Distributed Simulation

Optimistic Algorithm

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Please read over Assignment 5 System Requirements document (which accompanies this report) first to gain understanding of program overview.

# Algorithms

An optimistic algorithm is a distributed simulation executive algorithm which describes the behavior of continuously processing events (i.e., not waiting for all processes to send messages (msgs) before processing). Therefore, if a msg is received (recv’d) with time less than current simulation time, then rollback will have to occur. Rollback is a correction mechanism for reversing time. During rollback, executed events will be reversed until event with timestamp less than recv’d time is found. During the reversal of events, to account for events scheduling new events, anti-msgs will be created and sent. Anti-msgs eliminate scheduled future events and rollback executed events.

To create the optimistic algorithm, the following must be done:

* The ability to send and recv anti-msgs
* The ability to rollback when events from the pasted are recv’d

The following subsections will discuss these tasks.

## Anti-msg Management

Anti-msgs will be events that are send and scheduled to processes to cancel scheduled events or rollback events executed. Now, to do this, there are three tasks to complete:

1. How to determine the where, what, and when
   1. Where to send?
   2. What event-action anti-msg associated with?
   3. When is the event?
2. How to send anti-msgs
   1. When event is rollbacked, how do we tell sim-exec to schedule anti-msgs?
3. What to do when anti-msg is recv’d/scheduled?

The solutions to the first two tasks are to associate event scheduling relative to event-action class itself instead of sim-exec. I.e., if an event schedules another event, it will use event-action’s event scheduler instead of sim-exec’s. What the event-action does differently than sim-exec is during scheduling, the event-action will save the event scheduled (process sent too, time of event, and event random identifier) then schedule the event with sim-exec. Doing this will allow the event-action (EA) when rollbacked over to send anti-msgs via a send anti-msg method. Therefore, anti-msgs are sent when EAs are rollback on.

The random event identifier is used to consider simultaneous events. Every new EA created on the process will be associated with random ID. Therefore, when anti-msgs are sent and events with same time are found, the anti-msg knows exactly what event to remove or rollback. To do this, I am assuming for two events to have same random number and same event time is extremely low. Also, random numbers will be created by each process where each process will have different seed (decreasing the probability even further).

To consider non-rollback event deletion (e.g., global virtual time deletion), a global Boolean rollback variable will be used. The variable indicates whether the system is undergoing rollback or if the system is just deleting events. This variable will be used in destructor process.

The following is pseudocode for scheduling events and the destructor which sends events:

*EA::ScheduleEvent(event time (et), new EA (ea), process):*

*Save scheduled event information to anti-msg list (ea’s event id, process, and et)*

*SimExec::ScheduleEvent(et, ea, process)*

*End ScheduleEvent*

*EA::SendAntiMsg ():*

*If rollback:*

*Foreach anti-msg in anti-msg list:*

*If anti-msg == current simulation time AND anti-msg is associated w/this process:*

*Check with sim-exec’s event-set for simultaneous events*

*if simultaneous, eliminate event*

*else if NOT (anti-msg < current simulation time AND anti-msg == this process):*

*Schedule anti-msg - SimExec::scheduleEvent(anti-msg)*

*Else:*

*Remove all anti-msg from anti-msg list*

*END Destructor*

With the design for producing and sending anti-msgs is done, the next task is to determine what to do with anti-msgs when scheduled or recv’d. Now, there is a distinguishment between scheduling and recv’ing anti-msgs. Recv’ing is the process of processing anti-msgs so to determine if event associated with anti-msg was executed or scheduled into the future. If executed, then rollback will be conducted so to undo event.

## Rollback

Anti-msgs will be events that are send and scheduled to processes to cancel scheduled events or rollback events executed. Now, to do this, there are two tasks to complete:

1. How to determine the where, what, and when
   1. Where to send?
   2. What event-action anti-msg associated with?
   3. When is the event?
2. How to send anti-msgs
   1. When event is rollbacked, how do we tell sim-exec to schedule anti-msgs?

The solutions to these tasks are to associate event scheduling relative to event-action class itself instead of sim-exec. I.e., if an event schedules another event, it will use event-action’s event scheduler instead of sim-exec’s. What the event-action does differently than sim-exec is during scheduling, the event-action will save the event scheduled (process sent too, time of event, and event random identifier) then schedule the event with sim-exec. Doing this will allow the event-action (EA) when destroyed (destructor) to send anti-msgs. Therefore, anti-msgs are sent when EAs are rollback on (deleted/destroyed).

The random event identifier is used to consider simultaneous events. Every new EA created on the process will be associated with random ID. Therefore, when anti-msgs are sent and events with same time are found, the anti-msg knows exactly what event to remove or rollback. To do this, I am assuming for two events to have same random number and same event time is extremely low. Also, random numbers will be created by each process where each process will have different seed (decreasing the probability even further).

Lastly, to consider non-rollback event deletion (e.g., global virtual time deletion), a global Boolean rollback variable will be used. The variable indicates whether the system is undergoing rollback or if the system is just deleting events. This variable will be used in destructor process.

The following is pseudocode for scheduling events and the destructor which sends events:

*EA::ScheduleEvent(event time (et), new EA (ea), process):*

*Save scheduled event information to anti-msg list (ea’s event id, process, and et)*

*SimExec::ScheduleEvent(et, ea, process)*

*End ScheduleEvent*

*EA::Destructor():*

*If rollback:*

*Foreach anti-msg in anti-msg list:*

*If anti-msg == current simulation time AND anti-msg is associated w/this process:*

*Check with sim-exec’s event-set for simultaneous events*

*if simultaneous, eliminate event*

*else if NOT (anti-msg < current simulation time AND anti-msg == this process):*

*Schedule anti-msg - SimExec::scheduleEvent(anti-msg)*

*Else:*

*Remove all anti-msg from anti-msg list*

*END Destructor*

# Results