Esoteric Pull and Esoteric Push: Two Simple In-Place Streaming Schemes for the Lattice Boltzmann Method on GPUs

——D3Q19在LBM方法上的stream方法

Naive Implementation—One-Step Pull and One-Step Push

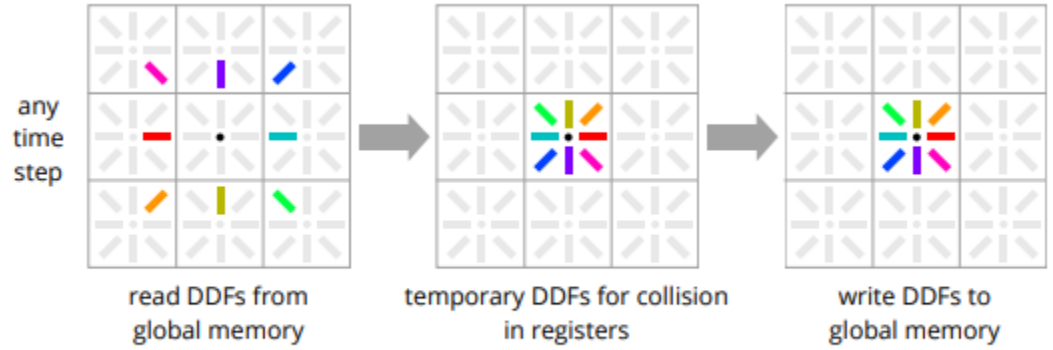

Figure 1. One-Step-Pull streaming scheme. Two copies of the DDFs are used to resolve data dependencies.

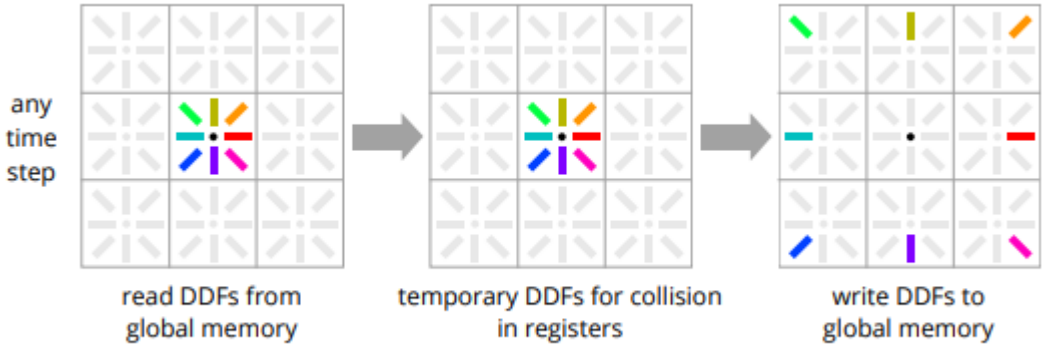

Figure 2. One-Step-Push streaming scheme. Two copies of the DDFs are used to resolve data dependencies.

Esoteric Twist

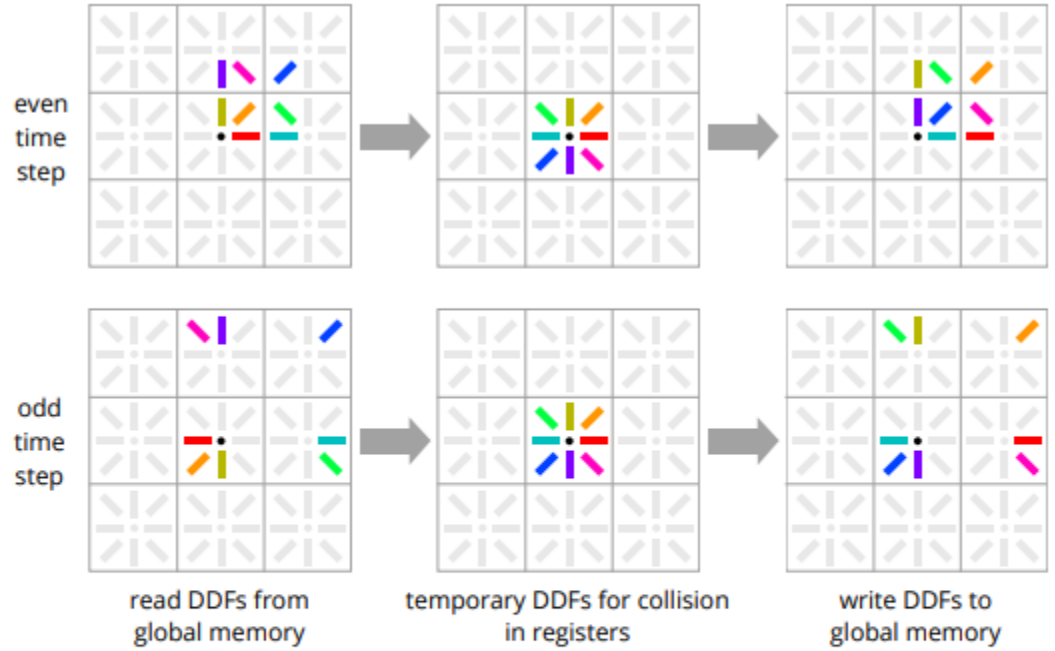

Figure 4. Esoteric Twist in-place streaming scheme [2]. Even time steps: DDFs are loaded in a criss-cross pattern shifted north-east by half a node. After collision, DDFs are stored in the same pattern but in opposite orientation. Odd time steps: DDFs are loaded in opposite orientation in a shifted criss-cross pattern that covers only DDFs not touched in the even time step. After collision, DDFs are written back in the same pattern but with regular orientation once again. DDFs are always stored in the same memory locations where they were loaded from, so only one copy of the DDFs is required.

Esoteric Pull and Esoteric Push

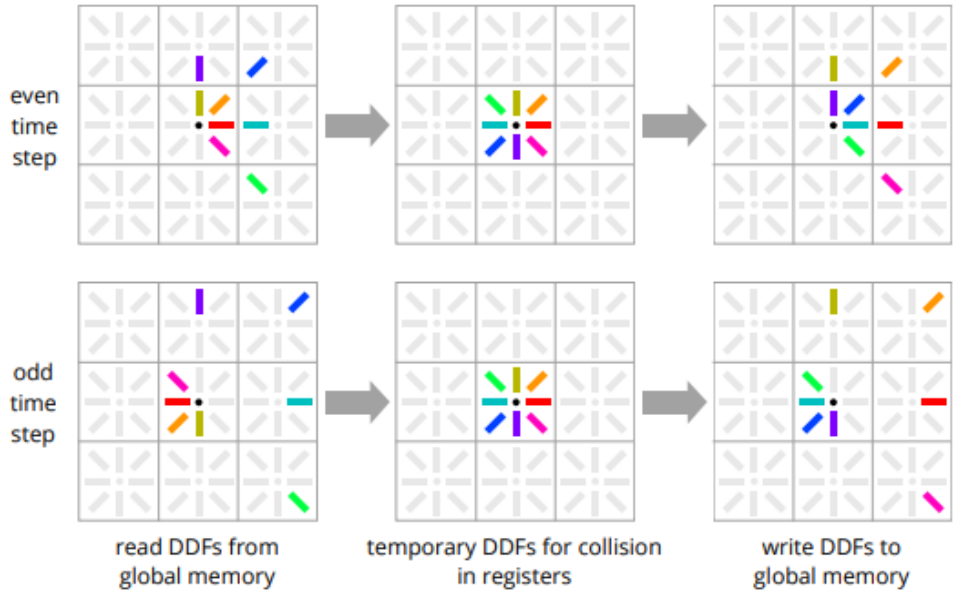

Figure 5. Esoteric Pull in-place streaming scheme. Even time steps: DDFs in positive directions are loaded from the center node, and DDFs from negative directions are pulled in from their regular streaming direction neighbors and are collided. Then, DDFs in positive directions are pushed out to neighbors and stored in opposite orientation, and DDFs in negative directions are stored at the center node in opposite orientation. Odd time steps: DDFs in positive directions are loaded from the center node in opposite orientation, and DDFs from negative directions are pulled in from their regular streaming direction neighbors in opposite orientation and are collided. Then, DDFs in positive directions are pushed out to neighbors, and DDFs in negative directions are stored at the center node. DDFs are always stored in the same memory locations where they were loaded from, so only one copy of the DDFs is required.

不同

- Esoteric Twist：拉负，推正，移动的十字交叉模式，类似于向东北移动半个节点的交叉访问模式

- Esoteric Pull and Esoteric Push：拉负向的一半部分，推正向的一半部分，邻近的常规流，使用规则流方向确定邻居节点