Hardware Algorithms: circuits & networks
Problem Set 3
submit by June 27th

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1. Compute the precision of the intermediate computations required to compute $1/x$ using Newton iterations. Compute the intermediate precision if the final required precision is $2^{-23}, 2^{-52}, 2^{-63}$.

2. (a) Design a semi-systolic circuit (systolic with broadcast) that implements a FIFO queue. The input in the ith clock cycle consists of: (1) $x_i \in \Sigma \cup \{\Lambda\}$, where Σ is the alphabet of input symbols and Λ denotes an empty symbol. (2) $op_i \in \{$enqueue, dequeue, nop$\}$.

   (b) Apply retiming and tiling to transform your design into a systolic circuit.

3. (a) Design a semi-systolic circuit (systolic with broadcast) that implements a heap. The input in the ith clock cycle consists of: (1) $x_i \in \Sigma \cup \{\Lambda\}$, where Σ is the alphabet of input symbols and Λ denotes an empty symbol. (2) $op_i \in \{$insert, delete-min, nop$\}$.

   (b) Apply retiming and tiling to transform your design into a systolic circuit.

4. (a) Design a semi-systolic circuit (systolic with instant accumulation) that implements the following functionality. The input in the ith clock cycle consists of $x_i \in \Sigma$, where Σ is the alphabet of input symbols. The output $y_i \in \{0,1\}$ satisfies in every cycle $i > 0$,

$$y_{i+1} = 1 \quad \Leftrightarrow \quad \forall 0 \leq j \leq i : x_j = x_{i-j}.$$

   (b) Apply retiming and tiling to transform your design into a systolic circuit.