Transaction Systems
Exercise Session 3

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November 4, 2013
Given the schedule

\[ s = r_1(x)r_3(x)w_3(y)w_2(x)c_3r_4(y)w_4(x)c_2r_5(x)c_4w_5(z)w_1(z)c_1c_5 \]

For some transactions, the function computed by the write step is the identity function in one of its arguments (*copier*):

\[ f_{ix}(v_1, \ldots, v_m) = v_j \text{ for some } j \]

Compute the "Herbrand semantics" of \( s \) given that \( t_3 \) and \( t_4 \) are copiers.
Homework

- Given the schedule

\[ s = r_1(x)r_3(x)w_3(y)w_2(x)c_3 r_4(y)w_4(x)c_2 r_5(x)c_4 w_5(z)w_1(z)c_1c_5 \]

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Compute the "Herbrand semantics" of \( s \) given that \( t_3 \) and \( t_4 \) are copiers.

- \( H_s[z] = f_{1z}(f_{0x}()) \)
- \( H_s[x] = f_{0x}() \)
- \( H_s[y] = f_{0x}() \)
Given the schedule

\[ s = r_1(x)r_3(x)w_3(y)w_2(x)r_4(y)c_2w_4(x)c_4r_5(x)c_3w_5(z)c_5w_1(z)c_1 \]

- FSR: \( t_5t_1t_3t_2t_4 \) is FS-equivalent serial schedule
- not VSR: it is not enough to test just one serial schedule!
- not CSR
Order preservation

A history $s$ is order-preserved conflict serializable, iff there is a serial $s'$:

- $\text{op}(s) = \text{op}(s')$
- $s \approx_c s'$
- For all $t, t'$: if $t$ occurs completely before $t'$ in $s$, the same holds for $s'$
Example

\[ s = r_1(x)w_1(z)r_2(z)w_1(y)c_1r_3(y)w_2(z)c_2w_3(x)w_3(y)c_3 \]
Projection of a schedule

- $s$ is a schedule, $T \subseteq \text{trans}(s)$.
- A Projection $\Pi_T(s)$ of $s$ onto $T$ is a result of erasing of all steps of transactions not in $T$
- $s = w_1(x)r_2(x)w_2(y)r_1(y)w_1(y)w_3(x)w_3(y)c_1a_2$
- $T = \{t_1, t_2\}$.
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- $T = \{t_1, t_2\}$. $\Pi_T(s) = w_1(x)r_2(x)w_2(y)r_1(y)w_1(y)c_1a_2$
Monotone class of histories

A class $E$ of histories is monotone if:

- if $s \in E$: for each $T \subseteq \text{trans}(s)$ holds $\Pi_T(s) \in E$
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VSR is not monotone:

$$s = w_1(x)w_2(x)w_2(y)c_2w_1(y)c_1w_3(x)w_3(y)c_3$$
Schedulers

We already have seen:

- 2PL
- Strict 2PL
- Strong 2PL
- \[ s = r_1(x)r_3(y)w_3(y)r_2(z)w_2(x)r_4(y)c_3w_4(z)c_4c_2c_1 \]
Homework: Task 1

- Prove that: $s \in CSR \iff (\forall T \subseteq \text{trans}(s)) \Pi_T(s) \in VSR$
  (i.e., CSR is the largest monotone subset of VSR)
Homework: Task 1

- Prove that: \( s \in CSR \iff (\forall T \subseteq \text{trans}(s)) \Pi_T(s) \in VSR \) (i.e., CSR is the largest monotone subset of VSR)
  - (\( \Rightarrow \)) Prove that the membership in class CSR is monotone
  - Prove this: Let \( s_1 \) be a schedule with the set of transactions \( T_1 \). Let \( CG(s_1) \) have an edge \( T_i \rightarrow T_j \) because of \( x \), and no other transaction writes \( x \). Then in any serial schedule that is view equivalent to \( s_1 \): \( T_i < T_j \)
  - (\( \Leftarrow \)) Suppose there is a cycle in \( CG(s) \). Select the shortest cycle \( \{T_1, \ldots, T_k\} \). Let \( s_1 \) be a projection of \( s \) onto the cycle. It is in VSR...
Homework: Task 2

For the input schedule show the output produced by 2PL, S2PL, SS2PL:

- \( s = w_1(x)r_2(y)r_1(x)c_1r_2(x)w_2(y)c_2 \)
Grading

- Task 1: 15 points
- Task 2: 5 points
Info

- Exercises due: 9 AM, November 11, 2012
- Submit to andrey.gubichev@in.tum.de