

Algorithms for Rule Inference in Modularized Rule Bases

Grzegorz J. Nalepa, Szymon Bobek, Antoni Ligęza and Krzysztof Kaczor

Institute of Automatics
AGH University of Science and Technology, Poland

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Outline

- 1 Introduction
- 2 Classic Rule Inference Algorithms
- 3 Knowledge Modularization Techniques
- 4 Formalization concepts
- 5 XTT2 Inference Algorithms
- 6 Future Work

Motivation

Rule-based systems shells

| State of the art | Our contribution |
|---|--|
| Rete-based algorithms provide mostly forward chaining | Different inference modes for the same rule base |
| No structured of the knowledge base | Each rule can be placed into precisely defined context |
| No design process | Modularization during the design |

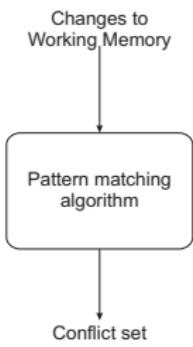
Classic Rule Inference Algorithms

② Classic Rule Inference Algorithms

- Rule Inference Algorithms
- Main Concepts
- RETE
- TREAT
- Gator

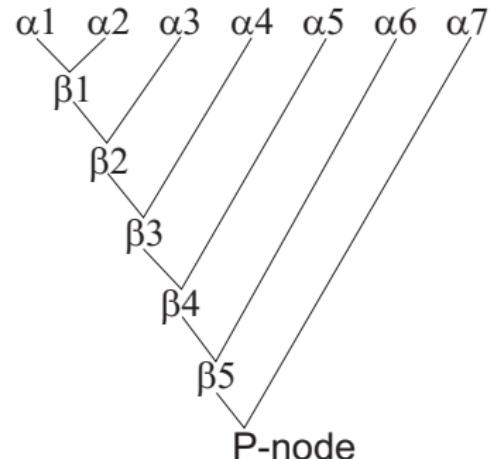
Rule Inference Algorithm

- An inference algorithm performs three steps:
 - ① Pattern Matching.
 - ② Conflict Set Resolution.
 - ③ Action Execution.
- *Pattern Matching* is a bottleneck of the inference process.
- The naive algorithm is far too slow.
- More efficient algorithms: RETE, TREAT, GATOR.
- These algorithms involves such concepts as: *working element*, *alpha*, *beta memory* and *nodes*, etc.



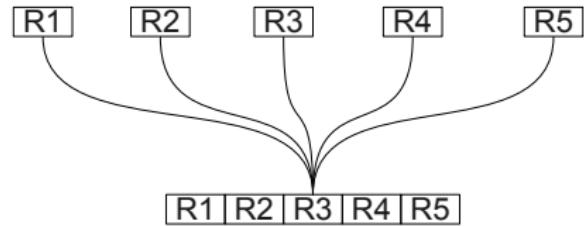
Rete

- RETE was considered the most efficient inference algorithm.
- It tries to avoid iterating over the working memory and the production set.
- Each node has a memory.



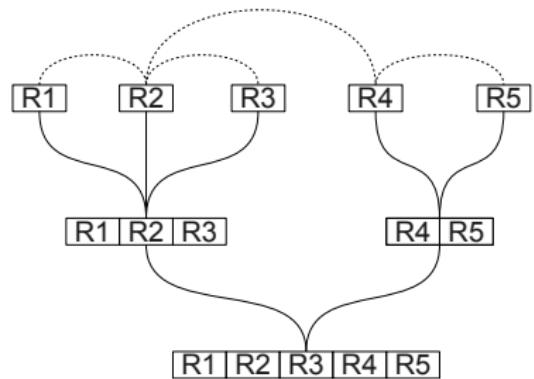
TREAT

- Based on three ideas:
 - ① Memory support – creation and maintenance of the **alpha-memory**.
 - ② Conflict set support – the conflict set is explicitly retained across production system cycles.
 - ③ Condition membership – introduces a new property for each rule, called *rule-active*. The match algorithm ignores rules that are *non-active*.
- TREAT **does not use beta-memory**.

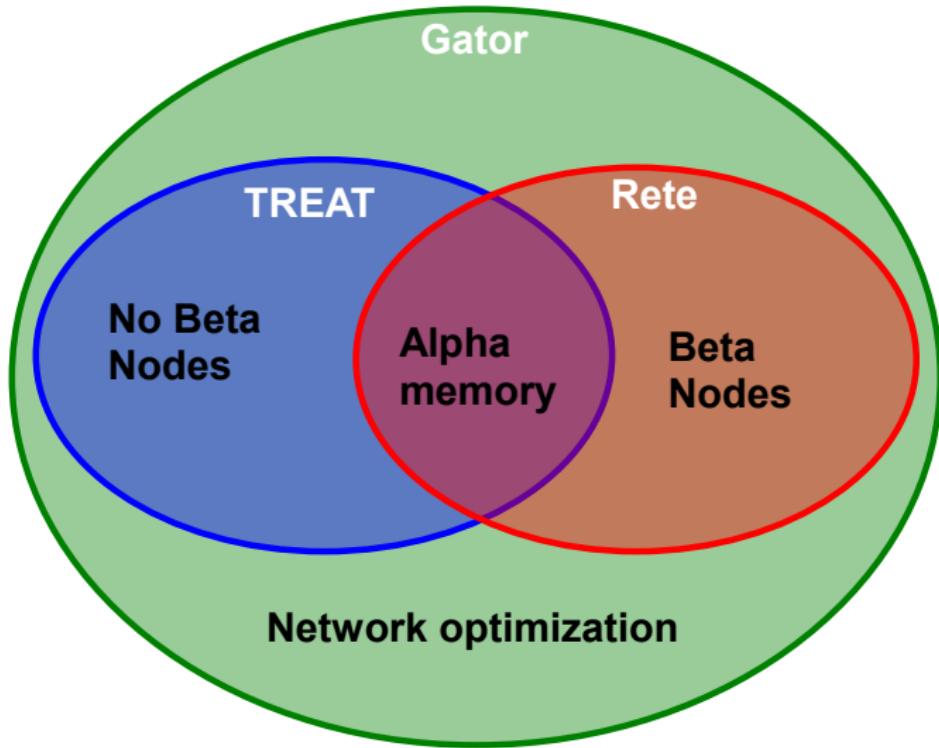


Gator

- Each rule can be represented by a condition graph.
- Gator network structure:
 - ① Alpha-memory.
 - ② Optional beta-memory.
 - ③ P-node.



Comparison of rete-like algorithms



Comparison with our approach

Rule inference algorithms

| Rete-like algorithms | Our approach |
|-------------------------|---|
| Mostly forward chaining | |
| Rule bases are flat | We can not use the classical algorithms |
| | We do not use networks, alpha and beta memory and nodes |
| | Different inference strategies for the same rule base |

Knowledge Modularization

③ Knowledge Modularization Techniques

- Knowledge modularisation
- CLIPS
- JESS
- Drools Flow
- Knowledge base modularisation

Knowledge modularization features

- Main goals of modularization:
 - ➊ to help manage large sets of rules,
 - ➋ to improve performance of inference algorithms,
 - ➌ to provide visualization of the knowledge base,
 - ➍ to improve inference control strategies.
- There aren't any tools supporting all four goals.

Comparison of modularization techniques

| | Heps manage large rules sets | Improves performance | Provides visualisation of KB | Advaanced inference strategies |
|--------|------------------------------|----------------------|------------------------------|--------------------------------|
| Clips | Yes | Yes | No | Partial |
| Jess | Yes | No | No | Partial |
| Drools | Yes | Yes | Yes | Partial |

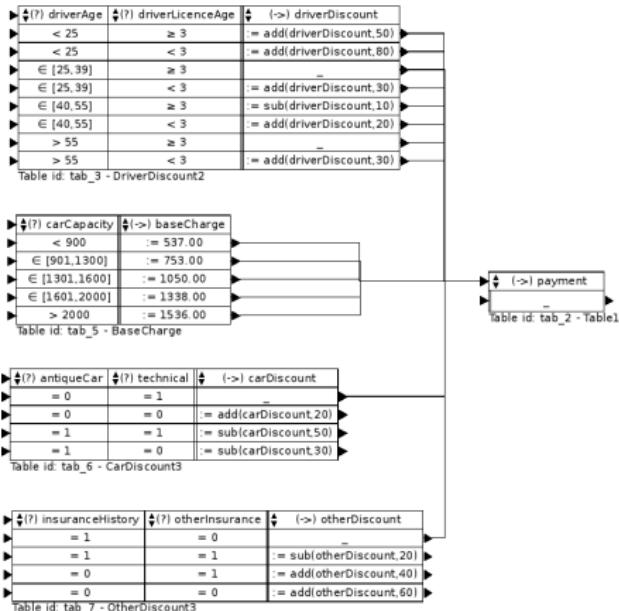
Formalization concepts

④ Formalization concepts

- Decision Component
- Rule
- Rule Schema
- Inference Link
- Knowledge Base

XTT2

- XTT2 stands for *eXtended Tabular Trees version 2*.
- Developed within HeKatE project
<http://hecate.ia.agh.edu.pl>
- Formalized methodology for rule-based system design and executing.
- Provides a complete framework supported by tools.



Rule

$$r = (\text{COND}, \text{DEC}, \text{ACT})$$

If `driverAge < 25` and `driverLicenceAge < 3`
 then `driverDiscount = driverDiscount + 80`

| $\Delta (?)$ driverAge | $\Delta (?)$ driverLicenceAge | Δ (\rightarrow) driverDiscount |
|-----------------------------|-------------------------------|--|
| < 25 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | ≥ 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | ≥ 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |

Table id: tab_3 - DriverDiscount2

Rule Schema

$$h(r) = (H^{cond}, H^{dec})$$

- $H^{cond} = \{driverAge, driverLicenceAge\}$
- $H^{dec} = \{driverDiscount\}$

| $\blacktriangleright \Delta (?) \text{ driverAge}$ | $\Delta (?) \text{ driverLicenceAge}$ | $\Delta (->) \text{ driverDiscount}$ |
|--|---------------------------------------|--|
| < 25 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | ≥ 3 | $-$ |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | ≥ 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | $-$ |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |

Table id: tab_3 - DriverDiscount2

Decision Component

$$t = (r_1, r_2, \dots, r_n) \quad \forall_{i,j} : r_i, r_j \in t \Rightarrow h(r_i) = h(r_j)$$

Contains rules working in the same context.

| \blacktriangleright | \blacktriangleleft (?) driverAge | \blacktriangleleft (?) driverLicenceAge | \blacktriangleleft (->) driverDiscount | \blacktriangleright |
|-----------------------|------------------------------------|---|---|-----------------------|
| \blacktriangleright | < 25 | ≥ 3 | $::= \text{add}(\text{driverDiscount}, 50)$ | \blacktriangleright |
| \blacktriangleright | < 25 | < 3 | $::= \text{add}(\text{driverDiscount}, 80)$ | \blacktriangleright |
| \blacktriangleright | $\in [25, 39]$ | ≥ 3 | - | \blacktriangleright |
| \blacktriangleright | $\in [25, 39]$ | < 3 | $::= \text{add}(\text{driverDiscount}, 30)$ | \blacktriangleright |
| \blacktriangleright | $\in [40, 55]$ | ≥ 3 | $::= \text{sub}(\text{driverDiscount}, 10)$ | \blacktriangleright |
| \blacktriangleright | $\in [40, 55]$ | < 3 | $::= \text{add}(\text{driverDiscount}, 20)$ | \blacktriangleright |
| \blacktriangleright | > 55 | ≥ 3 | - | \blacktriangleright |
| \blacktriangleright | > 55 | < 3 | $::= \text{add}(\text{driverDiscount}, 30)$ | \blacktriangleright |

Table id: tab_3 - DriverDiscount2

Knowledge Base

$$X = (\mathbb{T}, \mathbb{L})$$

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|----------------------------|---------------------------------|
| accidentNo | clientClass | clientClass |
| = 0 | $\in [-1, 8]$ | $\text{:= add(clientClass, 1)}$ |
| = 0 | = 9 | := 9 |
| > 0 | $\in \{-1, 0\}$ | := -1 |
| = 1 | = 1 | := 0 |
| = 1 | $\in [2, 5] \cup \{8, 9\}$ | $\text{:= sub(clientClass, 2)}$ |
| = 1 | $\in [6, 7]$ | $\text{:= sub(clientClass, 3)}$ |
| > 1 | $\in [1, 2]$ | := -1 |
| = 2 | = 3 | := 0 |
| = 2 | $\in [4, 5]$ | := 1 |
| = 2 | = 6 | := 2 |
| = 2 | $\in [7, 8]$ | := 3 |
| = 2 | = 9 | := 4 |
| > 2 | $\in [-1, 8]$ | := -1 |
| > 2 | = 9 | := 0 |

Table id: tab_4 - BonusMalus

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|--------------------------|---------------------------|
| clientClass | driverDiscount | driverDiscount |
| = -1 | := 260 | |
| = 0 | := 160 | |
| = 1 | := 100 | |
| = 2 | := 90 | |
| = 3 | := 80 | |
| = 4 | := 70 | |
| $\in [5, 6]$ | := 60 | |
| $\in [7, 8]$ | := 50 | |
| = 9 | := 40 | |

Table id: tab_8 - DriverDiscount1

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|--------------------------|-------------------------------------|
| driverAge | driverLicenceAge | driverDiscount |
| < 25 | ≥ 3 | $\text{:= add(driverDiscount, 50)}$ |
| < 25 | < 3 | $\text{:= add(driverDiscount, 80)}$ |
| $\in [25, 39]$ | ≥ 3 | - |
| $\in [25, 39]$ | < 3 | $\text{:= add(driverDiscount, 30)}$ |
| $\in [40, 55]$ | ≥ 3 | $\text{:= sub(driverDiscount, 10)}$ |
| $\in [40, 55]$ | < 3 | $\text{:= add(driverDiscount, 20)}$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $\text{:= add(driverDiscount, 30)}$ |

Table id: tab_3 - DriverDiscount2

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|--------------------------|---------------------------|
| carCapacity | baseCharge | baseCharge |
| < 900 | := 537.00 | |
| $\in [901, 1300]$ | := 753.00 | |
| $\in [1301, 1600]$ | := 1050.00 | |
| $\in [1601, 2000]$ | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|---------------------------|
| carAge | carDiscount |
| = 0 | := -20 |
| = 1 | := -15 |
| = 2 | := -10 |
| > 2 | := 0 |

Table id: tab_10 - CarDiscount1

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|----------------------------------|
| seatsNo | carDiscount |
| ≥ 6 | - |
| < 6 | $\text{:= add(carDiscount, 20)}$ |

Table id: tab_9 - CarDiscount2

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|--------------------------|----------------------------------|
| antiqueCar | technical | carDiscount |
| = 0 | := 1 | |
| = 0 | := 0 | $\text{:= add(carDiscount, 20)}$ |
| = 1 | := 1 | $\text{:= sub(carDiscount, 50)}$ |
| = 1 | := 0 | $\text{:= sub(carDiscount, 30)}$ |

Table id: tab_6 - CarDiscount3

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|---------------------------|
| installmentNo | otherDiscount |
| = 1 | := 0 |
| = 2 | := 10 |

Table id: tab_12 - OtherDiscount1

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|--------------------------|------------------------------------|
| insuranceCont | insuranceCarsNo | otherDiscount |
| = 1 | := 1 | $\text{:= sub(otherDiscount, 10)}$ |
| = 0 | := 1 | - |
| = 1 | > 1 | $\text{:= sub(otherDiscount, 20)}$ |
| = 0 | > 1 | $\text{:= sub(otherDiscount, 10)}$ |

Table id: tab_11 - OtherDiscount2

| $\uparrow\downarrow (?)$ | $\uparrow\downarrow (?)$ | $\uparrow\downarrow (->)$ |
|--------------------------|--------------------------|------------------------------------|
| insuranceHistory | otherInsurance | otherDiscount |
| = 1 | := 0 | |
| = 1 | := 1 | $\text{:= sub(otherDiscount, 20)}$ |
| = 0 | := 1 | $\text{:= add(otherDiscount, 40)}$ |
| = 0 | := 0 | $\text{:= add(otherDiscount, 60)}$ |

Table id: tab_7 - OtherDiscount3

XTT2 Inference Algorithms

⑤ XTT2 Inference Algorithms

- Main Algorithm
- Fixed Order
- Data Driven
- Token Driven
- Goal Driven

Input/Output for the main inference algorithm

INPUT:

- \mathbb{U} – an ordered set of tables

$$\mathbb{U} \subset \mathbb{T}$$

- the function z :

\rightarrow the final state of the system: s_n .

$$z: \mathbb{T} \rightarrow \mathbb{N} \times \mathbb{N}$$

$$z(t) = (k_n, k_r)$$

- initial state s_0 .

Algorithm

-
- ① If $\mathbb{U} = \emptyset$ then STOP.
 - ② Initialize the current state $s_c \leftarrow s_0$.
 - ③ Build \mathbb{U} .
 - ④ In a loop, process all tables in \mathbb{U} :
 - ① Select the next table from \mathbb{U} as t .
 - ② For the table t if $k_r < k_n$, where $z(t) = (k_n, k_r)$ then go to step 4.1.
 - ③ In a loop, process all rules in table t :
 - ① Select next rule in table t as r .
 - ② Fire rule r , that changes the system state $s_c \leftarrow s'$.
 - ③ If there exists a link from r in t to a table t' , and $k'_r < k'_n$, where $z(t') = (k'_n, k'_r)$, then $k'_r \leftarrow k'_r + 1$.
 - ⑤ $s_n \leftarrow s_c$.
 - ⑥ STOP.
-

The order of the tables in \mathbb{U} is determined by one of the algorithms: FOI, DDI, TDI or GDI.

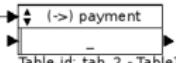
Algorithm example

| $\blacktriangleright \downarrow (?)$ driverAge | $\downarrow (?)$ driverLicenceAge | $\downarrow (->)$ driverDiscount |
|--|-----------------------------------|---|
| < 25 | ≥ 3 | $::= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $::= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | ≥ 3 | - |
| $\in [25, 39]$ | < 3 | $::= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | ≥ 3 | $::= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $::= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $::= \text{add}(\text{driverDiscount}, 30)$ |

Table id: tab_3 - DriverDiscount2

| $\blacktriangleright \downarrow (?)$ carCapacity | $\downarrow (->)$ baseCharge |
|--|------------------------------|
| < 900 | $::= 537.00$ |
| $\in [901, 1300]$ | $::= 753.00$ |
| $\in [1301, 1600]$ | $::= 1050.00$ |
| $\in [1601, 2000]$ | $::= 1338.00$ |
| > 2000 | $::= 1536.00$ |

Table id: tab_5 - BaseCharge



| $\blacktriangleright \downarrow (?)$ antiqueCar | $\downarrow (?)$ technical | $\downarrow (->)$ carDiscount |
|---|----------------------------|--|
| = 0 | = 1 | - |
| = 0 | = 0 | $::= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $::= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $::= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| $\blacktriangleright \downarrow (?)$ insuranceHistory | $\downarrow (?)$ otherInsurance | $\downarrow (->)$ otherDiscount |
|---|---------------------------------|--|
| = 1 | = 0 | - |
| = 1 | = 1 | $::= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $::= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $::= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

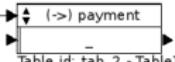
Algorithm example

| 30 | 2 | (->) driverDiscount |
|-----------------|------------------------|---------------------------|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

| 1900 | (->) baseCharge |
|-------------------|-------------------|
| ◆ (?) carCapacity | ◆ (->) baseCharge |
| < 900 | := 537.00 |
| ∈ [901,1300] | := 753.00 |
| ∈ [1301,1600] | := 1050.00 |
| ∈ [1601,2000] | := 1338.00 |
| > 2000 | := 1536.00 |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|------------------|-----------------|------------------------|
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|------------------------|----------------------|--------------------------|
| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|---------------|---------------------------|
| | | (->) driverDiscount |
| ▷ (?) driverAge | < 25 | := add(driverDiscount,50) |
| | ≥ 3 | |
| ▷ (?) driverAge | < 25 | := add(driverDiscount,80) |
| | < 3 | |
| ▷ (?) driverAge | $\in [25,39]$ | = |
| | ≥ 3 | |
| ▷ (?) driverAge | $\in [25,39]$ | := add(driverDiscount,30) |
| | < 3 | |
| ▷ (?) driverAge | $\in [40,55]$ | := sub(driverDiscount,10) |
| | ≥ 3 | |
| ▷ (?) driverAge | $\in [40,55]$ | := add(driverDiscount,20) |
| | < 3 | |
| ▷ (?) driverAge | > 55 | = |
| | ≥ 3 | |
| ▷ (?) driverAge | > 55 | := add(driverDiscount,30) |
| | < 3 | |

Table id: tab_3 - DriverDiscount2

| 1900 | | |
|-------------------|-------------------|-----------------|
| | | (->) baseCharge |
| ▷ (?) carCapacity | < 900 | := 537.00 |
| | $\in [901,1300]$ | := 753.00 |
| ▷ (?) carCapacity | $\in [1301,1600]$ | := 1050.00 |
| | $\in [1601,2000]$ | := 1338.00 |
| ▷ (?) carCapacity | > 2000 | := 1536.00 |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|-------|------------------|
| | | (->) carDiscount |
| ▷ (?) antiqueCar | = 0 | = 1 |
| | $= 0$ | $= 1$ |
| ▷ (?) antiqueCar | $= 0$ | $= 0$ |
| | $= 0$ | $= 1$ |
| ▷ (?) antiqueCar | $= 1$ | $= 0$ |
| | $= 1$ | $= 1$ |
| ▷ (?) antiqueCar | $= 1$ | $= 1$ |
| | $= 0$ | $= 0$ |
| ▷ (?) antiqueCar | $= 0$ | $= 0$ |
| | $= 1$ | $= 1$ |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|-------|--------------------|
| | | (->) otherDiscount |
| ▷ (?) insuranceHistory | = 1 | = 0 |
| | $= 1$ | $= 1$ |
| ▷ (?) insuranceHistory | $= 1$ | $= 1$ |
| | $= 0$ | $= 1$ |
| ▷ (?) insuranceHistory | $= 0$ | $= 0$ |
| | $= 1$ | $= 0$ |
| ▷ (?) insuranceHistory | $= 1$ | $= 0$ |
| | $= 0$ | $= 1$ |
| ▷ (?) insuranceHistory | $= 0$ | $= 0$ |
| | $= 1$ | $= 1$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|------------------------|---------------------------|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

| |
|-------|
| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

1900

| ◆ (?) carCapacity | ◆ (->) baseCharge |
|-------------------|-------------------|
| < 900 | := 537.00 |
| ∈ [901,1300] | := 753.00 |
| ∈ [1301,1600] | := 1050.00 |
| ∈ [1601,2000] | := 1338.00 |
| > 2000 | := 1536.00 |

Table id: tab_5 - BaseCharge

0 1

| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
|------------------|-----------------|------------------------|
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

1 0

| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
|------------------------|----------------------|--------------------------|
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3



Algorithm example

| 30 | 2 | |
|-----------------|------------------------|---------------------------|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

| |
|-------|
| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|-------------------|-------------------|--|
| ◆ (?) carCapacity | ◆ (->) baseCharge | |
| < 900 | := 537.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|-----------------|------------------------|
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|----------------------|--------------------------|
| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|----------------|-----------------------|---------------------------|
| | | (->) driverDiscount |
| ↳(?) driverAge | ↳(?) driverLicenceAge | := add(driverDiscount,50) |
| < 25 | ≥ 3 | |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | = |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | = |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|------------------|--|-----------------|
| | | (->) baseCharge |
| ↳(?) carCapacity | | := 537.00 |
| < 900 | | |
| ∈ [901,1300] | | := 753.00 |
| ∈ [1301,1600] | | := 1050.00 |
| ∈ [1601,2000] | | := 1338.00 |
| > 2000 | | := 1536.00 |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|-----------------|----------------|------------------------|
| | | (->) carDiscount |
| ↳(?) antiqueCar | ↳(?) technical | := |
| = 0 | = 1 | = |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|-----------------------|---------------------|--------------------------|
| | | (->) otherDiscount |
| ↳(?) insuranceHistory | ↳(?) otherInsurance | := |
| = 1 | = 0 | = |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|------------------------|--|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | ≥ 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | ≥ 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|--------------------|-------------------|--|
| ◆ (?) carCapacity | ◆ (->) baseCharge | |
| < 900 | $:= 537.00$ | |
| $\in [901, 1300]$ | $:= 753.00$ | |
| $\in [1301, 1600]$ | $:= 1050.00$ | |
| $\in [1601, 2000]$ | $:= 1338.00$ | |
| > 2000 | $:= 1536.00$ | |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|-----------------|---|
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
| = 0 | $\neq 1$ | - |
| $\neq 0$ | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| $\neq 1$ | $\neq 1$ | $:= \text{sub}(\text{carDiscount}, 50)$ |
| $\neq 1$ | $\neq 0$ | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|----------------------|---|
| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
| = 1 | $\neq 0$ | - |
| $\neq 1$ | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| $\neq 0$ | $\neq 1$ | $:= \text{add}(\text{otherDiscount}, 40)$ |
| $\neq 0$ | $\neq 0$ | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|------------------------|--|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | ≥ 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | ≥ 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |

Table id: tab_3 - DriverDiscount2

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| \cup |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

1900

| ◆ (?) carCapacity | ◆ (->) baseCharge |
|--------------------|-------------------|
| < 900 | $:= 537.00$ |
| $\in [901, 1300]$ | $:= 753.00$ |
| $\in [1301, 1600]$ | $:= 1050.00$ |
| $\in [1601, 2000]$ | $:= 1338.00$ |
| > 2000 | $:= 1536.00$ |

Table id: tab_5 - BaseCharge

0 1

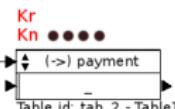
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
|------------------|-----------------|---|
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

1 0

| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
|------------------------|----------------------|---|
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3



Algorithm example

| 30 | 2 | (->) driverDiscount |
|-----------------|------------------------|---------------------------|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|-------------------|-------------------|--|
| ◆ (?) carCapacity | ◆ (->) baseCharge | |
| < 900 | := 537.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|------------------|-----------------|------------------------|
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|------------------------|----------------------|--------------------------|
| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|------------------------|--|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | ≥ 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | ≥ 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|--------------------|-------------------|--|
| ◆ (?) carCapacity | ◆ (->) baseCharge | |
| < 900 | $:= 537.00$ | |
| $\in [901, 1300]$ | $:= 753.00$ | |
| $\in [1301, 1600]$ | $:= 1050.00$ | |
| $\in [1601, 2000]$ | $:= 1338.00$ | |
| > 2000 | $:= 1536.00$ | |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|-----------------|---|
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|----------------------|---|
| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | (->) driverDiscount |
|-----------------|------------------------|---------------------------|
| ◆ (?) driverAge | ◆ (?) driverLicenceAge | ◆ (->) driverDiscount |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | (->) baseCharge |
|-------------------|-------------------|-----------------|
| ◆ (?) carCapacity | ◆ (->) baseCharge | |
| < 900 | := 537.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|------------------|-----------------|------------------------|
| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|------------------------|----------------------|--------------------------|
| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|---------------|---------------------------|
| | | (->) driverDiscount |
| ↳ (?) driverAge | < 25 | := add(driverDiscount,50) |
| | ≥ 3 | |
| ↳ (?) driverAge | < 25 | := add(driverDiscount,80) |
| | ≥ 3 | |
| ↳ (?) driverAge | $\in [25,39]$ | - |
| | ≥ 3 | |
| ↳ (?) driverAge | $\in [25,39]$ | := add(driverDiscount,30) |
| | < 3 | |
| ↳ (?) driverAge | $\in [40,55]$ | := sub(driverDiscount,10) |
| | ≥ 3 | |
| ↳ (?) driverAge | $\in [40,55]$ | := add(driverDiscount,20) |
| | < 3 | |
| ↳ (?) driverAge | > 55 | - |
| | ≥ 3 | |
| ↳ (?) driverAge | > 55 | := add(driverDiscount,30) |
| | < 3 | |

Table id: tab_3 - DriverDiscount2

| \cup |
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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|-------------------|-------------------|-----------------|
| | | (->) baseCharge |
| ↳ (?) carCapacity | < 900 | := 537.00 |
| | ≥ 900 | |
| ↳ (?) carCapacity | $\in [901,1300]$ | := 753.00 |
| | ≥ 1300 | |
| ↳ (?) carCapacity | $\in [1301,1600]$ | := 1050.00 |
| | ≥ 1600 | |
| ↳ (?) carCapacity | $\in [1601,2000]$ | := 1338.00 |
| | ≥ 2000 | |
| ↳ (?) carCapacity | > 2000 | := 1536.00 |
| | ≥ 2000 | |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|----------|------------------|
| | | (->) carDiscount |
| ↳ (?) antiqueCar | = 0 | = 1 |
| | ≥ 0 | ≤ 1 |
| ↳ (?) antiqueCar | = 0 | ≥ 0 |
| | ≥ 0 | ≤ 1 |
| ↳ (?) antiqueCar | = 1 | ≥ 1 |
| | ≥ 1 | ≤ 1 |
| ↳ (?) antiqueCar | ≥ 1 | ≤ 0 |
| | ≥ 1 | ≥ 0 |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|----------|--------------------|
| | | (->) otherDiscount |
| ↳ (?) insuranceHistory | = 1 | ≥ 0 |
| | ≥ 1 | ≤ 0 |
| ↳ (?) insuranceHistory | = 1 | ≥ 1 |
| | ≥ 1 | ≤ 1 |
| ↳ (?) insuranceHistory | ≥ 0 | ≥ 1 |
| | ≥ 0 | ≤ 1 |
| ↳ (?) insuranceHistory | = 0 | ≥ 0 |
| | ≥ 0 | ≤ 0 |
| ↳ (?) insuranceHistory | ≥ 0 | ≥ 0 |
| | ≥ 0 | ≤ 0 |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|----------------|-----------------------|---------------------------|
| | | (->) driverDiscount |
| ↳(?) driverAge | ↳(?) driverLicenceAge | := add(driverDiscount,50) |
| < 25 | ≥ 3 | := add(driverDiscount,80) |
| < 25 | < 3 | - |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

| U |
|-------|
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|------------------|--|-----------------|
| | | (->) baseCharge |
| ↳(?) carCapacity | | := 537.00 |
| < 900 | | := 753.00 |
| ∈ [901,1300] | | := 1050.00 |
| ∈ [1301,1600] | | := 1338.00 |
| ∈ [1601,2000] | | := 1536.00 |
| > 2000 | | - |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|-----------------|----------------|------------------------|
| | | (->) carDiscount |
| ↳(?) antiqueCar | ↳(?) technical | := - |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|-----------------------|---------------------|--------------------------|
| | | (->) otherDiscount |
| ↳(?) insuranceHistory | ↳(?) otherInsurance | := - |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------------|---------------|---------------------------|
| | | (->) driverDiscount |
| ↳ (?) driverAge | < 25 | := add(driverDiscount,50) |
| | ≥ 3 | |
| ↳ (?) driverAge | < 25 | := add(driverDiscount,80) |
| | ≥ 3 | |
| ↳ (?) driverAge | $\in [25,39]$ | - |
| | ≥ 3 | |
| ↳ (?) driverAge | $\in [25,39]$ | := add(driverDiscount,30) |
| | < 3 | |
| ↳ (?) driverAge | $\in [40,55]$ | := sub(driverDiscount,10) |
| | ≥ 3 | |
| ↳ (?) driverAge | $\in [40,55]$ | := add(driverDiscount,20) |
| | < 3 | |
| ↳ (?) driverAge | > 55 | - |
| | ≥ 3 | |
| ↳ (?) driverAge | > 55 | := add(driverDiscount,30) |
| | < 3 | |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

1900

| 1900 | | |
|-------------------|-------------------|-----------------|
| | | (->) baseCharge |
| ↳ (?) carCapacity | < 900 | := 537.00 |
| | ≥ 900 | |
| ↳ (?) carCapacity | $\in [901,1300]$ | := 753.00 |
| | ≥ 1300 | |
| ↳ (?) carCapacity | $\in [1301,1600]$ | := 1050.00 |
| | ≥ 1600 | |
| ↳ (?) carCapacity | $\in [1601,2000]$ | := 1338.00 |
| | ≥ 2000 | |
| ↳ (?) carCapacity | > 2000 | := 1536.00 |
| | ≥ 2000 | |

Table id: tab_5 - BaseCharge

0 1

| 0 | 1 | | |
|------------------|----------|------------------|------------------------|
| | | (->) carDiscount | |
| ↳ (?) antiqueCar | = 0 | = 1 | |
| | ≥ 0 | ≤ 1 | |
| ↳ (?) antiqueCar | = 0 | ≥ 0 | := add(carDiscount,20) |
| | ≥ 1 | ≤ 0 | |
| ↳ (?) antiqueCar | = 1 | ≥ 1 | := sub(carDiscount,50) |
| | ≤ 0 | ≥ 1 | |
| ↳ (?) antiqueCar | ≥ 1 | ≤ 0 | := sub(carDiscount,30) |
| | ≥ 0 | ≤ 1 | |

Table id: tab_6 - CarDiscount3

1 0

| 1 | 0 | | |
|------------------------|----------|--------------------|--------------------------|
| | | (->) otherDiscount | |
| ↳ (?) insuranceHistory | = 1 | ≥ 0 | |
| | ≥ 1 | ≤ 0 | |
| ↳ (?) insuranceHistory | = 1 | ≥ 1 | := sub(otherDiscount,20) |
| | ≤ 1 | ≤ 0 | |
| ↳ (?) insuranceHistory | = 0 | ≥ 1 | := add(otherDiscount,40) |
| | ≤ 0 | ≤ 1 | |
| ↳ (?) insuranceHistory | ≥ 0 | ≤ 0 | := add(otherDiscount,60) |
| | ≥ 1 | ≥ 1 | |

Table id: tab_7 - OtherDiscount3



Table id: tab_2 - Table1

Algorithm example

| 30 | 2 | (->) driverDiscount |
|----------------|-----------------------|---------------------------|
| ↳(?) driverAge | ↳(?) driverLicenceAge | |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

| U |
|-------|
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | (->) baseCharge |
|------------------|--|-----------------|
| ↳(?) carCapacity | | |
| < 900 | | := 537.00 |
| ∈ [901,1300] | | := 753.00 |
| ∈ [1301,1600] | | := 1050.00 |
| ∈ [1601,2000] | | := 1338.00 |
| > 2000 | | := 1536.00 |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|-----------------|----------------|------------------------|
| ↳(?) antiqueCar | ↳(?) technical | |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|-----------------------|---------------------|--------------------------|
| ↳(?) insuranceHistory | ↳(?) otherInsurance | |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | (->) driverDiscount |
|----------------|-----------------------|---------------------------|
| ↳(?) driverAge | ↳(?) driverLicenceAge | |
| < 25 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,30) |

Table id: tab_3 - DriverDiscount2

| U |
|-------|
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | (->) baseCharge |
|------------------|--|-----------------|
| ↳(?) carCapacity | | |
| < 900 | | := 537.00 |
| ∈ [901,1300] | | := 753.00 |
| ∈ [1301,1600] | | := 1050.00 |
| ∈ [1601,2000] | | := 1338.00 |
| > 2000 | | := 1536.00 |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|-----------------|----------------|------------------------|
| ↳(?) antiqueCar | ↳(?) technical | |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|-----------------------|---------------------|--------------------------|
| ↳(?) insuranceHistory | ↳(?) otherInsurance | |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|----------------|------------------|--|
| driverAge | driverLicenceAge | (->) driverDiscount |
| < 20 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 10)$ |

Table id: tab_3 - DriverDiscount2

| \cup |
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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

1900

| ◆ (?) carCapacity | ◆ (->) baseCharge |
|--------------------|-------------------|
| < 900 | $:= 537.00$ |
| $\in [901, 1300]$ | $:= 753.00$ |
| $\in [1301, 1600]$ | $:= 1050.00$ |
| $\in [1601, 2000]$ | $:= 1338.00$ |
| > 2000 | $:= 1536.00$ |

Table id: tab_5 - BaseCharge



0 1

| ◆ (?) antiqueCar | ◆ (?) technical | ◆ (->) carDiscount |
|------------------|-----------------|---|
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

1 0

| ◆ (?) insuranceHistory | ◆ (?) otherInsurance | ◆ (->) otherDiscount |
|------------------------|----------------------|---|
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| | | |
|----------------|------------------------|--|
| 30 | 2 | |
| ► (?) carAge | ► (?) driverLicenceAge | ► (->) driverDiscount |
| < 20 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 10)$ |

Table id: tab_3 - DriverDiscount2

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| \sqcup |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| | | |
|--------------------|-------------------|--|
| 1900 | | |
| ► (?) carCapacity | ► (->) baseCharge | |
| < 900 | $:= 537.00$ | |
| $\in [901, 1300]$ | $:= 753.00$ | |
| $\in [1301, 1600]$ | $:= 1050.00$ | |
| $\in [1601, 2000]$ | $:= 1338.00$ | |
| > 2000 | $:= 1536.00$ | |

Table id: tab_5 - BaseCharge



| | | |
|------------------|-----------------|---|
| 0 | 1 | |
| ► (?) antiqueCar | ► (?) technical | ► (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| | | |
|------------------------|----------------------|---|
| 1 | 0 | |
| ► (?) insuranceHistory | ► (?) otherInsurance | ► (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | (->) driverDiscount |
|----------------|----------|--|
| < 20 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 10)$ |

Table id: tab_3 - DriverDiscount2

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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | (->) baseCharge |
|--------------------|-----------------|
| < 900 | $:= 537.00$ |
| $\in [901, 1300]$ | 753.00 |
| $\in [1301, 1600]$ | $:= 1050.00$ |
| $\in [1601, 2000]$ | $:= 1338.00$ |
| > 2000 | $:= 1536.00$ |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|-------------------------|------------------------|---|
| $\Delta (?)$ antiqueCar | $\Delta (?)$ technical | (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|-------------------------------|-----------------------------|---|
| $\Delta (?)$ insuranceHistory | $\Delta (?)$ otherInsurance | (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | (->) driverDiscount |
|----------------|----------|--|
| < 20 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 10)$ |

Table id: tab_3 - DriverDiscount2

| \cup |
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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | (->) baseCharge |
|--------------------|------------------|
| < 900 | $:= 537.00$ |
| $\in [901, 1300]$ | := 753.00 |
| $\in [1301, 1600]$ | $:= 1050.00$ |
| $\in [1601, 2000]$ | $:= 1338.00$ |
| > 2000 | $:= 1536.00$ |

Table id: tab_5 - BaseCharge



| 0 | 1 | (->) carDiscount |
|-----|-----|---|
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| 1 | 0 | (->) otherDiscount |
|-----|-----|---|
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| | | |
|-------------|------------------------|---------------------------|
| 30 | 2 | |
| > driverAge | ▼ (?) driverLicenceAge | ► (->) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | 3 | sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,10) |

Table id: tab_3 - DriverDiscount2

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| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| | | |
|-------------------|-------------------|--|
| 1900 | | |
| ↳ (?) carCapacity | ↳ (->) baseCharge | |
| < 900 | := 537.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge



Table id: tab_2 - Table1

| | | |
|------------------|-----------------|------------------------|
| 0 | 1 | |
| ↳ (?) antiqueCar | ↳ (?) technical | ► (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| | | |
|------------------------|----------------------|--------------------------|
| 1 | 0 | |
| ↳ (?) insuranceHistory | ↳ (?) otherInsurance | ► (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------|------------------------|---------------------------|
| driverAge | ▼ (?) driverLicenceAge | ► (->) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | 3 | sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,10) |

Table id: tab_3 - DriverDiscount2

| U |
|--------------|
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|-------------------|-------------------|--|
| ↳ (?) carCapacity | ↳ (->) baseCharge | |
| < 900 | := 537.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|-----------------|------------------------|
| ↳ (?) antiqueCar | ↳ (?) technical | ► (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|----------------------|--------------------------|
| ↳ (?) insuranceHistory | ↳ (?) otherInsurance | ► (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| | | |
|----------------|-----------------------|--|
| 30 | 2 | |
| > driverAge | <(?) driverLicenceAge | (->) driverDiscount |
| < 20 | ≥ 3 | $:= \text{add}(\text{driverDiscount}, 50)$ |
| < 25 | < 3 | $:= \text{add}(\text{driverDiscount}, 80)$ |
| $\in [25, 39]$ | 3 | - |
| $\in [25, 39]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 30)$ |
| $\in [40, 55]$ | 3 | $:= \text{sub}(\text{driverDiscount}, 10)$ |
| $\in [40, 55]$ | < 3 | $:= \text{add}(\text{driverDiscount}, 20)$ |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | $:= \text{add}(\text{driverDiscount}, 10)$ |

Table id: tab_3 - DriverDiscount2

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| \cup |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| | | |
|-----------------------------------|-------------------------------------|--|
| 1900 | | |
| $\uparrow(?) \text{ carCapacity}$ | $\downarrow(->) \text{ baseCharge}$ | |
| < 900 | $:= 537.00$ | |
| $\in [901, 1300]$ | $:= 753.00$ | |
| $\in [1301, 1600]$ | $:= 1050.00$ | |
| $\in [1601, 2000]$ | 1338.00 | |
| > 2000 | $:= 1536.00$ | |

Table id: tab_5 - BaseCharge



| | | |
|----------------------------------|---------------------------------|---|
| 0 | 1 | |
| $\uparrow(?) \text{ antiqueCar}$ | $\uparrow(?) \text{ technical}$ | $\downarrow(->) \text{ carDiscount}$ |
| = 0 | = 1 | - |
| = 0 | = 0 | $:= \text{add}(\text{carDiscount}, 20)$ |
| = 1 | = 1 | $:= \text{sub}(\text{carDiscount}, 50)$ |
| = 1 | = 0 | $:= \text{sub}(\text{carDiscount}, 30)$ |

Table id: tab_6 - CarDiscount3

| | | |
|--|--------------------------------------|---|
| 1 | 0 | |
| $\uparrow(?) \text{ insuranceHistory}$ | $\uparrow(?) \text{ otherInsurance}$ | $\downarrow(->) \text{ otherDiscount}$ |
| = 1 | = 0 | - |
| = 1 | = 1 | $:= \text{sub}(\text{otherDiscount}, 20)$ |
| = 0 | = 1 | $:= \text{add}(\text{otherDiscount}, 40)$ |
| = 0 | = 0 | $:= \text{add}(\text{otherDiscount}, 60)$ |

Table id: tab_7 - OtherDiscount3

Algorithm example

| 30 | 2 | |
|-----------|------------------------|---------------------------|
| driverAge | ▼ (?) driverLicenceAge | ► (->) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | 3 | sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,10) |

Table id: tab_3 - DriverDiscount2

| U |
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| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |

| 1900 | | |
|-------------------|-------------------|--|
| ↳ (?) carCapacity | ↳ (->) baseCharge | |
| < 900 | := 537.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1338.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge



| 0 | 1 | |
|------------------|-----------------|------------------------|
| ↳ (?) antiqueCar | ↳ (?) technical | ► (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| 1 | 0 | |
|------------------------|----------------------|--------------------------|
| ↳ (?) insuranceHistory | ↳ (?) otherInsurance | ► (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

Algorithm example

| | | |
|-----------|------------------------|---------------------------|
| 30 | 2 | |
| driverAge | ▼ (?) driverLicenceAge | ► (->) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,10) |

Table id: tab_3 - DriverDiscount2

| | | |
|---------------|-------------------|-----------|
| 1900 | | |
| carCapacity | ▼ (->) baseCharge | |
| < 900 | = 500.00 | := 500.00 |
| ∈ [901,1300] | = 753.00 | - |
| ∈ [1301,1600] | = 1050.00 | - |
| ∈ [1601,2000] | = 1358.00 | - |
| > 2000 | = 1536.00 | - |

Table id: tab_5 - BaseCharge

| | | |
|------------------|-----------------|------------------------|
| 0 | 1 | |
| ► (?) antiqueCar | ► (?) technical | ► (->) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| | | |
|------------------------|----------------------|--------------------------|
| 1 | 0 | |
| ► (?) insuranceHistory | ► (?) otherInsurance | ► (->) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

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| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |



Algorithm example

| | | |
|-----------|-----------------------|---------------------------|
| 30 | 2 | |
| driverAge | ↓(?) driverLicenceAge | (→) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,20) |

Table id: tab_3 - DriverDiscount2

| | | |
|--------------|-----------------|-------------|
| 1900 | | |
| carCapacity | ↓(?) baseCharge | (→) payment |
| < 90 | := 500.00 | - |
| ∈ [90,130] | := 753.00 | - |
| ∈ [130,160] | := 1050.00 | - |
| ∈ [160,2000] | := 1288.00 | - |
| > 2000 | := 1536.00 | - |

Table id: tab_3 - BaseCharge

| | | |
|-----------------|----------------|------------------------|
| 0 | 1 | |
| ↑(?) antiqueCar | ↑(?) technical | (→) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| | | |
|-----------------------|---------------------|--------------------------|
| 1 | 0 | |
| ↑(?) insuranceHistory | ↑(?) otherInsurance | (→) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

| |
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| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |



Algorithm example

| | | |
|-----------|-----------------------|---------------------------|
| 30 | 2 | |
| driverAge | ↓(?) driverLicenceAge | (→) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,20) |

Table id: tab_3 - DriverDiscount2

| | | |
|--------------|-----------------|-------------|
| 1900 | | |
| carCapacity | ↓(?) baseCharge | (→) payment |
| < 90 | := 500.00 | - |
| ∈ [90,130] | := 753.00 | - |
| ∈ [130,160] | := 1050.00 | - |
| ∈ [160,2000] | := 1288.00 | - |
| > 2000 | := 1536.00 | - |

Table id: tab_3 - BaseCharge

| | | |
|-----------------|----------------|------------------------|
| 0 | 1 | |
| ↑(?) antiqueCar | ↑(?) technical | (→) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,30) |

Table id: tab_6 - CarDiscount3

| | | |
|-----------------------|---------------------|--------------------------|
| 1 | 0 | |
| ↑(?) insuranceHistory | ↑(?) otherInsurance | (→) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

| |
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| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |



Algorithm example

| | | |
|-----------|-----------------------|---------------------------|
| 30 | 2 | |
| driverAge | ↓(?) driverLicenceAge | (→) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | = |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | = |
| > 55 | < 3 | := add(driverDiscount,20) |

Table id: tab_3 - DriverDiscount2

| | | |
|---------------|-----------------|--|
| 1900 | | |
| carCapacity | ↓(→) baseCharge | |
| < 100 | := 50.00 | |
| ∈ [901,1300] | := 753.00 | |
| ∈ [1301,1600] | := 1050.00 | |
| ∈ [1601,2000] | := 1358.00 | |
| > 2000 | := 1536.00 | |

Table id: tab_5 - BaseCharge

| | | |
|---------------|----------------|------------------------|
| 0 | 1 | |
| ↓(?) valueCar | ↓(?) technical | (→) carDiscount |
| = 0 | = 1 | = |
| = 0 | = 1 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,20) |

Table id: tab_6 - CarDiscounts

| | | |
|-----------------------|---------------------|--------------------------|
| 1 | 0 | |
| ↓(?) insuranceHistory | ↓(?) otherInsurance | (→) otherDiscount |
| = 1 | = 0 | = |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

| |
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| U |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |



Algorithm example

| 30 | 2 | |
|-----------|-----------------------|---------------------------|
| driverAge | ↓(?) driverLicenceAge | (→) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | 3 | - |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | 3 | - |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | - |
| > 55 | < 3 | := add(driverDiscount,10) |

Table id: tab_3 - DriverDiscount2

| 1900 | | |
|---------------|-----------------|--|
| carCapacity | ↓(→) baseCharge | |
| < 100 | = 500.00 | |
| ∈ [901,1300] | = 753.00 | |
| ∈ [1301,1600] | = 1050.00 | |
| ∈ [1601,2000] | = 1358.00 | |
| > 2000 | = 1536.00 | |

Table id: tab_5 - BaseCharge

| 0 | 1 | |
|---------------|----------------|------------------------|
| ↓(?) valueCar | ↓(?) technical | (→) carDiscount |
| = 0 | = 1 | - |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,20) |

Table id: tab_6 - CarDiscounts

| 1 | 0 | |
|-----------------------|---------------------|--------------------------|
| ↓(?) insuranceHistory | ↓(?) otherInsurance | (→) otherDiscount |
| = 1 | = 0 | - |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := add(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscount3

| U |
|--------------|
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |



Algorithm example

| | | |
|-----------|-----------------------|---------------------------|
| 30 | 2 | |
| driverAge | ↓(?) driverLicenceAge | (→) driverDiscount |
| < 20 | ≥ 3 | := add(driverDiscount,50) |
| < 25 | < 3 | := add(driverDiscount,80) |
| ∈ [25,39] | ≥ 3 | = |
| ∈ [25,39] | < 3 | := add(driverDiscount,30) |
| ∈ [40,55] | ≥ 3 | := sub(driverDiscount,10) |
| ∈ [40,55] | < 3 | := add(driverDiscount,20) |
| > 55 | ≥ 3 | = |
| > 55 | < 3 | := add(driverDiscount,20) |

Table id: tab_3 - DriverDiscount2

| | | |
|---------------|-----------------|--|
| 1900 | | |
| carCapacity | ↓(→) baseCharge | |
| < 100 | = 500.00 | |
| ∈ [901,1300] | = 753.00 | |
| ∈ [1301,1600] | = 1050.00 | |
| ∈ [1601,2000] | = 1358.00 | |
| > 2000 | = 1536.00 | |

Table id: tab_5 - BaseCharge

| | | |
|---------------|----------------|------------------------|
| 0 | 1 | |
| ↓(?) valueCar | ↓(?) technical | (→) carDiscount |
| = 0 | = 1 | = |
| = 0 | = 0 | := add(carDiscount,20) |
| = 1 | = 1 | := sub(carDiscount,50) |
| = 1 | = 0 | := sub(carDiscount,20) |

Table id: tab_6 - CarDiscounts

| | | |
|-----------------------|---------------------|--------------------------|
| 1 | 0 | |
| ↓(?) insuranceHistory | ↓(?) otherInsurance | (→) otherDiscount |
| = 1 | = 0 | = |
| = 1 | = 1 | := sub(otherDiscount,20) |
| = 0 | = 1 | := sub(otherDiscount,40) |
| = 0 | = 0 | := add(otherDiscount,60) |

Table id: tab_7 - OtherDiscounts

| |
|--------------|
| \cup |
| tab_3 |
| tab_5 |
| tab_6 |
| tab_7 |
| tab_2 |



Data Driven

DDI algorithm determines the tables' order in set \mathbb{U}

- ① Find the set of start tables $N_1 \subset \mathbb{T}$:

$$N_1 \leftarrow \{t_i : h(t_i) = (H_i^{cond}, H_i^{dec}), \forall j : h(t_j) = (H_j^{cond}, H_j^{dec}), H_j^{dec} \cap H_i^{cond} = \emptyset\}, i \neq j$$

- ② In a loop:

- ① If $N_1 = \emptyset$ then STOP.

- ② Build set of tables $N_2 \subset \mathbb{T}$:

$$N_2 \leftarrow \{t_k : \forall i : t_i \in N_1 : H_k^{cond} = H_i^{dec}\} \text{ and } N_2 \cap (\mathbb{U} \cup N_1) = \emptyset$$

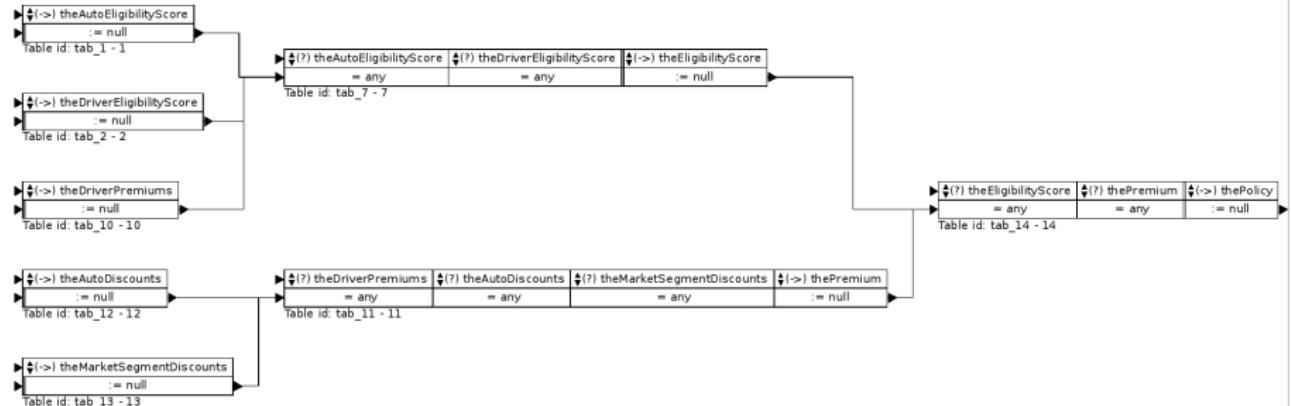
- ③ $\forall t_k \in N_2 : z(t_k) = (0, 0)$.

- ④ $\mathbb{U} \leftarrow \mathbb{U} \cup N_1$.

- ⑤ $N_1 \leftarrow N_2$.

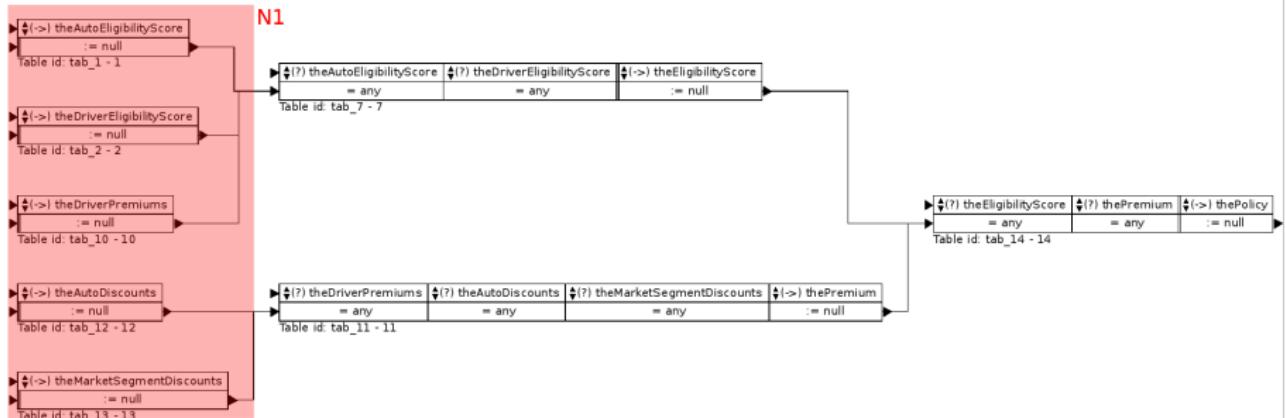
-
- It corresponds to a simple forward-chining strategy.
 - It has limitations.

Example



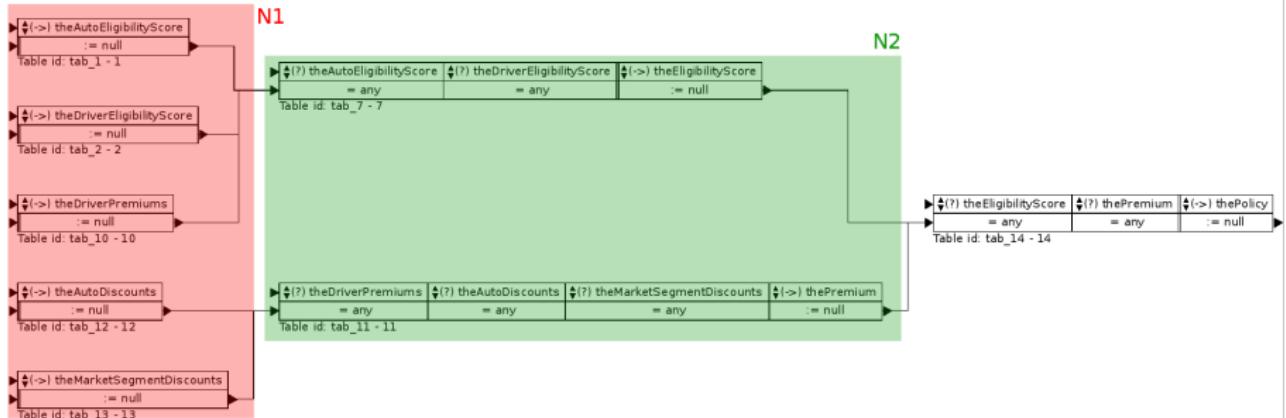
- $\mathbb{U} = \emptyset$
- $N1 = \emptyset$
- $N2 = \emptyset$

Example



- $\mathbb{U} = \emptyset$
- $N1 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$
- $N2 = \emptyset$

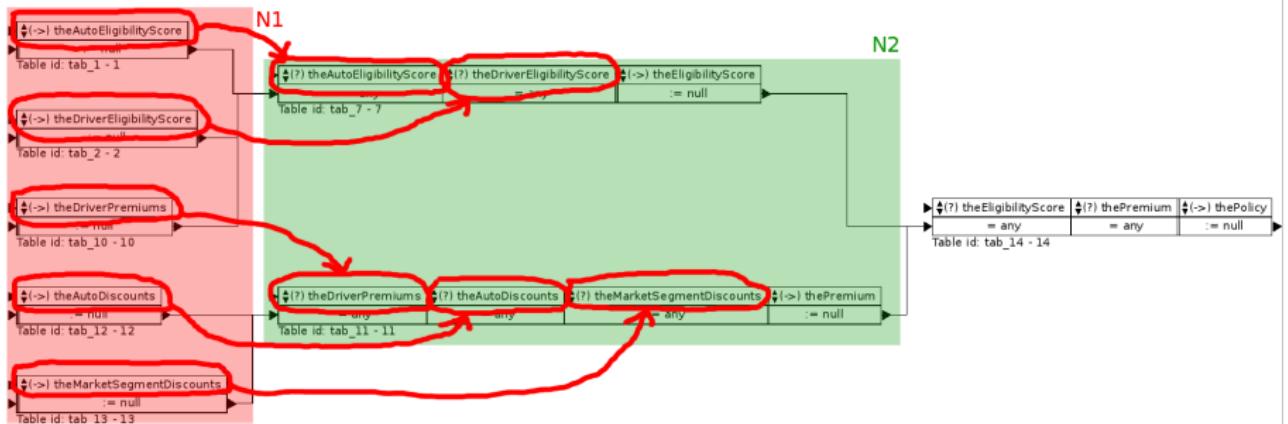
Example



- $\mathbb{U} = \emptyset$
- $N1 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$
- $N2 = \{tab_7, tab_11\}$

Example

Knowledge engineer select starting tables.



- $\mathbb{U} = \emptyset$
- $N1 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$
- $N2 = \{tab_7, tab_11\}$

Example



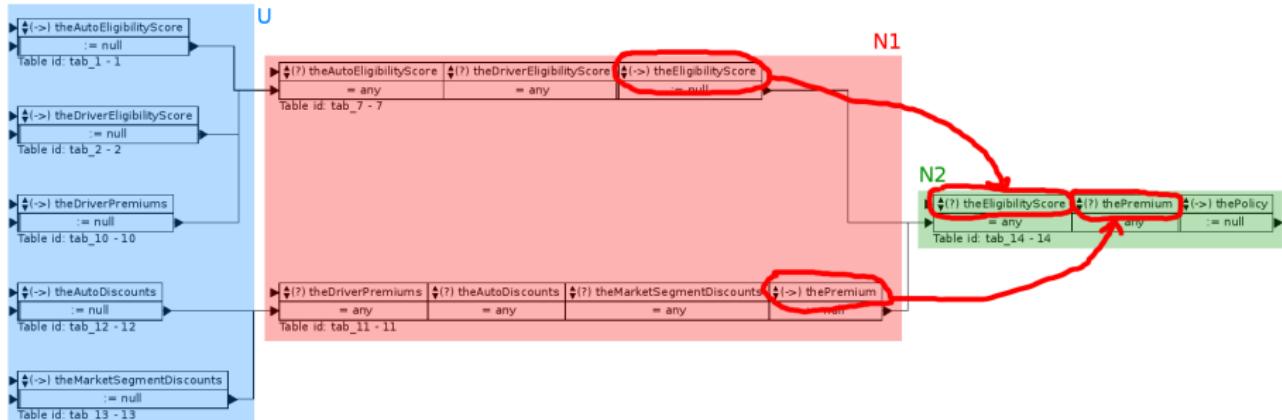
- $\mathbb{U} = \{\text{tab_1}, \text{tab_2}, \text{tab_10}, \text{tab_12}, \text{tab_13}\}$
- $N_1 = \{\text{tab_7}, \text{tab_11}\}$
- $N_2 = \emptyset$

Example



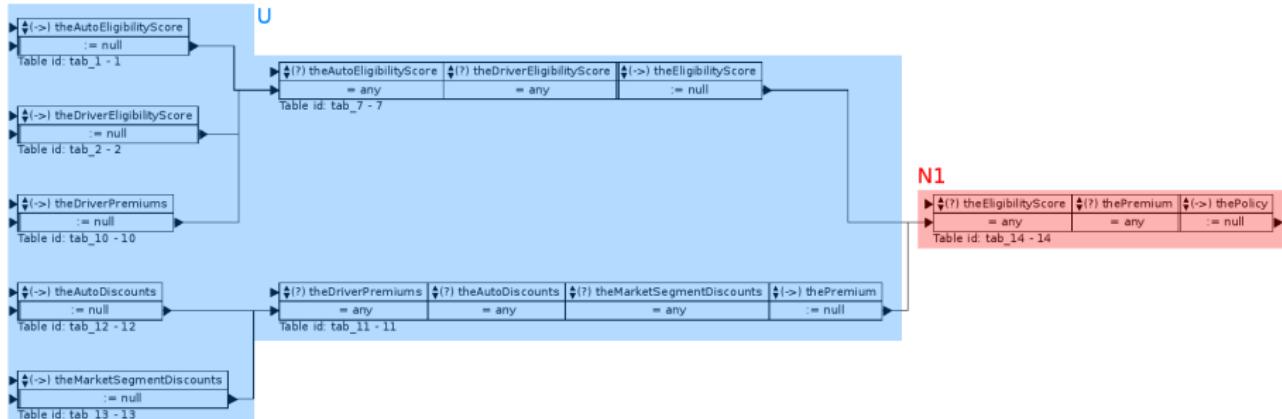
- $\mathbb{U} = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$
- $N_1 = \{tab_7, tab_11\}$
- $N_2 = \{tab_14\}$

Example



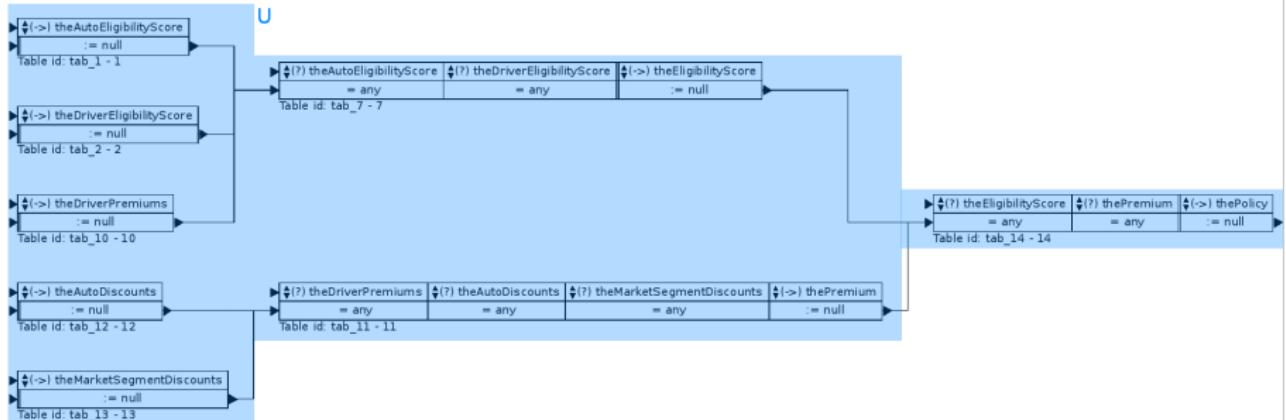
- $\mathbb{U} = \{ \text{tab_1}, \text{tab_2}, \text{tab_10}, \text{tab_12}, \text{tab_13} \}$
- $N1 = \{ \text{tab_7}, \text{tab_11} \}$
- $N2 = \{ \text{tab_14} \}$

Example



- $\mathbb{U} = \{ \text{tab_1}, \text{tab_2}, \text{tab_10}, \text{tab_12}, \text{tab_13}, \text{tab_7}, \text{tab_11} \}$
- $N1 = \{ \text{tab_14} \}$
- $N2 = \emptyset$

Example



- $\mathbb{U} = \{tab_1, tab_2, tab_10, tab_12, tab_13, tab_7, tab_11, tab_14\}$
- $N1 = \emptyset$
- $N2 = \emptyset$

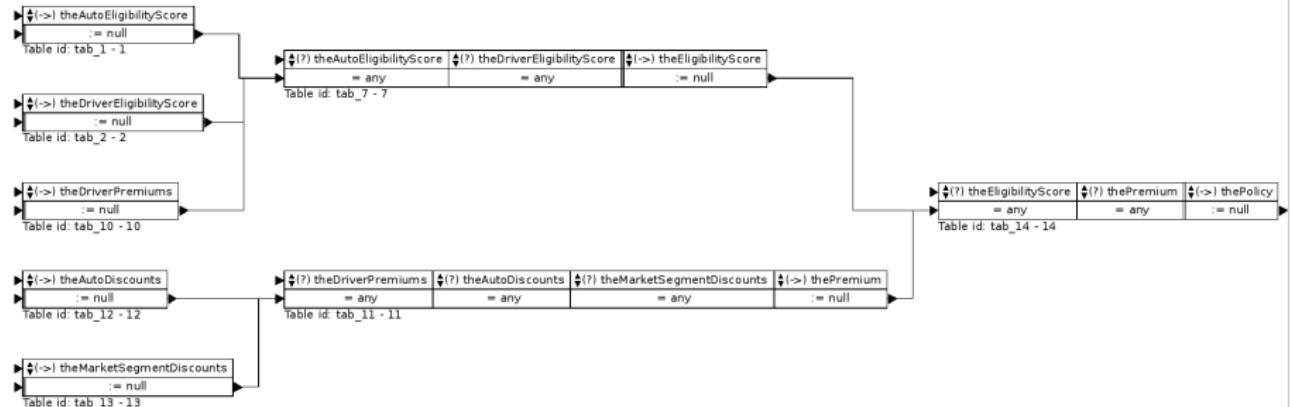
Token Driven

TDI algorithm determines the tables' order in set \mathbb{U}

- ① Find the set of tables $N_1 \subset \mathbb{T}$ where decision attributes constitute system response.
- ② In a loop:
 - ① If $N_1 = \emptyset$ then STOP.
 - ② Find the set $N_2 \subset \mathbb{T}$ of previous tables for each tables belonging to N_1 :
$$N_2 \leftarrow \{t \in \mathbb{T} : t \in \text{prev}(t_i)\} \quad \forall; t_i \in N_1, \text{ where } t \notin (\mathbb{Q} \cup N_1)$$
 - ③ Find the number of start tables for all tables in N_2 :
$$z(t) = (|\text{leaves}(t, \emptyset)|, 0) \text{ for every } t \in N_2.$$
 - ④ $\mathbb{U} \leftarrow \mathbb{U} \cup N_1$
 - ⑤ $N_1 \leftarrow N_2$

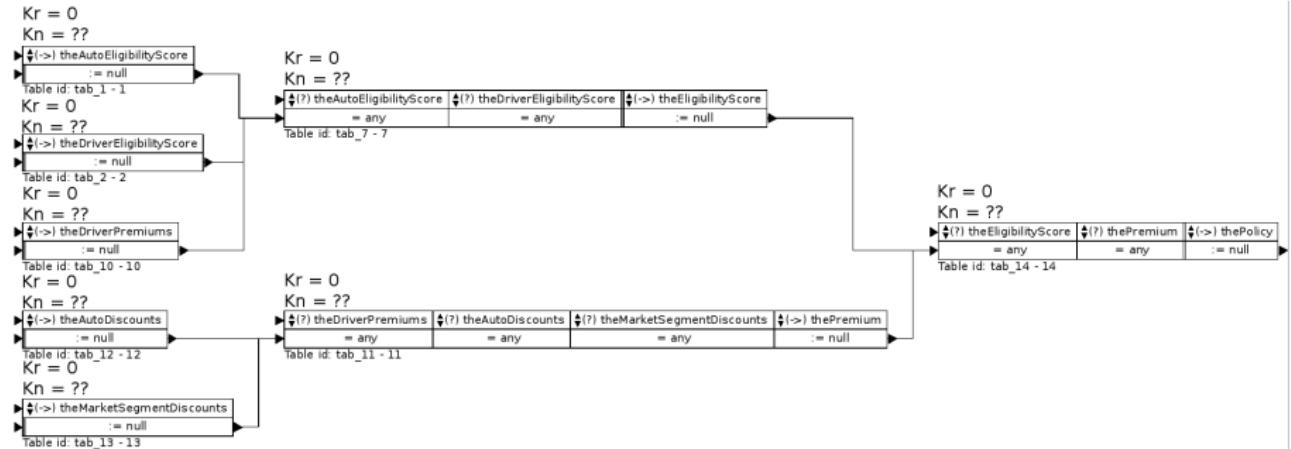
- It bases on the network structure.
- It uses tokens and links.

Example



- $\mathbb{U} = \emptyset$
- $N1 = \emptyset$
- $N2 = \emptyset$

Example



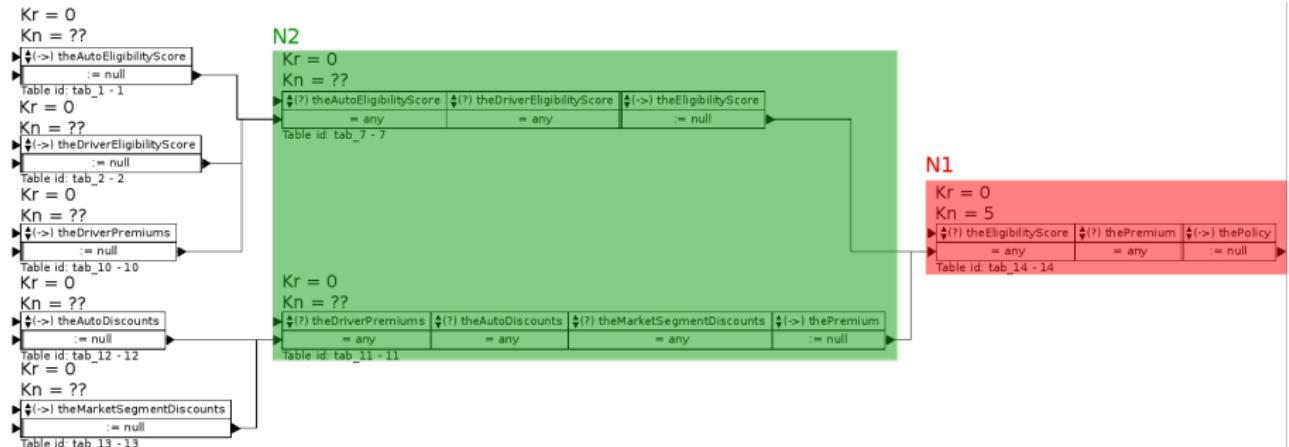
- $\mathbb{U} = \emptyset$
- $N1 = \emptyset$
- $N2 = \emptyset$

Example



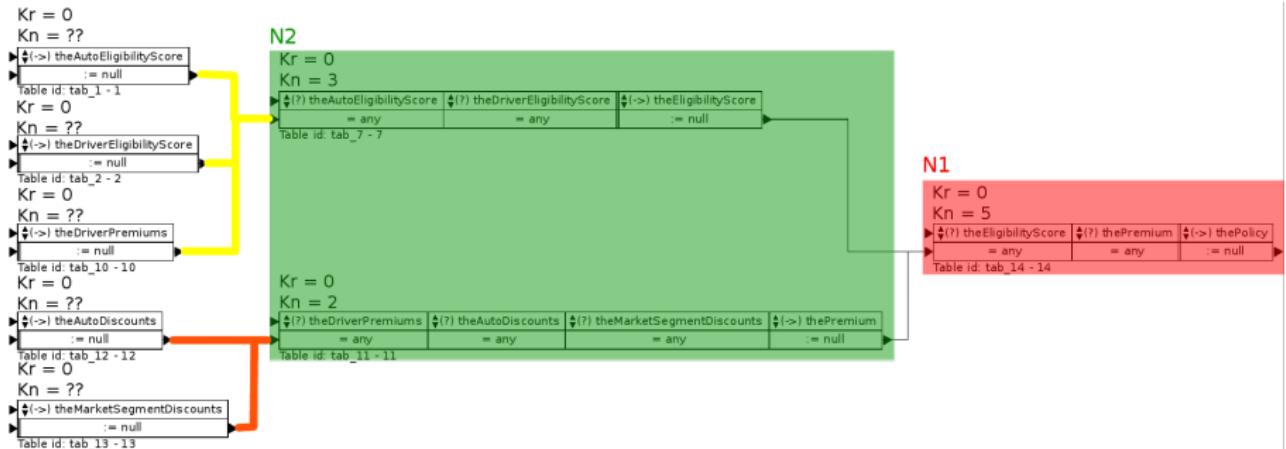
- $\mathbb{U} = \emptyset$
- $N1 = \{tab_14\}$
- $N2 = \emptyset$

Example



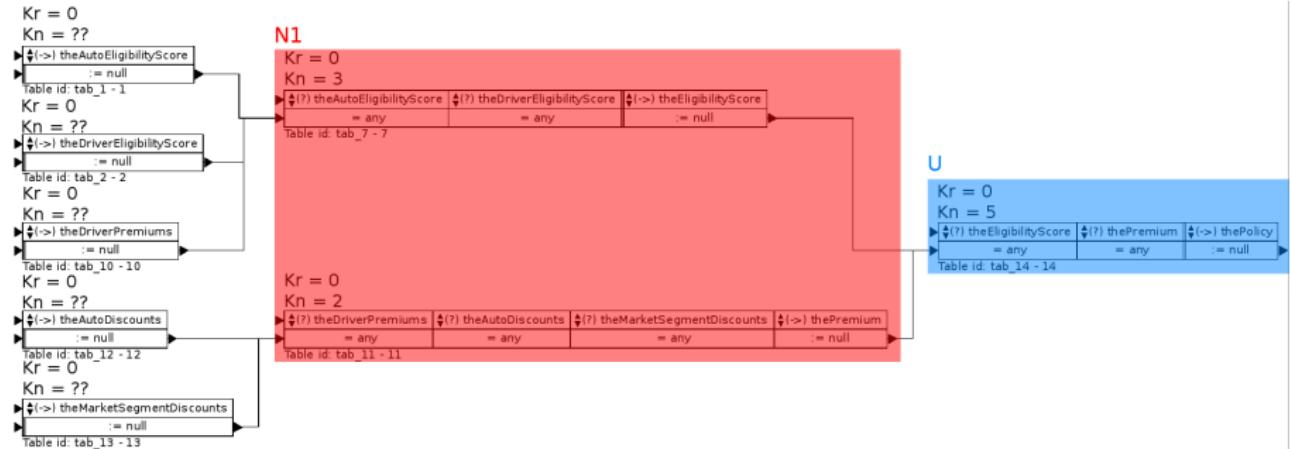
- $\mathbb{U} = \emptyset$
- $N1 = \{tab_14\}$
- $N2 = \{tab_7, tab_11\}$

Example



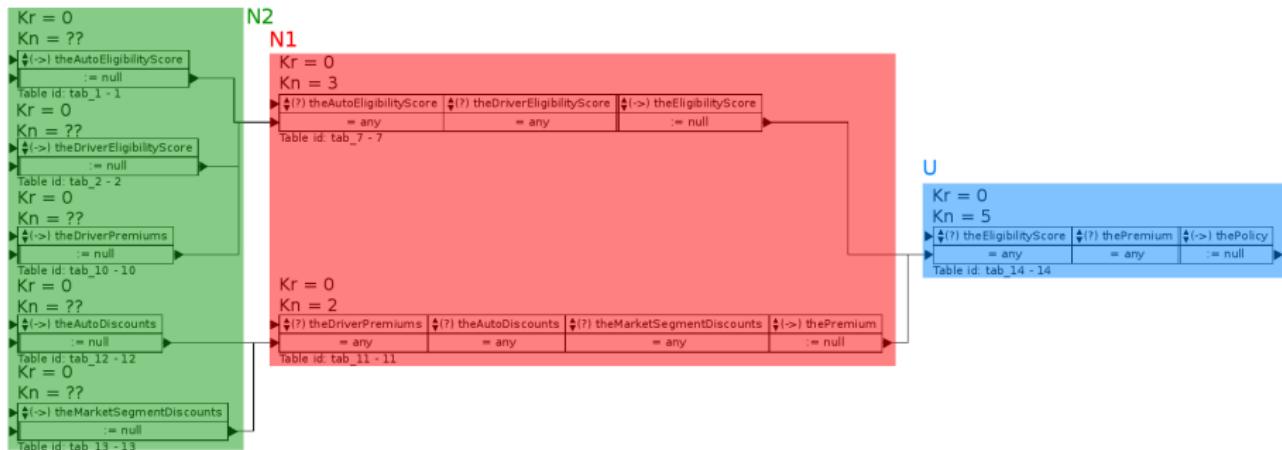
- $\mathbb{U} = \emptyset$
- $N1 = \{tab_14\}$
- $N2 = \{tab_7, tab_11\}$

Example



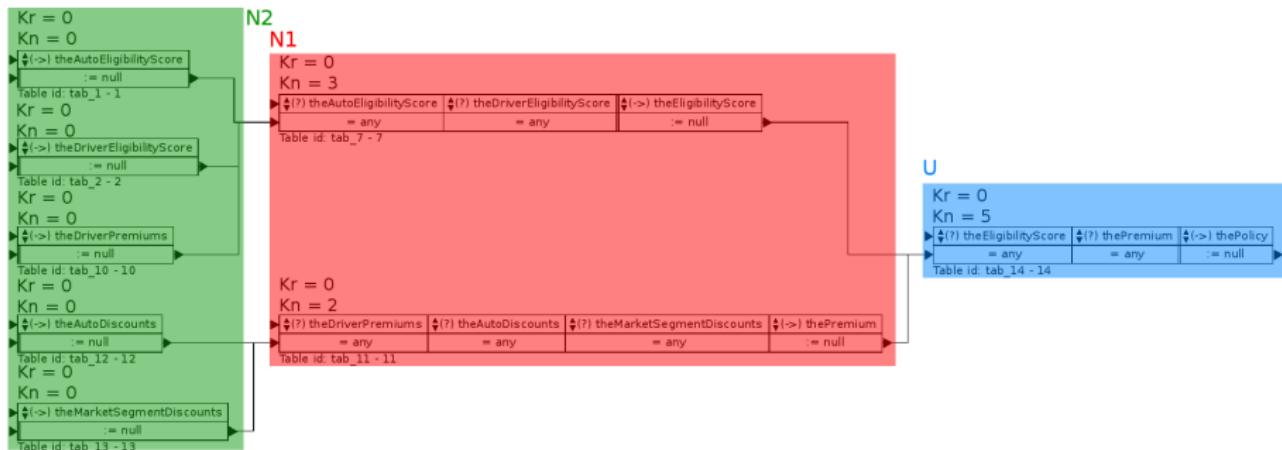
- $\mathbb{U} = \{tab_14\}$
- $N1 = \{tab_7, tab_11\}$
- $N2 = \emptyset$

Example



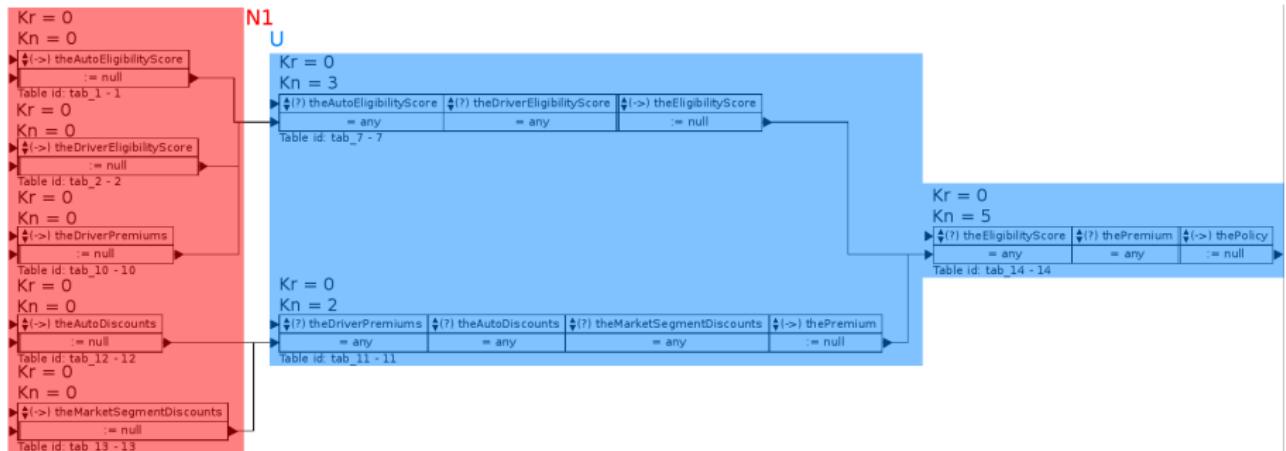
- $\mathbb{U} = \{tab_14\}$
- $N1 = \{tab_7, tab_11\}$
- $N2 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$

Example



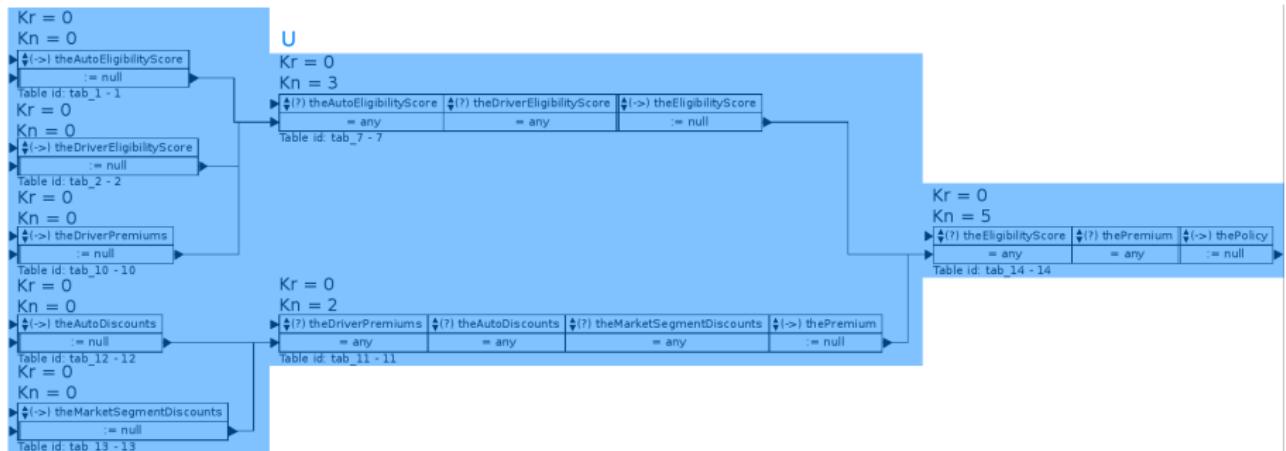
- $\mathbb{U} = \{tab_14\}$
- $N1 = \{tab_7, tab_11\}$
- $N2 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$

Example



- $\mathbb{U} = \{tab_7, tab_11, tab_14\}$
- $N1 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$
- $N2 = \emptyset$

Example



- $\mathbb{U} = \{tab_1, tab_2, tab_10, tab_12, tab_13, tab_7, tab_11, tab_14\}$
- $N1 = \emptyset$
- $N2 = \emptyset$

Goal Driven

GDI algorithm determines the tables' order in set \mathbb{U}

- ① Find the set of tables $N_1 \subset \mathbb{T}$ (the goal):

$$N_1 \leftarrow \{t_i \in \mathbb{T}: \forall_i \neq j H_i^{dec} = H_j^{cond}, i \neq j\}$$

- ② In a loop:

- ① If $N_1 = \emptyset$ then STOP.

- ② Build set of tables $N_2 \subset \mathbb{T}$:

$$N_2 \leftarrow \{t_k \in \mathbb{T}: \forall_i H_k^{dec} = H_i^{cond}\}, t_i \in N_1$$

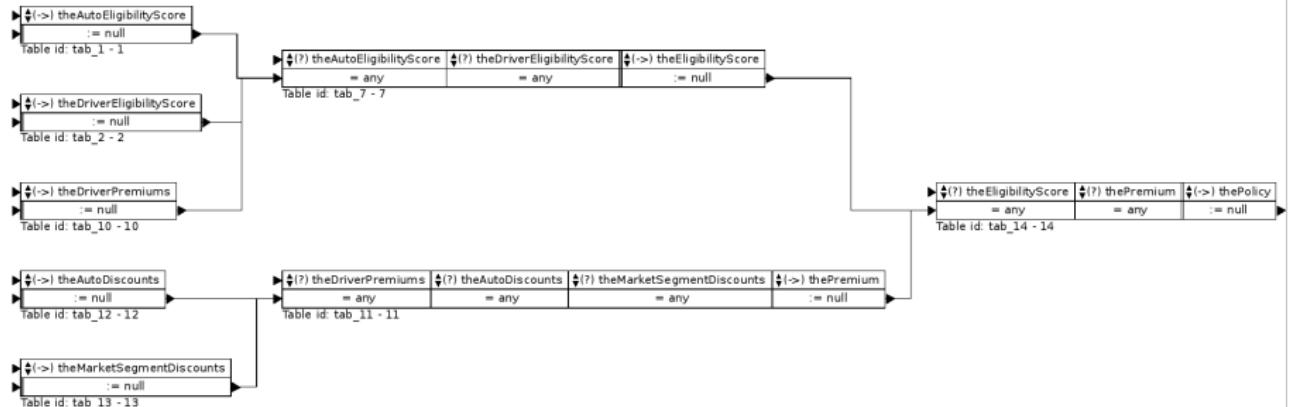
- ③ $z(t) = (0, 0)$ for every $t \in N_2$

- ④ $\mathbb{U} \leftarrow \mathbb{U} \cup N_1$

- ⑤ $N_1 \leftarrow N_2$

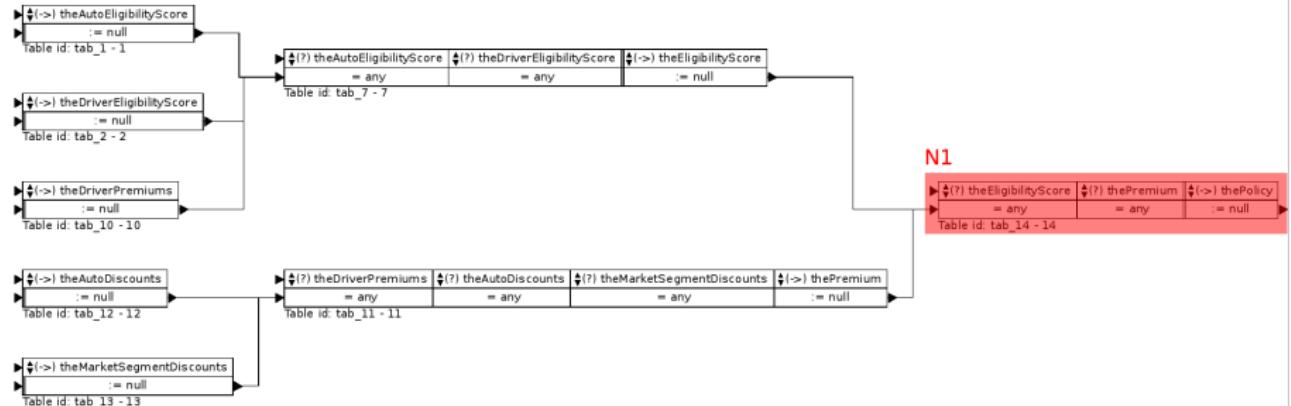
- It takes the inference goal into consideration.
- It selects only the necessary tables for a specific task.

Example



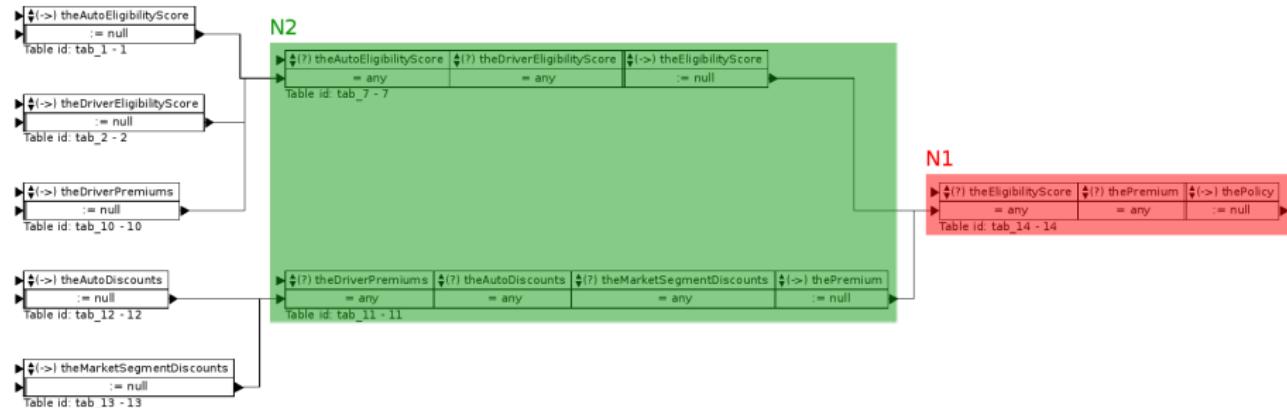
- $\mathbb{U} = \emptyset$
- $N1 = \emptyset$
- $N2 = \emptyset$

Example



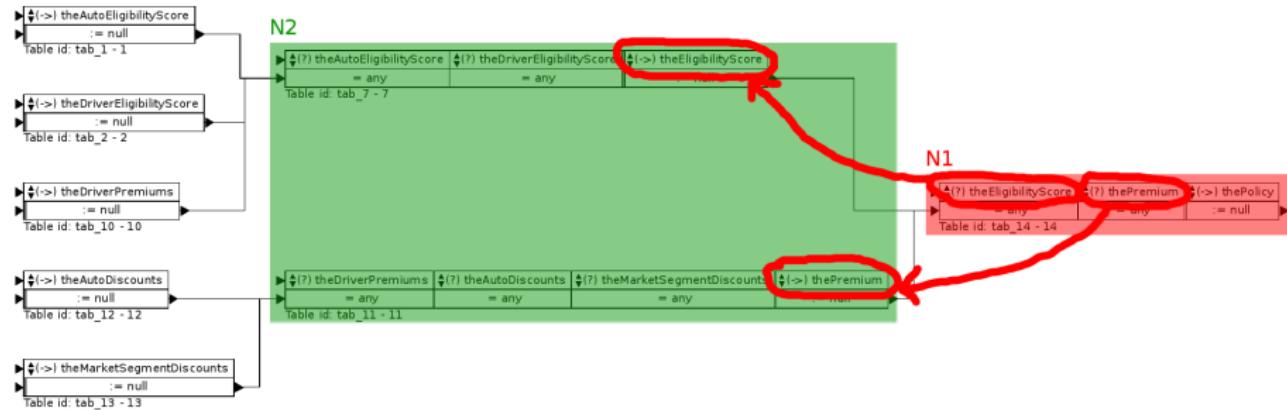
- $\mathbb{U} = \emptyset$
- $N1 = \{tab_14\}$
- $N2 = \emptyset$

Example



- $\mathbb{U} = \emptyset$
- $N1 = \{tab_14\}$
- $N2 = \{tab_7, tab_11\}$

Example



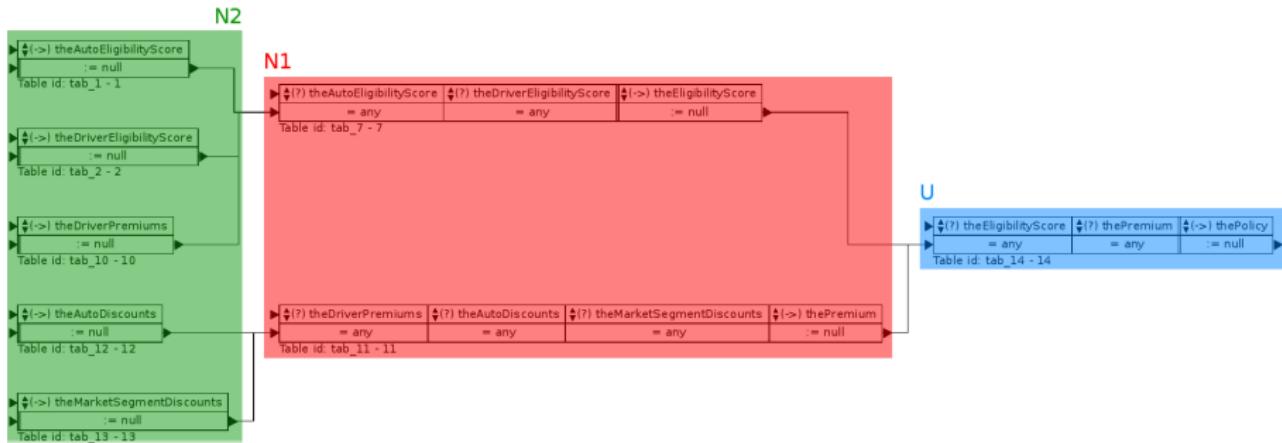
- $\mathbb{U} = \emptyset$
- $N1 = \{ \text{tab_14} \}$
- $N2 = \{ \text{tab_7}, \text{tab_11} \}$

Example



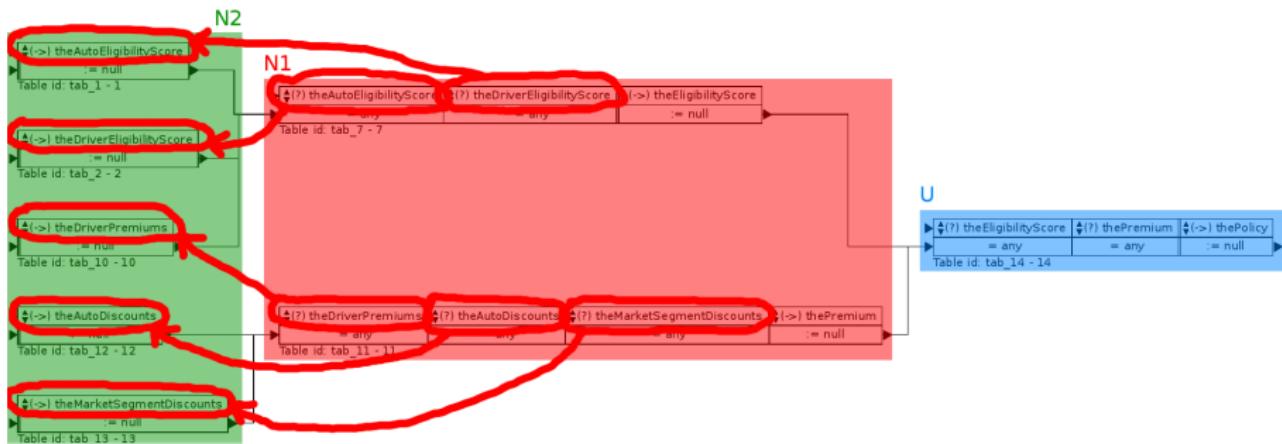
- $\mathbb{U} = \{ \text{tab_14} \}$
- $N1 = \{ \text{tab_7}, \text{tab_11} \}$
- $N2 = \emptyset$

Example



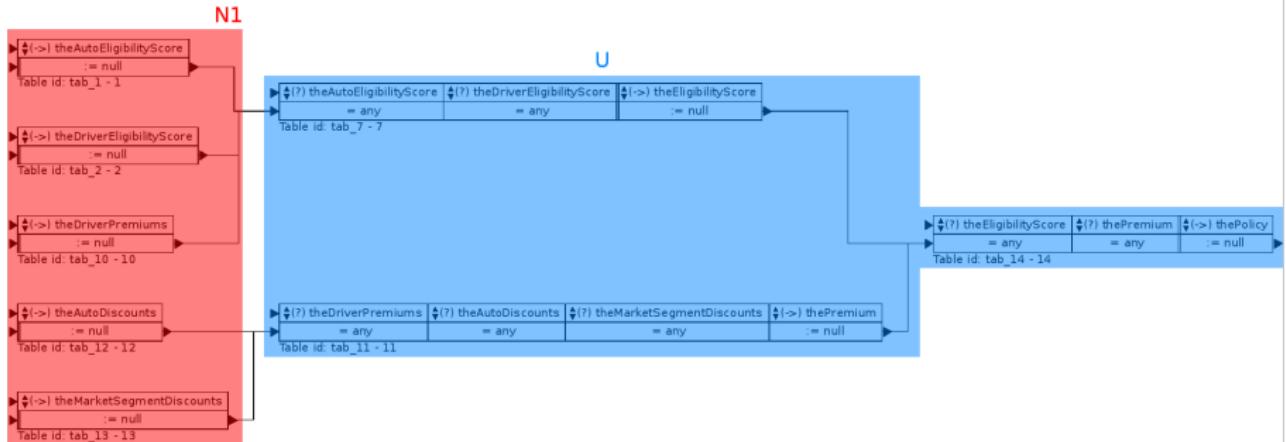
- $\mathbb{U} = \{tab_14\}$
- $N1 = \{tab_7, tab_11\}$
- $N2 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$

Example



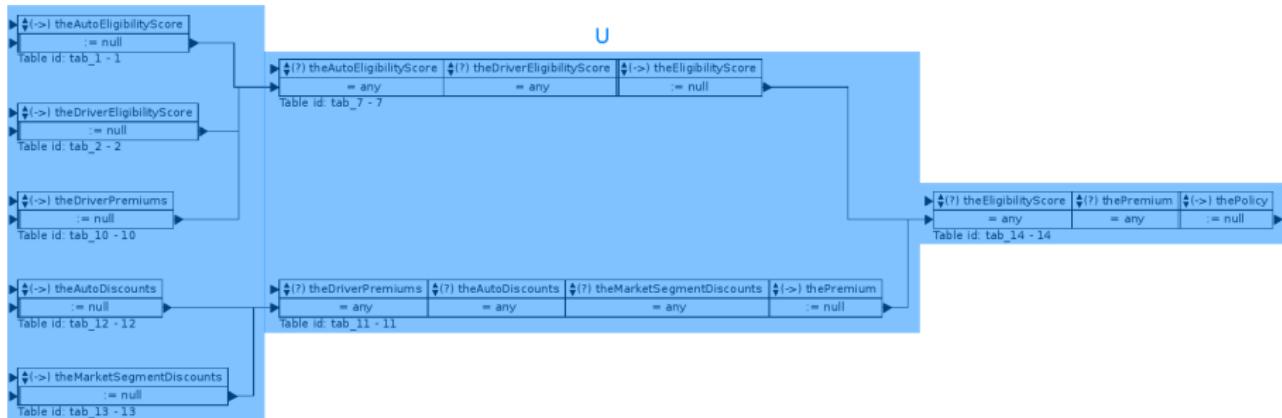
- $\mathbb{U} = \{\text{tab_14}\}$
- $N_1 = \{\text{tab_7}, \text{tab_11}\}$
- $N_2 = \{\text{tab_1}, \text{tab_2}, \text{tab_10}, \text{tab_12}, \text{tab_13}\}$

Example



- $\mathbb{U} = \{tab_7, tab_11, tab_14\}$
- $N_1 = \{tab_1, tab_2, tab_10, tab_12, tab_13\}$
- $N_2 = \emptyset$

Example



- $\mathbb{U} = \{ \text{tab_1}, \text{tab_2}, \text{tab_10}, \text{tab_12}, \text{tab_13}, \text{tab_7}, \text{tab_11}, \text{tab_14} \}$
- $N1 = \emptyset$
- $N2 = \emptyset$

Conclusion

XTT2 features:

- Provides design process, which builds structured rule base.
- Provides several inference algorithms.

The features of the presented inference algorithms:

- Dedicated for structured rulebases.
- Provide data-driven and goal oriented inference strategies.
- One general algorithm and three supportive algorithms for tables order determining.

Future Work

- Extending XTT2 towards BPMN:
 - ▶ Adding new types of tables and rules.
 - ▶ Using as the business rules modeling method.
- Development of new inference algorithms.
- Formal analysis of the algorithms complexity.
- Practical comparison with existing algorithms.

¡Thank you for your attention!

¿Any questions?



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