18th European Workshop on AD

Checkpointing on Adjoint MPI Programs

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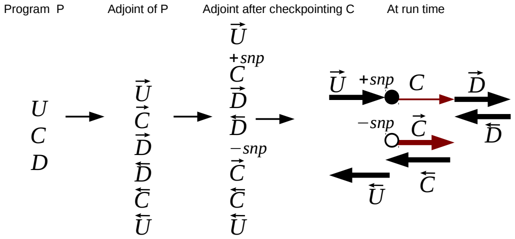
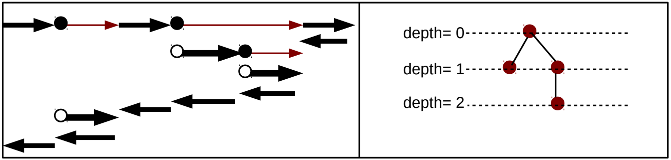
Checkpointing in the Store All context

- Select a piece of code "checkpointed piece"' and not store its intermediate values.
- Store only the values needed to reexecute the checkpointed piece later (a “snapshot”)
- The checkpointed piece is executed again, storing the intermediate values



Checkpointing serial adjoint programs

- The checkpointed piece of source code may correspond at run time to several checkpointed intervals of execution "checkpoints".
- At run time, the nested structure of checkpoints form a tree.



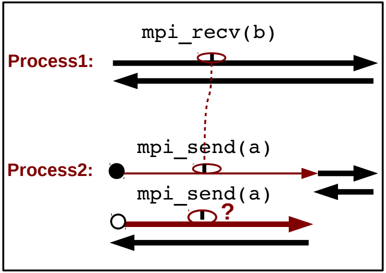
Checkpointing adjoint MPI programs (point-to-point communications)

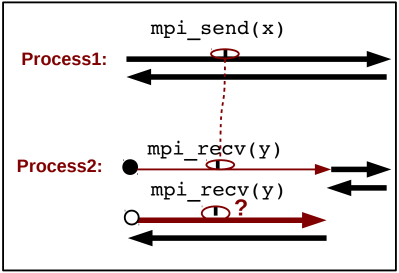
- Communications restrict application of Checkpointing
- Popular approach: checkpoining only occurs at a level that **encompasses** the level where communication takes place. In particular:

- Both ends of each communication must be checkpointed in the same way.
- Non blocking routines (e.g. isend) and their waits must be checkpointed together.

Popular MPI checkpointing is not general

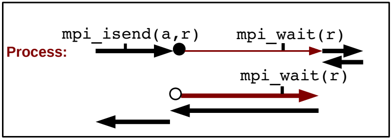
If only one end of a point-to-point communication is checkpointed, the resulting code fails.

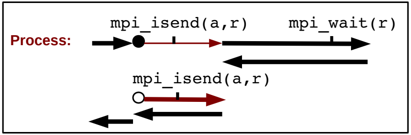




Another problem: nonblocking communications

If the non blocking routine doesn’t belong to the same checkpoint as its wait, the resulting code fails





⇒ Need to lift this restriction

Checkpointing Adjoint MPI Programs: "Memo technique"

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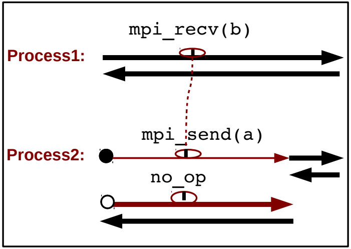
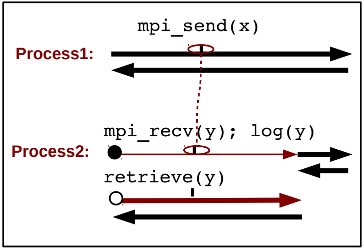
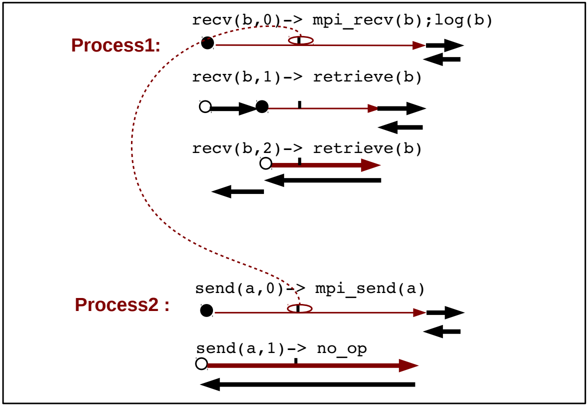
Checkpointing Adjoint MPI Programs: Memo technique

- mpi_recv log their received values. Same thing for the mpi_wait of a mpi_irecv
- Repeated mpi_send are disabled. Same thing for mpi_isend, mpi_irecv and mpi_wait of a mpi_isend
- Repeated mpi_recv are replaced by a read of the logged value. Same thing for the mpi_wait of mpi_irecv





What if nested checkpoints?



Discussion on the memo technique

The memo technique:

- Changes the behavior of communication calls
- Requires adaptation of the checkpoint mechanism: the logged values (conceptually a part of the snapshot) do not follow the stack order.
- Has no specific conditions in the choice of the checkpoints.
- Lets each process be checkpointed independently from other process.

Memory issues

- Logging values uses memory
- Messages are often larges
- Non-stack structure prevents memory reuse

⇒ The memo technique is general, but memory-costly

Re-sending

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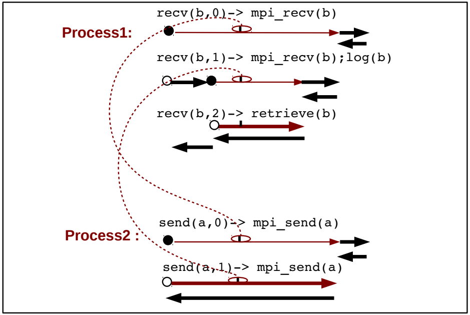
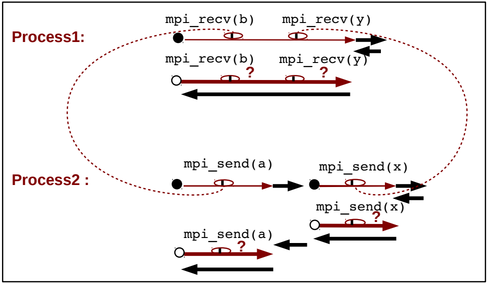
Re-sending

- Repeat communications whenever possible ⇒ this reduces logging size.
- The 2 ends of a repeated communication must be at the same checkpointing level.



When is resending possible?

- If the “re-send” communication is non-blocking, its wait must belong to the same checkpoint level.
- Defining checkpoints as “paired” the checkpoints that contain the 2 ends of a “resend” communication, one checkpoint in a process cannot be paired with two checkpoints in another.



Future work

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Future work

- Proof of correction
- Implementation in Tapenade and AMPI.
- Experiments on real codes

Acknowledgements

This work has been conducted within the **About Flow** project on "Adjoint-based optimisation of industrial and unsteady flows".

`http://aboutflow.sems.qmul.ac.uk`

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