ChARLES: Change-Aware Recovery of Latent Evolution Semantics in Relational Data

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SCAN ME

tinyurl.com/CharlesSIGMOD

How did my data change? Why?

name	gender	education	experience	salary	bonus
Anton	M	PhD	2	$230,000	$23,000
Bob	M	PhD	3	$250,000	$25,000
Jim	M	MS	5	$160,000	$16,000
Allen	M	MS	1	$130,000	$13,000
Cathy	F	BS	2	$110,000	$11,000
Tom	M	MS	4	$150,000	$15,000
Jane	F	BS	3	$120,000	$12,000
Ryan	M	MS	4	$150,000	$15,000
Frank	M	PhD	1	$210,000	$21,000

2016 data

name	gender	education	experience	salary	bonus
Anton	M	PhD	3	$230,000	$25,150
Bob	M	PhD	4	$250,000	$27,250
Jim	M	MS	6	$160,000	$17,440
Allen	M	MS	2	$130,000	$13,790
Cathy	F	BS	3	$110,000	$11,000
Tom	M	MS	5	$150,000	$16,400
Jane	F	BS	4	$120,000	$12,000
Ryan	M	MS	5	$150,000	$16,400
Frank	M	PhD	2	$210,000	$23,050

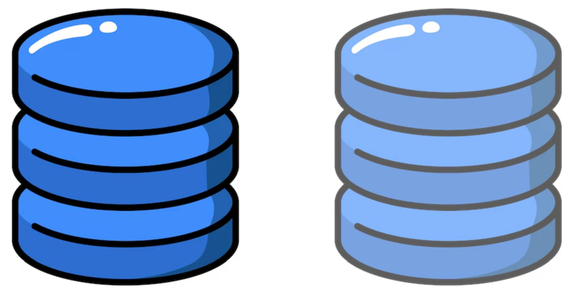
2017 data

What Accounts for the Bonus Discrepancy in 2017?

I'm curious about why Anton received a $2,150 increase, while Cathy did not receive any bonus at all!

How to convey data change semantics to humans?

`> Data Diff`



Too many changes have occurred between these two versions of the database.

I am unable to process all of them.

Could someone please provide a **summary** of the changes?

What makes a change summary effective?

Everyone receives about 6% increase

Less Accurate

More Interpretable

If PhD → 5% increase + $1000

If MS and served at least 3 years → 4% increase + $800

If MS and served less than 3 years → 3% increase + $400

Reasonably Accurate

Reasonably Interpretable

If PhD and Female → 5% increase + $1000

If MS and Female and served at least 3 years → 4% increase + $800

If MS and Male and served at least 3 years → 4% increase + $700

If BS and Female and served less than 3 years → 3% increase + $400

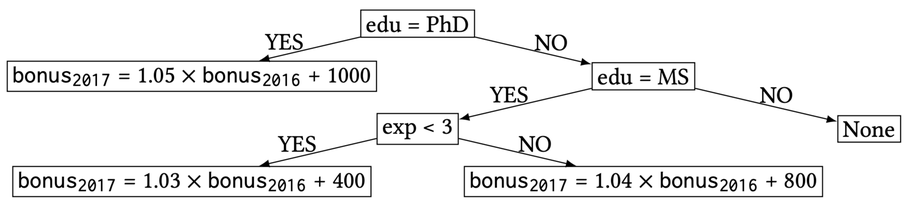
If BS and Male and served less than 3 years → 3% increase + $300

More Accurate

Less Interpretable

A good trade-off between **Accuracy** & **Interpretability**

What is a good primitive for data change summary?



Linear Model Tree

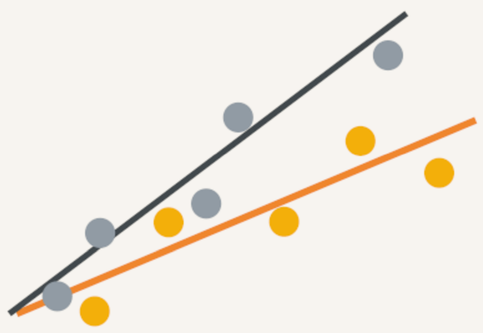
- Internal nodes denote *atomic* conditions
- Leaves denote transformations
- A path from root to a leaf denotes a condition, which is a conjunction of multiple atomic conditions
- Transformations are linear functions over the data attributes
- LMT is a *set* of conditional transformations

How do I model utility of a change summary?

Accuracy

- Inverse of the distance between the actual change and the change described by the change summary

$$\text{Accuracy}(S) = |D_{target} - S(D_{source})|$$



Interpretability

- Smaller summaries over larger ones
- Simpler conditions and transformations
- Transformations with fewer variables
- Conditions with higher data coverage
- "Normal" conditions and typical numerical values
- Domain expertise & LLMs can help!

All Female employees

All Asian, European Females, or Females working in HR, but ...

Age > 25

Age > 23.796

How to generate a summary with high utility?

Generate multiple LMTs, Rank them by utility

It appears that the company has chosen to implement a policy that rewards long-serving employees and supports educational advancement.

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