CMSC 330: Organization of Programming Languages

Project 6
Multithreaded Metro Simulation

Goal

1. Implement multithreaded simulation in Ruby
   • Separate threads for trains, passengers
   • Monitors to avoid data races
   • Conditions to efficiently acquire locks

2. Implement simulation verifier in Ruby
   • Examine log file of simulation
   • Determine whether simulation output is feasible

Metro Simulation

- You are given
  • List of metro lines & stations on each line
  • List of passengers & their stops
  • Locks & condition variables for each metro line

- You need to simulate
  • Trains
  • Passengers

Simulation Rules

- Trains
  • Start by entering 1st station in metro line
  • Travel back and forth between 1st and last station
    ➢ Stopping at all metro stations on line in order
  • For each metro line
    ➢ May have multiple trains
    ➢ Only one train in station at a time (regardless of travel direction)
      • Trains from different metro lines may be at station
Simulation Rules

- Passengers
  - Start at 1st station on list of stops
  - Board & leave trains only when train is at station
  - Possible to miss train
    - Take future train
  - May board trains going in either direction
  - May change metro lines
    - If multiple lines at station

Metro Simulation

- Multithreading
  - One thread per train
  - One thread per passenger

- Synchronization
  - One lock per metro line
  - 2 condition variables for each lock
    - One for trains, one for passengers
    - Must use for efficient synchronization

Simulation Output

- Output format
  - Train <color, #> entering <station>
  - Train <color, #> leaving <station>
  - <Passenger> boarding train <color, #> at <station>
  - <Passenger> leaving train <color, #> at <station>

Simulation Output

- Example
  - Train Green 1 leaving Fort Totten
  - Train Blue 1 entering L'Enfant Plaza
  - Train Red 1 entering Fort Totten
  - Train Yellow 1 entering Pentagon
  - Paul boarding train Yellow 1 at Pentagon
  - Train Green 1 entering Gallery Place
  - Train Red 1 leaving Fort Totten
  - Train Blue 1 leaving L'Enfant Plaza
  - Train Yellow 1 leaving Pentagon
  - Train Green 1 leaving Gallery Place
Simulation Verifier

- Analyze simulation output for feasibility
  - Trains start at their initial station
  - Trains move forward and backward along metro line
  - Trains enter a station before they leave it
  - Only a single train at station from each metro line
  - Passengers follow their path as given in input
  - Passengers only board & leave when train at station
  - Passengers reach their destinations