

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