Static Scheduling of synchronous Dataflow Programs for Digital Signal Processing

- Edward A. Lee
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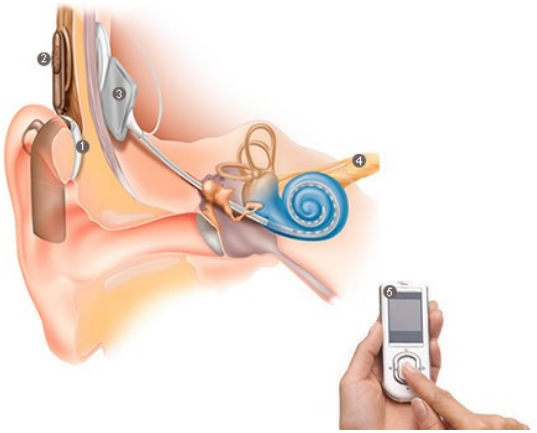
Impact



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Results

- Mathematical foundation for interpreting SDF graphs
  - Relation to computation graphs [1]
  - Conditions for validity/termination(or not)
  - Semi-extensions: delays
- Static scheduling
  - Combinatorial (factorial) complexity
  - Uses critical path estimation, Hu-Level [2] scheduling

Results

- Admissible graph:
  - Fig 5: rate inconsistencies, all rows of topology matrix are linearly independent
  - Fig 6: rate consistent, row 3 of topology matrix is sum of row 2 times row 1 plus row 2
- Source: [0]: p28

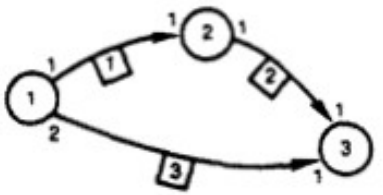

Fig. 5. Example of a defective SDF graph with sample rate inconsistencies. The topology matrix is

$$\Gamma = \begin{bmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ 2 & 0 & -1 \end{bmatrix} \quad \text{rank } (\Gamma) = s = 3.$$

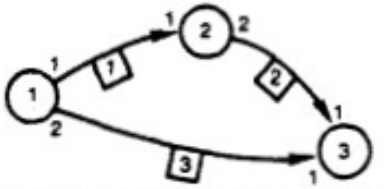

Fig. 6. An SDF graph with consistent sample rates has a positive integer vector q in the nullspace of the topology matrix Γ.

$$\Gamma = \begin{bmatrix} 1 & -1 & 0 \\ 0 & 2 & -1 \\ 2 & 0 & -1 \end{bmatrix} \quad q = \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} \epsilon \eta(\Gamma)$$

Reflection

- Very self contained, almost to the point of abstraction
- Does not deal with extensions to the SDF framework (admittedly there were fewer at time of writing)
- Does not deal with looping, paper assumes an no feedback
- Good understanding of limitations of the model
- Good discussion of optimality/feasibility of solutions

References

- [0] E.A. Lee, D.G. Messerschmitt; “Static Scheduling of Synchronous Data Flow Programs for Digital Signal Processing”, IEEE Transaction on Computers, vC-36 – Jan 1987
- [1] R.M. Karp, R.E. Miller; “Properties of a model for parallel computations: Determinacy, termination, queueing”, SIAM J: v14 – Nov 1966
- [2] T.C. Hu; “Parallel sequencing and assembly line problems”, Operating Resources: vC-25 - 1961

Questions?

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