Remedies for Reproducibility Issue in Conjugate Gradient Solvers

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Reproducibility issues in CG

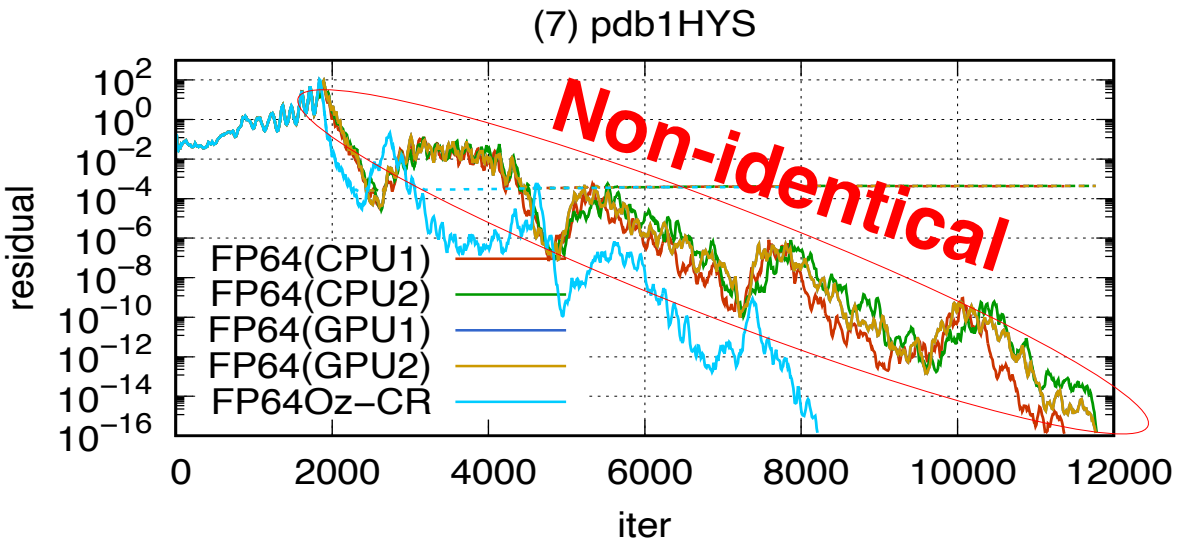
- Sparse solvers often return slightly different results in different computer systems due to rounding errors
- The major reason is that DOT and SpMV can be computed in a different order in parallel computation

Why reproducibility is needed?

- Scientific discussion and quality assurance of industrial applications; reproduction of result on different environments and by third party
- Code-porting for new system and debugging

Our poster

- Discuss remedies for the reproducibility issue in sparse solvers, introducing several approaches from our project



Non-reproducible convergence in CG

- CPU1: XeonGold6126, CPU2: XeonPhi7250
- GPU1: TeslaV100, GPU2: TeslaP100

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- **Remedies from our projects:**

1. Infinite-precision operations

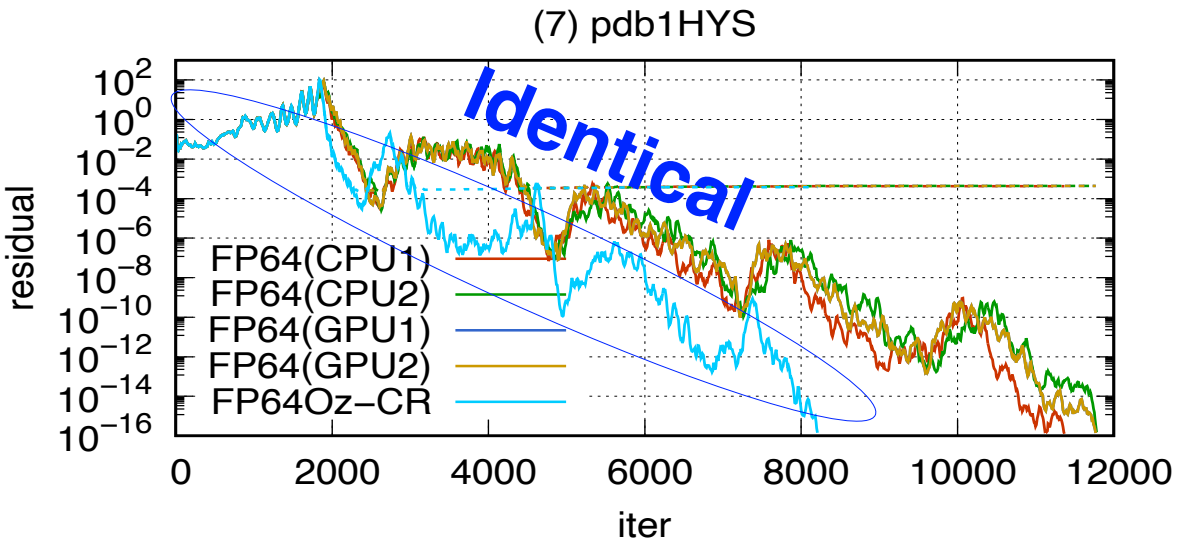
- Bit-wise reproducibility is ensured
- OzBLAS with Ozaki scheme + NearSum

2. Accurate operations

- Possibility of reproducibility and number of reproducible digits are increased
- ExBLAS with floating-point expansion

3. Numerical validation

- The digits unaffected by rounding errors (which are considered reproducible) are evaluated probabilistically
- CADNA with Discrete Stochastic Arithmetic



Reproducible CG with OzBLAS

- CPU1: XeonGold6126, CPU2: XeonPhi7250
- GPU1: TeslaV100, GPU2: TeslaP100