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How to (repeatedly) change preferences *

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* FOIKS'06, AMAI

Preference relations

- Binary relations between tuples
- Abstract way to capture a variety of criteria: desirability, relative value, quality, timeliness…
- More general than numeric scoring functions

Make	Year
VW	2002
VW	1998
Kia	1998

within each make, prefer more recent cars

Preference queries

- **Winnow**: In a given **table**, find the **best** elements according to a given **preference relation**.

Make	Year
VW	2002
VW	1998
Kia	1998

within each make, prefer a more recent car

Too many results…

Query modification via preference revision

Make	Year
VW	2002
VW	1998
Kia	1998

within each make, prefer a more recent car

among cars of the same production year, prefer VW

- Objectives:

  Preference **composition operators**

  Minimal change to preferences

  Preservation of **order properties**

Overview

- Preference representation
- Order axioms
- Preference revision
- Incremental evaluation of preference queries
- Related work
- Conclusions and future work

Preference relations

Preference relation

- binary relation (possibly infinite)
- represented by a quantifier-free first-order formula

within each make, prefer more recent cars:

$(m,y) \succ (m',y') \equiv (m = m' \land y > y')$

Winnow operator

$\omega_{\succ}(r) = \{ t \in r \mid \neg\exists\, t' \in r.\ t' \succ t \}$

Used to select the best tuples

Order axioms ORD

- Strict Partial Order (SPO) = transitivity + irreflexivity
  - Preference SQL
  - winnow is nonempty
  - efficient algorithms for winnow (BNL,…)
  - incremental query evaluation

- Weak Order (WO) = SPO + negative transitivity:
  $\forall x,y,z. (x \not\succ y \wedge y \not\succ z) \rightarrow x \not\succ z$
  - often representable with a utility function
  - single pass winnow evaluation

Composing preference relations

Union

$t\ (\succ_1 \cup \succ_2)\ s \Leftrightarrow t \succ_1 s \vee t \succ_2 s$

Prioritized composition

$t\ (\succ_1 \rhd \succ_2)\ s \Leftrightarrow t \succ_1 s \vee (s \not\succ_1 t \wedge t \succ_2 s)$

Pareto composition

$t\ (\succ_1 \otimes \succ_2)\ s \Leftrightarrow (s \not\succ_2 t \wedge t \succ_1 s) \vee (s \not\succ_1 t \wedge t \succ_2 s)$

Transitive closure

$(t,s) \in TC(\succ) \Leftrightarrow t \succ^n s$ for some $n > 0$

Preference revisions

Preference relation $\succ$
Revising pref.relation $\succ_0$
Composition operator θ

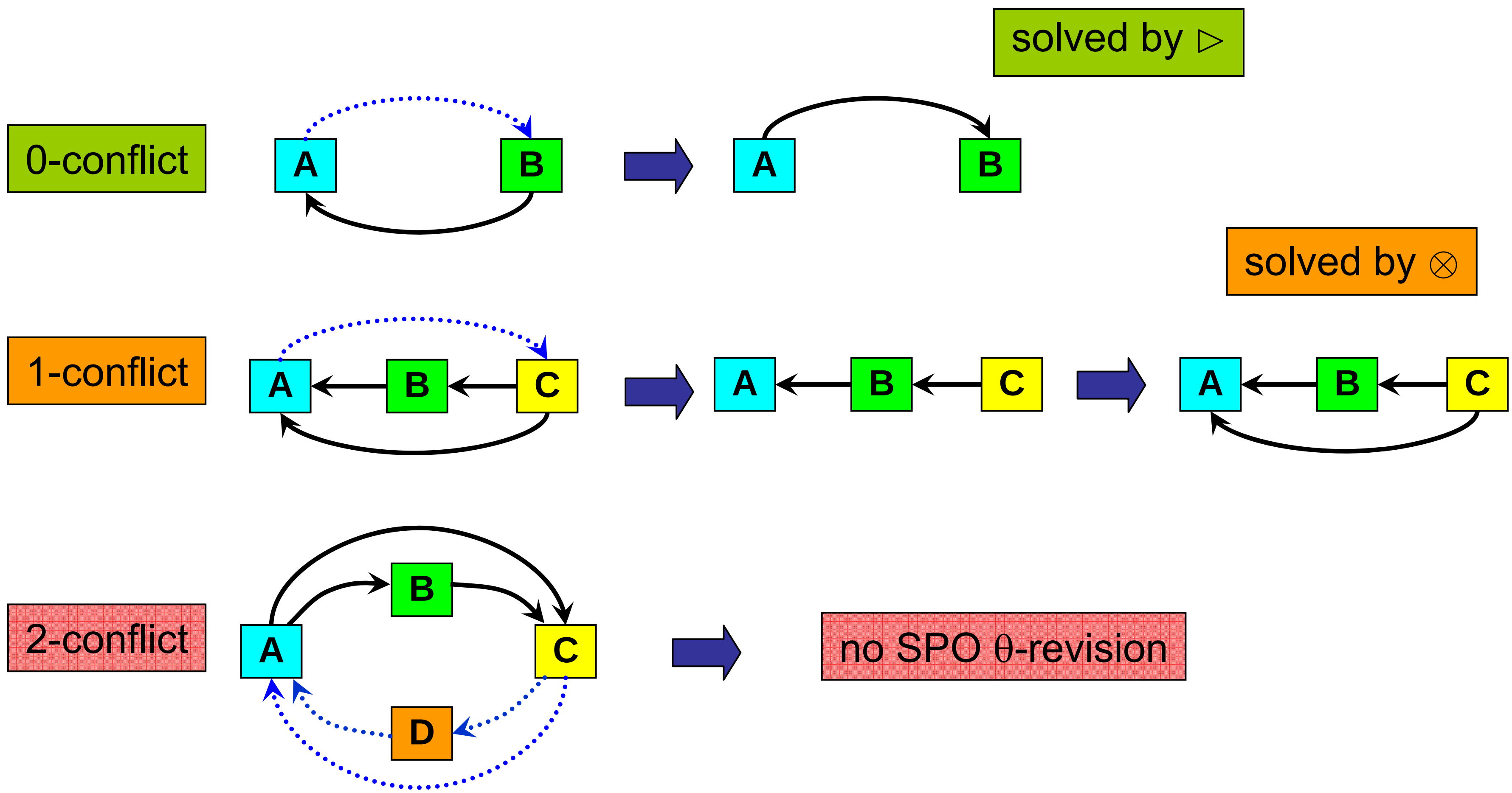
Order axioms ORD

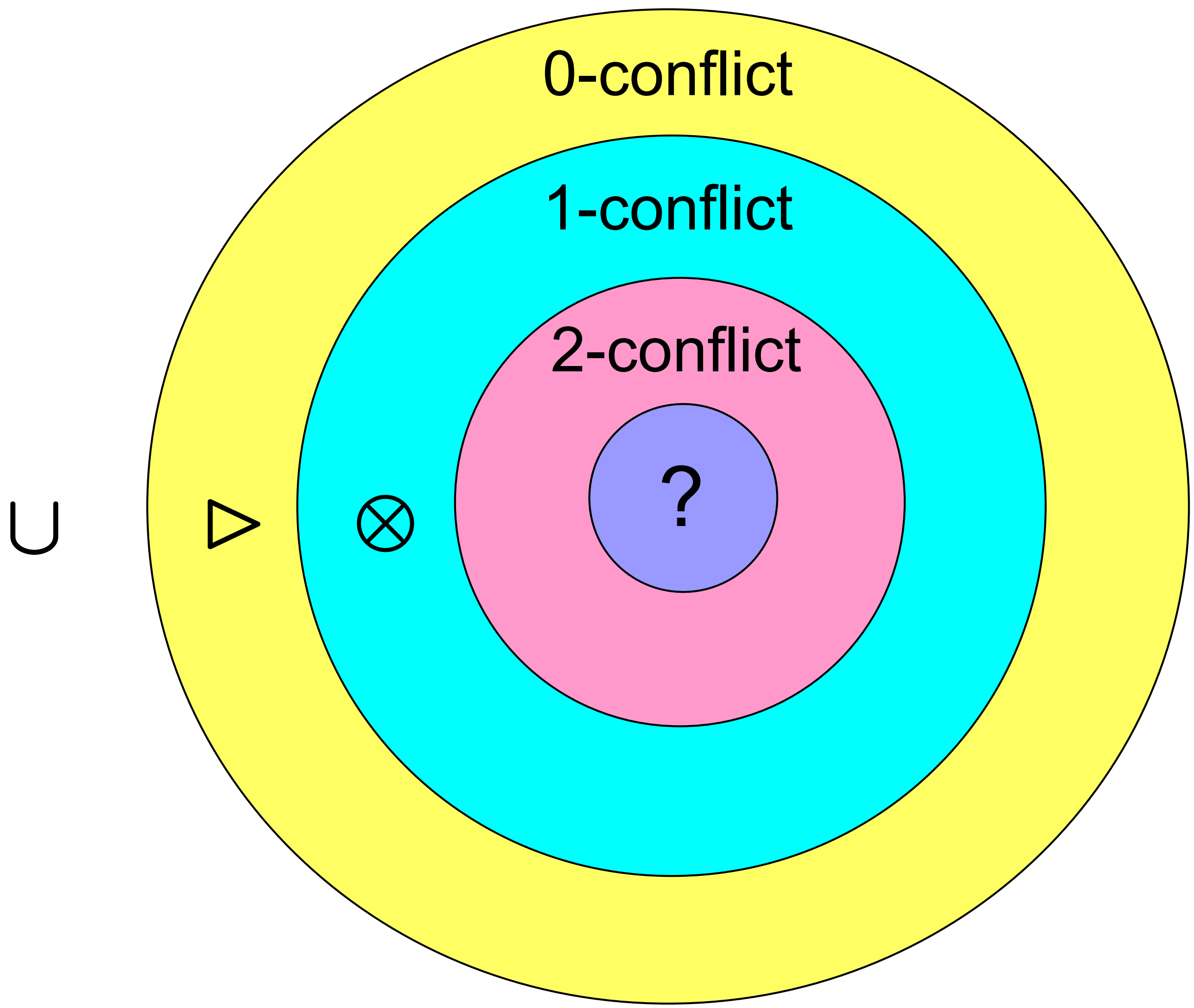
$\succ$ and $\succ_0$ satisfy ORD

ORD θ-revision of $\succ$ with $\succ_0$

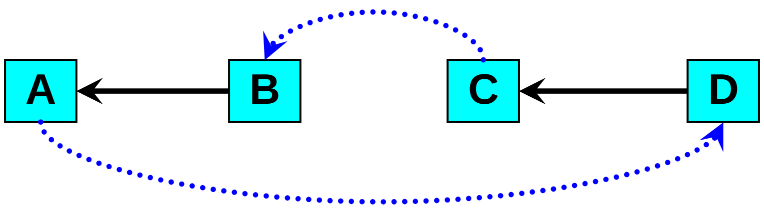
Preference relation $\succ'$:
- minimally different from $\succ$
- contains $\succ_0 \theta \succ$
- satisfies ORD

Conflicts and SPO revisions




0-conflict
1-conflict
2-conflict
?
∪
▷
⊗

Is lack of conflict sufficient?



No conflicts

However, no SPO revision!

Interval Order (IO) = SPO + $\forall x,y,z,w.\ (x \succ y \wedge z \succ w) \rightarrow (x \succ w \vee z \succ y)$

$\succ, \succ_0$ satisfy SPO
no 0-conflicts
$\succ$ or $\succ_0$ is IO

$\Rightarrow$

$\succ' = TC(\succ \cup \succ_0)$ is an SPO $\cup$-revision

$\succ, \succ_0$ satisfy SPO
no 1-conflicts
$\succ_0$ is IO

$\Rightarrow$

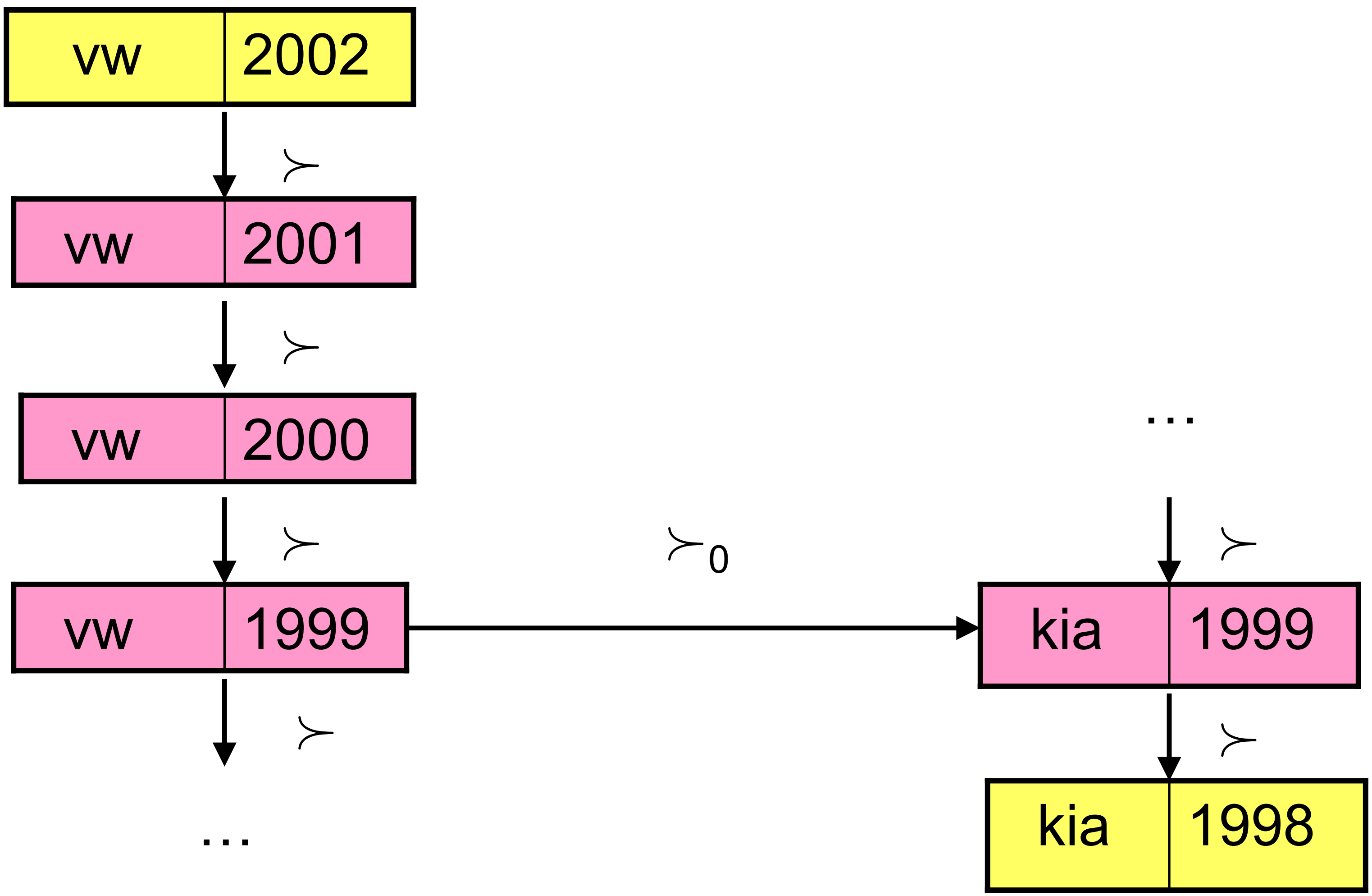
$\succ' = TC(\succ_0 \rhd \succ)$ is an SPO $\rhd$-revision

within each make, prefer more recent cars:
$(m,y) \succ (m',y') \equiv (m = m' \wedge y > y')$

among cars produced in 1999, prefer VW:
$(m,y) \succ_0 (m',y') \equiv m = vw \wedge m' \neq vw \wedge y = y' = 1999$

$TC(\succ_0 \cup \succ)$

$(m,y) \succ' (m',y') \equiv m=m' \wedge y > y' \vee m = vw \wedge m' \neq vw \wedge y \geq 1999 \wedge y' \leq 1999$


vw 2002
vw 2001
vw 2000
vw 1999
$\succ$
$\succ$
$\succ$
$\succ$
…
$\succ_0$
…
$\succ$
kia 1999
$\succ$
kia 1998

WO revisions and utility functions

$\succ, \succ_0$ satisfy WO
no 0-conflicts

$\Rightarrow$

$\succ' = \succ_0 \cup \succ$
is a WO $\cup$-revision

$\Rightarrow$

$u'(x)=a \cdot u(x)+b \cdot u_o(x)+c$
$a,b > 0$

$\succ, \succ_0$ satisfy WO
with conflicts

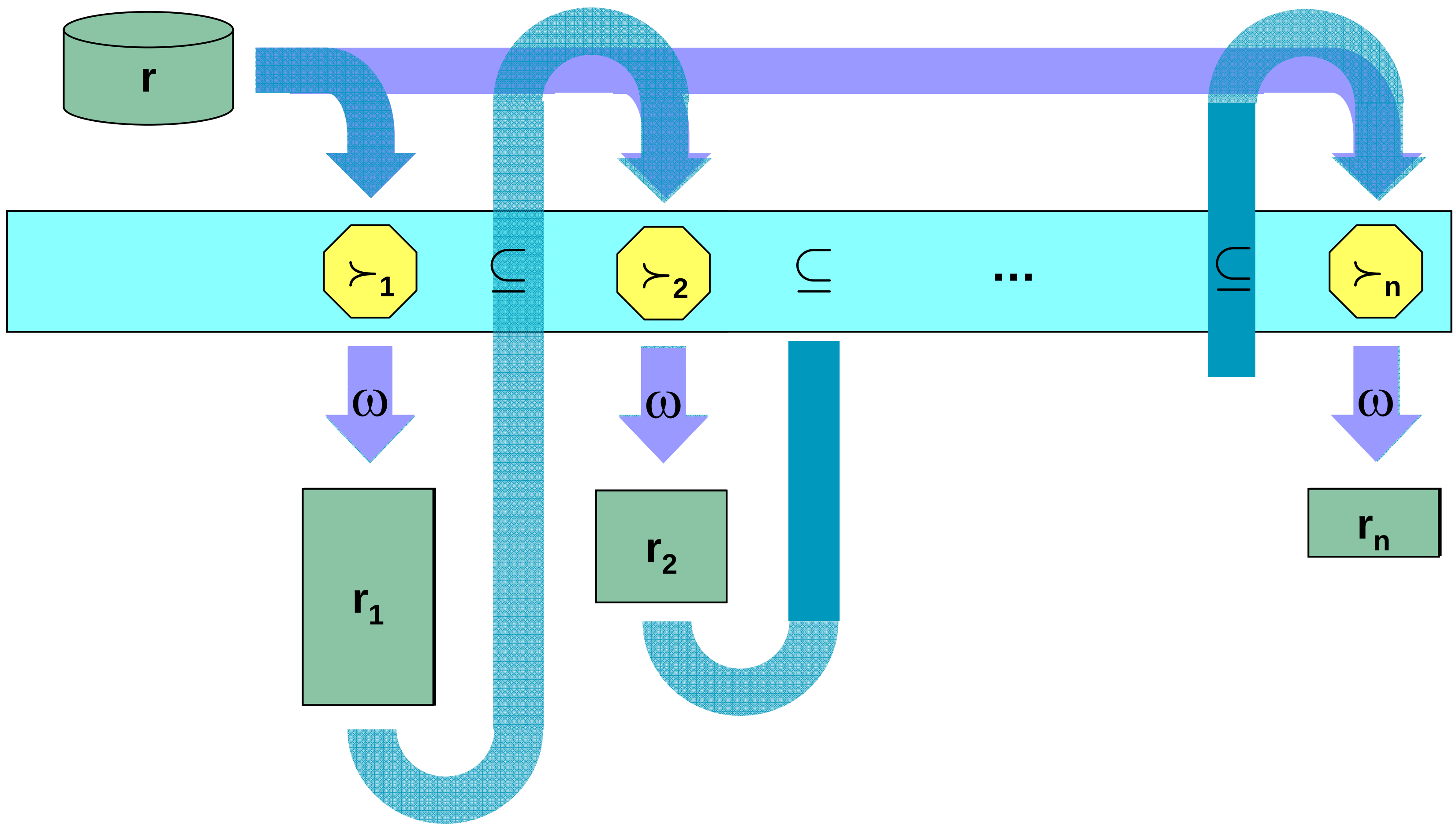
$\Rightarrow$

$\succ' = \succ_0 \rhd \succ$ is a
WO $\rhd$-revision

$\succ'$ may be **not** representable
with a utility function

$\succ$ represented with $u(x)$
$\succ_0$ represented with $u_0(x)$

Incremental evaluation: preference revision



$\succ$: within each make, prefer more recent cars

$\succ_0$: among cars produced in 1999, prefer VW

Make	Year
VW	2002
VW	1998
Kia	1998

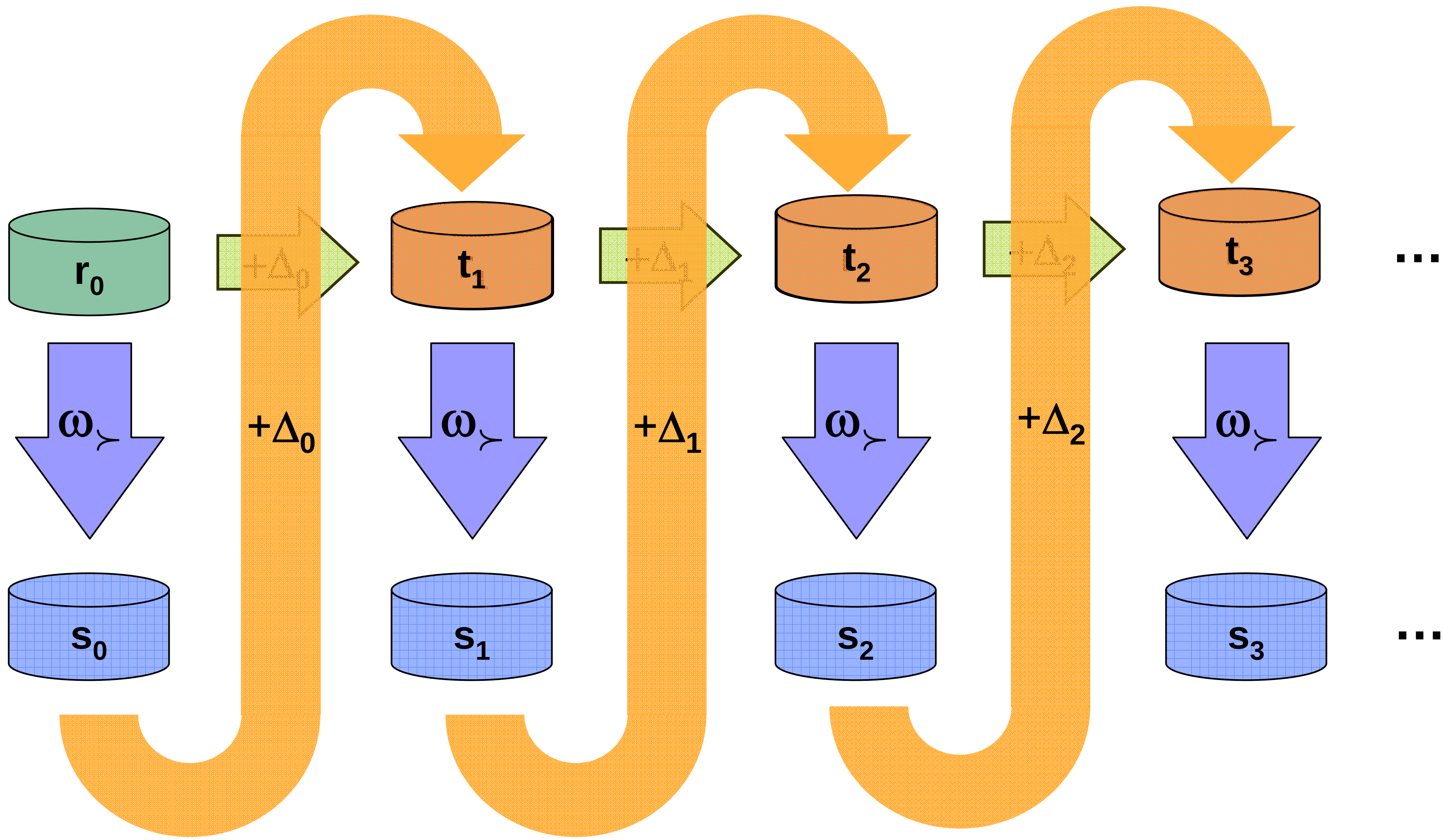
$\omega_{\succ}$

Make	Year
VW	2002
Kia	1998

$\omega_{TC(\succ \cup \succ_0)}$

Make	Year
VW	2002

Incremental evaluation: tuple insertion



Preference vs. belief revision

Preference revision

- First-order
- Revising a single, finitely representable relation
- Preserving order axioms

Belief revision

- Propositional
- Revising a theory
- Axiomatic properties of BR operators

Related work

- S. O. Hansson. *Changes in Preferences*, Theory and Decision, 1995
  - preferences = sets of ground formulas
  - preference revision $\simeq$ belief revision
  - no focus on construction of revisions, SPO/WO preservation
  - preference contraction, domain expansion/shrinking
- M.-A. Williams. *Belief Revision via Database Update*, IIISC, 1997
  - revising finite ranking with new information
  - new ranking can be computed in a simple way
- S. T. C. Wong. *Preference-Based Decision Making for Cooperative Knowledge-Based Systems*. ACM TOIS, 1994
  - revision and contraction of finite WO preferences with single pairs $t \succ_0 s$

Summary and future work

Summary:

- Preference query modification through **preference revision**
- Preference revision using **composition**
- **Closure** of SPO and WO under revisions
- **Incremental** evaluation of preference queries

Future work:

- **Integrating** with relational query evaluation and optimization
- General **revision language**
- Preference **contraction** (query result too small)
- Preference **elicitation**