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Process Analytics

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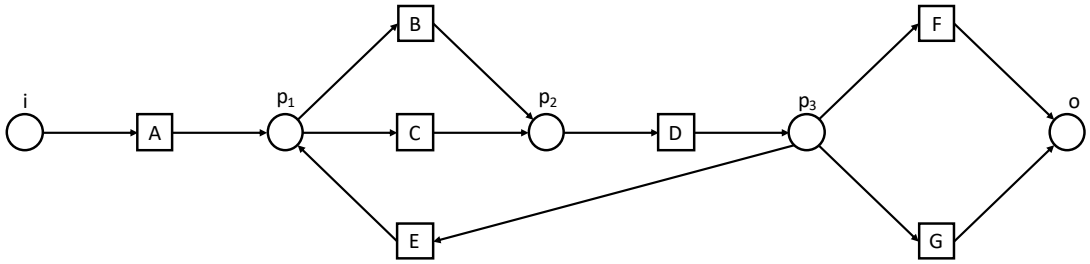
Advanced Process Mining

Summer term 2020

Exercise sheet 5

Alignments

Exercise 1: Alignments



#	Trace
200	ACDF
120	ADCEG
100	AFG
80	FDCA
10	C

a) Apply alignment-based conformance checking and apply the cost function in order to find an optimal alignment.

b) Determine the fitness of the process model above and the observed traces by considering the alignments.

Solution

a) The alignment with the lowest cost for the given traces are the following:

$$\gamma_1 = \begin{array}{c||c|c|c|c} \sigma & \text{A} & \text{C} & \text{D} & \text{F} \\ N & \text{A} & \text{C} & \text{D} & \text{F} \end{array} \qquad \gamma_2 = \begin{array}{c||c|c|c|c|c|c} \sigma & \text{A} & \text{D} & \text{C} & \gg & \text{E} & \text{G} \\ N & \text{A} & \gg & \text{C} & \text{D} & \gg & \text{G} \end{array}$$

$$\gamma_3 = \begin{array}{c||c|c|c|c|c} \sigma & \text{A} & \gg & \gg & \text{F} & \text{G} \\ N & \text{A} & \text{C} & \text{D} & \text{F} & \gg \end{array} \qquad \gamma_4 = \begin{array}{c||c|c|c|c|c|c|c} \sigma & \gg & \gg & \gg & \text{F} & \text{D} & \text{C} & \text{A} \\ N & \text{A} & \text{C} & \text{D} & \text{F} & \gg & \gg & \gg \end{array}$$

$$\gamma_5 = \begin{array}{c||c|c|c|c} \sigma & \gg & \text{C} & \gg & \gg \\ N & \text{A} & \text{C} & \text{D} & \text{F} \end{array}$$

The cost for each trace is:

Trace	δ
ACDF	0
ADCEG	3
AFG	3
FDCA	6
C	3

b) $fitness(\sigma, N) = 1 - \frac{\delta(\lambda^N_{opt}(\sigma))}{delta(\lambda^N_{worst}(\sigma))}$

#	Trace	$\delta(\lambda^N_{opt}(\sigma))$	$\delta(\lambda^N_{worst}(\sigma))$	$fitness(\sigma, N)$
200	ACDF	0	8	1
120	ADCEG	3	9	$\frac{2}{3}$
100	AFG	3	7	$\frac{4}{7}$
80	FDCA	6	8	$\frac{1}{4}$
10	C	3	5	$\frac{2}{5}$

$$fitness(L, N) = 1 - \frac{\sum_{\sigma \in L} L(\sigma) \times \delta(\lambda^N_{opt}(\sigma))}{\sum_{\sigma \in L} L(\sigma) \times \delta(\lambda^N_{worst}(\sigma))} = 1 - \frac{0+360+300+480+30}{1600+1080+700+640+50} = 0.713$$

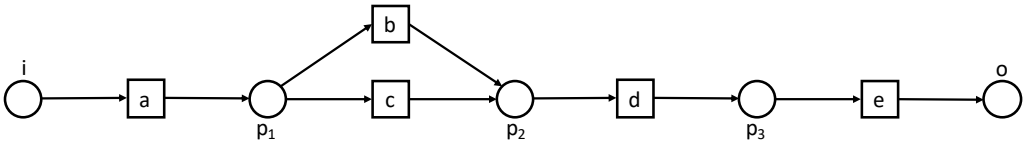
Exercise 2: Petri Net Construction

a) If possible draw a Petri net that has exactly two optimal alignments with replay fitness of $\frac{6}{7}$ given the trace $\sigma_i =< a, d, e >$.

b) If possible draw a Petri net that has exactly two optimal alignments with replay fitness of 1 given the trace $\sigma_i i =< a, b, c, d >$.

Solution

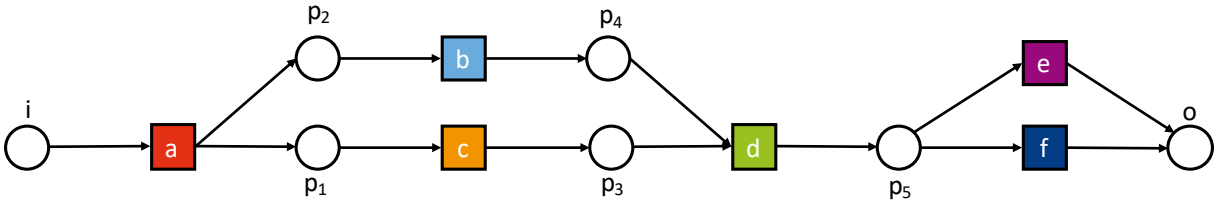
a)



$$fitness(\sigma_i, N) = 1 - \frac{\delta(\lambda^N_{opt}(\sigma_i))}{\delta(\lambda^N_{worst}(\sigma_i))} = 1 - \frac{1}{7} = \frac{6}{7}$$

b) Not possible: In order for $fitness(\sigma_{ii}, N) = 1$, the expression $\delta(\lambda^N_{opt}(\sigma_{ii})$ has to be zero. This will only be the case if the alignment fits perfectly with synchronous moves only. Exactly one alignment can fulfil this requirement.

Exercise 3: Alignment Search Space



Find the optimal alignment for the process model above and the given trace below. Draw the search space and indicate the optimal path.

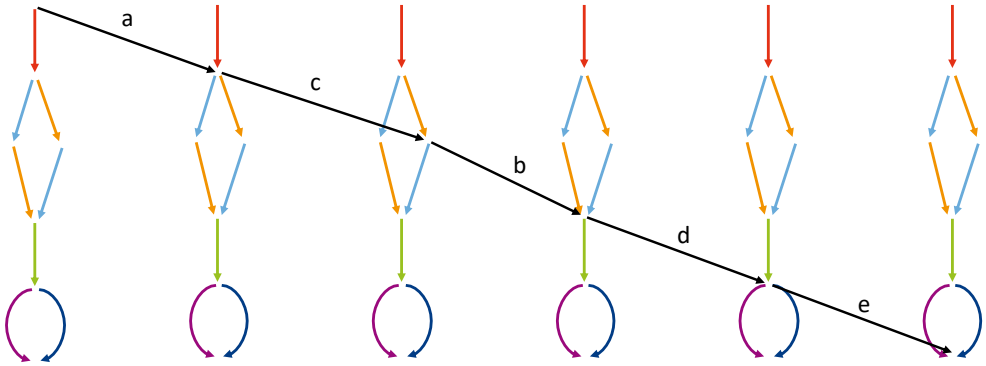
a) $\sigma_a =< a, c, b, d, e >$

b) $\sigma_b =< a, e, d >$

c) $\sigma_c =< a, d, f >$

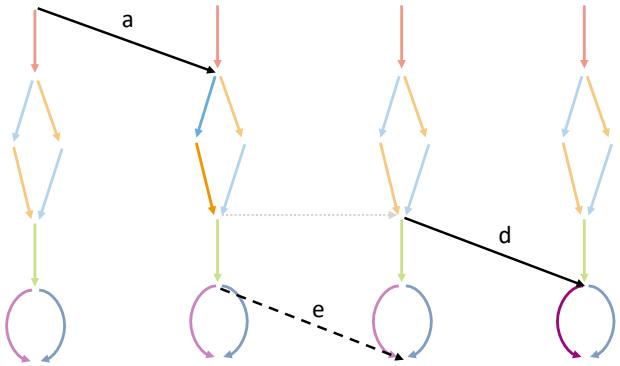
Solution

a) The ideal path in the state space for the given trace is the diagonal from top right to bottom left:



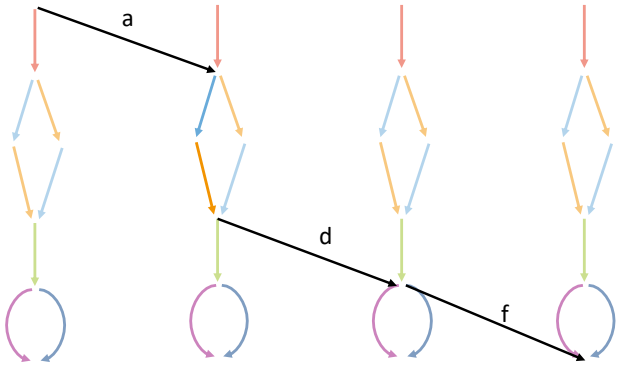
σ_a	a	c	b	d	e
N	a	c	b	d	e

b)



σ_b	a	$\gg$	$\gg$	e	d	$\gg$
N	a	b	c	$\gg$	d	e

c)



σ_b	a	$\gg$	$\gg$	d	f
N	a	b	c	d	f