A Taxonomy of Models of Computation

- Continuous time
- Discrete time
- Multirate discrete time

- Totally-ordered discrete events
- Partially-ordered discrete events
• 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
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 \textit{inconsistent}. For example:
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

```
TRUE

SWITCH
T  F

ENABLED

FIRED

FALSE

SWITCH
T  F

ENABLED

FIRED

TRUE

SELECT
T  F

ENABLED

FIRED

FALSE

SELECT
T  F

ENABLED

FIRED
```