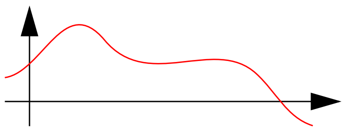
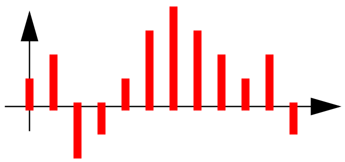
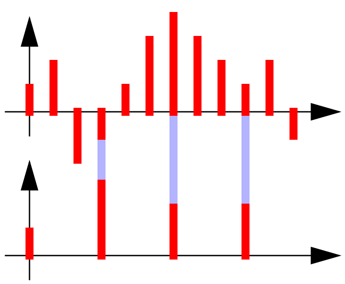
A Taxonomy of Models of Computation



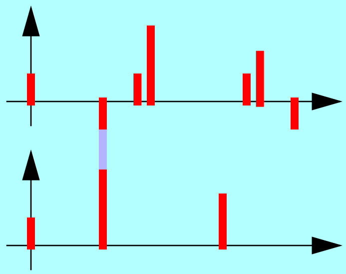
continuous time



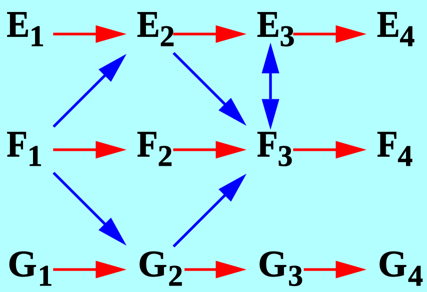
discrete time



multirate discrete time



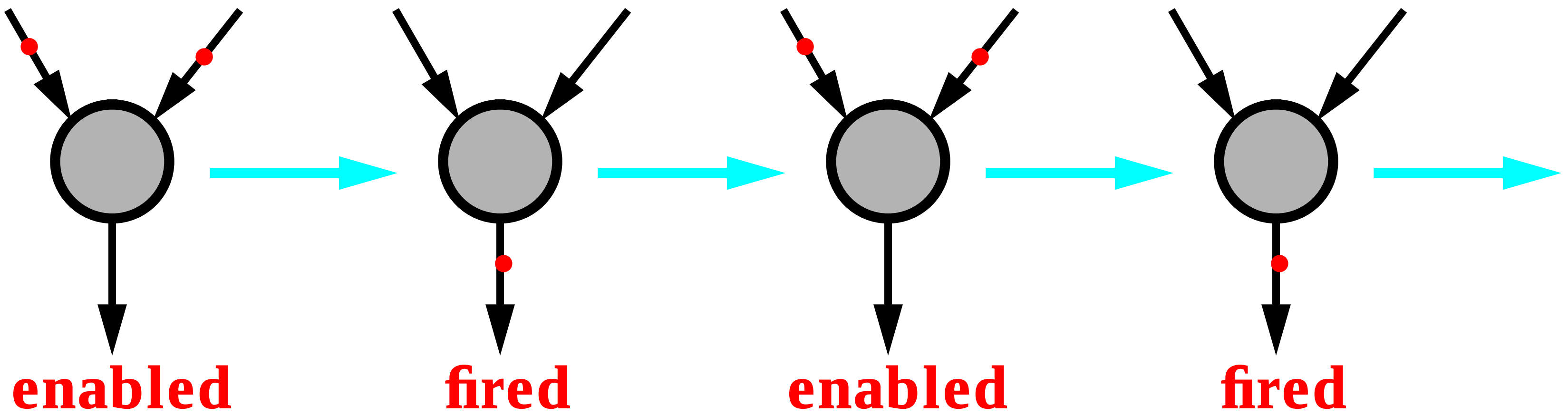
totally-ordered discrete events



partially-ordered discrete events

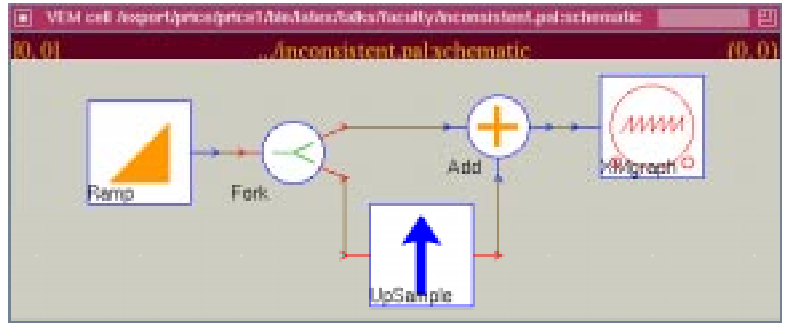
Dataflow Models of Computation

- A *signal* is a sequence of *tokens*.
- An *actor* maps input tokens onto output tokens.
- A set of *firing rules* specify when an actor can fire.
- A firing *consumes* input tokens and *produces* output tokens.
- A sequence of firings is a *dataflow process*.

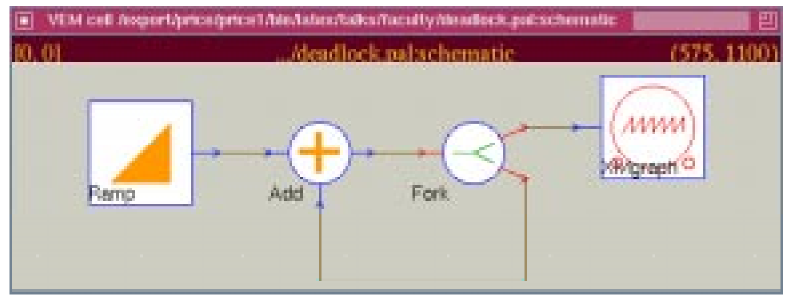


Problems Scheduling Dataflow Graphs

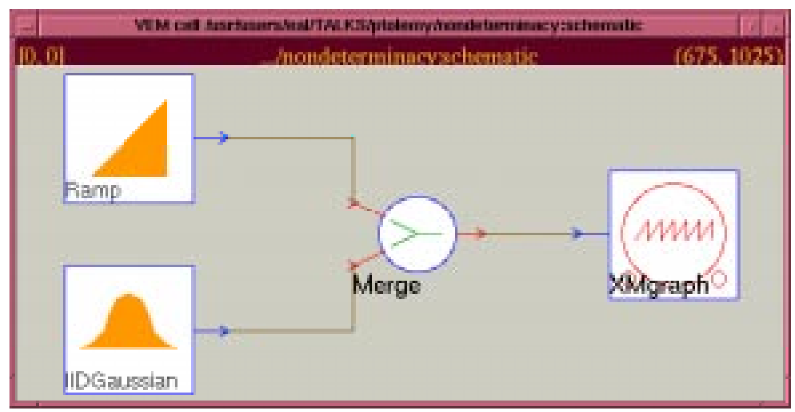
- **Tokens can build up uncontrollably on arcs**
  - **consistency: in the limit, tokens are produced and consumed at the same rate**



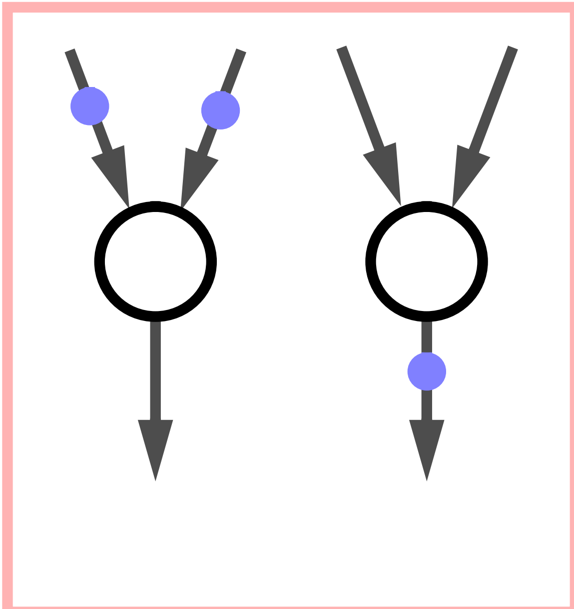
- **Dataflow graph might deadlock**
  - **no actors are enabled**
  - **some actors will never be enabled**



- **Graph might be non-determinate**
  - **determinacy: sequence of tokens only depends on input tokens and the graph**

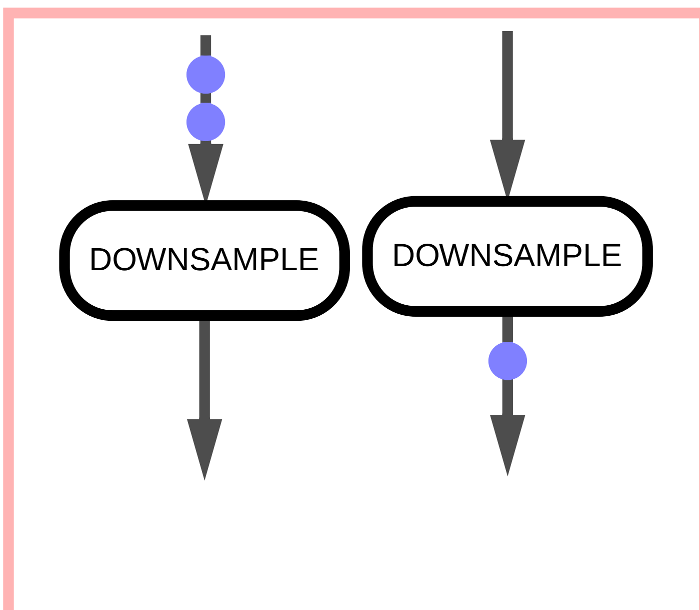


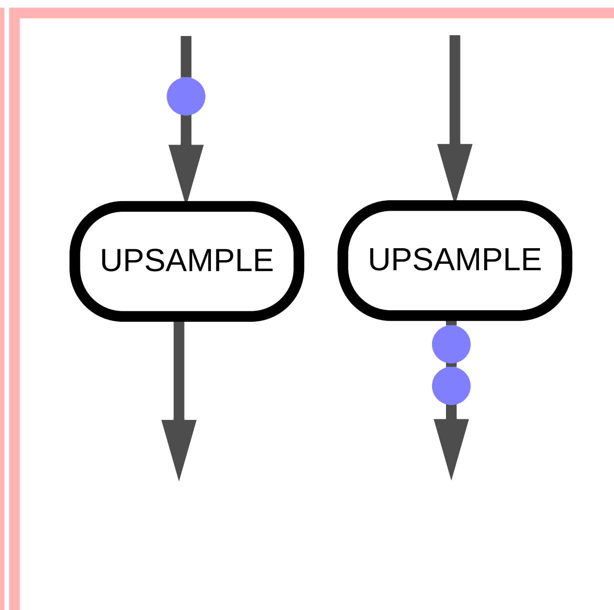
Synchronous Dataflow



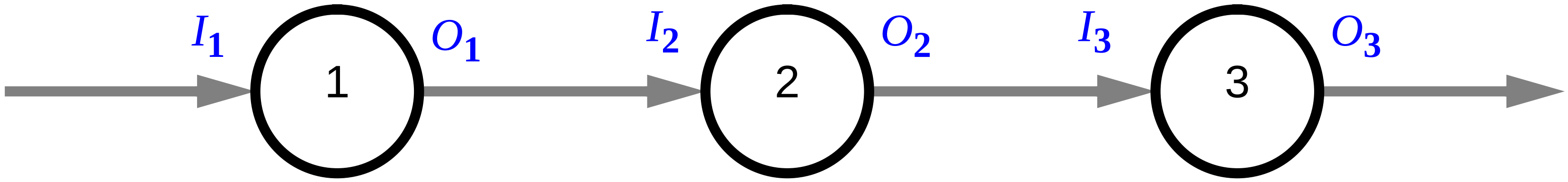
Properties

- Flow of control is predictable at compile time
- Schedule can be constructed once and repeatedly executed
- Well-suited to synchronous multirate signal processing





Consistency in Partially-Ordered Dataflow Models



Balance equations:

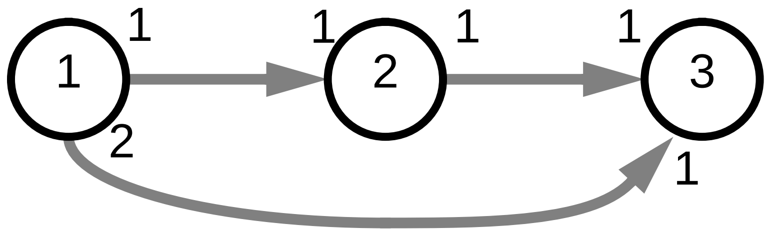
$$r_1 O_1 = r_2 I_2$$

$$r_2 O_2 = r_3 I_3$$

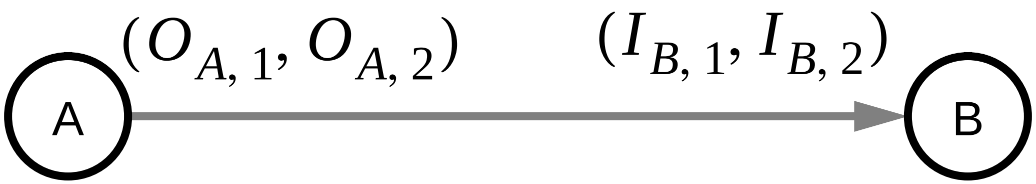
Solve for the smallest integers r_i.

Then schedule according to data dependencies until repetitions r_i have been met for all actors.

The balance equations have no solution if the graph is *inconsistent*. For example:



Multidimensional Dataflow Extension



Balance equations:

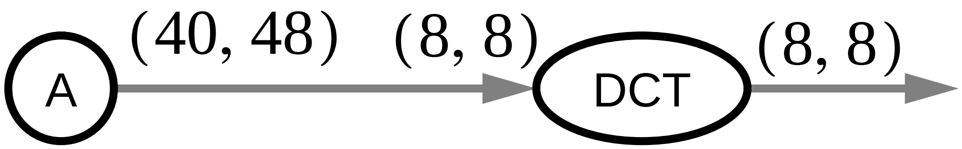
$$r_{A,1} O_{A,1} = r_{B,1} I_{B,1}$$

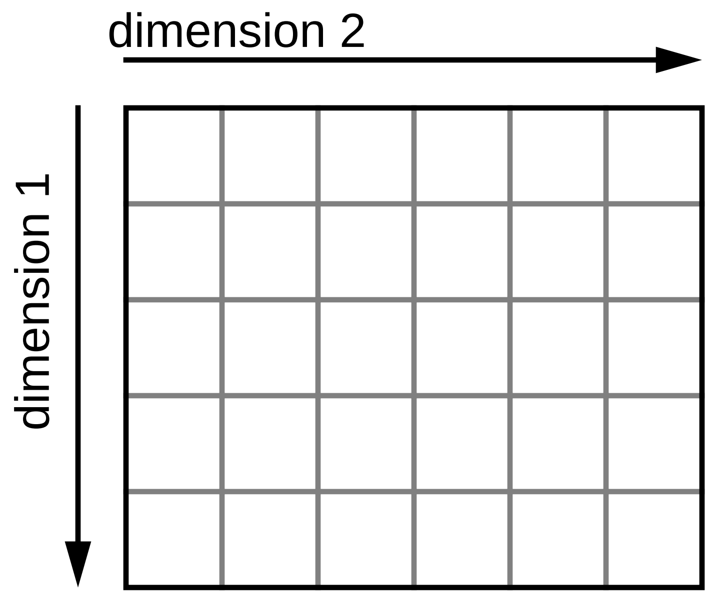
$$r_{A,2} O_{A,2} = r_{B,2} I_{B,2}$$

Solve for the smallest integers $r_{X,i}$, which then give the number of repetitions of actor X in dimension i.

Higher dimensionality follows similarly.

Example of Multidimensional Dataflow





$$r_{A,1} = r_{A,2} = 1$$

$$r_{DCT,1} = 5, \quad r_{DCT,2} = 6$$

Dynamic Dataflow