An Asynchronous Synchronization Strategy for Parallel Large-scale Agent-based Traffic Simulations

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Abstract:
Large-scale agent-based traffic simulation is a promising tool to study the road traffic and help solving traffic problems, such as congestion and high emission in megacities. Such simulation requires high computational resource which triggers the need for parallel computing. The parallelization of agent-based traffic simulations is generally performed by decomposing the simulation space into spatial subregions. The agent models contained by each subregion are executed by Logical Processes (LPs). As the simulated system evolves over the simulation time in individual LPs, synchronization among LPs is required due to data dependencies. Existing work has used global barriers for synchronization which is a type of synchronous synchronization method. However, global barriers have very low efficiency due to the waiting of processes at barriers. High synchronization overhead is still one of the major performance issues in parallel large-scale agent-based traffic simulations. In this paper, we proposed a novel asynchronous conservative synchronization strategy named Mutual Appointment (MA) to address this issue. MA removes global barriers and allows LPs to communicate individually. Since the efficiency of conservative synchronization relies on the lookahead of the simulated system, a heuristic was developed to increase the lookahead in agent-based traffic simulations. It takes advantage of the intrinsic uncertainties in traffic simulations. MA together with the lookahead heuristic forms the Relaxed Mutual Appointment (RMA) strategy. Its efficiency was investigated in the parallel agent-based traffic simulator SEMSim Traffic using real world traffic data. Experiment results showed that the MA strategy improved the
speed-up of the parallel simulation compared to the barrier method, and the RMA strategy further improved the MA strategy by reducing the number of synchronization messages significantly.

Stichworte:
agent-based traffic simulation, asynchronous conservative synchronization, relaxation, RP 5, TUM CREATE, CLUSTER B

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