

Algebraic tiling facing loop skewing

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Impact 2024
January 17th, 2024

Algebraic Loop Tiling

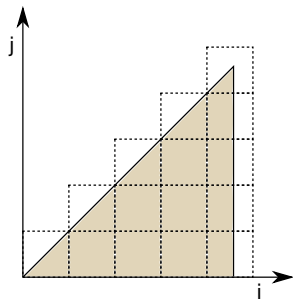
Loop tiling is powerful & well-known loop optimising transformation

- to improve data locality
- to adjust the grain of parallelism

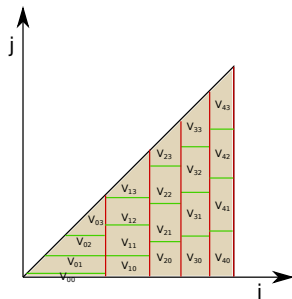
Last year we introduced algebraic loop tiling:

- Dynamic tiles of quasi-equal volume
- To address load-balancing among threads

Example



Rectangularly tiled triangle domain

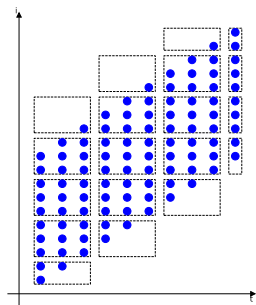


Algebraically tiled triangle domain

Issues when facing skewing

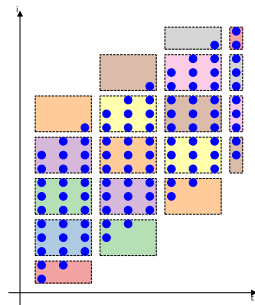
- No problem when handling sequential programs
- Some kernels need a last transformation over tiles to exhibit a parallel dimension.
 - Leads to an incorrect program when using algebraic tiling

Rectangular tiling parallelization



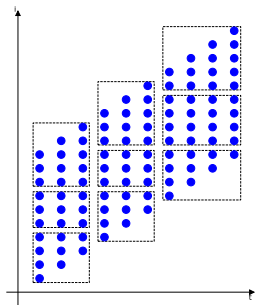
Standard tiled domain of
seidel-2d

$$(t_0 + t_1, t_1)$$

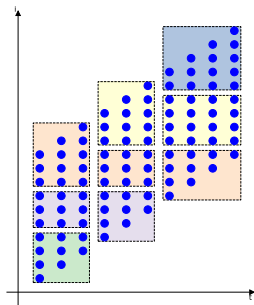


Parallel tiles of seidel-2d
after tile skewing. Same
color means concurrent

Algebraic tiling parallelization

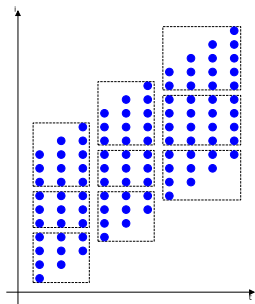


Algebraically tiled domain of
seidel-2d

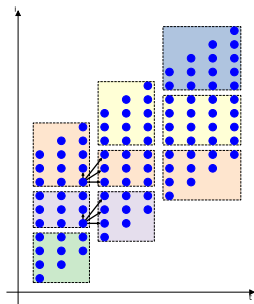


Invalid tile skewing of seidel-2d
Same color means concurrent

Algebraic tiling parallelization

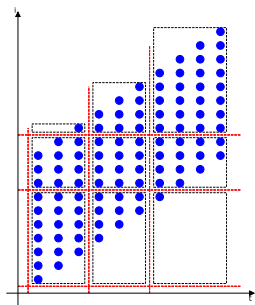


Algebraically tiled domain of
seidel-2d

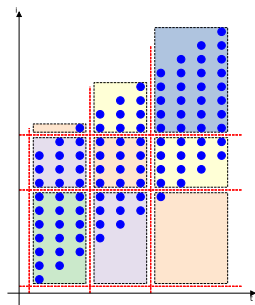


Invalid tile skewing of seidel-2d
Same color means concurrent

Our solution

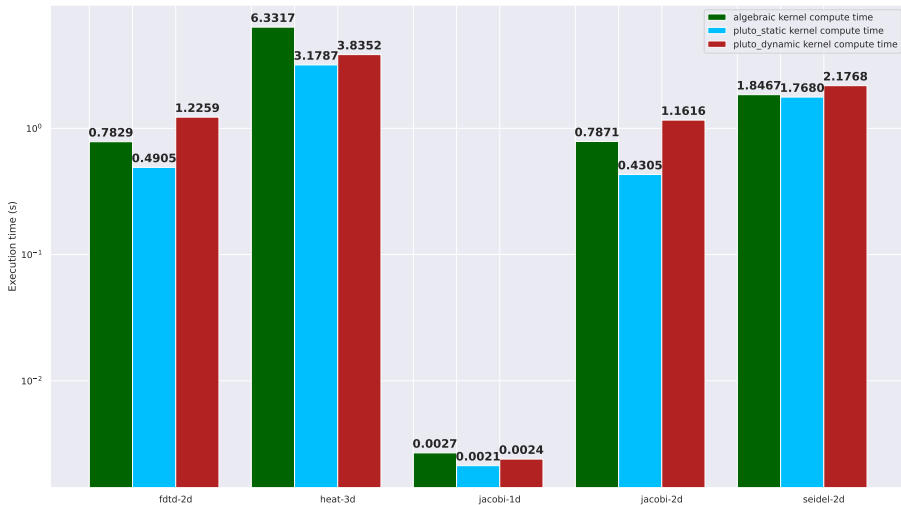


Algebraically tiled domain of
seidel-2d

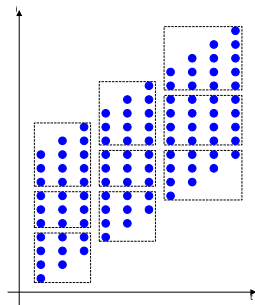


Valid tile skewing of seidel-2d
Same color means concurrent

Results



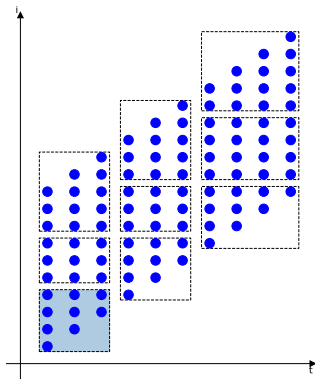
Performance of algebraic tiling vs standard tiling (lower is better).



Algebraically tiled iteration
domain of seidel-2d

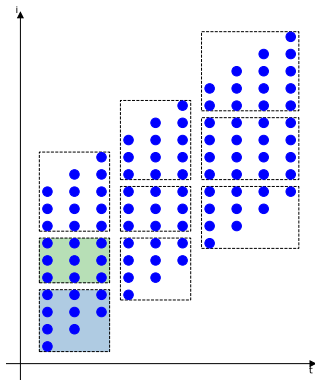
- Precompute all tile bounds
- Build a tile schedule at runtime

Algebraic scheduling



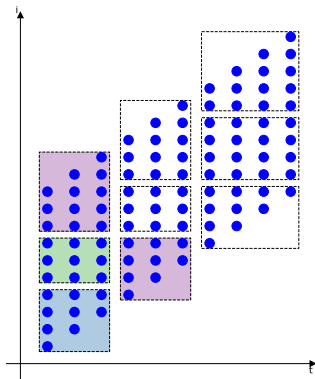
Build a valid schedule of algebraic tiles

Algebraic scheduling



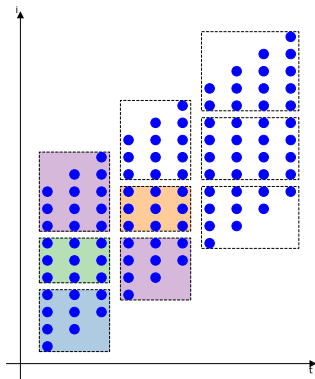
Build a valid schedule of algebraic tiles

Algebraic scheduling



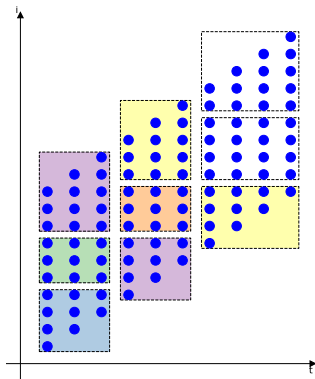
Build a valid schedule of algebraic tiles

Algebraic scheduling



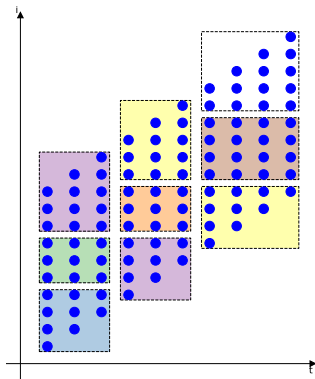
Build a valid schedule of algebraic tiles

Algebraic scheduling



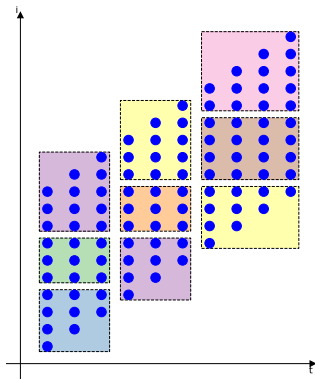
Build a valid schedule of algebraic tiles

Algebraic scheduling



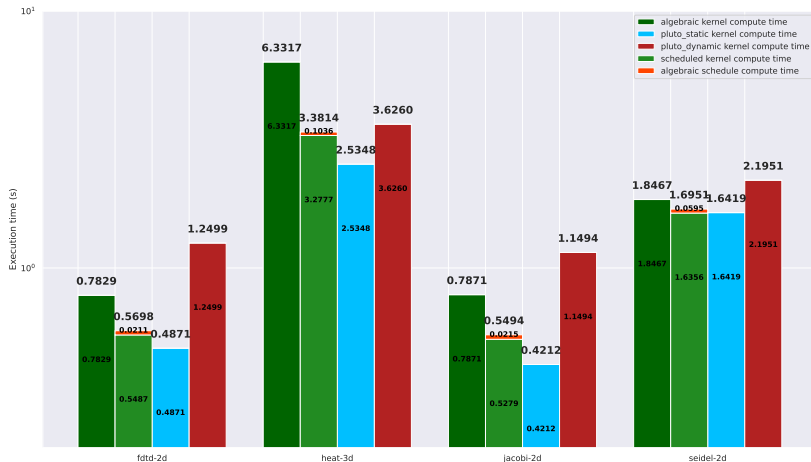
Build a valid schedule of algebraic tiles

Algebraic scheduling



Build a valid schedule of algebraic tiles

Algebraic scheduling performance



Performance of algebraic scheduling vs rectangular tiling (lower is better).

- We proposed a strategy to apply algebraic tiling when a skewing is required
- Valid program, but results are not satisfying
- New strategies should be investigated
- Algebraic scheduling seems promising
- Strategies similar to diamond tiling should be investigated

Thank you!