Lecture 23: Parallel Discrete-event Simulation

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Announcements

- Project demos: May 6 and 11
- Final project due on: May 13 11:59 pm AoE
Summary of last lecture

• \( n \)-body problem: gravitational forces on celestial bodies

• Several parallel algorithms:
  
  • Barnes-Hut
  
  • Fast Multipole Method
  
  • Particle Mesh
  
  • P3M

• Simulation codes: FLASH, Cello, ChaNGa, PKDGRAV
Discrete-event simulation

- Modeling a system in terms of events that happen at discrete points in time
- Either model discrete sequence of events
- Or model time-stepped sequences
- Simulation typically involves system state, event list and a global time variable
Parallel discrete-event simulation

• Divide the events to be simulated among processes
• Send messages wherever there are causality relationships between events
• Synchronize global clock periodically
Conservative vs. optimistic simulation

- **Conservaties DES**
  - Do not allow any causality errors

- **Optimistic DES**
  - Allow causality errors and rollback if needed
Trace-driven network simulation

- Task is started at time $t_s$
- Possible remote messages to other PEs
  - Kick off other tasks that depend on a message
- Completion event scheduled for time $t_s + t_e$
Running TraceR in optimistic mode

- Record extra information during forward execution to enable rollback later
  - List of tasks triggered by a message recv or completion event
- Implement reverse handlers for each event
Epidemiology simulations

- Agent-based modeling to simulate epidemic diffusion
- Models agents (people) and interactions between them
- People interact when they visit the same location at the same time
- These “interactions” between pairs of people are represented as “visits” to locations
- A bi-partite graph of people and locations is used
EpiSimdemics: Parallel implementation

- All the people and locations are distributed among all processes
- Computation can be done locally in parallel
- Communication when sending visit and infection messages
- Uses Charm++, a message-driven model
Questions?

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