Improving the Fidelity of Contextual Data Layouts Using a Generalized Barycentric Coordinates Framework

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Attributes (Variables) to Attributes Relation (e.g Horsepower and weight? Positive or negative?) MPG CYL Hpower Weight Accel Year Origin Q Quanta a 11.5 How to get the context, Data to Attributes Relation? (which cars have high Horsepower?) 8.5 8.5 Year Acceleration 9.5 MPG Data to Data Relation 15.5 15.5 (which cars are similar? Cluster? Outliers?) 14.5 Chevrolet Cavalier 20.5 MPG: 34 CYL: 4 17.5 Hpower: 88 Weight: 2395 14.5 Accel: 18 Year: 82 17.5 Origin: 1 12.5 13.5 Pontiac Catalina 18.5 MPG: 16

> CYL: 8 Hpower: 170 Weight: 4668 Accel: 11.5 Year: 75 Origin: 1

Contextual layouts

Radviz



Star Coordinates



Gravi++



Dust & Magnet Generalized Barycentric Coordinates





Generalized Barycentric Coordinates (GBC)



GBC interpolation the interpolation weight w_i of vertex v_i for *P* is

$$w_i = \frac{\cot(\alpha) + \cot(\beta)}{\|P - v_i\|^2}$$

The interpolated value *Pv* at *P* is

$$Pv = \sum_{i=1}^{n} w_i v_i$$
 where $a_i = w_i / \sum_{k=1}^{n} w_k$ and $\sum_{i=1}^{n} a_i = 1$

Car

Sales Campaign







Variables to Variables Error - distance spaced layout

- Linear ordering of the vertices Correlation matrix Approximate Traveling Salesman Problem (TSP) for ordering
- Circle layout Arrange on the circle, spaced with correlation





Data to Variables Error - iterative error reduction



- Compute the error of each dimension
- Construct the error polygon
- Move to the center of polygon iteratively







Data to Data Error - force directed adjustment

- Construct the Network vertices: data points edges: springs force: error real distance – mapped distance
- Drag or push the points in turn.







Finally – Combine together

Variables to Variables: Distance spaced layout Data to Variables: Iterative error reduction

Data to Data: Force directed adjustment



Error distribution

More Error ? – Data Overlap

[0.1, 0.2, 0.3], [0.2, 0.4, 0.6] - same location ??

GBC Error Explorer - combining different visualization methods into a interface



Parallel Coordinates Display

Conclusion and Future Work

Conclusion

- We unified the different contextual layouts.
- We proposed three algorithms distance spaced layout, iterative error reduction and force directed adjustment to reduce the error.
- We developed an interface by which users can explore the error by combining the different visualization schemes with interactions.

Future Work

 Attributes (variables) are arranged at the periphery of the data points. Better optimizations might be achievable by allowing the attribute points to mingle with the data points.

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Questions ?

This research was partially supported by NSF grant IIS 1117132 and the MSIP, Korea, under the "IT Consilience Creative Program (ITCCP)" (NIPA-2013-H0203-13-1001) supervised by NIPA.



Interactions

- Verification coloring: Distance color and Error color
- Linked displays
- Local layout refinement
 Data-centric refinement and
 Variable-centric refinement









Unified Definition

Table 1. The features of different layout methods

Method	VF	MF (P _i)					
Radviz	$v_i = \left(r \cdot \cos\frac{i}{2\pi}, r \cdot \sin\frac{i}{2\pi}\right)$	$\sum\nolimits_{j=1}^n \frac{x_{ij}}{\sum_{k=1}^n x_{ik}} \cdot v_j$					
Star Coordinates	$v_i = \left(r \cdot \cos \frac{\theta_i}{2\pi}, r \cdot \sin \frac{\theta_i}{2\pi}\right)$ Or other	$\sum_{j=1}^{n} x_{ij} v_j$					
Gravi++	$v_i = \left(r \cdot \cos \frac{\theta_i}{2\pi}, r \cdot \sin \frac{\theta_i}{2\pi}\right)$ Or other free layout	$\sum_{j=1}^{n} \frac{s_j x_{ij}}{\sum_{k=1}^{n} s_k x_{ik}} \cdot v_j$					
Dust & Magnet	$v_i = \left(r \cdot \cos \frac{\theta_i}{2\pi}, r \cdot \sin \frac{\theta_i}{2\pi}\right)$ Or other free layout	$\sum\nolimits_{j=1}^n a_{ij} x_{ij} \cdot v_j$					
GBC	$v_i = \left(r \cdot \cos \frac{\theta_i}{2\pi}, r \cdot \sin \frac{\theta_i}{2\pi}\right)$ Or other convex polygon	$\sum\nolimits_{j=1}^n \frac{x_{ij}}{\sum_{k=1}^n x_{ik}} \cdot v_j$					
Remarks	Remarks $\theta_1 + \sum_{i=2}^n (\theta_j - \theta_{j-1}) = 2\pi$. s_j stands for the multiplicator of v_j . a_{ij} is the attraction between duragnet j. r is the circle radius.						

