CSCI 1106
Lecture 9

Using State Transition Diagrams

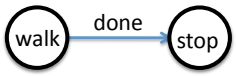
Announcements

- Today's Topics
  - States, transitions, and program blocks
  - Mapping state transition diagrams to programs
  - Discussion

Recall

States and Transitions

- State
  - Unique set of conditions
  - Describes a step of a task
  - Represented by a circle and a label
- Transition
  - Change of one or more conditions
  - Describes a change from one state to another
  - Represented by a labeled arc



Program Blocks

- Sense blocks

- Decide blocks


wait


loop

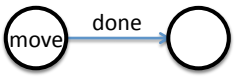

Switch (if)

- Action blocks

Translating State Transition Diagrams

- Problem:
  - We design our solution by creating a state transition diagram (STD)
  - We need to translate the STD into a program
- Idea: Divide and Conquer
  - Identify standard patterns in STD
  - Implement each pattern using one or more program blocks
- How do we identify the patterns?

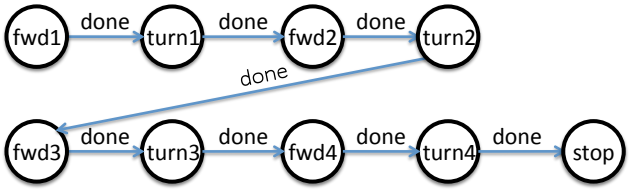
Standard Patterns

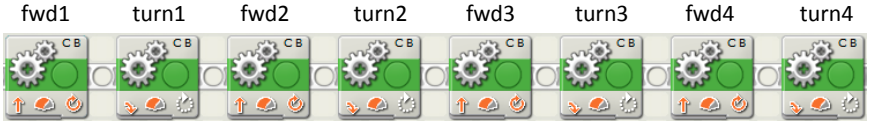
- Idea: We consider all the blocks and ask, what patterns do they implement?
- We start with simplest: Action Blocks
  - Synchronous Move: 

  - Asynchronous Move: 

  - Any other action will yield the same patterns

Example: Move in a Square

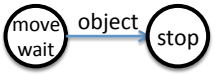




- The "stop" state is implicit in the program
- Transitions are triggered by internal events (action completions)
- The program can be shortened by using a loop

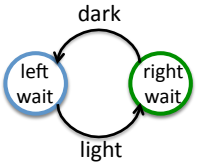
The Wait Block (Sense-Decide)

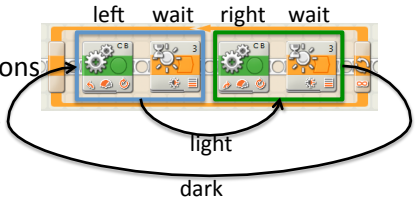
- The Wait block is used to represent a state and a transition due to an external event
- Use it after an asynchronous action
- Example: Move forward until an object is encountered
- Note: Only one transition can occur from an "action + wait" state.
  - Why?
  - Why would this be inadequate?
  - How do we get around this?



The Loop Block

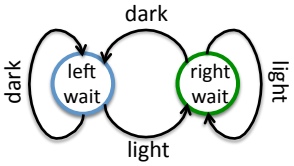
- The Loop Block is used to implement loop structures in a STD
- The loop allows us to repeat a state
- Easy if you have only one cycle
  - Even if more than two states
- Questions:
  - What if you have multiple cycles?
  - What if you have multiple transitions from states?
- Answer: Bring out the "big guns"
  - The Switch (if) Block

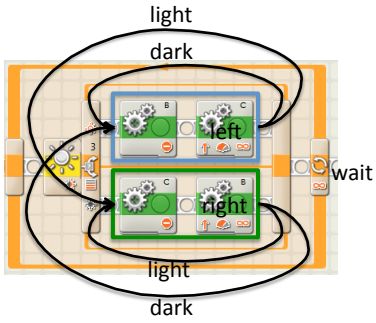




The Switch (If) Block

- Recall the definition of a *state …*
- Idea: Use a loop and switch blocks to implement multiple states and cycles
- Example: Follow the line
- Questions:
  - Where is the "wait"?



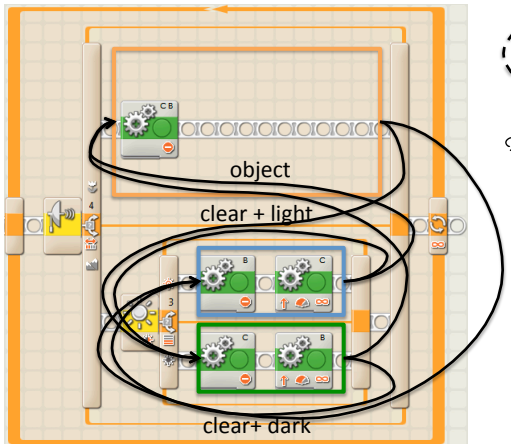


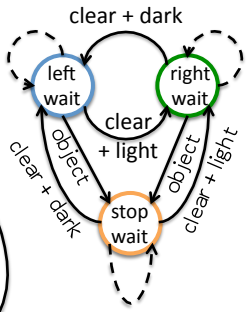
The True Meaning of State

- Observations:
  - A state is defined by a set of conditions
  - A switch (if) block can be used to test for conditions
- Idea: Use switch blocks to test what state the system is in each time through the loop

Example: Follow but Stop

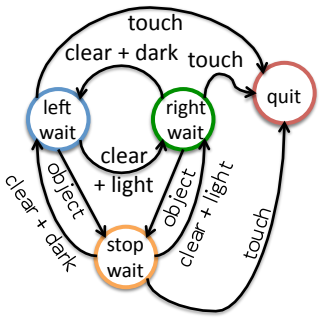
- Follow the line but pause for objects in the way





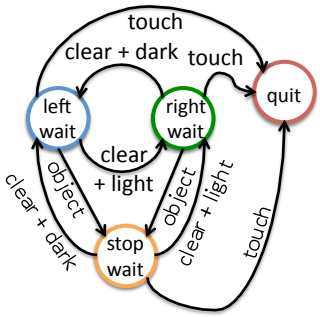
More Complexity

- Suppose we wanted add another constraint:
  - Stop and quit if rear touch sensor is activated
- Our STD gets another state
- The program becomes even more complex
- How do we change the program?



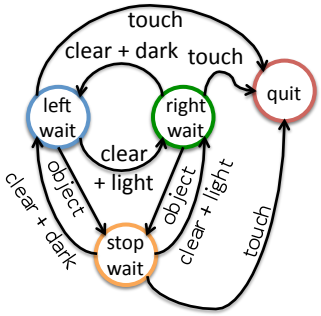
Options for Implementing the Changes

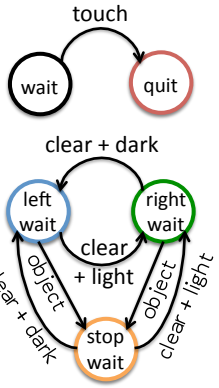
- Add another Switch Statement
  - Standard, but adds complexity
- Change loop condition
  - STD is still complex
- Use multiple threads and simplify the STD
  - Two simple STDs are easier to implement than one complex STD



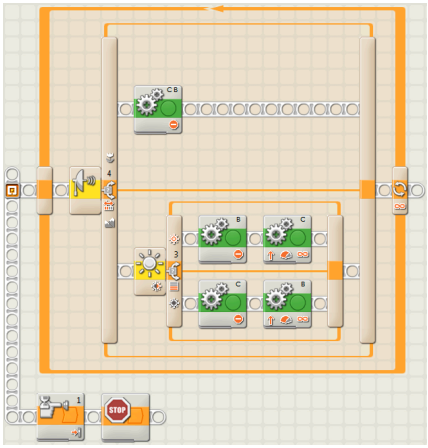
Simplifying the STD

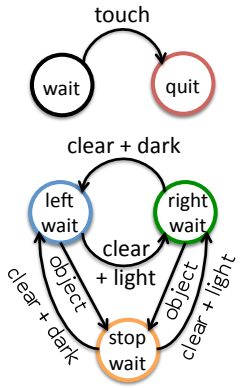
- Break one STD into two
- Use one thread per STD





The Resulting Program





Discussion

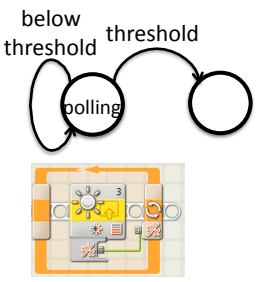
- Can an STD or program always be split into multiple threads?
  - Why or why not?
- How can we ensure that the threads do not interfere with each other?
- Can "Wait" blocks be used inside Switch blocks?
- What are sensor blocks for?

Why Do We Need Sensor Blocks?

- Viewing the measurements that a sensor is reporting when debugging a program
- Keeping track of previous measurements to compare against future measurements
  - E.g., Finding a minimum/maximum measurement
- Creating multiconditional Wait blocks

Multiconditional Wait Blocks

- A Wait block polls a sensor until a threshold is reached



- Idea: Combine measurements from multiple sensors