Visualizing changes over time using dynamic hierarchies: TreeVersity2 and the StemView

John Alexis Guerra Gómez, Michael L. Pack, Catherine Plaisant and Ben Shneiderman

parc®
A Xerox Company

Product					
Apples					
Oranges					
Milk					
Bread					
Butter					
Orange Juice					
Soda					

So you are collecting some data

Product	Category	Refrigerate?	Boxed	QTY	Price
Apples					
Oranges					
Milk					
Bread					
Butter					
Orange Juice					
Soda					

and it has many attributes

Product	Category	Refrigerate?	Boxed	QTY	Price
Apples				230	$1.5
Oranges				210	$5
Milk				93	$2
Bread				105	$3
Butter				10	$10
Orange Juice				143	$4
Soda				150	$7

some numerical

Product	Category	Refrigerate?	Boxed	QTY	Price
Apples	Fruit	No	No	230	$1.5
Oranges	Fruit	No	No	210	$5
Milk	Liquids	Yes	Yes	93	$2
Bread	Staple	No	No	105	$3
Butter	Staple	Yes	Yes	10	$10
Orange Juice	Liquids	Yes	Yes	143	$4
Soda	Liquids	Yes	Yes	150	$7

some categorical

Product	Category	Refrigerate?	Boxed	QTY	Price
Apples	Fruit	No	No	220	$2
Oranges	Fruit	No	No	110	$3
Milk	Liquids	Yes	Yes	95	$1
Bread	Staple	No	No	73	$2
Cherries	Fruit	No	Yes	22	$7.1
Orange Juice	Liquids	Yes	Yes	100	$4
Soda	Liquids	Yes	Yes	190	$7

And it changes over time…

Product	Category	Refrigerate?	Boxed	QTY	Price
Apples	Fruit	No	No	220	$2
Oranges	Fruit	No	No	110	$3
Milk	Liquids	Yes	Yes	95	$1
Bread	Staple	No	No	73	$2
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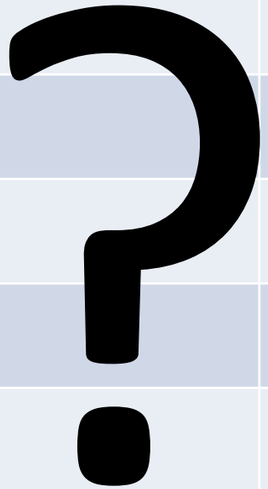
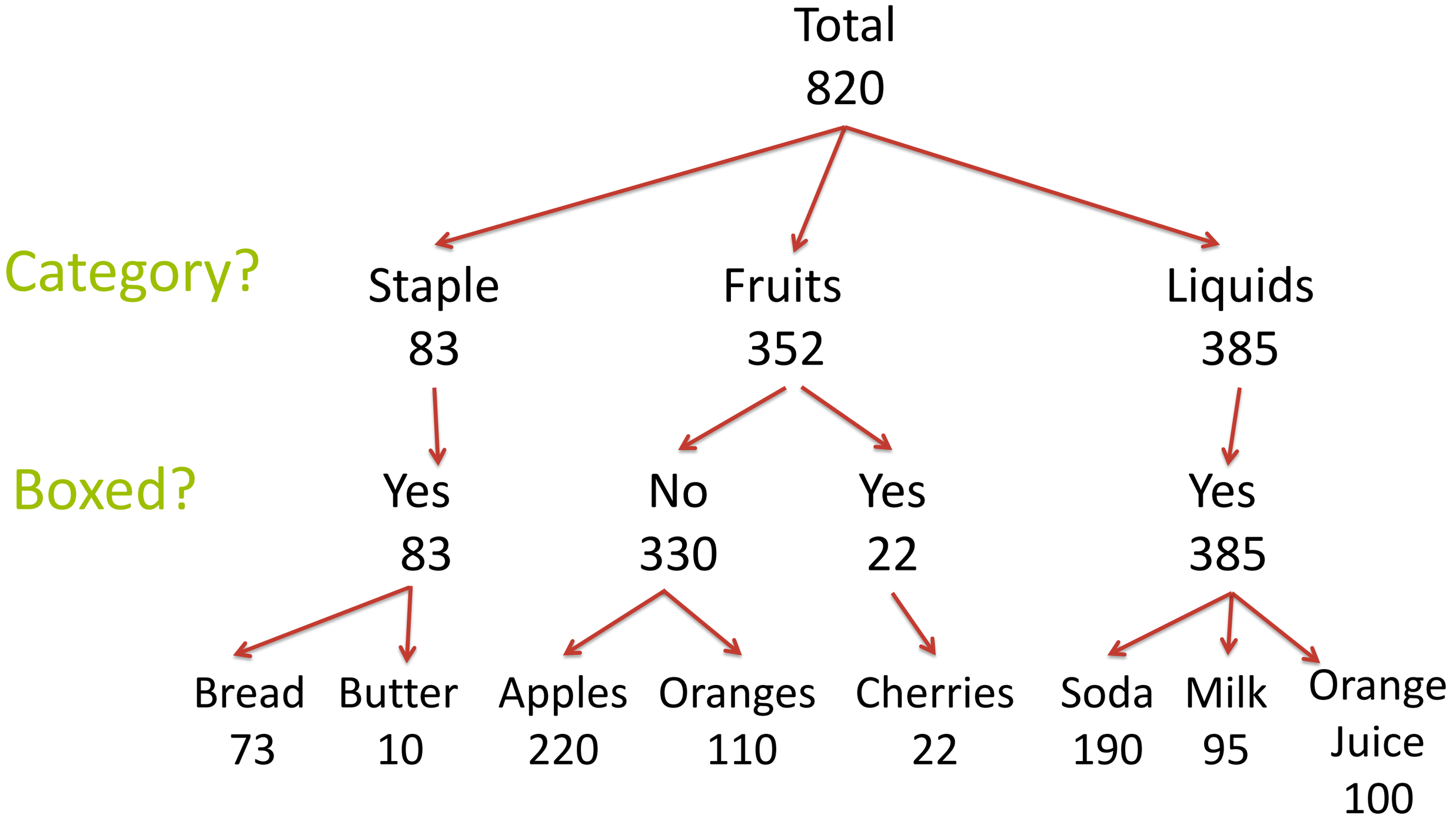
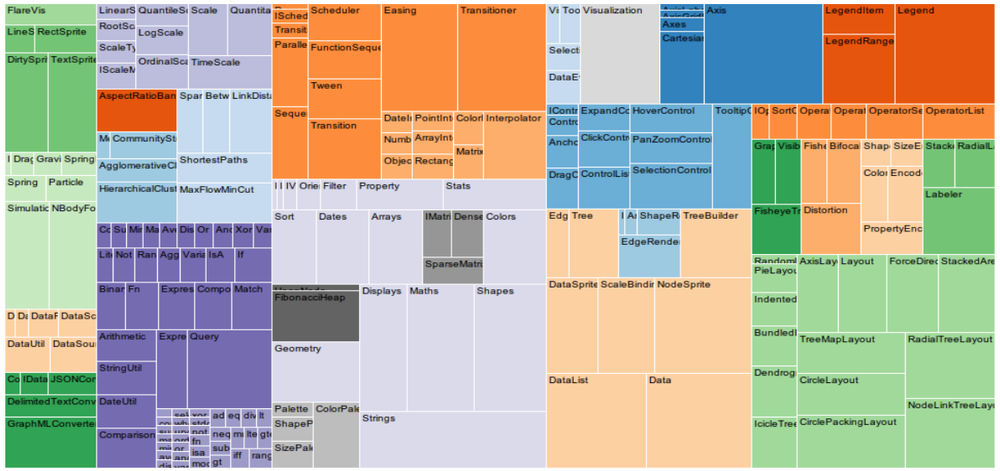


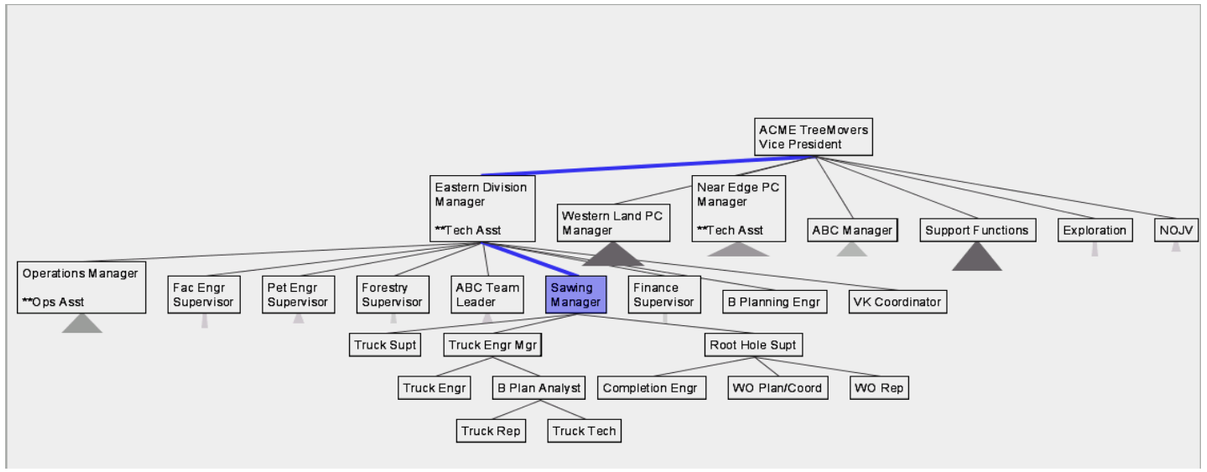
What Changed?


Total
820
Category?
Staple
83
Fruits
352
Liquids
385
Boxed?
Yes
83
No
330
Yes
22
Yes
385
Bread
73
Butter
10
Apples
220
Oranges
110
Cherries
22
Soda
190
Milk
95
Orange Juice
100

…and we are really good with them



TreeMaps [Johnson & Shneiderman 1991]



SpaceTree [Plaisant, Grosjean & Bederson 1998]

Visualizing

Navigating

Storing, Computing, etc…

What about comparing them?

Definitions

Tree

- Set of nodes and links that express the parent-to-child relationship.
- Where each node:
  - Is uniquely labeled in the tree.
  - Contains one or more numeric variables with values over time.
  - Contains one or more categorical attributes that may have more than one value.

Types of Trees

Fixed

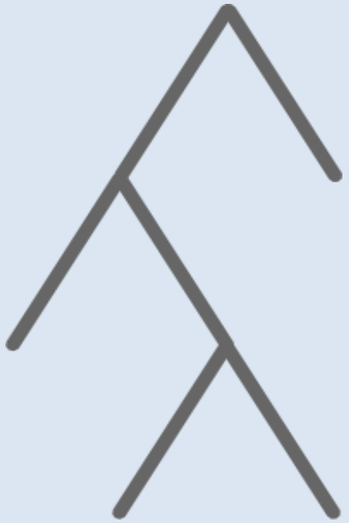
State

↓

County

↓

City



Dynamic

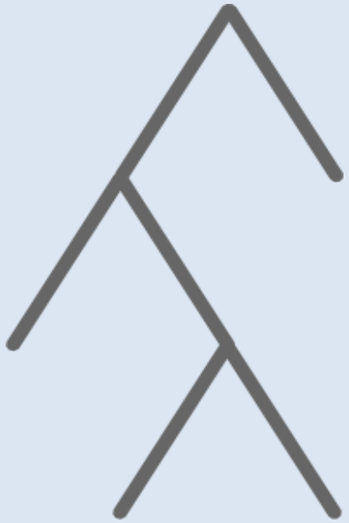
Gender

↕

Ethnicity

↕

Age range



Mixed

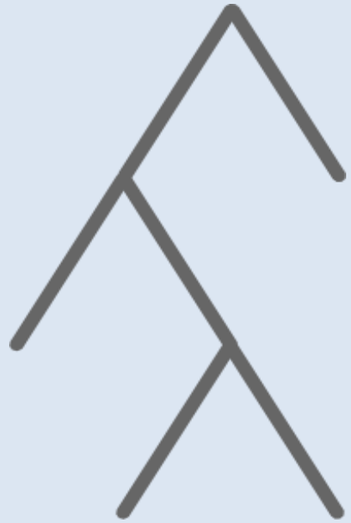
Gender

↕

State

↓

City

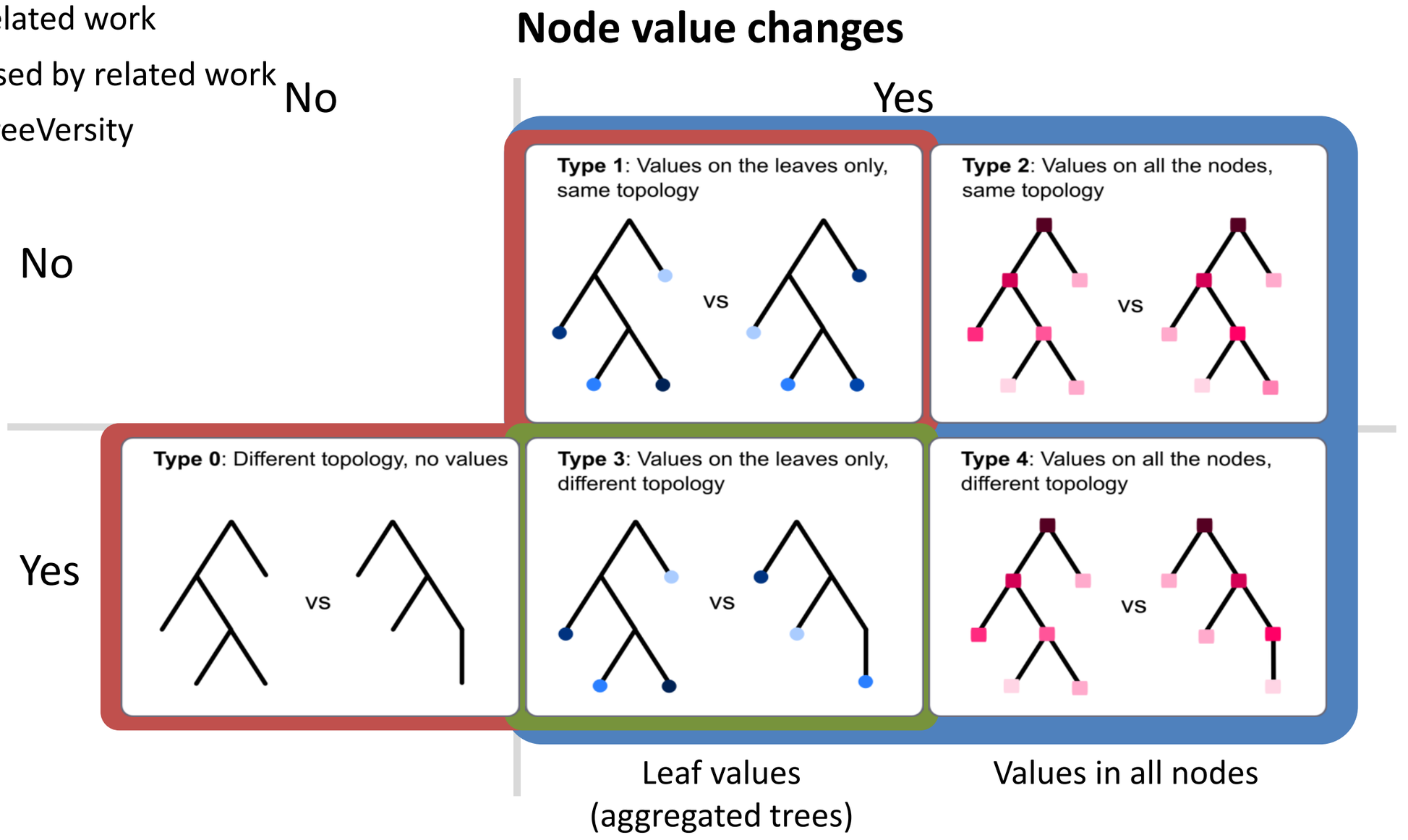


Types of Tree Comparison

Addressed by related work

Partially addressed by related work

Addressed by TreeVersity



Back to the problem

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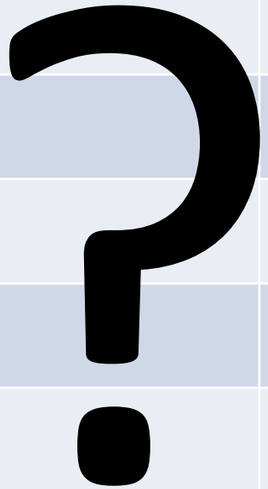
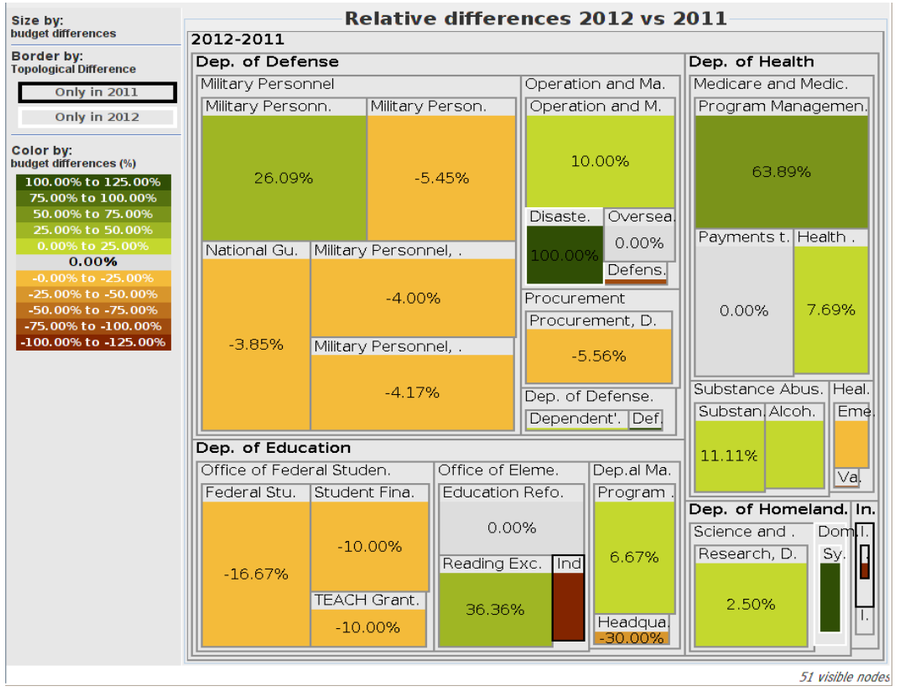
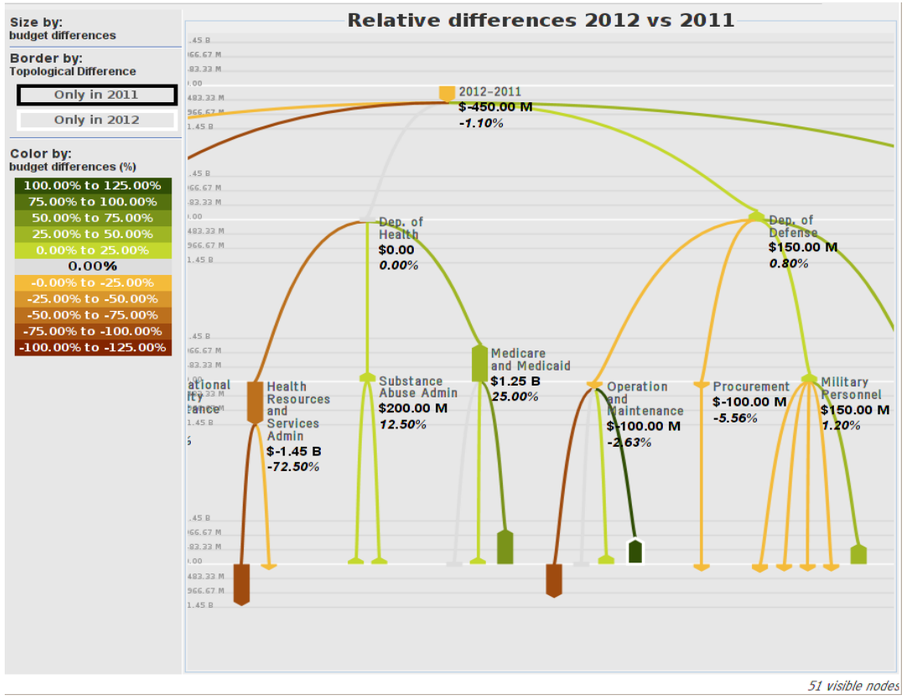


What Changed?

Current solutions

Node	Le...	budget diff	%budget diff
Domestic Nuclear Detection Office	2	$500.00 M	100.00%
Defense Vessel Transfer Receipt Acc...	3	$100.00 M	100.00%
Disaster relief	3	$800.00 M	100.00%
Systems Acquisition	3	$500.00 M	100.00%
Program Management	3	$1.15 B	63.89%
Reading Excellence	3	$400.00 M	36.36%
Dep. of Defense--Military	2	$200.00 M	33.33%
Dep. of Homeland Security	1	$550.00 M	27.50%
Military Personnel, Army	3	$600.00 M	26.09%
Medicare and Medicaid	2	$1.25 B	25.00%
Dependent's Education Gift Fund	3	$100.00 M	20.00%
Alcohol, Drug Abuse, and Mental He...	3	$100.00 M	14.29%
Substance Abuse Admin	2	$200.00 M	12.50%
Substance Abuse and Mental Health...	3	$100.00 M	11.11%
Operation and Maintenance, Defens...	3	$200.00 M	10.00%
Health Care Fraud and Abuse Contro...	3	$100.00 M	7.69%
Program Admin	3	$100.00 M	6.67%
Science and Technology	2	$50.00 M	2.50%
Research, Development, Acquisition...	3	$50.00 M	2.50%
Military Personnel	2	$150.00 M	1.20%
Dep. of Defense	1	$150.00 M	0.80%
Dep. of Health	1	$0.00	0.00%
Office of Elementary Ed	2	$0.00	0.00%
International Security Assistance	2	$0.00	0.00%
Overseas Humanitarian, Disaster, an...	3	$0.00	0.00%
Education Reform	3	$0.00	0.00%
Payments to Health Care Trust Funds	3	$0.00	0.00%
Peacekeeping Operations	3	$0.00	0.00%
/	0	$-450.00 M	-1.10%
Dep.al Management	2	$-50.00 M	-2.50%
Operation and Maintenance	2	$-100.00 M	-2.63%
National Guard Personnel, Army	3	$-100.00 M	-3.85%
Military Personnel, Navy	3	$-100.00 M	-4.00%
Military Personnel, Air Force	3	$-100.00 M	-4.17%
Military Personnel, Marine Corps	3	$-150.00 M	-5.45%
Procurement	2	$-100.00 M	-5.56%

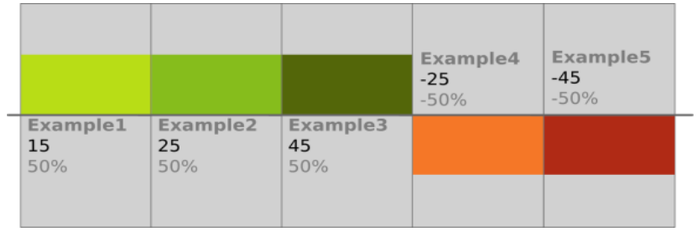




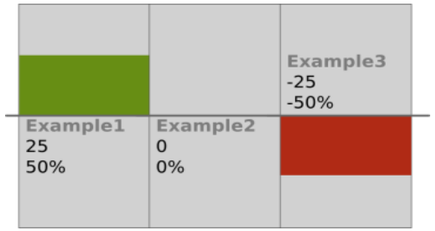
The Bullet [Guerra Gómez, Buck-Colmean, Plaisant, Shneiderman 2012]

The StemView: 5 characteristics of change

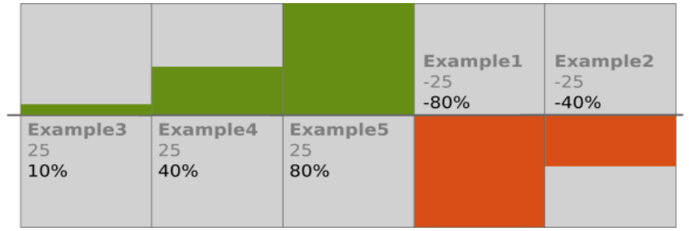
Actual Change (Color)



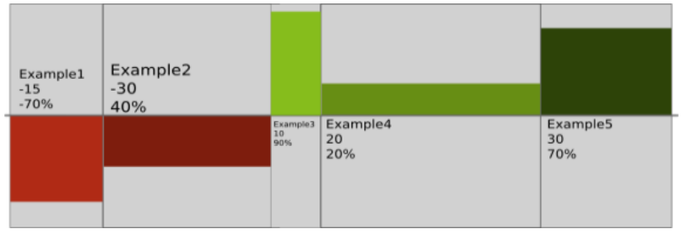
Direction



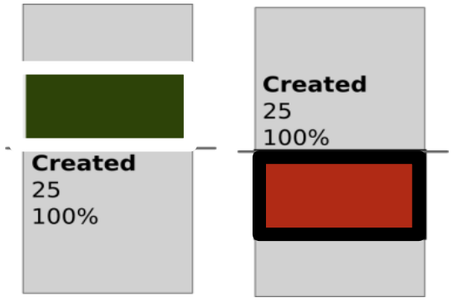
Relative Change (Height)



Ending Value (Width)



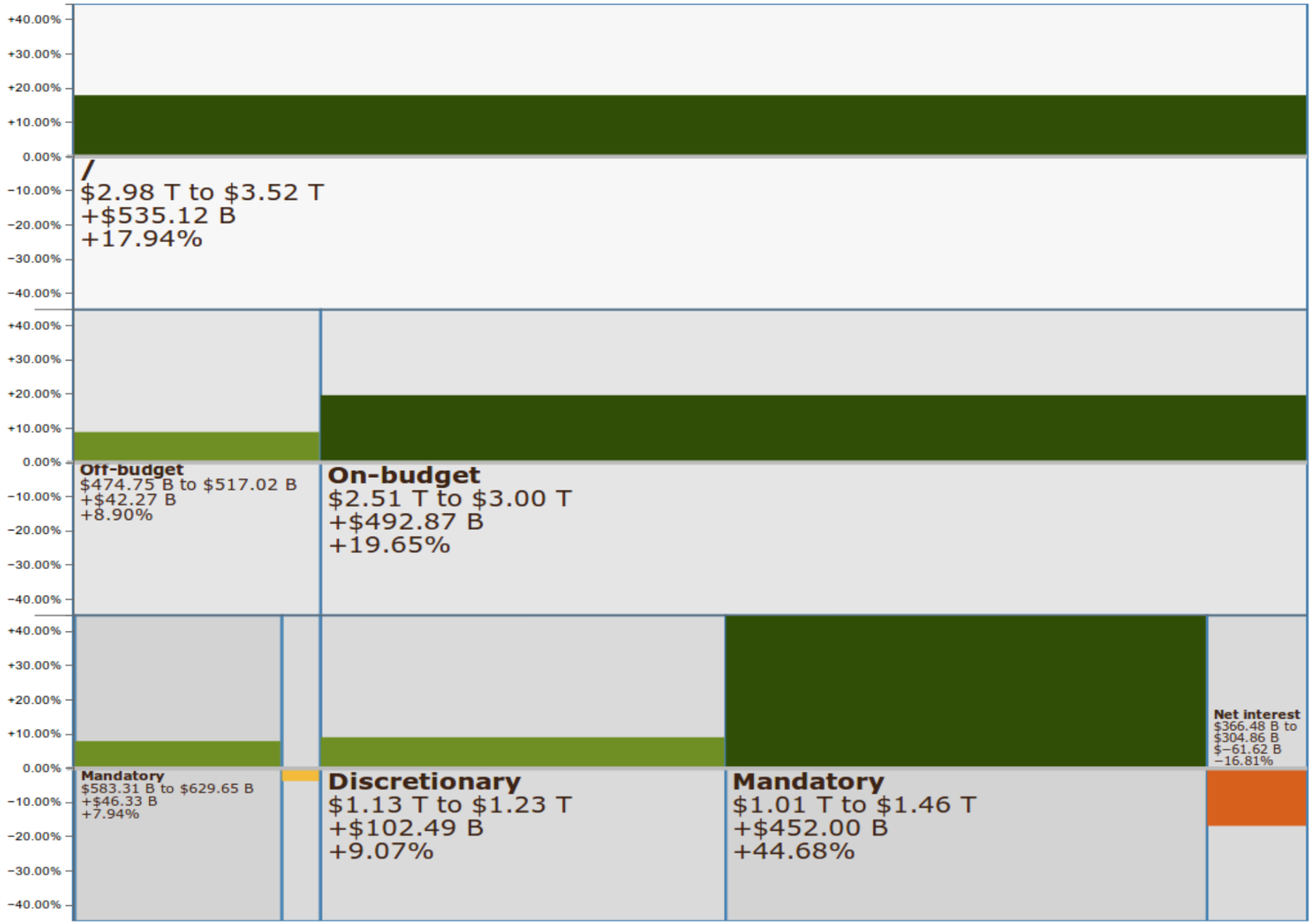
Created Node

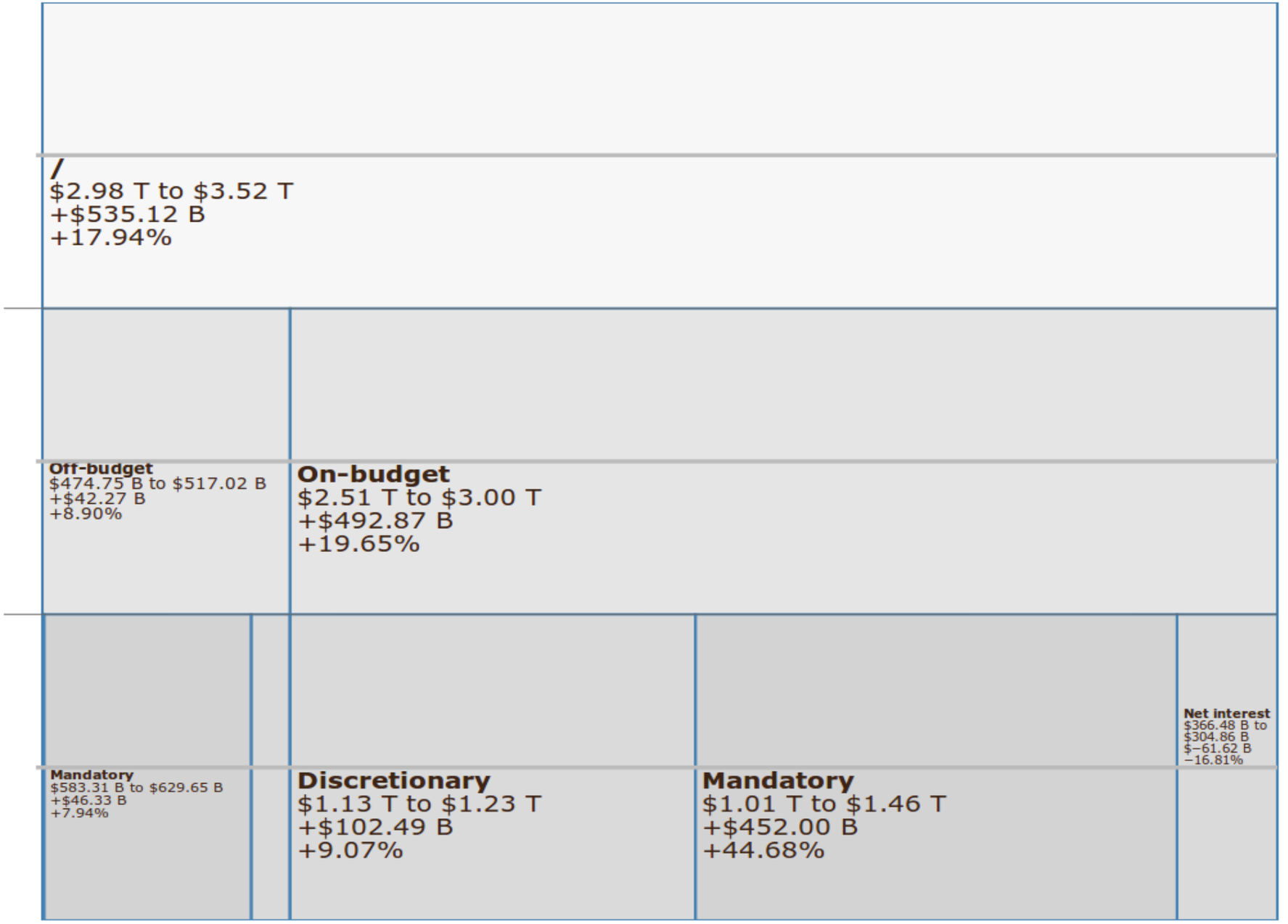


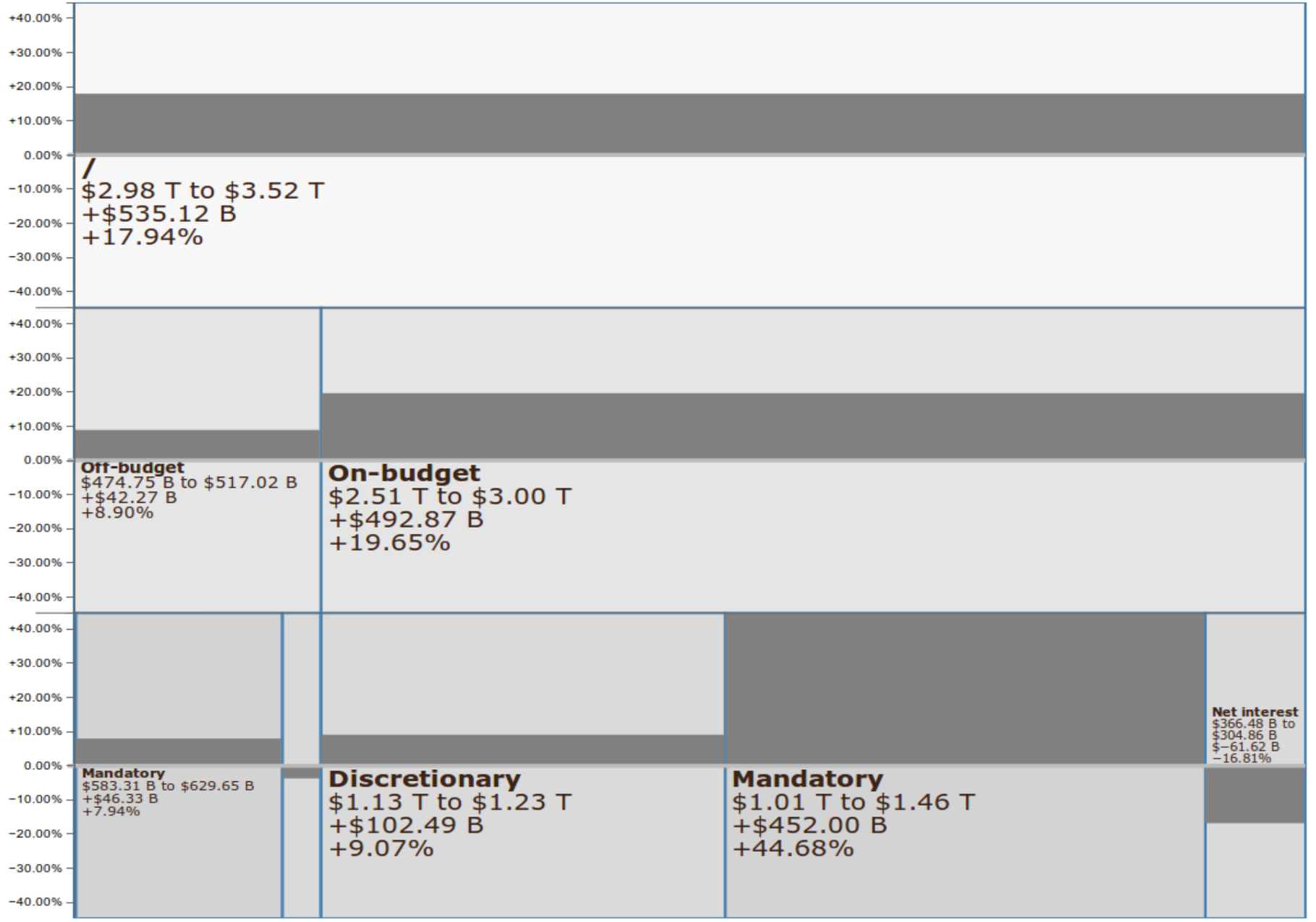
Removed node

Border

The StemView




/
$2.98 T to $3.52 T
+$535.12 B
+17.94%
Off-budget
$474.75 B to $517.02 B
+$42.27 B
+8.90%
On-budget
$2.51 T to $3.00 T
+$492.87 B
+19.65%
Mandatory
$583.31 B to $629.65 B
+$46.33 B
+7.94%
Discretionary
$1.13 T to $1.23 T
+$102.49 B
+9.07%
Mandatory
$1.01 T to $1.46 T
+$452.00 B
+44.68%
Net interest
$366.48 B to $304.86 B
$−61.62 B
−16.81%


+40.00%
+30.00%
+20.00%
+10.00%
0.00%
−10.00%
−20.00%
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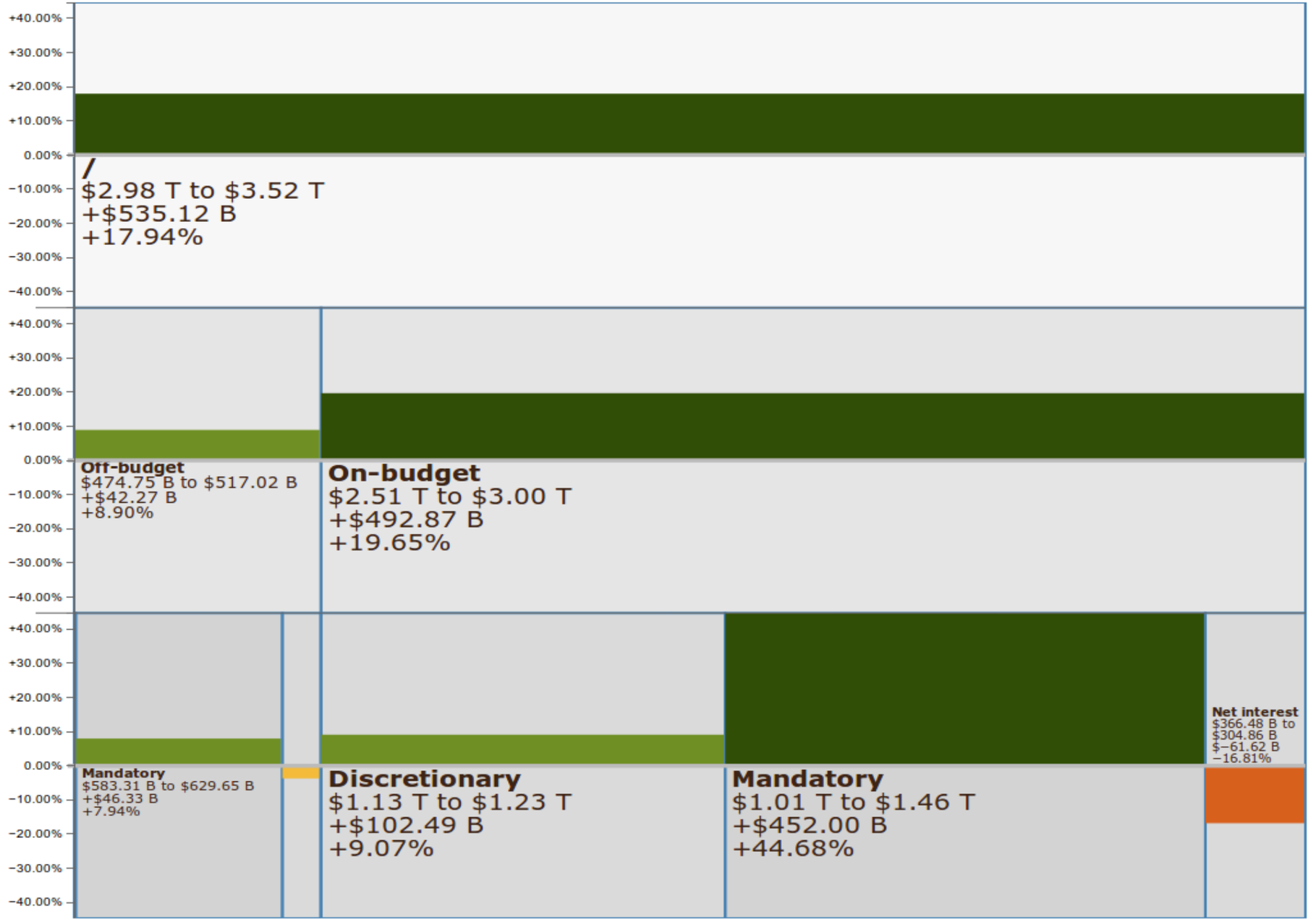
+40.00%
+30.00%
+20.00%
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0.00%
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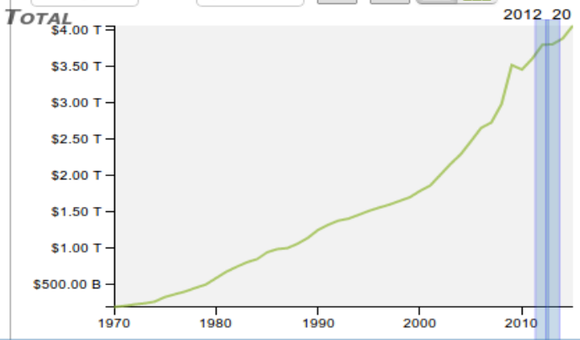
Live Demo

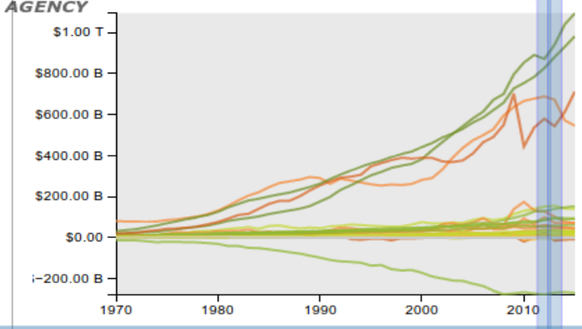
Timelines | Node Details

budge by: year <- ->

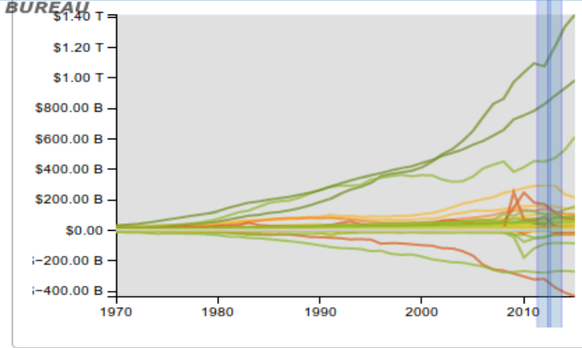
TOTAL



AGENCY

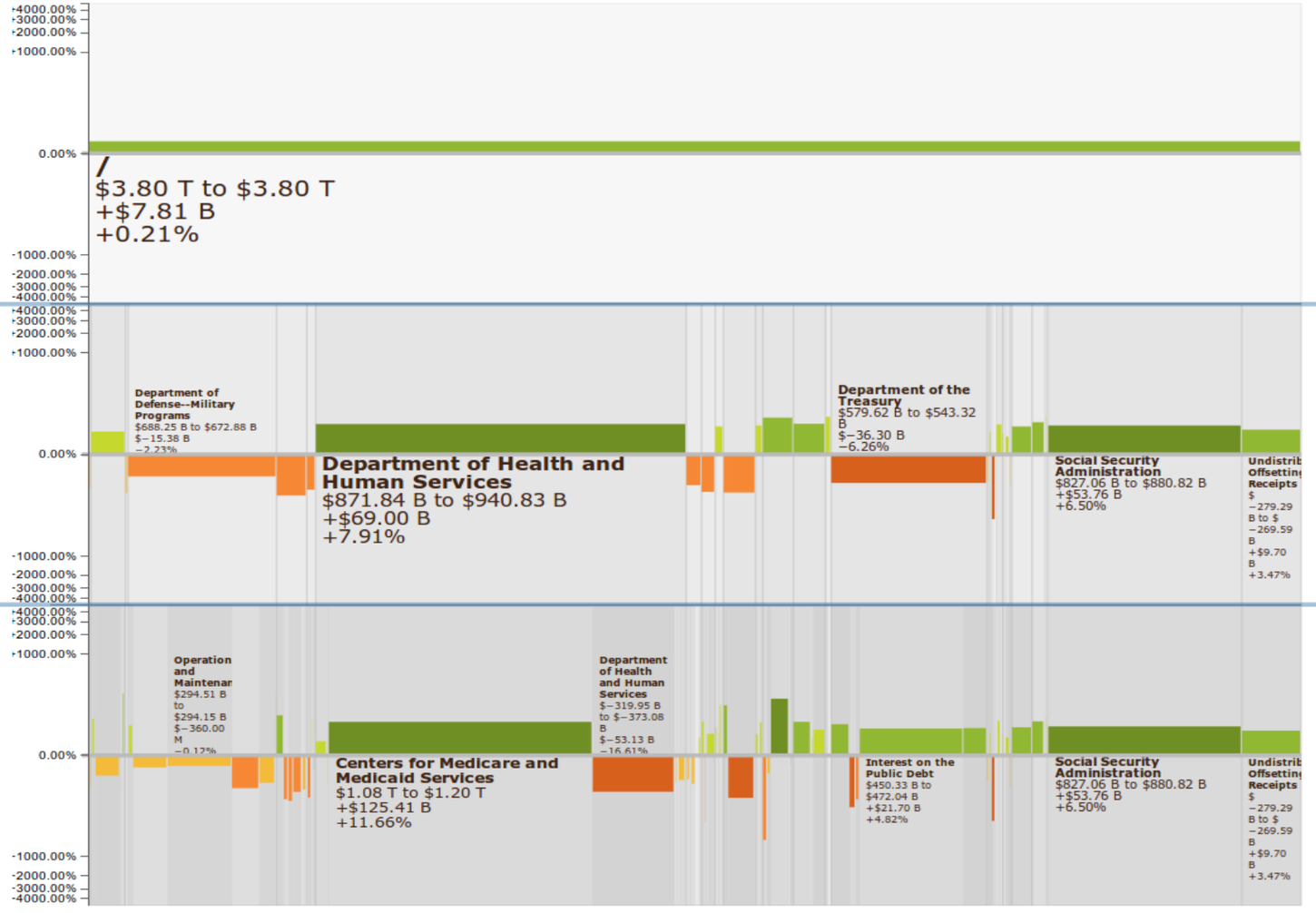


BUREAU



US Federal Budget

Comparing 2012 to 2013



Showing 474 nodes. Show all Show labels

Controls

Legend

Color by: budget Difference 4rt?

+$354.23 B to	+$777.80 B
+$129.96 B to	+$347.99 B
+$33.98 B to	+$127.02 B
+$4.45 B to	+$32.91 B
+$57.92 M to	+$4.22 B
$−49.36 M to	+$49.36 M
$−57.92 M to	$−4.22 B
$−4.45 B to	$−32.91 B
$−33.98 B to	$−127.02 B
$−129.96 B to	$−347.99 B
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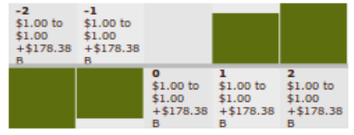
Height by: budget Percentage 4rt?



Sort by: Name

Width by: budget Ending Val

Border Color: Removed Created

What changed?

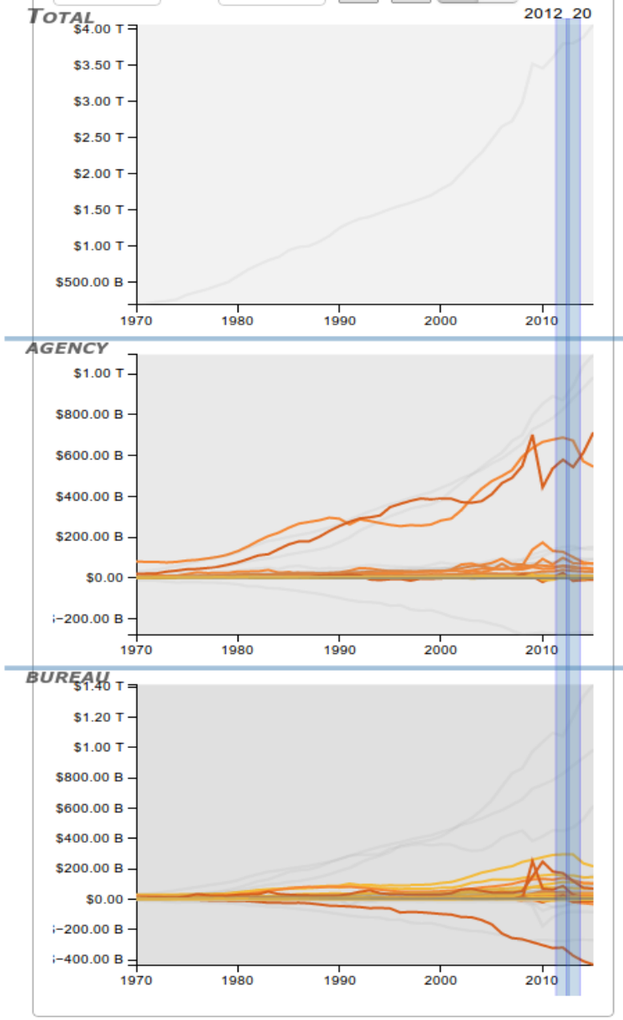
Hierarchy

Filters:

The Reporting Tool

Timelines | Node Details

budge by: year <- ->



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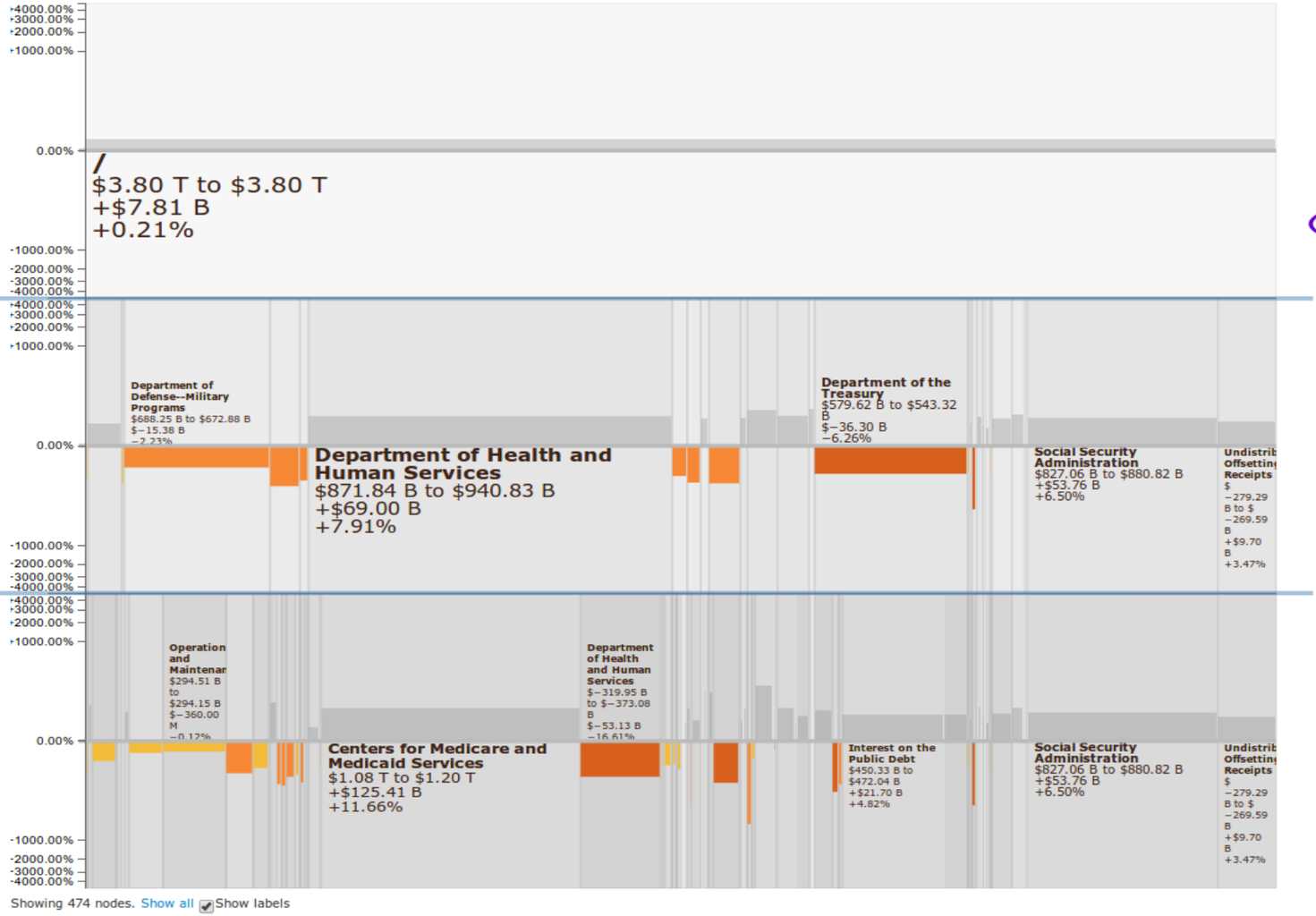


Showing 474 nodes. Show all Show labels

Controls

- Legend
- What changed?

Topology

457 nodes were on both

8 nodes were removed

9 nodes were created

Absolute overall change

145 nodes decreased more than $−14.00 M

124 nodes increased more than +$11.00 M

Relative overall change

114 nodes decreased more than −10.73%

90 nodes increased more than +9.84%

Absolute change by Level

43 agency decreased more than $−1.00 M

182 agency didn't change

103 bureau decreased more than $−29.00 M

77 bureau increased more than +$23.00 M

Relative change by Level

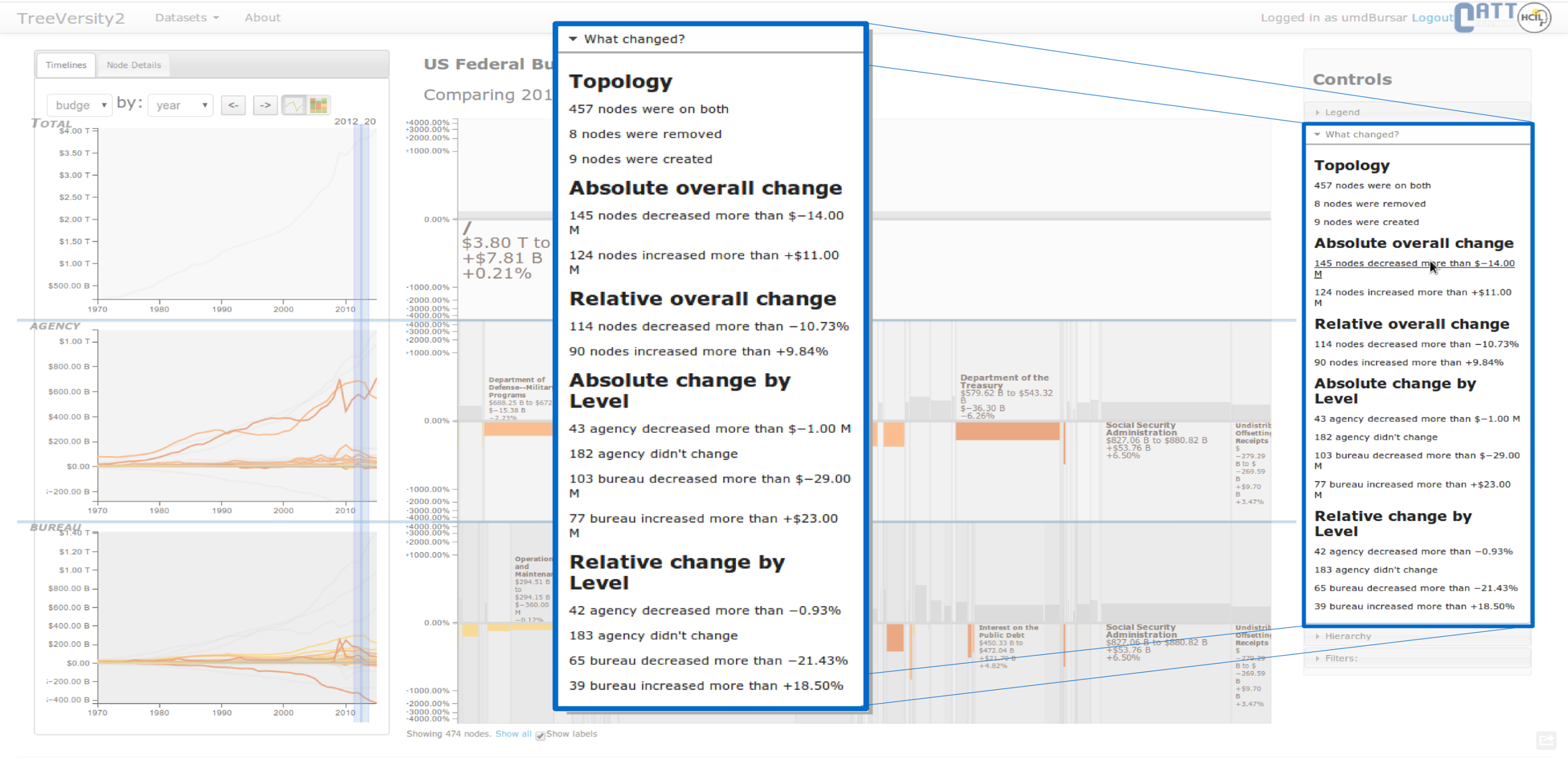
42 agency decreased more than −0.93%

183 agency didn't change

65 bureau decreased more than −21.43%

39 bureau increased more than +18.50%

- Hierarchy
- Filters:


TreeVersity2
Datasets
About
Logged in as umdBursar Logout
Timelines
Node Details
budge
by:
year
<-
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TOTAL
AGENCY
BUREAU
US Federal Bu
Comparing 201
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Controls
Legend
What changed?
Hierarchy
Filters:
Showing 474 nodes.
Show all
Show labels

Strengths & Weaknesses

13 case studies with 9 partners

Drugs' adverse effects
2,964 Records
5 Time points
Type 4 tree comp

Lung cancer death rates
1,716 Records
13 Time points
Type 2 tree comp

Passengers flying in the US
65,524 Records
162 Time points
Type 3 tree comp

Students demographics
227,158 Records
5 Time points
Type 3 tree comp

Product's sales and inventories
63,068 Records
4 Time points
Type 1 tree comp

US Federal Budget
4,845 Records
56 Time points
Type 3 tree comp

Imports/exports in the continent
119,741 Records
19 Time points
Type 3 tree comp

Traffic bottlenecks data
96,205 Records
24 Time points
Type 3 tree comp

FDA Case Study

The task

How do drug **adverse effects** change over time?

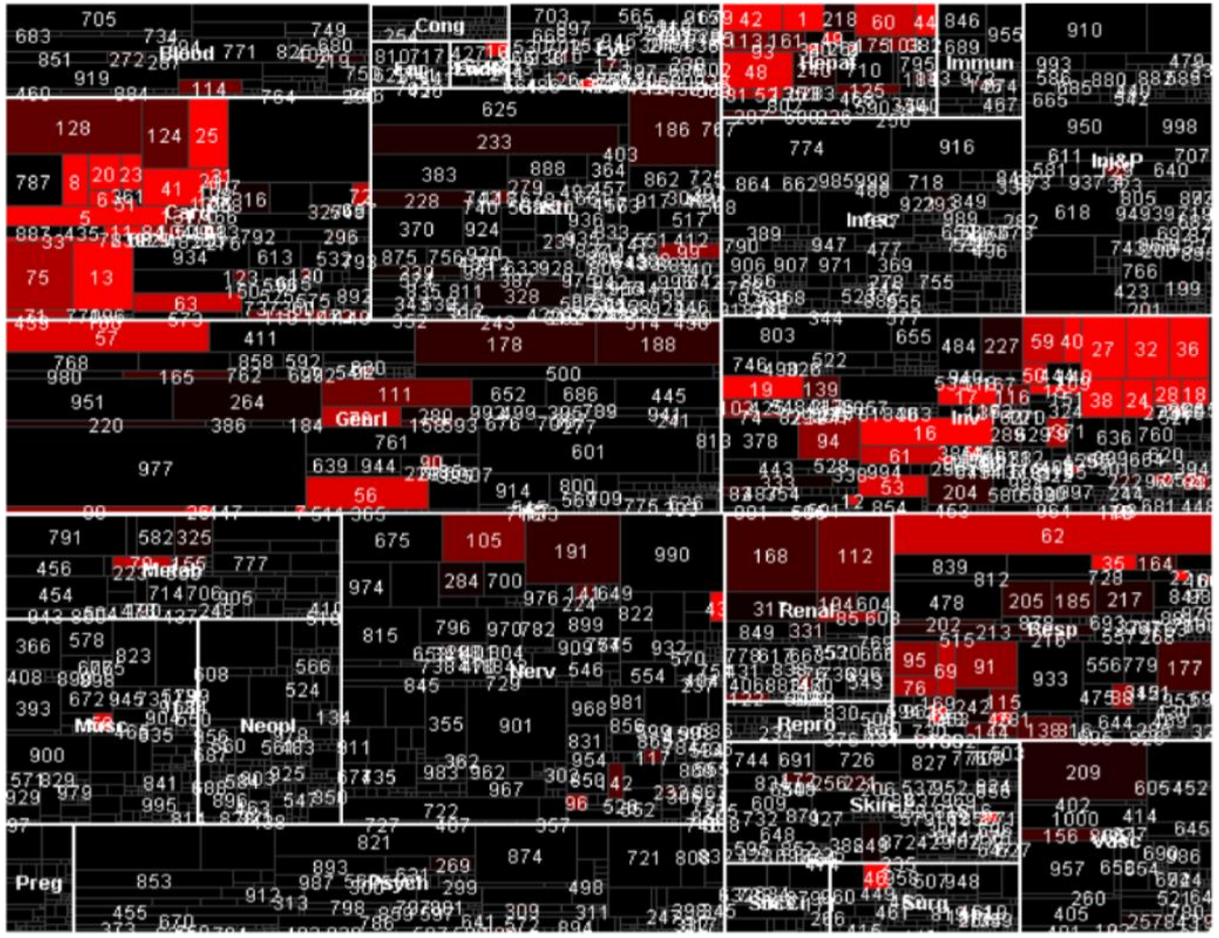
EBGM: Empiric Bayes Geometric Mean

In human:

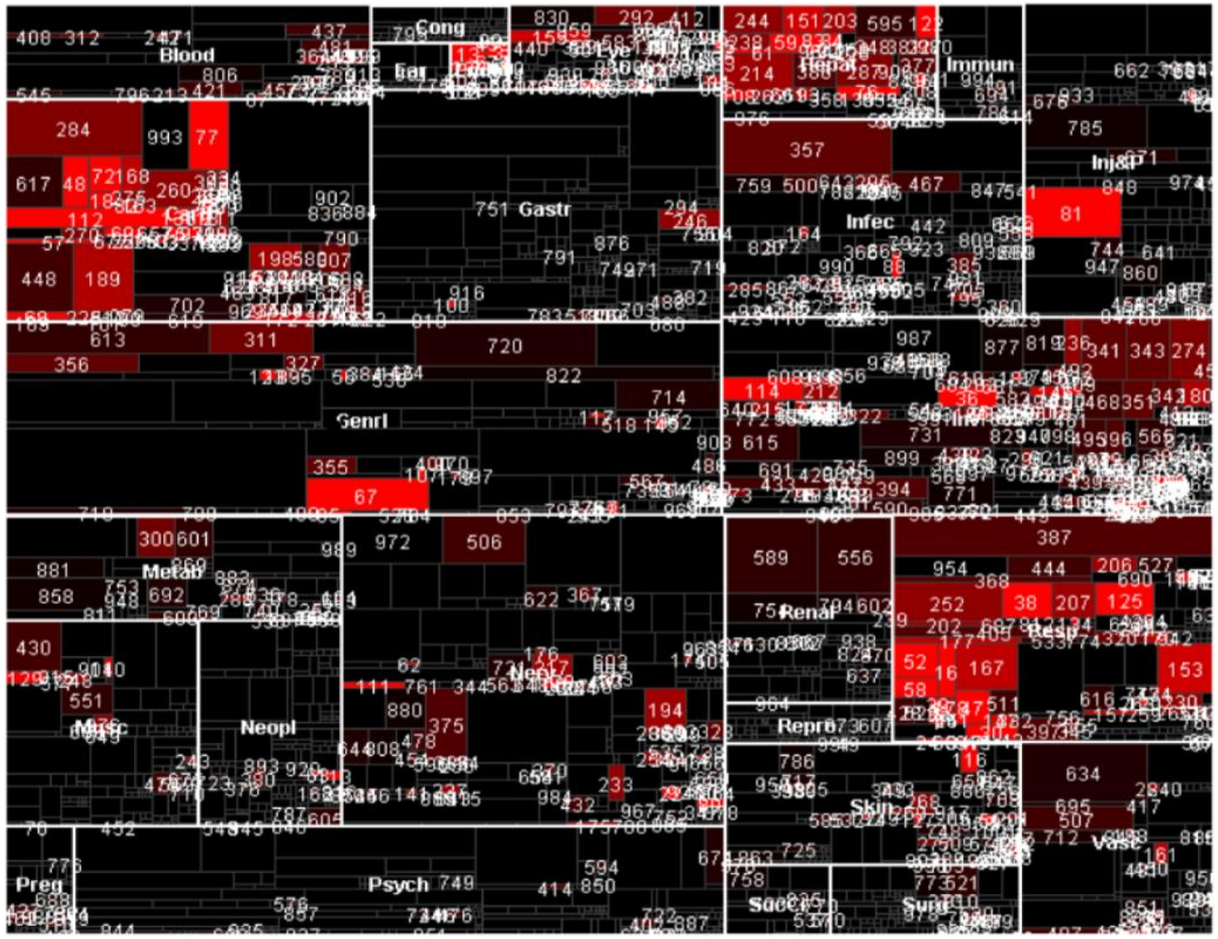
An index of how many more than expected reports of an adverse effect have been received

Sector Maps

Year 1



Year 2



Timelines | Node Details

ebgm by: year <- ->

TOTAL

SOC

HLGT

HLT

PT

FDA Adverse Drug Effects

Comparing 2010 to 2011

/
NaN to NaN
0.00
0.00%

Blood and lympha system disord 2.06 to 1.60

Gastrointestinal disorders 1.01 to 0.81 −0.20 −20.28%

General disorders and administration site conditions 0.86 to 0.42 −0.45 −51.45%

Injury, poisoning and procedural complications 3.49 to 1.17 −2.32 −66.51%

Investigations 1.76 to 1.02 −0.73 −41.72%

Musculo and connect tissue disorde 1.69 to 0.65 −1.04

Nervous system disorders 0.48 to 0.42 −0.06 −12.27%

Respiratory, thoracic and mediastinal disorders 0.39 to 1.93 +1.54 +399.74%

Skin and subcut tissue disord 0.51 to 0.53

Vascular disorders 3.27 to 3.87 +0.60 +18.35%

General system disorde NEC 0.55 to 0.34 −0.21 −38.27%

Procedural related injuries and complicati NEC 24.93 to 8.85

Haematolog investigati (incl blood groups) 6.22 to 3.13 −3.09

Pulmonary vascular disorders NaN to 17.63 +17.63 +100.00%

Embolism and thrombosis 0.77 to 16.56 +15.79 +2053.06%

Vascul haemo disord 20.88 to 7.59 −13.29 −63.63%

Non-site specific procedur complica 35.73 to 10.98 −24.75

Red blood cell analyse 13.21 to 7.63 −5.58

Pulmonary thrombotic and embolic conditions NaN to 24.52 +24.52 +100.00%

Peripheral embolism and thrombosis 0.94 to 24.55 +23.61

Haemo NEC 21.96 to 7.38 −14.58 −66.38%

Pulmonary embolism NaN to 25.90 +25.90 +100.00%

Deep vein thrombosis 1.01 to 26.80 +25.79 +2555.60%

Showing 754 nodes. Show all Show labels

Controls

Legend

Color by: Non-Overlapping 4rt?

+124.40 to +273.16
+45.64 to +122.21
+11.93 to +44.61
+1.56 to +11.56
+0.02 to +1.48
−0.02 to +0.02
−0.02 to −1.48
−1.56 to −11.56
−11.93 to −44.61
−45.64 to −122.21
−124.40 to −273.16

Height by: ebgm Percentage 4rt?

-2 1.00 to 1.00 +62.64 +851.87%
-1 1.00 to 1.00 +62.64 +851.87%
0 1.00 to 1.00 +62.64 +851.87%
1 1.00 to 1.00 +62.64 +851.87%
2 1.00 to 1.00 +62.64 +851.87%

Sort by: Name

Width by: n Max Value

Border Color: Removed Created

What changed?

Hierarchy

Filters:

“The work I can achieve with TreeVersity is equivalent to years of analysis with our previous methods”

“TreeVersity easily showed us multi-years of the data in a graphical form at once without having to download the data into excel and create graphics. We can do that analysis now, but TreeVersity was much quicker.”

“I've spent many hours in color coded Excel files expressing changes at query and category levels. The visualization and what changed views made this process much more efficient and easier to share.”

“Numerous examples of obvious, but heretofore unrevealed patterns were discovered.”

“We use Hyperion and excel for analysis. However, TreeVersity made it much easier to see multi-year trends.”

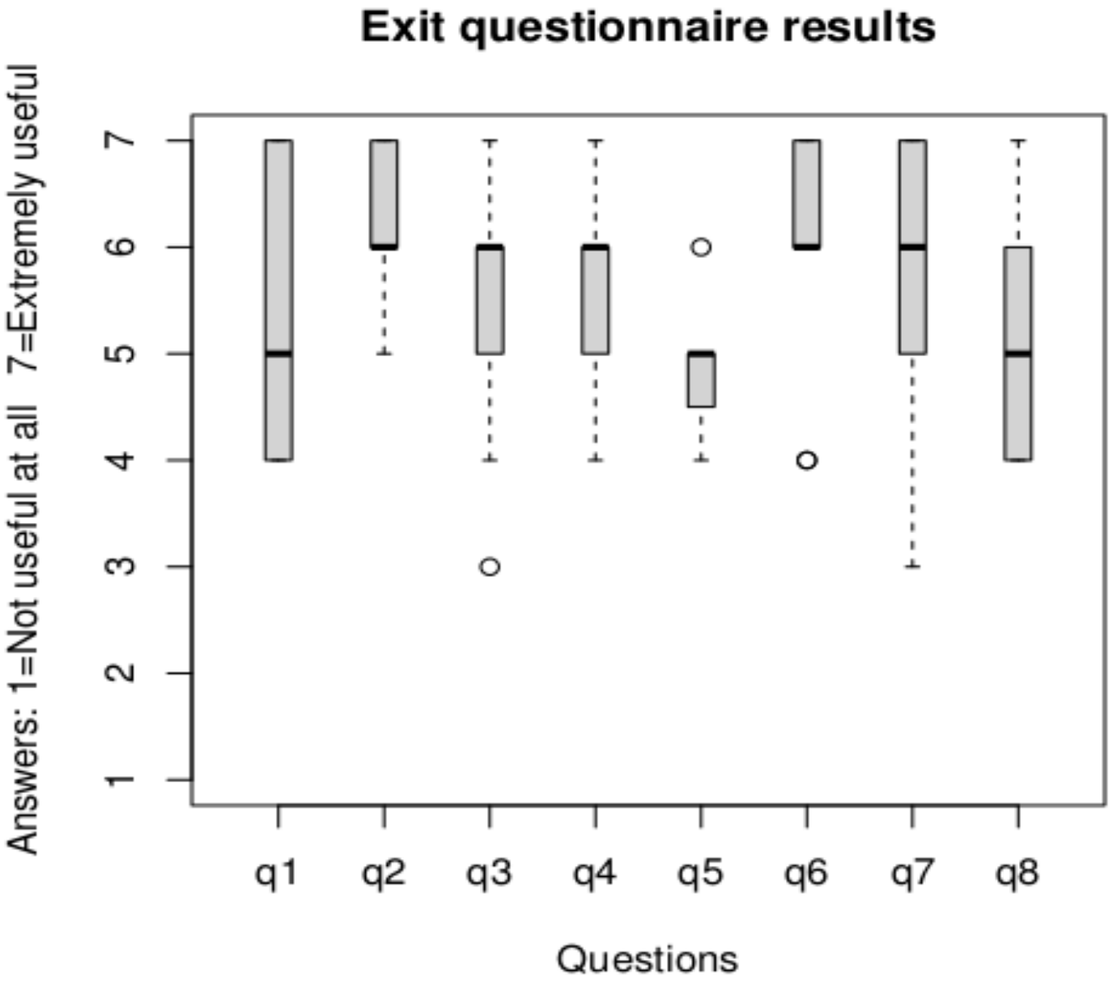
We need to run it in-site, and cannot install all the requirements

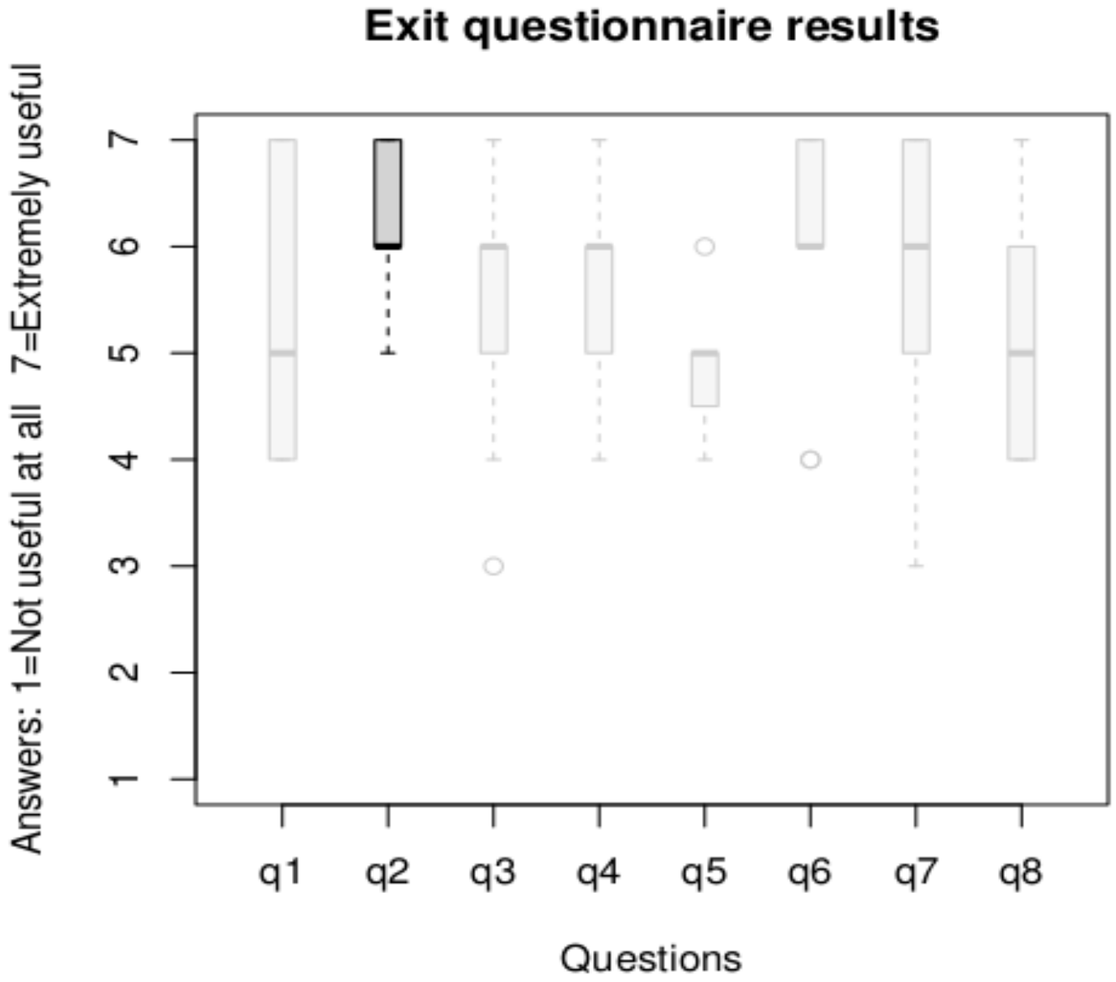
It shows too much information

We need to see more information

It requires some training to understand the StemView

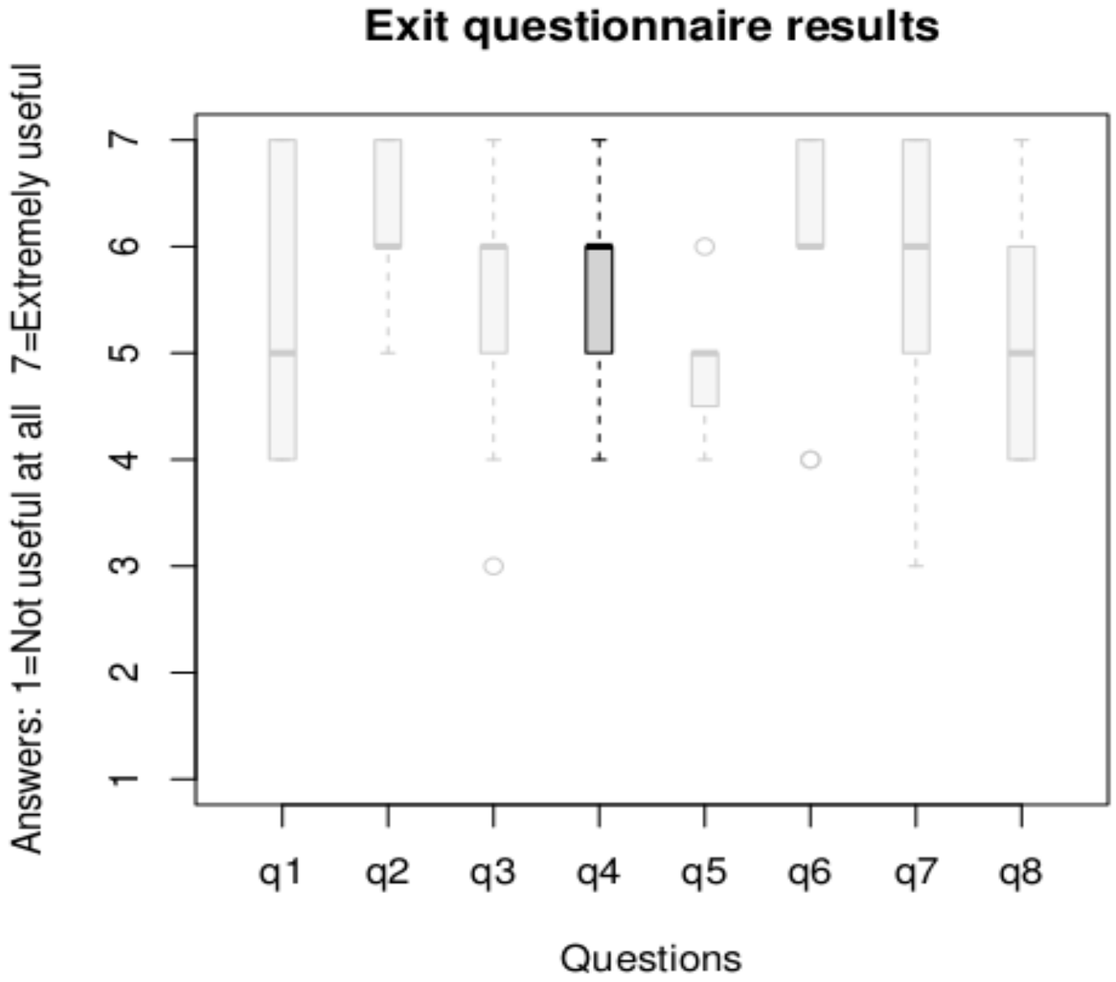
- q1: For this particular case study TreeVersity was:
- q2: In general the tool is likely to be:
- q3: Did the reporting tool help direct your exploration?
- q4: Did you find the StemView comprehensible?
- q5: Did you find the Bullet comprehensible?
- q6: Would you like to continue working with Treeversity?
- q7: Would you be willing to install and use Treeversity on your own?
- q8: How does this compare to your original expectations before starting with the tool.





q2: In general TreeVersity2 is likely to be

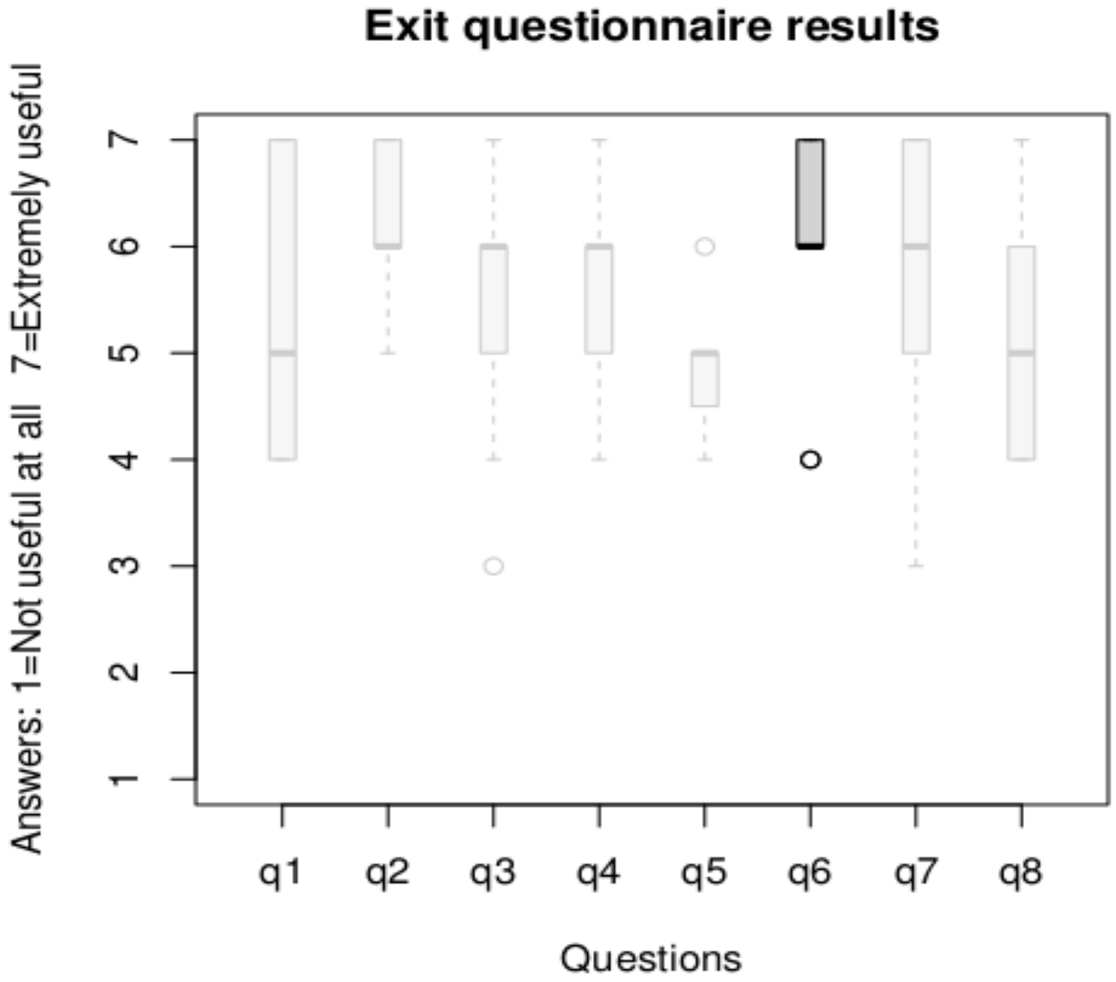
1: Not useful at all **7:** Extremely useful



q4: Did you find the StemView comprehensible?

1: Not comprehensible at all

7: Extremely easy to comprehend



q6: Would you like to continue working with Treeversity

1: Not at all

7: I will definitely use it

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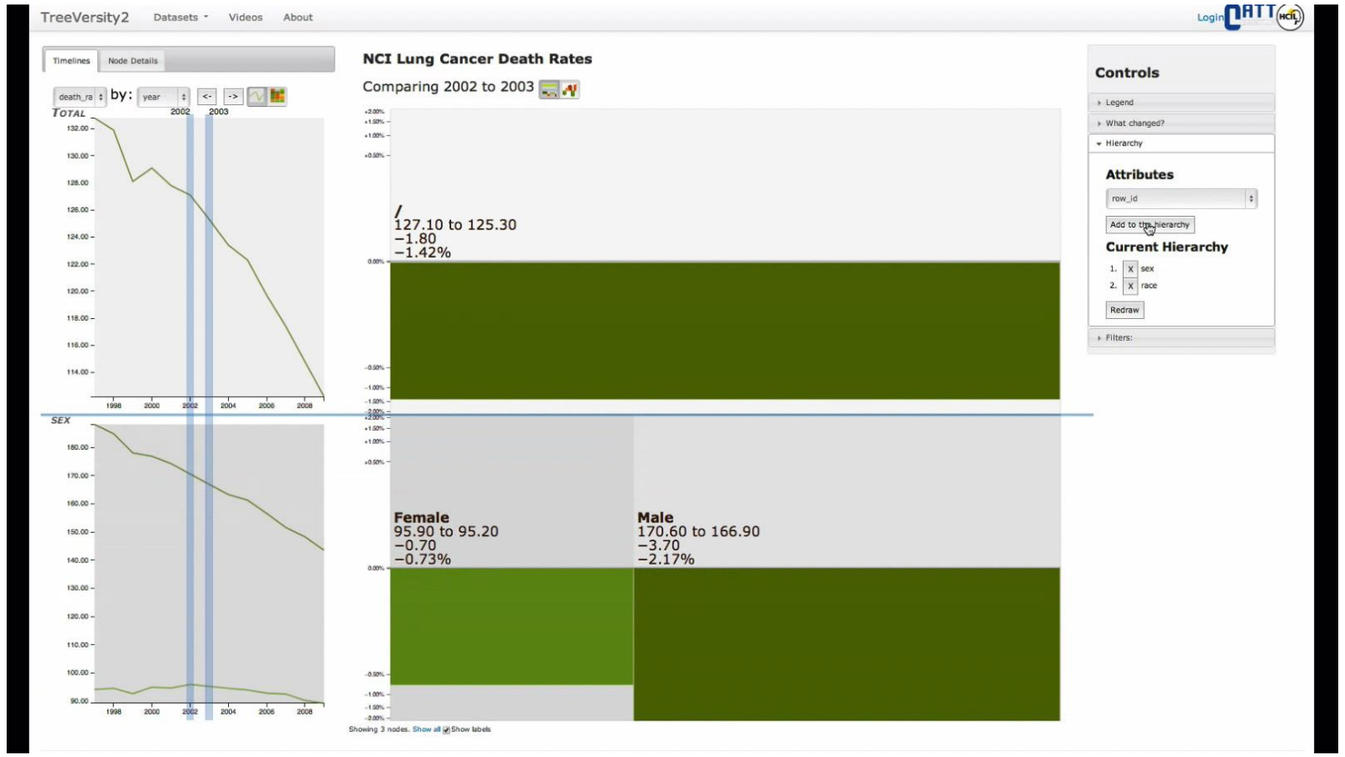
- Our Reviewers
- Our case studies partners

Thank you!

- StemView shows 5 characteristics of change
- Dynamic/Fixed/Hybrid Hierarchies that aggregate or not
- Created and removed nodes
- Not only leaf nodes
- Reporting tool



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