

# Towards Perception-aware Interactive Data Visualization Systems

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(faster)  
+ VIZ

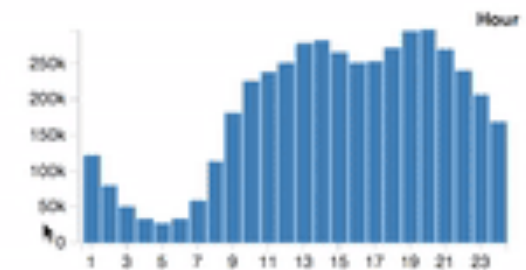
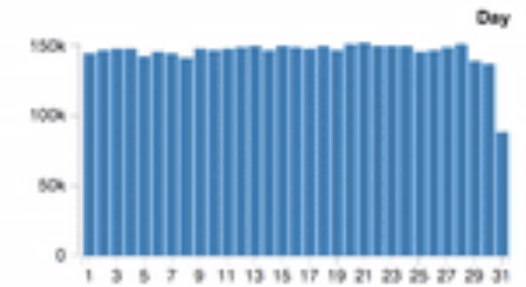
# Interaction







# Interaction



# Interactive Visualization

# Output Awareness

Don't show more data  
than # pixels in output

M4 (database community)

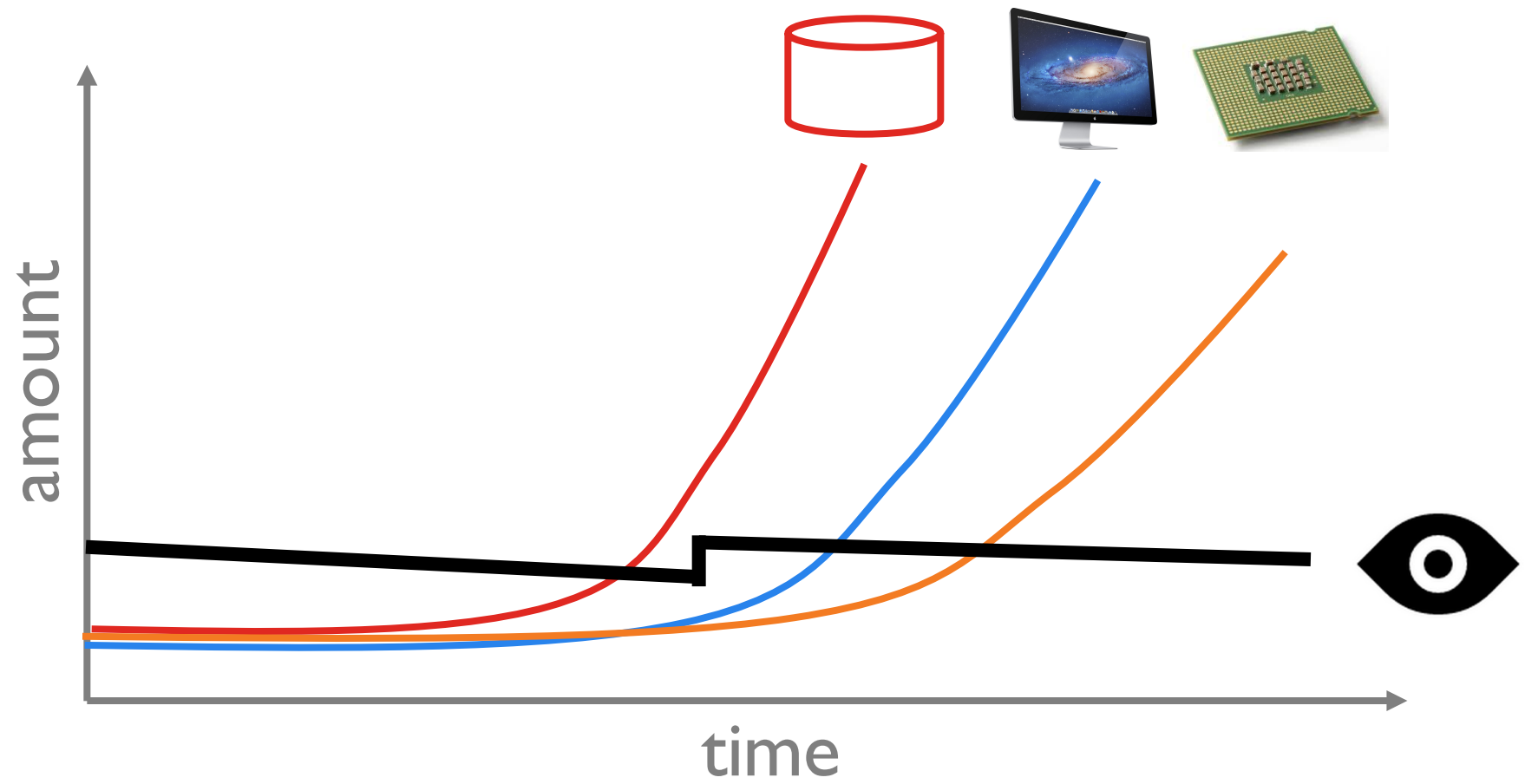
Immens (viz community)

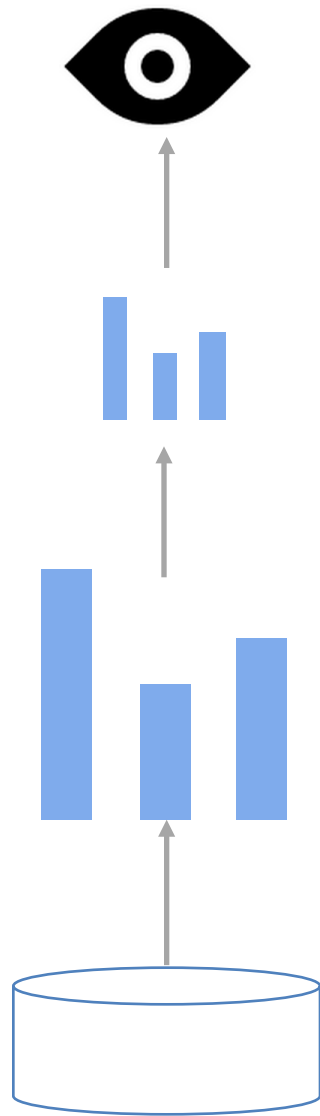
# Approximation

Read less data & render  
approximate results

Error bars, uncertainty

Sampling/Online Agg





Perceptual Awareness

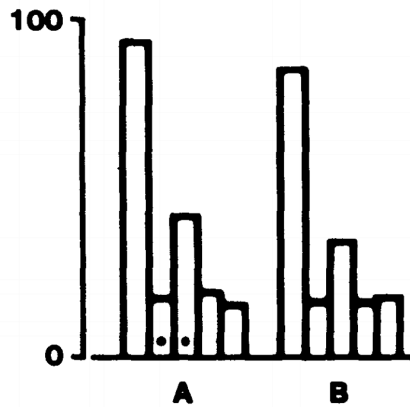
Resolution Awareness

Create Vis

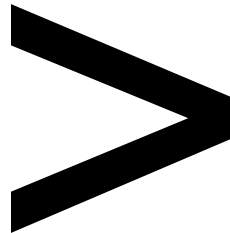
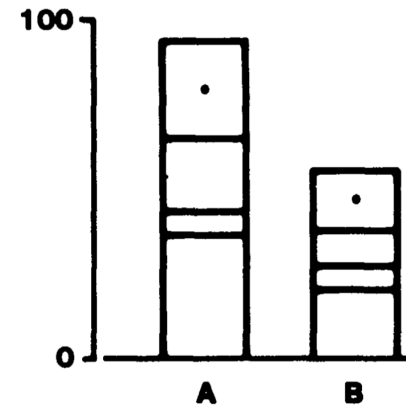


# Graphical Perception Cleveland et al.

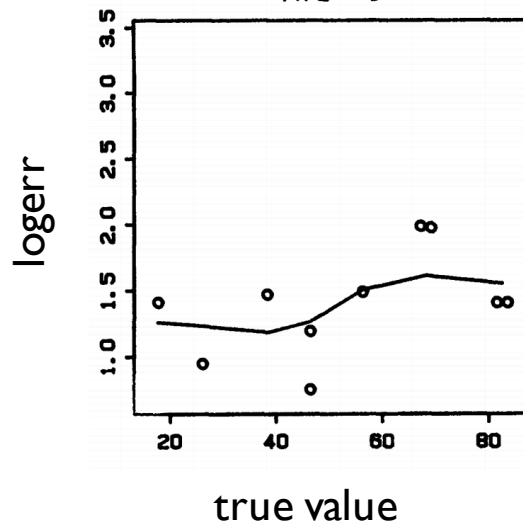
TYPE 1



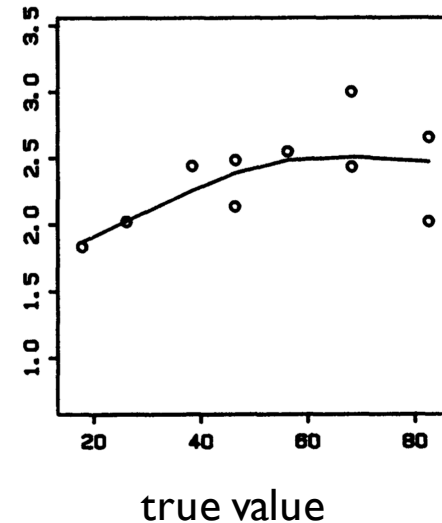
TYPE 4



TYPE = 1



TYPE = 4



# Just Noticeable Difference

how much change before you notice?

$$\text{JND} \sim k * \text{Magnitude}$$

Weber's Law

Steven's Law

# Perceptual Functions as Abstractions

Univariate (Cleveland)

$$p_{\text{enc}}(\text{true value}) = \text{err of perceived value}$$

Bivariate (JND)

$$p_{\text{enc}}(\text{true val}_1, \text{true val}_2) = \text{err of perceived difference}$$

# Exploration Specifications

```
SELECT gb0, ..., gbm, agg0(v0), ...  
  FROM (  
    SELECT gb'0, ..., gb'p, agg'0(v'0), ...  
    FROM T1 (JOIN T2 ON ax)?  
    WHERE gb'0 = ? and ... a'0 = ? ...  
    GROUP BY gb'0, ..., gb'p  
  ) as exploration-data  
WHERE gb0 = ? and ... a0 = ?, ... and an = ?  
GROUP BY gb0, ..., gm  
RENDERED BY <chart>, E1, ...,  
PERCEIVED BY P1, ...
```

# HCI Community Perceptual Studies

## Perceptual Functions

# Database Community Optimizations

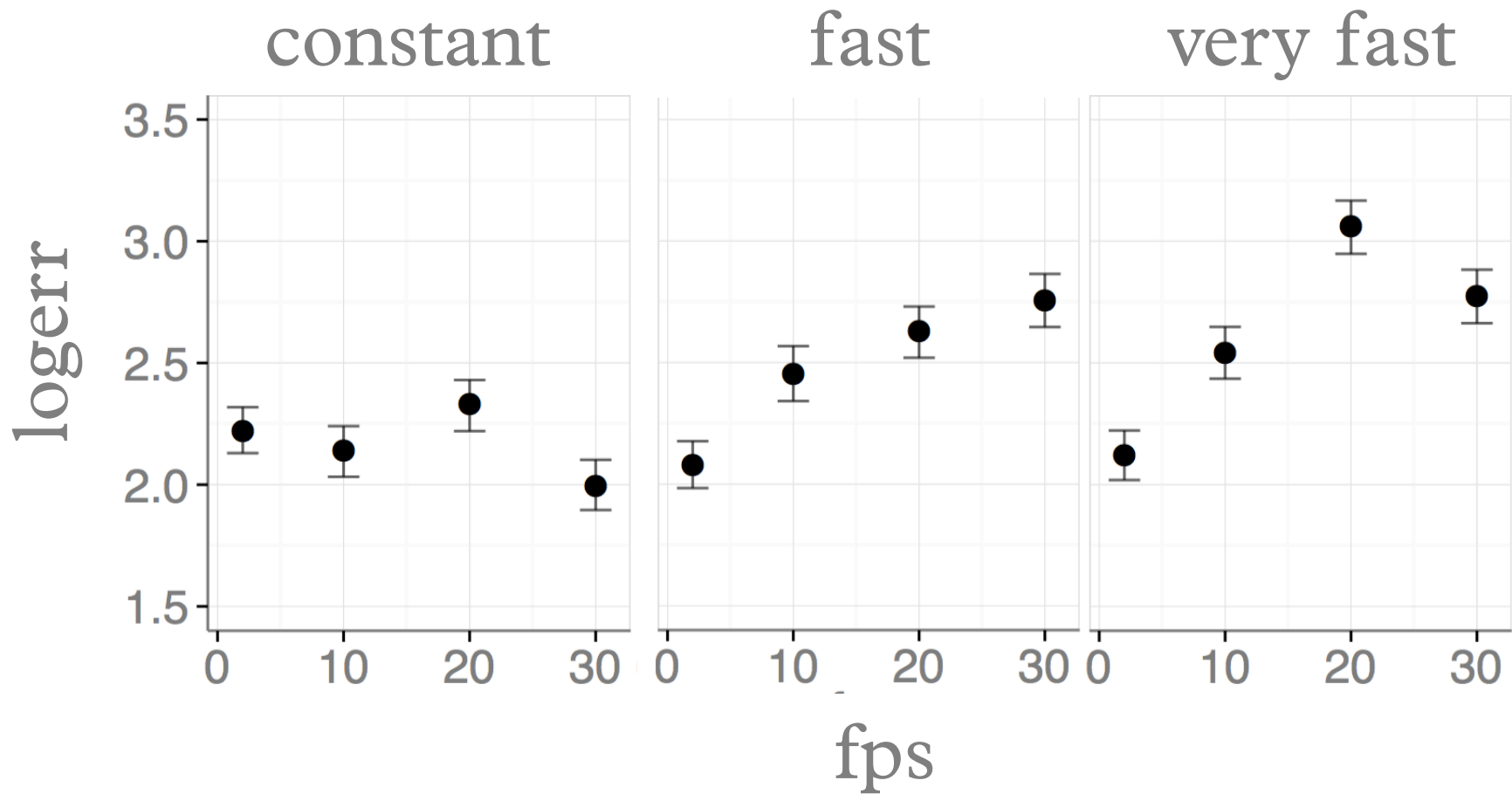


# Animated Graphical Perception

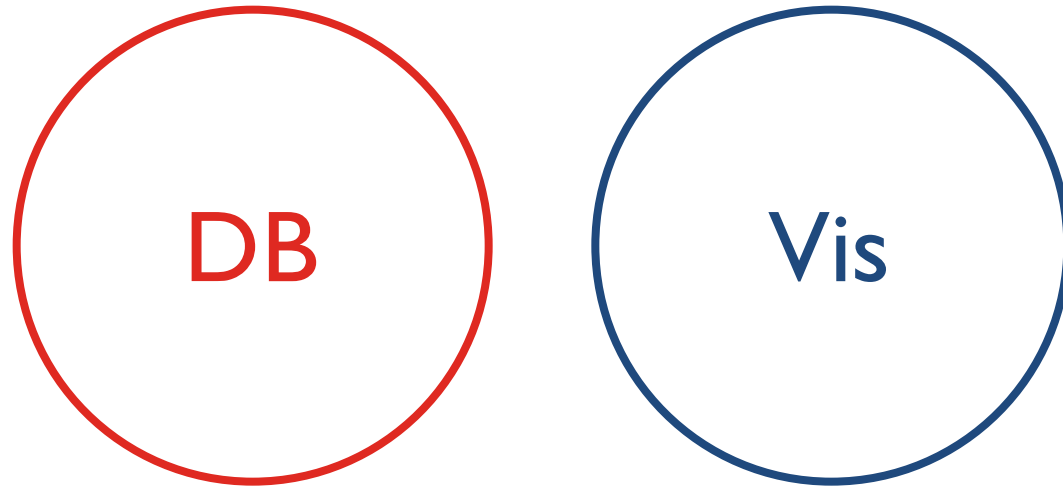


# Logerr vs fps

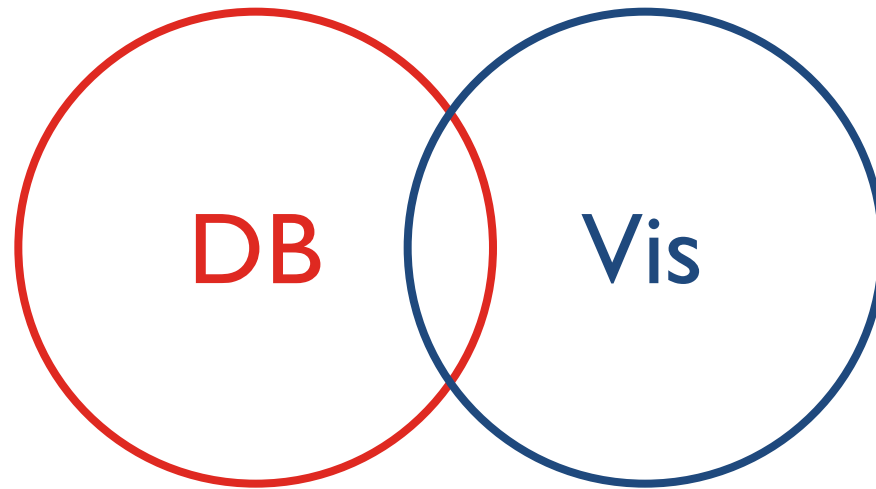
faceted on rate of change



# The Wu Lab at Columbia



# The Wu Lab at Columbia



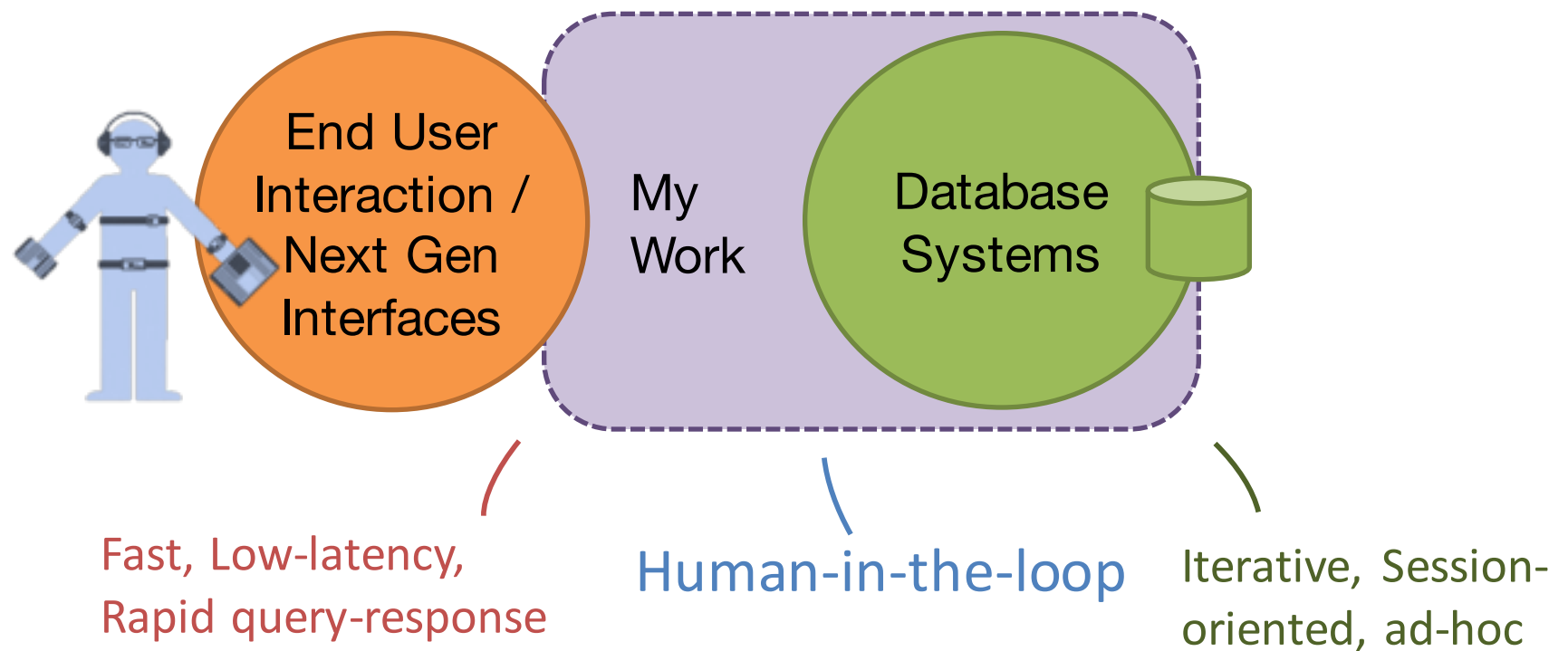
# The Wu Lab at Columbia





# interactive data systems

arnab's research group at ohio state



# Exploration Specifications + Perceptual Accuracy

<http://perceptvis.github.io>



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