

ReVize

A Library for Visualization Toolchaining with Vega-Lite

Marius Hogräfer, Hans-Jörg Schulz

for STAG 2019 (15.11.2019) in Cagliari, Italy



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DBMS



**Data Wrangling
Tool**



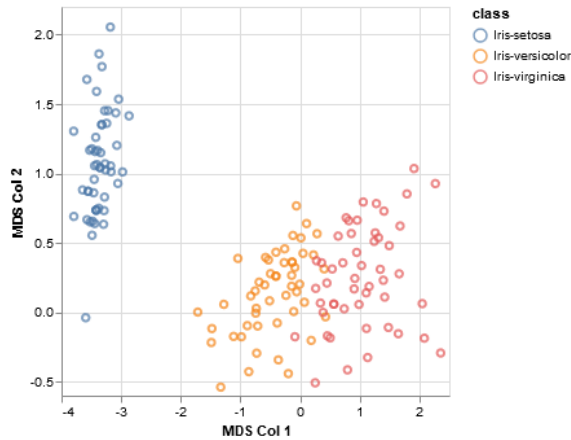
**Data Analysis
Tool**



**Authoring
System**



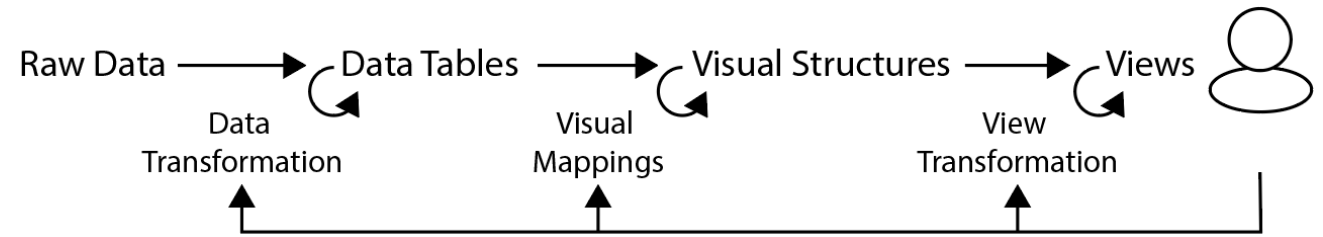
**Visual
Post-Processing**



Toolchaining

Using **multiple** different tools
to author one visualization

Visualization Pipeline



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**Data Wrangling
Tool**



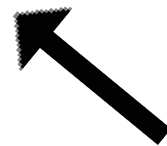
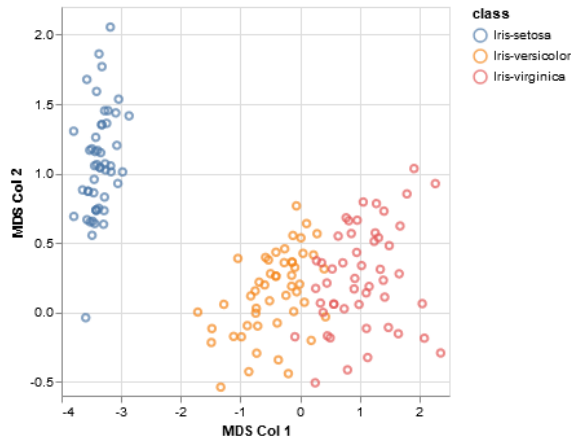
**Data Analysis
Tool**



**Authoring
System**



**Graphical
Editor**



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**Data Wrangling
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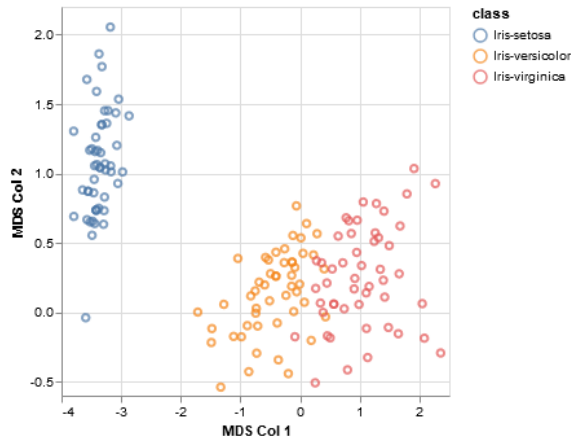
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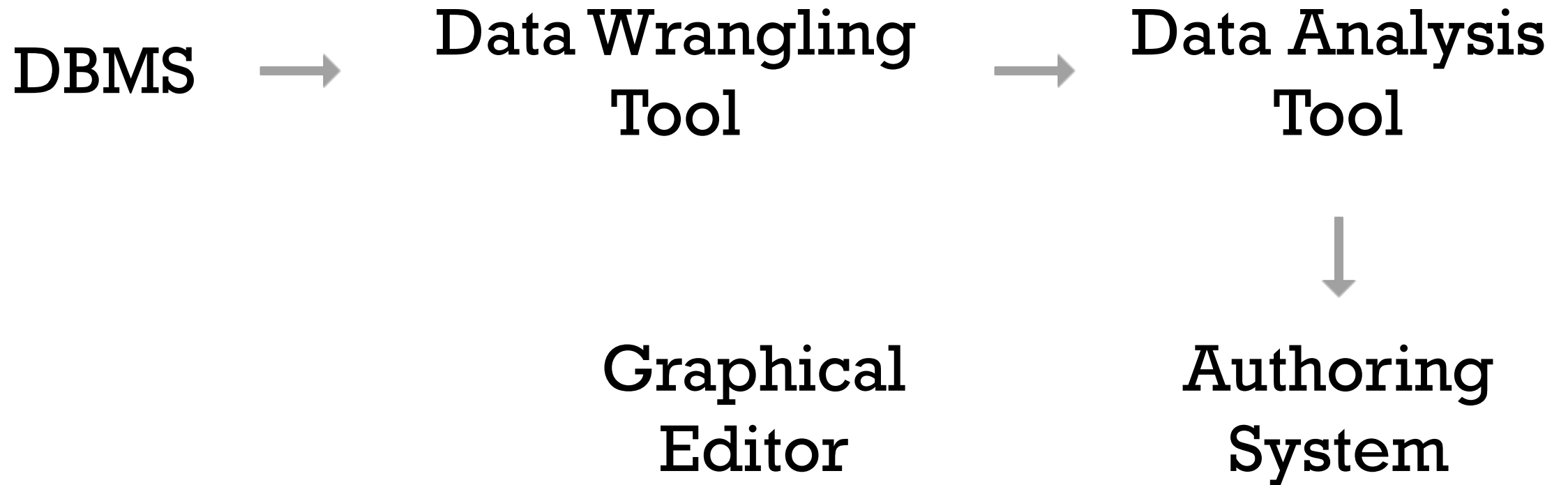
**Data Wrangling
Tool**

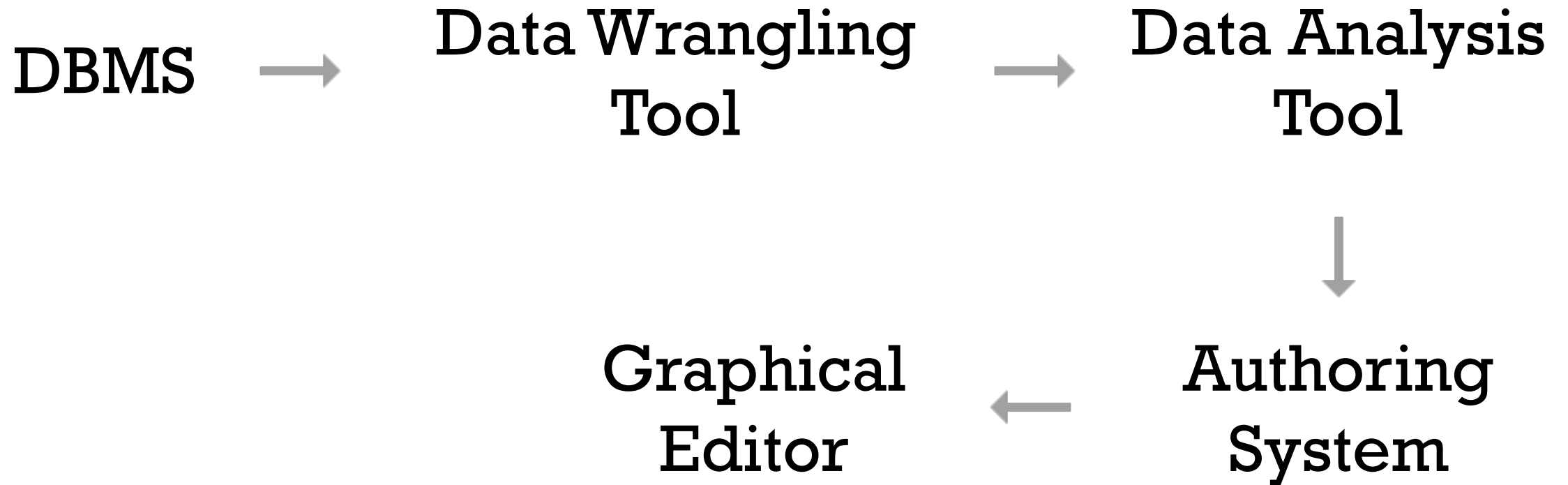


**Data Analysis
Tool**

**Graphical
Editor**

**Authoring
System**





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**Data Wrangling
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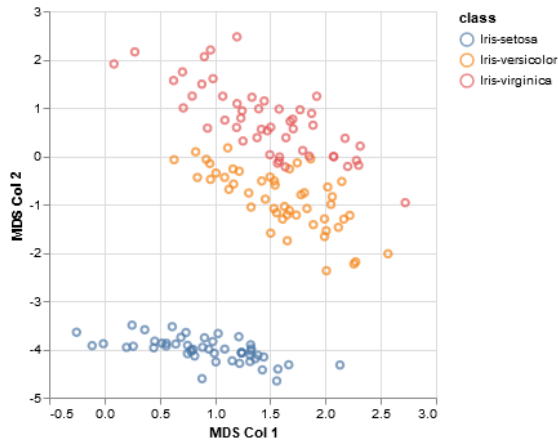
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Tool**

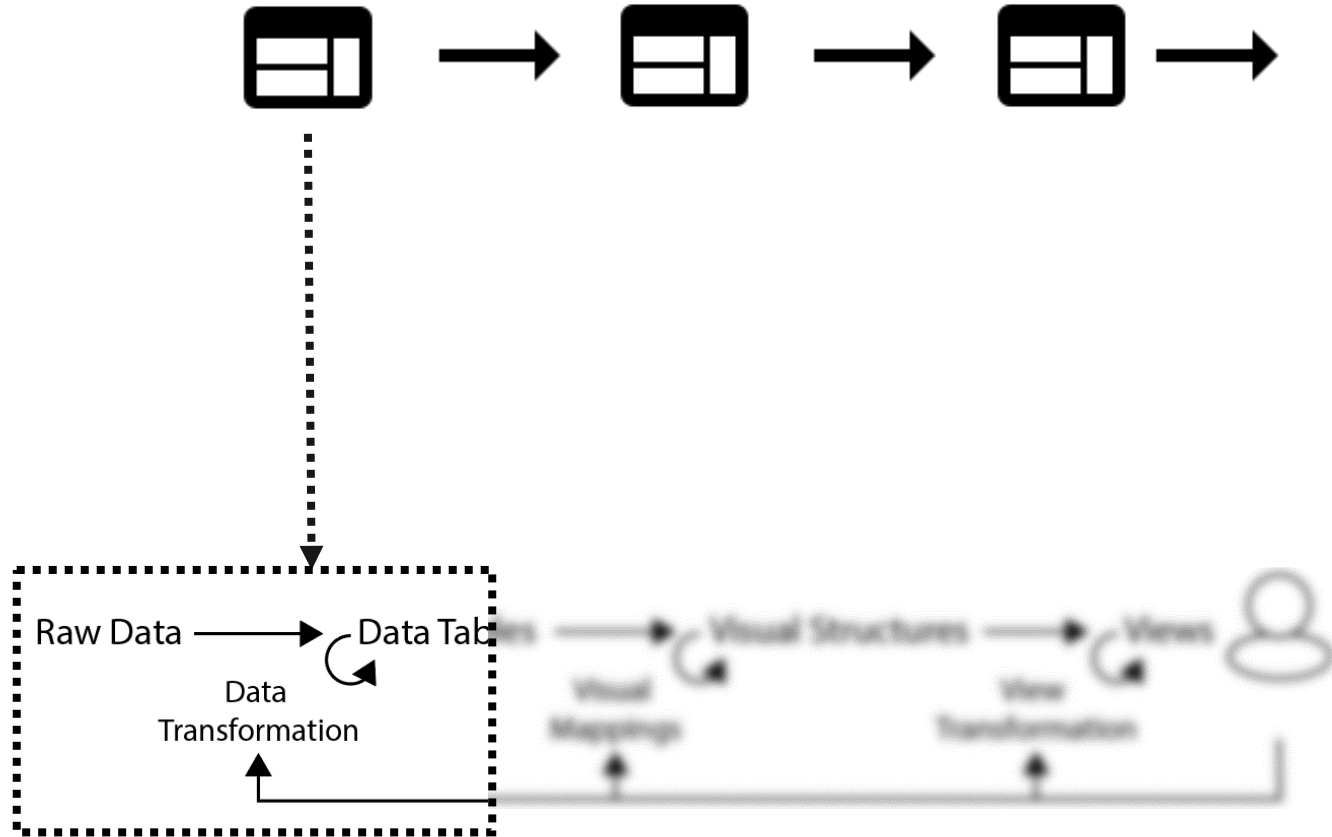


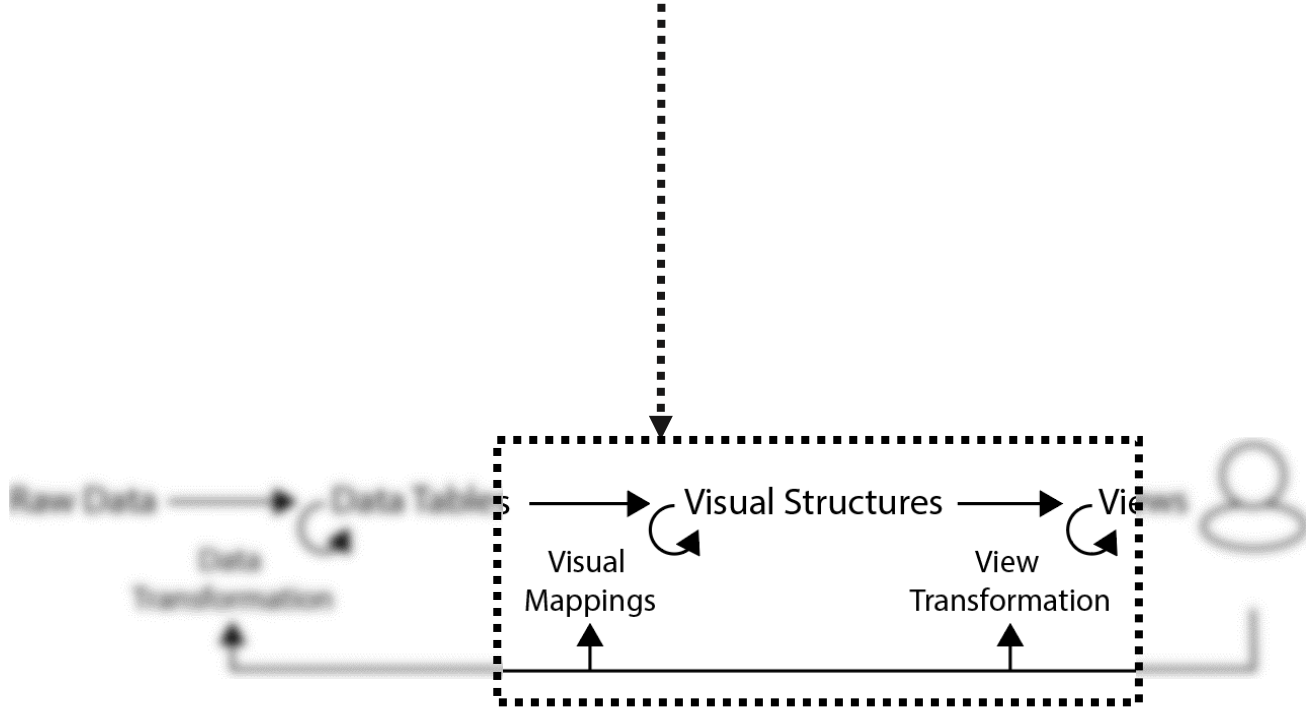
**Authoring
System**

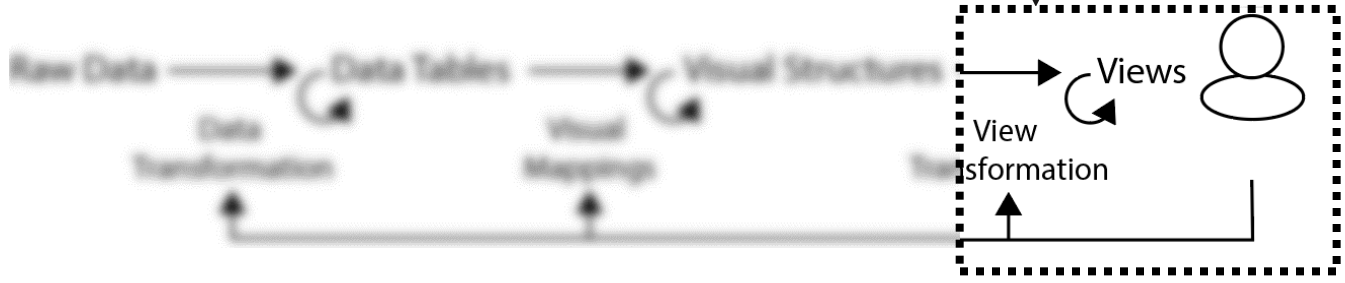


**Graphical
Editor**





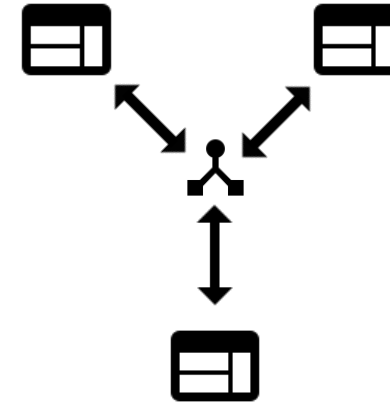




Existing Approaches



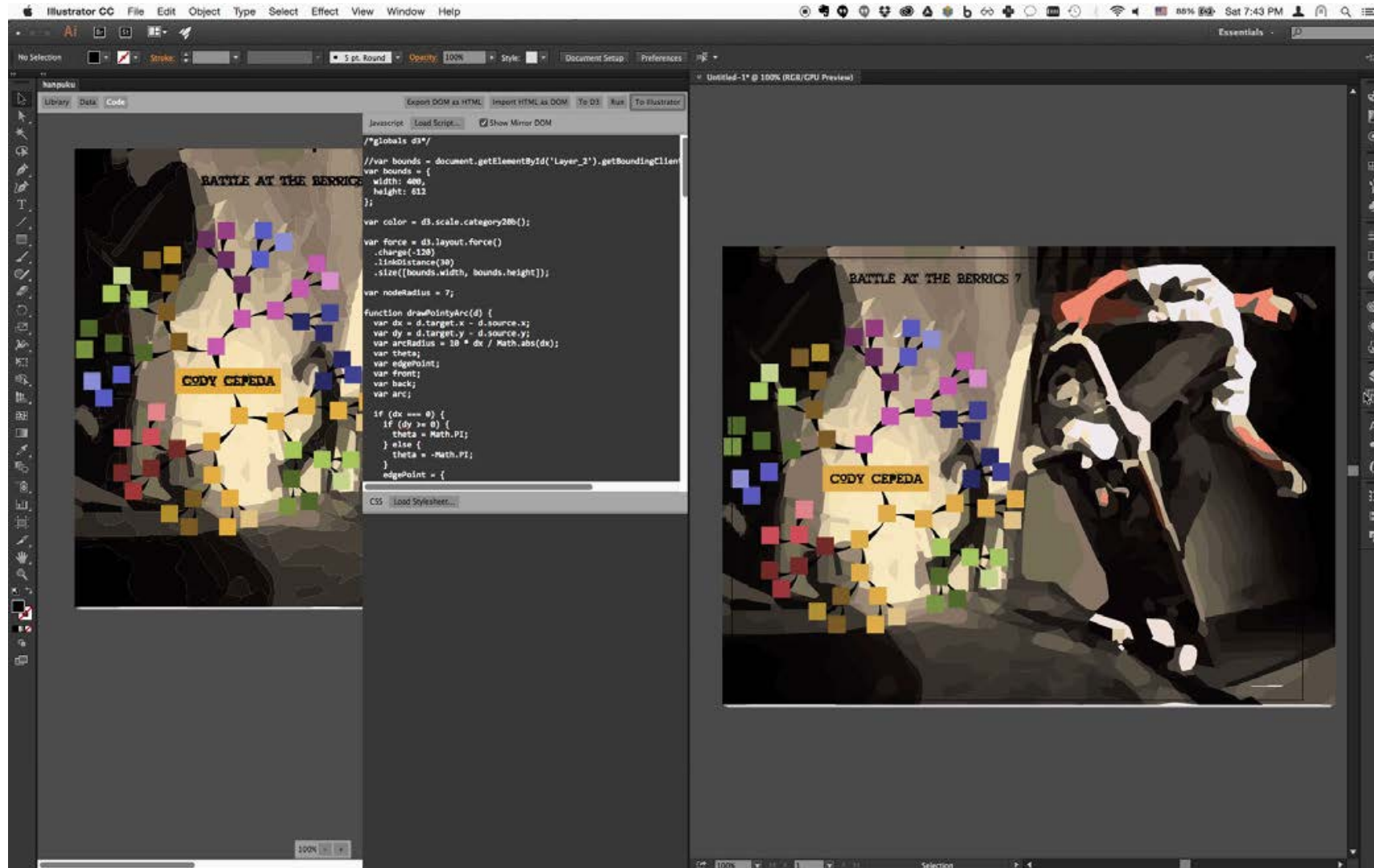
Consecutive



Parallel

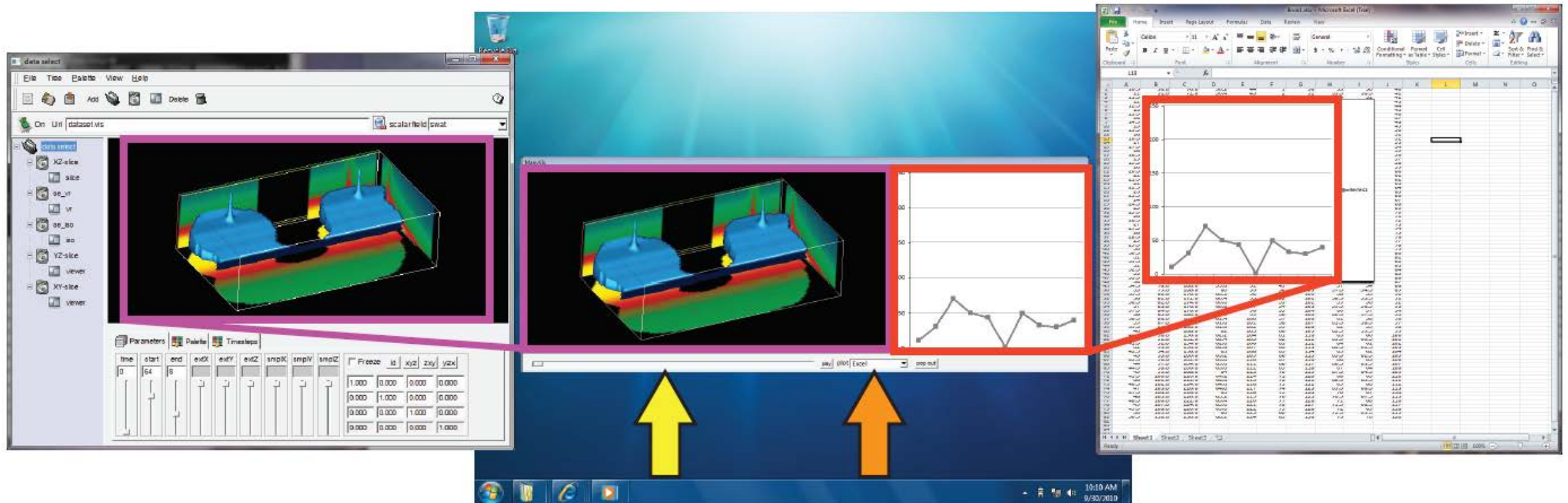
Hanpuku

[BDFM17]



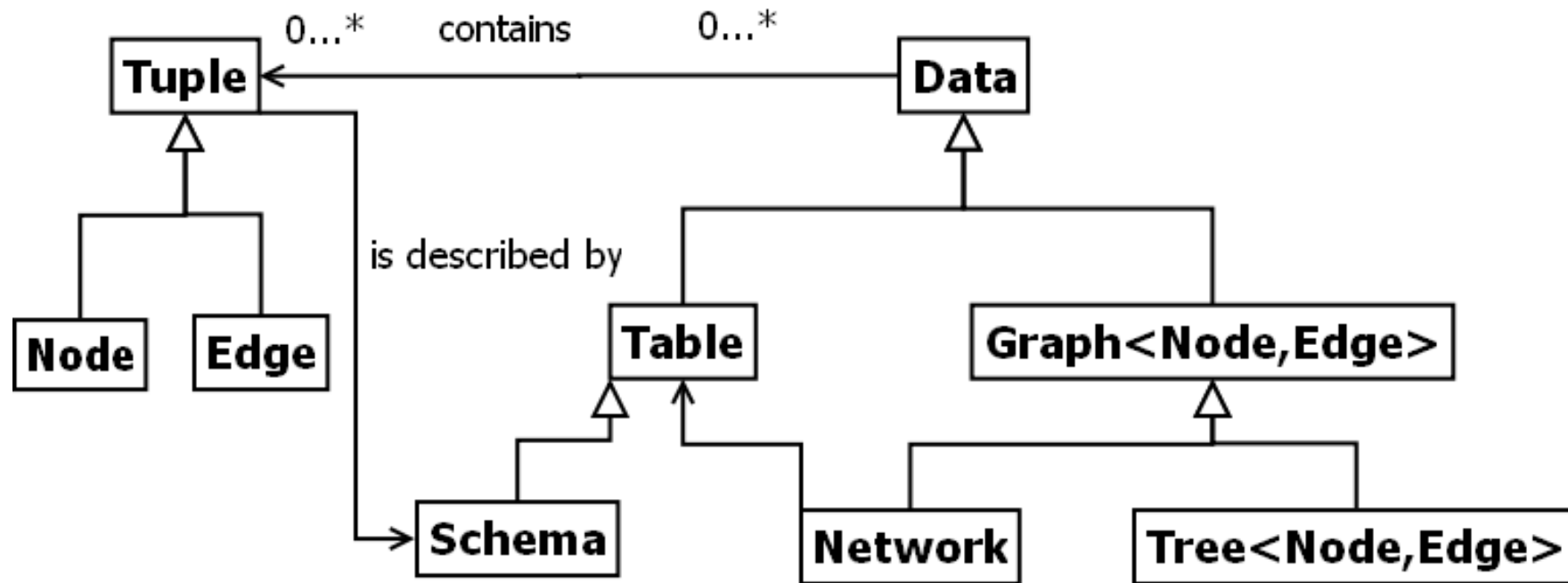
ManyVis

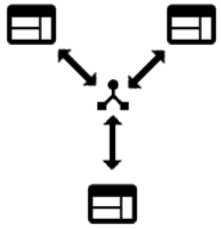
[RSD13*]



Obvious Framework

[FHBW11]





Parallel

Tool Iteration

All aspects of visualization are shared

Generally designed for specific toolchains

Coding effort for each tool that joins the toolchain

Consecutive



Decentralized

No adaptation of mediator to tools necessary

Lossy file formats

Tool-specific shared model

but

Our Approach

Exchanging a full model of the
visualization pipeline between all tools

Using a **declarative visualization grammar**

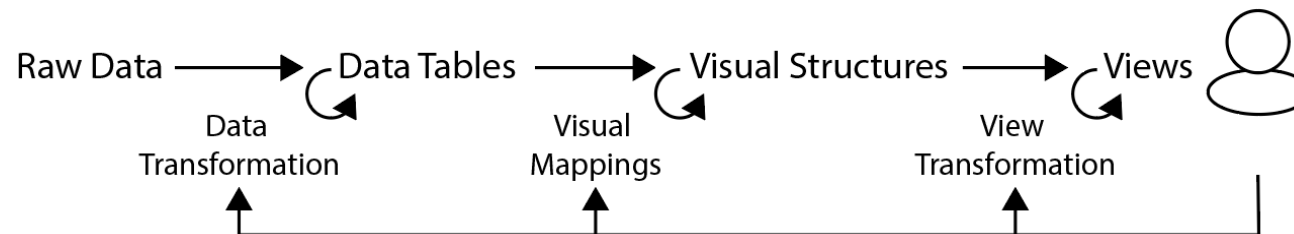




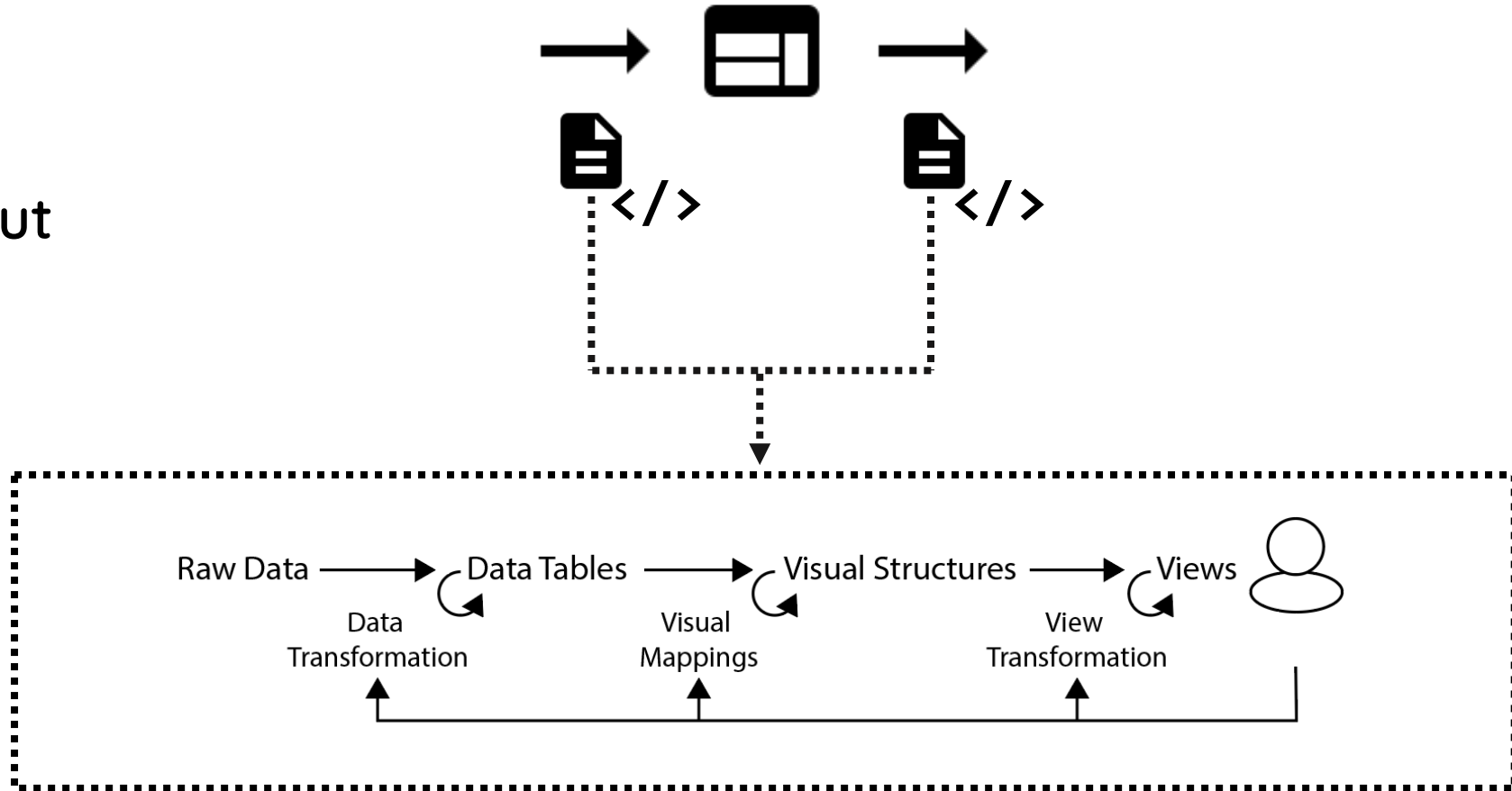
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      <operation type="MDS" "parameters="dim:2,iteration:4"/>
    </transformation>
  </source>

  <visualEncoding>
    <visualMark type="circle" data="myData">
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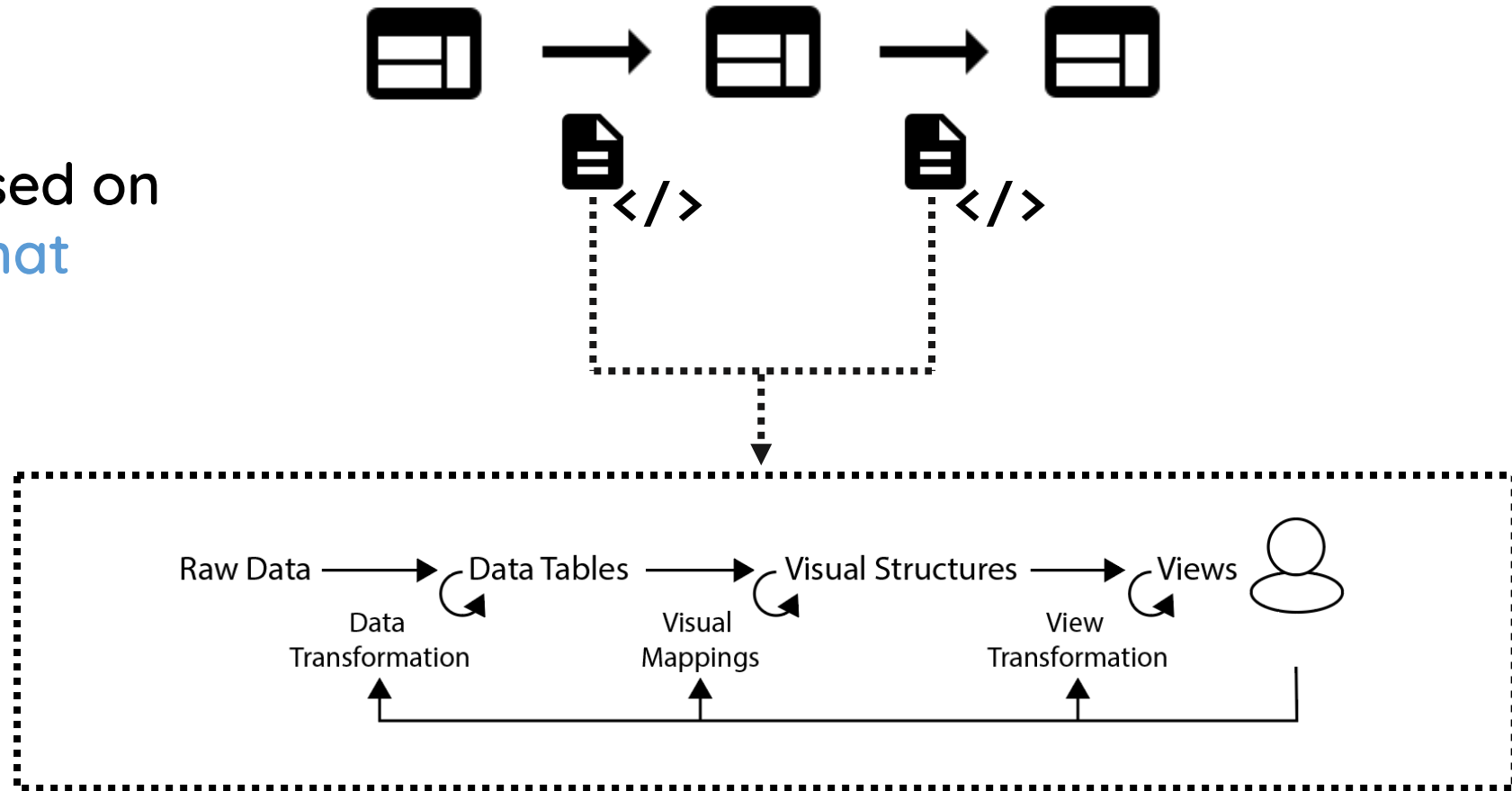
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</visualization>
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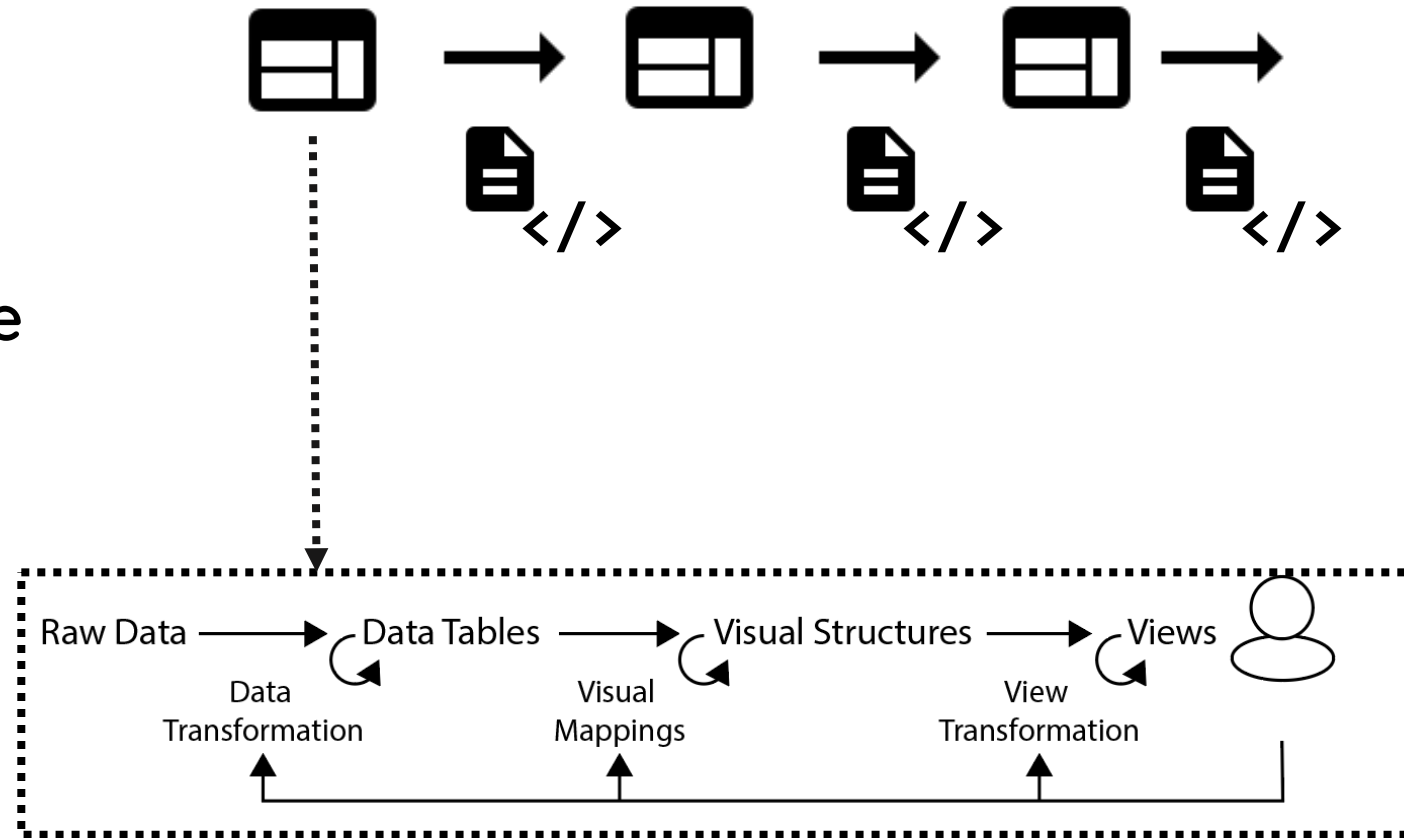
Symmetric input and output formats



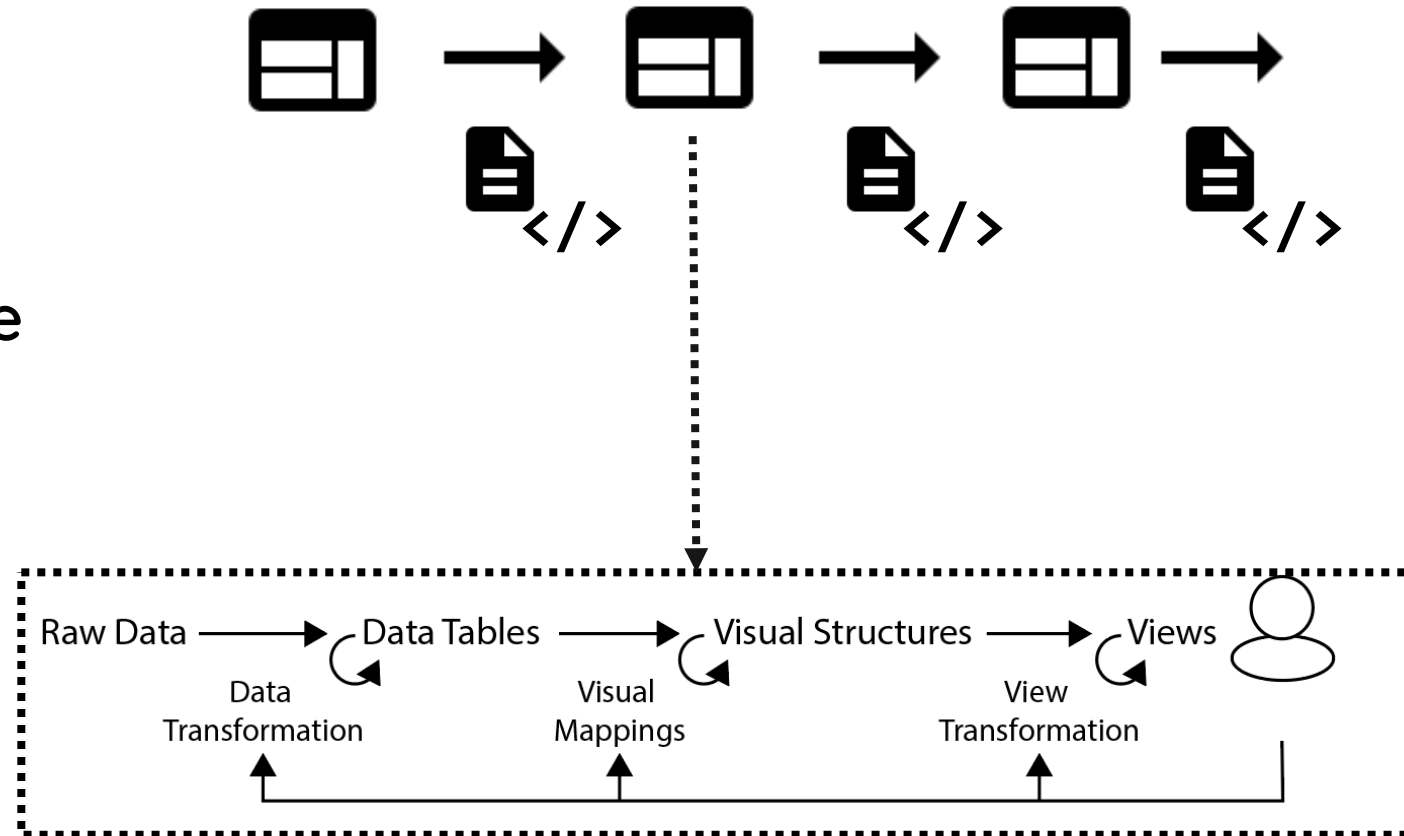
Toolchains based on exchange format



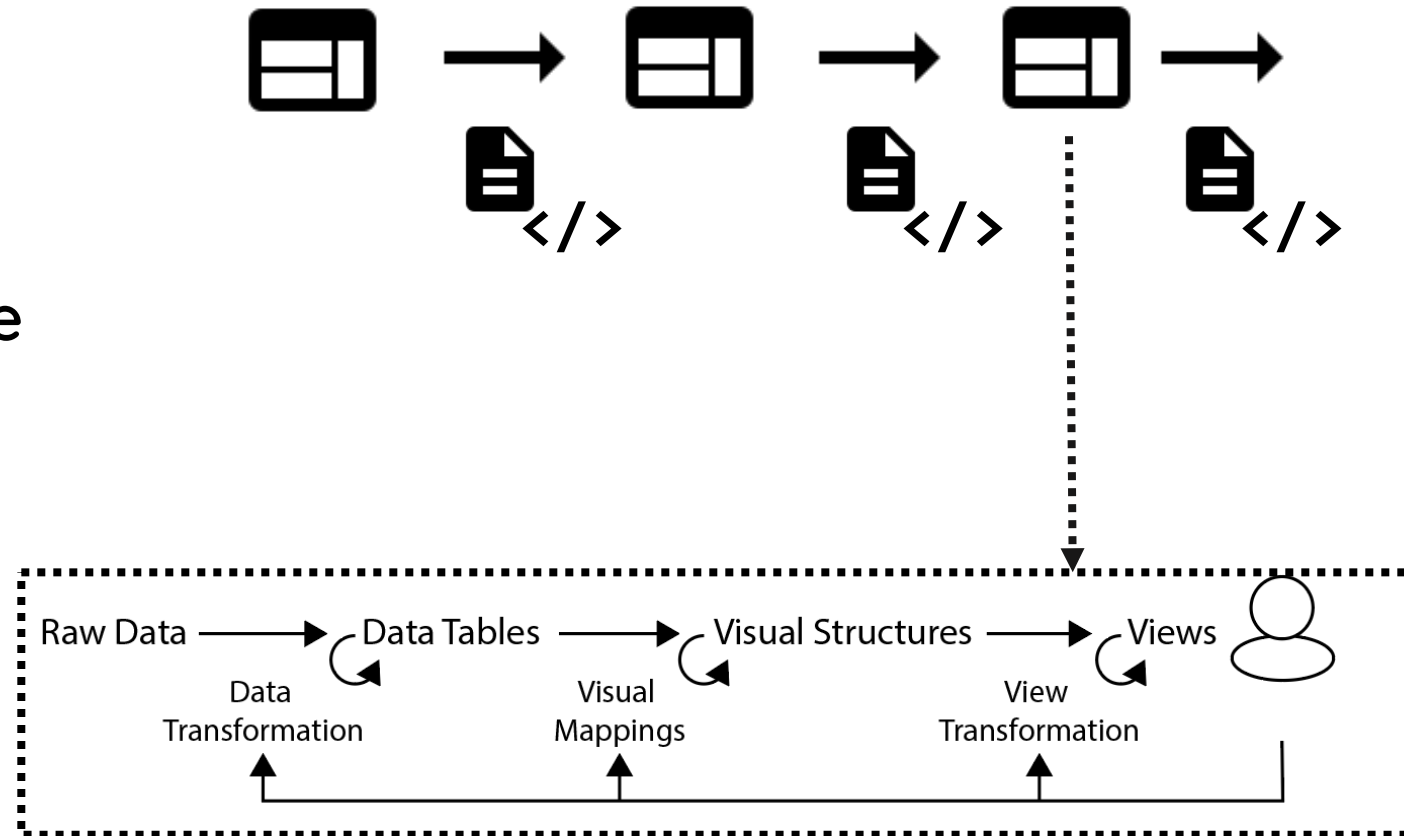
Every tool has
full command over
visualization pipeline



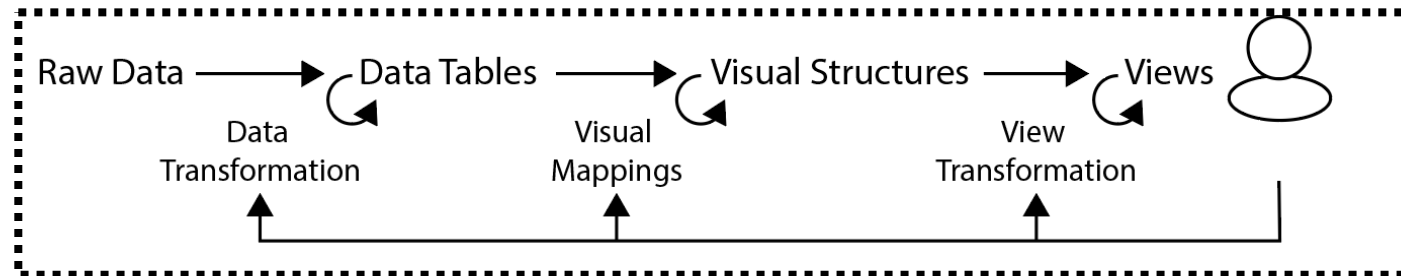
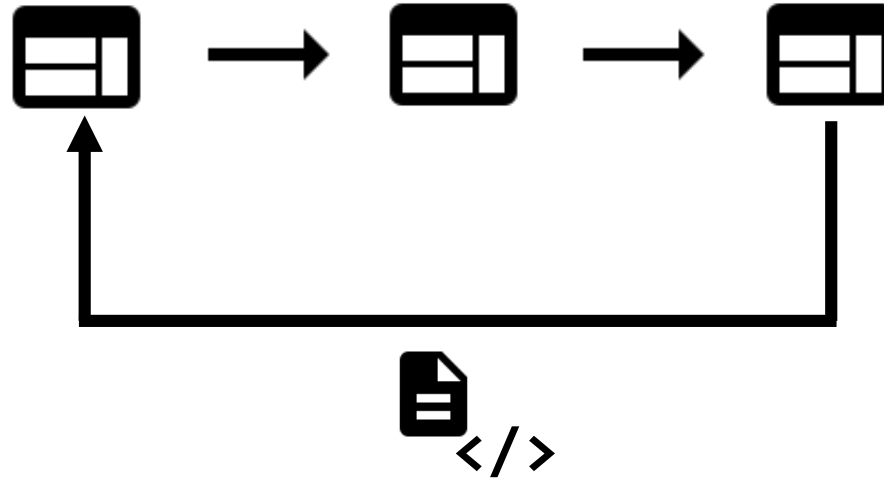
Every tool has
full command over
visualization pipeline



Every tool has
full command over
visualization pipeline



Supports
tool iteration



Why has this not been done before?

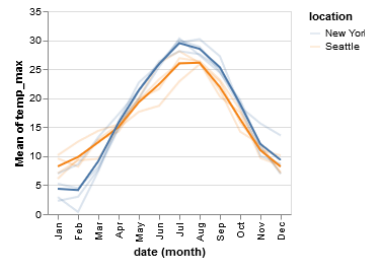
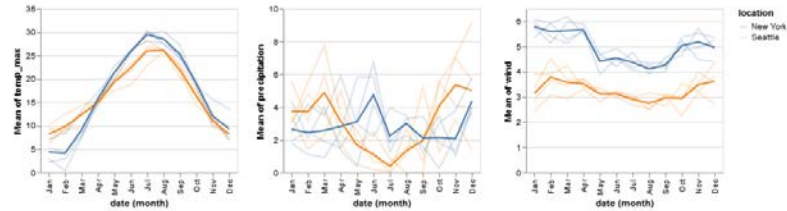
Few tools **export** to visualization grammars

No tool allows **importing** from declarative grammars

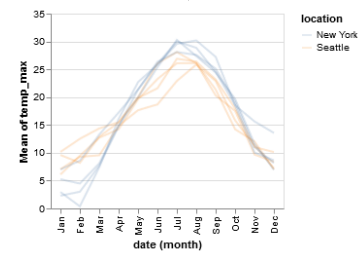
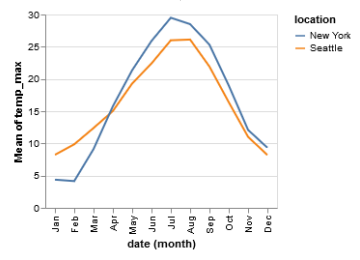
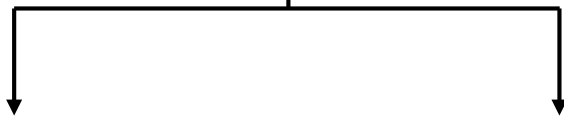
ReVize

A Library for Visualization Toolchaining
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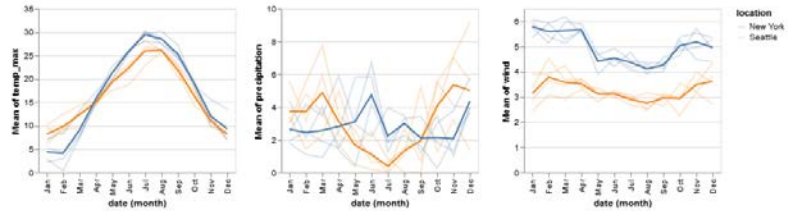
Import ()



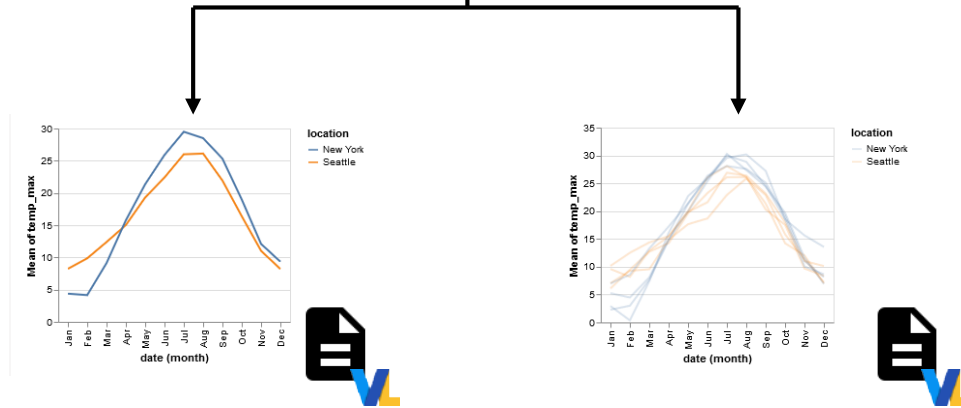
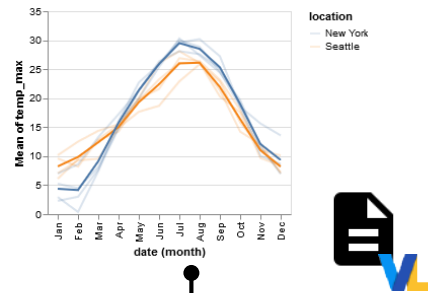
Hierarchical View Decomposition



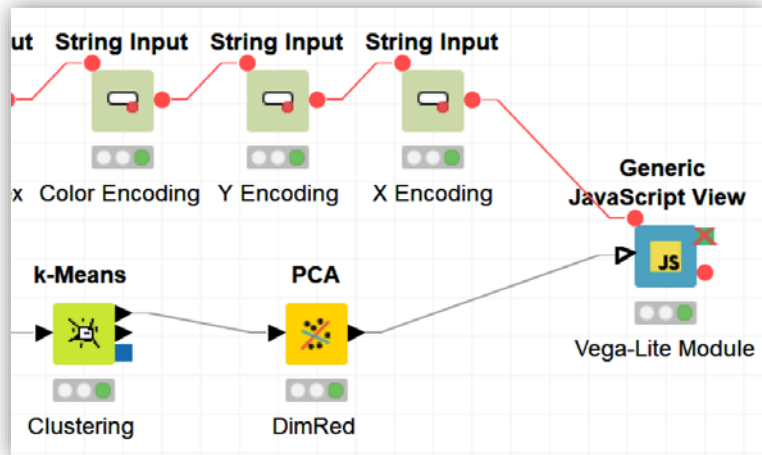
Import ()



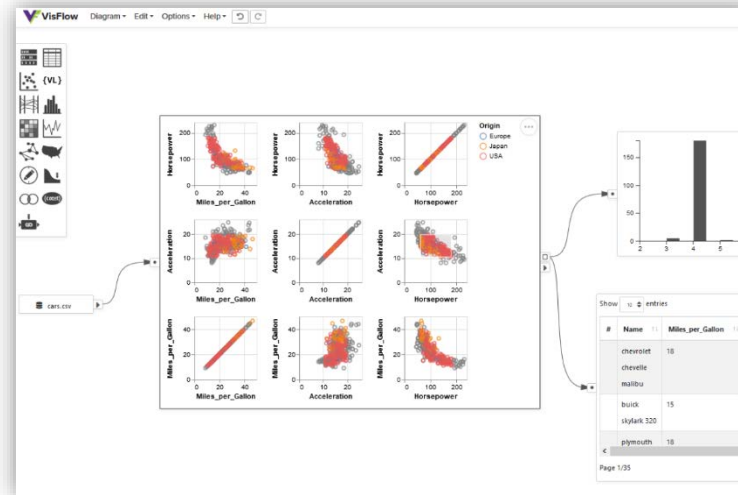
Visualization Reuse



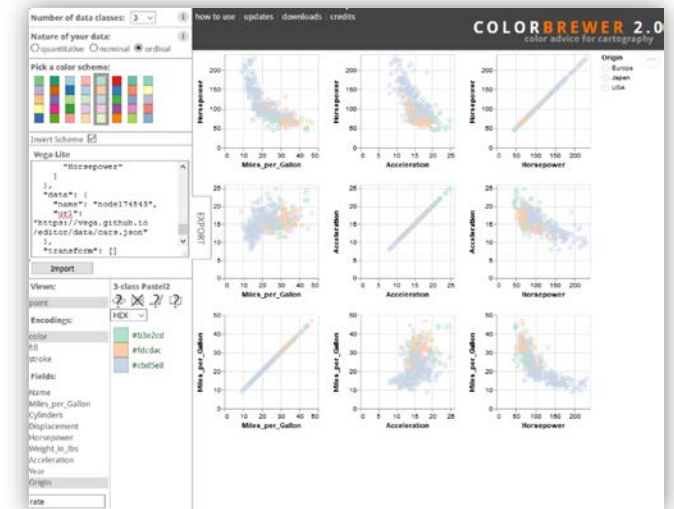
Example Scenario



KNIME



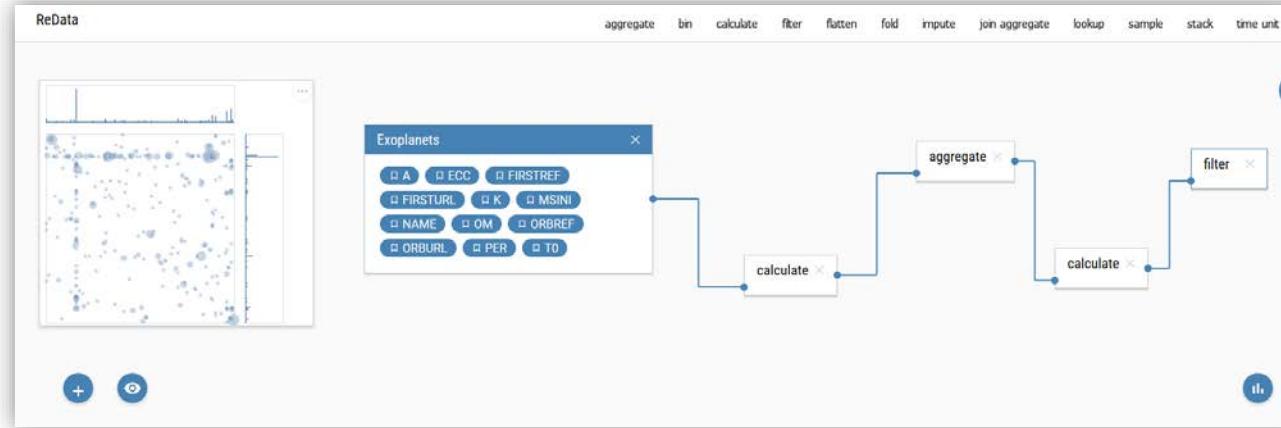
VisFlow



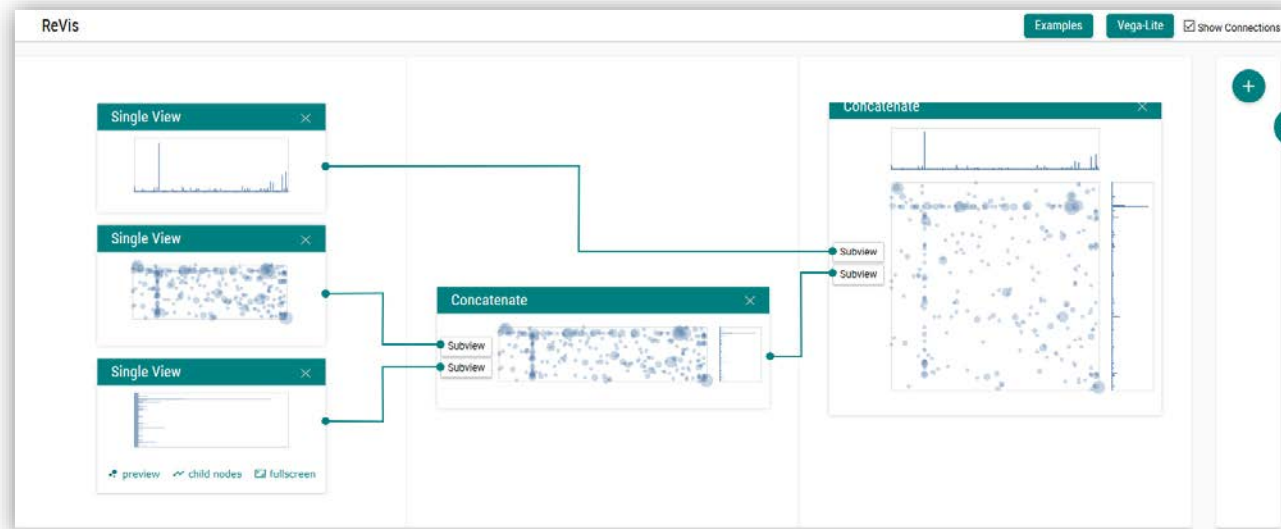
ColorBrewer

Demo Video

Built with ReVize

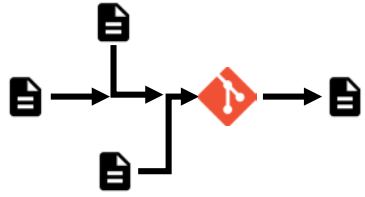


ReData

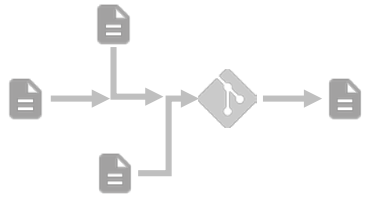


ReVisualize

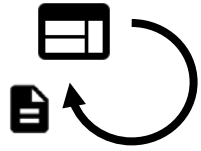
Additional Benefits



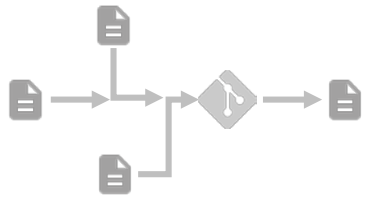
Line-based diff for **versioning control**



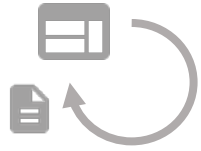
Line-based diff for versioning control



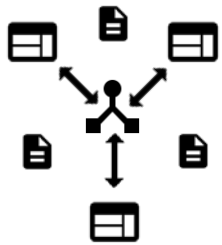
Using a visualization grammar to for project
persistence in visualization tools



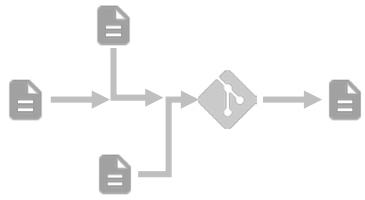
Line-based diff for versioning control



Using a visualization grammar to for project persistence in visualization tools



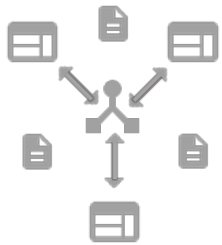
Content-based approach can be implemented for **mediated toolchaining**



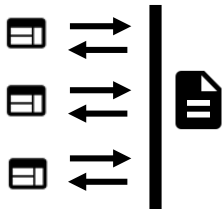
Line-based diff for versioning control



Using a visualization grammar to for project persistence in visualization tools

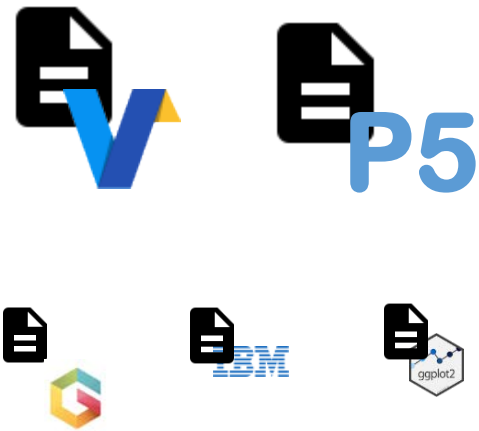


Content-based approach can be implemented for mediated toolchaining

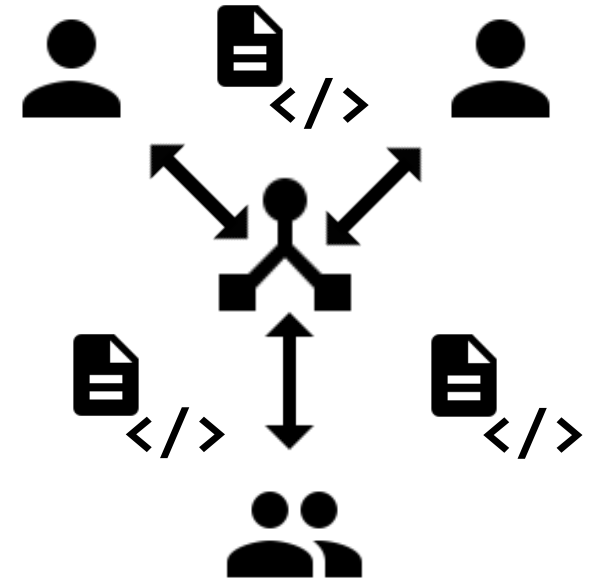


Unix-like specialized visualization tools instead of monolithic systems

Open Challenges



Toolchaining with other visualization grammars



Access control to parts of visualization pipeline?

Conclusion

Visualization toolchaining

Partial models of visualization pipeline

Declarative Visualization Grammars

ReVize

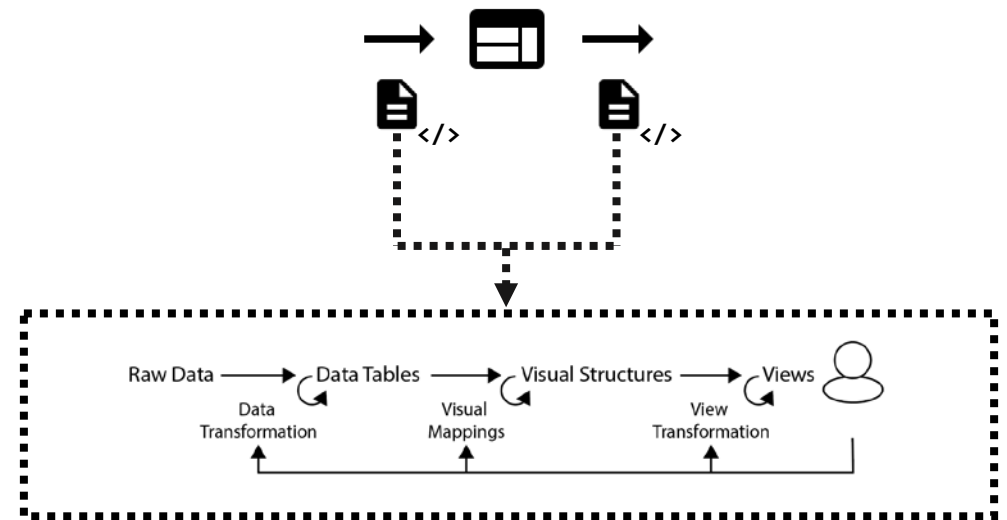
ReVize: A Library for Visualization Toolchaining with Vega-Lite

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 @Mahog

 mhograefer@cs.au.dk

 <https://vis-au.github.io/toolchaining>



References

- Rungta, A.; Summa, B.; Demir, D.; Bremer, P. T. & Pascucci, V. ManyVis: Multiple Applications in an Integrated Visualization Environment IEEE Transactions on Visualization and Computer Graphics, IEEE, 2013, 19, 2878-2885
- J. Fekete, P. Hémerly, T. Baudel and J. Wood, "Obvious: A meta-toolkit to encapsulate information visualization toolkits – One toolkit to bind them all," 2011 IEEE Conference on Visual Analytics Science and Technology (VAST), Providence, RI, 2011, pp. 91-100. doi: 10.1109/VAST.2011.6102446
- A. Bigelow, S. Drucker, D. Fisher and M. Meyer, "Iterating between Tools to Create and Edit Visualizations," in IEEE Transactions on Visualization and Computer Graphics, vol. 23, no. 1, pp. 481-490, Jan. 2017. doi: 10.1109/TVCG.2016.2598609

References

- Dill, F.; Thiel, K.; Kötter, T.; Gabriel, T. R.; Cebron, N.; Meinl, T.; Ohl, P.; Berthold, M. R. & Wiswedel, B. KNIME - the Konstanz information miner ACM SIGKDD Explorations Newsletter, 2009 , 11 , 26
- Yu, B. & Silva, C. T. VisFlow - Web-based Visualization Framework for Tabular Data with a Subset Flow Model IEEE Transactions on Visualization and Computer Graphics, 2017 , 23 , 251-260
- Harrower, M. & Brewer, C. A. ColorBrewer.org: An online tool for selecting colour schemes for maps Cartographic Journal, 2003 , 40 , 27-37

References

- Satyanarayan, A.; Moritz, D.; Wongsuphasawat, K. & Heer, J. Vega-Lite: A Grammar of Interactive Graphics IEEE Transactions on Visualization and Computer Graphics, 2017 , 23 , 341-350
- Satyanarayan, A.; Russell, R.; Hoffswell, J. & Heer, J. Reactive Vega: A Streaming Dataflow Architecture for Declarative Interactive Visualization IEEE Transactions on Visualization and Computer Graphics, 2016 , 22 , 659-668
- Guozheng Li, Min Tian, Qinmei Xu, Wentao Zhang, Michael McGuffin & Xiaoru Yuan GoTree: A Grammar of Tree Visualizations IEEE Transactions on Visualization and Computer Graphics, 2019

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