The Textile Plot

A Key to Interaction Through Data

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Overview

- What is Textile Plot?
- Possible enhancements of Textile Plot
- Interactive environment for understanding data through Textile Plot

Textile Plot

Kumasaka and Shibata 2006, 2007

- High dimensional data visualisation according to parallel coordinate system
- Necessary and sufficient background information
- Any kind of data vector (variable) including missing values

Automobile Data

Consumer Reports (USA) 1990, S-PLUS

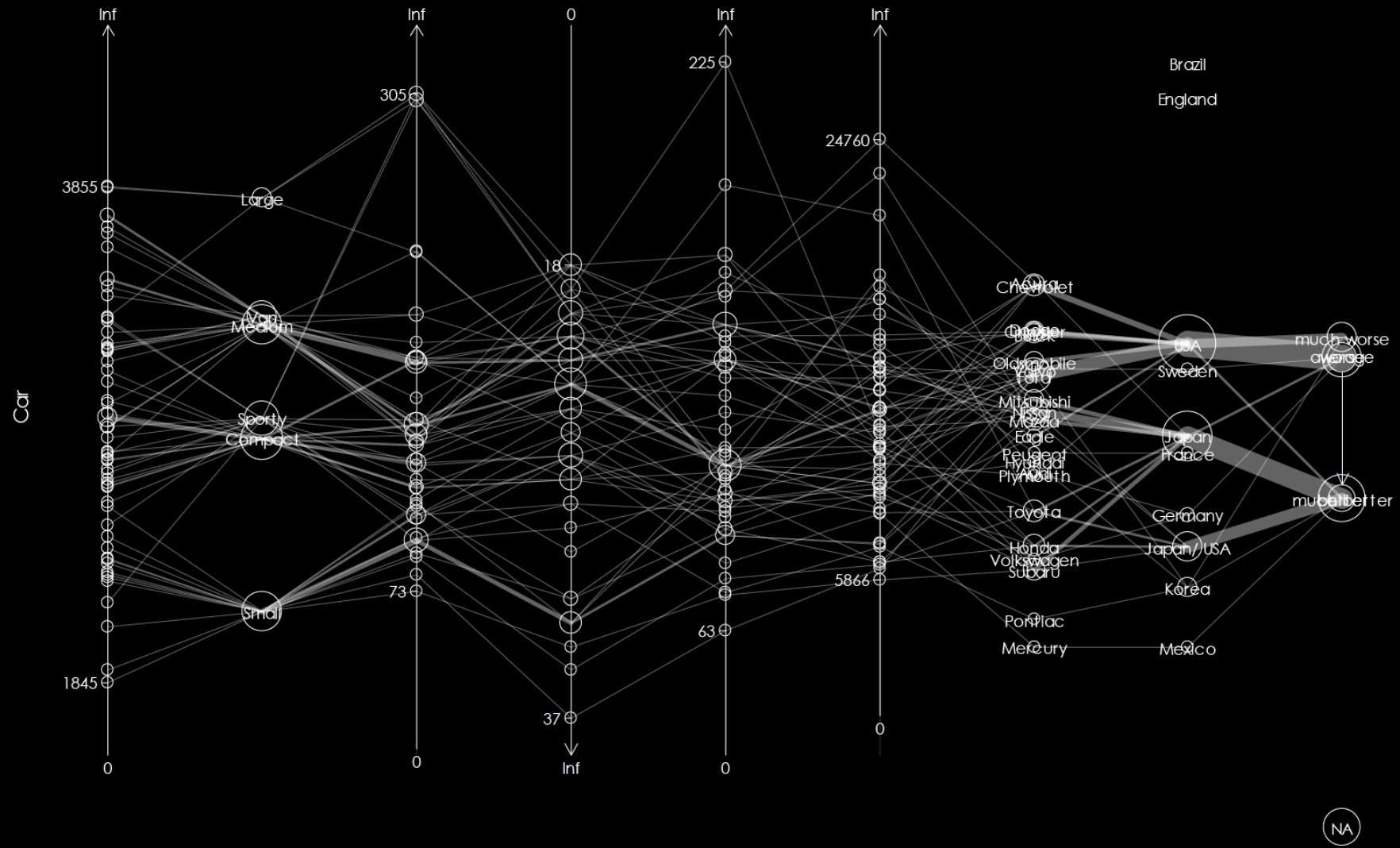
ID	price	country	reliability	type	weight	disp	hp	Manufacturer	mileage
Toyota Corolla	8748	Japan/USA	much better	Small	2390	97	102	Toyota	29
Peugeot 405	15930	France	NA	Compact	2575	116	120	Peugeot	24
Buick Le Sabre V6	16145	USA	average	Large	3325	231	165	Buick	23
Nissan Maxima V6	17899	Japan	much better	Medium	3200	180	160	Nissan	22
Mitsubishi Wagon	14929	Japan	NA	Van	3415	143	107	Mitsubishi	20
Plymouth Laser	10855	USA	NA	Sporty	2840	107	92	Plymouth	26
⋮									
Volvo 240	18450	Sweden	average	Compact	2985	141	114	Volvo	23
Volkswagen Jetta	9995	Germany	average	Small	2330	109	100	Volkswagen	26

Records

60 cars

Data Vectors (9 dimensional)

Price
Country
Reliability
Type
Weight
Displacement
Horsepower
Manufacturer
Mileage


Car
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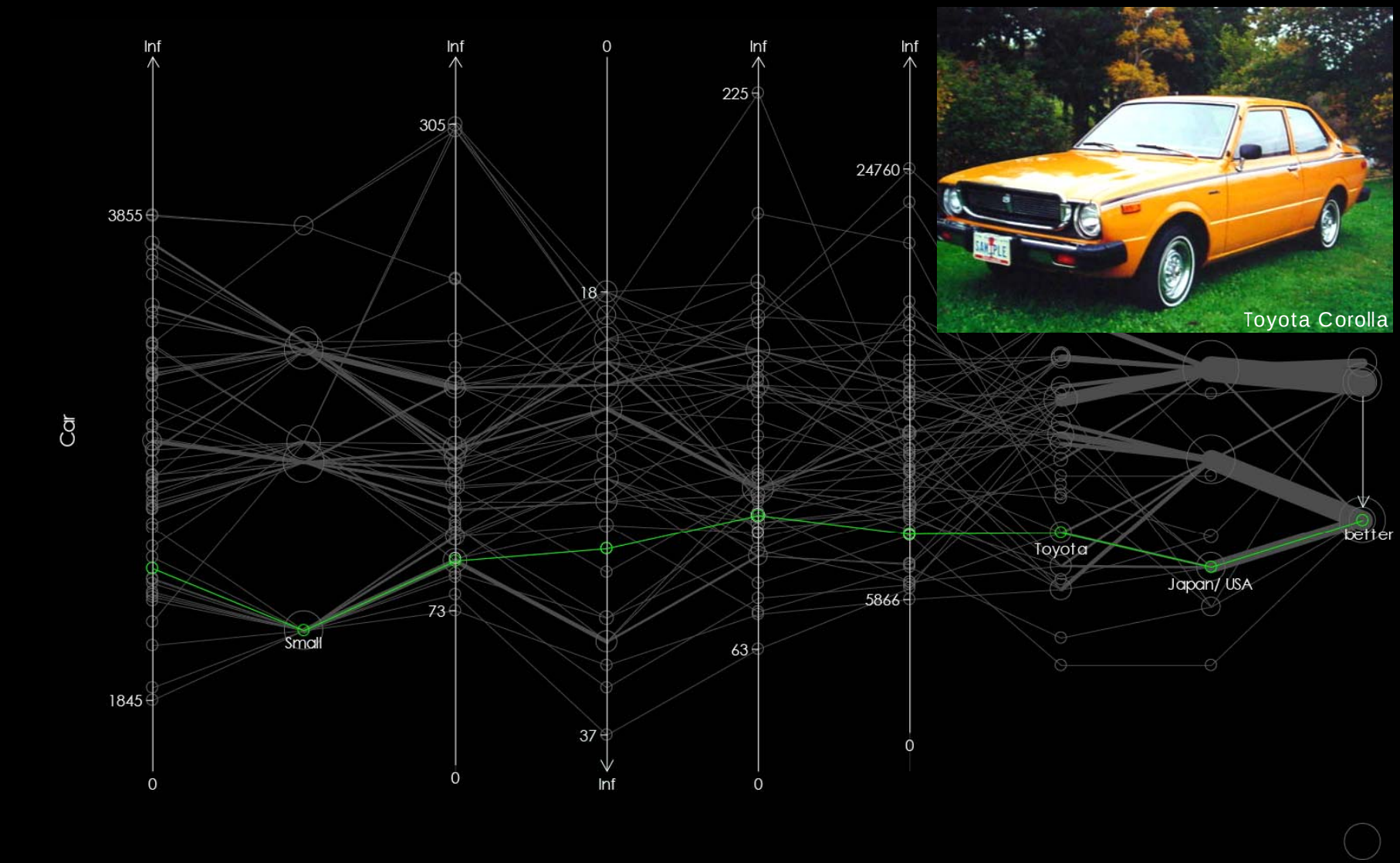
Subaru
Pontiac
Mercury
USA
Sweden
Japan
France
Germany
Japan/USA
Korea
Mexico
much worse
average
much better
NA
Weight (pound)
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability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Japan/ USA
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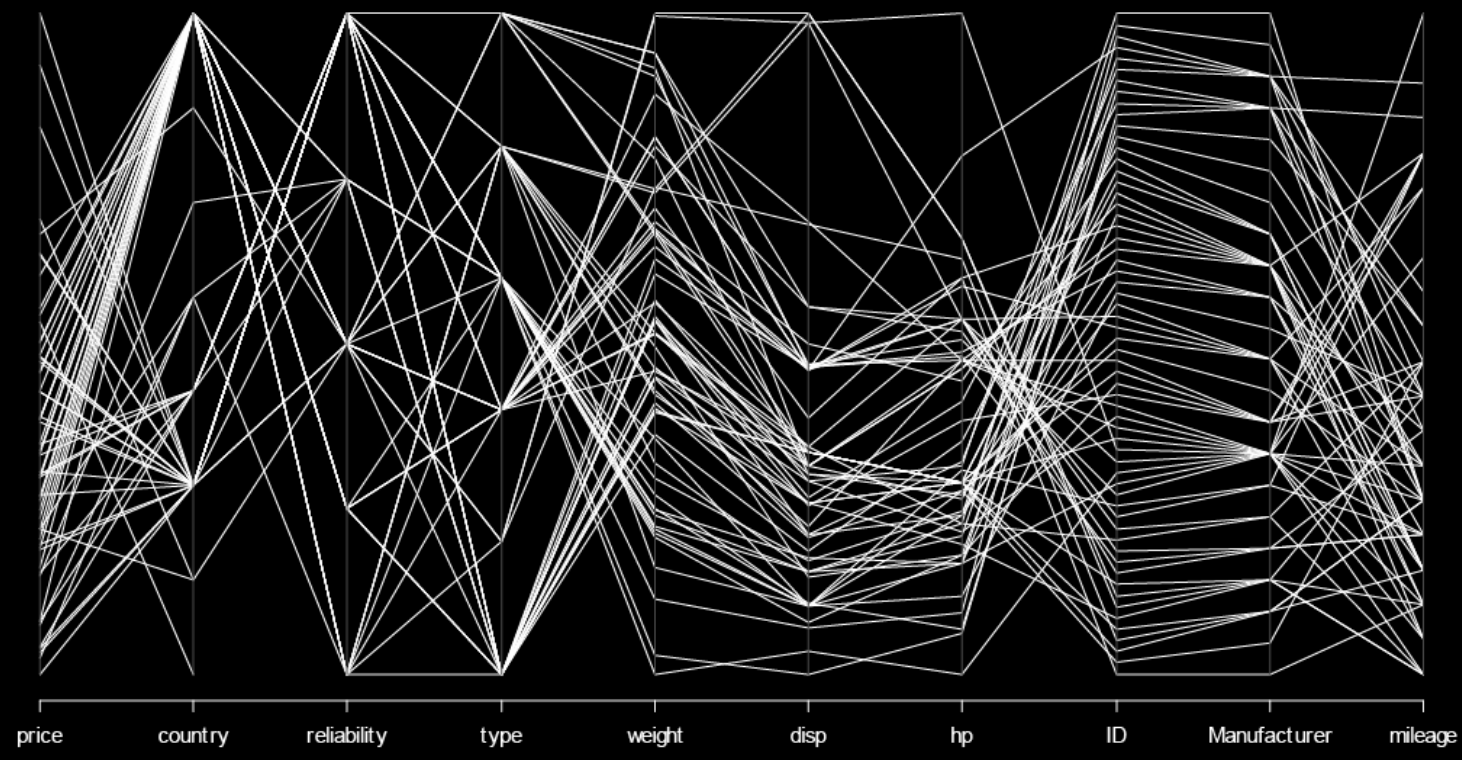
Weight (pound)
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability

Parallel Coordinate Plots

Inselberg 1985, Wegman 1990



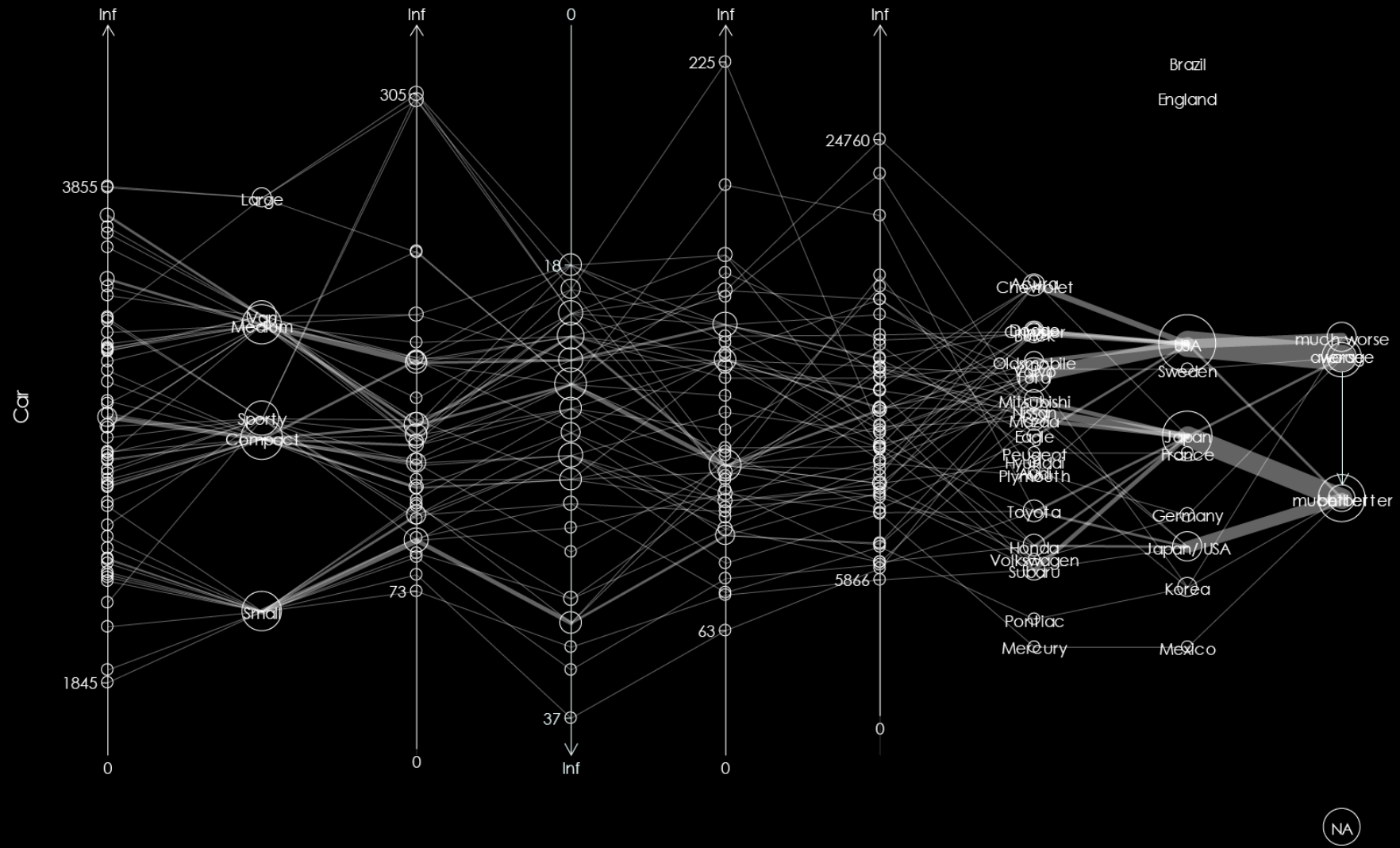
Location and scale of each axis

Independently chosen

Points fill up the range

Levels of categorical data

Equispaced on an axis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Eagle
Peugeot
Plymouth
Toyota
Honda
Volkswagen
Subaru
Pontiac
Mercury
USA
Sweden
Japan
France
Germany
Japan/USA
Korea
Mexico
much worse
average
much better
NA
Weight (pound)
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability

Choice of Locations and Scales

Data Vector $\boldsymbol{x}_j$ (n-dimensional)

Categorical

Numerical

$\mathbf{X}_j : n \times (q_j - 1)$ matrix

contrasts $\mathbf{C} = \begin{pmatrix} 0 & \cdots & 0 \\ & \ddots & \vdots \\ 1 & & \\ \vdots & \ddots & 0 \\ 1 & \cdots & 1 \end{pmatrix}$

Unordered

Ordered

$\boldsymbol{y}_j = \alpha_j \mathbf{1} + \beta_j \boldsymbol{x}_j$

$\boldsymbol{y}_j = \alpha_j \mathbf{1} + \mathbf{X}_j \boldsymbol{\beta}_j$

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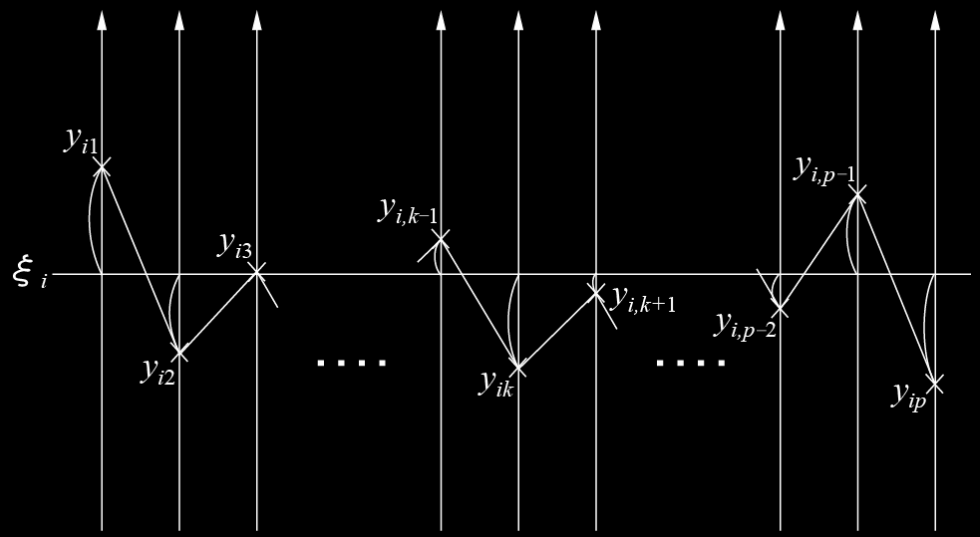
$\boldsymbol{\beta}_j \leq \mathbf{0}$ or $\geq \mathbf{0}$



Deviations for the ith observation

The sum of squares between **coordinate vectors** and an **ideal coordinate vector** is minimised.

$$\sum_{j=1}^{p} \|\boldsymbol{y}_j - \boldsymbol{\xi}\|^2 \underset{\{\alpha_j, \boldsymbol{\beta}_j\}_{j=1}^{p}, \boldsymbol{\xi}}{\rightarrow} \min$$

SNP Data on Calpain-10

Iwasaki, et al. 2005

Data Vectors (14-dimensional)

Phenotype (affected or non-affected)

12 Genotypes on SNP loci

Genotype on INDEL locus

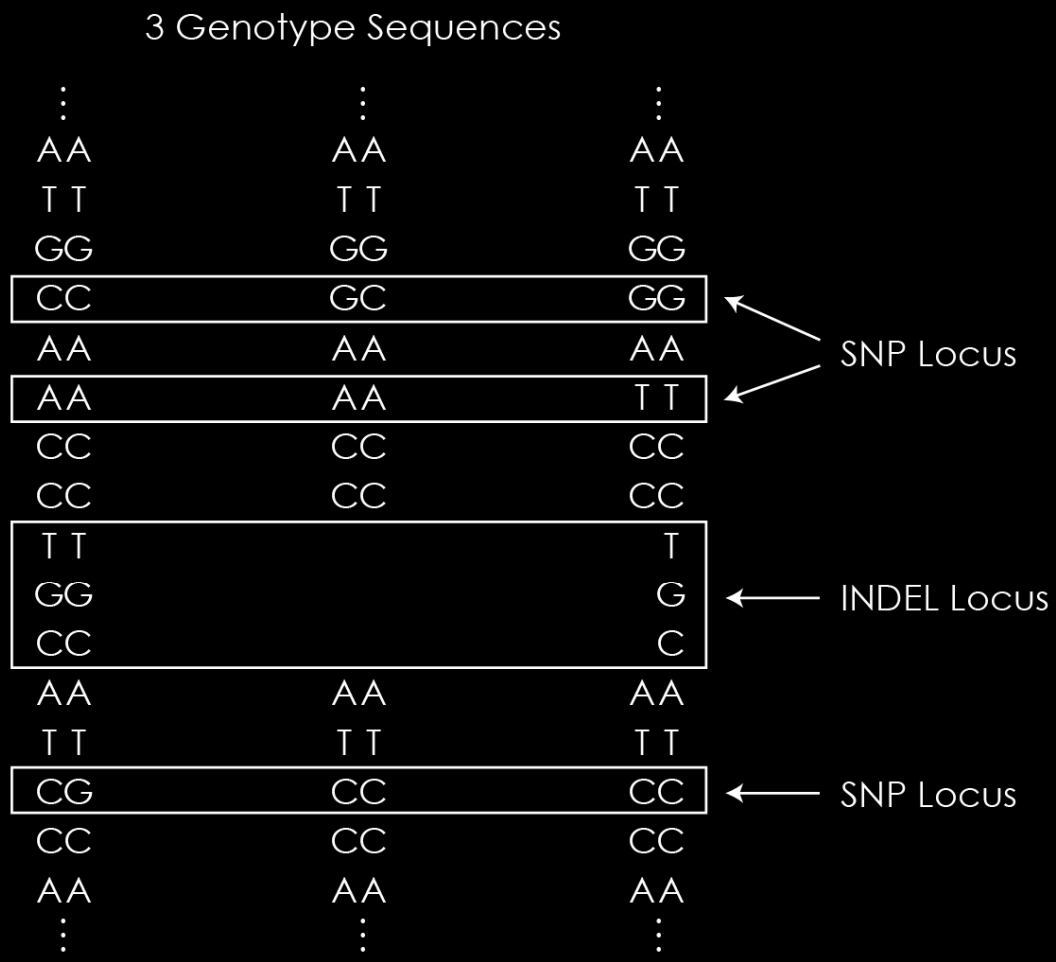
Joint work with

Dr Kamitsuji at Stagen (http://www.stagen.co.jp/)

Goal

To know the danger of a disease from genotypes

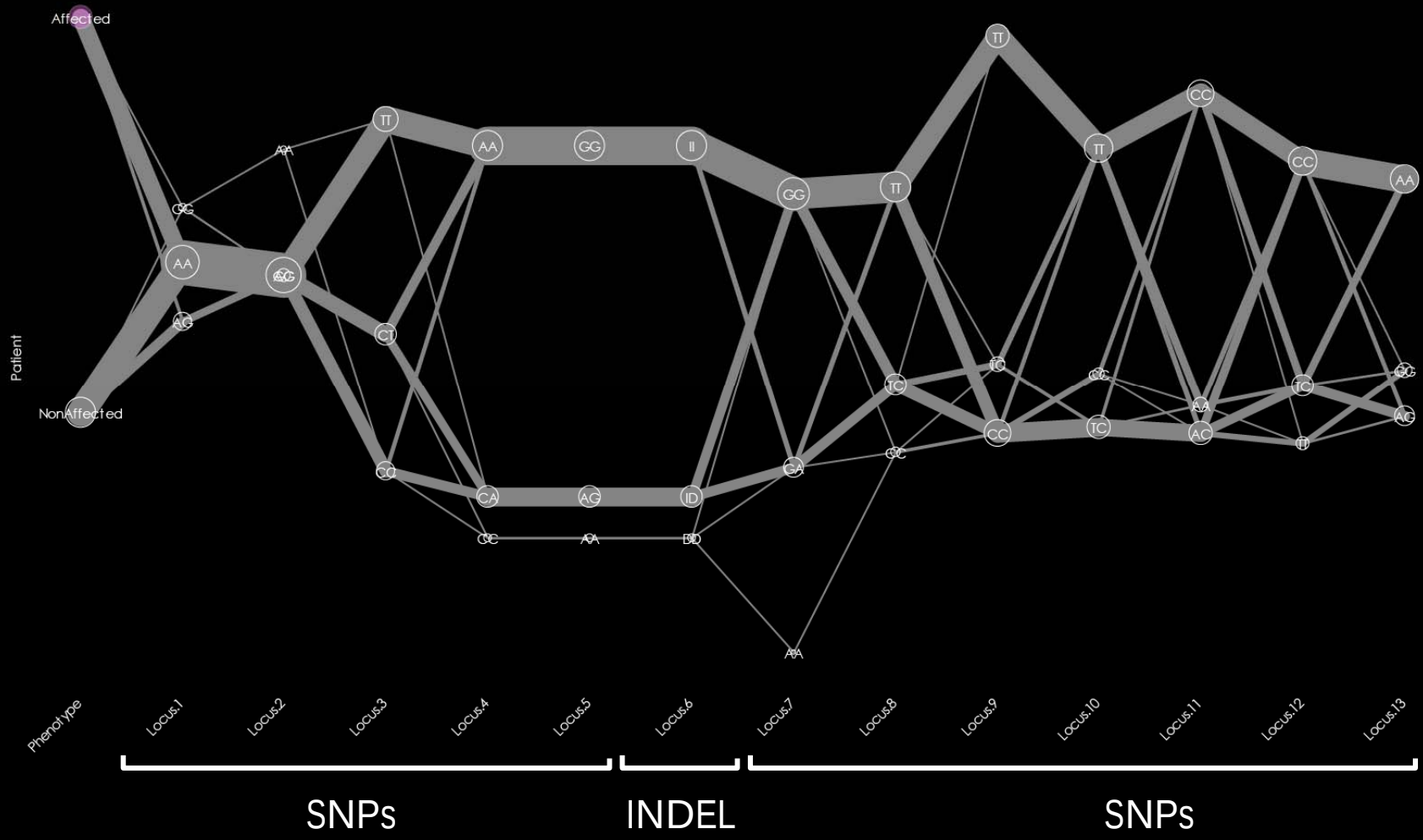
SNP / INDEL Locus



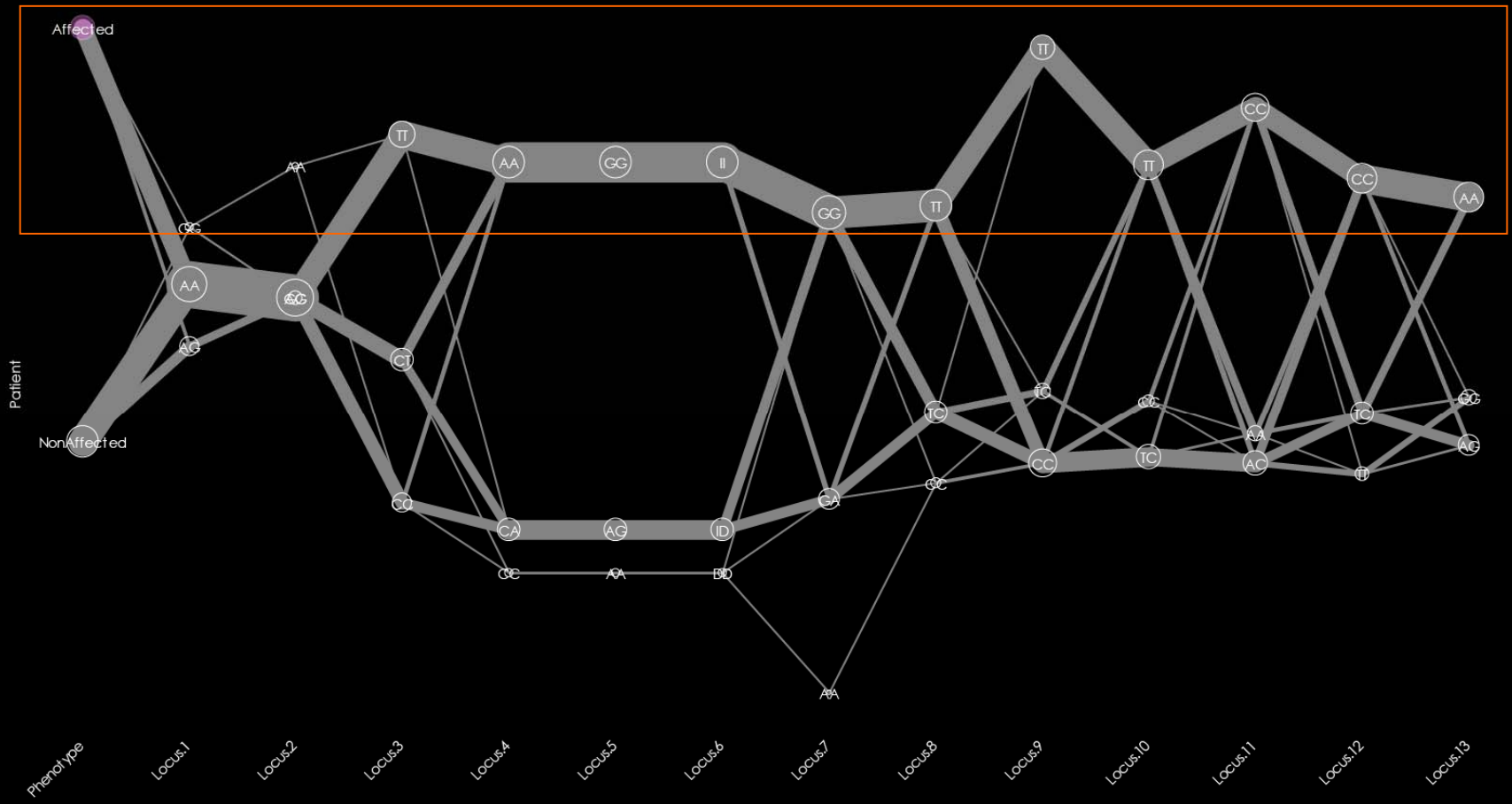


SNP = Single Nucleotide Polymorphism
INDEL = INsertion and DELetion

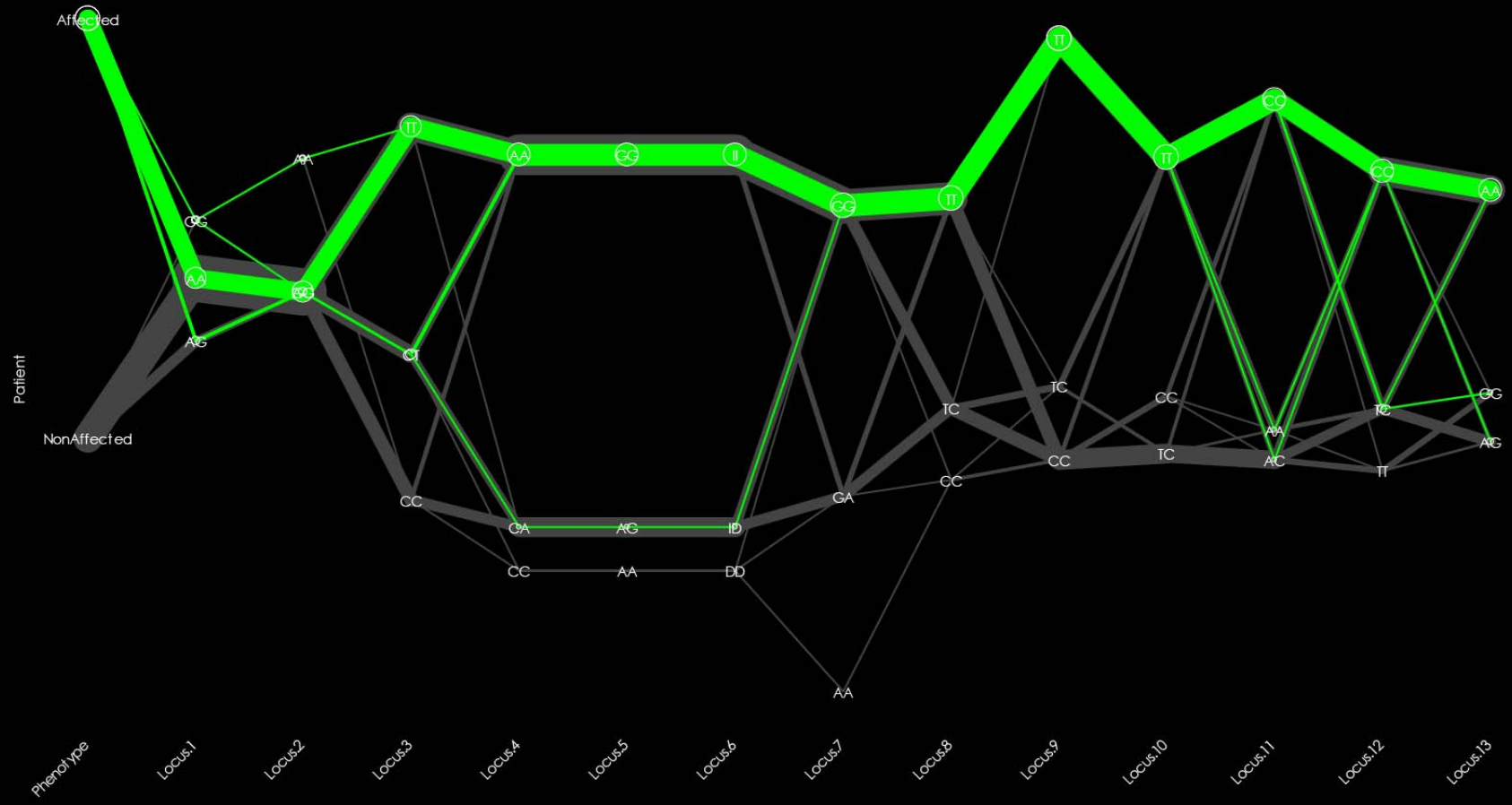
Textile Plot of SNP Data



Recessive Inheritance



Enhancements of Textile Plot



Enhancements of Textile Plot

Transform
- single data vector (log, inverse, etc)
- multiple data vectors (normalisation, etc)

Substitute Data Point

Extract/Remove
- records
- data vectors

Re-weight
- outliers

Order Data Vectors
- a priori
- distance to ideal coordinates
- distance between coordinate vectors

Highlight Connecting Lines

Select Graphical Parameters
- color, transparency, size, etc.

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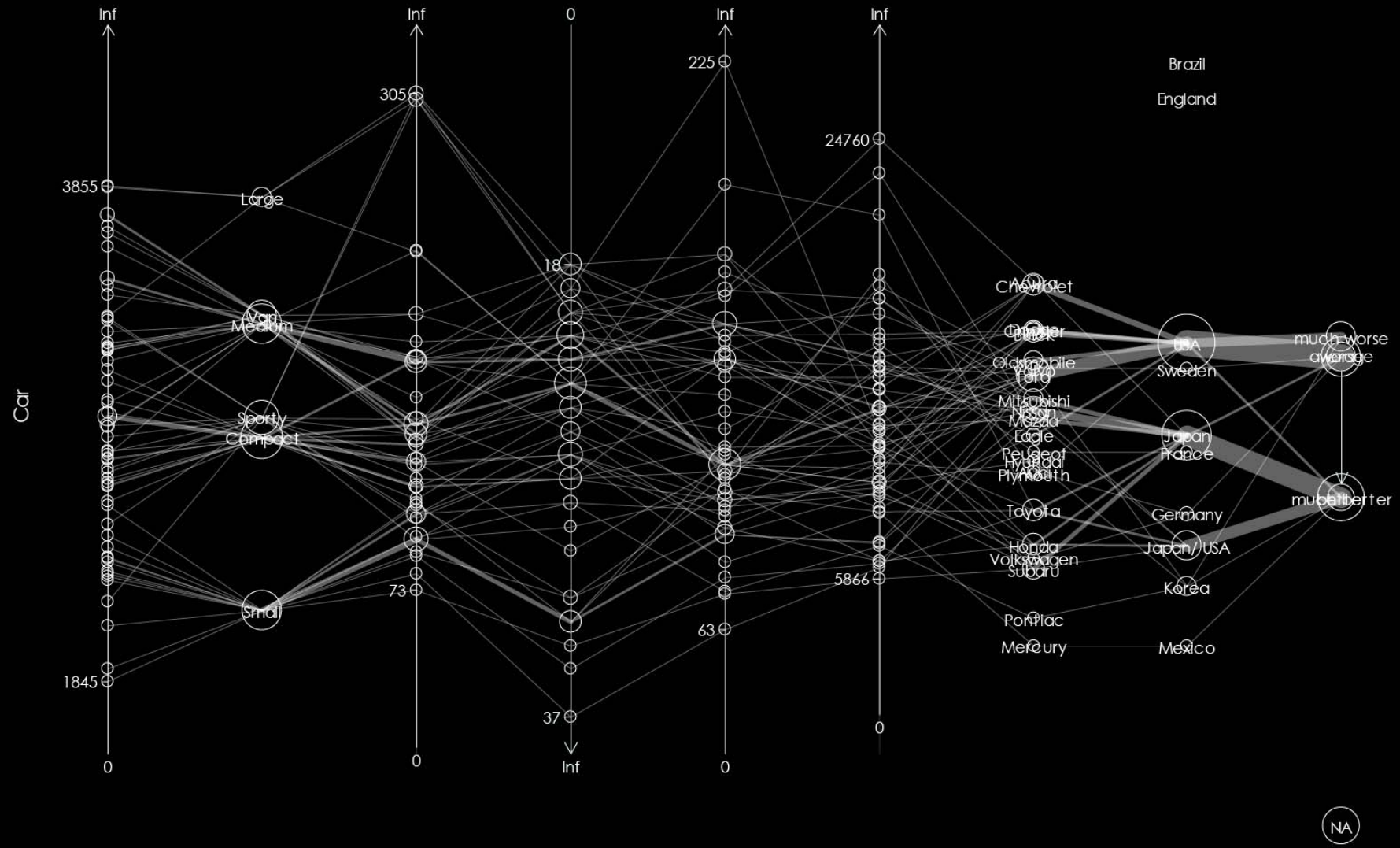
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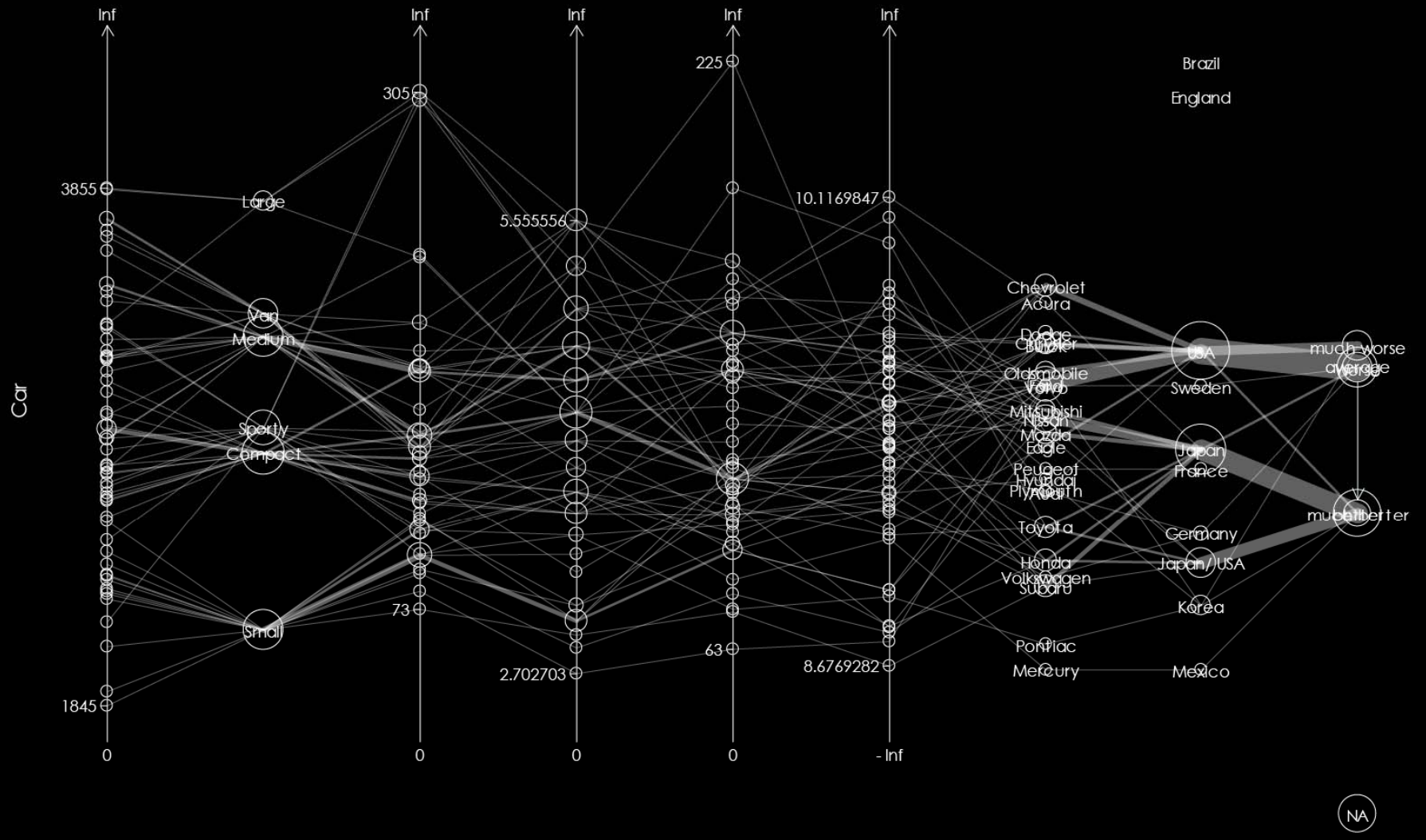
Plymouth
Toyota
Honda
Volkswagen
Subaru
Pontiac
Mercury
USA
Sweden
Japan
France
Germany
Japan/USA
Korea
Mexico
much worse
average
much better
NA
Weight (pound)
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability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Eagle
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Plymouth
Audi
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Displacement (cubic inch)
Fuel (100* gallon/ miles)
Horsepower (hp)
log(Price) (log(dollars))
Manufacturer
Country
Reliability

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- **Substitute Data Point**
- **Extract/Remove**
  - records
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- **Re-weight**
  - outliers
- **Order Data Vectors**
  - a priori
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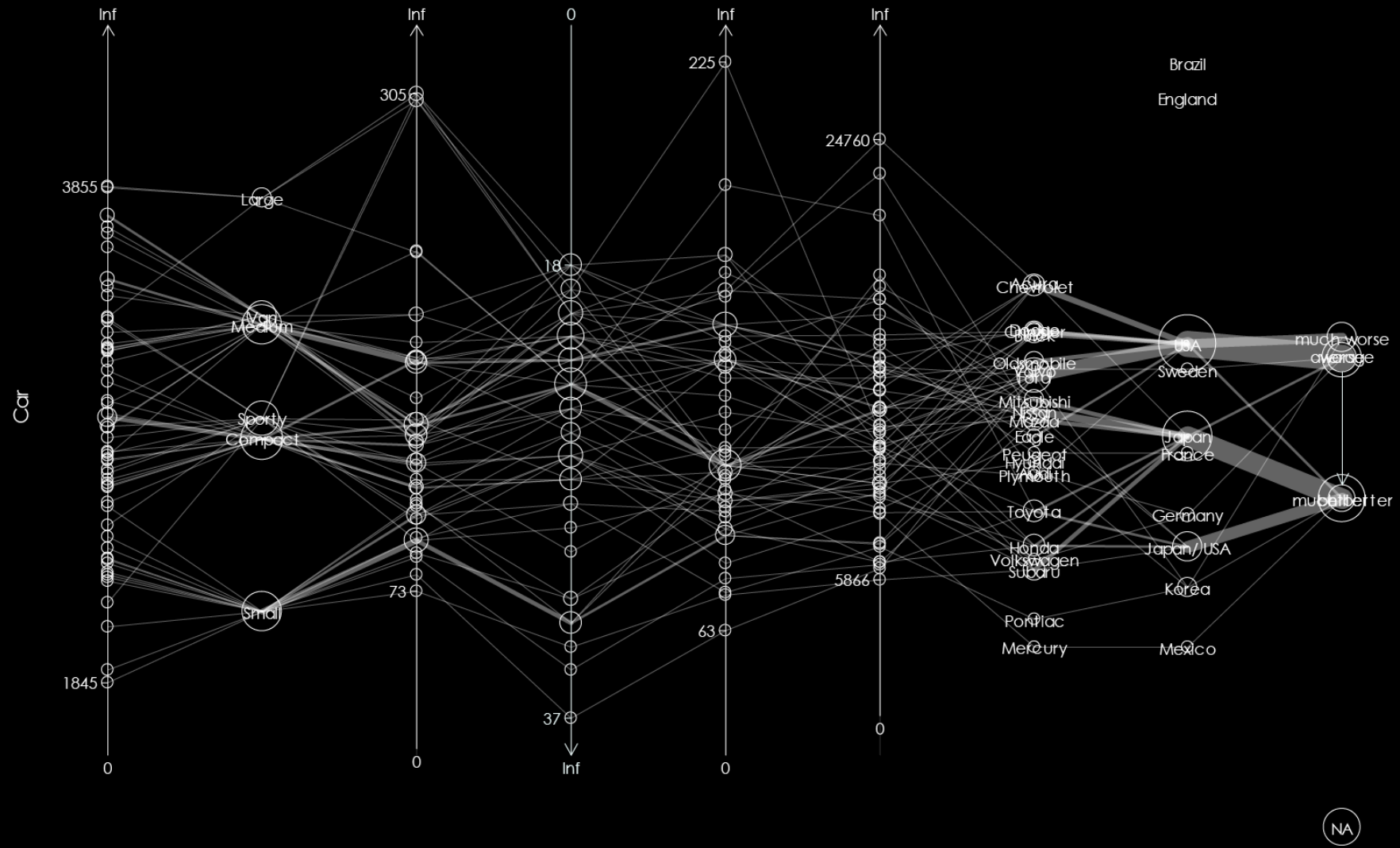
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Oldsmobile
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USA
Sweden
Japan
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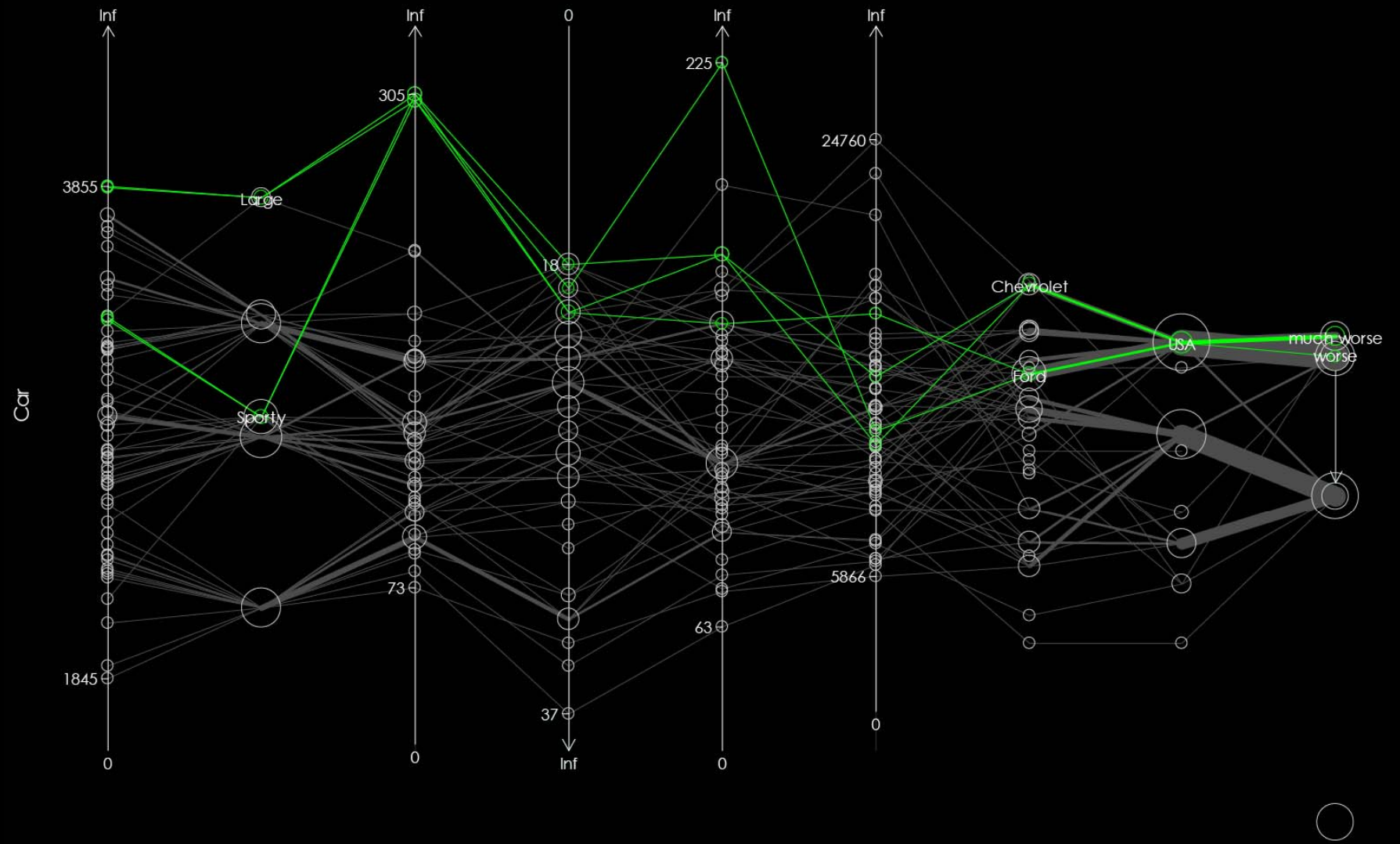
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Displacement (cubic inch)
Mileage (miles/ gallon)
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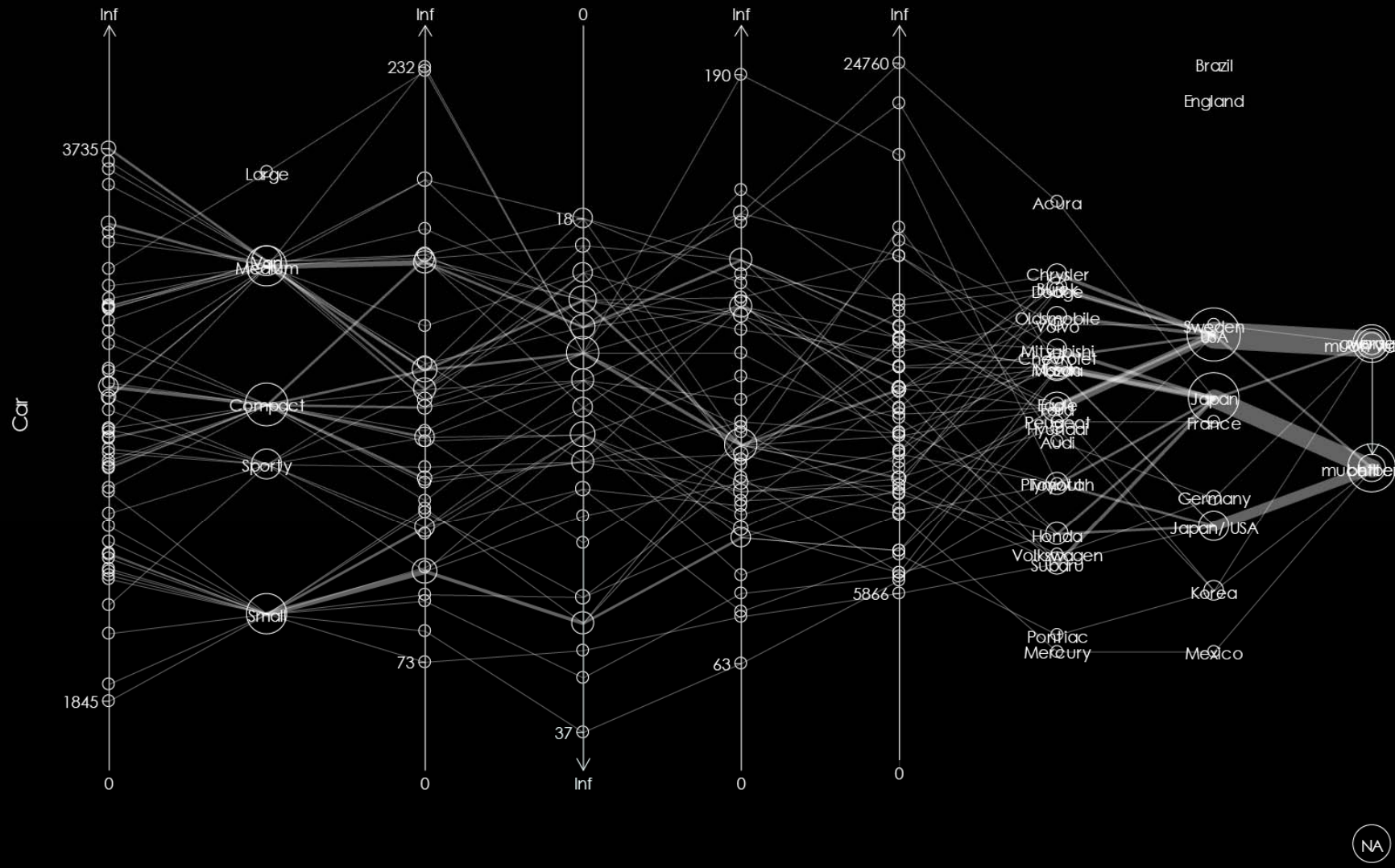
Price (dollars)
Manufacturer
Country
Reliability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England
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Chrysler
Dodge
Oldsmobile
Volvo
Mitsubishi
Chevrolet
Mazda
Eagle
Peugeot
Hyundai
Audi
Plymouth
Honda
Volkswagen
Subaru
Pontiac
Mercury
Sweden
USA
Japan
France
Germany
Japan/USA
Korea
Mexico
NA
Weight (pound)
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
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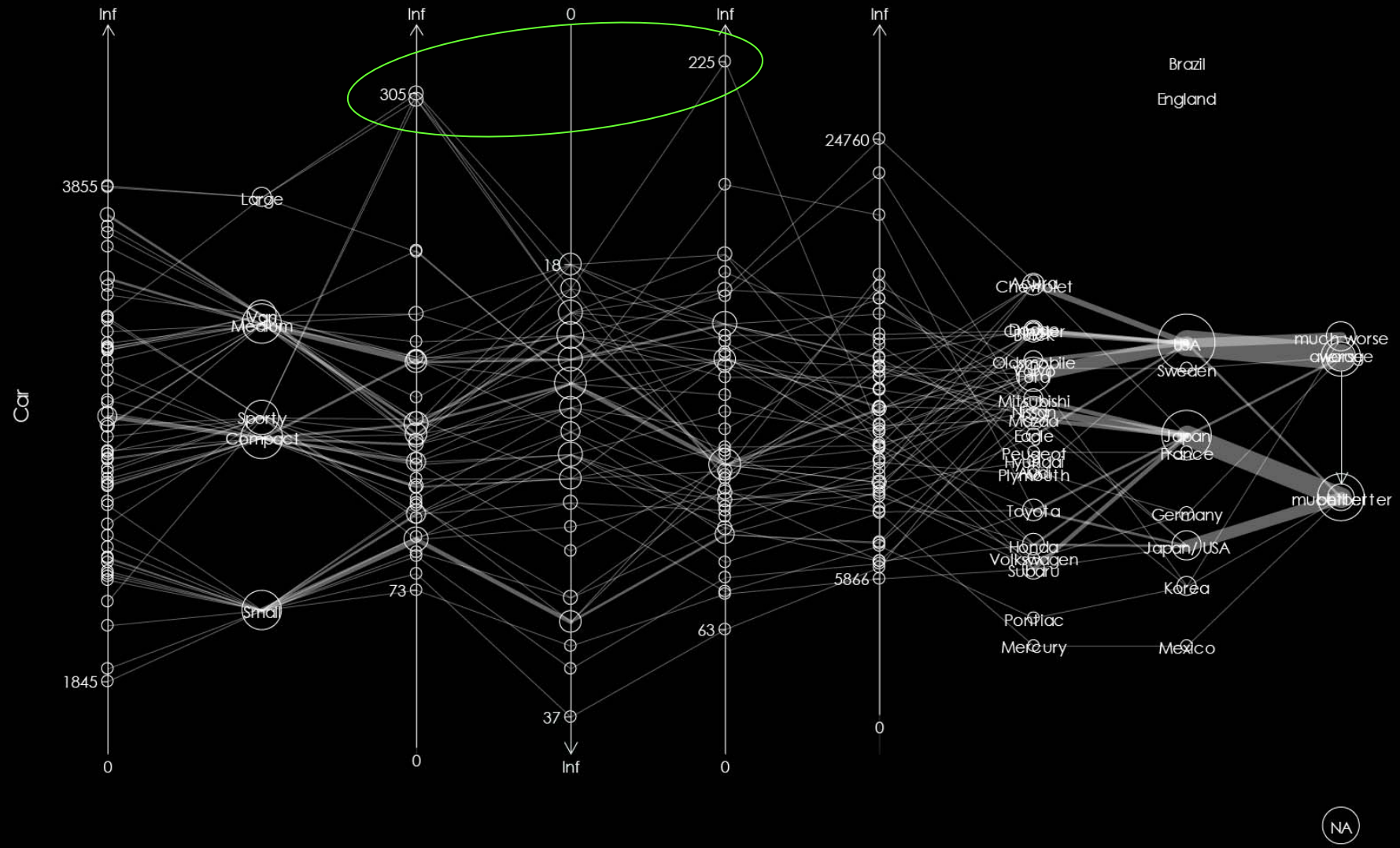
Car
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Brazil
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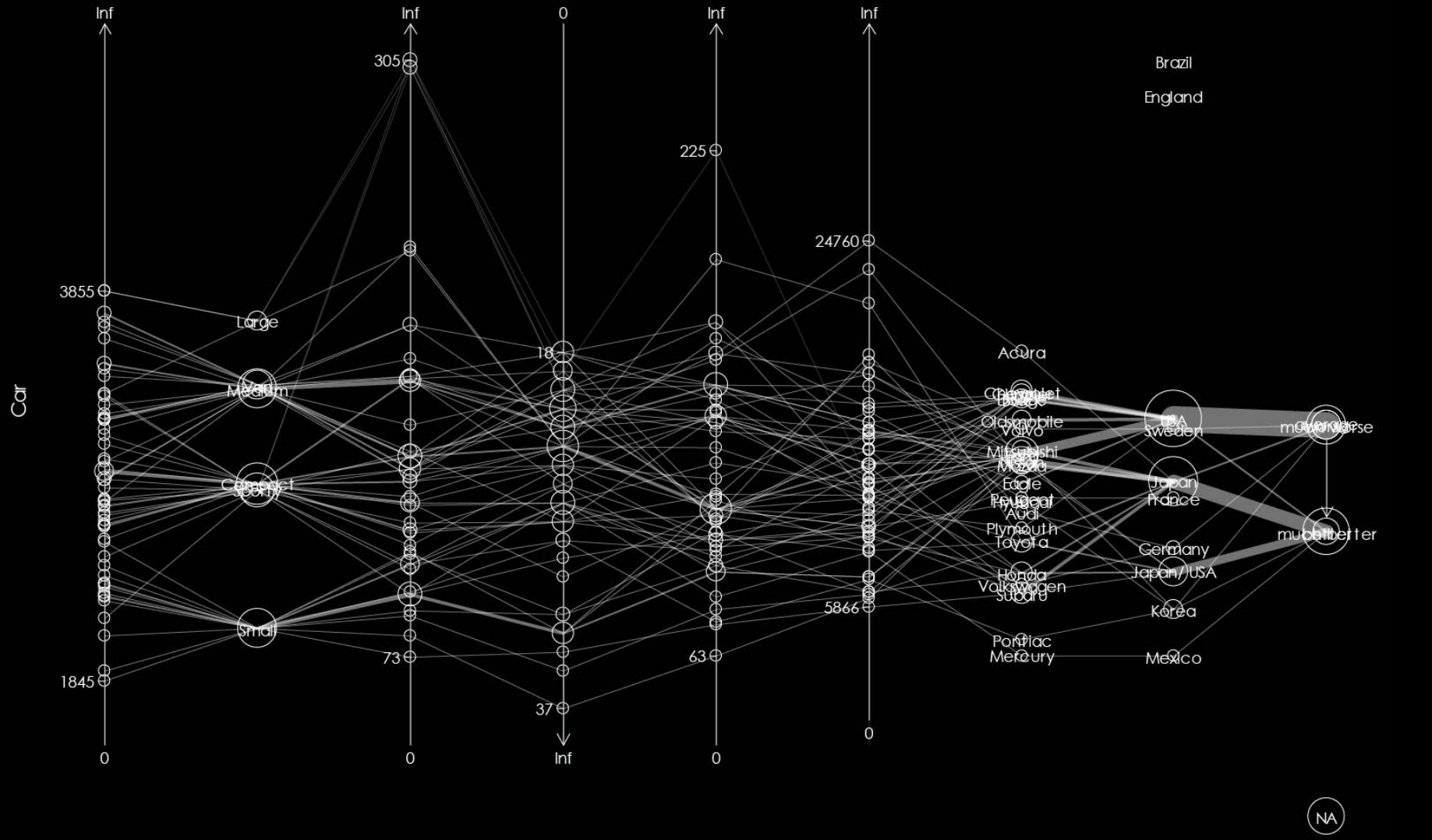
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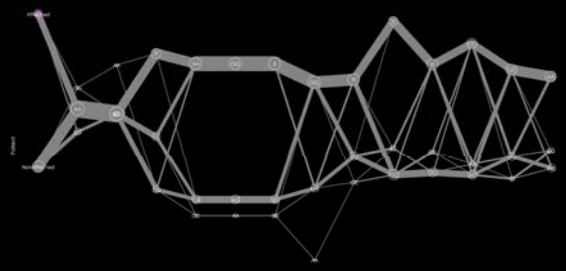
Order of Data Vectors

Data Vectors $\boldsymbol{x}_1, \ldots, \boldsymbol{x}_p$

A priori order

As it is



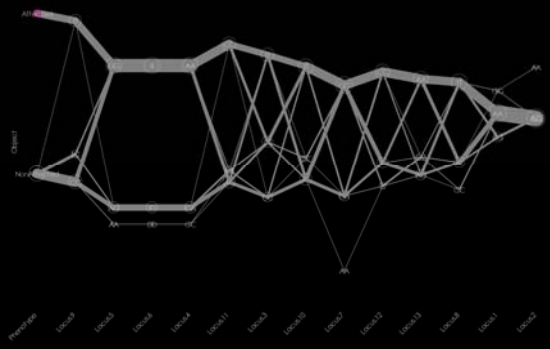
Distance to Ideal coord vec

The further left coordinate vector is closer to the ideal coordinate vector

$$\|\boldsymbol{y}_j - \hat{\boldsymbol{\xi}}\|^2 \leq \|\boldsymbol{y}_{j+1} - \hat{\boldsymbol{\xi}}\|^2$$

Ideal coordinate vector gives a set of ideal coordinates for each records

Classification of records



Distance between data vecs

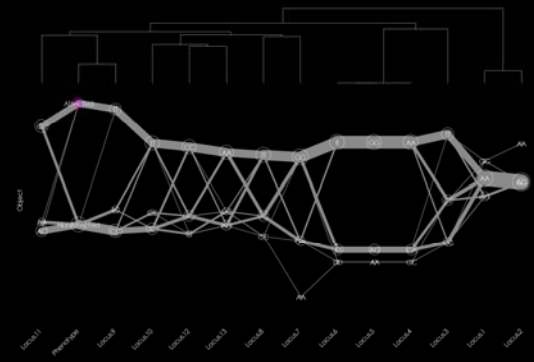
Sum of absolute values of slopes

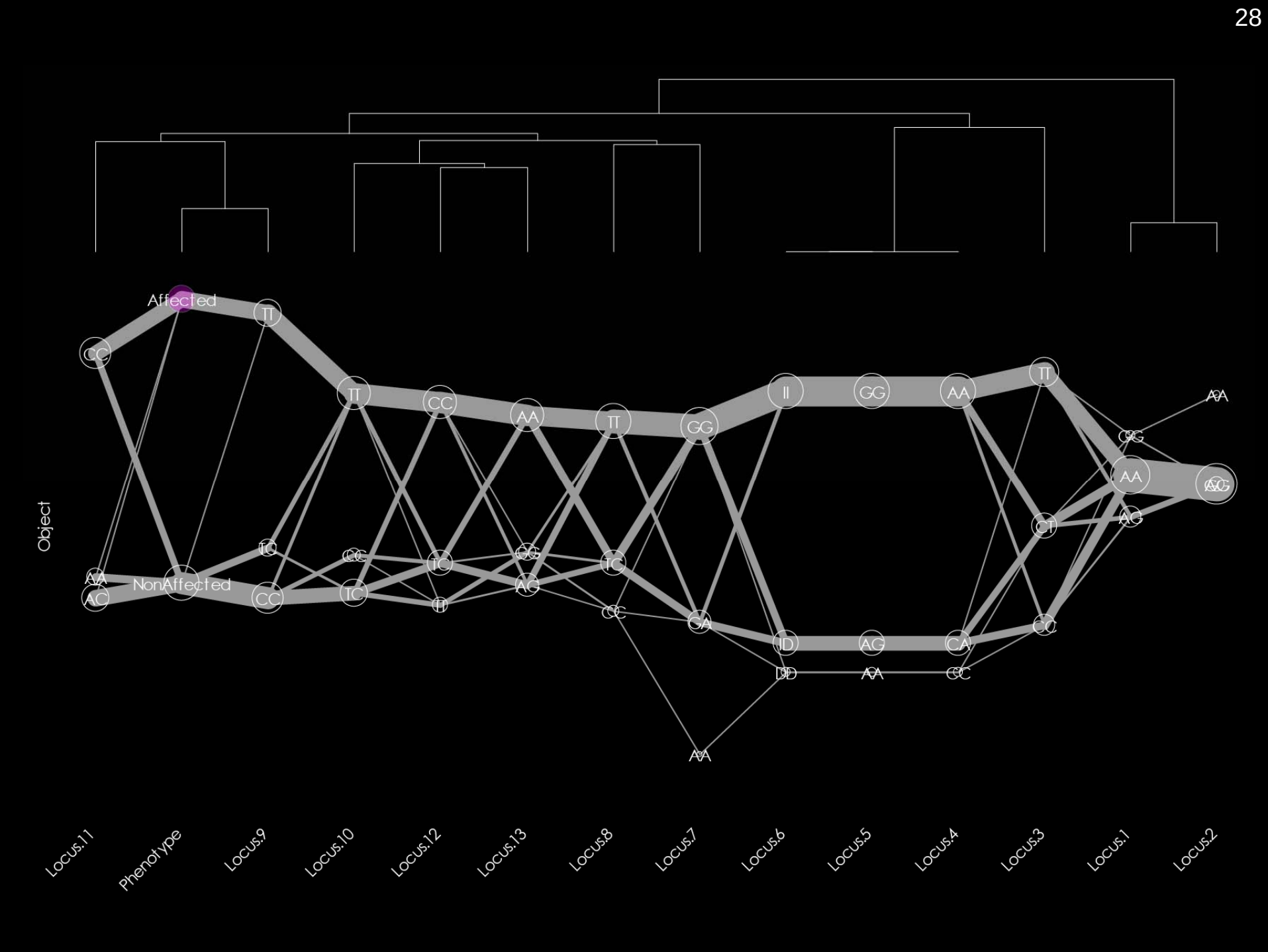
$$d(\boldsymbol{x}_j, \boldsymbol{x}_k) = \sum_{i=1}^{n} |y_{ij} - y_{ik}|$$

Linkage method

Ordered single end-linkage (Hurley 2004)

Classification of variables




Affected
NonAffected
Object
Locus.11
Phenotype
Locus.9
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Locus.12
Locus.13
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Locus.5
Locus.4
Locus.3
Locus.1
Locus.2

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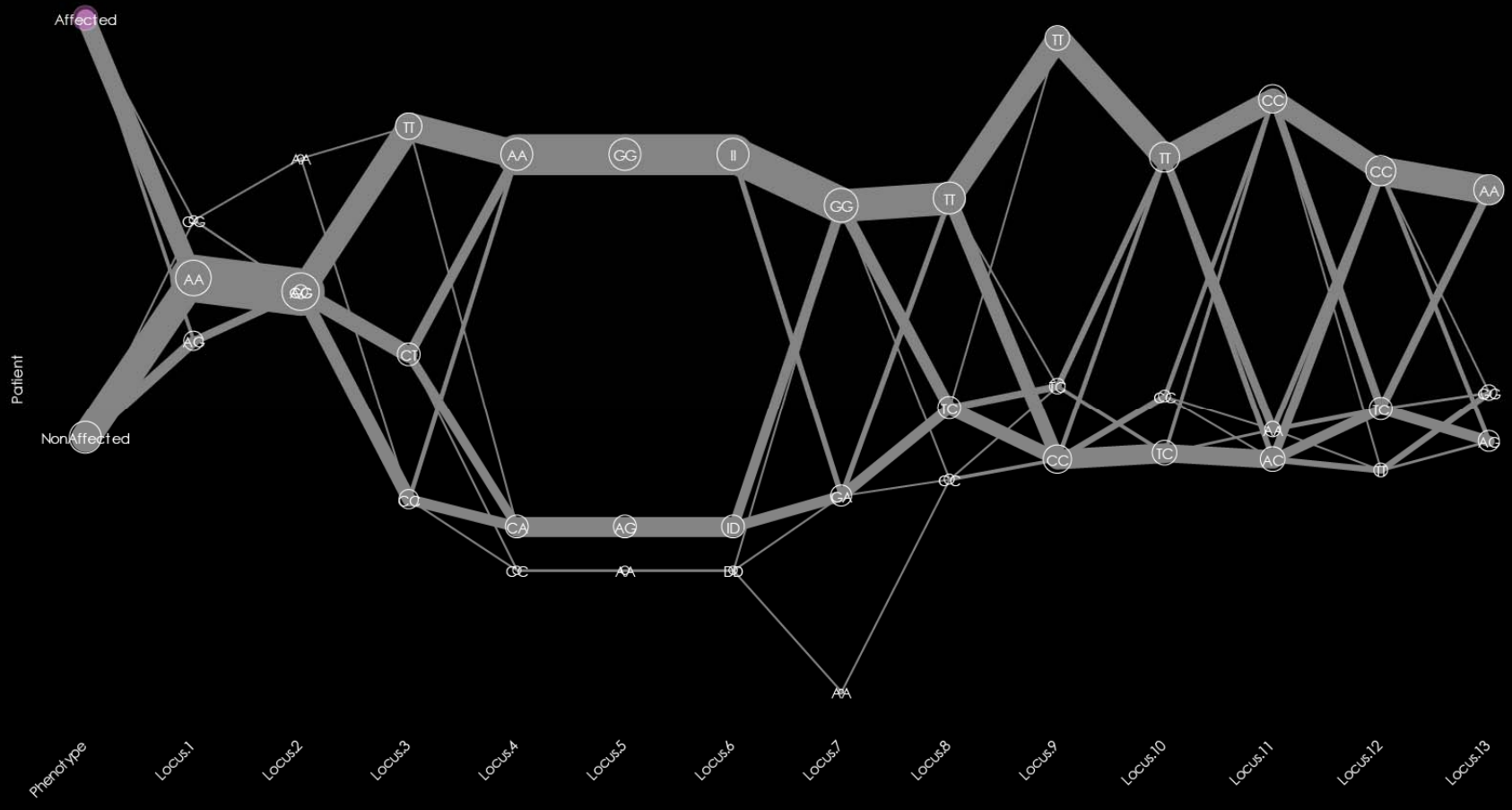
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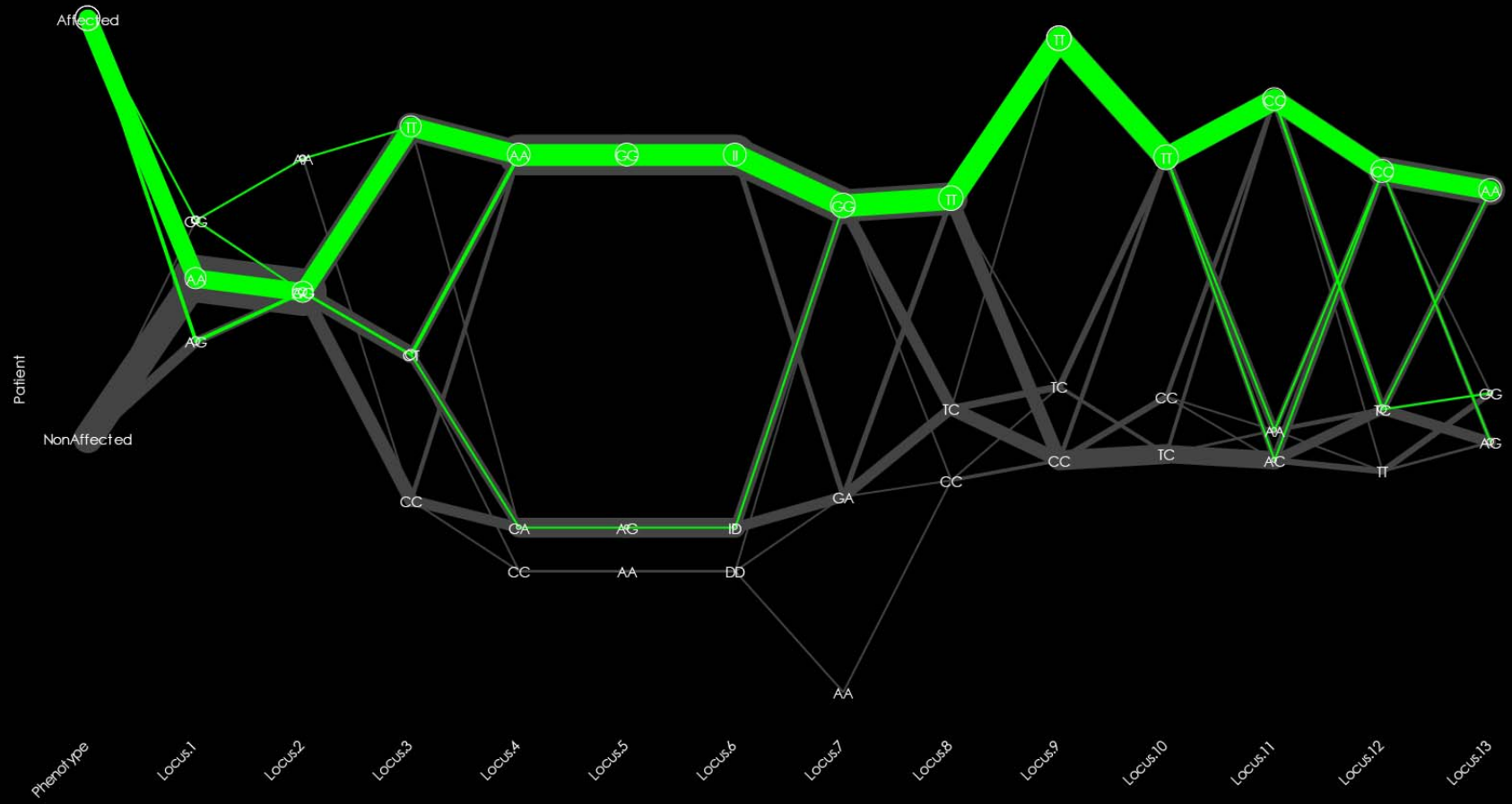
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GA
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ID
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DD
AA
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CC
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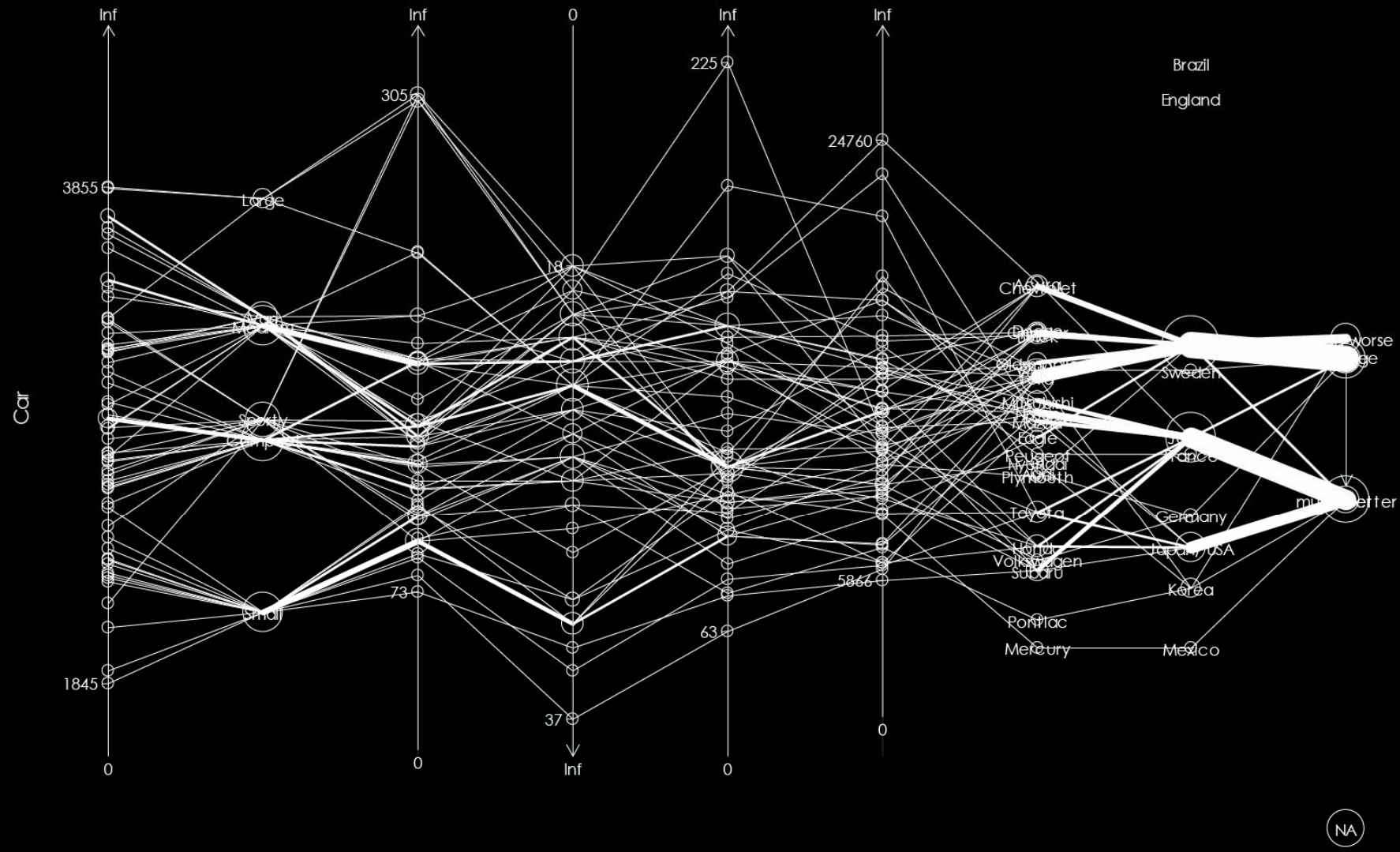
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Korea
Mexico
Toyota
Volkswagen
Subaru
Pontiac
Mercury
Eagle
Plymouth
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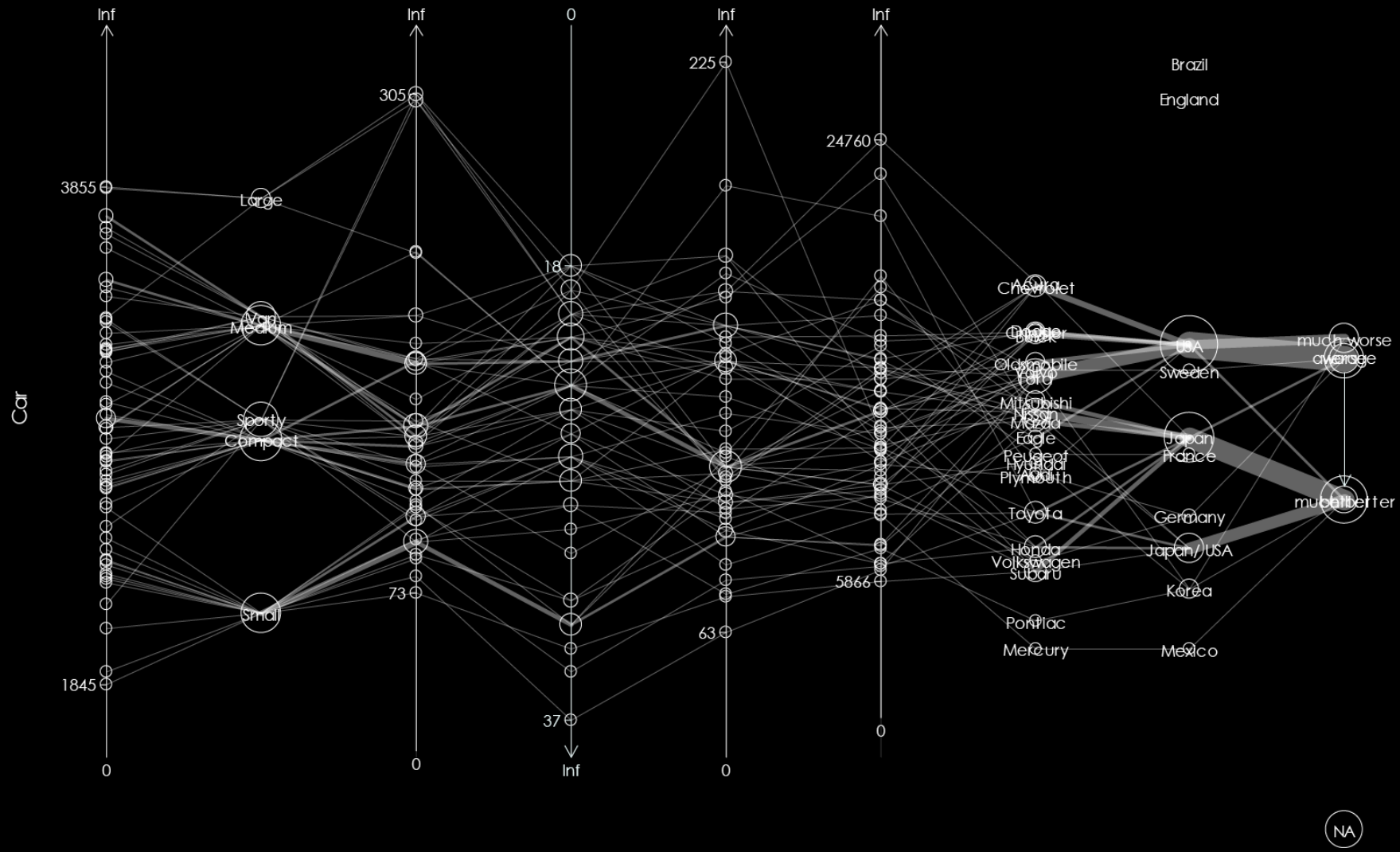
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability


Car
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Brazil
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Oldsmobile
Ford
Mitsubishi
Nissan
Mazda
Eagle
Peugeot
Hyundai
Plymouth
Toyota
Honda
Volkswagen
Subaru
Pontiac
Mercury
USA
Sweden
Japan
France
Germany
Japan/USA
Korea
Mexico
much worse
average
much better
NA
Weight (pound)
Type
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability

Enhancements of Textile Plot

Transform
- single data vector (log, inverse, etc)
- multiple data vectors (normalisation, etc)

Substitute Data Point

Extract/Remove
- records
- data vectors

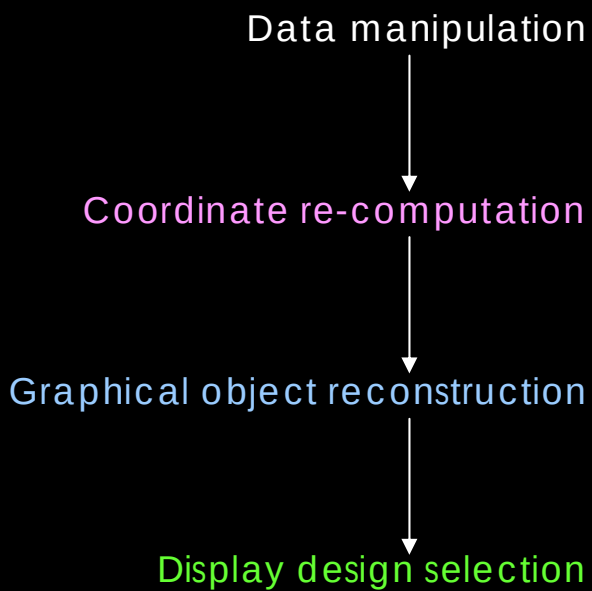
Re-weight
- outliers

Order Data Vectors
- a priori
- distance to ideal coordinates
- distance between coordinate vectors

Highlight Connecting Lines

Select Graphical Parameters
- color, transparency, size, etc.

Enhancements of Textile Plot



Transform
- single data vector (log, inverse, etc)
- multiple data vectors (normalisation, etc)

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Extract/Remove
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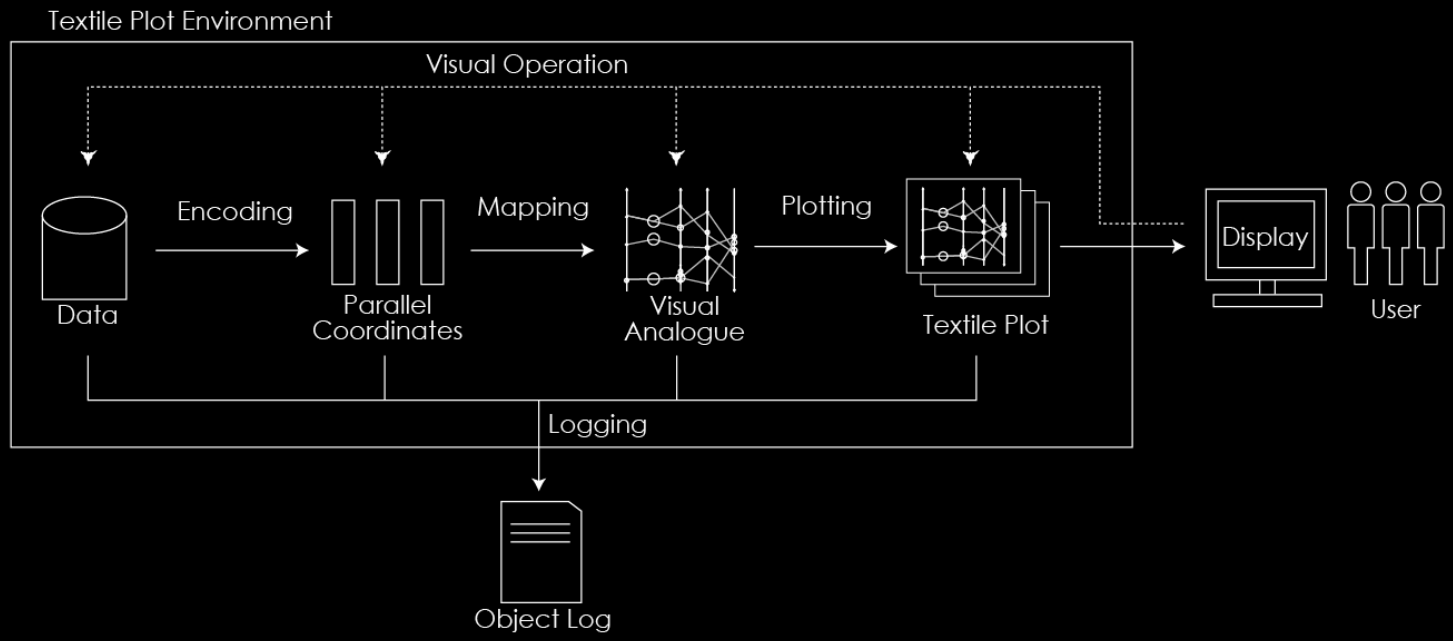
Reference Model

Kumasaka and Shibata 2007



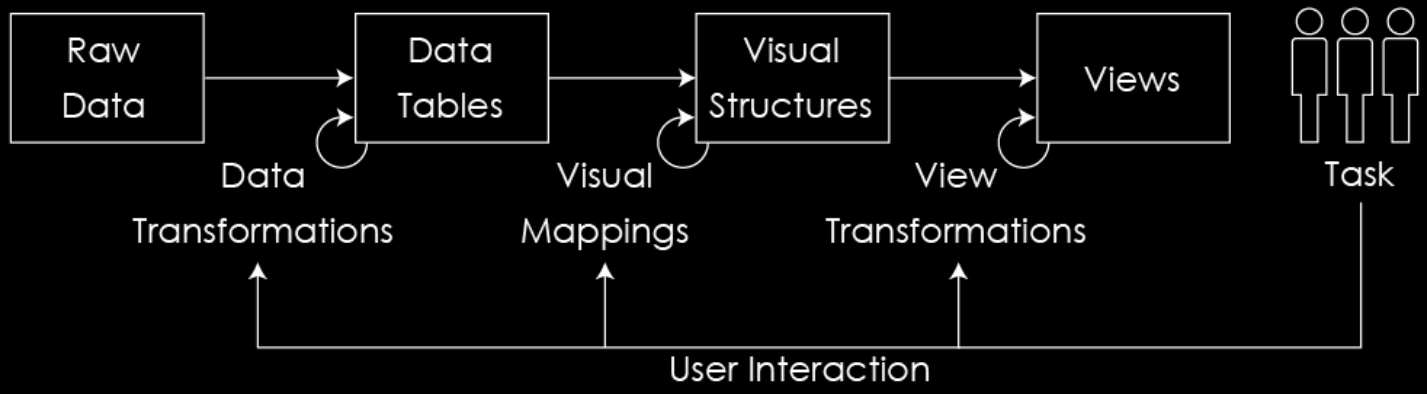
Sequence of objects

Visual operation

Object log

Reference Model for Information Visualization

Card, et al. 1999

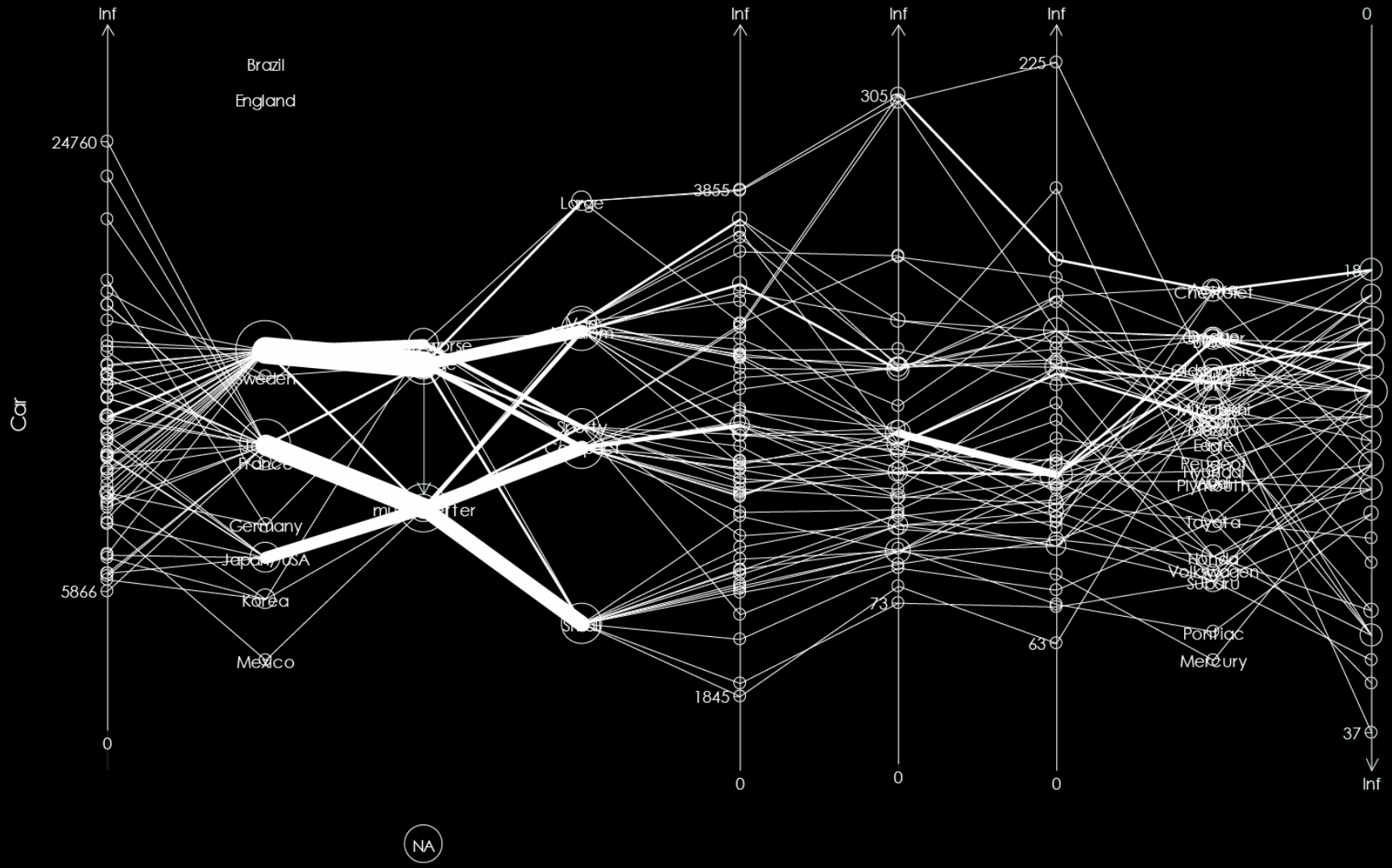


Raw Data idiosyncratic formats

Data Tables relations (cases by variables) + metadata

Visual Structures spatial substrates + marks + graphical properties

Views graphical parameters (positions, scaling, clipping,...)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Volkswagen
Subaru
Pontiac
Mercury
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37
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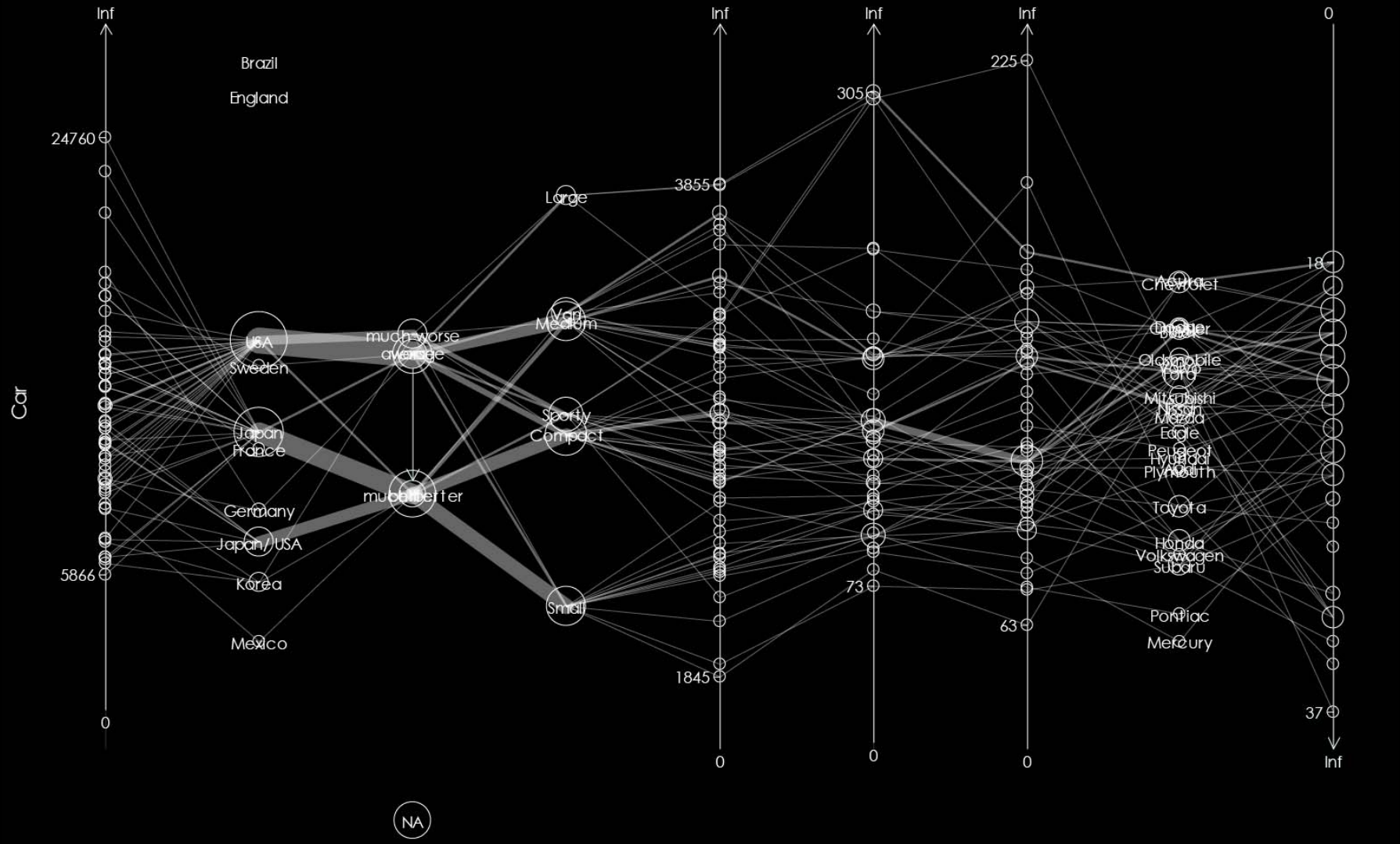
Price (dollars)
Country
Reliability
Type
Weight (pound)
Displacement (cubic inch)
Horsepower (hp)
Manufacturer
Mileage (miles/ gallon)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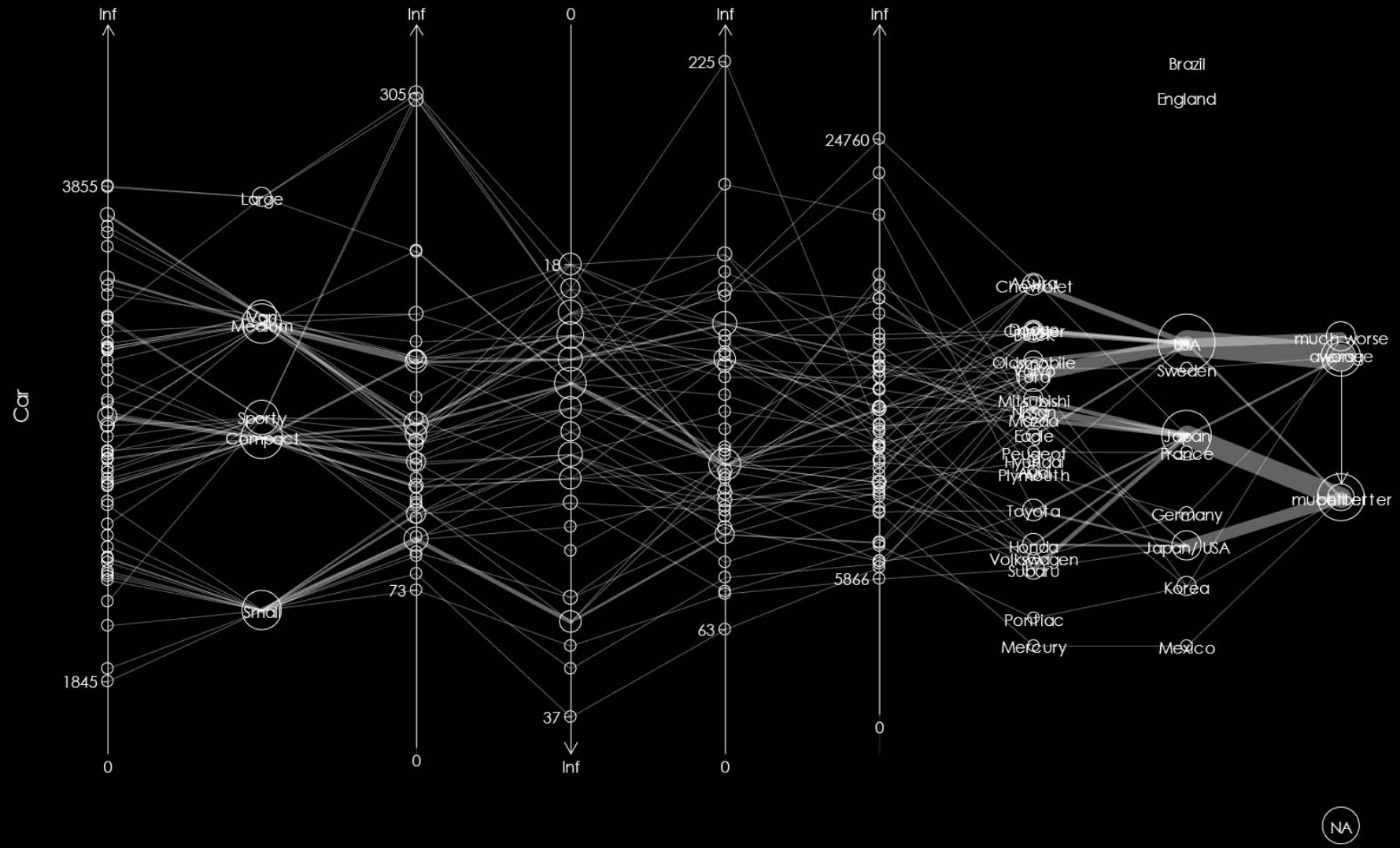
Reliability
Type
Weight (pound)
Displacement (cubic inch)
Horsepower (hp)
Manufacturer
Mileage (miles/ gallon)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Japan/USA
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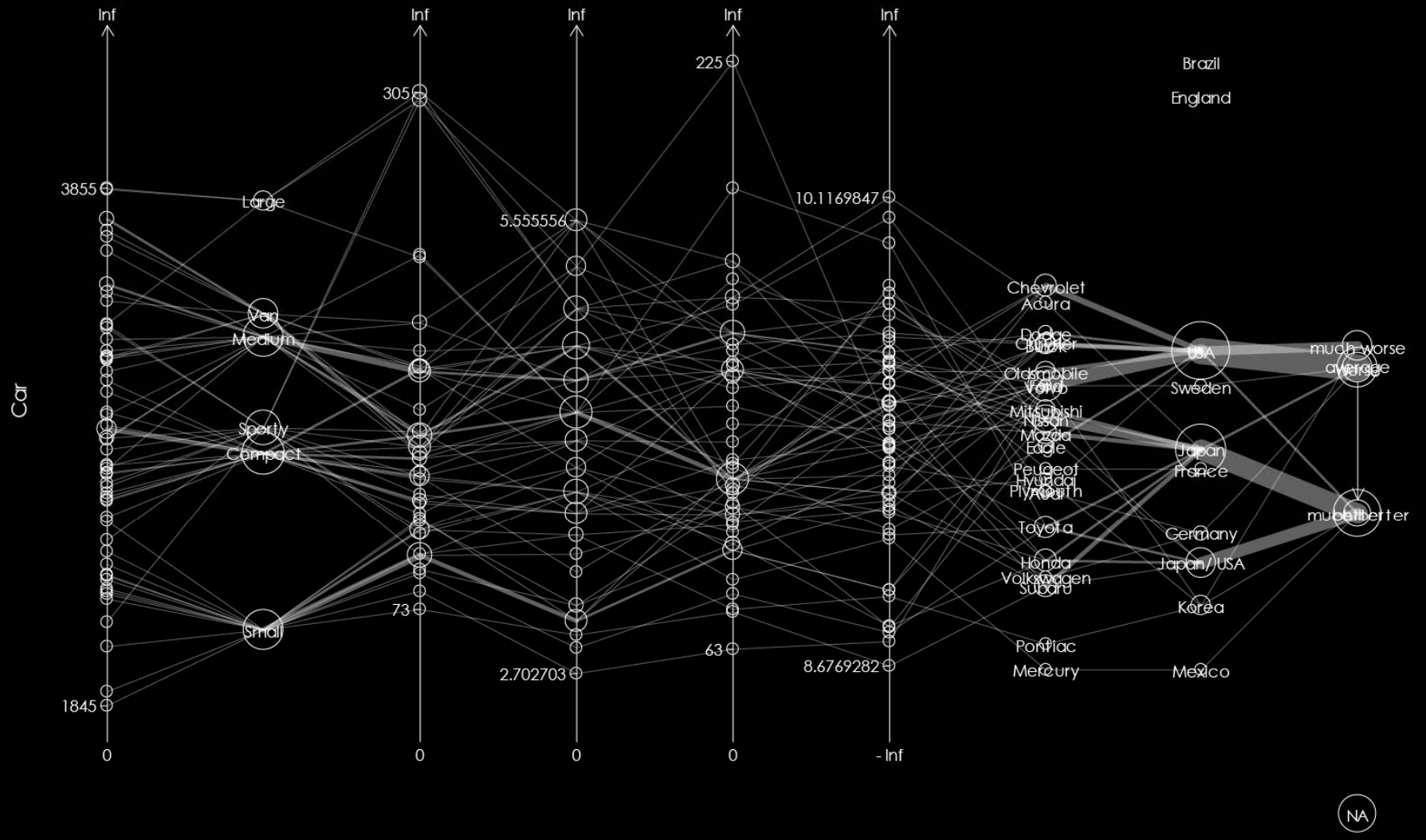
Displacement (cubic inch)
Mileage (miles/ gallon)
Horsepower (hp)
Price (dollars)
Manufacturer
Country
Reliability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Hyundai
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Audi
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Pontiac
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Germany
Japan/USA
Korea
Mexico
much worse
average
much better
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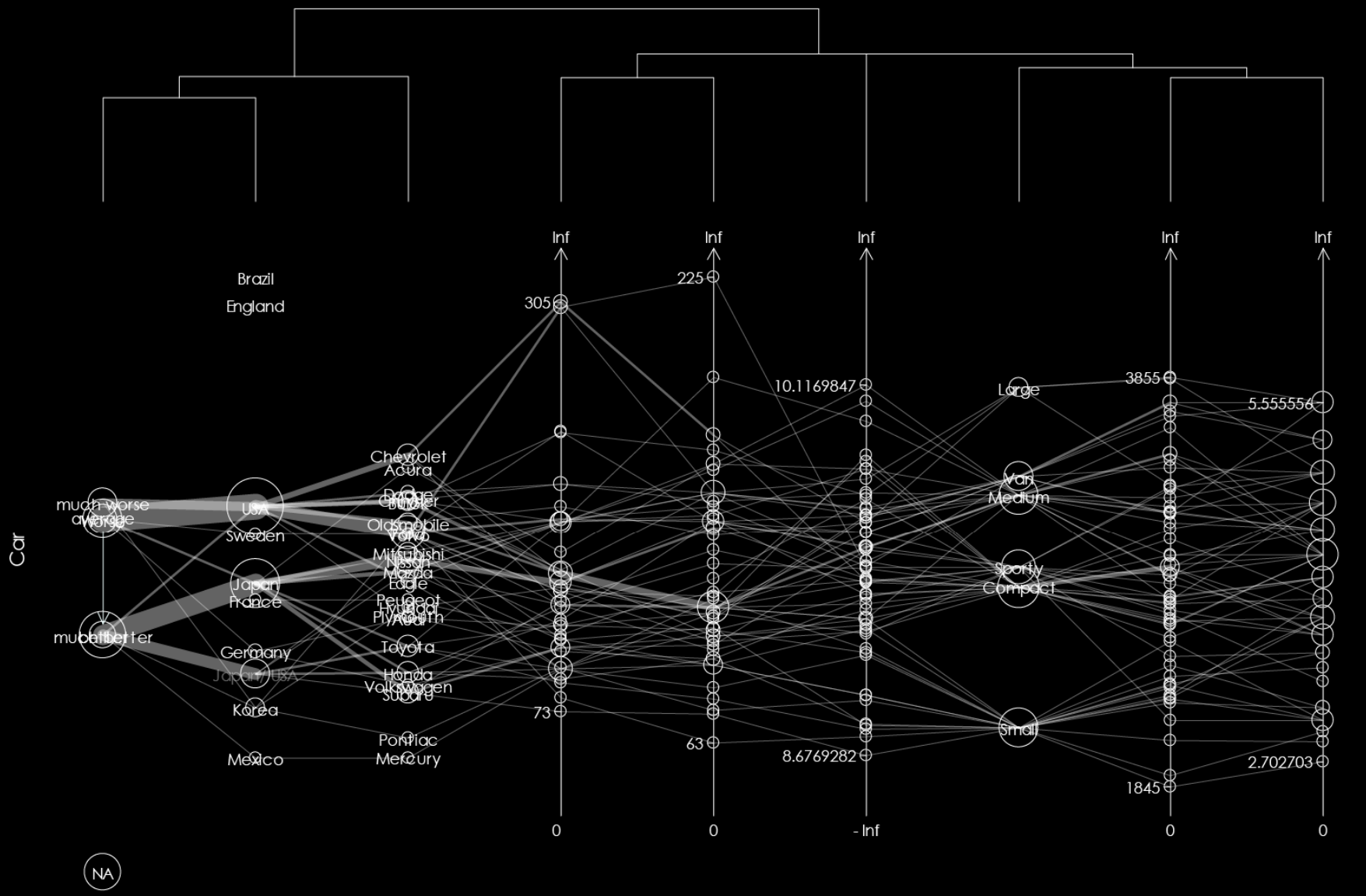
Weight (pound)
Type
Displacement (cubic inch)
Fuel (100* gallon/ miles)
Horsepower (hp)
log(Price) (log(dollars))
Manufacturer
Country
Reliability


Car
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Chevrolet
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Buick
Oldsmobile
Volvo
Mitsubishi
Nissan
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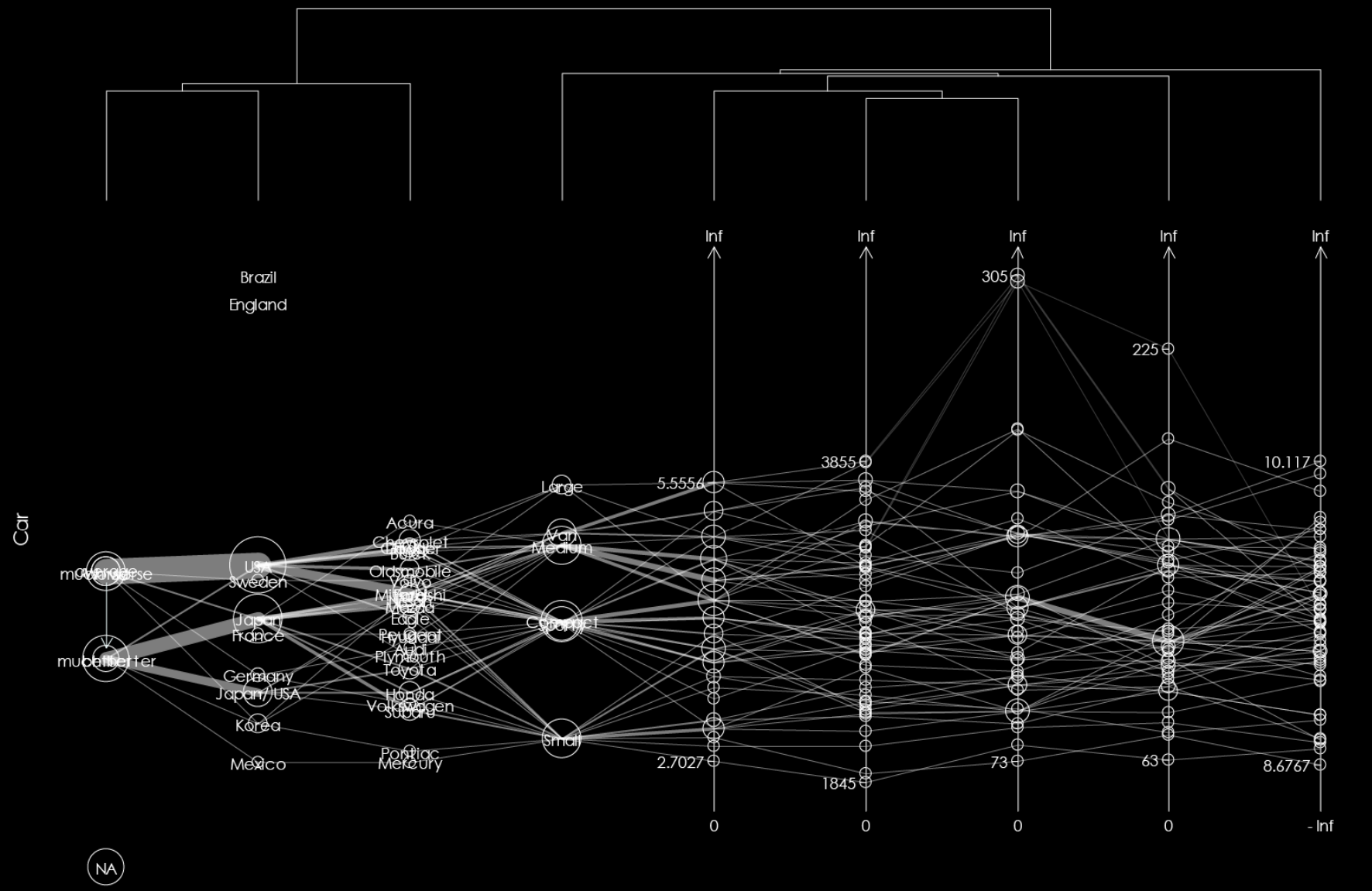
Reliability
Country
Manufacturer
Displacement (cubic inch)
Horsepower (hp)
log(Price) (log(dollars))
Type
Weight (pound)
Fuel (100* gallon/ miles)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Reliability
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Manufacturer
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Weight
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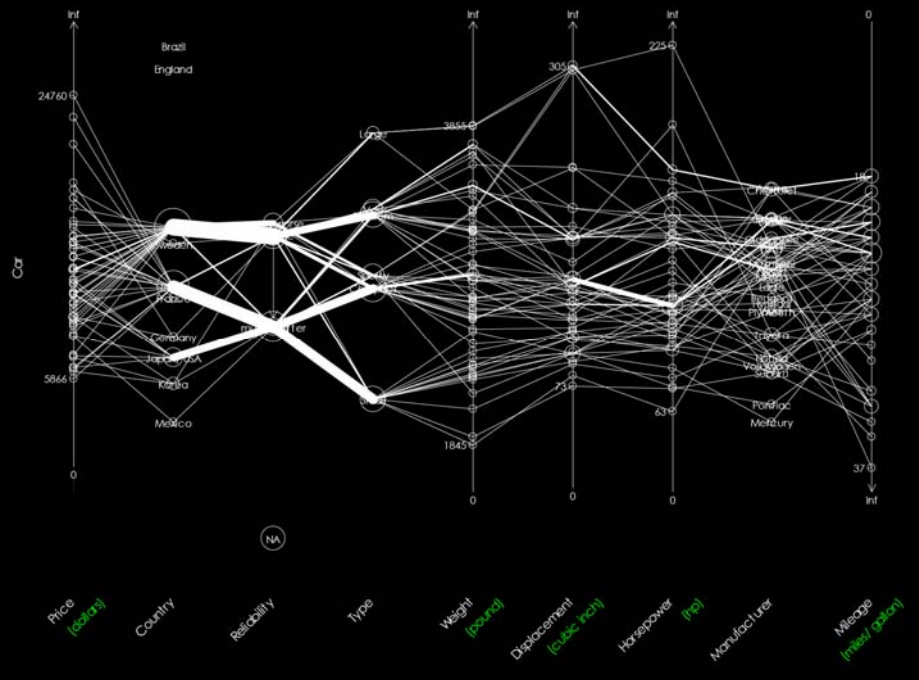
Horsepower
(hp)
log(Price)
(log(dollars))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Mercury
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Korea
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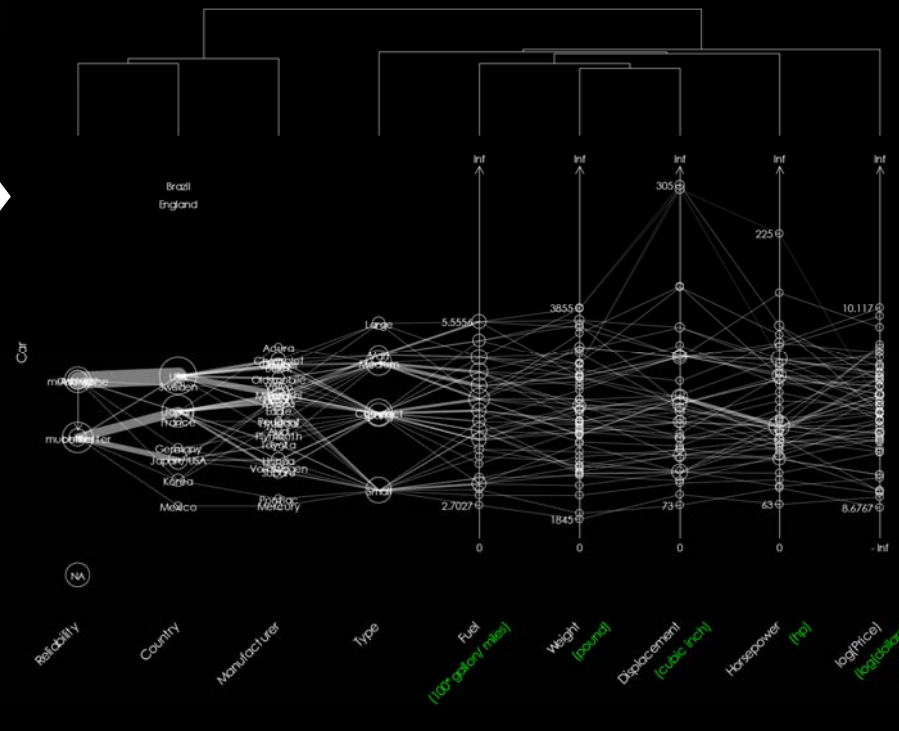
Price (dollars)
Country
Reliability
Type
Weight (pound)
Displacement (cubic inch)
Horsepower (hp)
Manufacturer
Mileage (miles/ gallon)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Large
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Mexico
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Korea
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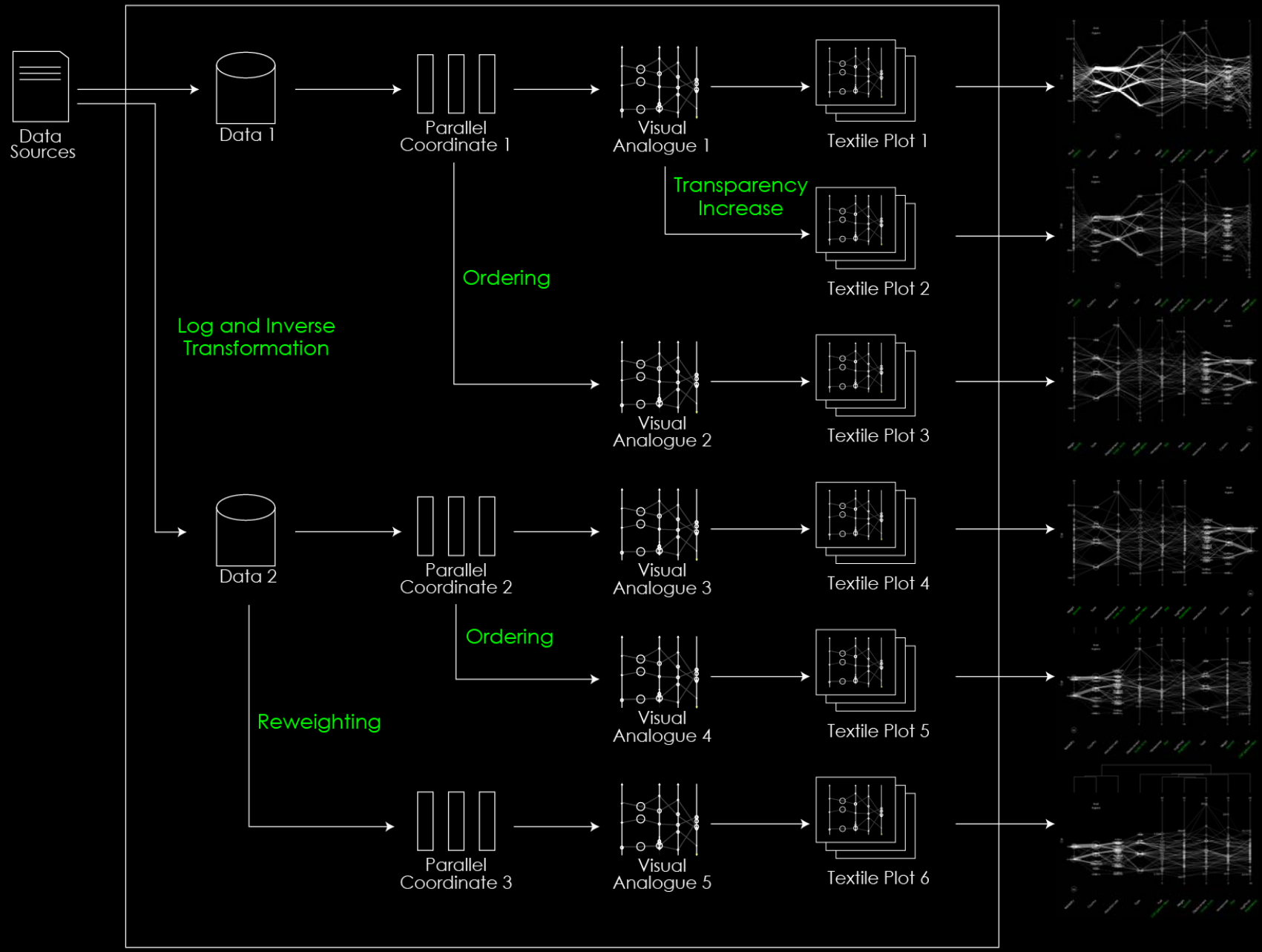
Reliability
Country
Manufacturer
Type
Fuel (100*gallon/ miles)
Weight (pound)
Displacement (cubic inch)
Horsepower (hp)
log(Price) (log(dollars))

Automobile Data Analysis Log



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