Business Process Intelligence (BPI) course

ILP-Miner, Inductive Miner

Nina Graves

BPI-Instruction 6

Chair of Process and Data Science

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Language-based regions

Language

Question 1

Create the inequation system

$$c \cdot \mathbf{1} + A' \cdot x - A \cdot y \geq 0$$

for the following logs:

a) L=[⟨a,c,d⟩, ⟨b,c,e⟩]

b) L=[⟨a,b,d,e⟩, ⟨a,c,d,e⟩, ⟨a,d,b,e⟩, ⟨a,d,c,e⟩]

Language
Solution Q1

a) L=[⟨a,c,d⟩, ⟨b,c,e⟩]

$$c \cdot \mathbf{1} + A' \cdot x - A \cdot y \geq 0$$

transition occurrences including the last activity

$$A = \begin{array}{r} \\ \langle a \rangle \\ \langle b \rangle \\ \langle a, c \rangle \\ \langle b, c \rangle \\ \langle a, c, d \rangle \\ \langle b, c, e \rangle \end{array} \begin{array}{c} \begin{array}{ccccc} a & b & c & d & e \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 \end{pmatrix} \end{array}$$

transition occurrences before the last activity

$$A' = \begin{array}{r} \\ \langle a \rangle \\ \langle b \rangle \\ \langle a, c \rangle \\ \langle b, c \rangle \\ \langle a, c, d \rangle \\ \langle b, c, e \rangle \end{array} \begin{array}{c} \begin{array}{ccccc} a & b & c & d & e \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 \end{pmatrix} \end{array}$$

Language

Solution Q1

a) L=[⟨a,c,d⟩, ⟨b,c,e⟩]

$$c \cdot \mathbf{1} + A' \cdot x - A \cdot y \geq 0$$

Initial marking

Incoming transitions

outgoing transitions

the place has no negative tokens

$$c \cdot \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} + \begin{pmatrix} 0&0&0&0&0 \\ 0&0&0&0&0 \\ 1&0&0&0&0 \\ 0&1&0&0&0 \\ 1&0&1&0&0 \\ 0&1&1&0&0 \end{pmatrix} \cdot \begin{pmatrix} x_a \\ x_b \\ x_c \\ x_d \\ x_e \end{pmatrix} - \begin{pmatrix} 1&0&0&0&0 \\ 0&1&0&0&0 \\ 1&0&1&0&0 \\ 0&1&1&0&0 \\ 1&0&1&1&0 \\ 0&1&1&0&1 \end{pmatrix} \cdot \begin{pmatrix} y_a \\ y_b \\ y_c \\ y_d \\ y_e \end{pmatrix} \geq \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

transition occurrences before the last activity

transition occurrences including the last activity

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Language

Solution Q1

a) L=[⟨a,c,d⟩, ⟨b,c,e⟩]

$$
\begin{aligned}
c - y_a &\geq 0 \\
c - y_b &\geq 0 \\
c + x_a - y_a - y_c &\geq 0 \\
c + x_b - y_b - y_c &\geq 0 \\
c + x_a + x_c - y_a - y_c - y_d &\geq 0 \\
c + x_b + x_c - y_b - y_c - y_e &\geq 0
\end{aligned}
$$

Every valid solution corresponds to a feasible place!

Language

Solution Q1

b) L=[⟨a,b,d,e⟩, ⟨a,c,d,e⟩, ⟨a,d,b,e⟩, ⟨a,d,c,e⟩]

$$A = \begin{array}{r} \\ \langle a\rangle \\ \langle a,b\rangle \\ \langle a,c\rangle \\ \langle a,d\rangle \\ \langle a,b,d\rangle \\ \langle a,c,d\rangle \\ \langle a,d,b\rangle \\ \langle a,d,c\rangle \\ \langle a,b,d,e\rangle \\ \langle a,c,d,e\rangle \\ \langle a,d,b,e\rangle \\ \langle a,d,c,e\rangle \end{array} \begin{array}{c} \begin{array}{ccccc} a & b & c & d & e \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 & 1 \end{pmatrix} \end{array}$$

$$A' = \begin{array}{r} \\ \langle a\rangle \\ \langle a,b\rangle \\ \langle a,c\rangle \\ \langle a,d\rangle \\ \langle a,b,d\rangle \\ \langle a,c,d\rangle \\ \langle a,d,b\rangle \\ \langle a,d,c\rangle \\ \langle a,b,d,e\rangle \\ \langle a,c,d,e\rangle \\ \langle a,d,b,e\rangle \\ \langle a,d,c,e\rangle \end{array} \begin{array}{c} \begin{array}{ccccc} a & b & c & d & e \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 \end{pmatrix} \end{array}$$

Language
Solution Q1

b) L=[⟨a,b,d,e⟩, ⟨a,c,d,e⟩, ⟨a,d,b,e⟩, ⟨a,d,c,e⟩]

$$c \cdot \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} + \begin{pmatrix} 0&0&0&0&0 \\ 1&0&0&0&0 \\ 1&0&0&0&0 \\ 1&0&0&0&0 \\ 1&1&0&0&0 \\ 1&0&1&0&0 \\ 1&0&0&1&0 \\ 1&0&0&1&0 \\ 1&1&0&1&0 \\ 1&0&1&1&0 \\ 1&1&0&1&0 \\ 1&0&1&1&0 \end{pmatrix} \cdot \begin{pmatrix} x_a \\ x_b \\ x_c \\ x_d \\ x_e \end{pmatrix} - \begin{pmatrix} 1&0&0&0&0 \\ 1&1&0&0&0 \\ 1&0&1&0&0 \\ 1&0&0&1&0 \\ 1&1&0&1&0 \\ 1&0&1&1&0 \\ 1&1&0&1&0 \\ 1&0&1&1&0 \\ 1&1&0&1&1 \\ 1&0&1&1&1 \\ 1&1&0&1&1 \\ 1&0&1&1&1 \end{pmatrix} \cdot \begin{pmatrix} y_a \\ y_b \\ y_c \\ y_d \\ y_e \end{pmatrix} \geq \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Language

Solution Q1

b) L=[⟨a,b,d,e⟩, ⟨a,c,d,e⟩, ⟨a,d,b,e⟩, ⟨a,d,c,e⟩]

$$
\begin{aligned}
c - y_a &\geq 0 \\
c + x_a - y_a - y_b &\geq 0 \\
c + x_a - y_a - y_c &\geq 0 \\
c + x_a - y_a - y_d &\geq 0 \\
c + x_a + x_b - y_a - y_b - y_d &\geq 0 \\
c + x_a + x_c - y_a - y_c - y_d &\geq 0 \\
c + x_a + x_d - y_a - y_b - y_d &\geq 0 \\
c + x_a + x_d - y_a - y_c - y_d &\geq 0 \\
c + x_a + x_b + x_d - y_a - y_b - y_d - y_e &\geq 0 \\
c + x_a + x_c + x_d - y_a - y_c - y_d - y_e &\geq 0 \\
c + x_a + x_b + x_d - y_a - y_b - y_d - y_e &\geq 0 \\
c + x_a + x_c + x_d - y_a - y_c - y_d - y_e &\geq 0
\end{aligned}
$$

Language-based Regions
Question 2

Consider the following solutions to an inequation system

$$c \cdot \mathbf{1} + A' \cdot x - A \cdot y \geq 0$$

and give the corresponding places:

a) $c=1, x_a=0, x_b=0, x_c=1, y_a=1, y_b=0, y_c=1$

b) $c=2, x_a=0, x_b=0, x_c=0, y_a=1, y_b=0, y_c=1$

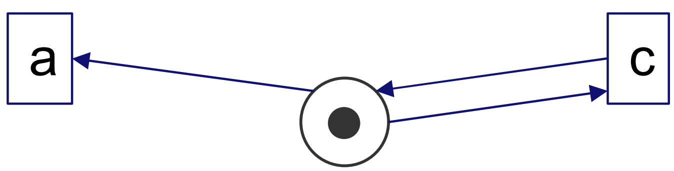
Language-based Regions
Solution Q2

Consider the following solutions to an inequation system

$c \cdot \mathbf{1} + A' \cdot x - A \cdot y \geq 0$

and give the corresponding places:

a) $c=1, x_a=0, x_b=0, x_c=1, y_a=1, y_b=0, y_c=1$



b, d are not connected to the place

Bonus question: Can this place ever be part of a sound workflow net?

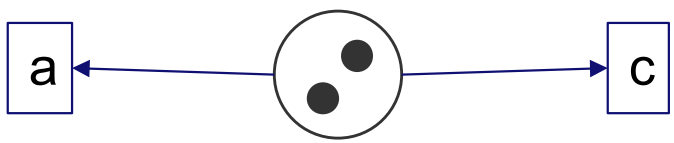
Language-based Regions
Solution Q2

Consider the following solutions to an inequation system

$c \cdot \mathbf{1} + A' \cdot x - A \cdot y \geq 0$

and give the corresponding places:

b) $c=2, x_a=0, x_b=0, x_c=0, y_a=1, y_b=0, y_c=1$

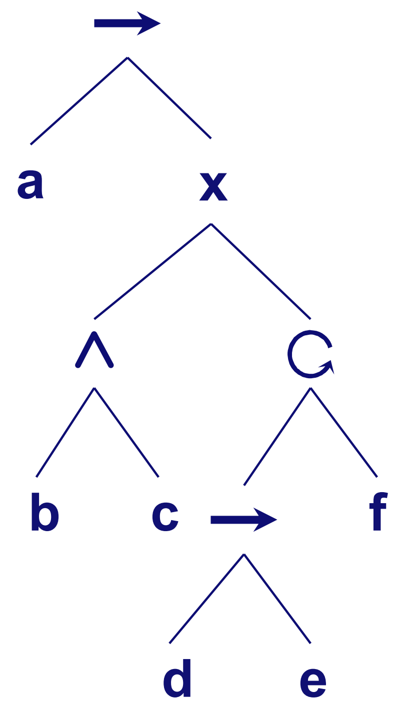


b is not connected to the place

Inductive Miner Questions

Inductive Miner

Question 1



Consider the process tree on the left.

a) *Is the following trace in accordance with the model? Explain your answer.*

$$\sigma = \langle a, c, b, e, d \rangle$$

b) *Is the following trace in accordance with the model? Explain your answer.*

$$\sigma = \langle a, d, e, f, d, e, f \rangle$$

c) *Provide two traces described by the model.*

d) *Convert the process tree into a petri net.*

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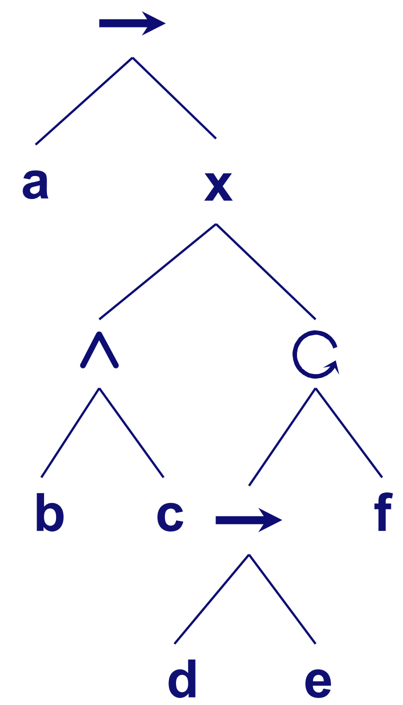
Inductive Miner

Solution Q1 a-c)



a) No, valid traces must either contain *b* and *c* or *d* and *e*. Also, *d* must be performed before *e*.

b) No, the loop must always end with the “do” part.

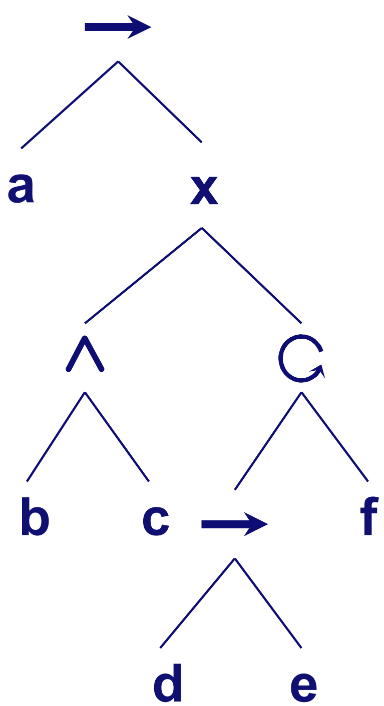
c) The model describes the following three traces (among others):

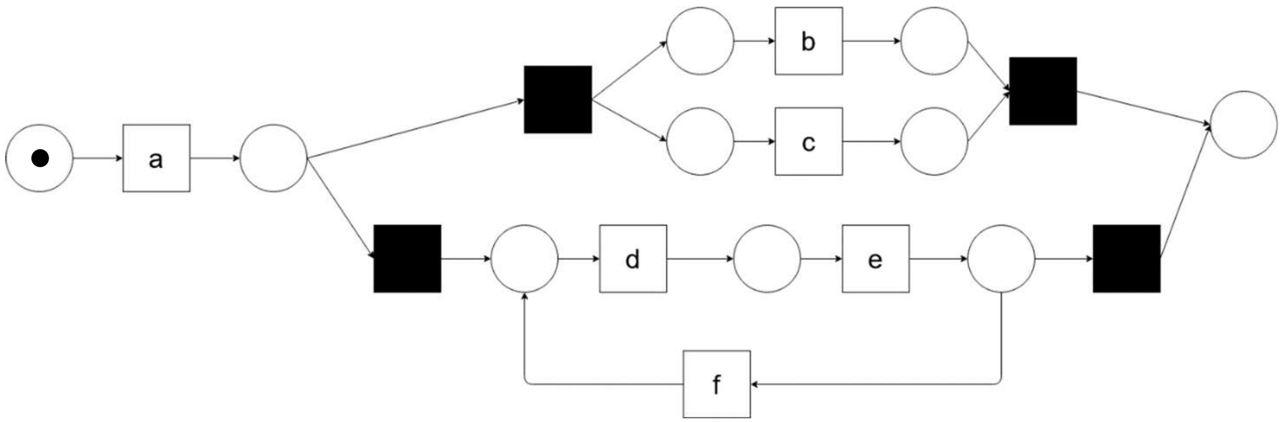
$$\sigma_1 = \langle a, b, c \rangle$$
$$\sigma_2 = \langle a, d, e, \rangle$$
$$\sigma_3 = \langle a, d, e, f, d, e, f, d, e \rangle$$

Inductive Miner

Solution Q1 d)

Convert the process tree to a Petri net.





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Inductive Miner

Question 2

Consider the following event log and perform the inductive miner algorithm on it.

$$L = [\langle a, b, c, d\rangle, \langle a, c, d\rangle, \langle a, b, a, b, d\rangle]$$

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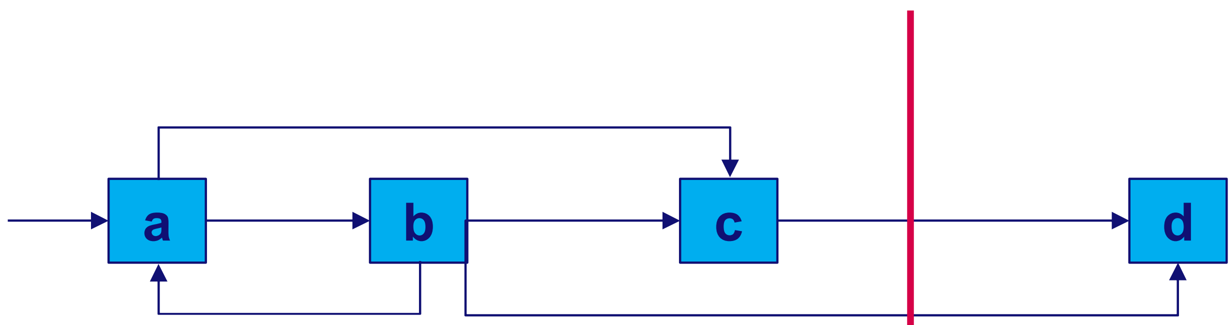
Inductive Miner

Solution Q2

$$L = [\langle a,b,c,d\rangle, \langle a,c,d\rangle, \langle a,b,a,b,d\rangle]$$

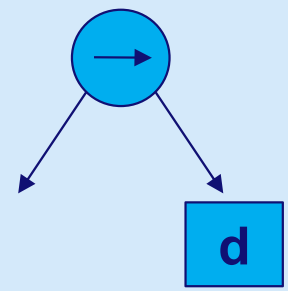


$$L_{C1_2} = [\langle a,b,c\rangle, \langle a,c\rangle, \langle a,b,a,b\rangle]$$

$$L_{C1_2} = [\langle d\rangle, \langle d\rangle, \langle d\rangle]$$

Base Case! Only entries of one type with max 1 activity.

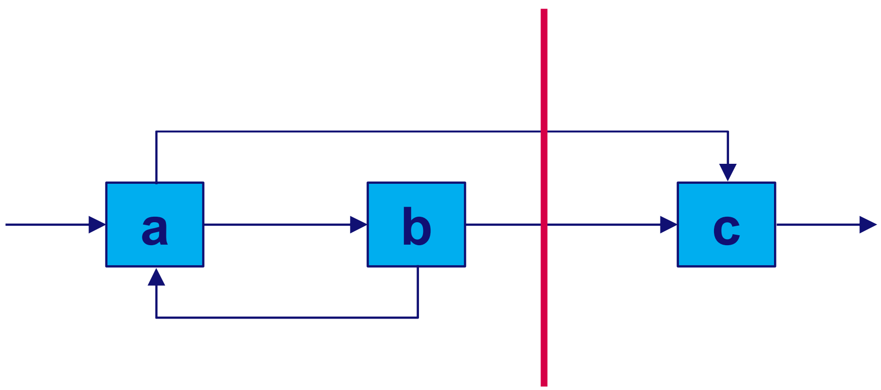
Process Tree



Inductive Miner

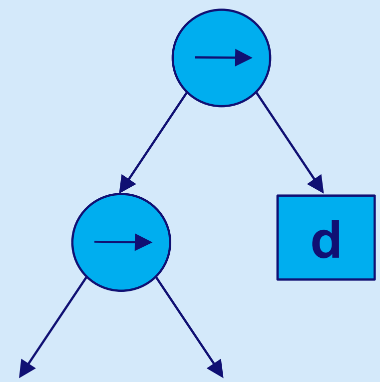
Solution Q2

$$L_{C1_2} = [\langle a, b, c\rangle, \langle a, c\rangle, \langle a, b, a, b\rangle]$$



$$L_{C2_1} = [\langle a, b\rangle, \langle a\rangle, \langle a, b, a, b\rangle] \qquad L_{C2_2} = [\langle c\rangle, \langle c\rangle, \langle\ \rangle]$$

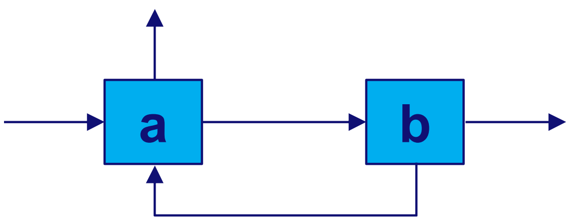
Process Tree



Inductive Miner

Solution Q2

$$L_{C2_1} = [\langle a, b\rangle, \langle a\rangle, \langle a, b, a, b\rangle]$$



XOR: Arcs between both activities.

Sequence: End activities in both parts.

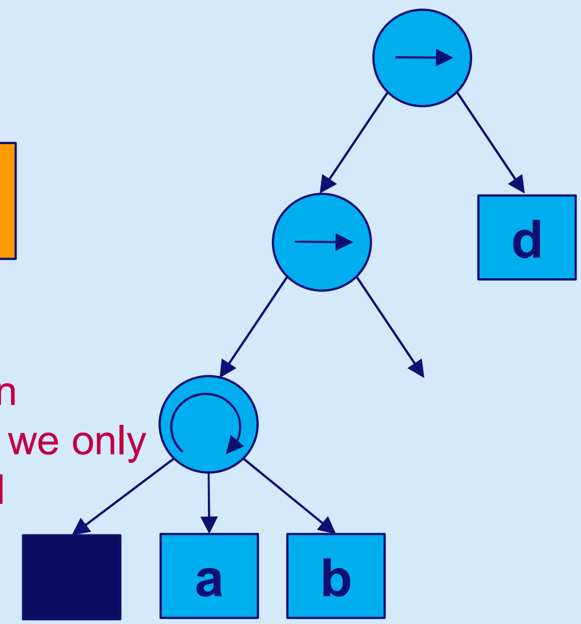
Parallel: *b* is not a start activity.

Loop: End activities in both partitions.

Fall through!

Can be modelled in different ways, but we only use this one in BPI

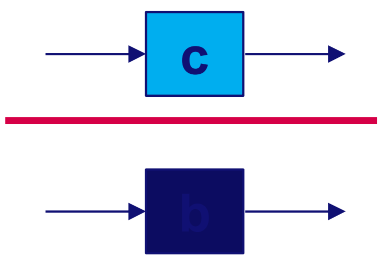
Process Tree



Inductive Miner
Solution Q2

$$L_{C2_1} = [\langle c \rangle, \langle c \rangle, \langle\ \rangle]$$

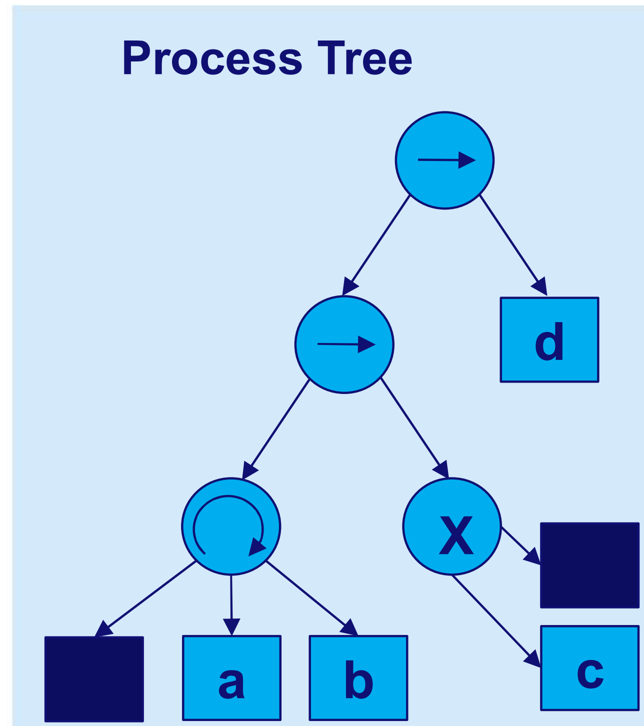
Base Case! Only entries of one type with max 1 activity.



$$L_{C3_1} = [\langle c \rangle, \langle c \rangle]$$

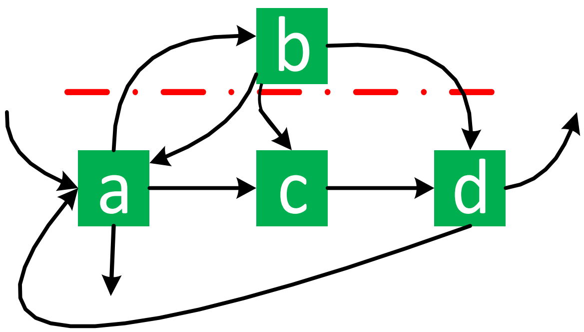
$$L_{C3_2} = [\langle\ \rangle, \langle\ \rangle, \langle\ \rangle]$$

Base Case! Only entries of one type with max 1 activity.



Inductive Miner

Question 3



Given the following event log and the corresponding directly follows graph:

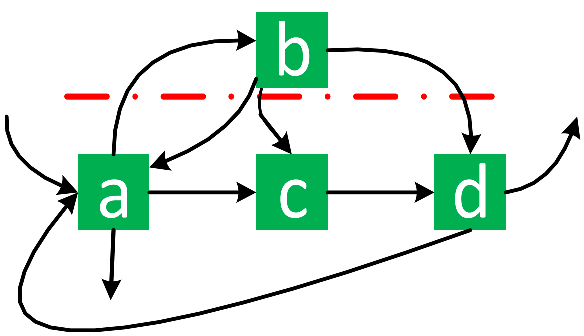
$$L = [\langle a,b,a,c,d\rangle, \langle a,b,c,d\rangle, \langle a,b,d,a\rangle]$$

Name the cut and make the projection on the event log.

Inductive Miner

Solution Q3

$$L = [\langle a,b,a,c,d\rangle, \langle a,b,c,d\rangle, \langle a,b,d,a\rangle]$$

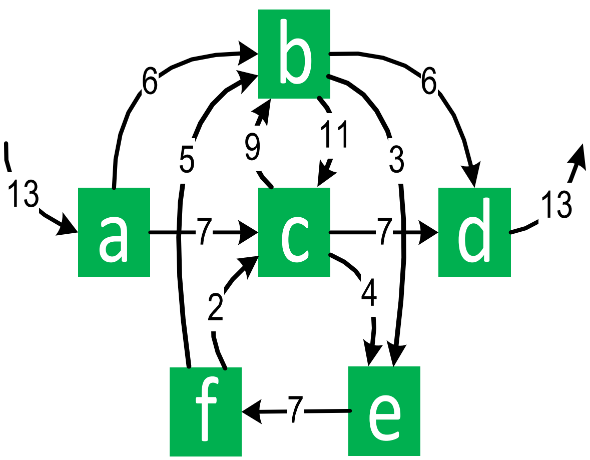


No Cut! → Fall though

(You do not need to know all fallthroughs or how to apply them. You do need to identify sitations where a standard cut is not possible.)

Inductive Miner

Question 4



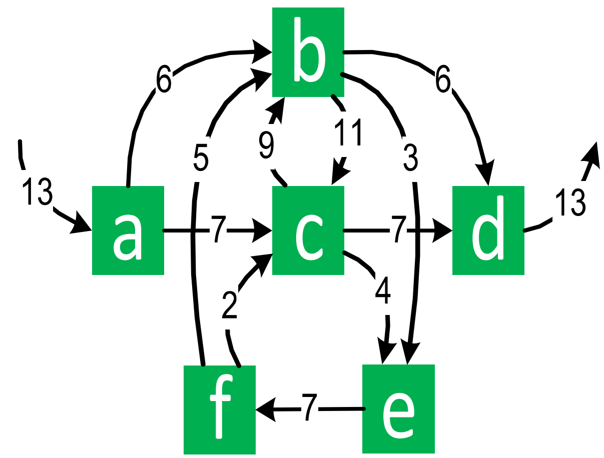
Execute the Inductive Miner on the given directly follows graph without log projections (i.e., re-use the partitions in the DFG for recursion without considering the log projections and re-drawing the DFG).

Give the resulting process tree.

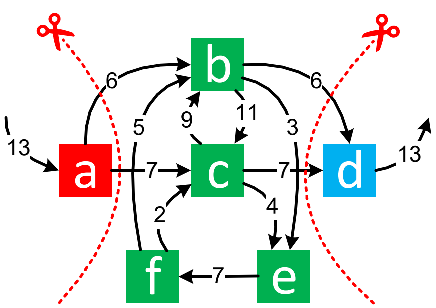
Inductive Miner

Solution Q4

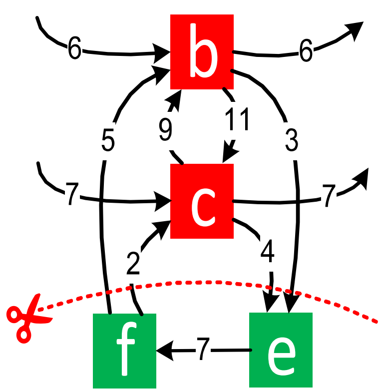
1. **Sequence cut:** $\rightarrow(\{a\},\{b,c,f,e\},\{d\})$
2. **Loop cut:** $\rightarrow(a, \circlearrowleft(\{b,c\},\{f,e\}), d)$
3. **AND cut:** $\rightarrow(a, \circlearrowleft(\wedge(b,c)),\{f,e\}), d)$
4. **Sequence cut:** $\rightarrow(a, \circlearrowleft(\wedge(b,c)), \rightarrow(f,e), d)$



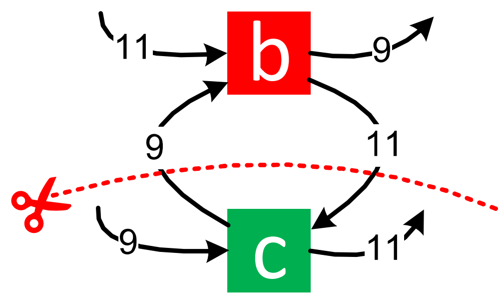
Sequence



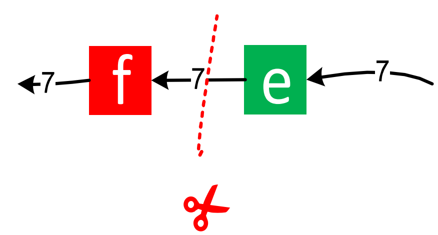
Loop



And



Sequence



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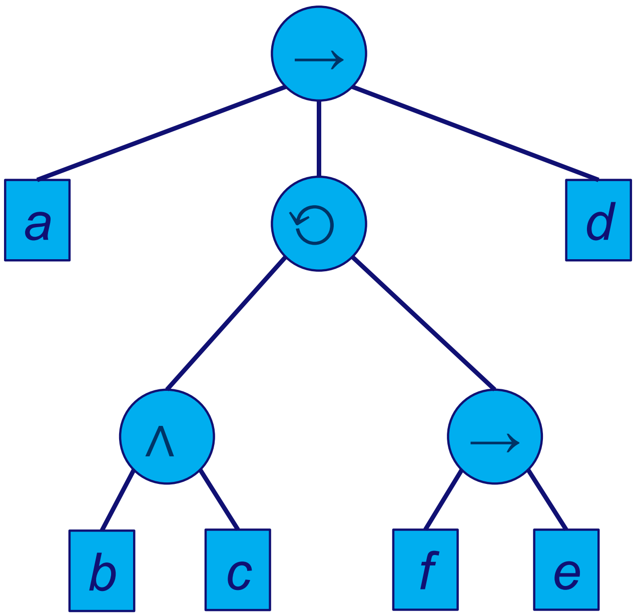
Inductive Miner

Solution Q4



Sequence cut: $\rightarrow(\{a\},\{b,c,f,e\},\{d\})$

Loop cut: $\rightarrow(a, \circlearrowleft(\{b,c\},\{f,e\}), d)$

AND cut: $\rightarrow(a, \circlearrowleft(\wedge(b,c),\{f,e\}), d)$

Sequence cut: $\rightarrow(a, \circlearrowleft(\wedge(b,c),\rightarrow(f,e)), d)$

$\boxed{\rightarrow(a, \circlearrowleft(\wedge(b,c),\rightarrow(f,e)), d)}$

Inductive Miner

Question 5

Discover a process tree using the Inductive Miner for event logs given below, and give a trace that is possible according to the tree but has not been seen in the event log (if possible).

a) Without log projections.

b) With log projections.

  i) $L = \{\langle a, b, c, d, e, f, b, d, c, e, g\rangle, \langle a, b, d, c, e, g\rangle, \langle a, b, c, d, e, f, b, c, d, e, f, b, d, c, e, g\rangle\}$

  ii) $L = \{\langle a, d, e, f, h\rangle, \langle a, e, d, b, f, h\rangle, \langle g, h\rangle, \langle a, b, c, d, f, h\rangle, \langle a, c, b, d, f, h\rangle, \langle a, b, d, c, e, f, h\rangle, \langle a, e, b, e, c, f\rangle\}$

  iii) $L = \{\langle a, c, d, e\rangle, \langle a, d, c, e\rangle, \langle a, d, e, c, f, d, e\rangle, \langle b, d, e, c\rangle, \langle b, c, d, e, f, d, e\rangle, \langle b, d, e, f, c, d, e\rangle\}$

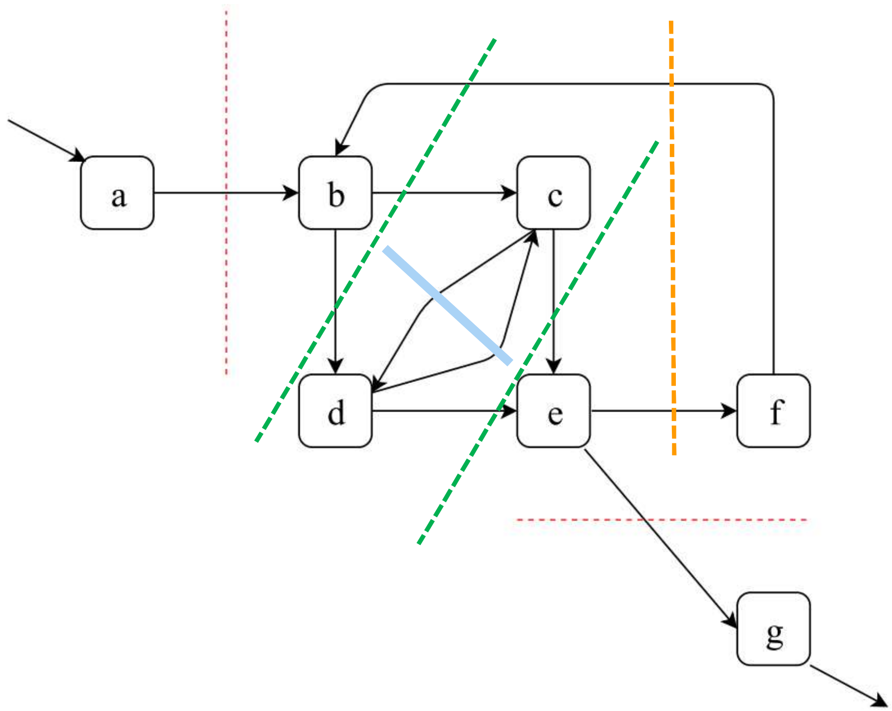
  iv) $L = \{\langle a, b, c, d, f\rangle, \langle a, c, b, d, f\rangle, \langle a, b, d, c, f\rangle, \langle a, c, d, b, f\rangle, \langle a, d, e, f\rangle, \langle a, e, d, f\rangle\}$

Inductive Miner

Solution Q5 a i)

Solution for a) (without log projection):

i. $L = \{\langle a, b, c, d, e, f, b, d, c, e, g\rangle, \langle a, b, d, c, e, g\rangle, \langle a, b, c, d, e, f, b, c, d, e, f, b, d, c, e, g\rangle\}$



$\rightarrow(\{a\}, \{b, c, d, e, f\}, \{g\})$

$\rightarrow(a, \circlearrowleft(\{b, c, d, e\}, \{f\}), g)$

$\rightarrow(a, \circlearrowleft(\rightarrow(\{b\}, \{c, d\}, \{e\}), f), g)$

$\rightarrow(a, \circlearrowleft(\rightarrow(b, \wedge(\{c\}, \{d\}), e), f), g)$

$\boxed{\rightarrow(a, \circlearrowleft(\rightarrow(b, \wedge(c, d), e), f), g)}$

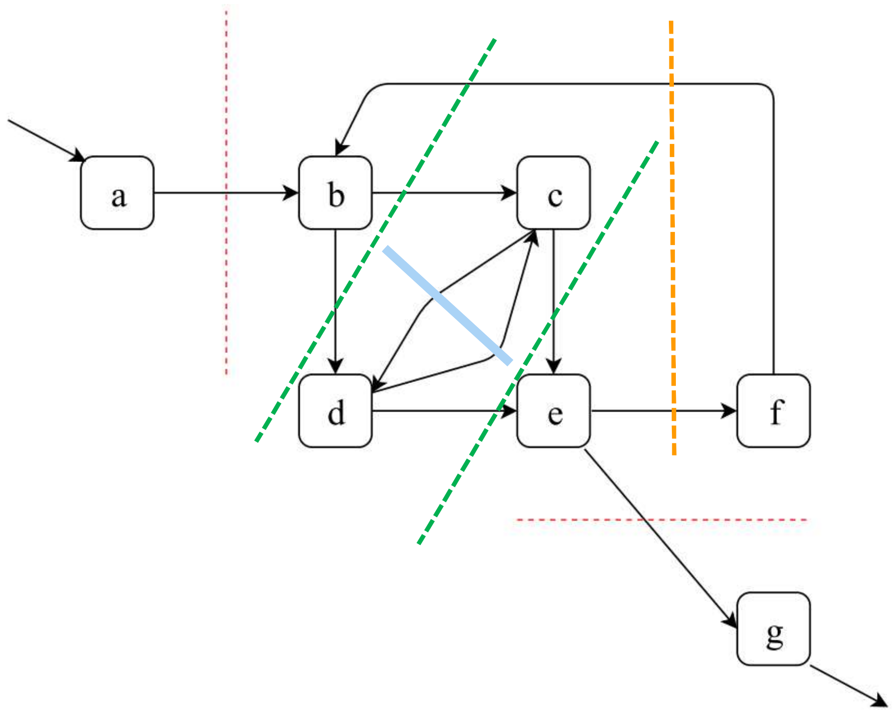
Trace in tree but not in log:
$\langle a, b, c, d, e, g\rangle$

Inductive Miner

Solution Q5 b i)

Solution for b) (with log projection) same as for a):

i. $L = \{\langle a, b, c, d, e, f, b, d, c, e, g\rangle, \langle a, b, d, c, e, g\rangle, \langle a, b, c, d, e, f, b, c, d, e, f, b, d, c, e, g\rangle\}$



$\rightarrow(\{a\}, \{b, c, d, e, f\}, \{g\})$

$L_a = [\langle a\rangle]$, $L_g = [\langle g\rangle]$

$L_1 = [\langle b, c, d, e, f, b, d, c, e\rangle, \langle b, d, c, e\rangle,$
$\langle b, c, d, e, f, b, c, d, e, f, b, d, c, e\rangle]$

$\rightarrow(a, \circlearrowleft(\{b, c, d, e\}, \{f\}), g)$

$L_f = [\langle f\rangle]$

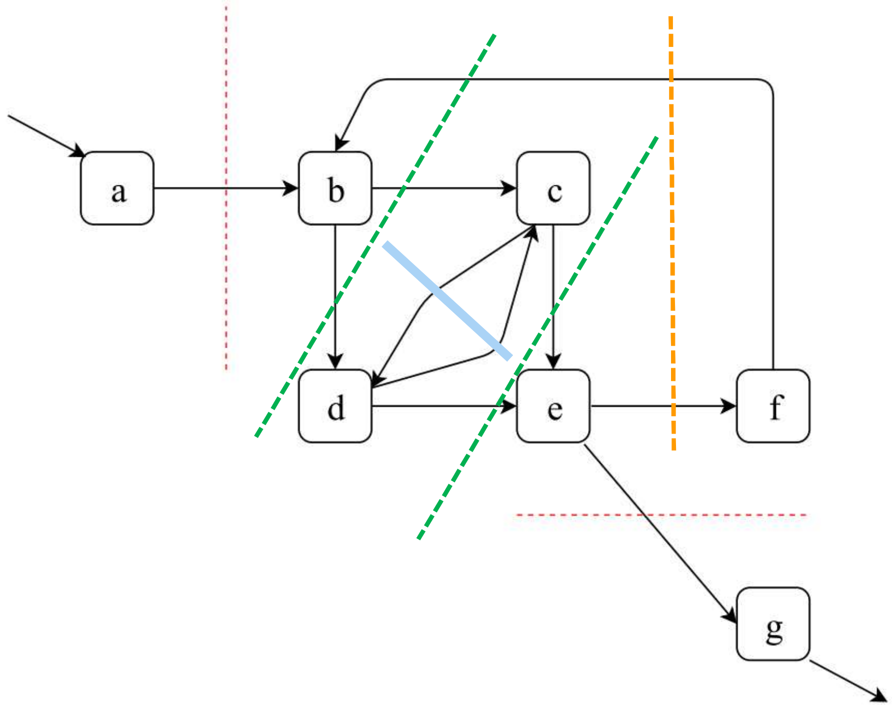
$L_2 = [\langle b, c, d, e\rangle, \langle b, d, c, e\rangle]$

Inductive Miner

Solution Q5 b i)

Solution for b) (with log projection) same as for a):

i. $L = \{\langle a, b, c, d, e, f, b, d, c, e, g\rangle, \langle a, b, d, c, e, g\rangle, \langle a, b, c, d, e, f, b, c, d, e, f, b, d, c, e, g\rangle\}$



$\rightarrow(a, \circlearrowleft(\{b, c, d, e\}, \{f\}), g)$

$L_2 = [\langle b, c, d, e\rangle, \langle b, d, c, e\rangle]$

$\rightarrow(a, \circlearrowleft(\rightarrow(\{b\}, \{c, d\}, \{e\}), f), g)$

$L_b = [\langle b\rangle], L_e = [\langle e\rangle], L_3 = [\langle c, d\rangle, \langle d, c\rangle]$

$\rightarrow(a, \circlearrowleft(\rightarrow(b, \wedge(\{c\}, \{d\}), e), f), g)$

$L_c = [\langle c\rangle], L_d = [\langle d\rangle]$

$\boxed{\rightarrow(a, \circlearrowleft(\rightarrow(b, \wedge(c, d), e), f), g)}$

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Inductive Miner

Solution Q5 a ii)

Solution for a) (without log projection):

ii. $L = \{\langle a,d,e,f,h\rangle, \langle a,e,d,b,f,h\rangle, \langle g,h\rangle, \langle a,b,c,d,f,h\rangle, \langle a,c,b,d,f,h\rangle, \langle a,b,d,c,e,f,h\rangle, \langle a,e,b,e,c,f\rangle\}$

$\rightarrow(\{a,b,c,d,e,f,g\},\{h\})$

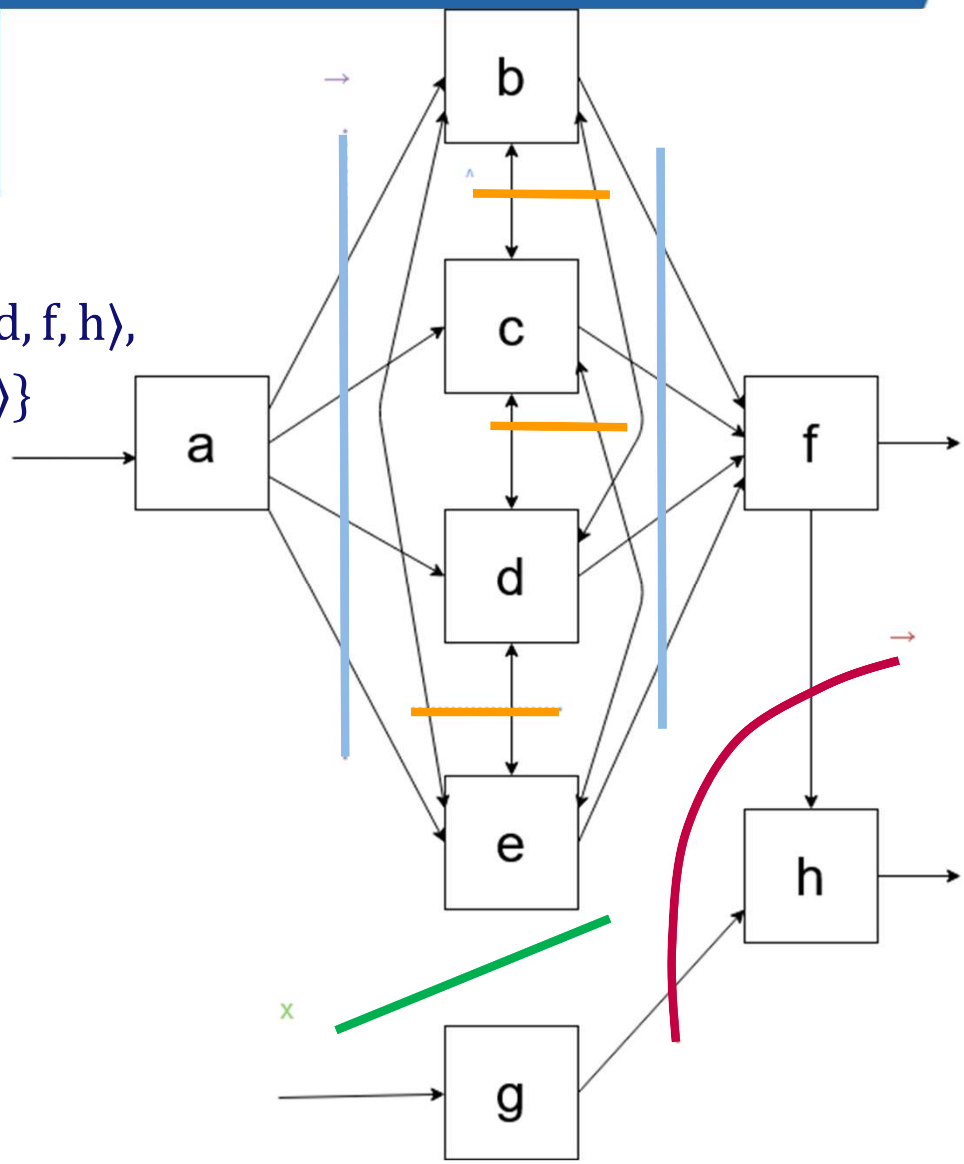
$\rightarrow(\times(\{a,b,c,d,e,f\},\{g\}),h)$

$\rightarrow(\times(\rightarrow(\{a\},\{b,c,d,e\},\{f\}),g),h)$

$\rightarrow(\times(\rightarrow(a,\ \wedge(\{b\},\{c\},\{d\},\{e\}),f),g),h)$

$\boxed{\rightarrow(\times(\rightarrow(a,\ \wedge(b,c,d,e),f),g),h)}$

Trace in tree but not in log:
$\langle a,b,c,d,e,f,h\rangle$



Inductive Miner

Solution Q5 b ii)

Solution for b) (with log projection):

ii. $L = \{\langle a, d, e, f, h\rangle, \langle a, e, d, b, f, h\rangle, \langle g, h\rangle, \langle a, b, c, d, f, h\rangle, \langle a, c, b, d, f, h\rangle, \langle a, b, d, c, e, f, h\rangle, \langle a, e, b, e, c, f\rangle\}$

$\rightarrow(\{a, b, c, d, e, f, g\}, \{h\})$

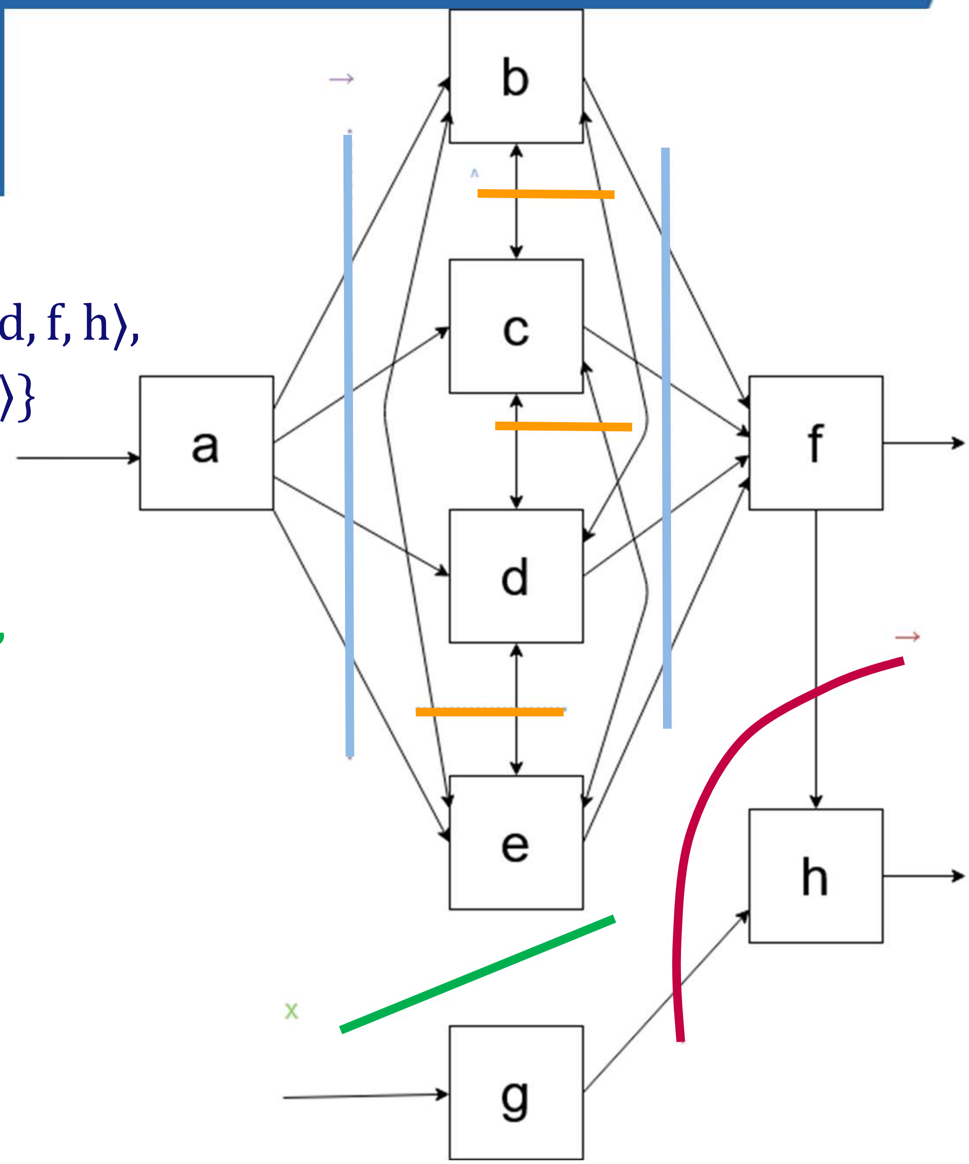
$L_1 = \{\langle a, d, e, f\rangle, \langle a, e, d, b, f\rangle, \langle g\rangle, \langle a, b, c, d, f\rangle, \langle a, c, b, d, f\rangle, \langle a, b, d, c, e, f\rangle, \langle a, e, b, e, c, f\rangle\}$

$L_2 = \{\langle h\rangle, \langle\rangle\}$

$\rightarrow(\times(\{a, b, c, d, e, f\}, \{g\}), \times(h, \tau))$

$L_3 = \{\langle a, d, e, f\rangle, \langle a, e, d, b, f\rangle, \langle a, b, c, d, f\rangle, \langle a, c, b, d, f\rangle, \langle a, b, d, c, e, f\rangle, \langle a, e, b, e, c, f\rangle\}$

$L_4 = \{\langle g\rangle\}$



Inductive Miner

Solution Q5 b ii)

Solution for b) (with log projection):

ii. $L = \{\langle a,d,e,f,h\rangle, \langle a,e,d,b,f,h\rangle, \langle g,h\rangle, \langle a,b,c,d,f,h\rangle, \langle a,c,b,d,f,h\rangle, \langle a,b,d,c,e,f,h\rangle, \langle a,e,b,e,c,f\rangle\}$

$\rightarrow(\times(\{a,b,c,d,e,f\}, g), \times(h,\tau))$

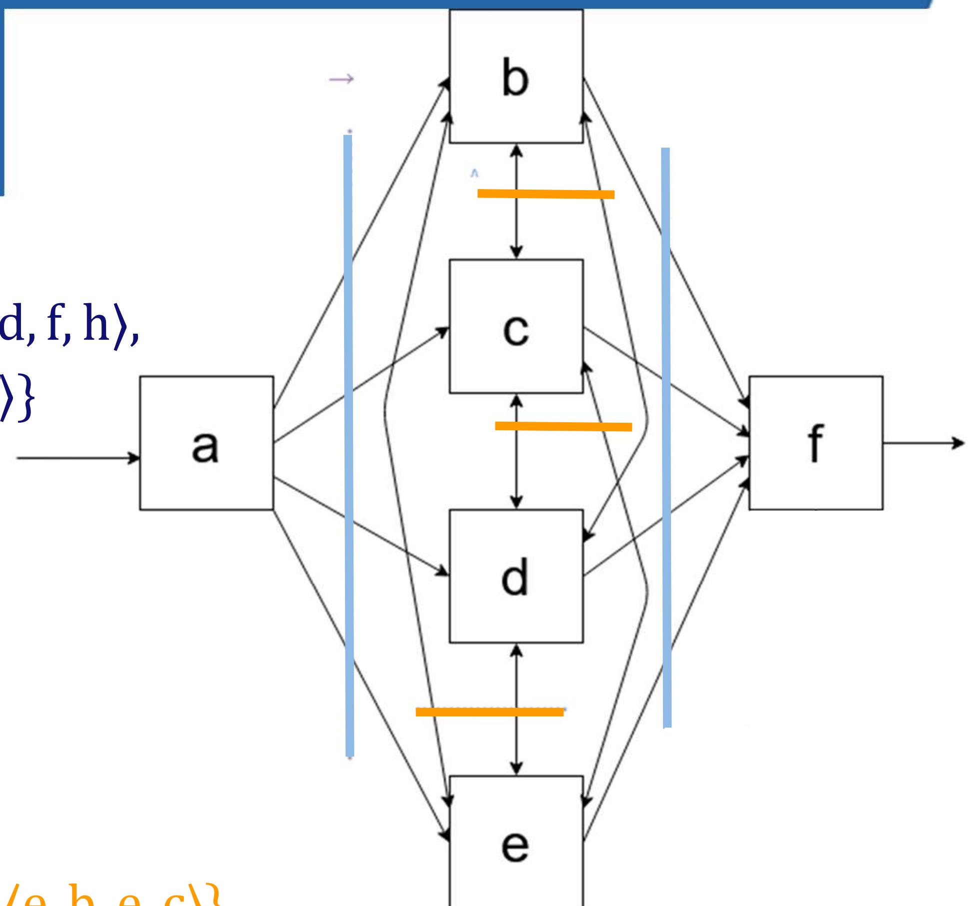
$L_3 = \{\langle a,d,e,f\rangle, \langle a,e,d,b,f\rangle, \langle a,b,c,d,f\rangle, \langle a,c,b,d,f\rangle, \langle a,b,d,c,e,f\rangle, \langle a,e,b,e,c,f\rangle\}$

$\rightarrow(\times(\rightarrow(\{a\},\{b,c,d,e\},\{f\}), g), \times(h,\tau))$

$L_5 = \{\langle a\rangle\}$

$L_6 = \{\langle d,e\rangle, \langle e,d,b\rangle, \langle b,c,d\rangle, \langle c,b,d\rangle, \langle b,d,c,e\rangle, \langle e,b,e,c\rangle\}$

$L_7 = \{\langle f\rangle\}$

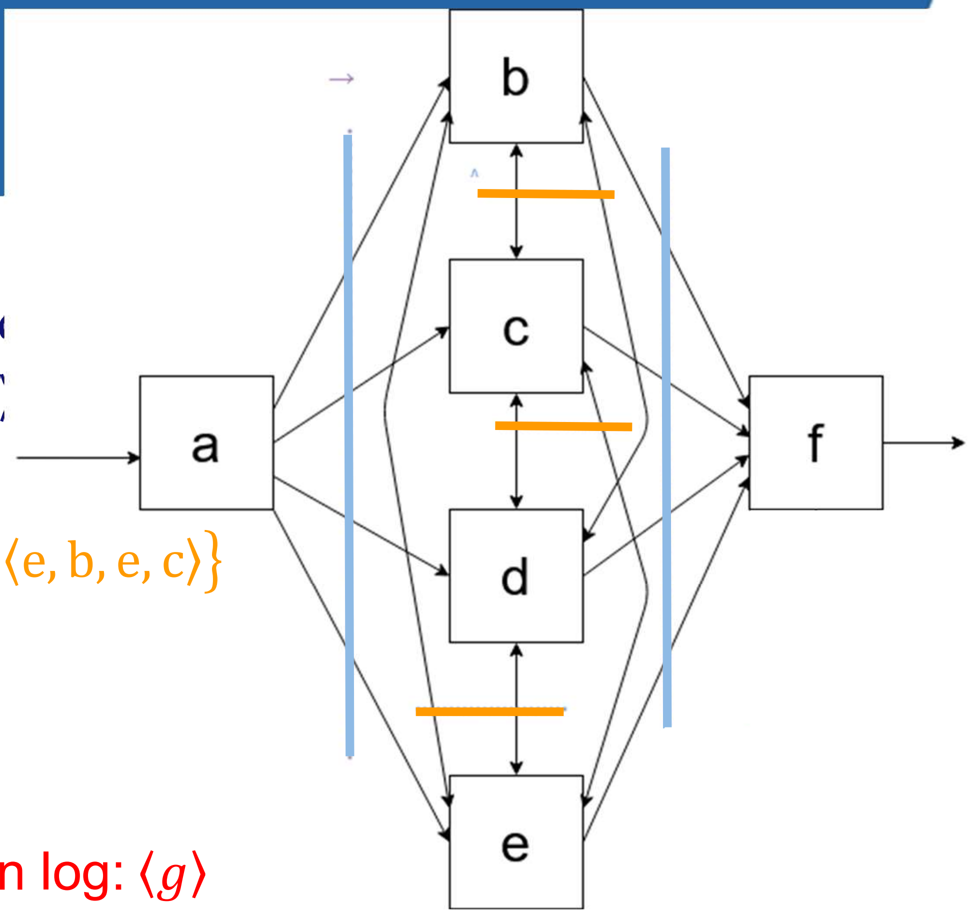


Inductive Miner

Solution Q5 b ii)

Solution for b) (with log projection):

ii. $L = \{\langle a,d,e,f,h\rangle, \langle a,e,d,b,f,h\rangle, \langle g,h\rangle, \langle a,b,c,$
$\langle a,c,b,d,f,h\rangle, \langle a,b,d,c,e,f,h\rangle, \langle a,e,b,e,c,f$



$\rightarrow(\times(\rightarrow(a,\{b,c,d,e\},f),g),\times(h,\tau))$

$L_6 = \{\langle d,e\rangle, \langle e,d,b\rangle, \langle b,c,d\rangle, \langle c,b,d\rangle, \langle b,d,c,e\rangle, \langle e,b,e,c\rangle\}$

$\rightarrow(\times(\rightarrow(a, \wedge(\{b\},\{c\},\{d\},\{e\}),f),g),\times(h,\tau))$

$L_b = \{\langle\ \rangle, \langle b\rangle\}$

$L_c = \{\langle\ \rangle, \langle c\rangle\}$

$L_d = \{\langle d\rangle, \langle\ \rangle\}$

$L_e = \{\langle e\rangle, \langle\ \rangle, \langle e,e\rangle\}$

Trace in tree but not in log: $\langle g\rangle$

$$\boxed{\rightarrow(\times(\rightarrow(a, \wedge(\times(b,\tau),\times(c,\tau),\times(d,\tau),\times(\circlearrowleft(e,\tau),\tau)),f),g),\times(h,\tau))}$$

Inductive Miner

Solution Q5 a/b iii)

Solution Part 1 for a) and b) (with and without log projection):

iii. $L = \{\langle a, c, d, e \rangle, \langle a, d, c, e \rangle, \langle a, d, e, c, f, d, e \rangle, \langle b, d, e, c \rangle, \langle b, c, d, e, f, d, e \rangle, \langle b, d, e, f, c, d, e \rangle\}$

$\rightarrow (\{a, b\}, \{c, d, e, f\})$

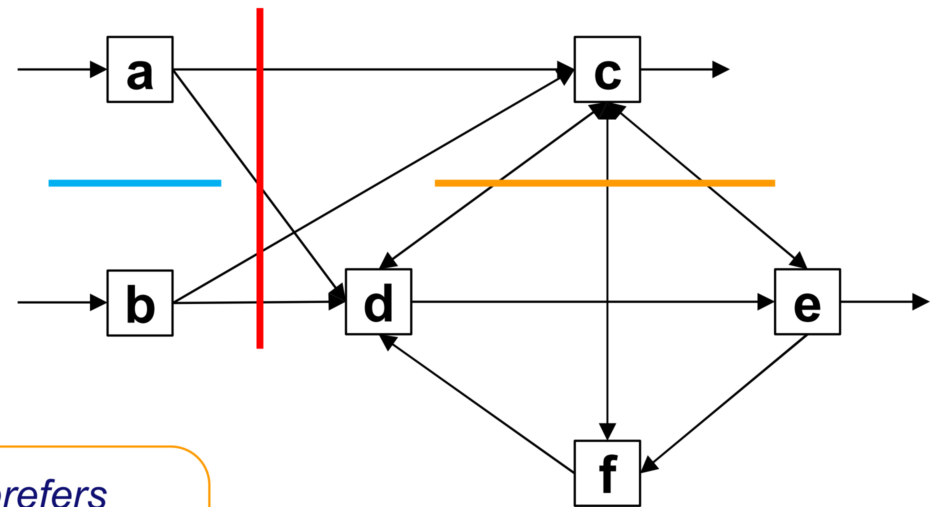
$L_1 = \{\langle a \rangle, \langle b \rangle\}$

$L_2 = \{\langle c, d, e \rangle, \langle d, c, e \rangle, \langle d, e, c, f, d, e \rangle, \langle d, e, c \rangle, \langle c, d, e, f, d, e \rangle, \langle d, e, f, c, d, e \rangle\}$

$\rightarrow (\times(\{a\}, \{b\}), \wedge(\{c\}, \{d, e, f\}))$

$L_a = \{\langle a \rangle\}$, $L_b = \{\langle b \rangle\}$, $L_c = \{\langle c \rangle\}$

$L_3 = \{\langle d, e \rangle, \langle d, e, f, d, e \rangle\}$



IM prefers parallel cut over loop cut (both possible on L_2)

Inductive Miner

Solution Q5 a iii)

Solution Part 2 for a) (with log projection):

iii. $L = \{\langle a, c, d, e \rangle, \langle a, d, c, e \rangle, \langle a, d, e, c, f, d, e \rangle, \langle b, d, e, c \rangle, \langle b, c, d, e, f, d, e \rangle, \langle b, d, e, f, c, d, e \rangle\}$

$\rightarrow (\times(\{a\},\{b\}), \wedge(\{c\},\{d,e,f\}))$

$L_a = \{\langle a \rangle\}$, $L_b = \{\langle b \rangle\}$, $L_c = \{\langle c \rangle\}$

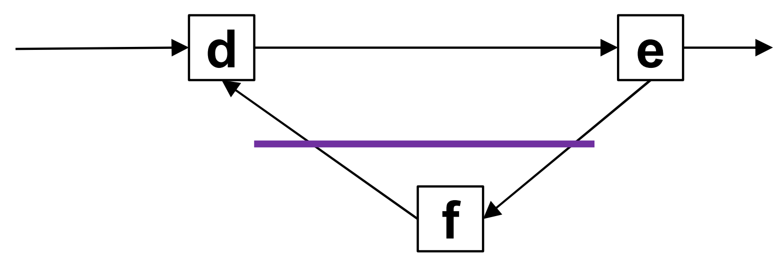
$L_3 = \{\langle d, e \rangle, \langle d, e, f, d, e \rangle, \}$

$\rightarrow (\times(a, b), \wedge(c, \circlearrowleft(\{d, e\}, \{f\})))$

$L_4 = \{\langle d, e \rangle\}$

$L_f = \{\langle f \rangle\}$

DFG based on projected event log L_3 allows for **loop cut:**

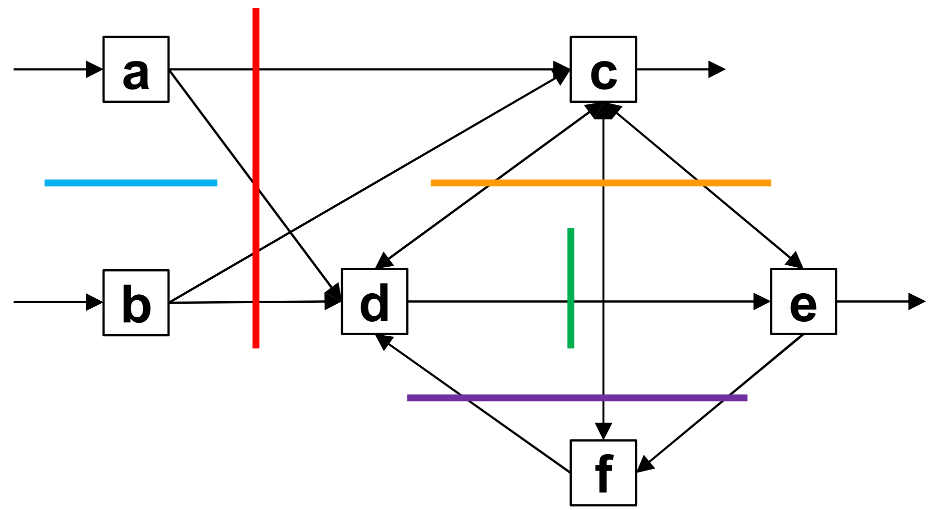


Inductive Miner

Solution Q5 a iii)

Solution Part 2 for a) (with log projection):

iii. $L = \{\langle a, c, d, e \rangle, \langle a, d, c, e \rangle, \langle a, d, e, c, f, d, e \rangle, \langle b, d, e, c \rangle, \langle b, c, d, e, f, d, e \rangle, \langle b, d, e, f, c, d, e \rangle\}$



$\rightarrow (\times(a, b), \wedge(c, \circlearrowleft(\{d, e\}, \{f\})))$

$L_4 = \{\langle d, e \rangle\}$

$L_f = \{\langle f \rangle\}$

$\rightarrow (\times(a, b), \wedge(c, \circlearrowleft(\rightarrow(\{d\}, \{e\}), f)))$

$L_d = \{\langle d \rangle\}, L_e = \{\langle e \rangle\}$

$\boxed{\rightarrow (\times(a, b), \wedge(c, \circlearrowleft(\longrightarrow(d, e), f)))}$

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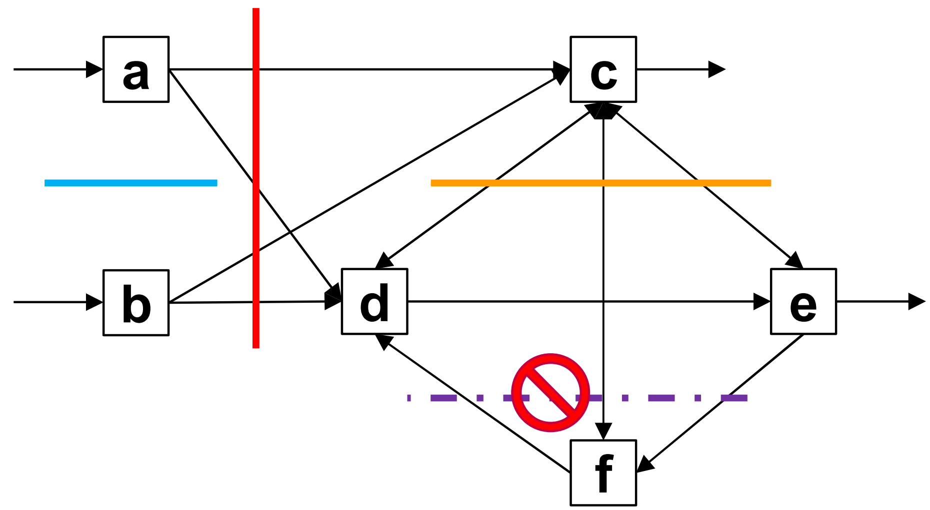
Inductive Miner

Solution Q5 b iii)

Solution Part 2 for b) (without log projection):

iii. $L = \{\langle a, c, d, e \rangle, \langle a, d, c, e \rangle, \langle a, d, e, c, f, d, e \rangle, \langle b, d, e, c \rangle,$
$\langle b, c, d, e, f, d, e \rangle, \langle b, d, e, f, c, d, e \rangle\}$



$\rightarrow (\times(\{a\},\{b\}), \wedge(\{c\},\{d,e,f\})))$

$L_a = \{\langle a \rangle\}$, $L_b = \{\langle b \rangle\}$, $L_c = \{\langle c \rangle\}$

$L_3 = \{\langle d, e \rangle, \langle d, e, f, d, e \rangle, \}$

With the basic techniques introduced in the lecture, the loop cut cannot be discovered without redrawing the DFG (because f is a start activity).

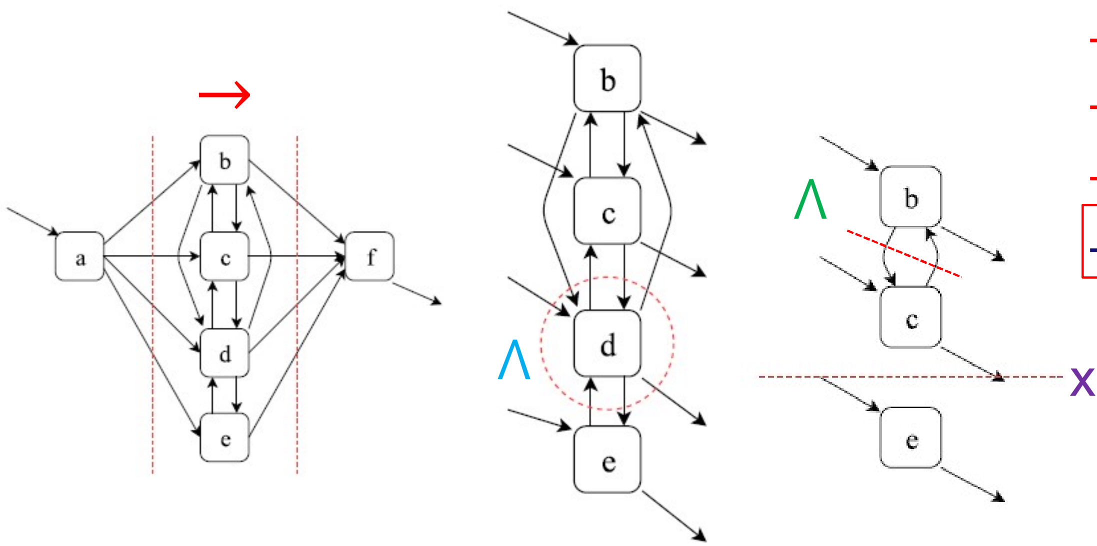
Note, that the 'real' Inductive Miner includes strategies to discover this loop cut (not relevant for the exam).

Inductive Miner

Solution Q5 a/b iv)

Solution for a) and b) (with and without log projection):

iv. $L = \{\langle a, b, c, d, f\rangle, \langle a, c, b, d, f\rangle, \langle a, b, d, c, f\rangle, \langle a, c, d, b, f\rangle, \langle a, d, e, f\rangle, \langle a, e, d, f\rangle\}$



$\rightarrow (\{a\}, \{b, c, d, e\}, \{f\})$

$\rightarrow (a, \wedge(\{b, c, e\}, \{d\}), f)$

$\rightarrow (a, \wedge(\times(\{b, c\}, \{e\}), d), f)$

$\rightarrow (a, \wedge(\times(\wedge(\{b\}, \{c\}), e), d), f)$

$\boxed{\rightarrow (a, \wedge(\times(\wedge(b, c), e), d), f)}$