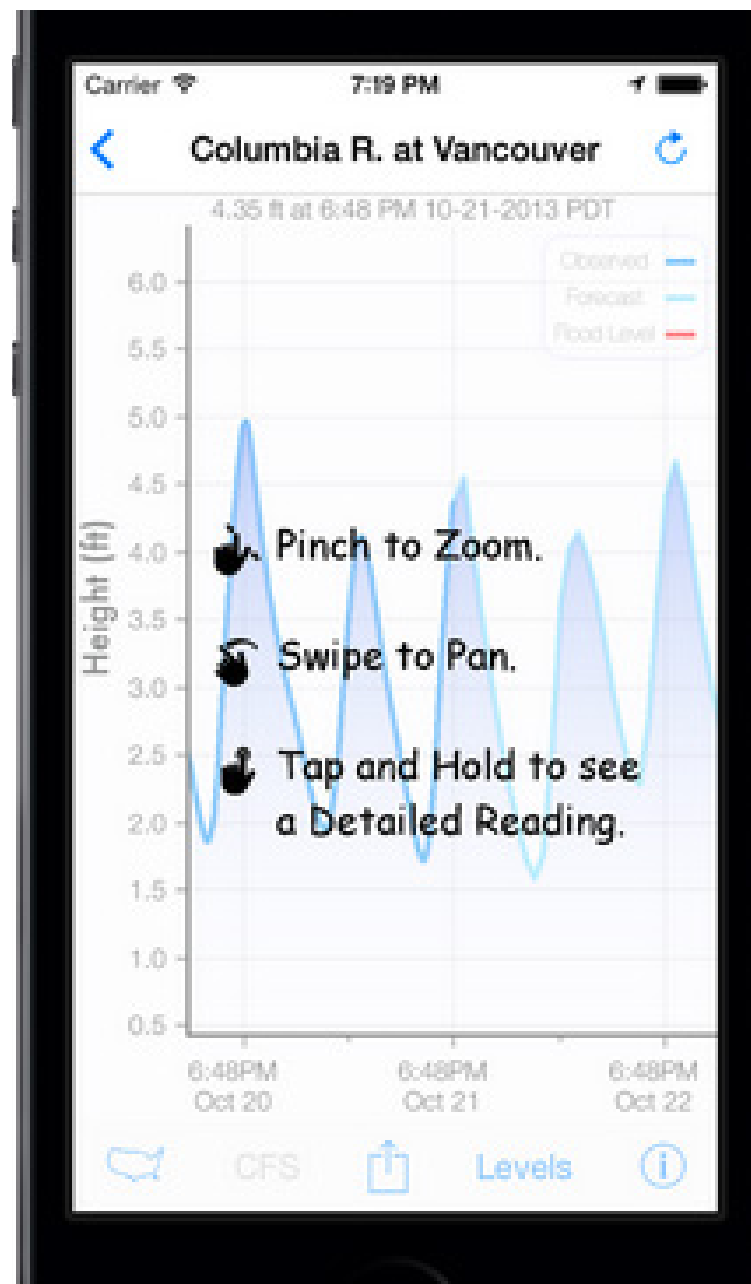
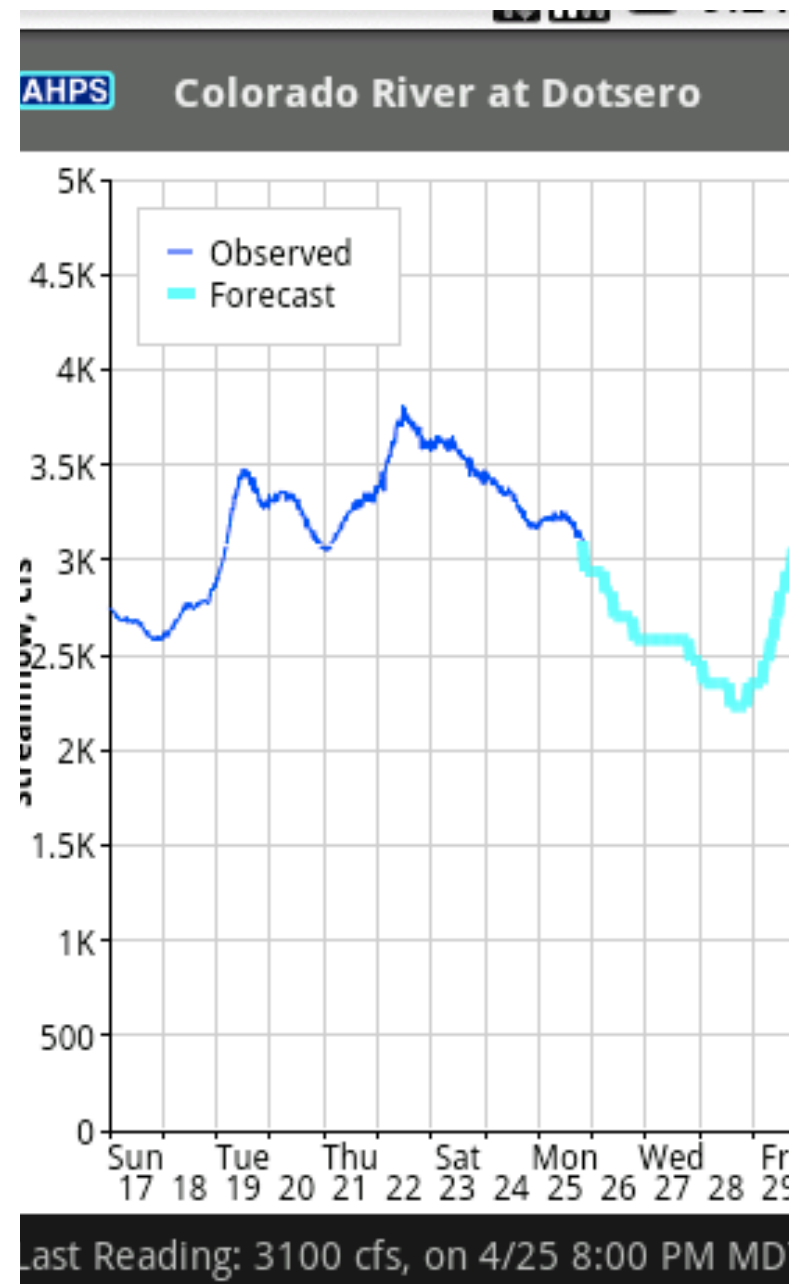
# EXISTING WORK

Commercial applications have a limited focus...



# EXISTING WORK

...and disregard best practices







## EXISTING WORK

Mapping the rivers has been done.

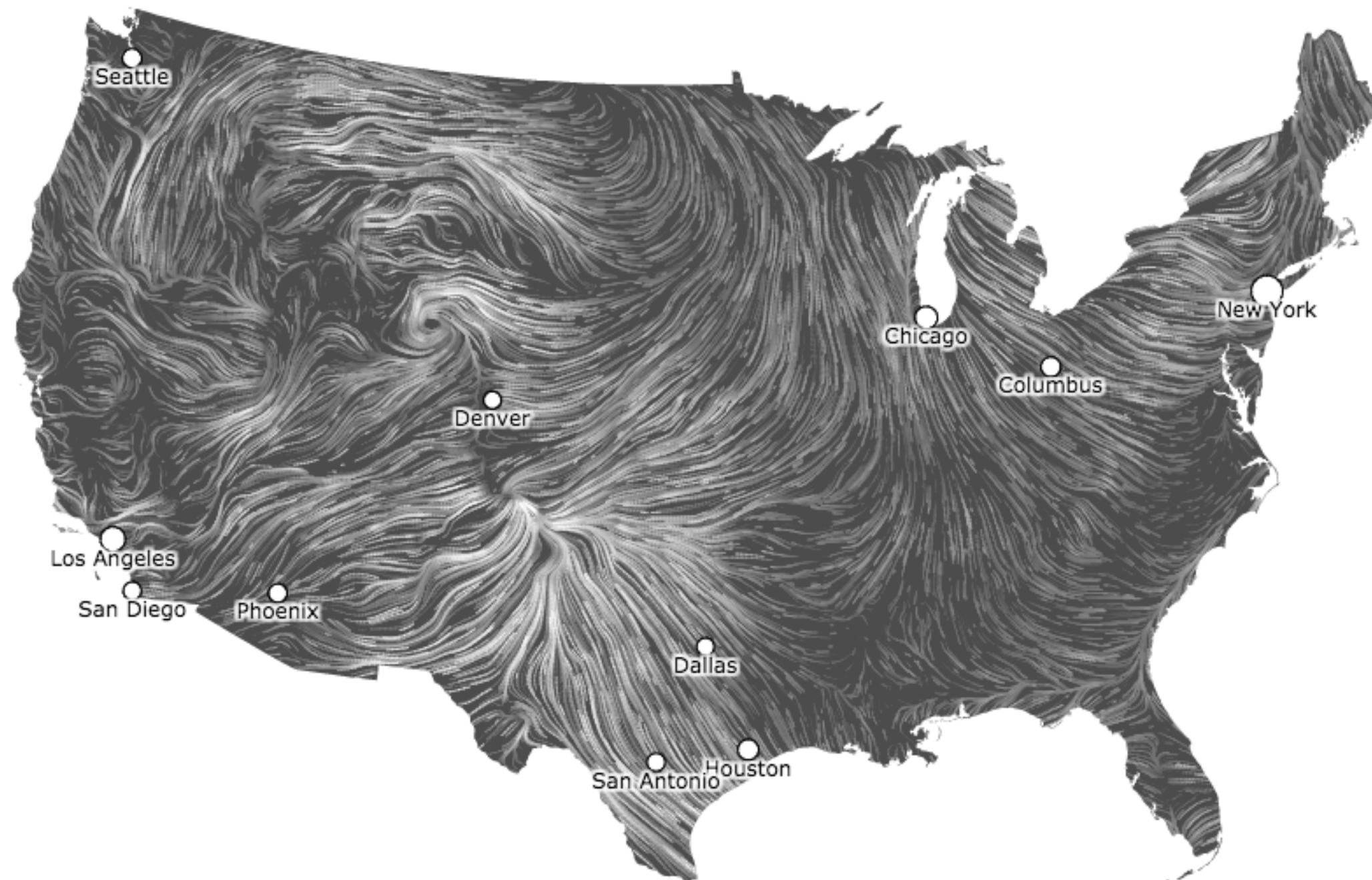


## WITH THIS DATA

Local, regional and national comparisons.

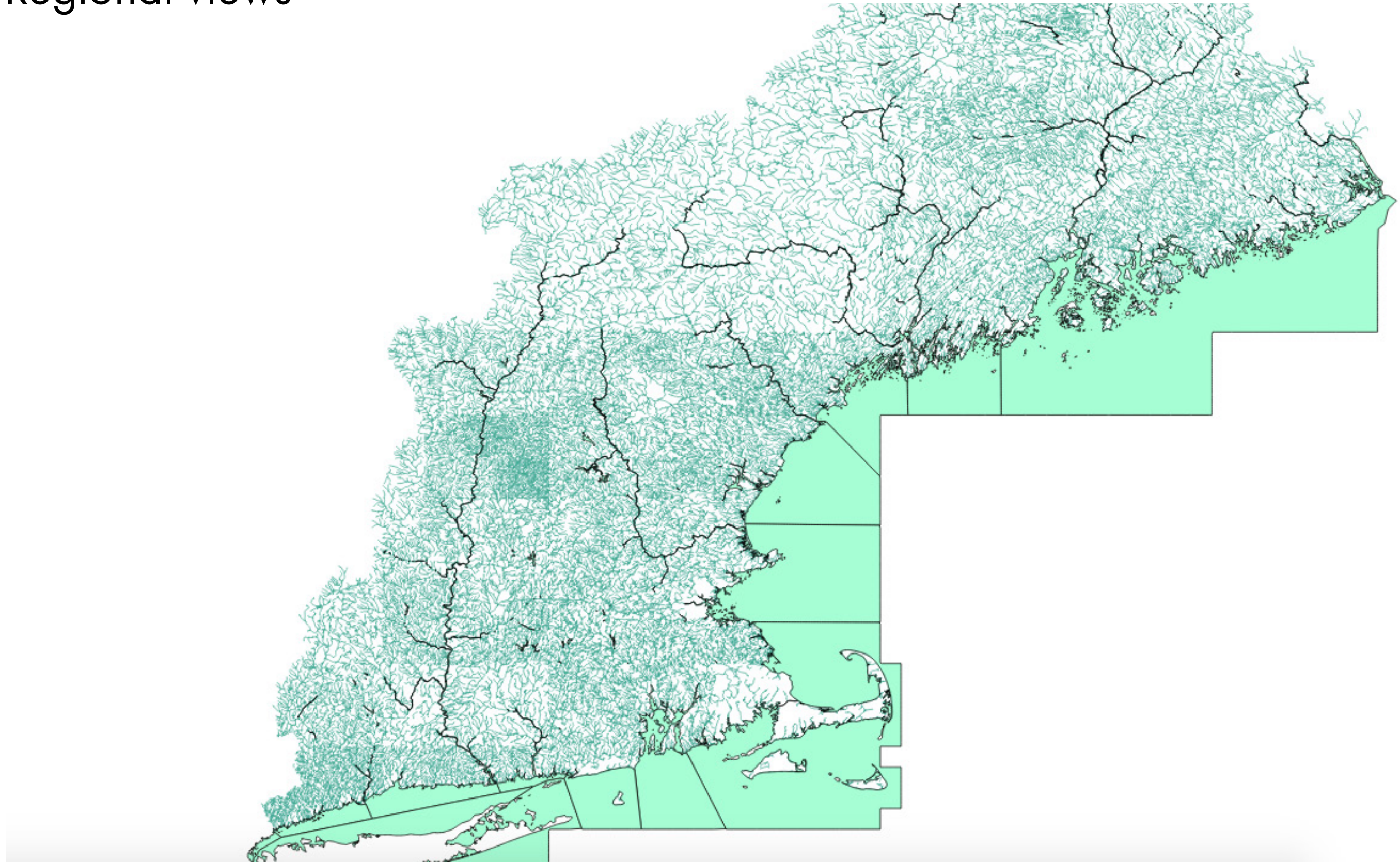
Time series. Historical events.

How can we visualize streamflow nationwide?



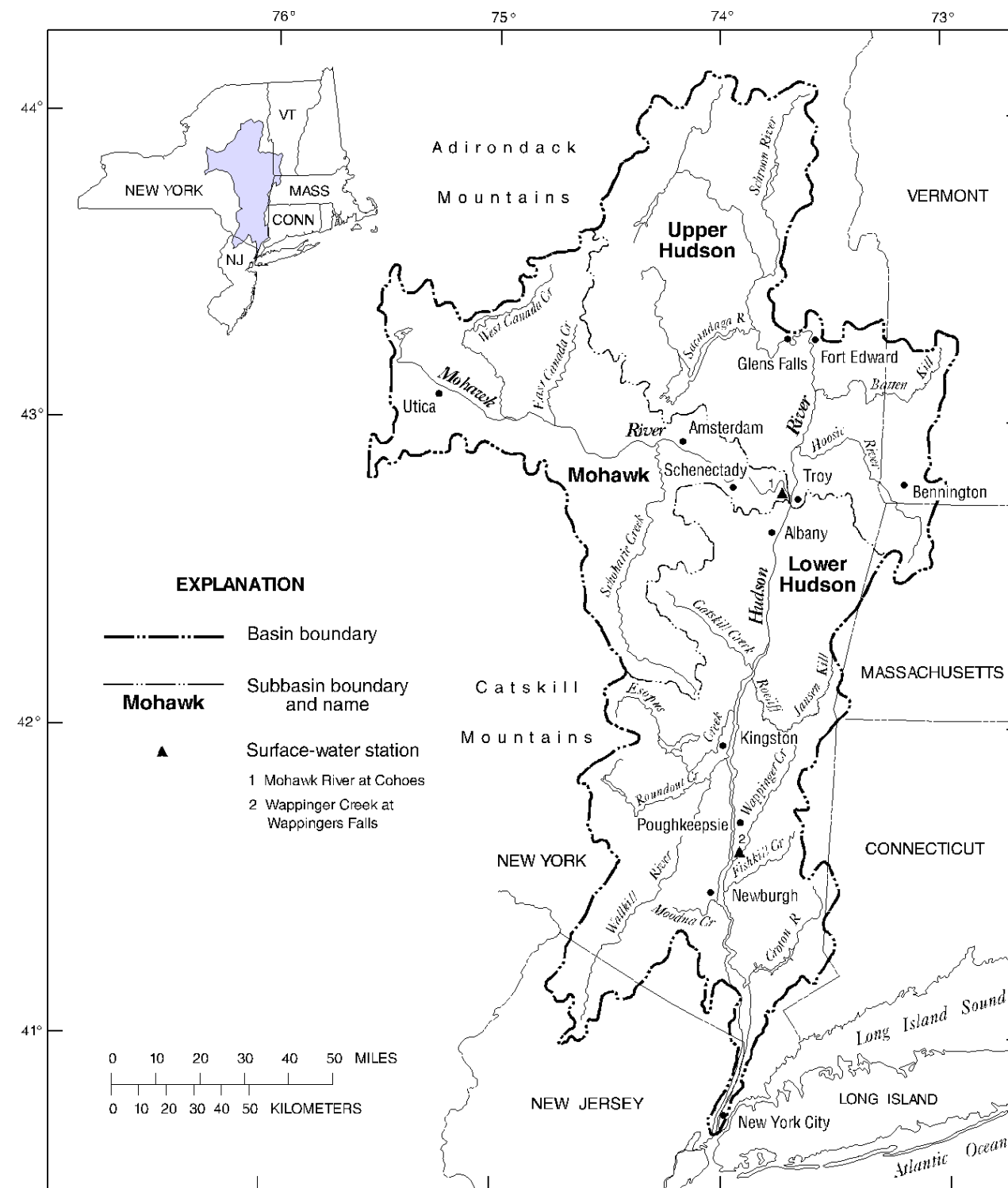
WITH THIS DATA

Regional views



# WITH THIS DATA

## Locally relevant networks

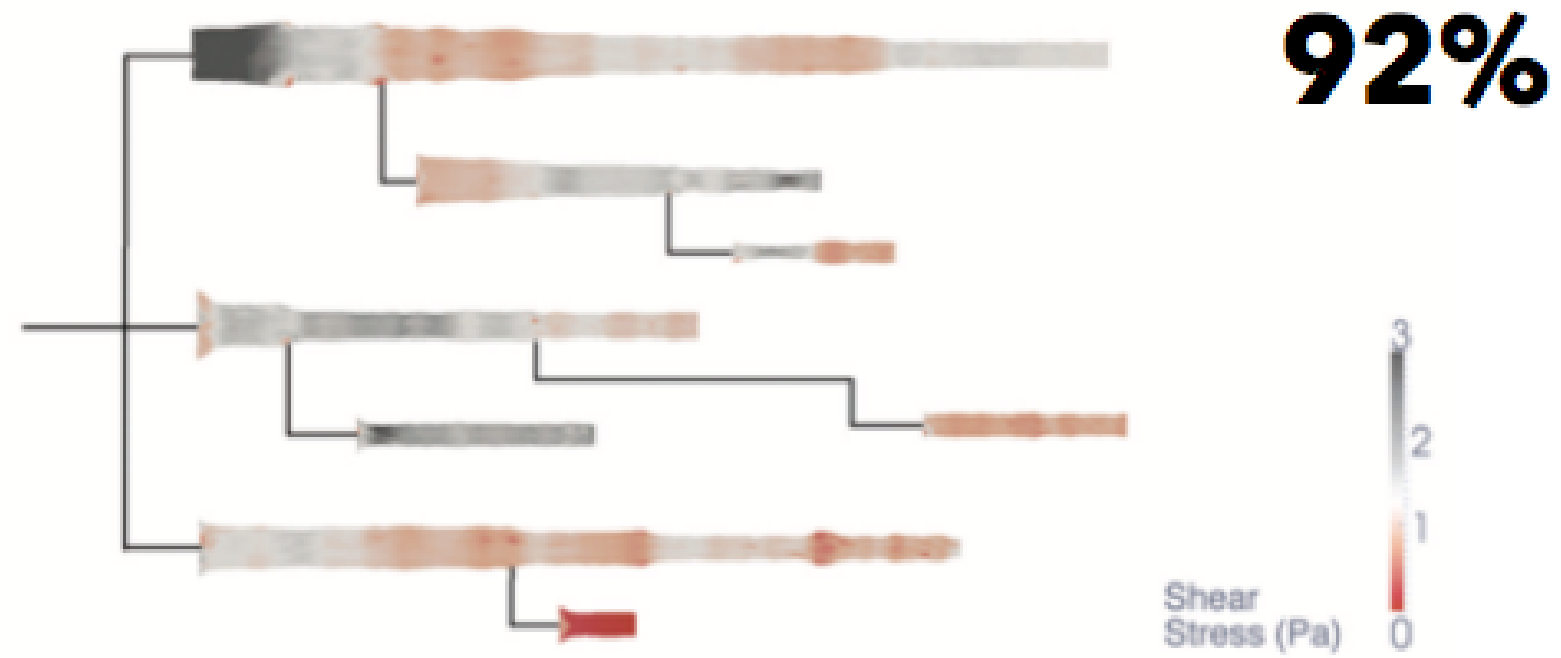


Base from U.S. Geological Survey digital data 1:2,000,000, 1972  
Albers Equal-Area Conic projection  
Standard parallels 29° 30' and 45° 30', central meridian -74°

WITH THIS DATA

Alternative representations

## Diverging Palette



# WITH OTHER DATA

How does streamflow data relate to...

## DROUGHT

**NOAA National Climatic Data Center**  
National Oceanic And Atmospheric Administration

DCC > NOAA > NESDIS > NCDC

Search Field:  Search NCDC

NCDC / Climate Monitoring / Palmer Indices / Search / Help

### Climate of 2013 - April U.S. Palmer Drought Indices

National Climatic Data Center, 15 May 2013

Current Palmer Drought Indices

The Palmer Z Index shows how monthly moisture conditions depart from normal (short-term drought and wetness). The animated maps to the right show the geographical pattern of the moisture anomalies for the last 12 months. On these maps, the red shading denotes dry conditions while the green shading indicates wet conditions.

Palmer Z Index Short-Term Conditions  
April 2013

extreme drought	severe drought	moderate drought	mid-range	moderately moist	very moist	extremely moist
-2.75 and below	-1.50 to -2.74	-1.25 to -1.49	-1.24 to -1.24	+1.00 to +1.24	+1.25 to +2.49	+2.50 and above

larger Z Index animated image

Palmer Drought Index Long-Term (Meteorological) Conditions  
April 2013

The Palmer Drought Index (PDI) maps show long-term (cumulative) meteorological drought and wet conditions. The animated maps to the left show how the geographical pattern of the long-term (meteorological) moisture conditions has changed over the last 12 months. On these maps, the red shading denotes drought conditions while the green shading indicates wet conditions.

extreme drought	severe drought	moderate drought	mid-range	moderately moist	very moist	extremely moist
-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to -1.99	+2.00 to +1.99	+1.99 to +2.99	+3.00 and above

## STORMS

**NOAA NATIONAL CLIMATIC DATA CENTER**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home Contact Us About NCDC Help

NCDC > Storm Events Database

### Storm Events Database

The Storm Events Database contains the records used to create the official NCDC documenting:

- The occurrence of storms and other significant weather phenomena having loss of life, injuries, significant property damage, and/or disruption to communities.
- Rare, unusual, weather phenomena that generate media attention, such as Florida or the San Diego coastal area; and
- Other significant meteorological events, such as record maximum or minimum precipitation that occur in connection with another event.

The database currently contains data from **January 1950 to January 2015**, as reported by the National Weather Service (NWS). Due to changes in the data collection and processing procedures over time, there are unique periods of record available depending on the event type. NCDC has implemented changes to the database to improve consistency and standardization of event types but has not changed any data values for local events. Please refer to the documentation for more information.

Select State or Area:

Narrative Text Search:

Search

The Storm Events Database has changed greatly over time. Please refer to the documentation for detailed version information and release dates. If you have questions, please contact us.

Privacy Policy | FOIA | Information Quality | Disclaimer | Contact Us

USA.gov Ready

# WITH OTHER DATA

How does streamflow data relate to...

## AGRICULTURE

**USDA CENSUS OF AGRICULTURE**  
United States Department of Agriculture

USDA | NAS

About the Census | Newsroom | Publications | Your Census. Your Story.

You are here: Home / Publications / 2012 [Stay](#)

**Census Publications**  
Choose a Census

**Find Current Data By**

- > Congressional District
- > Race, Ethnicity & Gender
- > State & County
- > Topic

**2012 Census Publications**

- Full Report
- Online Resources
- Subject Series
- Special Studies
- Rankings and Profiles

**2012 Census Full Report**

**U.S. Summary and State Data**  
A comprehensive summary of agricultural activity for the United States and for each state. Includes number of farms by size and type, inventory and values for crops and livestock, operator characteristics, and much more.

[U.S. by Table](#) | [States by Table](#)

You can also download the report as a single text or pdf file.

[TXT](#) | [PDF](#)

To learn how we conducted the Census or to view the Census form, use these links.

[Appendix A - Census of Agriculture Methodology](#)  
[Appendix B - General Explanation and Report Form](#)

**State and County Data**  
A comprehensive summary of agricultural activity for each state, county, or county equivalent.

[State-level Data](#) | [County-level Data](#)

**Puerto Rico** - [PDF](#) | [by Table](#) | [Municipios](#)

**Specialty Crops** - [TXT](#) | [PDF](#)  
National and state data on number of farms, land in farms, irrigation acreage, value of sales, and operator characteristics for specialty crops.

**Data and Supplemental Information**

- [Data Underlying Figures \(xls\)](#)
- [Supplemental Tables \(xls\)](#)

## INFRASTRUCTURE

**40 Congressional Budget Office**  
Since 1975 Nonpartisan Analysis for the U.S. Congress

ABOUT CBO | TOPICS | COST ESTIMATES | FAQs

**Public Spending on Transportation and Water Infrastructure, 1956 to 2014**

March 2, 2015 | Report

This report provides information on spending by federal, state, and local governments for transportation and water infrastructure, which totaled \$416 billion in 2014.

[View Document](#)  
PDF 409.65 KB

[Get Data](#)

**Summary**

Public spending—spending by federal, state, and local governments for transportation and water infrastructure totaled \$416 billion in 2014. Most of that spending was for transportation and water infrastructure: They provided \$320 billion, and the federal government provided \$196 billion.

This report provides information on spending for six types of infrastructure:

- Highways,
- Mass transit and rail,
- Aviation,
- Water transportation,
- Water resources, and
- Water utilities.

[...read more](#)

**Data and Supplemental Information**

- [Data Underlying Figures \(xls\)](#)
- [Supplemental Tables \(xls\)](#)

# CHALLENGES

Define scope.

Filter data.

Vector tiling.

Interactivity.

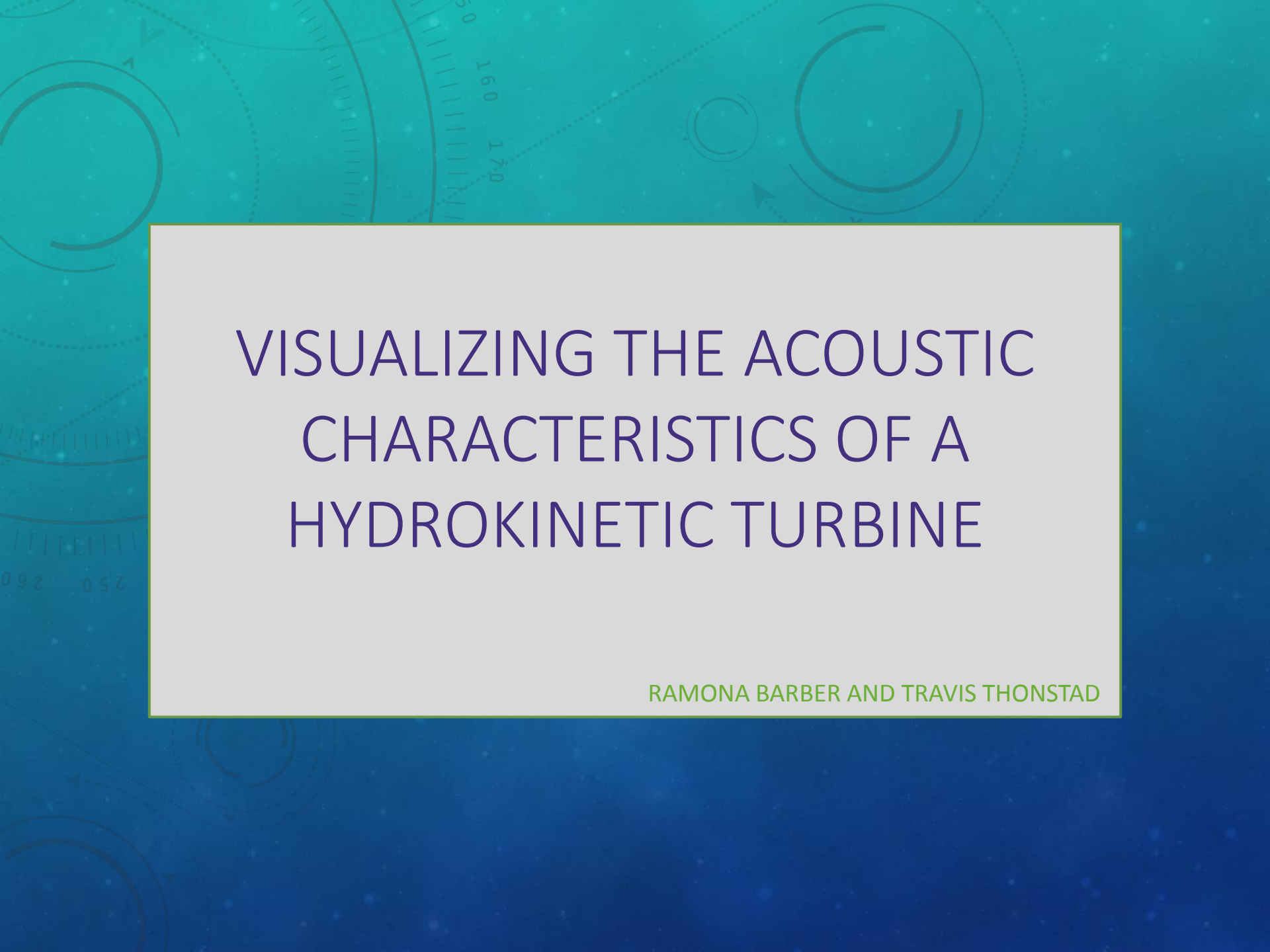


## FEEDBACK

What interests **you** about these numbers?

How granular should I go?

Raise your hand if you can teach me to back end.

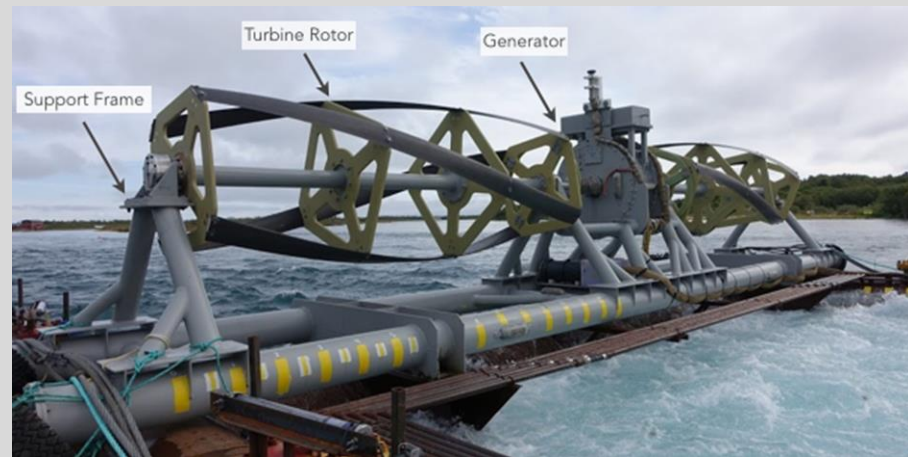
The background features a teal-to-blue gradient with faint technical drawings, including circular gauges with scales and arrows, suggesting a scientific or engineering context.

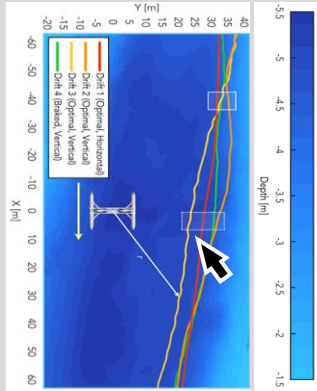
# VISUALIZING THE ACOUSTIC CHARACTERISTICS OF A HYDROKINETIC TURBINE

RAMONA BARBER AND TRAVIS THONSTAD

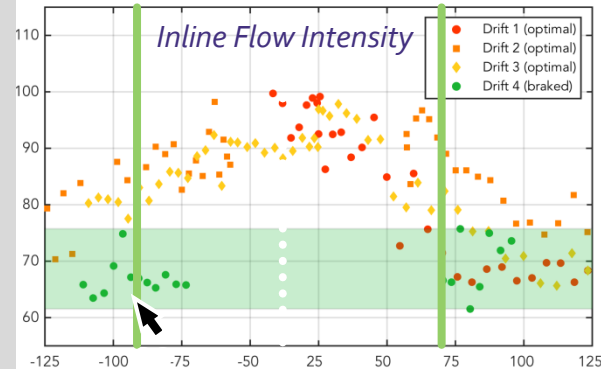
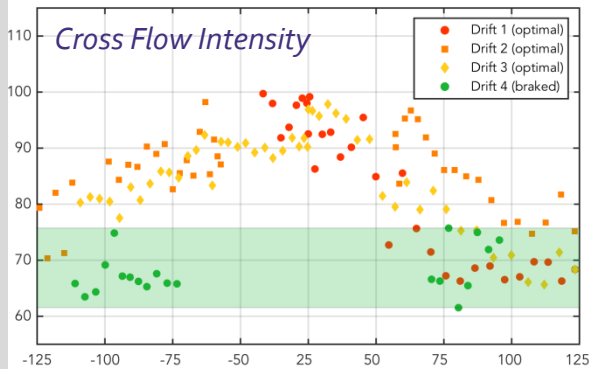
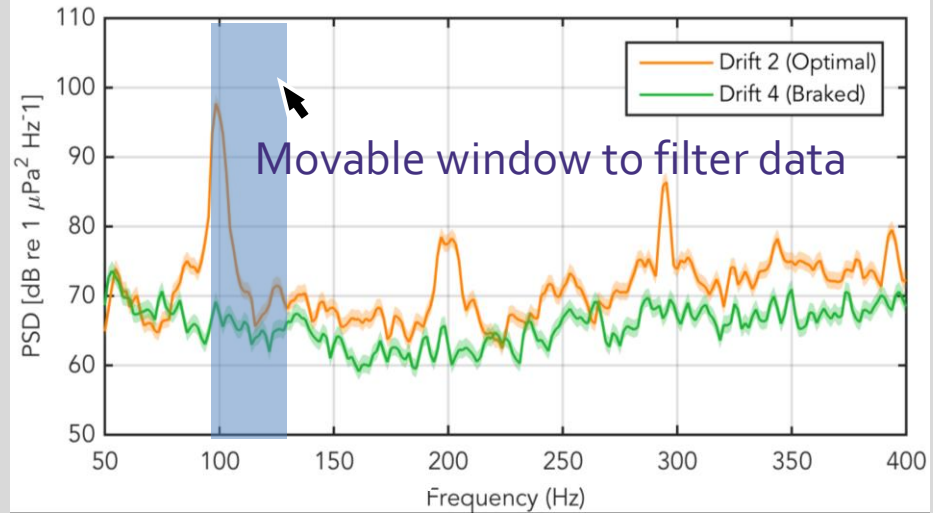
## ENERGY FROM CURRENTS

Hydrokinetic turbines operate similarly to wind turbines, by extracting kinetic energy from a moving fluid and converting it to electricity. Due to the sensitive nature of marine and other underwater environments, it is essential to understand the potential impacts of hydrokinetic turbines before they are commercially deployed. One step in this process is to study the acoustic signature of a turbine under various operating conditions.





Mouse-over runs to highlight data in other windows



Movable lines show attenuation up and downstream of turbine for comparison and updates cross-flow map

## QUESTIONS

- Would a heatmap of acoustic pressures be redundant with the linear plots, or useful as another way to visualize the area?
- We have information about how fast the turbine was spinning, which changes along each run independently as the drifts did not happen at the same time. Could that data be encoded in a useful way?
- Should there be an option to select specific runs for visualization, or is the proposed linking/highlighting strategy enough?
- Is the interaction intuitive or does there need to be explanation?
- Is there something you can imagine that you would want to do that is currently not supported?



# Better Tools for Fault Diagnosis

Nat Guy & Nick Reiter  
CSE 512



# Description

- Vehicle telemetry systems have lots of data
- There's automatic fault detection, but root cause diagnosis typically requires a domain expert
- Current tools == lots of mini-plots, thousands of mostly unsorted data channels

We want to create a fault diagnosis system where:

- Users are assisted in finding root causes and patterns
- Users don't need extensive expert knowledge to begin to look for root causes

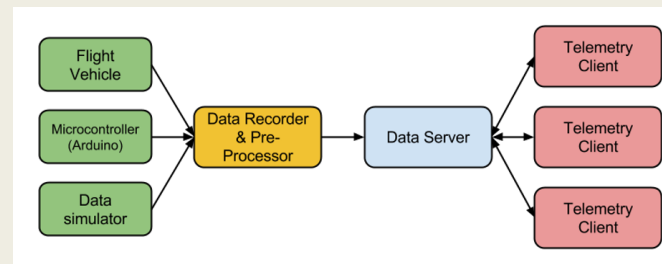
# Prior Work

- “An Interactive Visualization System for Analyzing Spacecraft Telemetry” (APL)
- “Visually mining and monitoring massive time series” (Lin et al)
- Much work is proprietary/undocumented
  - NASA (some projects documented)
  - SpaceX, United Launch Alliance
- Our work seeks to find cleaner, more intuitive ways to show data and their relationships, with a more dynamically configurable (rather than static) interface



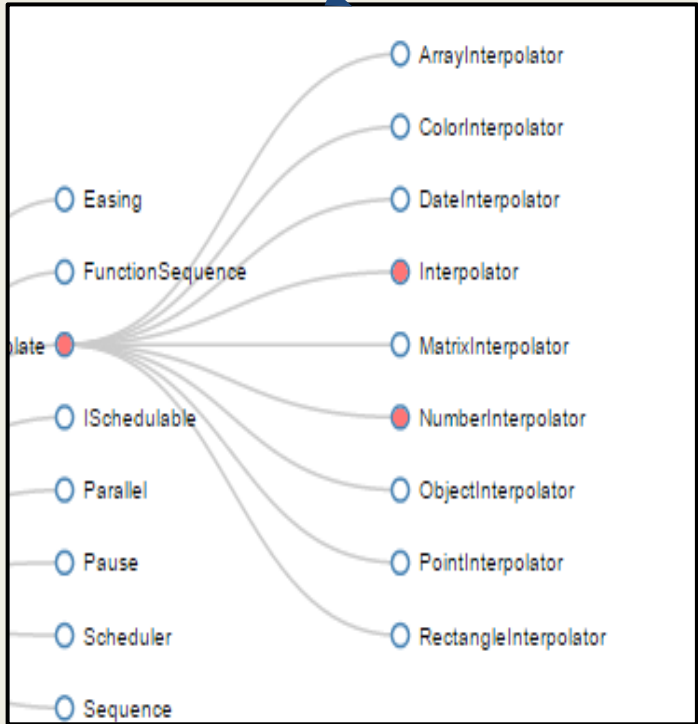
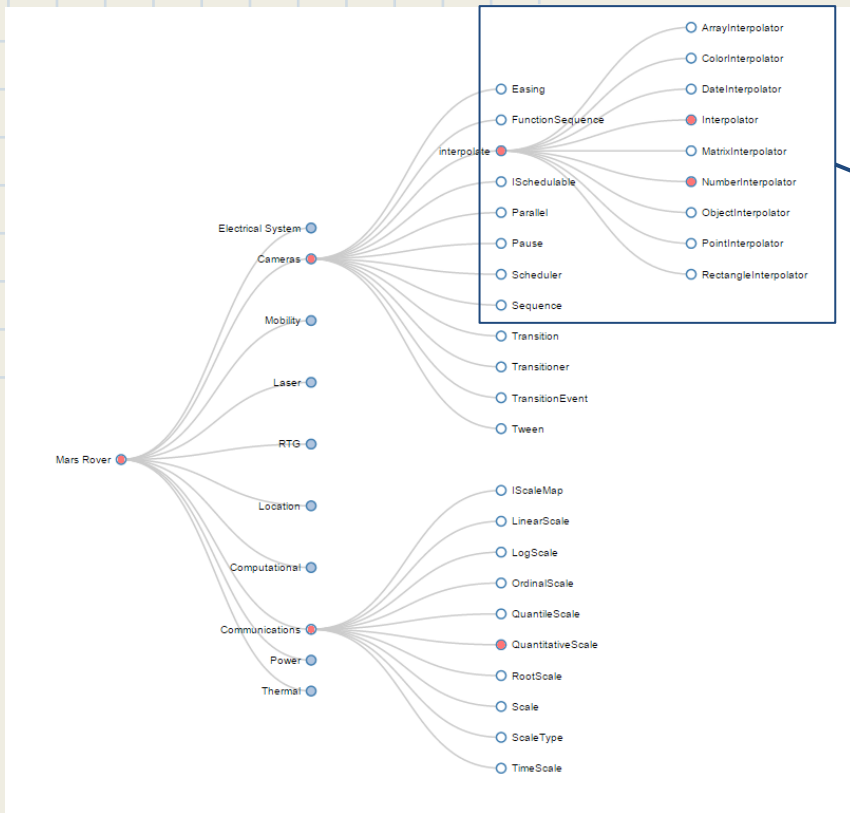
# Current Progress

- Generating simulated data
- Loading data channel metadata and fault detection rules from metafiles
- Client-server data communication (client: telemetry client)

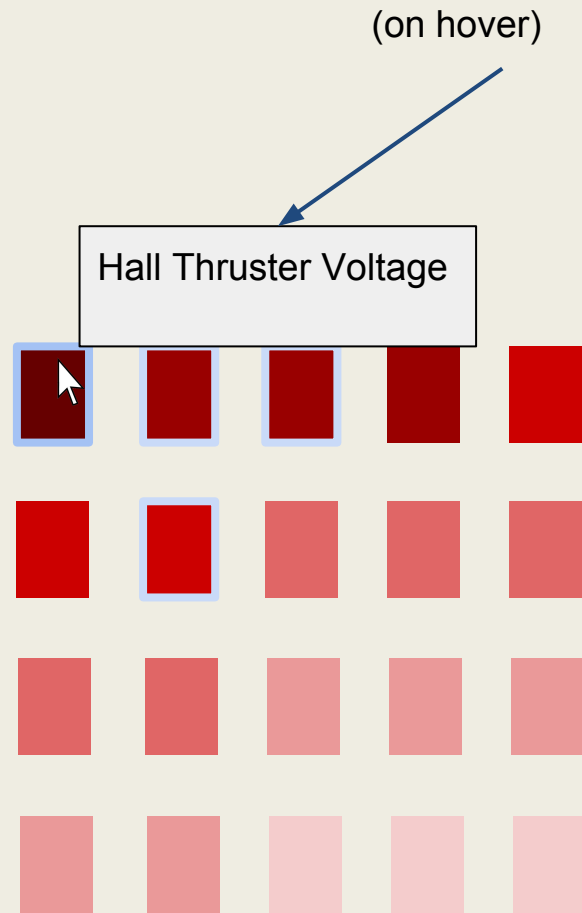
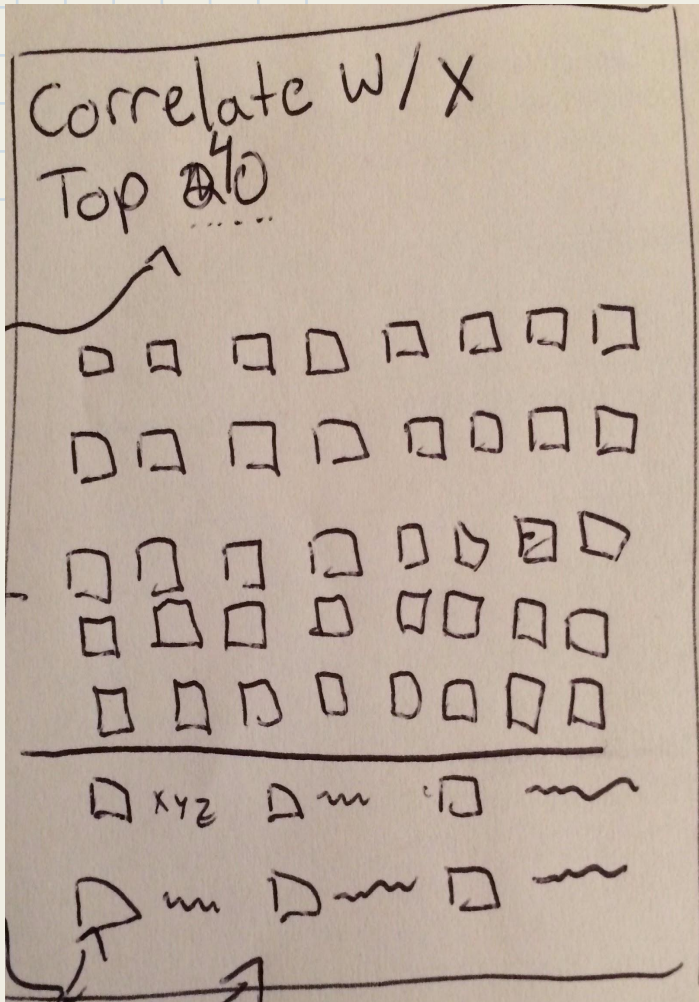


# System Features

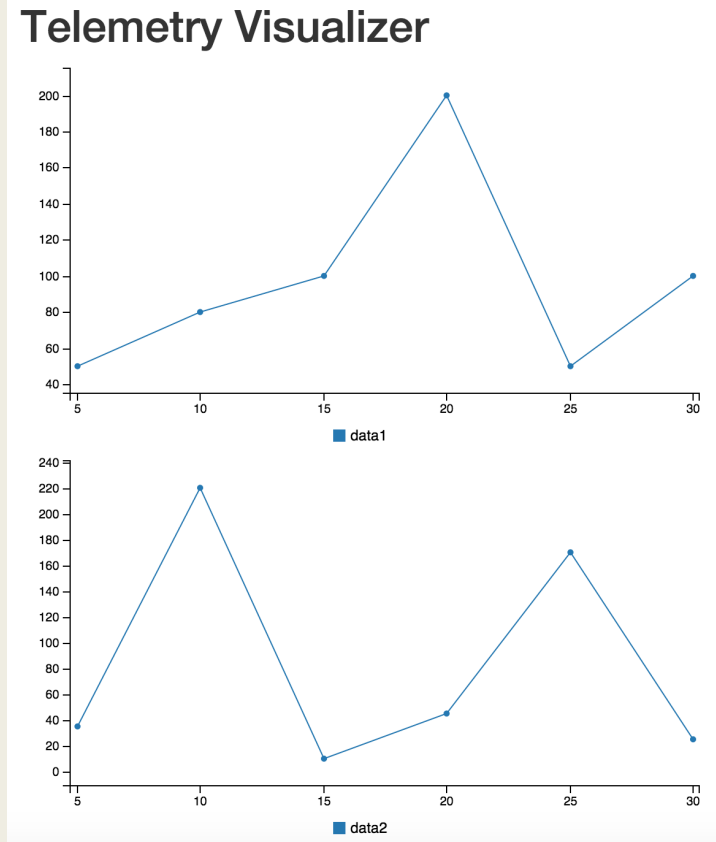
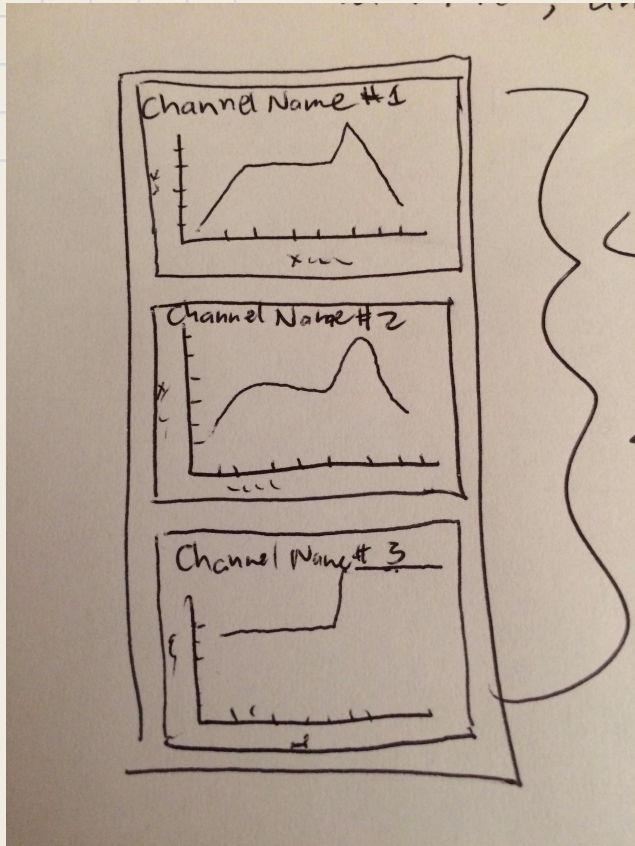
- Degree of interest tree showing relevant channels
  - Hierarchy of channel relationships
- Automatic fault detection based on basic rules
- When a fault occurs, determines correlated channels
- Detailed charts provide channel visualization
- Simple interface to find faulted channels easily
- Users can mark data of interest and easily compare channels



Degree of interest channel hierarchy containing status information



When a fault occurs, shows top  $n$  correlated channels for a selected channel



An example of stacked detail charts for various telemetry channels

# Questions

- Best viz for showing correlation between datasets? (Corr. matrix? Graph structure?)
- How to get discoverability of certain data within a dataset of thousands of channels?
- Is there a solution for channel navigation that would allow DoI trees without requiring manual division into a hierarchy with small numbers of children per parent?

# Student Data for Teacher Intervention

Yvonne Chen & Nell O'Rourke

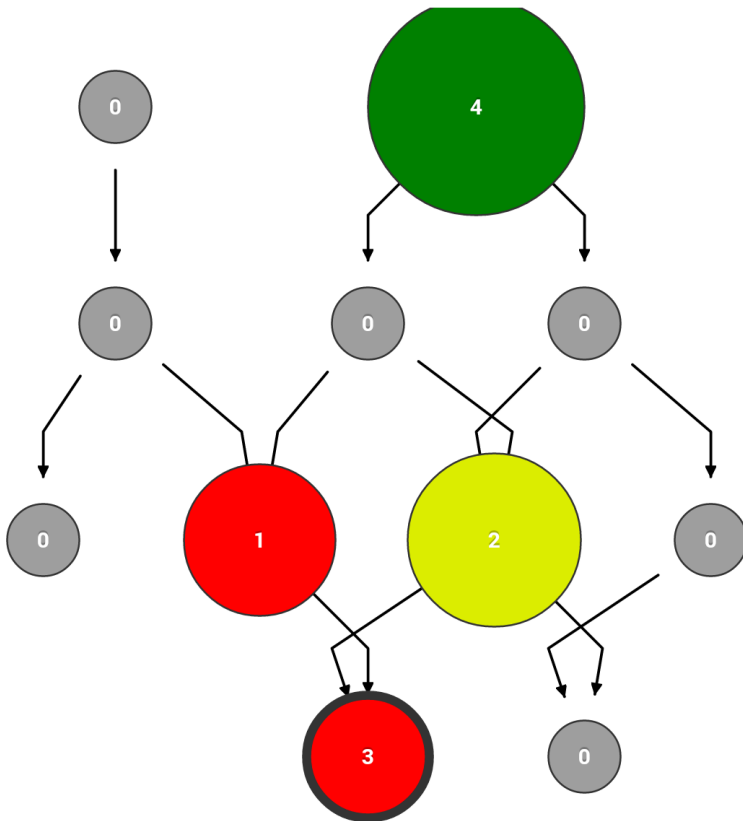
# Motivation

- Prior work
  - Student data is very useful for teachers
- Enlearn
  - Tablet based math software for students and teacher in classroom
- Current visualizations
  - Learning Map aggregates student progress
  - Teacher dashboard
- Problem
  - Inappropriate real time visualizations
  - Not actionable



# Current Real Time Visualization

## Real Time (Software)



- Dislikes
  - Clumsy interface
  - Aggregate data not useful
  - Learning Map not useful, prefer old dashboard
  
- Wishlist
  - Quick, actionable suggestions

## Assessment and Practice

	1	2	3	4	5	6	Ext
██████████	8	8	2	2	8	4	
██████████	6						
██████████	10	6					
██████████	2						
██████████	1						
██████████	7						
██████████	5						
██████████	1						
██████████	8	1					
██████████	1						

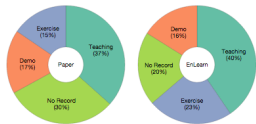
# Current Web Based Visualization

## Post Analysis (Web-based)

EnLearn Platform - Tablet Teacher Activities

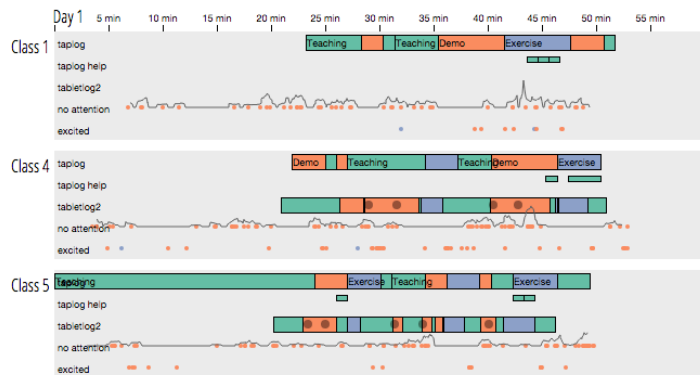


Taplog Teacher Activities



## Timeline

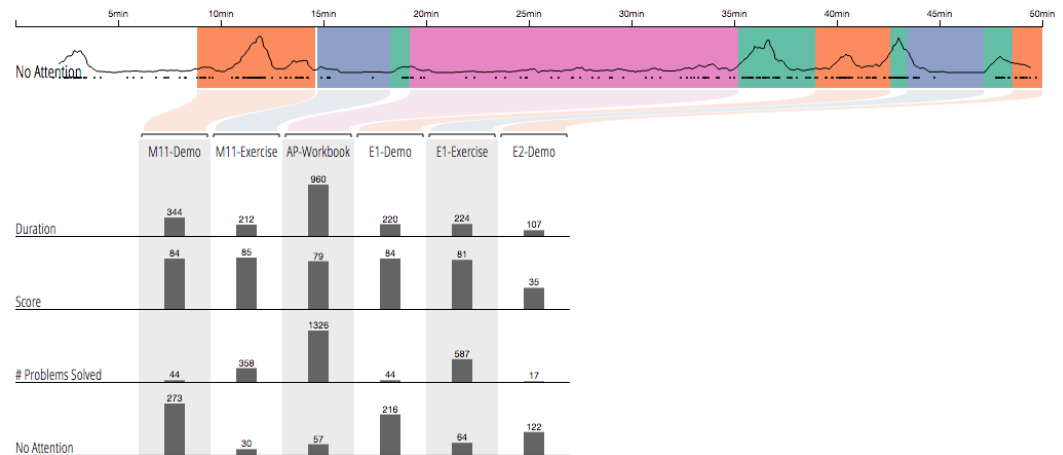
HIMS 6-1, 6-4, 6-5, 2014/03/31-2014/04/04. Kelly Barker.  
HIMS 6-1 is the paper version, the others use the tablet version.



## Problems

- Never designed for teacher use; hence, cluttered
- Teachers are not data scientists
- Also need actionable suggestions

## TimeTable



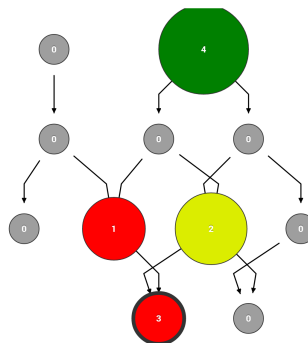
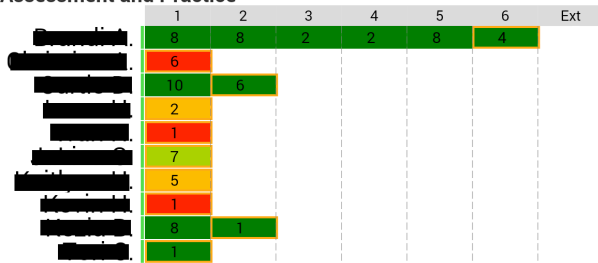
# Progress

- Met Enlearn staff, learned about teacher frustrations and needs
- Deeply explored data using A3 visualization
- Next steps
  - Design
  - Prototype
  - Iterate
  - Polish

# Comments?

- Suggestions for visualizations that combine aggregate and individual data?
- What are some techniques to create at-a-glance visuals?
- Any issues specific to creating tablet based visualizations?
- Specific improvements based on below visualizations:

Assessment and Practice



TimeTable

