EECE 276
Embedded Systems

Techniques:
FSMs and StateCharts
Finite State Machines

● Finite state model
  » States: States of the system (finite set)
  » Initial State: a single element of States
  » Terminal States: a subset of States for “stopping”
  » Events: cause state transitions
  » State transition function:
    \[ F: \text{States} \times \text{Events} \to \text{States} \]

● Variants:
  » Self-loops
  » Deterministic/non-deterministic transitions
FSM Example: Fighter aircraft

**States:**
- TAK: takeoff
- NAV: navigate
- NAE: navigate/evade
- NAA: navigate/attach
- LAN: land

**Events:**
- MA: mission assignment
- LO: enemy lock-on
- TD: target detected
- EE: enemy evaded
- ED: enemy destroyed
- MC: mission completed

Self-loops are not shown!
FSM Example: Table

- Tabular form

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<th>MA</th>
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- Extensions:
  - Time triggers, variables.
FSM Example
Statecharts

- Statecharts extend FSMs with
  - Hierarchy: containment of states
  - Orthogonality: concurrent states
  - Broadcast communication: events triggering events

Event $X$ triggers a transition if condition $C$ is true. When the transition is taken, event $Y$ is broadcast.
Statecharts

- Hierarchy

A has two sub-states: A1(initial), A2
B has two sub-states: B1, B2(initial)
Statecharts

- Orthogonality

**OR-state “C”: The system is either in A or B, but never in both.**

**AND-state Z: The system is in both X and Y**
Statechart Summary

Summary:

- Concise notation to describe complex reactive systems
- Easy to generate code from
- Standardized (UML)
Statechart Example

Traffic light behavior

- **NS**
  - **Preventing for green**
    - start NS /
  - **Red**
    - entry / start EW
    - after(5 secs) /
  - **Yellow**
    - after(30 secs) /
    - after(5 secs) /
  - **Green**
- **EW**
  - **Preventing for green**
    - start EW /
    - after(5 secs) /
  - **Red**
    - after(5 secs) / start NS
    - after(30 secs) /
    - after(5 secs) /
  - **Yellow**
    - after(30 secs) /