Evaluation
(Section 4.4)

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Constraint Databases = Finite Representation of Infinite Relational Databases using Constraints

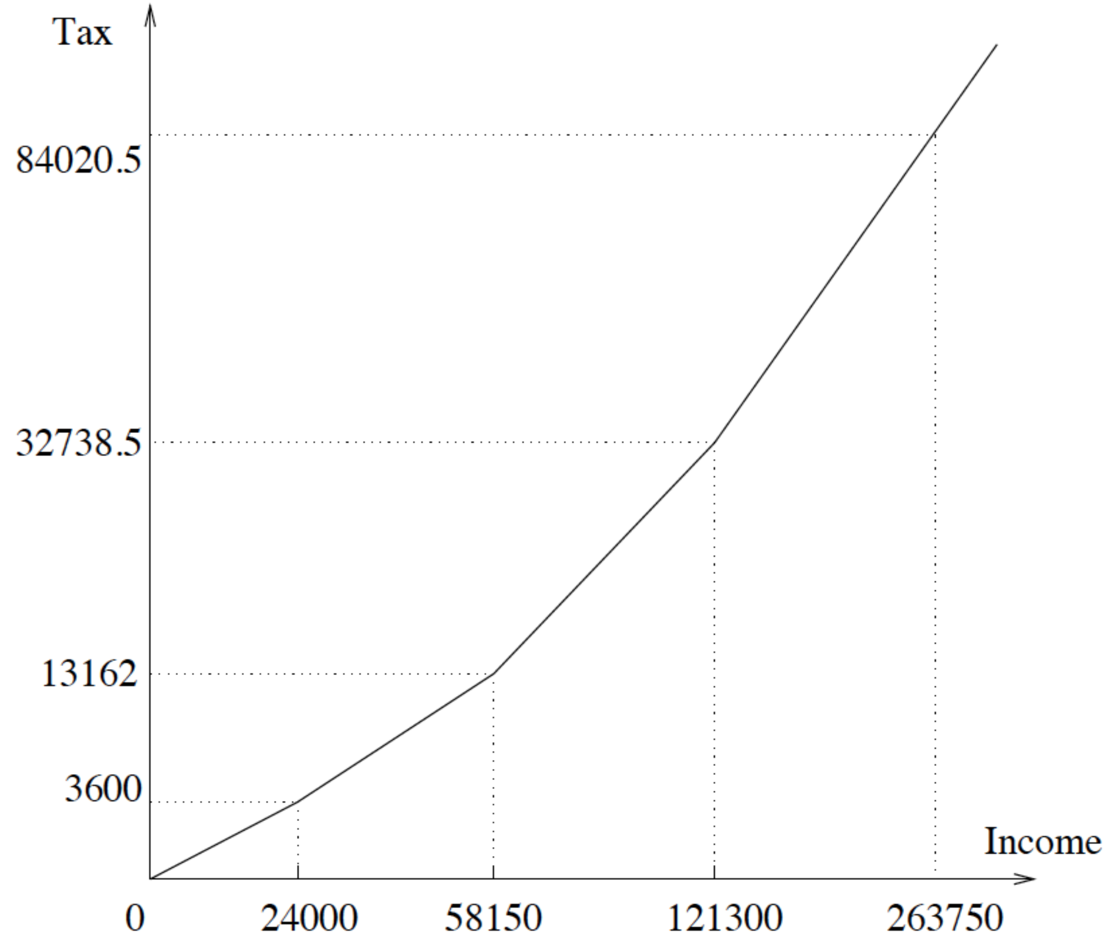
Constraints:

Equality :	u	$=$	v	
Inequality :	u	$\neq$	v	
Lower Bound :	u	θ	b	
Upper Bound :	$-u$	θ	b	
Order :	u	θ	v	
Gap-Order :	$u - v$	θ	b	where $b \geq 0$
Difference :	$u - v$	θ	b	
Half-Addition :	$\pm u \pm v$	θ	b	where $b \geq 0$
Addition :	$\pm u \pm v$	θ	b	
Linear :	$c_1 x_1 + \ldots + c_n x_n$	θ	b	
Polynomial :	$p(x_1, \ldots, x_n)$	θ	b	

Infinite Relational Data Model:

Taxtable

Income	Tax
0	0
⋮	
10080	1512
⋮	



Constraint Data Model:

Taxtable

Income	Tax	
i	t	$0 \leq i,\ i \leq 24000,\ t = 0.15i$
i	t	$24000 < i,\ i \leq 58150,\ t = 3600 + 0.28(i - 24000)$
i	t	$58150 < i,\ i \leq 121300,\ t = 13162 + 0.31(i - 58150)$
i	t	$121300 < i, i \leq 263750, t = 32738.5 + 0.36(i - 121300)$
i	t	$263750 < i,\ t = 84020.5 + 0.396(i - 263750)$

Constraint Data Model

Height

CM	IN	
c	i	$0.39c = i$

Kepler

Period	Radius	
t	r	$t^2 = r^3$

Suppose that Anderson loses six kilograms per month during the first five months and two kilograms per months during the next seven months of the dieting program. Suppose also that Smith loses two kilograms per month during the entire twelve months of the dieting program. Then the *Diet* relation can be represented by the following constraint relation:

Diet

ID	KG	Month	
100	y	t	$y = -6t + 130, \quad 0 \leq t, \quad t \leq 5$
100	y	t	$y = -2t + 100, \quad 5 \leq t, \quad t \leq 12$
755	y	t	$y = -2t + 120, \quad 0 \leq t, \quad t \leq 12$

Data Abstraction

View Level: **How users can view their data. For example, a map.**

Logical Level: **Describes data by an infinite relational database r.**

Constraint Level: **Describes data by a constraint database R.**

a tuple t is in r if and only if there is a constraint tuple C in R such that after substitution of the constants in t into the variables of C we get a true formula, that is, t satisfies C. We can summarize:

$$t \in r \text{ iff } t \models C \text{ for some } C \in R$$

Physical Level: **The way data is actually stored in a computer.**

Practice

2. Express the following in SQL using the *Package* and the *Postage* relations.

   (a) Find how much Mr. Johnson should pay to send all the packages.

   (b) Find how much Mr. Johnson should pay for each destination city.

   (c) Find the name of the most expensive destination city for Mr. Johnson.

Package

Number	Origin	Destination	Weight
101	Omaha	Chicago	12.6
102	Omaha	Atlanta	27.3
103	Omaha	Boston	37.5
104	Omaha	Atlanta	18.7
105	Omaha	Chicago	22.4

Postage

Weight	Fee
0	0
⋮	⋮
5	2.65
⋮	⋮
50	16.65

Solutions

2. (a)

```
SELECT   Sum(Postage.Fee)
FROM     Package, Postage
WHERE    Package.Weight = Postage.Weight
```

(b)

```
CREATE VIEW   Pay(Destination, Fee)  AS
SELECT        Destination, Sum(Fee)
FROM          Package, Postage
WHERE         Package.Weight = Postage.Weight
GROUP BY      Destination
```

(c)

```
SELECT   Destination
FROM     Pay
WHERE    Fee >= ALL   (SELECT   Fee
                       FROM     Pay)
```