Chapter 7
Lecture 15b
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Models of Sequential Systems
A Finite State Transition Structure

If \( g \) is defined for all states and input symbols, it is complete:

- If \( |S| = I \) then the FST is strongly deterministic.

\[
S \supseteq I
\]

\( \forall s \in S \) \( g(s, \cdot) = I \)

\( S \leftarrow S \times X : (s, \cdot) g \)

Non-deterministic: \( g(s, \cdot) \) maps \( s \) into a set of next states. \( T \)

\[
S \subseteq \forall (x, \cdot) g
\]

\( S \leftarrow S \times X : (x, \cdot) g \)

Deterministic: \( g(s, \cdot) \) maps \( s \) into a unique next state. \( T \)

Deterministic and Non-deterministic FSTS

Models of Finite State Transition Systems

- \( S \subseteq \) is the set of initial (reset) states
- \( S \subseteq \) is the set of final states
- \( g : \) \( \forall x \) is the next-state function
- \( S \subseteq \) is the (finite) non-empty set of states
- \( X \subseteq \) is the input alphabet (a finite non-empty set of input values)
- \( \langle x, S \rangle \subseteq \) Finite State Transition Structures
NFA Example with ε-Moves

THE EFS of the Medd-Conway Traile Controller

\[(x \in \sigma \ni t \ni x \in \tau) = (\tau \mapsto I)\]

For each edge \(e \in E \ni t \ni i \ni s \ni \tau \ni (t, s, \epsilon)\) a possible state transition

The edges \(e \in E \ni t \ni i \ni s \ni \tau \ni (t, s, \epsilon)\)

The vertices are the states \(s \in S\).

\[\langle X, S, \epsilon \rangle\] is specified by \(\sigma \ni t \ni x \ni \tau \ni I\)

FSTS as Labelled Digraphs
\[ s \leftarrow S \times X : (x^{-f} s)^{\frac{1-f}{u^{-f}} \Pi} = \frac{(x^{-f} s^x \cdots s)}{g} \]

\[ f' s^{\frac{1-f}{u^{-f}}} \Pi = os \]

\[ f' s^{\frac{1-f}{u^{-f}}} \Pi = s \]

\[ f' (x^{-f} s)^{\frac{1-f}{u^{-f}}} = \Pi \]

\[ \text{Given in PSTS (X, \cdot, X), the product is:} \]

\[ \text{Product of PSTS} \]

The combination of a string/tape and a run is called a \textit{chain}.

A run is an infinite sequence of states.

A string is a finite sequence of states.

A transition is a sequence of states which ends with an initial state.

\textit{Tapes, Tapes, and Runs of PSTS}

\textit{Product of Non-deterministic PSTS}

\textit{Product of PSTS}
If \( n = 32 \), the same BDD represents 2.5 billion elements:

\[
\{ (0, [2, 10, 16, 31]) \} = S^0 \\
\{ (0, [2, 10, 16, 28]) \} = S
\]

BDD Representations of Characteristic Functions
Two Non-Equivalent FSMs

Transition Relations and Symbolic Image Computation

Symbolic Image Computation Example
Summary

- Application of BDDs to FSA
- Procedure for FSA equivalence checking
- Important graph algorithms
- Algorithm for state equivalence
- Modes of sequential systems (FSM, FA, FSA)