

CS-472: Design Technologies for Integrated Systems

Exercise Problem Set 4

Date: 02/10/2025

Topic: Scheduling (cf. slide set 5)

For all problems, consider the following sequencing graph.

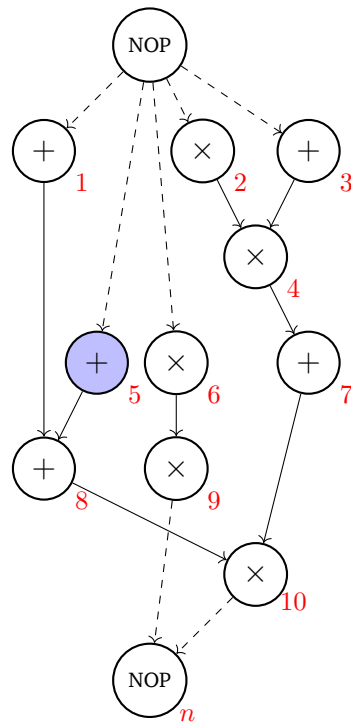


Figure 1: Sequencing graph

Problem 1

Assume all operations have unit execution delay.

- Schedule the graph with ASAP.
- Schedule the graph with ALAP and a latency bound $\bar{\lambda}$ of 5 cycles.
- Compute the mobility of each operation.

Problem 2

Schedule the sequencing graph using the list algorithm with at most two multipliers and one adder (at the same time per level). Assume that the multiplier takes two units of time and the adder one. Try to obtain the minimum latency subject to the resource bounds.

Problem 3

Assume again that the multiplier takes two units of time and the adder one, and that at most two multipliers and one adder are available at the same time.

- (a) Write down the integer linear programming (ILP) inequalities describing the sequencing graph and subject to the resource constraints. Use an upper bound on the latency $\bar{\lambda} = 9$.
- (b) What variable assignment correspond to the solution you obtained in Problem 2? Plug these values into the inequalities. Are they all satisfied?

Problem 4

Assume now all operations have unit delays. Consider an upper bound on the latency $\bar{\lambda} = 5$. Use a force calculation schedule the colored operation (node 5) to reduce concurrency.

Table 1: Time frames obtained from ASAP and ALAP ($\bar{\lambda} = 5$), mobility μ and probabilities $p_i(l)$

	t_S	t_L	L_1	L_2	L_3	L_4	L_5	μ	$p_i(1)$	$p_i(2)$	$p_i(3)$	$p_i(4)$	$p_i(5)$	type
v_1														adder
v_2														multiplier
v_3														adder
v_4														multiplier
v_5														adder
v_6														multiplier
v_7														adder
v_8														adder
v_9														multiplier
v_{10}														multiplier

Table 2: Type distributions $q_k(l)$

adder						multiplier				
$q_a(1)$	$q_a(2)$	$q_a(3)$	$q_a(4)$	$q_a(5)$		$q_m(1)$	$q_m(2)$	$q_m(3)$	$q_m(4)$	$q_m(5)$

Table 3: Force calculation of v_5

	Self-force	PS-force	Total force
L_1			
L_2			
L_3			

Conclusion: The smallest force is in _____, thus we should schedule v_5 at this level to reduce concurrency.